Informative Inventory Report

about Belgium’s annual submission of air emission data reported in February 2014 under the Convention on Long Range Transboundary Air Pollution CLRTAP

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Executive Summary

The Belgian Informative Inventory Report (IIR) is the descriptive report that accompanies the Belgian Emission inventory of air pollutants submitted by 15 February 2014 under the Convention on Long Range Transboundary Air Pollution (CLRTAP) of the United Nations Economic Commission for Europe (UNECE).

This report follows the recommended structure for Informative Inventory Report (Annex VI to the Guidelines). It provides background information on institutional arrangements for inventory preparation, methodologies, data sources, emission factors used, QA/QC activities, key source analyses, trend analyses, recalculations and improvement plans. Furthermore, for each sector more detail is given on the methodologies and assumptions made for estimating the Belgian air emissions. The improvement of the IIR is a work in progress. This year, more information on heavy metals and POPs is added in the sectorial chapters.

The emission data presented in this report were compiled according to the recommendations of the Guidelines for Estimating and Reporting Emission Data under CLRTAP (ECE/EB.AIR/97) revised in 2009. For the reporting, the NFR09 templates provided by the EMEP Centre on Emission Inventories and Projections[1] were used. The submission of 2014 contains emissions and activity data for the whole time series from1990 to 2011 (recalculated) and 2012 (first reporting). Also emission projections for 2015, 2020 and 2030 are provided. The 2014 submission includes emission data of the pollutants covered in the Convention and its Protocols. These are the main pollutants ($NO_{x,}$ $SO_{x,}$ NMVOC, NH_3, CO), particulate matter (PM2,5, PM10 and TSP), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn) and persistent organic pollutants (POPs – PCDD/PCDF, PAHs, HCB, HCH, PCB).

The transport emissions reported are based on fuels used. These emissions will be used for compliance checking in accordance with the EMEP reporting guidance. Reporting of emissions based on fuels sold should be tuned between the 3 regions and is one of the business matters of the ad hoc Technical Group on Transport of the Working Group 'Emissions' of the Coordination Committee for International Environmental Policy (CCIEP). Belgium is aware of the need to report emissions based on fuels sold in addition to the reporting of emissions based on fuels used. Therefore, it is one of the priorities of the Technical Group to reach a solid solution, which is consistent for all regions.

The national totals of the LRTAP emissions slightly differ from the totals as reported under the UNFCCC reporting of greenhouse gases. This is due to the fact that the UNFCCC excludes international aviation and includes domestic and cruise activities from civil aviation, whereas the latter is a memo-item in the LRTAP inventory. The national total reported under the UNFCCC is calculated as followed:

UNFCCC total = LRTAP total - international aviation (LTO) + Civil aviation (Domestic Cruise)

For NMVOC, emissions of grassland and forests (NFR 7B) are also included in the UNFCCC total, but are not included in the LRTAP total (memo-item).

<u>Main differences from last submission - recalculations</u>

- To continue the quality improvement, the notation keys for the NEC pollutants (NO_x, NMVOC, SO_x and NH_3) and the other LRTAP pollutants (CO, particulate matter, heavy metals, POPs) have been revised. Special attention was given to reduce the use of 'NE'.

[1] www.ceip.at

- For the road transport sector, great efforts are made on the harmonisation of modelling between the three regions. A common fleet module and the same module for the assignment of mobility are now used as input for the COPERT4 v10.0 model applied in the three regions. The emissions of PCBs are included in the data reporting.

- As a result of the In country review in September 2012 of the GES Belgium inventory and to be coherent with this GES inventory, the off road emissions of the following sectors are now allocated as follows:
    - Industry and building in 1A2fii
    - Airports, harbours, trans-shipment companies in 1A3e (formerly in 1A4aii)
    - Households in 1A4bii
    - Forestry and green area in 1A4cii
    - Defence in 1A5b

- The wood consumption from the residential sector was updated on the base of the Eurostat survey. The Tier 1 emission factors of the EMEP/EEA emission inventory guidebook 2013 were used in the 3 regions.

Plans for improvement

In spite of the intensive work that is already carried out and is still going on to improve estimates of air emissions in Belgium, it remains a continuous task of all members involved to improve the quality of emission inventories. The tuning and information exchange between the regions is taken care of in the bosom of the CCIEP Working Group 'Emissions'. Additional to the 'routine' consultation moments concerning the practical harmonisation of emission calculations between the regions, emphasis is laid on the reduction of the notation key 'NE'.

As is mentioned above, it is one of the priorities of the CCIEP ad hoc Technical Group on Transport to reach a solid and region-consistent solution for the calculation issues related to fuels used versus fuels sold.

It was decided within the CCIEP Working Group 'Emissions' to start a study in the three regions on the calculation of uncertainty values related to the emissions reported for NEC and LRTAP The results of this study will be available at the end of this year.

Chapter 1. Introduction

1.1. National inventory background

The increasing problems of transboundary air pollution led to the signature of the Convention on Long Range Transboundary Air Pollution (CLRTAP) by the United Nations Economic Commission for Europe (UNECE). This Convention was adopted in November 1979 in Geneva and is ratified by Belgium in July 1982. The Convention came into force in March 1983.

The CLRTAP, together with the 8 Protocols that followed, is a framework for international scientific collaboration and policy negotiation to combat air pollution including long range transboundary air pollution. The 51 member parties to the CLRTAP commit themselves to develop policies and strategies to reduce air pollutants which threaten human health and ecosystems. The different Protocols that followed the Convention aim at the reduction of specific pollutants like SO_x, heavy metals, POPs, and emissions leading to acidification, eutrophication and ground level ozone. Table 1.1 gives an overview of the ratification status of Belgium to the Convention and its Protocols.

Table 1.1 Belgian ratification status on the CLRTAP and its Protocols

Convention on Long Range Transboundary Air Pollution	**Signature**	**Ratification**
1979 CLRTAP	13/11/1979	15/07/1982
Protocol	**Signature**	**Ratification**
1984 EMEP Protocol	25/02/1985	5/08/1987
1985 Sulphur Protocol	9/07/1985	9/06/1989
1988 NO_x Protocol	1/11/1988	31/10/2000
1991 VOC Protocol	19/11/1991	31/10/2000
1994 Sulphur Protocol	14/06/1994	31/10/2000
1998 POP Protocol	24/06/1998	8/06/2005
1998 Heavy Metals Protocol	24/06/1998	25/05/2006
1999 Gothenburg Protocol	4/02/2000	13/09/2007

In order to fulfil the obligations of the Protocols under the Convention, annual reporting of emission data to the Executive Body of the Convention on Long Range Transboundary Air Pollution is required.

The Belgian national emission data reported under CLRTAP are established using the Guidelines for Estimating and Reporting Emission Data under CLRTAP (ECE/EB.AIR/97). The Nomenclature For Reporting (NFR09) was used as template for the reporting. The submission of the Belgian emission inventory under CLRTAP of 2014 contains emission and activity data of the years 1990 to 2012.

Currently a new datawarehouse is developed in the Flemish region. This will lead to an improvement in consistency and completeness of the whole time series of the national inventory. The Belgian inventory contains emission estimates for NO_x, SO_x, NMVOC, NH_3, CO, particulate matter (PM2,5, PM10, TSP), Heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn), dioxins, PAH, HCB,HCH and PCBs.

The key information needed to establish the emission inventories are energy balances (at regional level), national statistics, annual reports of industrial facilities, transport statistics, etc. For several sectors (in particular key sources) national or regional methodologies are developed to give the best emission estimates. Other methodologies and emission factors are taken from the EMEP/EEA Air Pollutant Emission Inventory Guidebook.

1.2. Institutional arrangements

In the Belgian federal context, major responsibilities related to environment lie with the regions. Compiling atmospheric emissions inventories is one of these responsibilities. Each region implements the necessary means to establish their own emission inventory in accordance with the EMEP/EEA Emission Inventory Guidebook. The emission inventories of the three regions are subsequently combined to compile the national atmospheric emission inventory. Since 1980, the three regions have been developing different methodologies (depending on various external factors) for compiling their atmospheric emission inventories. During the last years important efforts are made to harmonise these different methodologies, especially for the most important (key) sectors. Obviously, this requires some coordination to ensure the consistency of the data and the establishment of the national inventory. This coordination is one of the permanent tasks of the Working Group on ‘Emissions’ of the Coordination Committee for International Environmental Policy (CCIEP), where the different actors decide how the regional data will be aggregated to a national total, taking into account the specific characteristics and interests of each region as well as the available means. This working group consists of representatives of the 3 regions and of the federal public services. The Belgian Interregional Environment Agency (CELINE - IRCEL) is responsible for integrating the emission data from the inventories of the three regions and for compiling the national inventory.

The Inter-ministerial Conference for the Environment is one of the permanent working groups of the Concerted Action Committee and is composed of representatives of the several Belgian governments authorized for environmental matters. Decisions that have an impact on all regions are discussed and taken in consensus to guarantee a coherent Belgian policy.

Since environmental policy is a very specific matter, the federal estate and the 3 regions have entered into a cooperation treaty (5 April 1995, publication in the Belgian Law Gazette on 13 December 1995) on international environmental policy within the scope of the Inter-ministerial Conference for the Environment. A preliminary coordination prior to the Belgian position at international fora is necessary given the complexity of the Belgian competence distribution. The cooperation treaty provides for the establishment of the Coordination Committee of International Environmental Policy (CCIEP). The CCIEP is composed of representatives of the federal and the regional administrative departments and the governmental services with environmental competences. Consistent with the cooperation treaty and depending on particular needs, the CCIEP establishes expert working groups, with a specific mandate, e.g. to discuss and harmonise emission data. All matters related to the national emission inventory (compilation, harmonisation between the regions, information exchange,…) are discussed during regular meetings of the CCIEP Working Group on Emissions.

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

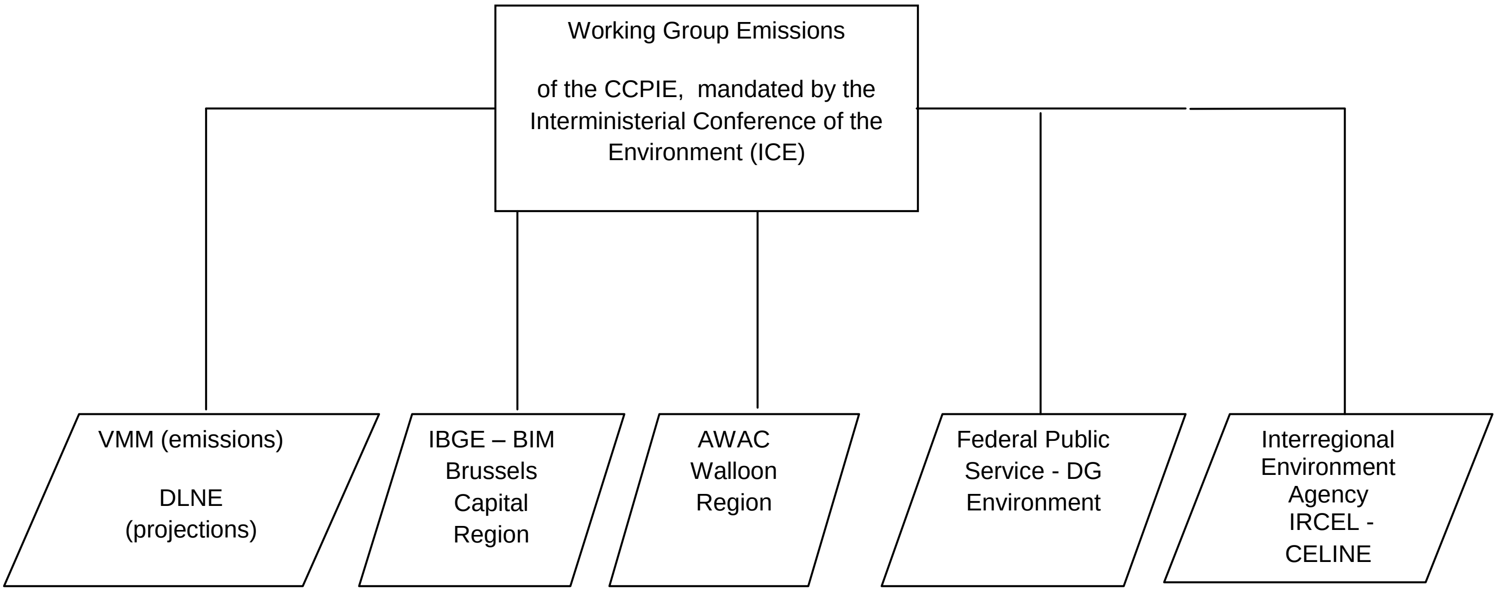


Figure 1.1 Overview of the entities responsible for the constitution and performance of the Belgian Inventory System

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

- The Department Air, Environment and Communication of the Flemish Environment Agency (VMM) in the Flemish Region (Flemish emissions) and Flemish Environment, Nature and Energy Department (DLNE) (Flemish projections);
- The Walloon Agency for Air and Climate (AWAC) in the Walloon Region;
- Brussels Environment (IBGE-BIM) in the Brussels Capital Region.

Each region has its own legal and institutional arrangements, which are detailed in the NIS (2010).

The institutions involved in the constitution (compilation and coordination) of the national emission inventory are:

- The Working group on Emissions of the Coordination Committee for International Environmental Policy (CCIEP) (referred to below as 'CCIEP-WG Emissions') plays a central role in the coordination of the national atmospheric emissions inventory.
- The Belgian Interregional Environment Agency (IRCEL-CELINE) is the single national entity with overall responsibility for the preparation of the Belgian atmospheric emissions inventory. IRCEL-CELINE operates as national compiler of the emissions inventories in Belgium.

1.3. *Inventory preparation process*

The regional atmospheric emissions inventories and projections are transmitted by 1 December (NEC pollutants) and by 1 February (all other pollutants for LRTAP reporting) in the shape of NFR-tables to IRCEL-CELINE, the national inventory compiler. IRCEL-CELINE compiles the three regional inventories into the national one, in the NFR09 template by 20 December (NEC) and by 10 February (LRTAP). This implies coordination with all regions, within the context of the CCIEP-WG Emissions. The compiled data are fed back to the regions for cross-check. After approval by the regions, the data are submitted to the EU Commission via the Permanent Representation of Belgium to the European Union by 31 December (upload to CDR with notification mail and officially sent to the EC) and to the UNFCCC secretariat by 15 February (upload to CDR with notification mail to the UNFCCC secretariat). An overview of the inventory preparation process in Belgium is given in fig. 1.2.

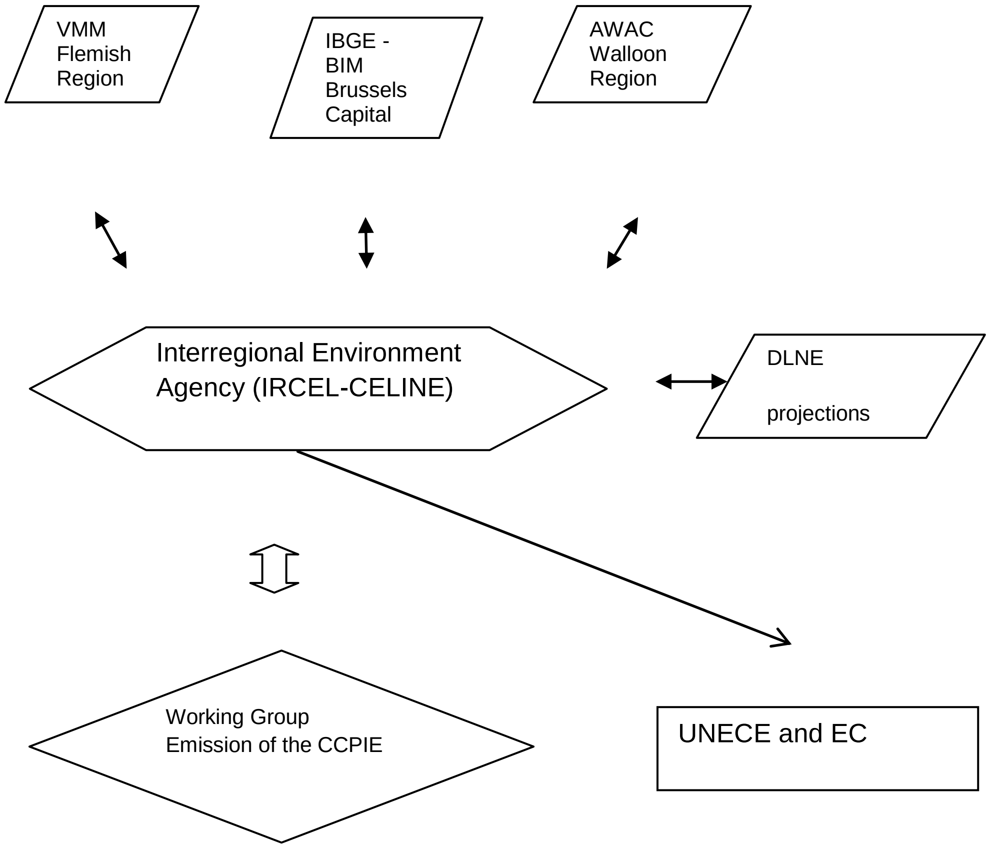


Figure 1.2 Overview of the inventory preparation process in Belgium

1.4. Methods and data sources

As a consequence of the responsibility of the regions in preparing the emission inventories, concomitant methodologies have been developed by the three regions for compiling their inventory from basic data. Where it is possible, the existing methodologies are tuned within the regions. When optimisation of a methodology or the development of new methodologies occur, the regions aim at the use of the same methods. This section describes per sector the general approach developed by each region. The text box gives some more specific detail on the data sources per region.

The emissions of the industrial sector (including the waste sector) are obtained from the annual industrial reports, submitted by the plant manager to the competent authorities. When this detailed information is not available, the emission data from this sector are based on calculations using the EMEP/EEA methodology or on plant specific emission factors (see also text box). Energy data are provided in the regional energy balances of Flanders, Wallonia and Brussels.

To have a total picture of all emissions by industrial activities, also activities with emissions below the threshold (see text box Flanders for more information) have also to be taken into account. These emissions are estimated in a collective way. The collective estimation of the emissions is done by multiplying the appropriate activity data with default emission factors.

A detailed description of the methodologies used in the energy and industrial sectors is given in Chapters 3 and 4.

Emissions by heating systems of buildings are calculated on a collective basis. A distinction is made between emissions due to residential combustion (heating by households) and tertiary combustion (heating by hotels/restaurants, medical services, education, offices and administrative activities, trade, other). Emissions are calculated by multiplying the energy use and emission factors. A more detailed description of the methodologies used can be found in 3.5.2.

The methodologies that are used to calculate transport emissions are described in 3.4. Emissions of road transport are calculated with a harmonized methodology between the 3 regions (based on COPERT IV v10.0). Air transport emissions are calculated by emission factors from the EMEP/EEA Guidebook or other internationally accepted emission factors. The emissions of railway traffic are estimated by a region specific approach. Flanders uses the EMMOSS model, whereas emissions in Wallonia and Brussels are calculated by multiplying the train's fuel consumption by fuel specific emission factors. Emissions from maritime navigation (only in Flanders) are calculated with the emission model EMMOSS.

Off-road emissions (except for agriculture) are calculated by the same mathematical model OFFREM (Off-road emission model) in the three regions. Emissions are calculated for machinery used in

Data sources per region

Flanders

Since the reporting year of 1993 most important industrial companies in the Flemish region in terms of air pollution are obliged to report annually about their emissions when exceeding a threshold value, as defined in Vlarem, the Flemish (regional) environmental legislation. From 2006 on this reporting obligation was harmonized in the Flemish region with the EPER-decision (2000/479/EC) and with the EPRTR-regulation (166/2006/EC). In total nearly 1000 industrial companies are registered in a database, due to this obliged emission reporting by the industrial companies. Mainly for the refineries, iron and steel sectors and the chemical industry (process emissions) this obliged reporting of emissions remains since that time an important source of information for the European and international reporting obligations.

Energy data are obtained from the Energy Balance for Flanders, made by the Flemish Institute for Technological Research (VITO, Vlaams Instituut voor Technologisch Onderzoek.)

Wallonia

The emission inventories of the Walloon region are compiled using the EMEP/EEA methodology. Emission factors used, are performed for all industrial sectors. In some cases as agriculture and forestry, the emissions estimates are based on a specific study reflecting the Walloon environment.

One main data source for the inventory preparation is the energy balance delivered yearly by the Energy and Sustainable Building Department. The energy balance describes the quantities of energy imported, produced, transformed and consumed in the Walloon Region in a given year. In 2003, an environmental integrated survey has been created which includes all pertinent environment-related reporting requirements for 300 companies. The environmental integrated survey is personalised to the 300 operators of the activities/installations pointed out by one or several regulations (four international Conventions and their protocols, seven European Directives, three European Regulations, two European Decisions, one European Recommendation, two Walloon laws, one Walloon Decree and several non- legally binding agreements).

Brussels

The emission inventory in the Brussels-Capital region is compiled by IBGE-BIM (the Brussels Institute for Environmental Management) using the EMEP/EEA methodology. The emissions are calculated by multiplying activity data by an emission factor. The activity data are mostly coming from the Energy Balance of the region performed annually by the ICEDD (Institut de Conseil et d'Etudes en Développement Durable).

The different sectors taken into account in the Brussels emissions inventory reflect the characteristics of a strict urban environment. Nearly all the emissions of this urban region originate from energy consumption (Residential, Commercial and Road Transport).

industry and building (category 1A2fii), for machinery used in defence (category 1A5b), in harbours, airports and trans-shipment companies (category 1A3e) , in households (category 1A4bii) and in forestry and green area (category 1A4cii). Exhaust emissions as well as non-exhaust emissions are calculated. Activity data as input for the model are activity data from the energy balance, statistics from harbours and airports, information about households and data on sales of machinery.

In Belgium the emissions of NMVOC in the source category 'Solvent and other product use' come from a number of subsectors. The regions in Belgium are using comparable methodologies to estimate the emissions of solvent and other product use in their region. The sector is discussed in detail in chapter 5.

The agricultural sector includes the emissions originating from animal manure, the use of synthetic N-fertilizer, N-excretion on pasture and from manure processing. The methodologies that are used to calculate the emission data are given in detail in Chapter 6. The main activity data are the livestock figures, N-excreted and amount of synthetic fertilizer use. In Flanders, the EMAV-model is used to calculate the emissions for the entire time series. In Wallonia, the emissions are calculated using a model developed by a consultant agency Siterem.

More detailed information on emissions due to fuel use in the agricultural sector is included in Chapter 3 Energy (3.5). Combustion emissions in the agricultural sector are calculated by multiplying the energy use (regional energy balances) and emission factors of the EMEP/EEA guidebook or region specific emission factors.

Although NMVOC emissions of biogenic nature are not included in the national total, the methodology is written out in detail in chapter 9 due to the importance of the emissions in absolute figures.

1.5. Key categories

A key category is one that is prioritised within the national inventory system because its emission estimate has a significantly influence, for one or a number of air pollutants, on the level of the national total inventory in terms of the absolute level, or the trend in emissions, or both.

The identification of the key categories is performed according to 'Approach 1' as described in the EMEP/EEA emission inventory guidebook 2009 (see Chapter 2: 'Key category analysis and methodological choice', 2.4.1) for both the level assessment and trend assessment. The key category analysis (level and trend) is performed for all reported gases at the least aggregated level of NFR categories.

1.5.1. Level assessment

The level assessment is a quantitative analysis of the magnitude of emissions in one year of each category compared to the total national emissions. For each pollutant, the contribution of each source category estimate to the absolute total national estimate is calculated. The source categories are sorted in descending order of contribution magnitude and then summed together. Source categories are identified as 'key source' when 80% of the national total emissions is covered.

Tables 1.2 to 1.6 show the results of the level assessment for 2012 for the main pollutants and PM10. For the results of the key source level assessment of all the pollutants, we refer to Annex 1.

Table 1.2 Key source level assessment for NO_x, 2012

NO_x **Source category**	**Gg NO_2**	**Level ass.**	**2012** **Cum. Total**
1 A 3 b i Road transport: Passenger cars	46,121	23,6%	23,6%
1 A 3 b iii Road transport:, Heavy duty vehicles	39,881	20,4%	44,0%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	13,943	7,1%	51,1%
1 A 1 a Public electricity and heat production	11,447	5,9%	57,0%
1 A 4 b i Residential: Stationary plants	11,212	5,7%	62,7%
2 A 1 Cement production	10,521	5,4%	68,1%
1 A 3 b ii Road transport:Light duty vehicles	9,478	4,9%	73,0%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	5,881	3,0%	76,0%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	5,2	2,7%	78,7%
1 A 4 a i Commercial / institutional: Stationary	3,855	2,0%	80,6%

Table 1.3 Key source level assessment for NMVOC, 2012

NMVOC Source category	Gg	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	16,629	15,9%	15,9%
3 D 2 Domestic solvent use including fungicides	14,804	14,2%	30,1%
2 B 5 a Other chemical industry	10,319	9,9%	40,0%
3 A 2 Industrial coating application	8,163	7,8%	47,8%
3 C Chemical products	5,345	5,1%	53,0%
3 A 1 Decorative coating application	4,234	4,1%	57,0%
1 A 3 b i Road transport: Passenger cars	3,497	3,4%	60,4%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	3,164	3,0%	63,4%
1 B 2 b Natural gas	3,08	3,0%	66,4%
2 D 2 Food and drink	3,039	2,9%	69,3%
1 B 2 a iv Refining / storage	2,913	2,8%	72,1%
3 D 1 Printing	2,638	2,5%	74,6%
3 D 3 Other product use	2,571	2,5%	77,0%
1 A 3 b v Road transport: Gasoline evaporation	2,385	2,3%	79,3%
3 B 1 Degreasing	2,217	2,1%	81,5%

Table 1.4 Key source level assessment for SO_x, 2012

SO_x Source category	Gg SO_2	Level ass.	**2012** Cum. Total
1 A 4 b i Residential: Stationary plants	7,745	15,8%	15,8%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	7,093	14,5%	30,3%
1 B 2 a iv Refining / storage	5,791	11,8%	42,2%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	5,649	11,6%	53,7%
2 A 1 Cement production	3,928	8,0%	61,8%
2 B 5 a Other chemical industry	3,507	7,2%	68,9%
1 A 1 a Public electricity and heat production	2,427	5,0%	73,9%
1 A 1 b Petroleum refining	1,835	3,8%	77,7%
1 B 2 c Venting and flaring	1,443	3,0%	80,6%

Table 1.5 Key source level assessment for NH_3, 2012

NH_3 Source category	Gg	Level ass.	**2012** Cum. Total
4 B 8 Swine	22,122	32,4%	32,4%
4 B 1 b Cattle non-dairy	16,799	24,6%	57,1%
4 B 1 a Cattle dairy	10,595	15,5%	72,6%
4 D 1 a Synthetic N-fertilizers	5,291	7,8%	80,4%

Table 1.6 Key source level assessment for PM10, 2012

PM10 Source category	Gg	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	18,663	48,2%	48,2%
2 A 7 a Quarrying and mining of minerals other than coal	2,294	5,9%	54,1%
1 A 3 b vi Road transport: Automobile tyre and brake wear	1,836	4,7%	58,9%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	1,624	4,2%	63,0%
1 A 3 b i Road transport: Passenger cars	1,426	3,7%	66,7%
2 C 1 Iron and steel production	1,21	3,1%	69,9%
1 A 3 b vii Road transport: Automobile road abrasion	1,004	2,6%	72,4%
4 B 8 Swine	0,962	2,5%	74,9%
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,865	2,2%	77,2%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	0,838	2,2%	79,3%
1 A 3 b iii Road transport:, Heavy duty vehicles	0,72	1,9%	81,2%

Table 1.7 gives an overview of the key source level assessment for 2012. The results of the key source analysis (level assessment) of other years are presented in Annex 1.

Table 1.7 Key source analysis (level assessment) for 2012

2012	Key source categories (sorted from high to low, from left to right)										Total
NO_x	1A3bi 23,6%	1A3biii 20,4%	1A2fi 7,1%	1A1a 5,9%	1A4bi 5,7%	2A1 5,4%	1A3bii 4,9%	1A4cii 3,0%	1A2a 2,7%	1A4ai 2,0%	80,62%
NMVOC	1A4bi 15,9%	3D2 14,2%	2B5a 9,9%	3A2 7,8%	3C 5,1%	3A1 4,1%	1A3bi 3,4%	1A4cii 3,0%	1B2b 3,0%	2D2 2,9%	81,46%
	1B2aiv 2,8%	3D1 2,5%	3D3 2,5%	1A3bv 2,3%	3B1 2,1%						
SO_x	1A4bi 15,8%	1A2fi 14,5%	1B2aiv 11,8%	1A2a 11,6%	2A1 8,0%	2B5a 7,2%	1A1a 5,0%	1A1b 3,8%	1B2c 3,0%		80,61%

2012	Key source categories (sorted from high to low, from left to right)										Total
NH_3	4B8 32,4%	4B1b 24,6%	4B1a 15,5%	4D1a 7,8%							80,37%
PM2,5	1A4bi 56,9%	1A4cii 4,7%	1A3bi 4,5%	1A3bvi 3,1%	2C1 3,1%	1A2d 2,6%	2A7a 2,5%	1A2fi 2,4%	1A3bii 2,3%		81,97%
PM10	1A4bi 48,2%	2A7a 5,9%	1A3bvi 4,7%	1A4cii 4,2%	1A3bi 3,7%	2C1 3,1%	1A3bv 2,6%	4B8 2,5%	1A2d 2,2%	1A2fi 2,2%	81,19%
	1A3biii 1,9%										
TSP	1A4bi 37,0%	2A7a 13,0%	1A3bvi 4,5%	1A4cii 4,1%	4B8 4,1%	1A3bvii 3,7%	1A3bi 2,7%	2C1 2,5%	1A2fii 2,3%	4B1b 2,3%	80,20%
	4B9b 2,2%	1A2fi 1,8%									
CO	1A4bi 32,6%	1A2a 20,9%	1A3bi 9,5%	1A2fi 6,0%	2C1 5,3%	1A4bii 3,3%	1A3bii 3,2%				80,70%
Pb	2C1 54,3%	2C5e 8,8%	1A3bvi 6,5%	1A4bi 5,8%	1A2a 3,5%	1B2aiv 3,4%					82,35%
Cd	2C5e 28,4%	1A4bi 21,2%	2C1 10,6%	1B2aiv 9,0%	1A1a 6,9%	1A2c 4,0%					80,17%
Hg	2A1 14,8%	1B2aiv 13,8%	2C1 13,7%	1A4bi 12,7%	2B5a 11,2%	1A1a 7,1%	1A2c 4,7%	1A2fi 3,8%			81,82%
As	2C5e 34,8%	2C1 16,3%	1A4bi 11,7%	1A1a 10,8%	1A2c 4,4%	1A2fi 3,6%					81,60%
Cr	2C1 44,3%	1A2a 18,2%	1A4bi 7,6%	1A3bvi 7,1%	1A1a 5,8%						82,99%
Cu	1A3bvi 58,2%	1A3c 11,9%	3D3 10,0%								80,15%
Ni	2C1 15,4%	1A2a 13,6%	1A2c 10,7%	1A2fi 7,3%	1A4bi 6,3%	1B2aiv 6,2%	1A1a 5,3%	1A4ci 5,2%	1A2e 4,4%	2C5e 4,2%	82,25%
	1A4ai 3,6%										
Se	2A7d 32,6%	1A4bi 21,5%	1A2fi 11,5%	2A1 9,4%	1A2c 7,8%						82,88%

2012	Key source categories (sorted from high to low, from left to right)									Total
Zn	2C5e 32,0%	1A4bi 16,9%	1A3bi 8,9%	1A3bvi 8,7%	2C1 7,6%	1A1a 4,5%	1A2a 4,3%			82,89%
PCDD/ PCDF	1A4bi 41,9%	2C1 21,6%	6Ce 18,4%							81,93%
PAH	3D3 35,0%	1A4bi 32,2%	1B1b 16,7%							83,88%
HCB	3C 34,4%	2C1 27,3%	2A1 21,2%							82,91%
HCH	3D3 100,0%									100,00 %
PCB	2C1 46,7%	2A1 38,2%								84,85%

1.5.2. Trend assessment

The trend assessment is a quantitative analysis of the change in emission year to year of each category compared to the change in total national emissions. As emissions for the base year as well as the last year are provided, a trend key category analysis could be performed. The trend assessment identifies categories as key sources when they have a trend that significantly differs from the trend of the national total inventory. Key sources are those categories whose trend differences are, when summed together in descending order of magnitude, cover 80% of the total of all source trend differences.

Tables 1.8 to 1.12 show the key source trend analyses for the main pollutants and PM10 (base year – 2012). The results for all pollutants are presented in Annex 1.B.

Table 1.8 Key source trend assessment for NO_x, 1990-2012

NOx	1990	2012	trend ass.	% contrib	cum. total
1 A 1 a Public electricity and heat production	60,84	11,45	0,055	28,5%	28,5%
1 A 3 b ii Road transport:Light duty vehicles	7,92	9,48	0,014	7,4%	36,0%
1 A 3 b i Road transport: Passenger cars	97,32	46,12	0,013	6,9%	42,9%
1 A 3 b iii Road transport:, Heavy duty vehicles	67,54	39,88	0,012	6,2%	49,0%
2 A 1 Cement production	14,71	10,52	0,008	3,9%	52,9%
1 A 4 b i Residential: Stationary plants	16,26	11,21	0,007	3,7%	56,7%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	14,92	5,20	0,007	3,7%	60,3%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	6,57	5,88	0,007	3,4%	63,7%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	22,03	13,94	0,006	3,3%	67,0%
1 A 3 d i (ii) International inland waterways	2,67	3,64	0,006	3,1%	70,2%
1 A 1 b Petroleum refining	7,32	1,81	0,005	2,8%	73,0%
1 A 4 a i Commercial / institutional: Stationary	3,50	3,86	0,005	2,8%	75,8%

Table 1.9 Key source trend assessment for NMVOC, 1990-2012

NMVOC	1990	2012	trend ass.	% contrib	cum. total
1 A 3 b i Road transport: Passenger cars	57,62	3,50	0,062	23,0%	23,0%
1 A 4 b i Residential: Stationary plants	10,98	16,63	0,044	16,4%	39,4%
3 D 2 Domestic solvent use including fungicides	9,41	14,80	0,04	14,8%	54,2%
3 A 2 Industrial coating application	40,21	8,16	0,023	8,6%	62,8%
1 B 2 a iv Refining / storage	16,93	2,91	0,012	4,3%	67,1%
1 A 3 b v Road transport: Gasoline evaporation	15,30	2,39	0,011	4,2%	71,3%
2 D 2 Food and drink	2,16	3,04	0,008	2,9%	74,2%
1 B 2 a v Distribution of oil products	11,38	1,94	0,008	2,9%	77,1%
3 D 1 Printing	12,31	2,64	0,007	2,5%	79,6%
1 B 2 b Natural gas	3,91	3,08	0,006	2,1%	81,7%

Table 1.10 Key source trend assessment for SO_x, 1990-2012

SOx	1990	2012	trend ass.	% contrib	cum. total
1 A 1 a Public electricity and heat production	94,89	2,43	0,029	23,1%	23,1%
1 B 2 a iv Refining / storage	0,01	5,79	0,016	12,7%	35,8%
1 A 4 b i Residential: Stationary plants	27,16	7,75	0,011	8,9%	44,7%
1 A 1 b Petroleum refining	40,84	1,84	0,01	8,2%	52,9%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	15,73	5,65	0,01	7,7%	60,7%
2 A 1 Cement production	4,33	3,93	0,009	7,3%	68,0%
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	28,34	1,04	0,008	6,2%	74,2%
1 B 2 c Venting and flaring	0,37	1,44	0,004	3,1%	77,3%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	61,92	7,09	0,004	2,9%	80,2%

Table 1.11 Key source trend assessment for NH_3, 1990-2012

NH_3	1990	2012	trend ass.	% contrib	cum. total
4 B 8 Swine	50,95	22,12	0,054	30,8%	30,8%
4 B 1 b Cattle non-dairy	24,48	16,80	0,025	14,4%	45,2%
4 D 1 a Synthetic N-fertilizers	4,97	5,29	0,021	11,8%	57,0%
4 B 1 a Cattle dairy	21,54	10,60	0,012	7,2%	64,2%
4 B 9 b Broilers	1,41	2,08	0,011	6,1%	70,3%
1 A 4 b i Residential: Stationary plants	0,69	1,66	0,01	6,0%	76,3%
4 B 9 a Laying hens	4,54	1,59	0,008	4,6%	80,9%

Table 1.12 Key source trend assessment for PM10, 2000-2012

PM10	2000	2012	trend ass.	% contrib	cum. total
1 A 4 b i Residential: Stationary plants	9,90	18,66	0,217	38,9%	38,9%
2 C 1 Iron and steel production	9,63	1,21	0,114	20,4%	59,3%
1 A 3 b i Road transport: Passenger cars	4,24	1,43	0,033	5,9%	65,2%
1 A 1 a Public electricity and heat production	2,53	0,32	0,03	5,4%	70,6%
1 A 3 b iii Road transport:, Heavy duty vehicles	2,34	0,72	0,02	3,5%	74,1%
2 A 1 Cement production	1,20	0,03	0,016	3,0%	77,0%
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,20	0,87	0,014	2,5%	79,5%
2 A 2 Lime production	0,96	0,03	0,013	2,4%	81,9%

1.5.3. Summary of key category analysis

Key categories are identified by means of their contribution to the national total emissions (level assessment) and according to the difference in their trend compared to the trend of the national total emissions (trend assessment). Key source categories identified by the approach 1 level assessment (L1) or trend assessment (T1) are summarized in table 1.13.

Table 1.13 Key category analysis for 2012 based on level (L1) or trend (T1) assessment

2012	NO_x	NMVOC	SO_x	NH_3	PM2,5	PM10	TSP	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	HCH	PCB
1 A 1 a	L1,T1		L1,T1		T1	T1	T1		T1	L1, T1	L1,T1	L1,T1	L1, T1	T1	L1,T1		L1,T1	T1		T1		
1 A 1 b	T1		L1,T1																			
1 A 1 c																						
1 A 2 a	L1,T1		L1,T1					L1	L1				L1, T1		L1,T1		L1					
1 A 2 b									T1	T1				T1								
1 A 2 c										L1	L1	L1,T1			L1,T1	L1,T1						
1 A 2 d					L1,T1	L1,T1																
1 A 2 e											T1				L1,T1							
1 A 2 f i	L1,T1		L1,T1		L1	L1	L1	L1,T1			L1,T1	L1			L1,T1	L1,T1	T1					
1 A 2 f ii							L1															
1 A 3 b i	L1,T1	L1,T1			L1,T1	L1,T1	L1,T1	L1,T1	T1								L1,T1					
1 A 3 b ii	L1,T1																					
1 A 3 b iii	L1,T1				L1,T1	L1,T1	T1	L1														

2012	NO_x	NMVOC	SO_x	NH_3	PM2,5	PM10	TSP	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	HCH	PCB
1 A 3 b iv																						
1 A 3 b v		L1,T1																				
1 A 3 b vi					L1	L1	L1,T1		L1,T1				L1, T1	L1,T1			L1,T1					
1 A 3 b vii						L1	L1															
1 A 3 c														L1,T1								
1 A 3 d i (ii)	T1																					
1 A 3 d ii	T1																					
1 A 4 a i	L1,T1														L1							
1 A 4 b i	L1,T1	L1,T1	L1,T1	T1	L1,T1	L1,T1	L1,T1	L1,T1	L1	L1, T1	L1,T1	L1,T1	L1, T1		L1,T1	L1	L1,T1	L1,T1	L1,T1			
1 A 4 b ii								L1,T1														
1 A 4 c i			T1												L1							
1 A 4 c ii	L1,T1	L1			L1	L1	L1															
1 B 1 b																			L1,T1			
1 B 2 a iv		L1,T1	L1,T1						L1	L1	L1				L1							

2012	NO_x	NMVOC	SO_x	NH_3	PM2,5	PM10	TSP	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	HCH	PCB
1 B 2 a v		T1																				
1 B 2 b		L1,T1																				
1 B 2 c			L1,T1																			
2 A 1	L1,T1		L1,T1			T1					L1,T1					L1,T1				L1,T1		L1,T1
2 A 2						T1	T1															
2 A 7 a					L1	L1	L1,T1															
2 A 7 d																L1						
2 B 5 a		L1	L1								L1						T1					
2 C 1	T1				L1,T1	L1,T1	L1,T1	L1,T1	L1,T1	L1	L1,T1	L1,T1	L1	T1	L1,T1		L1,T1	L1	T1	L1,T1		L1,T1
2 C 5 e									L1	L1, T1		L1,T1			L1		L1,T1					
2 D 2		L1,T1																				
3 A 1		L1																				
3 A 2		L1,T1																				
3 B 1		L1																				

2012	NO_x	NMVOC	SO_x	NH_3	PM2,5	PM10	TSP	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAH	HCB	HCH	PCB
3 C		L1																		L1		
3 D 1		L1,T1																				
3 D 2		L1,T1																				
3 D 3		L1												L1					L1,T1		L1,T1	
4 B 1 a				L1,T1																		
4 B 1 b				L1,T1			L1															
4 B 8				L1,T1		L1	L1															
4 B 9 a				T1																		
4 B 9 b				T1			L1															
4 D 1 a				L1,T1																		
6 C b																		T1		T1		
6 C c									T1	T1	T1		T1		T1		T1	T1				
6 C e																		L1,T1				

1.5.4. General remarks

To evaluate the key sources in time, the level assessments for the base years 1990 (all pollutants except particulate matter) and 2000 (particulate matter) are actualized as well. The summary of these key source analyses can be found in Annex 1.

The absolute change in emission values of key source categories for a particular pollutant over the period 1990-2012 will be discussed in chapter 2.

By comparing the key sources (level assessment) between 1990 and 2012 some remarks can be made. Besides some (smaller) shifts in the order of ranking, a number of more structural shifts in the following sectors can be seen:

- *1A1a Public electricity and heat production:* disappears as a key source for Pb, Cu, Se, dioxins and particulate matter in 2012 compared to 1990. Also for SO_x, NO_x and the other metals, the relative contribution of this sector to the national total decreases. Emissions of NO_x, SO_x, particulate matter and (heavy) metals decrease with the termination of some coal power plants, the use of environment-friendlier fuels (minimal use of liquid fuels, application of renewable sources), the higher efficiency of existing plants and the application of new technologies.
- *1A1b Petroleum refining:* disappears for PM2,5 in 2012 compared to 1990. In 1990, the refining plants (all situated in the Flemish region) were not yet obliged to report their emissions (obligation from 1993 described in the Flemish environmental law Vlarem II). As a result, very little information on emissions at plant level is available before 1993. Emissions were only estimated collectively based on the existing knowledge.
- *1A2a Iron and steel:* appears as a key source in 2012 for Pb, Cr, Ni and Zn due to a part of process emissions allocated in the combustion sector. The sector has an increasing importance for CO as the absolute emissions change in other sectors (which become relatively less important).
- *1A2b Non-ferrous metals:* for Cd and Cu, the non-ferro industry disappears as key source in 2012 compared to 1990. This is due to the efforts of one Flemish company with several exploitations
- *1A2c Chemicals:* appears as a key source in 2012 for Cd, As, and Se. Relative changes in the key sources for heavy metals can be attributed to an optimised methodology that is applied for the years 2000 to 2012 in Flanders.
- *1A2d Pulp, paper and print:* appears as a key source for PM2,5 and PM10 in 2012 compared to 2000 due to the increased use of renewable solid fuels.
- *1A2e Food processing, beverages and tobacco :* Is no longer a key source for Hg in 2012. The proportion of the Ni emissions from this sector to the national total decreases strongly (19.3% in 1990 to 4.4% in 2012).The reduction of Ni emissions is due to the reduction of the residual oil as fuel.
- *1A2fi Other:* appears for CO and As as key source in 2012 compared to 1990. The shift for As can be explained by absolute emission changes in other sectors (which become relatively less important). This sector disappears as key sector for Zn since the absolute emission values decrease significantly.
- *1A3bi Road transport (Passenger cars):* Disappears as key sector in 2012 for Pband has a very much lower relative importance for NMVOC and CO in 2012 compared to 1990 due to the increasing use of catalytic converters and other technical measures. The absolute Pb emissions of passenger cars have strongly decreased due to the removing of leaded petrol.
- *1A3biii Road transport (Heavy duty vehicles):* Appears for CO due to absolute emission changes in other sectors.. This is also a key sector for NO_x and particulate matter but no great changes are seen in the relative importance of this sector between 1990 and 2012 for these pollutants.

- *1A3bv Gasoline evaporation:* The relative importance for NMVOC decreases in 2012 due to the decrease of gasoline use between 1990 and 2012.
- *1A3bvi Automobile tyre and brake wear:* this is the most important key source for Cu emissions. The sector appears as a key source for Pb, Cr and Zn in 2012 compared to 1990. This is due to the increase in mobility and the optimised methodology to estimate heavy metals for the years 2000 to 2012 in Flanders.
- *1A3bvii Automobile road abrasion:* The relative importance of the sector increases slightly for PM10 and TSP. This is due to the increase in mobility and so the increase in road distance travelled.
- *1A3c Railways:* appears as a key source for Cu in 2012 compared to the base year. This can be attributed to the optimised methodology to estimate heavy metals for the years 2000 to 2012 in Flanders. Cu emissions, due to the abrasion of overhead wires and electric contact withdrawals were estimated in 2012, but not in 1990.
- *1A4ai Commercial/Institutional:* appears as key source in 2012 for NOx and Ni due to absolute emission changes in other sectors which become relatively less important.
- *1A4bi Residential:* Stationary plants: appears as a key source for Pb, Cr, Ni and Zn in 2012. Also the relative importance of this sector for NMVOC, SOx, CO and Cd increases in 2012 compared to 1990. Since the absolute heavy metal emissions remain rather stable, this is mainly due to emission changes in other sectors. There is a significant absolute decrease in dioxin emissions due to the reduction of coal consumption. However, the sector becomes the principal key source of dioxins due to the huge emission decline in the electricity sector and the sector of waste incineration. This sector is also the most important key source for particulate matter due to the high consumption of wood for residential heating. *1A4bii Residential:* Household and gardening (mobile): appears as a key source for COin 2012 compared to 1990 due to absolute emission changes in other sectors.
- *1A4ci Agriculture/Forestry/Fishing: Stationary:* disappears as key source for SO_x due to the decreasing emissions in the greenhouse culture (more natural gas and less heavy fuel). Appears as key source for Ni due to the lower importance of other sectors.
- *1A4cii Agriculture/Forestry/Fishing: Off-road vehicles an*d *other machinery:* appears as a key *s*ource for NO_x and NMVOC, due to emission changes in other sectors.
- *1B1b Solid fuel transformation:* disappears as a key source for Cr and the proportion of PAH's emissions to the total PAH's emissions decreases strongly because the activities of the Brussels and Flemish coke ovens have been terminated respectively in 1993 and 1996. The sector disappears as a key source for TSP due to emission changes in other sectors.
- *1B2aiv Refining/storage:* appears as a key source for SOx, Pb, Cd, Hg and Ni in 2012 compared to 1990. In 1990, the refining plants (all situated in the Flemish region) were not yet obliged to report their emissions (obligation from 1993 described in the Flemish environmental law Vlarem II). As a result, very little information on emissions at plant level is available before 1993. Emissions were only estimated collectively based on the existing knowledge.
- *1B2av Distribution of oil products:* disappears as a key source for NMVOC in 2012 due to the obliged vapour recycling during the refuelling of petrol stations and during tanking (the so-called Stage I and Stage II measures)
- *1B2b Natural gas:* appears as a key source for NMVOC in 2012 due to the change in emissions in other sectors. *2A1 Cement production:* disappears as key source for PM10 and TSP. A significant emission reduction was obtained du*e to new dust purifi*cation systems of some plants in 2008, 2010 and 2012. The sector becomes key source for $SO_{x,}$ Hg ,Se, HCB and PCB in 2012 compared to 1990. The absolute SO_2 and Hg emissions remain stable between 1990 and 2012 but the emissions of other sectors have decreased.
- *2A2 Lime production:* disappears for PM10 and TSP. The change in relative importance of this sector can be attributed to emission changes in the other sectors.
- *2A7d Other Mineral products:* appears as key source for Se in 2012 compared to 1990. This can be attributed to the optimised methodology to estimate heavy metals for the years

from 2000 on in Flanders. The sector disappears as key source for PM2.5 and PM10 in 2012 compared to 2000 due to lower emissions from bricks and tiles production. Lower activity data and a lower emission factor were provided by the brick federation.

- *2B5a Other chemical industry:* disappears as a key source for Zn. Also the relative importance of Hg emissions decreased strongly. The emissions in 1990 originate from a number of sulphuric acid production installations in a (Flemish) non-ferro plant. These installations have been shut down in 1992.
- *2C1 Iron and steel production:* disappears as a key sector for Cu and PAH in 2012 compared to 1990. For Cu, this is because of a different emission estimation method before and after 1993 (obligation from 1993 for Flemish plants to report their emissions as described in Vlarem II). In the Walloon region, all the blast furnace plants and basic oxygen plants have been closed since 2011. They were a emission source of PAH. 2C1 appears as a key sector for Hg and remains an important (key) source for most metals and dioxins This sector remains an important sector in Belgium.
- *2C5e Other metal production: a*ppears as a key source for Ni due to the optimised methodology to estimate heavy metals for the years 2000 to 2012 in Flanders. 2C5e disappears as key source for Cu due to changes in other sectors.
- *2D2 Food and drink:* appears as a key source for NMVOC. This can be attributed to emission changes in the other sectors.
- *3D3 Other product use:* appears for NMVOC, Cu and PAH as key sector in 2012 compared to 1990 due to emission changes in other sectors.
- *4B9b Broilers:* appears as a key source for TSP due to emission changes in other sectors.
- *4 G Agriculture other: HCH emissions* of the use in pesticides have decreased significantly due to a ban on the use of HCH in Belgium from 2002.
- *6Cb Industrial waste incineration:* disappears as a key sector in 2012 compared to 1990 for dioxins and HCB. A (structural) reorganisation of the sector in 1994 led to a strong decline of the emissions. From 2006 on intermunicipal waste incinerators recuperate their energy; the emissions are then allocated in sector 1A1a.
- *6Cc Municipal waste incineration:* for a number of heavy metals (Pb/Cd/Hg/Cr/Ni/Zn), municipal waste incineration disappears as key source in 2012 compared to 1990. This can be attributed to the (structural) reorganisation of the sector in 1994, which included also air purification measures. Moreover, the majority of the intermunicipal waste incinerators recuperate their energy nowadays. As a consequence their emissions are reported under the sector 1A1a. For dioxins, the sector disappears as key source because of air purification measures.
- *6Ce Small scale waste burning:* appears as a key source in 2012 for dioxins. Emissions in this sector declined less than in other sectors.

It can be assumed that most categories with a notation key NE will not bring big differences in the ranking of the key sources if they would be estimated, since most emissions are relatively low or even not existing. More information on the reasons for not estimating the emissions in a sector are given in 1.8 (table 1.14).
The emissions of the categories that are IE (included elsewhere) are explained in 1.8 (table 1.15).

1.6. QA/QC and Verification methods

In the framework of the European and international obligations with respect to the greenhouse gas emission inventory, Belgium has developed a QA/QC-plan.

Although this plan is focused on greenhouse gas emissions, a lot of these issues are also appropriate for the air pollutants.

Information about the developed QA/QC-plan in Belgium and all procedures involved can be found in the NIR (National Inventory Report) of March 2014, more specifically in chapter 1.6. 'Information on the QA/QC plan including verification and treatment of confidentiality issues where relevant'.

The three regions have their own QA/QC procedures. The regional inventories are compiled by the Belgian Interregional Environment Agency (IRCEL-CELINE), which is responsible for the international emission reporting obligations. The national inventory compiler is not involved in the development of the regional inventories.

Before compilation at the national level, the regional inventories are again controlled by the national compiler (as an additional control from an external person). The regional emission inventories are compared with the regional inventories used in the former submission, compared with the reporting under the NEC Directive and checked for sudden dips or jumps in the time series. Remarkable results of this review are fed back to the regions in order to obtain confirmation or adjustments on the emission data.

The same control processes are applied for the compiled national inventory. An additional check is made on the consistency in allocation of source categories of the 3 regional inventories. Also a cross-check is performed of the national aggregated data with the sum of the data from the input inventories to ensure that emissions are correctly aggregated from a lower reporting level to a higher reporting level. Any changes in the emission inventory at the national level is conducted by IRCEL-CELINE after coordination with the regional contact persons.

At last, the compiled national inventory is tested with the electronic RepDab-tool, on-line available at the ceip website before submission.

1.7. General uncertainty evaluation

For all emission measurements or estimations, a particular uncertainty can be determined, that is inseparably related to the emission value. Nowadays, no uncertainties are estimated for the regional or Belgian emission values. The Guidelines for Estimating and Reporting Emission Data under CLRTAP (ECE/EB.AIR/97) stipulate that uncertainty estimations have to be determined; for this reason, the study for calculating uncertainty values related to the emissions reported for NEC and LRTAP is currently developed. The results of this study will be available at the end of this year.

1.8. General assessment of completeness

The Belgian emission inventory covers all pollutants of the CLRTAP and its Protocols, i.e. main pollutants (NO_x, SO_x, NMVOC, NH_3, CO), particulate matter (PM2,5, PM10, TSP), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn) and POP's (PCDD/PCDF, PAH, HCB, HCH). Estimations of the individual PAH's could only be made for the Flemish region, so in the national inventory only the totals of the 4 PAH's are reported. Estimations of the POP's for the Flemish region could only be made for the years 1990, 1995, 2000 and 2005 up to 2012. An interpolation has been made for the intervening years.

In the 2014 submission, recalculations were made for the whole time series 1990 to 1999 (for all pollutants except particulate matter), 2000 (base year for particulate matter up to 2011. 2012 was reported for the first time.

The Belgian emission inventory covers all relevant sources specified in the CLRTAP. However, it is not always possible to estimate the emissions of all subsectors in detail. Therefore, notation keys have been used. An overview and explanation of the notation keys NE and IE used in the 2012 emission inventory, as well as the sub-sources accounted for in reporting codes ‘other’ are summarized in tables 1.14 to 1.16.

An overview of the basis that is used to estimate emissions from mobile sources (fuels sold versus fuels used) is given in table 1.17.

Table 1.14 Explanation to the Notation key NE

NFR09 code	Substance(s)	Reason for not estimated
all	benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene	No information available by PAHs specified in Walloon en Brussels region
1A1b	NH3, PCB's	No data available from the facilities or no emission factors available to calculate the emissions
1A1c	Cr, Cu, Se, Zn, PCB's	No emission factors available to calculate the emissions
1A2b	PCB's	emissions probably not relevant
1A3ai(i) 1A3aii(i)	NH3, Hg, dioxins, PAH, PCB's	No emission factors available to calculate the emissions
1A3aii(ii) 1A3ai(ii)	NH3, PM, heavy metals, dioxins, PAH	No emission factors available to calculate the emissions
1A3b (i to iv)	Hg, As, HCB, PCB's	No emission factors available to calculate the emissions
1A3bv	dioxins, HCB, PCB's	No emission factors (EMEP/EEA) available to calculate the emissions
1A3bvi	Hg, As, PAHs, HCB, PCB's	Hg, As, no emission factors and PAHs, no emission factors in the tier 1 methodology
1A3bvii	heavy metals, PAHs, HCB, PCB's	Considering the diversity of the road coatings, no estimate was made
1A3c	Hg, PCB's	No emission factors available to calculate the emissions
1A3dii	HCB, PCB's	No emission factors available to calculate the emissions
1A3di(ii)	Cr, dioxins, HCB, PCB's	No emission factors available to calculate the emissions
1A3e	Hg, As, dioxins, HCB, PCB's	No emission factors available to calculate the emissions
1A4aii	Hg, As, HCB	No emission factors available to calculate the emissions
1A4bii	Hg, As, dioxins, HCB	No emission factors available to calculate the emissions
1A4ci	PCB's	No emission factors available to calculate the emissions
1A4cii	PCB's	No emission factors available to calculate the emissions
1A4ciii	NH3, Cd, Hg, As, Cr, Cu, Ni, Se, Zn,dioxins, PAH's, HCB	No emission factors available to calculate the emissions
1A5a	all	There are no data available. The activity data are coming from the military sector (confidentiality).
1A5b	Pb, Hg, As, dioxins, HCB	no emission factors available to calculate the emissions
1B2c	NH3, dioxins, PAHs	no detailed data available
2A2	PCB's	No emission factors available to calculate the emissions, emissions probably not relevant

NFR09 code	Substance(s)	Reason for not estimated
2A5	NMVOC, particulate matter, CO, priority heavy metals, dioxins, PAH, HCB	no activity data available
2A6	dioxins, PAH, HCB	Emissions are not relevant in Belgium or no data available
2A7d	NH3, HCB	Emissions are not relevant in Belgium or no data or emission factors available
2B2	SOx, CO	There are no data available or the EF aren't available
2B5a	Se, PAH's, HCB, HCH, PCB's	No emission factors available to calculate the emissions, POP's emissions probably not relevant
2B5b	Hg, HCB, HCH, PCB's	There are no data available or the EF aren't available
2C1	NH3	no detailed data available
2C3	NH3, HCB	no data available from the facilities
2C5a	PCB's	No emission factors available to calculate the emissions, emissions probably not relevant
2C5b	NH3, HCB,PCB's	no data available from the facilities
2C5c	NH3, HCB, PCB's	no data available from the facilities
2C5d	HCB	No emission factors available to calculate the emissions, emissions probably not relevant
2C5e	NH3, HCB, HCH	no data available from the facilities, POP's emissions probably not relevant, insufficient data available for HCB
2C5f	Hg, Ni, Se, dioxins, PAH, HCB, HCH, PCB's	no data available from the facilities or no emission factors available, POP's emissions probably not relevant
2D1	NH3, PAH's, HCB,PCB's	no data available from the facilities or no emission factors available, POP's emissions probably not relevant
2D3	particulate matter, CO, As, Cu	There are no data available or the EF aren't available
2E	particulate matter, CO, HCB, HCH, PCB's	There are no data available or the EF aren't available
2F	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, HCB, HCH	no data available from the facilities or no emission factors available, POP's emissions probably not relevant
2G	NOx, SOx, NH3, CO, Se, PAH, HCB, PCB's	There are no data available or the EF aren't available, POP's emissions probably not relevant
3C	SOx, Pb, As, Cr, Cu, Zn	No emission factors available to calculate the emissions
3D3	Zn	No emission factors available to calculate the emissions
4B1, 8, 9	NMVOC	No emission factors available to calculate the emissions

4B3,4,6,7,13	NMVOC, particulate matter	No emission factors available to calculate the emissions
4D1a	NOx, NMVOC, particulate matter, HCH	No emission factors available to calculate the emissions
4D2a	NOx, particulate matter	No data available
4D2b	NOx, particulate matter	No data available
4D2c	NOx, particulate matter, HCH	No data available
6A	SOx, NH3, particulate matter, Hg	No emission factors available to calculate the emissions
6B	SOx, NMVOC, particulate matter, CO	SOx: no data available from the facilities, NMVOC: there is an EF in the guidebook, an estimation will be made in the future; PM : no EF in the guidebook
6Ca	NH3, particulate matter, heavy metals, PAH's, HCB, PCB's	There are no data available from the facilities or the EF aren't available; emissions of installations with energy recuperation are allocated in 1A1a
6Cb	NH3, PAH, Pb, Cd, Hg, Cr, Ni, PCB's	There are no data available or the EF aren't available; emissions of installations with energy recuperation are allocated in 1A1a, POP's emissions probably not relevant
6Cc	PCB's	emissions probably not relevant
6Cd	Se, HCB, PCB's	No emission factors available to calculate the emissions, POP's emissions probably not relevant
6Ce	main pollutants, CO, heavy metals, HCB, PCB's	No emission factors available to calculate the emissions , POP's emissions probably not relevant
6D	NOx, CO, Cd, As, Se, dioxins, PAH, HCB, HCH, PCB's	No data available from the facilities or no emission factors available to calculate the emissions
1A3d i(i)	dioxins, Cr	No emission factors available

Table 1.15 Explanation to the Notation key IE

NFR09 code	Substance(s)	Included in NFR code
1A1c	Pb, Cd, Hg, As, Ni	3C1
1A3a ii(i)	heavy metals except Hg	1A3ai(i)
1A4aii	all except Hg, As, HCB, HCH and PCB's	1A3e
1B2ai	NMVOC	1B2av
2A3	particulate matter	2A7a
2A4	NOx, NMVOC, SOx, particulate matter	2A7d
2A6	particulate matter	2A7d
2A7b	particulate matter	2A7d
2A7c	particulate matter	2A7a
2B1	NMVOC, NH3, particulate matter, CO	2B5a
2B2	particulate matter	2B5a
2B5b	all, except Hg, HCB, HCH, PCB	2B5a
2C3	NOx, NMVOC, SOx, Particulate matter, CO, all heavy metals, dioxins, PAH's	2C5e
2C5a	NOx, NMVOC, SOx, NH3, Particulate matter, CO, all heavy metals, dioxins, PAH's, HCB	2C5e
2C5b	NOx, NMVOC, SOx, particulate matter, CO, heavy metals, dioxins, PAH's	2C5e
2C5c	NOx, NMVOC, SOx, particulate matter, CO, heavy metals, dioxins, PAH's	2C5e
2C5d	NOx, NMVOC, SOx, NH3, Particulate matter, CO, all heavy metals, dioxins, PAH's, PCB	2C5e
2D1	SOx, particulate matter	1A2d
3A2	all heavy metals except Cd, Se and Hg	2G
3B1	Pb/As/Cr/Ni	2G
3D1	CO	3D3
4B7	NH3	4B6
6Ca	NOx, NMVOC, SOx, CO, dioxins	6Cb (Flanders)

Table 1.16 Sub-sources accounted for in reporting codes 'other'

NFR09 code	Substance(s) reported	Sub-source description
1 A 2 f	all	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)
1 A 3 e	Nox, NMVOC, Sox, NH3, particulate matter, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PAH	Pipeline compressors (NMVOC) and off road
1 A 5 a	-	NE, cfr. Table 1.14, military source
1 A 5 b	NOx, NMVOC, SOx, particulate matter, CO	Military aviation in Wallonia and in the Flemish Region+off-road defence
1 B 1 c	-	NO
1 B 3		NA
2 A 7 d	NOx, SOx, NMVOC, particulate matter, CO, heavy metals, dioxins	Manufacture and processing of flat and hollow glass, glass fibres and other glass, manufacture of bricks, tiles and construction products in baked clay, manufacture of articles of concrete, plaster and other non-metallic products, manufacture of ceramic household and ornamental articles
2 B 5 a	all except Se,PAH,HCB, HCH, PCB's	Production of sulfuric acid, ammonium nitrate, ammonium phosphate, vinylchloride, PEHD, polypropylene, PVC, polystyrene, phtalic anhydride, titanium dioxide, processes in organic chemical industry (excl. adipic acid)
2 B 5 b	pollutants included in 2B5a	IE or NE
2 C 5 e	all except NH3, HCB, HCH	galvanization, non-ferro
2 C 5 f	NOx, NMVOC, SOx, particulate matter, CO, Pb, Cd, As, Cr, Cu, Zn	metallurgic activities, including (iron) foundries and galvanization activities
2 G	NMVOC, Particulate matter, all heavy metals except Se	construction, manufacture of other non-metallic mineral products including asphalt production, manufacture of man-made fibres, surface treatment and casting of metals, manufacture of fabricated metal products, machinery and equipment, electrical and optical equipment, transport equipment, manufacture of textile and textile products, leather and leather products, manufacture of wood and wood products incl. furniture, manufacture of rubber and plastic products, manufacture of matresses, recycling of metal and non-metal waste and scraps, industrial cleaning,
3 A 3	NMVOC	road markings

NFR09 code	Substance(s) reported	Sub-source description
3D3	NOx, SOx, NH3, CO, NMVOC, PAHs, particulate matter, Cu, HCH	application of glues and adhesives, plant oil extraction, wood preservation, recuperation of waste solvents, Flemish estimation of tobacco smoke (PM) and fireworks (Cu)
4 B 9 d	NH3	hens for multiplication and austriches
4 B 13	NH3	rabbits and minks
4 D 2 c	NH3	N excretion due to manure spread, during grazing and on pasture
4 G	-	NA
6 D	NMVOC, SOx, NH3, particulate matter, Pb, Hg, Cr, Cu, Ni, Zn	Waste recuperation, compost
7 B	NMVOC	Forest and grassland
11 C	-	NO

Table 1.17 Basis for estimating emissions from mobile sources

NFR09 code	Description	Fuel sold	Fuel used	Comment
1 A 3 a i (i)	International aviation (LTO)		X	
1 A 3 a i (ii)	International aviation (Cruise)		X	
1 A 3 a ii (i)	1 A 3 a ii Civil aviation (Domestic, LTO)		X	
1 A 3 a ii (ii)	1 A 3 a ii Civil Aviation (Domestic, Cruise)		X	-
1A3b	**Road transport**		X	The emissions are the sum of the emissions of the regions and the quantities of fuel sold by regions aren't known. There does not exist either a national model calculating these emissions. A working group is set up to determine the shares of sold fuels by regions
1A3c	Railways		X	
1A3di (i)	International maritime navigation		X	
1A3di (ii)	International inland waterways		X	
1A3dii	National navigation		X	
1A4ci	Agriculture		X	
1A4cii	Off-road vehicles and other machinery		X	
1A4ciii	National fishing		X	
1 A 5 b	Other mobile (Including military)		X	

Chapter 2. Explanation of key trends

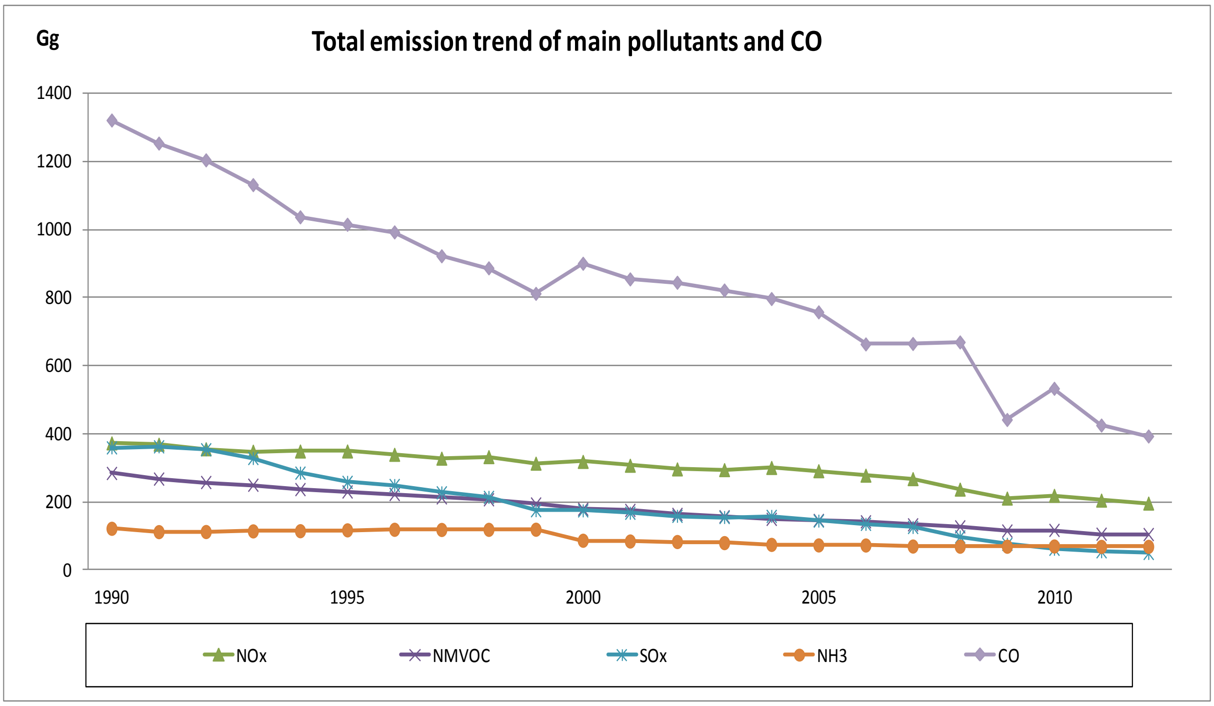
2.1. National total emission trends

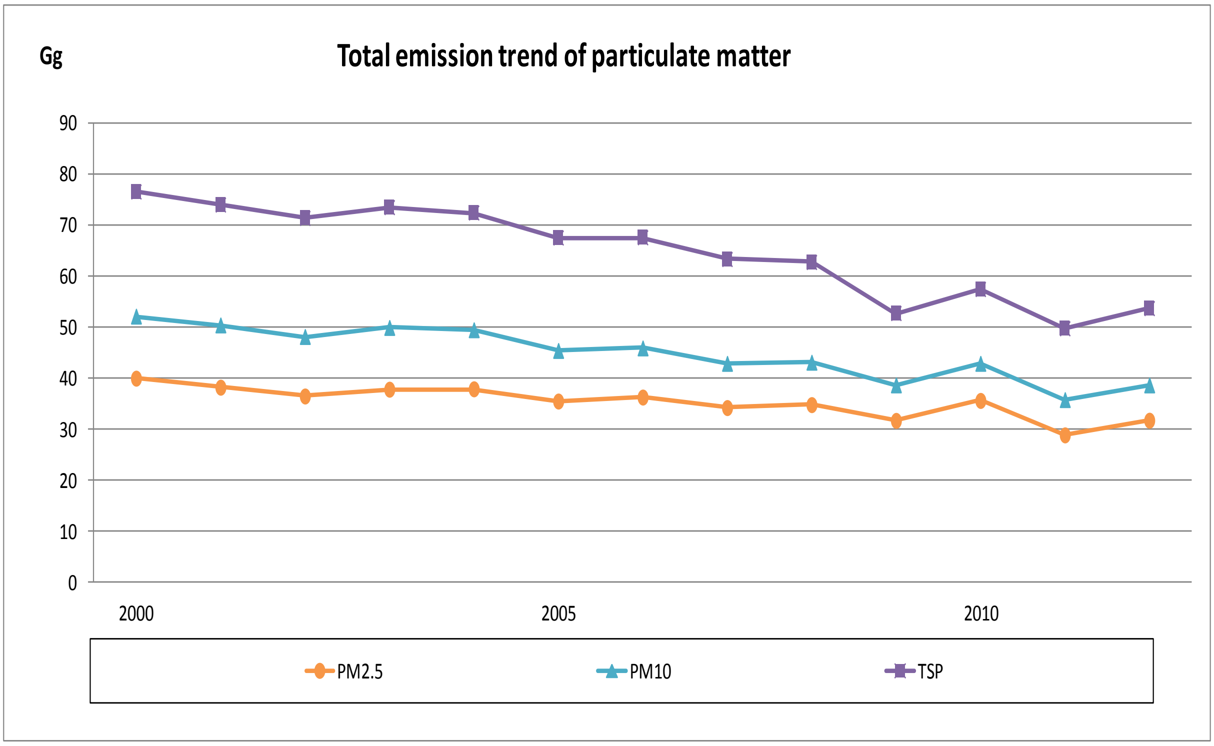
The Belgian absolute total emissions per pollutant are summarized in Table 2.1 for each year recalculated in the 2014 LRTAP-submission. The absolute difference as well as the relative difference are calculated between 2012 and the base year. For all pollutants the base year is 1990, except for particulate matter the base year is 2000. The emissions of all pollutants have a downward trend between 1990 (2000) and 2012. Main reasons for this are the great emission reduction efforts made by the industrial and transport sectors as well as the changeover to less polluting fuels. The larger decrease between 2008 and 2009 is mainly due to the crisis that hit the heavy industry in Belgium. Emissions of most pollutants increased again slightly in 2010 after which the reduction is continued in 2011, except for particulate matter, which increased again in 2012 due to the cold winter period.

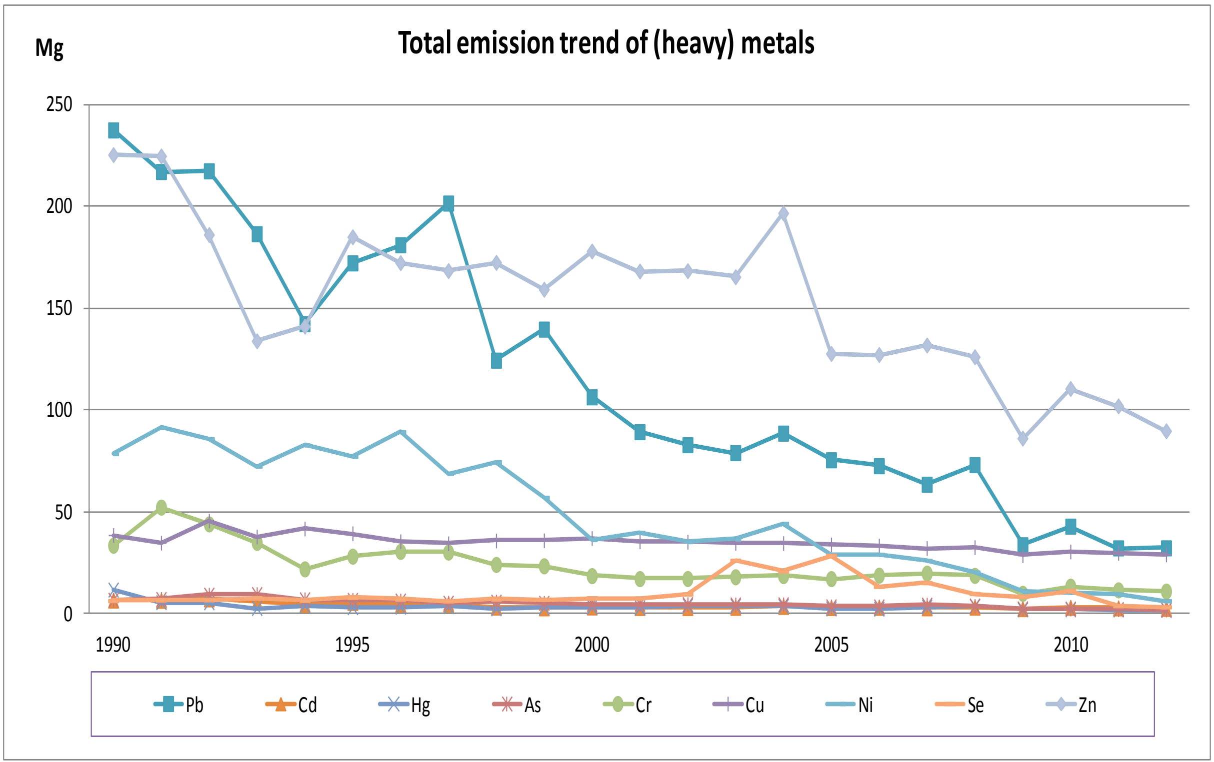
Figure 2.1 shows the trends of the national total emissions per pollutant group. Reasons for the changes in the time series are given in the next paragraphs.

Table 2.1 Absolute total emissions and absolute and relative differences for the time series 1990-2012

Pollutant	Unit	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012	absolute difference base-2012	relative difference base-2012
NOx	Gg as NO2	372	318	290	277	267	236	210	218	204	195	-177	-48%
NMVOC	Gg	284	179	146	142	133	127	115	117	105	104	-180	-63%
SOx	Gg as SO2	359	174	144	134	125	97	76	61	54	49	-310	-86%
NH3	Gg	121	86	72	72	69	69	69	69	68	68	-53	-44%
PM2.5	Gg	NR	40	36	36	34	35	32	36	29	32	-8	-21%
PM10	Gg	NR	52	45	46	43	43	39	43	36	39	-13	-26%
TSP	Gg	NR	77	68	68	63	63	53	58	50	54	-23	-30%
CO	Gg	1321	900	757	663	664	669	441	533	425	392	-928	-70%
Pb	Mg	237	106	75	72	63	73	34	43	32	32	-205	-86%
Cd	Mg	7	3	3	3	3	3	2	3	3	2	-4	-62%
Hg	Mg	12	3	2	2	3	4	2	2	2	2	-10	-86%
As	Mg	7	5	3	3	4	4	2	2	2	2	-5	-72%
Cr	Mg	33	19	17	19	20	19	10	13	12	11	-23	-67%
Cu	Mg	38	37	34	33	32	33	29	30	30	29	-10	-25%
Ni	Mg	78	36	29	29	26	20	11	10	9	6	-72	-92%
Se	Mg	6	8	29	13	15	10	8	11	4	3	-3	-48%
Zn	Mg	225	178	128	127	132	126	86	110	102	90	-136	-60%
PCDD/ PCDF	g I-Teq	542	113	57	53	54	66	47	52	45	52	-491	-90%
PAH	Mg	84	49	43	42	44	42	34	38	36	34	-49	-59%
HCB	kg	68	44	28	31	29	29	25	27	41	28	-40	-58%
HCH	kg	19481	3514	170	171	172	173	174	175	176	177	-19304	-99%
PCB	kg	112	96	73	84	67	68	15	96	58	10	-102	-91%


Gg
Total emission trend of main pollutants and CO
1400
1200
1000
800
600
400
200
0
1990
1995
2000
2005
2010
NOx
NMVOC
SOx
NH3
CO


Gg
Total emission trend of particulate matter
90
80
70
60
50
40
30
20
10
0
2000
2005
2010
PM2.5
PM10
TSP



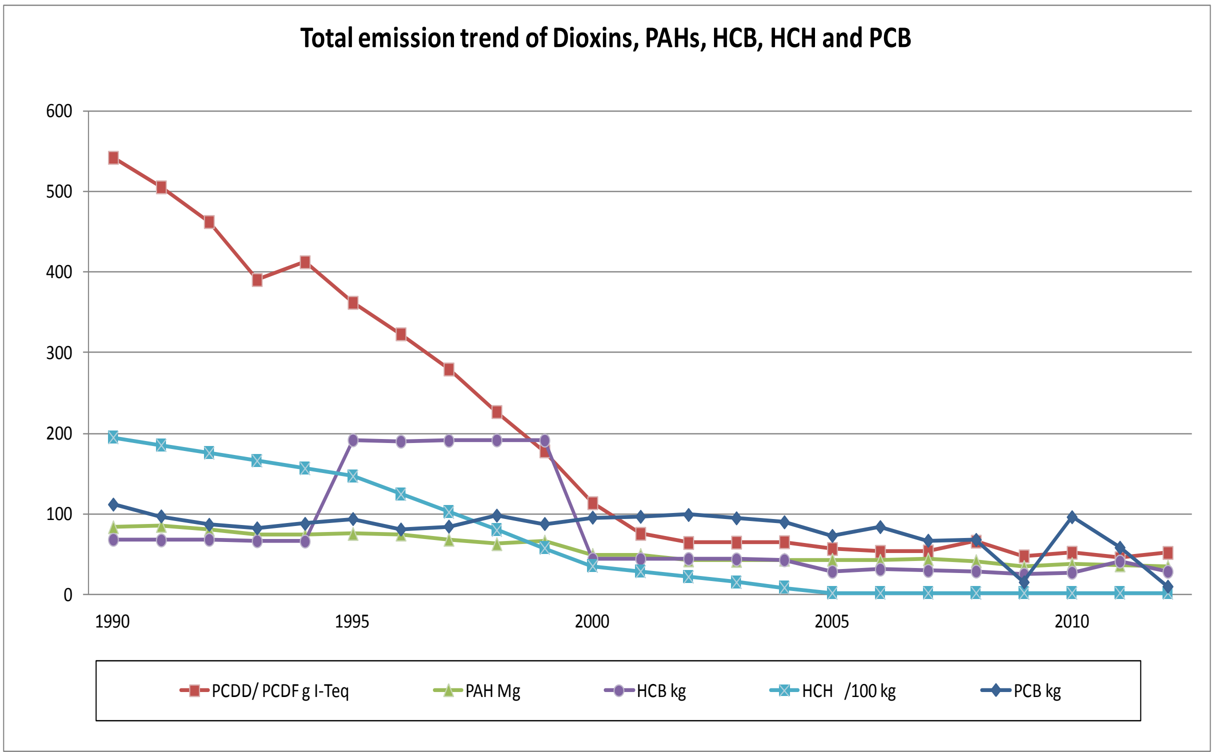


Figure 2.1 Time trends of Belgian total emissions

2.2. Trends/Time series inconsistencies: general explanations

Below, some general explanations are given for the occurring inconsistencies and changes in the time trends caused by the changes in emissions of the different sectors.

- In 1993 environmental legislation (Vlarem II) came into force in Flanders. This included a reporting obligation for class 1 industrial plants, which induced in some cases a difference in methodology to calculate/estimate emissions before and after 1993. In 1995 Vlarem II was extended with class 2 industrial plants and thresholds per pollutant. In 2004 the emission reporting (as part of the reporting of environmental data) was established by decree in the integrated annual environmental report (IMJV). The modification of some thresholds can result in the incomparability of emission data from 2004 on compared to the period before 2004 for e.g. some heavy metals. In Wallonia, IPPC plants have had to report their emissions since 2001 and it's sometimes difficult to make a recalculation before 2001 because of the lack of data.
- In Flanders, there is a different level of data handling in some years (1990- 1993, 1995, 1996, 1998, 2000, 2001, 2008-2012) compared to the other years (1994, 1997, 1999, from 2001 to 2007). In the former years emissions are available on installation level (SNAP code) and are allocated to the correspondent NFR code based on the correspondence table between SNAP and IPCC codes (http://www.eea.europa.eu/publications/EMEPCORINAIR5/BSVI_A.pdf), whereas in the latter years the emissions are available on a less detailed level (facility/sector level). A partition key based on the most recent detailed data (e.g. for emission data of 1999, the partition used in 1998 is applied for 1999) is used to attribute the emissions to the appropriate NFR code for the year where less detailed emission data are available.
- *Public electricity and heat production:* decrease of the emissions because of the introduction of highly performant power stations, application of technical measures and changeover to natural gas, use of fossil fuels with less sulphur, opting for renewable/less polluting fuels. Emissions of waste incineration with energy recuperation and emissions of CHP installations are allocated to the electricity sector.
- *Petroleum refining:* decrease of SO_x and NO_x to meet the bubble emission thresholds for 2010 as imposed by the Flemish Government (e.g. by desulphurization of the fuels used or by technical measures).
- *Manufacture of solid fuels:* decreasing emissions due to the closure of coke ovens in Brussels and Flanders, resp. in 1993 and 1996 and closure of the last Flemish mines in 1992.
- *Stationary combustion in manufacturing industries:* in general decreasing emission trends between 1990 and 2012 due to important efforts to reduce emissions. The decrease between 2008 and 2009 is mainly due to the crisis in the industry in this period.
- *Residential sector:* emissions are highly climate related. Fluctuations in emissions can also be attributed to a shift towards natural gas, the increasing number of households (with fewer persons per household), the limited isolation degree of the houses and the low compactness. Emissions of NMVOC and particulate matter increase due to the increased consumption of wood for heating.
- *Commercial/institutional sector:* as for the residential sector, emissions are highly climate related.
- *Road transport:* decrease of emissions of SO_x due to the use of fuels with low sulphur content (from 2003 on). A significant decline in Pb emissions occurs due to the use of unleaded petrol (from 2000 on) , but the emissions of the other heavy metals increase due to a higher fuel use. Due to the enhanced application of catalytic converters NO_x, CO and NMVOC emissions decrease, but NH_3 emissions increase. More stringent emission standards for diesel cars from 2005 induced lower emissions of particulate matter. *Railways:* decreasing emissions due to the gradual change of diesel trains towards less polluting alternatives. Decreasing emissions in particular for freight trains due to increased efficiency (more wagons per engine, better loading, …).
- *Inland shipping:* decrease of the emissions in 2009 due to the lower economic activity (crisis)
- *Maritime navigation:* gradual increase of emissions of most pollutants due to the expansion of the merchant fleet (number of services and magnitude of ships). Decrease of most emissions in 2009

due to the economic crisis, decrease of SO_2 emissions in international maritime navigation, as determined by the Marpol Convention (more stringent sulphur limits in 2008 and 2010)

- *National fishing:* decreasing emissions due to the scaling down of the sector.
- *Off*-road: decrease of SO_2 and Pb emissions due to the lower S and Pb content of the fuels used (contents taken from Mimosa)
- *Manure management:* significant decreases of NH_3 emissions in 1991 (Flemish Manure Decree of 23/1/1991), 2000 (MAP 2bis), 2003 (more stringent legislation) and 2007 (MAP 3, particular influence on emissions from cattle). Decrease of NH_3 emissions of poultry in 2003 due to the brake-out of bird flu and the subsequent extermination of poultry by the authorities. From 1990 to 1999 activity data are obtained from the yearly count of cattle, from 2000 on data are available from the Manure Bank of the Flemish Land Agency. In Wallonia, the reduction of livestock is a main driver for the decrease of emissions.
- *Fertilizer:* emissions are related to the amount of fertilizer used (depending on the price) and the type of fertilizer used (liquid fertilizer, ureum,…).
- *Fuel combustion in agriculture:* decreasing emissions (in particular emissions of heavy metals) due to the switchover towards less polluting fuels. Decrease of SO_2 emissions due to the lower S content in gasoil from 2008 on.
- Dioxin emissions of the *metallurgical sector* have decreased significantly due to emission reduction measures.
- PAH emissions of *wood preservation* have decreased significantly due to emission reduction measures in the sector.
- *Waste incineration:* global emissions have decreased significantly due to the (structural) reorganisation of the sector in 1994, which included also air purification measures. Moreover, in Flanders and Brussels, the emissions of waste incinerators with energy recuperation are reported under the sector 1A1a.
- An optimised methodology to estimate heavy metals emissions in Flanders is applied for the years 2000 to 2012. For some sectors, this might cause an inconsistency between the years before 2000 and the years from 2000 on.
- *Agriculture (other)*: HCH emissions of the use in pesticides have decreased significantly due to a ban on the use of HCH in Belgium from 2002.

2.3. Trends in key sectors of main pollutants, CO and PM

A great part of the trend in the absolute total emissions can be explained by the changes in key sector emissions. Therefore, an analysis was made of the key sector emissions throughout the time series for the NEC pollutants NO_x, NMVOC, SO_x and NH_3, for CO and PM10.

2.3.1. NO_x

The greatest contributors to NO_x emissions are the transport (passenger cars and heavy duty vehicles) and energy sector. The largest absolute emission reductions are made in these sectors. Consequently, this led to the decrease in total NO_x emissions from 372 Gg in 1990 to 195 Gg in 2012, which is a decline of 48% (figs. 2.2 and 2.3).

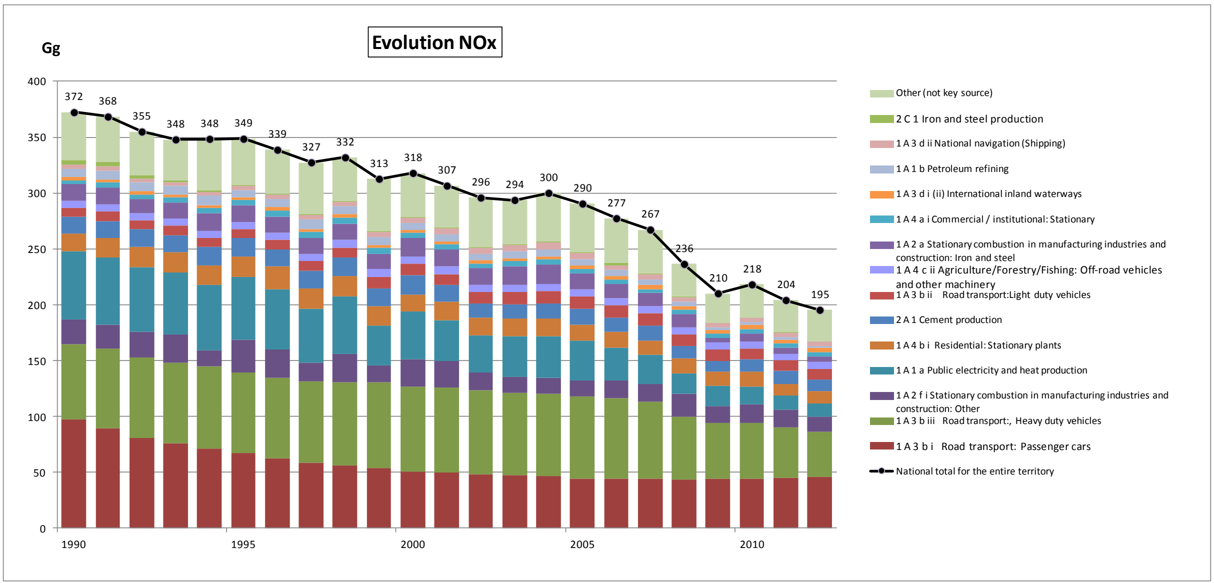


Figure 2.2 Trends in NOx emissions for the key sectors

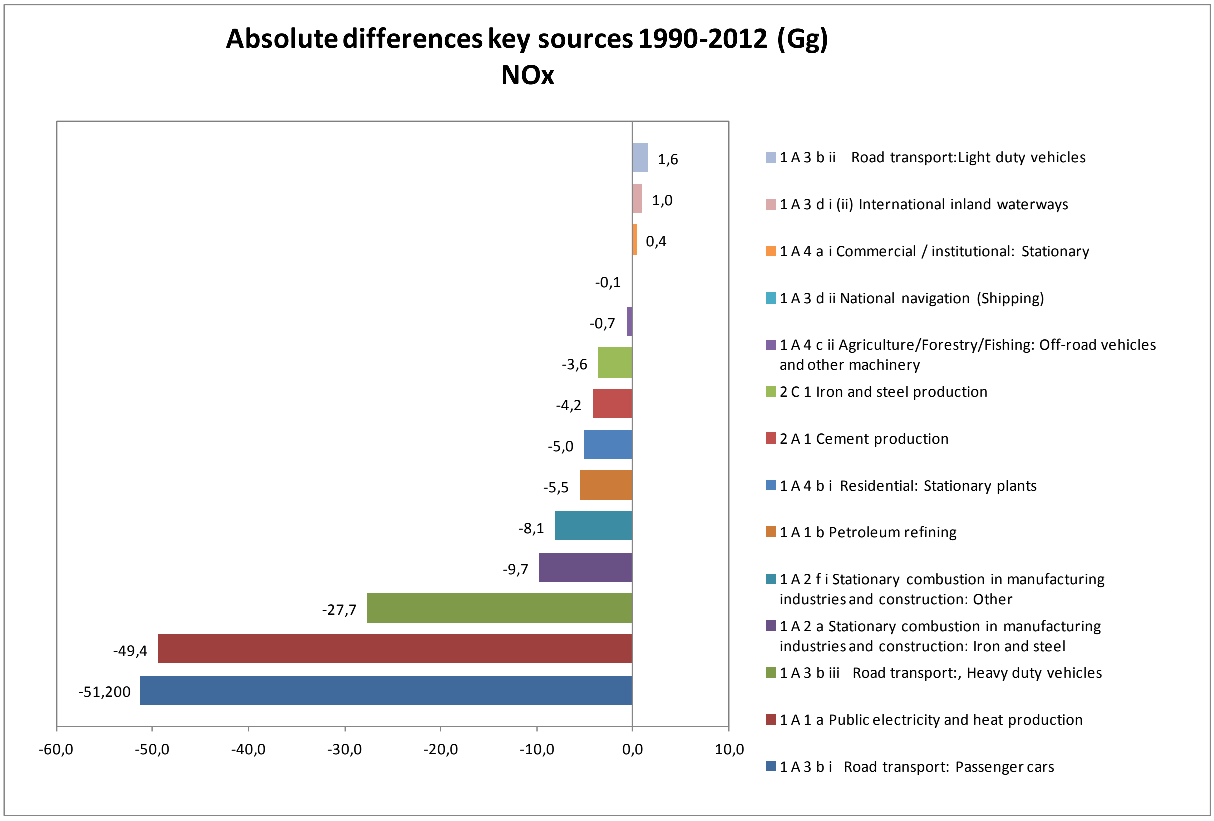


Figure 2.3 Absolute NOx emission differences from 1990 to 2012 for all key sectors

2.3.2. NMVOC

The emissions of NMVOC show a steady decrease between 1990 and 2012, from 284 Gg to 104 Gg (-63%, figs. 2.4 and 2.5). The largest absolute emission reductions are made in the transport sector (passenger cars). An explanation is the shift of fuel (gasoline to diesel oil). Other sectors with significant emission reductions are *Industrialcoating application* and *Other chemical industry*. A minor increase in the NMVOC emissions over the 23-years period is observed in the *Residential: stationary plants, domestic solvent use* and the *food and drink production*.

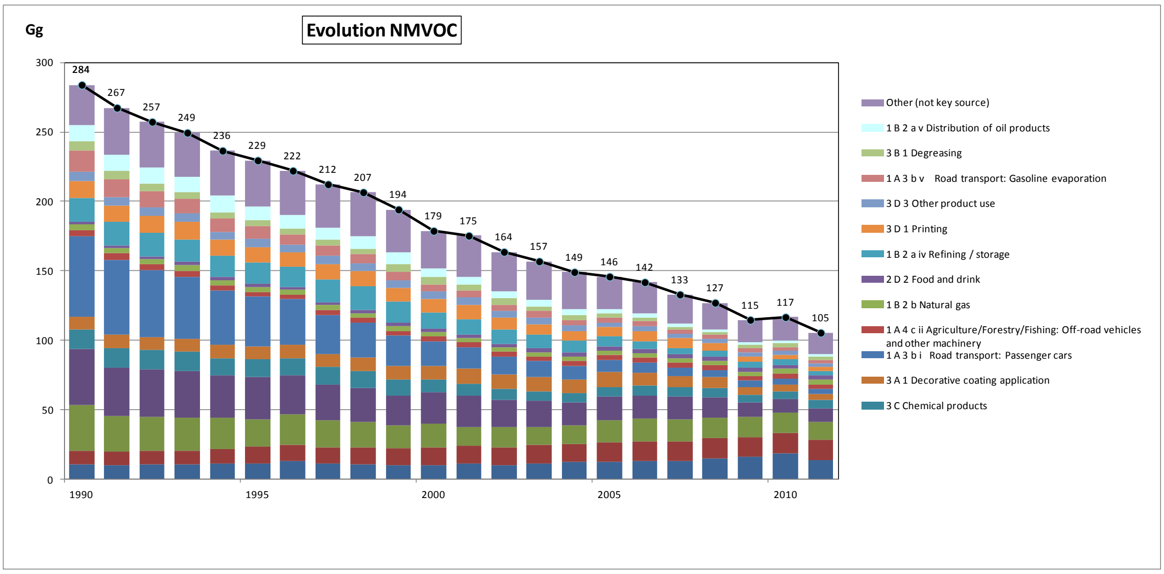


Figure 2.4 Trends in NMVOC emissions for the key sectors

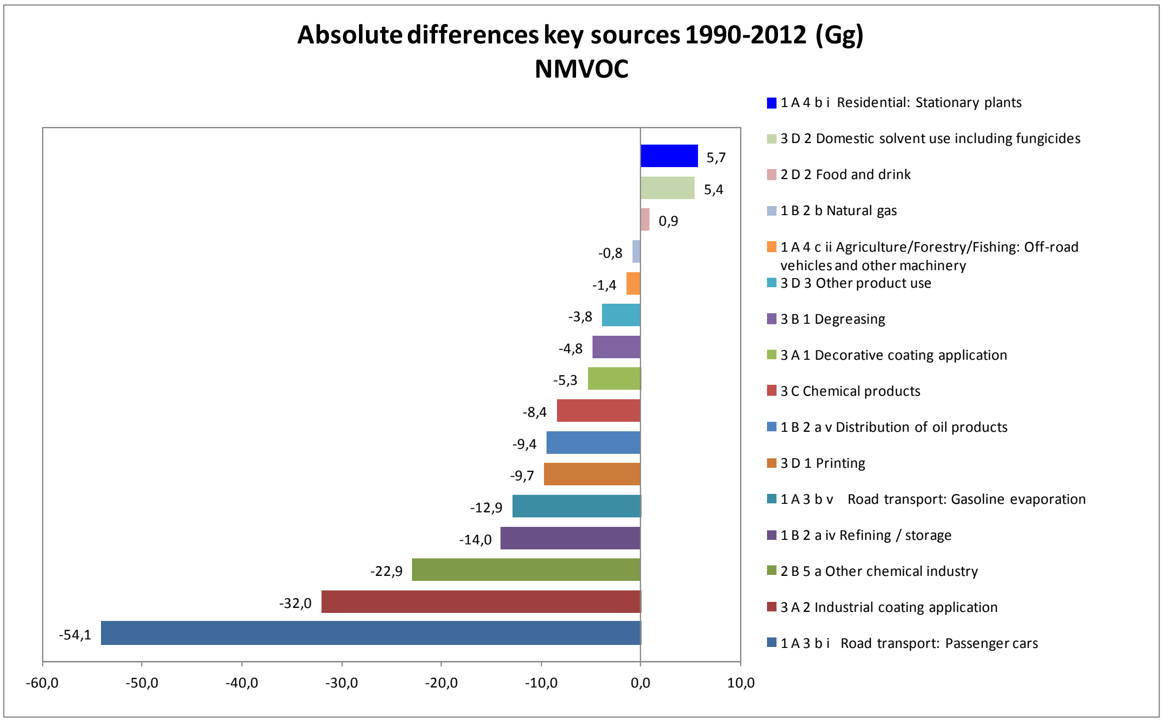


Figure 2.5 Absolute NMVOC emission differences from 1990 to 2012 for all key sectors

2.3.3. SO_x

SO_x emissions declined from 359 Gg in 1990 to 49 Gg in 2012, a reduction of 86% (figs. 2.6 and 2.7). This is largely due to the use of fuels with less sulphur in combustion in the energy and manufacturing industries.

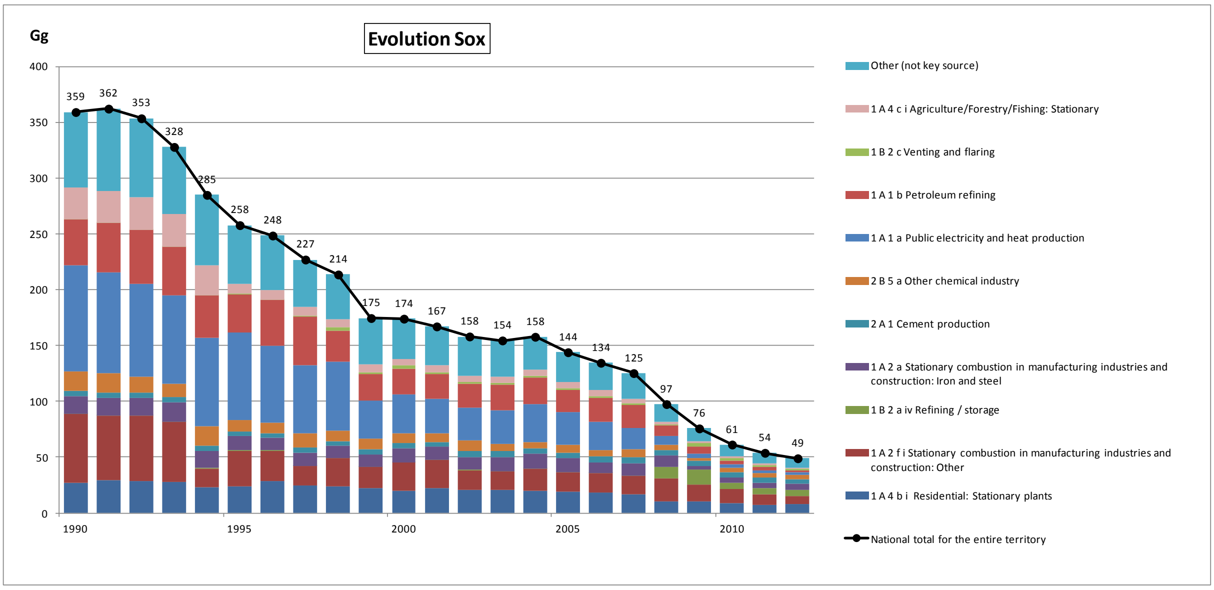


Figure 2.6 Trends in SO_x emissions for the key sectors

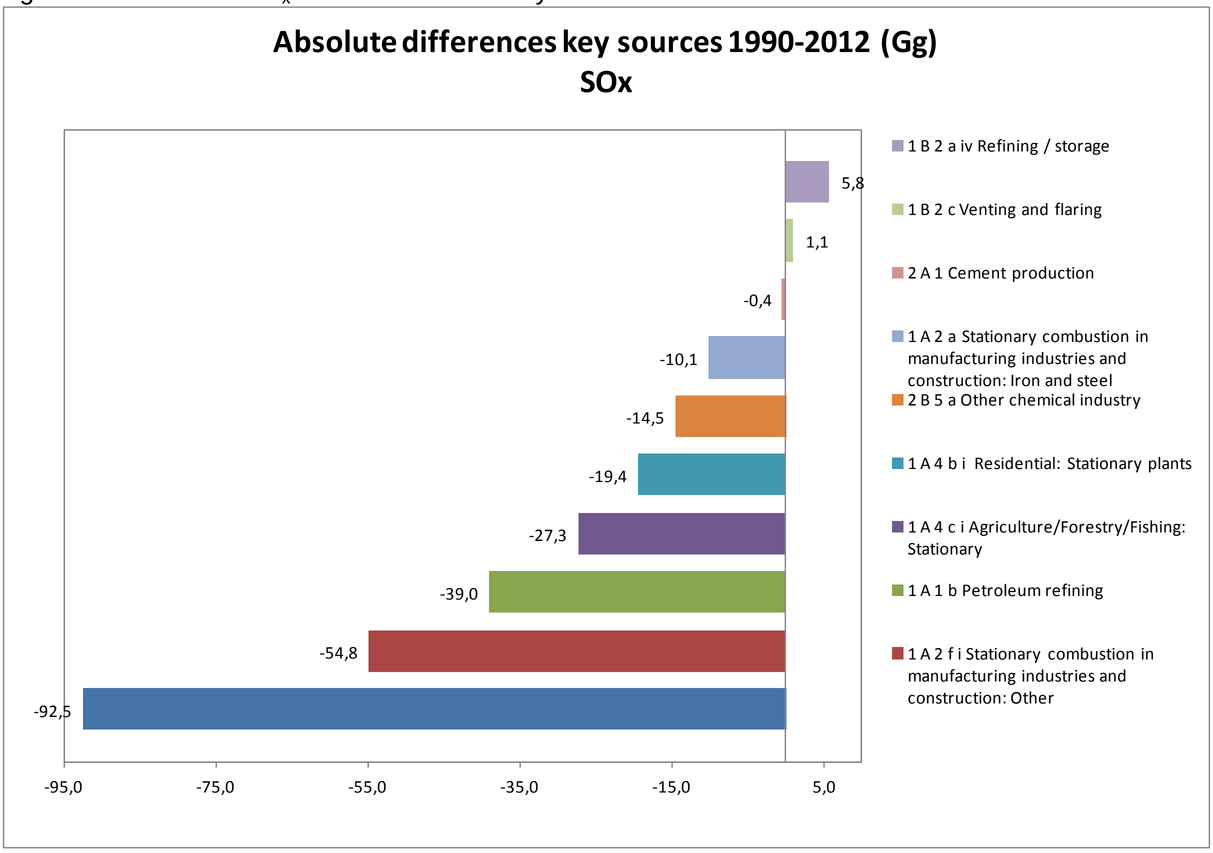


Figure 2.7 Absolute SO_x emission differences from 1990 to 2012 for all key sectors

2.3.4. NH3

In Belgium, over 90% of the NH_3 emissions are attributed to agricultural activities. Due to the successive Flemish Manure Decrees (1991, 2000, 2003 and 2007), focusing on including manure application and a reduction of the livestock population, the ammonia emissions show a reduction of 44% between 1990 and 2012 (figs. 2.8 and 2.9). In Flanders, more than half this reduction is attributed to the emission reduction of swine. In Wallonia, the decrease of emissions is driven by the reduction of livestock on the one hand and on the reduction of use of mineral fertilizer on the other hand. The latter is linked to the implementation of the Nitrates Directive (EC 91/676) and the Sustainable Nitrogen management program put in place for supervising and advising farmers with their formalities and ensuring compliance with the Directive objectives (http://www.nitrawal.be/101-documents-anglais.htm).

NH_3 emissions from the road transport sector increase significantly due to the use of catalytic converters.

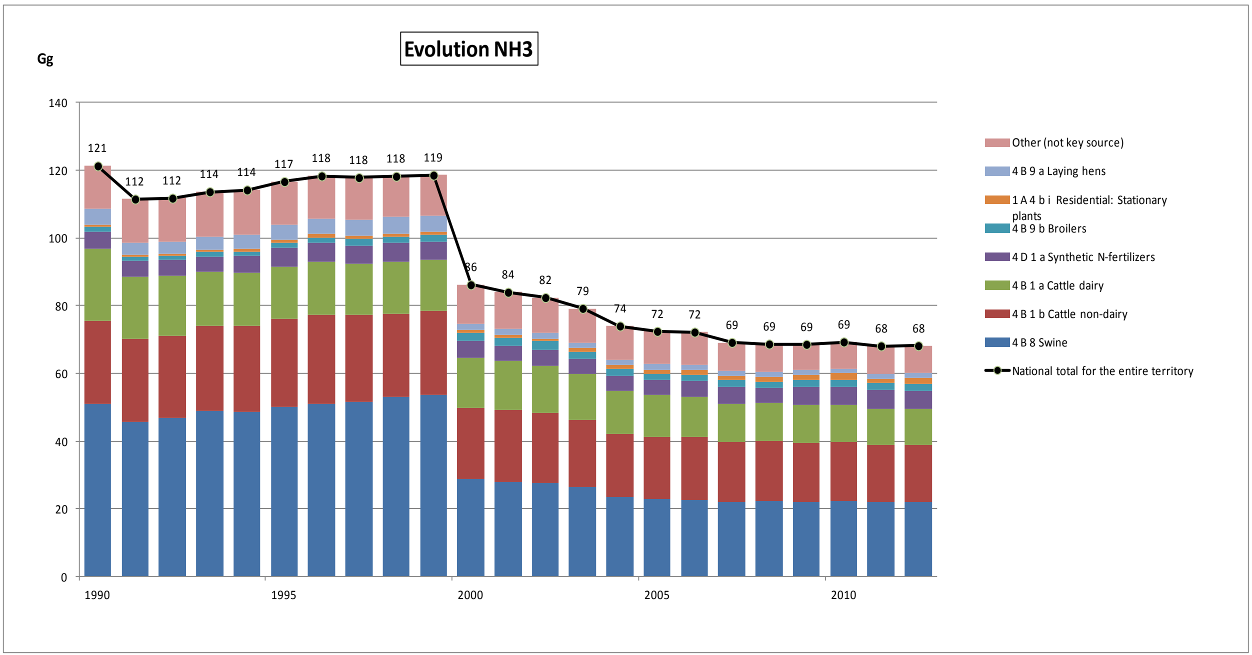


Figure 2.8 Trends in NH_3 emissions for the key sectors

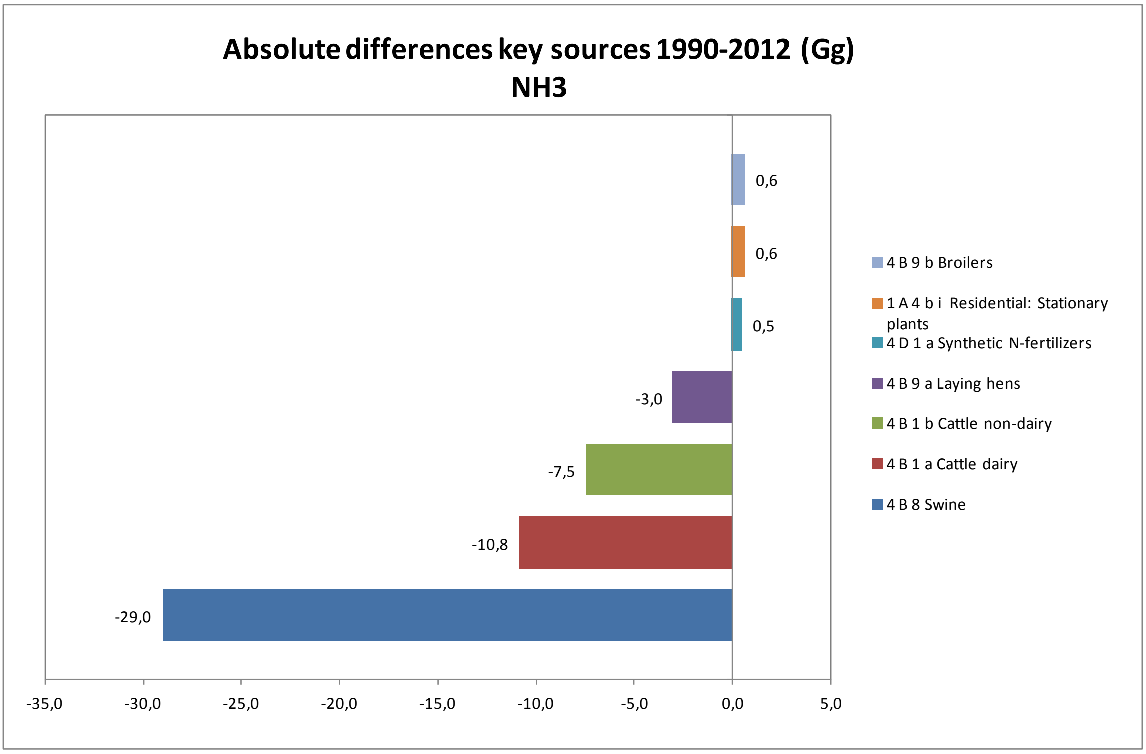


Figure 2.9 Absolute NH_3 emission differences from 1990 to 2012 for all key sectors.

2.3.5. CO

CO emissions decreased from 1321 Gg in 1990 to 392 Gg in 2012, a reduction of 70% (figs. 2.10 and 2.11). This is mainly due to the reductions realized in the road transport sector and the iron and steel industry. The drop between 2008 and 2009 is mainly due to the closure of some iron and steel plants in Wallonia during 2008 (one coking plant, one sinter plant and one blast furnace plant). There is still one coking plant in Wallonia in 2012. The last sinter plant and the last blast furnace closed in 2011.

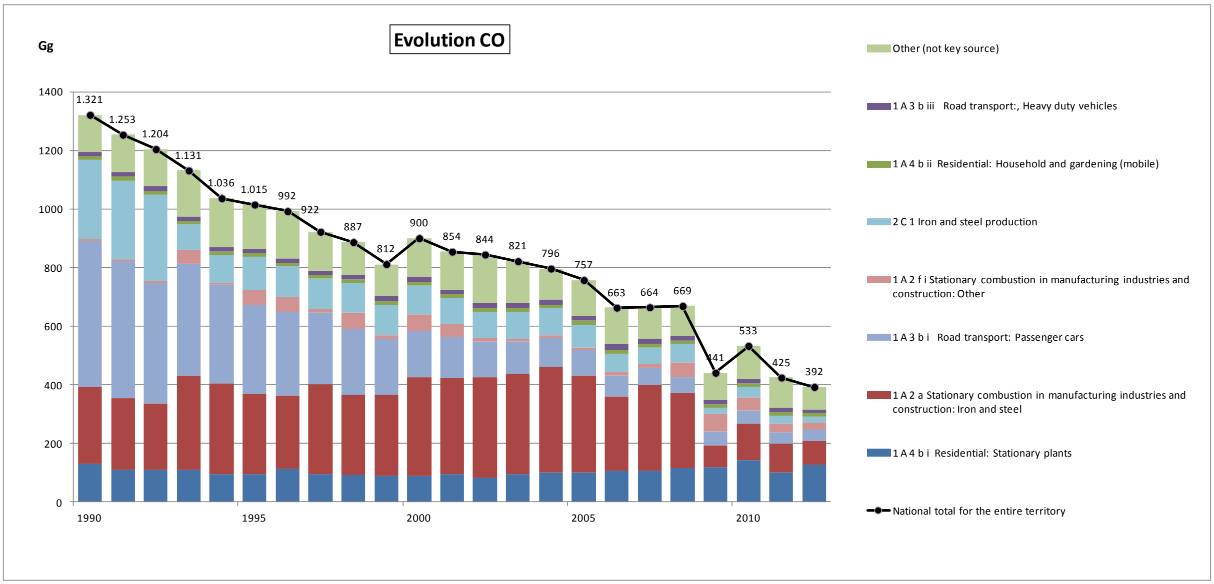


Figure 2.10 Trends in CO emissions for the key sectors

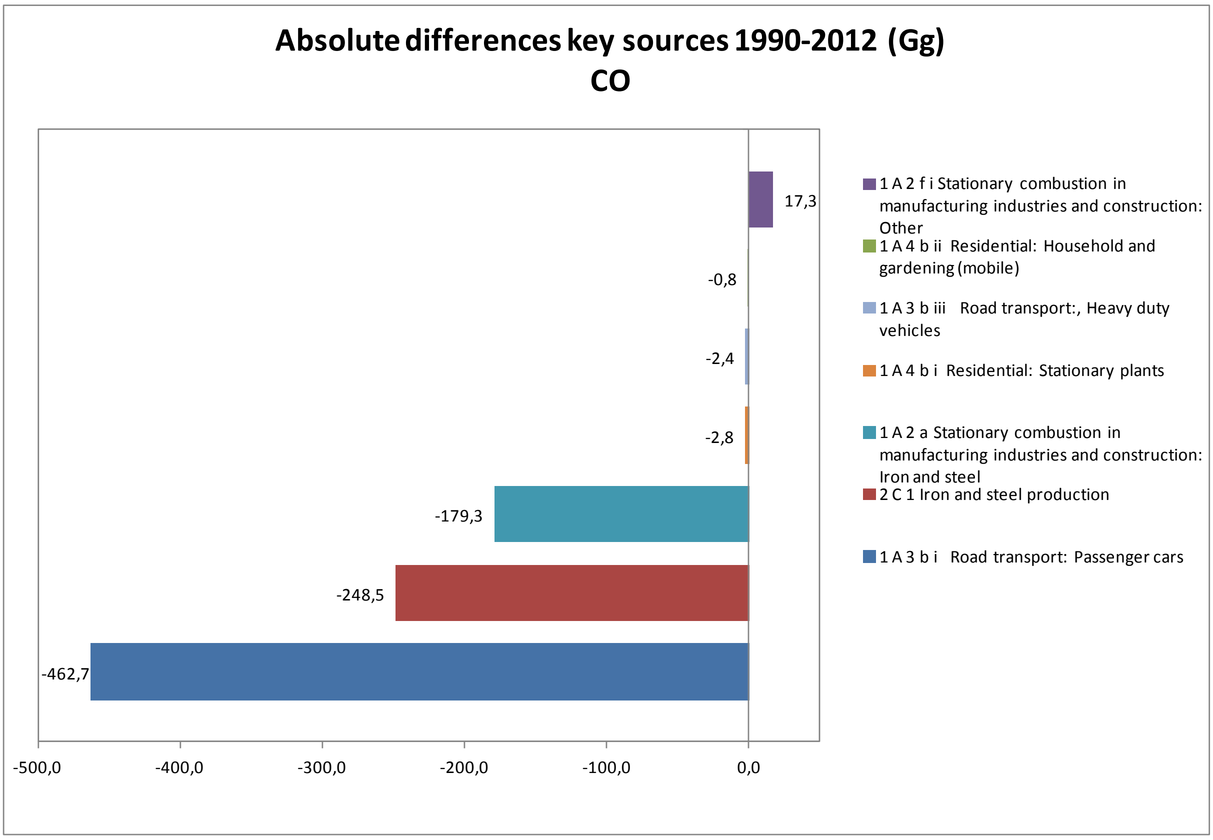


Figure 2.11 Absolute CO emission differences from 1990 to 2012 for all key sectors

2.3.6. PM10

PM10 emissions between 2000 and 2012 declined with 26%, from 52 Gg to 39 Gg (figs. 2.12 and 2.13). Many sectors contribute to the dust emissions. The sources with the largest absolute emission reductions are the iron and steel production, road transport (passenger cars and heavy duty vehicles) and the energy sector. The reduction in the transport sector is due to more stringent emission standards for diesel cars. Between 2008 and 2009 the emissions of the iron and steel production have been reduced significantly due to the closure of some iron and steel plants in Wallonia during 2008 (one coking plant, one sinter plant and one blast furnace plant). There is still one coking plant in Wallonia in 2012. The last sinter plant and the last blast furnace closed in 2011.

The emissions from the residential sector increase significantly over the last 13 years due to the increased use of wood for residential heating.

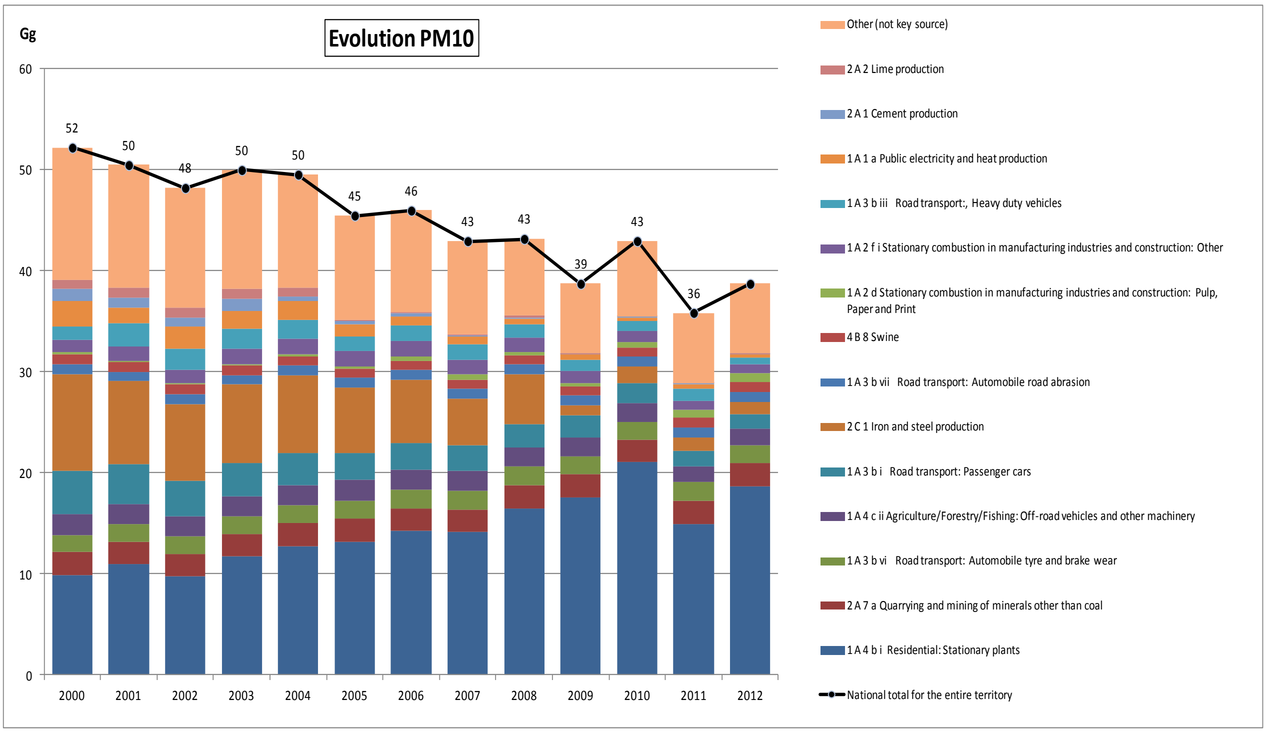


Figure 2.12 Trends in PM10 emissions for the key sectors

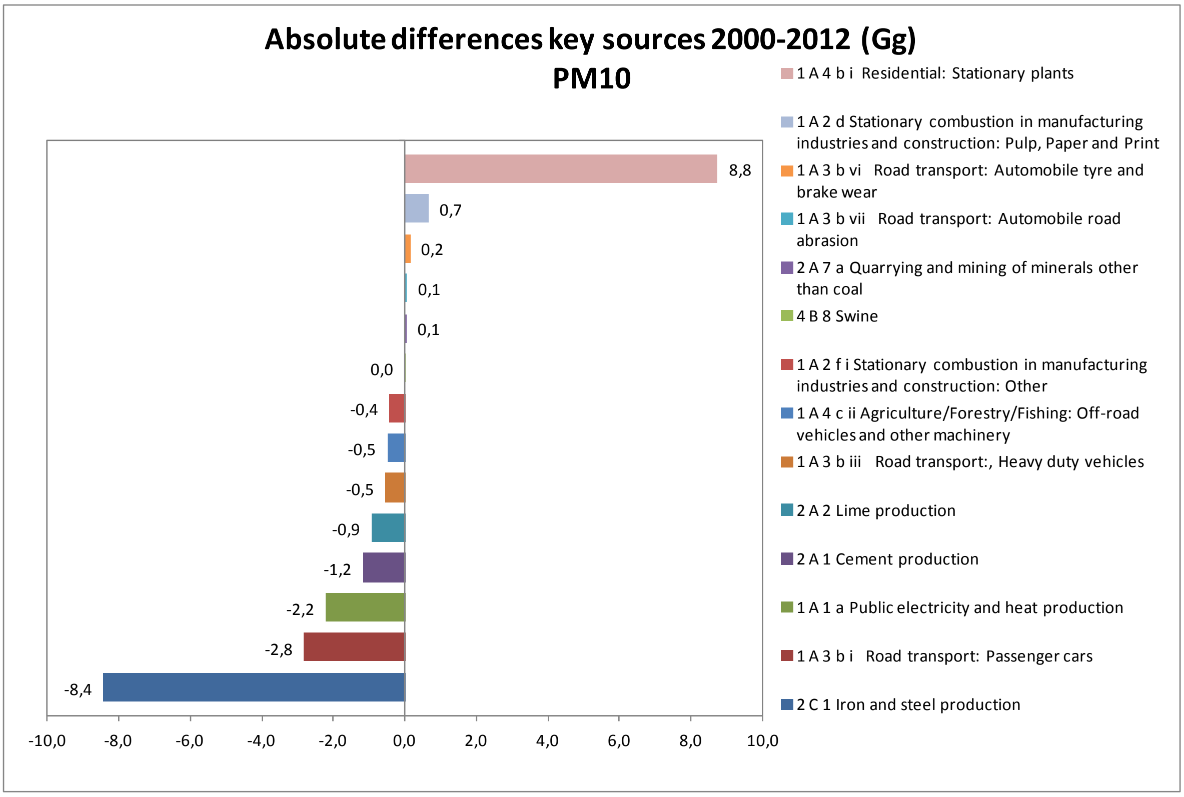


Figure 2.13 Absolute PM10 emission differences from 1990 to 2012 for all key sectors

Chapter 3. Energy (NFR sector 1)

3.1. Overview

This sector includes all combustion emissions (stationary and mobile combustion emissions). Furthermore, it includes fugitive emissions from the energy sector.

The emission data from this sector are based on calculations (fuel consumed x default emission factors) or on direct emission measurements.

To prepare the Belgian inventory for the energy sector, the regional energy balances of Flanders, Wallonia and Brussels are the prime source of activity data.

The main source of information on the industrial emissions is also obtained from the annual industrial reports.

To have a total picture of all emissions by industrial activities, also activities with emissions below the threshold have to be taken into account. These emissions are estimated in a collective way. The collective estimation of the emissions due to combustion processes is done by multiplying the energy data with default emission factors.

3.2. Energy industries (1A1)

3.2.1. Source category description (1A1)

The energy industries contain the following sectors: the public electricity and heat production, petroleum refining and the manufacture of solid fuels and other energy industries.

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

The following chart (fig. 3.1) shows the trend of the energy consumption in this sector :

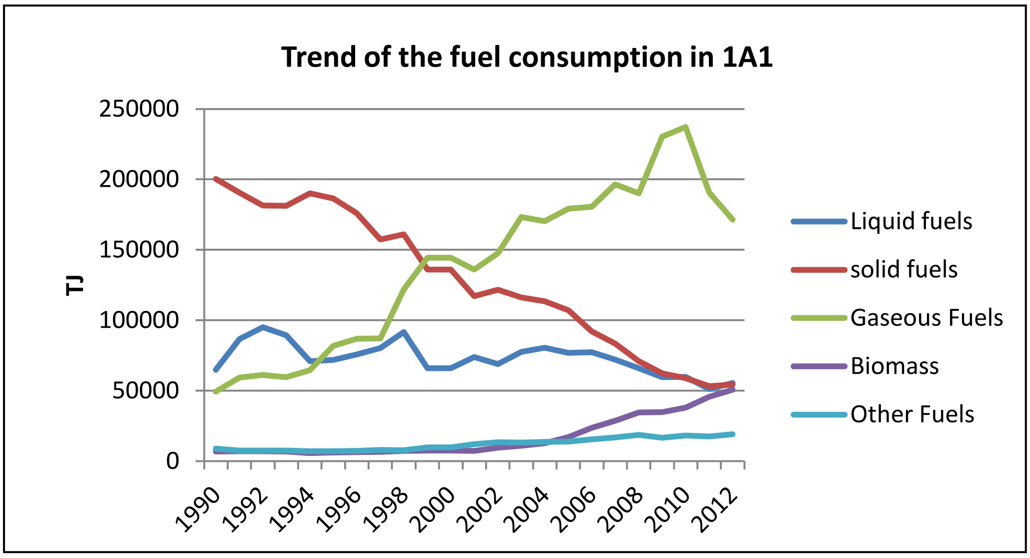


Figure 3.1 Trend of fuel consumption in the energy industries.

The emissions of the refineries, an activity which takes place only in the Flemish region, are allocated in the category 1A1b (combustion emissions) and in the category 1B2a (oil) (diffuse emissions) and in the category 1B2c (flaring emissions). The emissions of CHP of the refinery sector are allocated in 1A1a.

The emissions reported in category 1A1c 'Manufacture of Solid Fuels and Other Energy Industries' are the emissions coming from the combustion in the cokes ovens. Also the emissions of some energetic activities in the mines (mainly an auto-generator) in the Flemish and Brussels region during the beginning of the nineties are included in this category 1A1c. Fugitive emissions are reported in category 1B1b.

3.2.2. Methodological issues

Public electricity and heat production (1A1a)

This category contains the power installations for the production of electricity and heat, including turbojets, and the (other) combined heat-power (CHP) installations (in joint venture with the electricity producers). These latter installations are located in different sectors in Belgium (refineries, industry, agriculture and service sector). Also included in this sector are the waste incineration installations with energy recuperation (waste incineration installations without energy recuperation are allocated in the sector 6C).

Category 1A1a is a key category of NO_x, SO_x, Cd, Hg, As, Cr, Ni and Zn emissions in terms of emissions level and trend and a key category of PM2,5, PM10, TSP, Pb, Cu, PCDD/F and HCB emissions in terms of emissions trend.

The activity data reported in this sector are the fuel consumption data as reported in the regional energy balances.

The emission data are based on environmental annual reports submitted by the operator of the power plants, the waste incinerators and the industrial plants owning a CHP installation. If the installation is equipped with continuous measuring devices, the SO_2, NO_x, TSP and CO emissions are based on continuous analyses in the chimneys.

For the estimation of other air pollutants and when there aren't plant specific data or the installation is not equipped with continuous measurement devices, emission factors were used. Emission factors used in the three regions are given below (tables 3.1 to 3.12).

Table 3.1 Emission factors for the sector 1A1a Public electricity and Heat Production in the Walloon region (EMEP/EEA Guidebook 2009-MNZ)

Fuel	UNIT	NMVOC	CO	NH_3	PM2,5	PM10	TSP
Coal	g/GJ	1,2	15	0,4	Plant specific	Plant specific	Plant specific
Fuel	g/GJ	0,8	5	0,1	13	18	25
diesel oil	g/GJ	0,8	15	0,1	1	2	3
Diesel oil (in gas turbine)	g/GJ	0,2		0,1	3	3	3
natural gas (in gas turbine and in heat & gasturbines)	g/GJ	1	39	0,6	0,9	0,9	0,9
natural gas	g/GJ	1,5	39	0,6	0,9	0,9	0,9
Cokes gas	g/GJ	2,5	10	0,87	5	5	5
Wood (< 50 MWth)	g/GJ	146	1596	7	149	149	156
Wood (> 50 MWth)	g/GJ	7,3	258	7	Plant specific	Plant specific	Plant specific
Biogas (stat. engines))	g/GJ	2.5	13				

Fuel	As	Cd	Cu	Cr	Ni	Pb	Se	Zn	Hg	Diox	PAH (4)	HCB	PCB
UNIT	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ	µg/GJ	µg/GJ
Coal	PS	PS	PS	PS	PS	PS	PS	PS	PS	10	1.12	0.62	170
Fuel	4.3	1.3	5.7	2.7	273	4.9	2.2	94	0.4	2.5	10.5		
diesel oil	1.8	1.4	2.7	1.4	1.4	4.1	6.8	1.8	1.4	1.5	10.5		
natural gas	0.09	0.5	0.4	0.7	1	0.2	0.01	14	0.1	0.5	0.003		
Wood	PS	PS	PS	PS	PS	PS	PS	PS	PS	50	1.55	6	60

Emission factors of NMVOC, CO, NH_3 and PM10 for the sector 1A1a Public electricity and Heat Production in the Brussels region are given in table 3.18.

Table 3.2 Emission factors of NMVOC, CO, NH_3 and PM10 for the sector 1A1a Public electricity and Heat Production in the Brussels region.

Fuel	UNIT	NO_x	NMVOC	CO	NH_3	PM10
Natural gas	g/GJ	100	2.5	20	-	0
Waste	g/tonne	315.4	20	41.71	9	2.67

The Flemish emission factors to calculate NO_x emissions are given below. The emissions are calculated based on electricity production only (final net).

Table 3.3 Emission factors of NO_x for the sector 1A1a Public electricity and Heat Production in the Flemish region

Installation	Unit	Emission factor	Source
CHP (power plant) - existing	g/MWhe	280	MBO*
Gas motor - existing	g/MWhe	1.400	MBO
Diesel motor - existing	g/MWhe	5.000	MBO

CHP (power plant) - new	g/MWhe	100	MBO
Gas motor - new	g/MWhe	1.000	MBO
Diesel motor - new	g/MWhe	1.500	MBO
Turbojets	g/MWhe	3000	Emission measurements
Open cycle gasturbines	g/MWhe	1500	Emission measurements
Steam power plant Alost	kg/kNm3	1.6	US-EPA

*MBO: Environmental Policy Agreement

The calculation of SO_2 emissions originating from installations not equipped with continuous measurements is not applicable: it concerns gas turbines, CHP, gas motors (all burnt on gas) or turbojets (use of fuel with very low sulphur content).

The emission factors used to calculate the emissions of NMVOC are adjusted with rest factors for FGD (flue gas desulphurisation) and SCR (selective catalytic reduction). A distinction is made between normal boilers and gas turbines (GT).

Emissions calculation:

$$Em(kg) = \frac{M\ (GJ) \times EF\ \left(\frac{g}{GJ}\right)}{1000} \times \frac{RF_{FGD}}{100} \times \frac{RF_{SCR}}{100}$$

Table 3.4 Emission factors of NMVOC for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Unit	Emission factor - uncontrolled	RF-FGD	RF-SCR	Source
Coal	g/GJ	0,4	1	0,3	Eurelectric
Water treatment sludge	g/GJ	10	1	0,3	VMM + Eurelectric for reduction
Olive stones	g/GJ	10	1	0,3	VMM + Eurelectric for reduction
Wood dust	g/GJ	10	1	0,3	VMM + Eurelectric for reduction
Wood chips	g/GJ	10	1	0,3	VMM + Eurelectric for reduction
Wood pellets	g/GJ	10	1	0,3	VMM + Eurelectric for reduction
Biodust	g/GJ	10	1	0,3	VMM + Eurelectric for reduction
Fuel A	g/GJ	0,6	1	0,3	Eurelectric
Gas oil	g/GJ	7,5	1	1	VMM
Gasoil – gas turbine	g/GJ	1,5	1	1	Eurelectric
Paraffin	g/GJ	3	1	1	CITEPA
Natural gas	g/GJ	1	1	0,3	VMM + Eurelectric for reduction
Natural gas – gas turbine	g/GJ	0,5	1	1	Eurelectric
Blast-furnace gas	g/GJ	0	1	1	VMM

An emission factor of 8 mg CO/Nm^3 flue gas is applied for gas-fired installations not equipped with continuous measurement devices (based on continuous measurements of other similar installations).

Although the TSP emissions originating from installations not equipped with continuous measurement devices are very low per unit fuel (installation groups fed with natural gas, blast-furnace gas, gas oil and paraffin or lamp oil), the high volumes of fuel burnt cause a significant emission. The emission factors used to calculate the emissions of TSP are adjusted with rest factors for ESP (electrostatic precipitation for thermal power plants), FGD and SCR.

Emissions calculation:

$$Em(ton) = \frac{M\ (GJ) \times EF\ \left(\frac{g}{GJ}\right)}{1.000.000} \times \frac{RF_{ESP}}{100} \times \frac{RF_{FGD}}{100} \times \frac{RF_{SCR}}{100}$$

Table 3.5 Emission factors of TSP for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Unit	Emission factor	RF_{ESP}	RF_{FGD}	RF_{SCR}	Source
Gas oil	g/GJ	3	0,01	0,1	1	CORINAIR
Paraffin	g/GJ	3	0,01	0,1	1	CORINAIR
Natural gas	g/GJ	0,005	0,01	0,1	1	CORINAIR
Blast-furnace gas	g/GJ	0,1	0,01	0,1	1	CORINAIR

Emissions of PM10 and PM2,5 are calculated as a fraction of TSP:

$$Em_{PM10}\,(ton) = Em_{TSP}\,(ton) \times \frac{\%PM10}{100}$$

$$Em_{PM2,5}\,(ton) = Em_{TSP}\,(ton) \times \frac{\%PM2,5}{100}$$

The percentages applied per power plant are given below:

Table 3.6 Percentages of PM10 and PM2,5 as a fraction of TSP per power plant

Power Group	%PM10	%PM2,5	Source
EDF Luminus Gent	80	70	VITO
EDF Luminus Harelbeke	80	70	VITO
E.on Langerlo	100	100	CORINAIR
Kallo 1	100	100	CORINAIR
Kallo 2	100	100	CORINAIR

Mol 12	64,4	32,7	LBE-2001
Rodenhuize 2	100	100	CORINAIR
Rodenhuize 3	100	100	CORINAIR
Rodenhuize 4	78,2	32,3	LBE-2001
Ruien 3	67	29	EPA
Ruien 4	67	29	EPA
Ruien 5	46	33	LBE-2008
Ruien 6	100	100	CORINAIR
Ruien after deSO$_x$	71	51	EPA
Turbojets	100	100	CORINAIR
Gas groups	100	100	CORINAIR
A&S Energie	71.43	34.30	EMEP/EEA Guidebook

Heavy metals can come from various fuels. Depending on the fuel and the type of installation different techniques will be used and/or be combined.

In case one features analyses of the flue gases, these will be used at first to determine the emissions of heavy metals (this will particularly be the case at sites with flue gas desulphurisation (FGD)). In case no such measurements are available, or for certain heavy metals the emission was not determined by the flue gas analysis, one can use the following techniques:

- gaseous fuels (natural gas and blast furnace gas): use of emission factors
- liquid fuels (heavy fuel, gas oil and lamp oil): use of emission factors
- solid fuels (coal, biofuels): method based on the emission rates determined by Laborelec and elementary analyses of the solid fuels.

In certain cases, one shall combine techniques when:

- the flue gas analysis does not cover all the necessary parameters: combination of the flue gas analyses with 1 or more other techniques (emission factors/calculation on the basis of the analyses on the solid fuel). The missing parameters will be completely replaced by the alternative calculation.
- another emission point (chimney) is used for the same group, but no flue gas analyses are available: use of 1 or more other techniques for the whole calculation of the emissions through the other chimney, taking into account the utilization rate of the chimneys (split factor).

Heavy metals from solid fuels

Calculation based on flue gas analyses

Where analyses of the flue gases (min. 1 per year) are available for the installation, these measurements are used to determine the annual emissions of heavy metals.
Emissions calculation:

$$Em_{ZM1}\left(\frac{kg}{y}\right) = \frac{AW_{ZM1}\left(\frac{mg}{Nm^3}\right) \times V_{RG}\left(\frac{Nm^3}{y}\right)}{1.000.000}$$

with :

- Em_{ZM1} : annual emission of the heavy metal considered
- AW_{ZM1} : average analysis value of the heavy metal in the dry flue gases at a specific oxygen content (e.g. 6% O_2)
- V_{RG} : Volume of the flue gases on yearly basis

Calculation from fuel analyses

If no analyses of the flue gases are available or parameters are missing in the existing flue gas analyses, the emissions of the heavy metals are calculated using the fuel analyses.

<u>Calculation of the emission per heavy metal per amount of fuel:</u>

$$Em_{ZM1}(kg) = \left[\frac{M\,(ton) \times 1000 \times \frac{As\,(\%)}{As_{std}\,(\%)} \times \frac{PM_{inst-av}\,(\frac{mg}{Nm^3})}{PM_{std}(\frac{mg}{Nm^3})} \times AW_{ZM1}\left(\frac{mg}{kg}\right) \times \frac{EP_{solid-ZM1}}{100}}{1.000.000} + \frac{M\,(ton) \times 1000 \times AW_{ZM1}\left(\frac{mg}{kg}\right) \times \frac{EP_{gas-ZM1}}{100}}{1.000.000}\right] \times \frac{RF_{FGD}}{100}$$

with :

- M : the amount of dry fuel expressed in tons. This may be the total annual quantity, or the quantity per batch delivered. The data comes from Michelangelo and is provided by TDM. However, the raw data is the wet quantity, so that it has to be converted first to the dry quantity by means of the moisture content.

$$M_{dry\,(ton)} = M_{wet}\,(ton) \times \frac{100 - moisture\ content}{100}$$

- As : the ash content of the fuel, either coming from Michelangelo and provided by TDM, either submitted by external analyses, provided by Fuel Procurement.
- As_{std} : standard ash content that was used in the study of Laborelec to determine the emission rates. this default percentage should be calculated to the current ash-percentage. It amounts to 18.5%.
- $PM_{inst-av}$: the (weighted) yearly average dust emission for the set of groups for which the calculation is performed, expressed in mg/Nm3 at 0% O_2 and dry flue gases. The data is available in Image and is provided by TDM.
- PM_{std} : standard dust emission that was used in the study of Laborelec to determine the emission rates. The default percentage should be calculated to the current dust emission (100 mg/Nm3 at 0% O_2)
- AW : the analysis value of the heavy metal in the solid fuel. This information is taken from the external analysis reports provided by Fuel Procurement

- EP_{solid} : the emission rate for a particular heavy metal in terms of emissions in ash-bound state. The bulk of the heavy metals emitted is adsorbed on the fly ashes.
- EP_{gas} : the emission rate for a particular heavy metal in terms of emissions in the volatile state. Only a few heavy metals are emitted in volatile state.
- RF_{FGD} : the rest factor as a result of the presence of a FGD installation (flue gas desulphurisation). For the heavy metals this factor is put at 100% because the effect of the FGD is already taken into account by reduced dust emissions. Only heavy metals that are emitted in volatile state are even further reduced by the FGD.

Table 3.7 Factors to calculate emissions of heavy metals for the sector 1A1a Public electricity and Heat Production in the Flemish region based on fuel analyses

Parameter	EP_{solid} (%)	EP_{gas} (%)	RF_{FGD} (%)
As	2,42	0	100
Cd	2,56	0	100
Cr	0,84	0	100
Cu	1,03	0	100
Ni	1,1	0	100
Pb	1,54	0	100
Se	1,69	20,2	55
Zn	1,96	0	100
Hg	-	100	15

Conversion of delivered to consumed solid fuels:

the quantities of solid fuels available in Michelangelo are delivered quantities. To know the exact emissions, these values must be converted into the amount of fuel consumed

$$Em_{ZM1-used}\ (kg) = Em_{ZM1}\ (kg) \times \frac{M_{total}\ (ton) - \Delta stock\ (ton)}{M_{total}\ (ton)}$$

with :

- M_{total} : the total annual amount of delivered fuels
- Δstock : the stock difference between the end of the year and the beginning:

$$\Delta stock = stock_{31/12/yyyy} - stock_{1/1/yyyy}$$

Heavy metals from fluid fuels (fuel A and gas oil)

The emission factors shown are intended for installations without any form of dust reduction measures or NO_x or SO_2 reduction measures. So a rest factor must be used according to the availability of certain installations :

- ESP : dust reduction via electrostatic dust filter (or sleeve filter)

- FGD : SO_2-reduction via FGD
- SCR : NO_x-reduction via Selective Catalytic Reduction (SCR)

Table 3.8 Emission factors for heavy metals from fluid fuels for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel		Emission factor - uncontrolled (g/ton)	RF_{ESP}	RF_{FGD}	RF_{SCR}	source
Fuel A	As	0,081	0,01	0,1	1	EPA (CORINAIR for reductions)
Fuel A	Cd	0,051	0,1	0,1	1	EPA (CORINAIR for reductions)
Fuel A	Cr	0,139	0,01	0,1	1	EPA (CORINAIR for reductions)
Fuel A	Cu	0,223	0,01	0,1	1	EPA (CORINAIR for reductions)
Fuel A	Hg	0,014	0,965	0,05	1	EPA (CORINAIR for reductions)
Fuel A	Ni	10,723	0,01	0,1	1	US-EPA + CORINAIR for reductions
Fuel A	Pb	0,192	0,1	0,1	1	US-EPA + CORINAIR for reductions
Fuel A	Se	0,087	0,235	0,24	1	US-EPA + CORINAIR for reductions
Fuel A	Zn	3,693	0,1	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	As	0,074	0,01	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	Cd	0,0555	0,1	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	Cr	0,0555	0,01	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	Cu	0,111	0,01	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	Hg	0,0555	0,965	0,05	1	US-EPA + CORINAIR for reductions
Gas oil	Ni	0,0555	0,01	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	Pb	0,1665	0,1	0,1	1	US-EPA + CORINAIR for reductions
Gas oil	Se	0,2775	0,235	0,24	1	US-EPA + CORINAIR for reductions
Gas oil	Zn	0,074	0,1	0,1	1	US-EPA + CORINAIR for reductions

Emissions calculation :

$$Em_{ZM1}(kg) = \frac{M\ (ton) \times EF\ \left(\frac{g}{ton}\right)}{1000} \times RF_{ESP} \times RF_{FGD} \times RF_{SCR}$$

Heavy metals from gaseous fuels (natural gas and blast-furnace gas)

Only mercury and selenium are considered, given their volatility.

The emission factors shown are intended for installations without any form of dust reduction measures or NO_x or SO_2 reduction measures. So a rest factor must be used according to the availability of specific installations:

- ESP : dust reduction via electrostatic dust filter (or sleeve filter)
- FGD : SO_2-reduction via FGD
- SCR : NO_x-reduction via Selective Catalytic Reduction (SCR)

Table 3.9 Emission factors for heavy metals from gaseous fuels for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel		Emissiefactor - uncontrolled (g/kNm³)	RF_{ESP}	RF_{FGD}	RF_{SCR}	Source
Natural gas	Hg	0,00416	0,965	0,05	1	US-EPA + CORINAIR for reductions
Natural gas	Se	0	0,235	0,24	1	US-EPA + CORINAIR for reductions
Blast-furnace gas	Hg	0,0000625	0,965	0,05	1	NPI + CORINAIR for reductions

Emission calculations:

$$Em_{ZM1}(kg) = \frac{M\ (kNm^3) \times EF\ \left(\frac{g}{kNm^3}\right)}{1.000} \times RF_{ESP} \times RF_{FGD} \times RF_{SCR}$$

The calculation of emissions of the PAHs benzo(a)pyrene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and benzo(b)fluoranthene is based on emission factors, which are given in table 3.10.

Table 3.10 Emission factors for PAH(4) for the sector 1A1a Public electricity and Heat Production in the Flemish region

g/GJ	benzo(a) pyrene	benzo(k) fluoranthene	indeno(1,2,3-cd)pyrene	benzo(b) fluoranthene	source
coal	6,80E-08	0	1,09E-06	0	EPA
gas oil	0	0	0	0	EPA
gas oil gas turbine	0	0	0	0	Econotec
heavy fuel	0	0	6,40E-06	0	EPA
natural gas	2,55E-07	3,80E-07	3,80E-07	3,80E-07	Econotec
blast-furnace gas	0	0	0	0	Econotec
sludge, olive stones, wood dust, pellets, coffee, wood chips, biodust	8,00E-05	0	0	0	CORINAIR
biofuel	0	0	0	0	EPA

The calculation of emissions of dioxins and furans (PCDD/PCDF) is based on emission factors, representing the sum of PCDDs and PCDFs. The emission is expressed in mg I-TEQ (International toxic equivalent).
It is assumed that only FGD affects the PCDD/PCDF-emissions. A distinction should be made between normal boilers and gas turbines.

Table 3.11 Emission factors for PCDD/PCDF for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Emission factor (mg I-TEQ/TJ)	RF_{FGD}	source
Coal	0,000417	0,0124	Analyses by the power plants
Water treatment sludge	0,000417	0,0124	Analyses by the power plants
Olive stones	0,000417	0,0124	Analyses by the power plants
Wood dust	0,00163	0,0124	ESI
Wood chips	0,00163	0,0124	ESI
Wood pellets	0,00163	0,0124	ESI
Biodust	0,00163	0,0124	ESI
Fuel A	0,00124	0,0124	ESI
Gas oil	0,0009	0,0124	ECONOTEC
Gas oil – gas turbine	0,0005	0,0124	ECONOTEC
Paraffin	-	-	ECONOTEC
Natural gas – gas turbine	0	-	-
Natural gas – gas turbine	0	-	-
Blast-furnace gas	0	-	-

Emission calculation:

$$Em\ (mg\ I-TEQ) = \frac{M\ (GJ) \times EF\ \left(\frac{mg\ I-TEQ}{TJ}\right)}{1000} \times \frac{RF_{FGD}}{100}$$

The calculation of the emissions of polychlorinated biphenyls (PCB) is based on emission factors, representing the sum of PCBs.

It is assumed that neither FGD nor SCR affect the PCB emissions.

Table 3.12 Emission factors for PCBs for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Emission factor (mg/TJ)	Source
Coal	0,04	ESI
Water treatment sludge	0,0456	ESI
Olive stones	0,0456	ESI
Wood dust	0,0456	ESI
Wood chips	0,0456	ESI
Wood pellets	0,0456	ESI

Fuel	Emission factor (mg/TJ)	Source
Biodust	0,0456	ESI
Fuel A	0,0415	ESI
Gas oil	-	-
Paraffin	-	-
Natural gas	0	-
Blast-furnace gas	-	-

<u>Emission calculation :</u>

$$Em(kg) = \frac{M\ (GJ) \times EF\ \left(\frac{mg}{TJ}\right)}{1.000.000.000}$$

The combined heat-power (CHP) installations (in joint venture with the electricity producers) are located in different sectors in Belgium (refineries, industry, agriculture and service sector).

Emissions of CHP installations in the refinery sector are reported in the environmental annual reports submitted by the operator of the refinery.

Emissions of industrial installations are mainly reported in the environmental annual reports submitted by the operator of the plant. The missing emissions are estimated based on the energy data per CHP installation multiplied by an emission factor, as given below in table 3.13 and 3.14.

Table 3.13 Emission factors of NO_x, CO and SO_2 for the industrial CHP installations in joint-venture with the power plants in the Flemish region

Installation	Unit	NO_x	CO	SO_2	Source
Gas turbine	g/GJ	89	39	0.3	VMM (Sleeuwaert et al., 2010)
Gas motor	g/m^3	7.6	11	0.015	TNO

Table 3.14 Emission factors of heavy metals for the industrial CHP installations in joint-venture with the power plants in the Flemish region

CHP installations	Fuel	Unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Chemical industry	coal	mg/GJ	8,1	1	1,6	8	5	4,8	5,4	25	19	EMEP/EEA Guidebook 2009
Chemical industry	heavy fuel	mg/GJ	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Chemical industry	natural gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Chemical industry	gas oil	mg/GJ	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
Chemical industry	biogas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Chemical industry	industrial waste	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Food, drinks and tabacco	natural gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Food, drinks and tabacco	biogas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Paper industry	natural gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009

CHP installations	Fuel	Unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Textile, leather and clothing industry	natural gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Gas distribution	natural gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009

Emissions of waste incineration installations with energy recuperation are generally reported in the environmental annual reports submitted by the operator of the installation. In the Flemish region the waste incineration with energy recuperation includes the incineration of industrial and domestic waste.

The PCDD/F emissions of 1990 and 1995 (industrial and domestic waste) are based on the results of a study performed by VITO under the authority of VMM (Polders et al., 2003). Since 2000 the emissions of domestic waste incineration are reported in the yearly environmental reports. Since 2000 the emissions of industrial waste incineration are calculated by using activity data and emission factors. The activity data are the amount of waste obtained from OVAM (Public Waste Agency of Flanders). The emission factors are taken from the UNEP Standardized Toolkit for PCDD/F (Table 3.1515).
The HCB emissions are calculated by using activity data and emission factors. The activity data are the amount of waste obtained from OVAM (Public Waste Agency of Flanders). The emission factors are taken from the EMEP/CORINAIR Guidebook for HCB (

Table 3.16).

Table 3.15 Emission factors of PCDD/F for the sector 1A1a Incineration of waste in the Flemish region

Fuel	Unit	Value	Reference
Industrial waste	µg TEQ/tonne	0.5	UNEP Standardized Toolkit; Category 1a4: Waste incineration; Municipal solid waste incineration; High tech. combustion, sophisticated APCS
Hazardous waste	µg TEQ/tonne	0,75	UNEP Standardized Toolkit; Category 1b4: Waste incineration; Hazardous waste incineration; High tech. combustion, sophisticated APCS
Clinical waste	µg TEQ/tonne	1	UNEP Standardized Toolkit; Category 1c4: Waste incineration; Medical/hospital waste incineration; High tech, continuous, sophisticated APCS
Sewage sludge	µg TEQ/tonne	0,4	UNEP Standardized Toolkit; Category 1e3: Waste incineration; Sewage sludge incineration; State-of-the-art, full APCS

Table 3.16 Emission factors *of* HCB for the sector 1A1a Incineration of waste in the Flemish region

Fuel	Unit	Value	Reference
Industrial waste	g/tonne	0.0001	EMEP/CORINAIR Guidebook (2005)
Hazardous waste	g/tonne	0.01	EMEP/CORINAIR Guidebook (2005)
Clinical waste	g/tonne	0.019	EMEP/CORINAIR Guidebook (2005)
Sewage sludge	g/tonne	0.002	EMEP/CORINAIR Guidebook (2009)
Domestic waste	g/tonne	0.001	EMEP/CORINAIR Guidebook (2005)

Emissions of CHP installations in the service and agricultural sector are calculated based on the energy data (energy balance) and emission factors, as given below in tables 3.17 and 3.18.

Table 3.17 Emission factors for the sector CHP installations in the service sector, reported in sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Unit	SO_2	NO_x	COV	CO	NH_3	TSP/PM10/PM2,5
renewable fuels	g/GJ	0	165	50	407	-	0,2
diesel oil	g/GJ	48	307	46	385	-	5
natural gas	g/GJ	0	158	47	407	-	0,2
Source		S-content	Emission limit values	Emission limit values	EMEP/EEA 2009		VMM (Schrooten & Van Rompaey, 2002)

Fuel	Unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Natural gas	mg/GJ	0,234	0,515	0,1	0,0937	0,656	0,398	0,984	0,0112	13,6	EMEP/EEA Guidebook
Biogas	mg/GJ	0,234	0,515	0,1	0,0937	0,656	0,398	0,984	0,0112	13,6	EMEP/EEA Guidebook

Fuel	benzo(a)pyrene (kg/TJ)	benzo(b)fluoranthene (kg/TJ)	benzo(k)fluoranthene (kg/TJ)	indeno(1,2,3-cd)pyrene (kg/TJ)	PCDD/F (mg TEQ/TJ)
Natural gas					0,0005
diesel oil	0,000101	5,38E-05	8,19E-05	0,000201	0,0005
biogas/waste gas					0,008
Source	TNO	TNO	TNO	TNO	UNEP

Table 3.18 Emission factors for the CHP installations in the agricultural sector, reported in sector 1A1a Public electricity and Heat Production in the Flemish region

CHP agriculture	Unit	natural gas	other (biogas)	diesel oil
CO	kg/TJ	407	407	385
NOx	kg/TJ	158	165	307
CxHy	kg/TJ	47	50	46
dust	kg/TJ	0,2	0,2	5
PM10	kg/TJ	0,2	0,2	5
SOx	kg/TJ	0	0	48
Pb	kg/TJ	0,000234	0,000234	0,004
NH3	kg/TJ			
As	kg/TJ	0,000	0,000	0,002
Cd	kg/TJ	0,001	0,001	0,001
Cr	kg/TJ	0,001	0,001	0,001
Cu	kg/TJ	0,000	0,000	0,003
Hg	kg/TJ	0,000	0,000	0,001
Ni	kg/TJ	0,001	0,001	0,001
Se	kg/TJ	0,000	0,000	0,007
Zn	kg/TJ	0,014	0,014	0,002
PM2,5	kg/TJ	0,200	0,200	5,000

Petroleum refining (category 1.A.1 b)

Petroleum refining activities (5 refineries) only take place in Flanders.

Category 1A1b is a key category of SO_x emissions in terms of emissions level and trend and a key category of NOx emissions in terms of emissions trend.

The activity data of the petroleum refining are taken from the Flemish energy balance as petroleum refining only occurs in Flanders.

Combustion emissions of SO_2, NO_x, CO, NMVOC, TSP and heavy metals are directly reported by the refineries in the environmental annual reports submitted by the operator of the plant.

SO_2 emissions are calculated based on the sulphur content of the fuel or on measurements. NO_x, CO, NMVOC, TSP and heavy metals emissions are calculated with emission factors provided by the refineries or emissions are calculated based on measurements.

Emissions of PM10 and PM2,5 are calculated as a fraction of TSP (Schrooten & Van Rompaey, 2002):

Table 3.19 Percentages of PM10 and PM2,5 as a fraction of TSP for petroleum refineries

Fuel	%PM10	%PM2,5	Source
Refinery gas	100	100	VMM
Light fuel	100	100	VMM
Heavy fuel	80	70	VMM
Cokes	60	35	VMM

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

The emissions originating from category 1A1c ‘Manufacture of Solid Fuels and Other Energy Industries’ are the emissions coming from the combustion in the coke ovens. Nowadays 2 plants are still operational in Belgium instead of 8 plants in the beginning of the nineties. One plant was closed in the Flemish region in 1996, 4 plants closed in the Walloon region (one in 1995, a second in 2000, a third in 2005 and a fourth in 2010) and the only plant active in the Brussels region was closed in 1994.

In Wallonia, the emission factors for all pollutants are plant specific The non-diffuse NH_3 emissions are estimated by using the default emission factors (coke gas, 0,87 g/GJ).

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

In Flanders the last coke plant has closed in 1996. But there are still cokes ovens as part of the iron and steel sector. The emission factors for SO_x are based on the sulphur content of the fuel. The emission factors for NO_x and CO are based on literature data.

The emission factors for heavy metals are given in table 3.20.

Table 3.20 Emission factors of heavy metals for the cokes ovens in Flanders in the sector 1A1c

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
g/Mg produced coke	1,2	0,03	0,02	0,1			0,3			EMEP/EEA Guidebook 2008

Emissions of coal mining activities were reported until the beginning of the nineties. The emission factors for SO_x are based on the sulphur content of the fuel. CO and NO_x emissions are calculated with emission factors provided by the company. The mining industries have disappeared with the closure of the last coalmines in 1992.

3.3. Manufacturing Industries and Construction (1A2)

3.3.1. Source category description (1A2)

The structure of the industrial sector has undergone profound changes over recent decades. The metallurgy and textile sectors have been relatively stable, after several waves of closures and restructuring. The metallurgical industry nevertheless remains one of the key sectors of Belgian industry, both in terms of employment and turnover. The two other key sectors of industrial activity are the chemical industry and the food processing industry. These three sectors each contribute about 10% of gross value added of the industrial sector.

The category 1A2 ‘Manufacturing industries and construction’ contains the energetic emissions of the industrial sector of the 3 regions in Belgium. The following sectors are involved: iron and steel (1A2a), non-ferrous metals (1A2b), chemicals (1A2c), pulp, paper and print (1A2d), food processing, beverages and tobacco (1A2e) and other industries (1A2f).

The following industries are integrated in category 1A2f (Other industries): non-metallic mineral products (cement, lime, asphalt concrete, glass, mineral wool, bricks and tiles, fine ceramic materials), metal products, textile, leather and clothing and other industry (wood industry, rubber and synthetic material, manufacturing of furniture, recycling and construction included).

The industrial sector is not very developed in the Brussels region, mainly due to its urban features. The only big industry is a car manufacturer. The other industries are (very) small companies specialised in high added value products and/or located close to the final consumer. All these industries are classified in the 1A2f category (Other industries).

The emissions originating from the use of recovered fuels from cracking units or other processes where a fuel is used as a raw material and where a part of this fuel (or transformed product) is recovered for energy purposes is allocated to category 1A2c / other fuels.

Emissions of industrial combined heat-power installations in joint venture with the energy sector are allocated in the category 1A1a.

Emissions of the combustion of blast furnace gas, produced in the steel plants and delivered to the energy sector, are allocated in the category 1A1a. The following chart (fig. 3.2) shows the trend of the energy consumption in this sector :

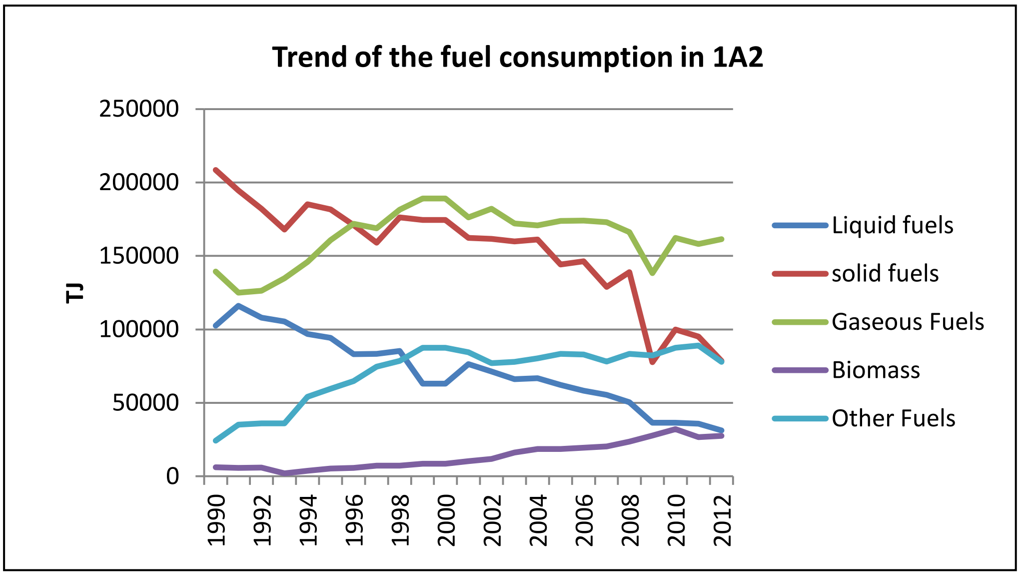


Figure 3.2 Trend of fuel consumption in the manufacturing Industries and construction.

3.3.2. Methodological issues

Default emission factors

Pollutant emissions are mostly reported directly by the individual large companies on the basis of analyses. 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 listed in tables above.

The energy consumption data originate from the regional energy balances in the 3 regions, supplemented with specific information from the companies themselves, for example activity data from iron and steel industry.

Generally in the combustion processes, the SO_2 emissions are mainly based on the sulphur content of the fuel and the NO_x emissions vary with the fuel and the sector.

The following tables (3.21 and 3.22) give the default emission factors used in the Walloon and Brussels region. Estimated emissions in individual plants in Flanders are based on plant-specific emission factors per installation.

Table 3.21 Emission factors for the sector 1.A.2 Manufacturing Industries and Construction in the Walloon region for 2012 (EMEP/EEA Guidebook-ESSEN 97-MNZ)

Fuel	UNIT	SOx	NOx	NMVOC	CO	NH_3	PM2,5	PM10	TSP
Coal	g/GJ	600	173	88	931	0.1	108	117	124
Fuel	g/GJ	495	100	10	40	0.1	16	21	27
diesel oil	g/GJ	48	100	10	40	0.1	16	21	25
natural gas	g/GJ		70	2.5	25	0.6	0,5	0.5	0,5
Cokes gas	g/GJ	600	70	2.5	25	0.87	0,5	0.5	0,5
Wood	g/GJ	38	150	146	1596	7	149	149	156
Biogas	G/GJ	288	88	2.5	13	15			

Fuel	As	Cd	Cu	Cr	Ni	Pb	Se	Zn	Hg	Dio	PAH (4)	HCB	PCB
UNIT	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ	µg/GJ	µg/GJ
Coal	4	1.8	13.5	17.5	7.9	13	134	1.8	200	203	146	0.62	170
Coke	4	1.8	13.5	17.5	7.9	13	134	1.8	200	25	15		
Fuel	4.3	1.3	5.7	2.7	273	4.9	2.2	94	0.4	10	17.6		
diesel oil	1.8	1.4	2.7	1.4	1.4	4.1	6.8	1.8	1.4	10	17.6		
natural gas	0.09	0.5	0.4	0.7	1	0.2	0.01	14	0.2	2	0.003		
Wood	1.4	1.8	4.6	6.5	2	24.8	0.5	113.6	0.7	32650	155.2	6	60

SOx		S content	EF
		%	g/GJ
FUEL	<1993	3	1400
	1994	2.17	1085
	1995	1.05	520
	1996	1.0	495
gasoil	<1993	0.5	160
	1994		
	1995	0.2	95
	1996	0.2	95
	2008	0.1	48

Table 3.22 Emission factors of NMVOC, CO, NH_3 and PM10 for the sector 1.A.2 Manufacturing Industries and Construction in the Brussels region.

Fuel	UNIT	SOx	NOx	NMVOC	CO	NH_3	PM10
Fuel	g/GJ	48	180	1.5	12	-	5
Natural gas	g/GJ	0	100	2.5	20	-	0

Iron and steel sector (category 1A2a)

Category 1A2a is a key category of SO_x, NOx, Cr and Ni emissions in terms of emissions level and trend and a key category of CO, Pb and Zn emissions in terms of emissions level.

In the Flemish region there is one integrated steel plant, one plant that produces stainless steel and one that handles molybdenum to be used in the production of stainless steel. In the Walloon region, there is one integrated steel plant and 5 electric arc furnace plants. No iron and steel activities take place in the Brussels region.

Because different approaches approved by the different companies involved (a.o. based on historical background) it is not possible to harmonize completely these methodologies between the 2 regions involved (Flanders and Wallonia).

The emissions from the iron and steel sector are partly put in category 1A2a (energetic part / except for the emissions from the cokes ovens which are allocated in the category 1A1c in Wallonia) and partly in category 2C1 (process part).

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

Since 2004, all the IPPC companies are obliged to report their energy consumptions, their productions and their emissions of IPPC pollutants on a website (Regine). IPPC companies which are also emission trading companies are obliged to report on the same way. This plant information is compared and combined with the energy balance of the sector. The remainder of the emissions is calculated on the basis of the remaining fuel consumption (energy balance of the sector minus plant energy consumptions) and by using the default emission factors (tables 3.23).

Tables 3.23 Emission factors of for the sector 1A2a Iron and steel production (EMEP/EEA Guidebook-ESSEN 97 – MNZ- guidebook 1996-Parcom 90)

Fuel	UNIT	SOx	NOx	NMVOC	CO	NH_3	PM2,5	PM10	TSP
Fuel	g/GJ	PS	PS	10		0.1	16	21	27
diesel oil (<50MWth)	g/GJ	PS	PS	2.5		0.1	16	21	25
diesel oil (>50MWth)	g/GJ	PS	PS	10		0.1	16	21	25
natural gas (<50 MWth)	g/GJ	PS	PS	2.5		0.6	0,5	0.5	0,5
natural gas (>50 MWth)	g/GJ	PS	PS	5		0.6	0,5	0.5	0,5
Cokes gas	g/GJ	PS	PS	5		0.87	0,5	0.5	0,5
Blast furnace gas	g/GJ	PS	PS	2.5			0.5	0.5	0.5

	As	Cd	Cu	Cr	Ni	Pb	Se	Zn	Hg	Diox	PAH (4)	HCB	PCB
UNIT	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ	µg/GJ	µg/GJ
Fuel oil	14.1	13.6	33.4	12.4	4.2	643.6	23.5	12.4	2.7	0.89	10.5		
diesel oil	1.8	1.4	2.7	1.4	1.4	4.1	6.8	1.8	1.4	10	17.6		
natural gas	0.09	0.5	0.4	0.7	1	0.2	0.01	14	0.2		0.15		
CG											0.15		
BFG											5		

In Flanders, emissions are reported directly by the individual companies. SO_x emissions are calculated based on the sulphur content of the fuel or on (continuous) measurements. NO_x, CO and NMVOC emissions are generally calculated based on measurements.

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Emissions of PM10 and PM2,5 are calculated as a fraction of TSP (table 3.24).

Table 3.24 Emission factors of TSP and fractions of PM10 and PM2.5 for the sector 1A2a Iron and steel

Iron and steel		Emission factor	% PM_{10}	% $PM_{2,5}$
Heavy fuel	ton/PJ	50,00	80%	70%
Gas- en diese oil	ton/PJ	5,00	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Cokes gas	ton/PJ	1,00	100%	100%
Renewables - solid	ton/PJ	150,00	95%	93%

Also heavy metals emissions are based on calculations. The emission factors to calculate the heavy metals emissions for the iron and steel sector are given in table 3.25.

Table 3.25 Emission factors of heavy metals for the sector 1A2a Iron and steel production

Iron and steel		Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Heavy fuel	mg/GJ	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Gas-en diesel oil	mg/GJ	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
LPG	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Natural gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Cokes oven gas	mg/GJ	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
renewables - solid	mg/GJ	24,8	1,8	0,7	1,40	6,5	4,6	2	0,50	114	EMEP/EEA Guidebook 2009

To calculate the remainder of the emissions (emissions not reported directly by the individual companies) from the iron and steel sector in Flanders a new methodology is used (Sleeuwaert et al., 2010). For this methodology (used for the first time during this submission) 3 types of activity data are important: the total energy consumption reported in the regional energy statistics for the iron and steel sector (for each fuel type), the energy consumption reported by the individual companies in this sector (for each fuel type), the pollutants reported by each individual company in the sector. This methodology calculates in the first place, for each fuel type, the difference between the energy consumption reported in the regional energy statistics for the iron and steel sector and the energy consumption reported by the individual companies in this sector. Furthermore this difference is calculated for each pollutant separately on the level of the company. This results for each pollutant and each fuel type, in a percentage of the total energy consumption from which emissions have to be estimated. In combination with a region specific corresponding emission factor (see table 3.26) the estimated emission is calculated.

Table 3.26 Emission factors of CO, SO_x and NO_x in the iron and steel sector used in the collective approach

Iron and steel	Unit	CO (g/GJ)	SO_x (g/GJ)	NO_x (g/GJ)
Coal	g/GJ	82	693	242
Cokes	g/GJ	82	683	242
LPG	g/GJ	62	0.0000435	90
Gas and dieseloil	g/GJ	67	47	166
Heavy fuel	g/GJ	67	493	180
Natural gas	g/GJ	59	0.0000450	46
Cokes gas	g/GJ	40	0.5	58

Category 1A2b to 1A2e

Category 1A2b is a key category of Pb, Cd and Cu emissions in terms of emissions trend.

Category 1A2c is a key category of As, Ni and Se emissions in terms of emissions level and trend and a key category of Cd and Hg emissions in terms of emissions level.

Category 1A2d is a key category of PM2,5 and PM10 emissions in terms of emissions level and trend.

Category 1A2e is a key category of Ni emissions in terms of emissions level and trend and a key category of Hg emissions in terms of emissions trend

In Flanders, emissions of the main pollutants are reported directly by the individual companies. SO_x emissions are calculated based on the sulphur content of the fuel or on measurements. NO_x, CO and NMVOC emissions are measured, calculated or estimated based on plant specific information. To calculate the remainder of the emissions (emissions not reported directly by the individual companies) from the categories 1A2b – 1A2e in Flanders a new methodology is used (Sleeuwaert et al., 2010). For a description of this methodology see above in chapter 1A2a, iron and steel. For this collective approach, for each sector in these categories and each fuel type a specific corresponding emission factor is used.

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Activity data are taken from the Flemish energy balance. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP.

The emission factors used to calculate the TSP emissions and the fractions of PM10 and PM2,5 of the key categories is given below in table 3.27:

Table 3.27 Emission factors used to calculate the TSP emissions and the fractions of PM10 and PM2,5 for combustion in the sectors of non-ferro, chemistry, pulp and paper and food and drinks.

Non-ferro	Unit	Emission factor TSP	%PM10	%PM2,5
Cokes	ton/PJ	100	60%	35%
Coal	ton/PJ	100	60%	35%
Heavy fuel	ton/PJ	60	80%	70%
Petrol cokes	ton/PJ	100	60%	35%
Gas-and diesel oil	ton/PJ	5	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Other fuels	ton/PJ	2,600	100%	100%
Renewables - solid	ton/PJ	150	95%	93%

Chemical sector 1A2c	Unit	Emission factor TSP	%PM10	%PM2,5
Petroleum cokes	ton/PJ	100,0	60%	35%
Heavy fuel	ton/PJ	60,0	80%	70%
Gas and diesel oil	ton/PJ	5,00	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Other fuels	ton/PJ	2,60	100%	100%
Renewable fuels - liquid	ton/PJ	5,00	100%	100%
Renewable fuels - gaseous	ton/PJ	0,20	100%	100%
Pulp and paper 1A2d	Unit	Emission factor TSP	%PM10	%PM2,5
Coal	ton/PJ	2.12	60%	35%
Heavy fuel	ton/PJ	60,0	80%	70%
Gas and diesel oil	ton/PJ	5,00	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Other fuels	ton/PJ	0,200	100%	100%
Renewable fuels - liquid	ton/PJ	156,000	96%	96%
Renewable fuels - gaseous	ton/PJ	0,200	100%	100%

Food, drinks and tobacco				
Cokes	ton/PJ	100	60%	35%
Coal	ton/PJ	100	60%	35%
Heavy fuel	ton/PJ	60	80%	70%
Gas-and diesel oil	ton/PJ	5	100%	100%
Lamp petrol	ton/PJ	5	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Renewables - solid	ton/PJ	150	95%	93%
Renewables - gaseous	ton/PJ	0,200	100%	100%

In Wallonia, all the plants which are under the IPPC directive report their annual emissions. The remainder of the emissions is calculated on the basis of the energy balance and the default emissions factors (table 3.21).

Other industries (category 1A2fi)

Category 1A2fi is a key category of NO_x, SO_x, CO, Hg, Ni and Se emissions in terms of emissions level and trend and a key category of TSP, PM10, PM2.5, As and Zn emissions in terms of emissions level or trend.

In Flanders, emissions are reported directly by the individual companies. SO_x emissions are calculated based on the sulphur content of the fuel or on measurements. NO_x, CO and NMVOC emissions are measured, calculated or estimated based on plant specific information.

To calculate the remainder of the emissions (emissions not reported directly by the individual companies) from the category 1A2fi in Flanders a new methodology is used (Sleeuwaert et al., 2010). For a description of this methodology see above in chapter 1A2a, iron and steel. For this collective approach, for each sector in these categories and each fuel type a specific corresponding emission factor is used.

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Activity data are taken from the Flemish energy balance. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP.

The emission factors used to calculate the TSP emissions and the fractions of PM10 and PM2,5 of the key categories is given below in table 3.28:

Table 3.28 Emission factors used to calculate the TSP emissions and the fractions of PM10 and PM2,5 for combustion in the sectors of non-metallic mineral product activities, metal products, textile, leather and clothing and other industries

Non-metallic mineral product 1A2f	Unit	Emission factor TSP	%PM10	%PM2,5
Cokes	ton/PJ	100	60%	35%
Coal	ton/PJ	100	60%	35%
Petrol cokes	ton/PJ	100	60%	35%
Heavy fuel	ton/PJ	60,0	80%	70%
Gas and diesel oil	ton/PJ	5,00	100%	100%

LPG	ton/PJ	0,200	100%	100%
Petrol	ton/PJ	5,0	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Other petrol products	ton/PJ	70	80%	70%
Other fuels	ton/PJ	100	60%	35%
Metal products 1A2f	Unit	Emission factor TSP	%PM10	%PM2,5
Cokes	ton/PJ	100	60%	35%
Heavy fuel	ton/PJ	60,0	80%	70%
Gas and diesel oil	ton/PJ	5,00	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Other fuels	ton/PJ			
Renewable solid	ton/PJ	150	95%	93%
Renewable liquid	Ton/PJ	5	100%	100%
Textile, leather and clothing 1A2f	Unit	Emission factor TSP	%PM10	%PM2,5
Heavy fuel	ton/PJ	60,0	80%	70%
Gas and diesel oil	ton/PJ	5,00	100%	100%
Lamp petrol				
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Renewable fuels - solid	ton/PJ	150,000	95%	93%
Other industries 1A2f	Unit	Emission factor TSP	%PM10	%PM2,5
Coal	ton/PJ	100,0	60%	35%
Heavy fuel	ton/PJ	60,0	80%	70%
Gas and diesel oil	ton/PJ	5,00	100%	100%
Petrol	ton/PJ	5,00	100%	100%
Lamp petrol	ton/PJ	5,00	100%	100%
LPG	ton/PJ	0,200	100%	100%
Natural gas	ton/PJ	0,200	100%	100%
Other fuels	ton/PJ	0,200	100%	100%
Renewable - solid	ton/PJ	150	95%	93%

Heavy metals emissions are based on calculations (fuel consumed x emission factors per fuel type). Activity data are taken from the Flemish energy balance. Table 3.29 gives an overview of the emission factors that are used to calculate the emissions of the sectors included in category 1A2f.

Table 3.29 Emission factors used to calculate the emissions of heavy metals for combustion in the sectors of non-metallic mineral product activities, metal products, textile, leather and clothing and other industries

Mineral non-metallurgical products	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Cokes	134,0	1,8	7,9	4	13,5	17,5	13	1,8	200	EMEP/EEA Guidebook 2009
Coal+ petrol cokes	134,0	1,8	7,9	4	13,5	17,5	13	1,8	200	EMEP/EEA Guidebook 2009
Heavy fuel	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Gas-and diesel oil	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
LPG	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Petrol	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
Natural gas	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Other petrol products	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Other fuels	134,0	1,8	7,9	4	13,5	17,5	13	1,8	200	EMEP/EEA Guidebook 2009
Metallurgical manufacturing	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Cokes	134,0	1,8	7,9	4	13,5	17,5	13	1,8	200	EMEP/EEA Guidebook 2009
Heavy fuel	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Gas-and diesel oil	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
LPG	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Natural gas	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Other fuels										EMEP/EEA Guidebook 2009
Renewables - solid	24,8	1,8	0,7	1,4	6,5	4,6	2	0,5	114	EMEP/EEA Guidebook 2009
renewables - gaseous	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
Textile, leather and clothing	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Heavy fuel	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Gas-and diesel oil	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
LPG	0,20	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Natural gas	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009

Renewables - solid	24,8	1,8	0,7	1,4	6,5	4,6	2	0,5	114	EMEP/EEA Guidebook 2009
Other industries (including wood manufacturing)	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
Coal	134,0	1,8	7,9	4	13,5	17,5	13	1,8	200	EMEP/EEA Guidebook 2009
Heavy fuel	4,9	1,3	0,4	4,3	2,7	5,7	273	2,2	94	EMEP/EEA Guidebook 2009
Gas-and diesel oil	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
Petrol	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
Lamp petrol	4,1	1,4	1,4	1,8	1,4	2,7	1,4	6,8	1,8	EMEP/EEA Guidebook 2009
LPG	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Natural gas	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Other fuels	0,2	0,5	0,2	0,09	0,7	0,4	1	0,01	14	EMEP/EEA Guidebook 2009
Renewables - solid	24,8	1,8	0,7	1,4	6,5	4,6	2	0,5	114	EMEP/EEA Guidebook 2009

In Wallonia, all the plants which are under the IPPC directive report their annual emissions. The sector 1A2fi includes emissions of the glass sector, the ceramic sector, the lime production in a chemical plant, in sugar plants and in a paper pulp plant, textile plant and other plants. All the emissions of the cement plants and the lime plants are in the category 2A and are plant specific.

The emissions of the area source is calculated on the basis of the energy balance and the default emissions factors (table 3.30) (these EF can be different following the sector).

Table 3.30 Default emission factors for the sector 1A2fi for particulate cases in the Walloon region (EMEP/EEA Guidebook-ESSEN 97 – MNZ-Guidebook 2006)

Fuel	**UNIT**	**SOx**	**NOx**	**NMVOC**	**CO**	**NH_3**	**PM2,5**	**PM10**	**TSP**
Brown coal in ceramic plants	g/GJ	800	300	1.5	14		18	17	20
Coke (lime in sugar plant)	g/GJ	200	170	8	300	0.4	18	18	18

	As	**Cd**	**Cu**	**Cr**	**Ni**	**Pb**	**Sé**	**Zn**	**Hg**	**Diox**	**PAH (4)**
UNIT	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ
Brown coal in ceramic plants	4.2	0.4	2	0.1	3.9	3.9		10.6	4.4	25	15
Coke (lime in sugar plant)	4	1.8	17.5	13.5	13	134	1.8	200	7.9	25	15

The asphalt concrete plants emissions are estimated by using the capacity of the Walloon and multiplied the capacity by the following emission factor (table 3.31):

Table 3.31 Emission factors – asphalt concrete plants (EPA)

Pollutant	Unit	EF
SO2	kg/tonne	0.12
NOx	kg/tonne	0.084
CO	kg/tonne	0.035
TOC	kg/tonne	0.023
PM-10	kg/tonne	0.008
As	g/tonne	0.00033
Cd	g/tonne	0.00042
Cr	g/tonne	0.00045
Cu	g/tonne	0.00018
Pb	g/tonne	0.00037
Hg	g/tonne	0.00023
Ni	g/tonne	0.0021
Se	g/tonne	0.000046
Zn	g/tonne	0.0034
PAH	g/tonne	0.04
Dioxins	µg TEQ/tonne	0.0034

The calculation of industry emissions in Brussels is based on the energy consumptions described in the regional energy balance and the emission factors mentionned in Table 3.22.

Mobile Combustion in manufacturing industries and construction (category 1A2fii)

Off-road emissions are calculated by the same mathematical model OFFREM (Off-road emission model))(Schrooten et al., 2009) in the three regions. Emissions are calculated for machinery used in industry and building (category 1A2fii). In Wallonia, some plants (cement plant, carriers,...) report their off road emissions which are also included in 1A2fii.

3.4. Transport (sector 1A3, 1A5b and off-road)

3.4.1. Source category description

Belgium is provided with a very dense road (3.94 km/km²) and rail (117 m/km²) network (2009). These densities of road and rail networks should be looked at in conjunction with the very high density of population in Belgium: relative to the number of inhabitants the infrastructure is close to the European average. The port of Antwerp, located in the Flemish region, is very important for Belgium. It is the second largest European seaport, and one of the 5 largest in the world. The port of Antwerp benefits from excellent connections to the hinterland and the large French and German industrial basins by waterway (1500 km of navigable routes). It has also been decided to strengthen the rail infrastructure giving access to the port of Antwerp. Road transport is the mean of transport the most generally used in Belgium, both for the transport of goods and passengers, generating severe traffic congestion. Damages to the environment resulting from fuel use in road traffic are considerable. Goods (without pipelines) are transported by railways for 10.2% of total achieved tonne-kilometres in Belgium, on navigable waterways for 12.1% and by road transport for 77.7% (2009[2]).

The reported emissions in the transport sector are reported in the categories 1A3a civil aviation, 1A3b road transportation, 1A3c railways, 1A3d navigation and 1A3e other transportation.

In the category 1A3e the emissions originating from the transport of natural gas through pipelines are allocated as well as emissions of off road machinery in harbours, airports and due to storage and handling.

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

Emissions of the military aviation are allocated to the category 1A5b.

Sea navigation takes only place in the Flemish region.

3.4.2. Methodological issues

3.4.2.1 Road transport (1A3b)

Until the 2013 submission, the 3 regions used COPERT 4 methodologies in specific regional models (previous versions of COPERT 4 were used in the Walloon and the Brussels regions, MIMOSA was used in Flemish region. Moreover the process to transfer the basic data of the Belgian vehicle fleet to a regional fleet file that serves as input for the regional models was performed separately for the 3 regions).
Since 2014, regional submissions are almost fully harmonised:

- each region uses a common fleet module (produced by Transport & Mobility Leuven (TML)) which provides harmonised regional fleet files as input for COPERT. The vehicles fleet is based on actual registration data for the period 2007-2012 and on a combination of fleet data and backwards extrapolations for the period 1990-2006.
- each region uses the same module for the assignment of mobility (produced by IRCEL-CELINE).
- each region uses directly COPERT 4 v10.0 to produce regional emissions and “fuel used” consumptions.

The 2 major determinants of COPERT modelling (fleet and mobility) are now fully harmonized across the 3 regions. However, for some parameters regional data based on specific measurements and/or modelling have been used (average trip length and duration, driving modes and corresponding average speed values).
The emissions from road transport have been recalculated for the whole time series 1990-2012 using the COPERT IV v10.0 software. For PM, a post process correction was applied to account for the retrofitted particulate filters for Euro 4 passenger cars and Euro II and Euro III urban busses.
Because the COPERT results for non-exhaust PM emissions do not allow to differentiate “tyre & brake wear” and “road abrasion” emissions, the non-exhaust PM emissions are calculated based on the emission factors from the 2013 EMEP Guidebook.

The consumption modelling in COPERT is entirely based on the energy content of fossil fuels. A post-process correction based on specific fuel LHVs has been considered to reflect the percentage of

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

biofuels included in the blend and to take account of its actual energy content. This correction slightly increase the fuel consumption.
It should also be noticed that in COPERT 4 v10.0. fuel consumptions increase because the use of air-conditioning is now included.

Figure 3.3 shows the trend of the energy consumption in the road transport sector.

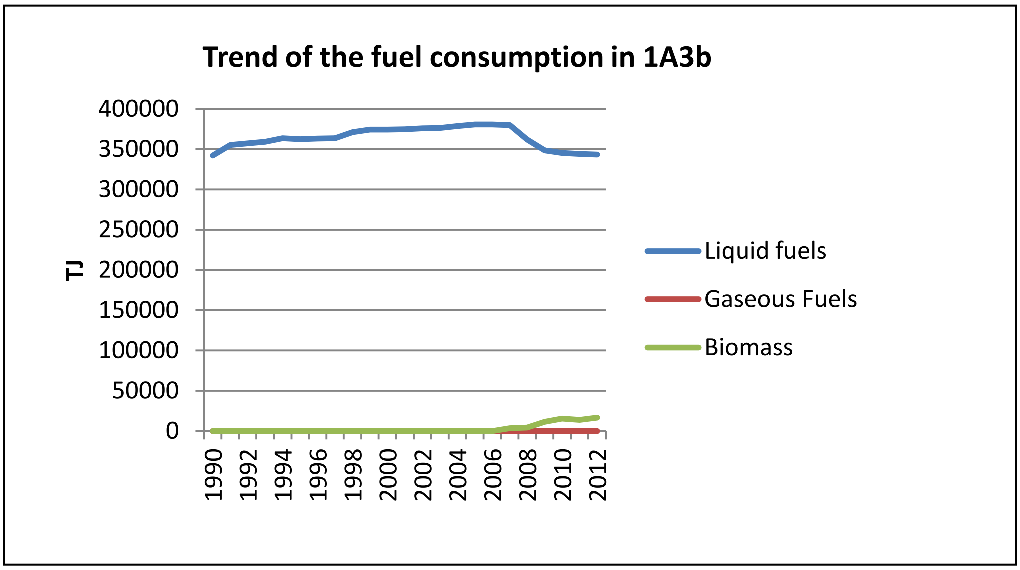


Figure 3.3 Trend of fuel used in road transport.

3.4.2.2 Air transport (1A3a)

Category 1A3ai is a key category of NO_x emissions in terms of emissions trend.

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

In Flanders, emissions of civil aviation are calculated for Landing and Take-Off cycles (LTO) based on flight data (data per flight, statistics delivered by the airports) and emission factors. These emissions are calculated for 4 airports for civil aviation (Antwerp, Ostend, the international airport Brussels Airport and from 2008 on also Kortrijk-Wevelgem) and for 6 airports for military aviation between 1990 and 1996 (Kleine Brogel, Brasschaat, Koksijde, Sint-Truiden, Goetsenhove and Melsbroek) and 4 airports for military aviation from 1997 until 2011 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek) . The airport of origin and airport of destination are known, a division in domestic/international traffic can be made. Emission factors form the EMAP/EEA Guidebook (2009 table 3-5) are used as well as emission factors from EPA.

In Wallonia, the emissions from civil aviation (category 1.A.3.a) are estimated on the basis of the number of LTO of the two main airports (Liège and Charleroi) and the amount of LTO in little airports. Each year, the two main airports report the jet fuel and the gasoline consumptions for the domestic and for the international activities. They also report the amount of domestic LTO and the amount of international LTO. Some information on the walloon's total number of LTO is available (Liège and Charleroi airports flights, training flights,..). Unfortunately, there is no general knowledge about the aircraft types carrying out the aviation activities. Emission factors used to estimate emissions from domestic and international traffic are based on the table 3-3 in the EMEP/EEA guidebook 2009. The specific energy consumption by LTO is 105 kg fuel/LTO for the domestic flight. For the international flight in one of the two international airports, the specific energy consumption by LTO is 3400 kg fuel/LTO instead of 825 kg fuel/LTO as the planes are mainly cargo planes.

The emissions from domestic LTO and international LTO are reported under the category 1A3ai and 1A3aii, while emissions from cruise activities are reported under ‘Memo items”.

3.4.2.3 Railways

The emissions of railway traffic are estimated by a region specific approach.

Flemish emissions of railway traffic are estimated by the EMMOSS model (Vanherle et al., 2007, 2010). The basis for the calculations is gross ton kilometres driven by trains.

Emission calculation:

$$EM(g) = gross\ ton\ kilometers\ \left(\frac{ton}{km}\right) x\ specific\ end - energy\ use\ \left(kWh.\frac{km}{ton}\right) x\ EF\left(\frac{g}{kWh}\right)$$

Emission factors are derived from ISO 8178/F test cycles for CO, NO_x, TSP and VOC (table 3.32).

Table 3.32 Emission factors for different train types (g/kWh) to calculate emissions from rail transport in Flemish Region

	Type HLD77	Type MW41	old locos	old railcars
CO	0.73	1.07	10.70	10.70
NOx	11.70	8.74	18.20	18.20
TSP	0.20	0.15	0.60	0.60
VOC	0.11	0.61	1.60	1.60

Emissions for NH_3 and PAH were taken over from Klein, 2006 (The Netherlands) (table 3.33). SO_2 and heavy metals are fuel-specific (SO_2 calculated dependent on content of S in fuel).

Table 3.33 Emission factors from Klein, 2006 (NL) to calculate emissions from rail transport in Flemish Region

pollutant	EF(g/g or %)	calculation base off
NH3	0,00001	kgFC
Cd	0,00000001	kgFC
Cu	0,0000017	kgFC
Cr	0,00000005	kgFC
Ni	0,00000007	kgFC
Se	0,00000001	kgFC
Zn	0,000001	kgFC
benz(b)fluoranteen	0,0000169	fractionVOC
benz(k)fluoranteen	0,00000643	fractionVOC
benz(a)pyreen	0,0000169	fractionVOC
Indeno(1,2,3-cd)-pyreen	0	fractionVOC
PM2.5	0,95	fractionPM
PM10	1	fractionPM

Emissions for shunting trains are also calculated. Emissions are reported in the IPCC category 1A3c (railways).

The emissions from railways are estimated in the Walloon region and in the Brussels region by multiplying the train's fuel consumption by the fuel specific emission factors. The emission factors are those described in table 8.1 of the EMEP/EEA guidebook 2006.

In Wallonia and Brussels, the data from the National Society of the Belgian Railways (SNCB-NMBS) are used to calculate the energy consumption for the train services in Belgium. These data are available for the transport of persons and goods and for electricity and gasoil driving. The total consumption of gasoil in the Walloon and Brussels regions is based on the Belgian data of gasoil consumption and the regional information on driven train- and ton-kilometres of persons and goods. The emissions are estimated by multiplying the train's fuel consumption by the fuel specific emission factors. Following the study of VITO on Heavy Metals, it must also take into account the wear catenary (Cu : 961 mg/GJ).

Table 3.34 Emission factors in the Walloon region (EMEP/EEA Guidebook-Guidebook 2006-ULg(1998))

Pollutant	UNIT	EF
SO2	g/GJ	48
NOx	g/GJ	1229
VOC	g/GJ	109
CO	g/GJ	252
TSP	g/GJ	108
As	mg/GJ	1.800
Cd	g/GJ	0.236
Cr		1.18
Cu	mg/GJ	(40.120 + 961)
Pb	mg/GJ	1.190
Hg	mg/GJ	1.400
Ni	mg/GJ	1.652
Se	mg/GJ	0.236
Zn	mg/GJ	23.600
PAH	mg/GJ	500
Dioxins	ng TEQ/tonne	1.180

3.4.2.4 Navigation

Category 1A3di(ii) is a key category of NO_x emissions in terms of emissions trend.

For navigation, fuel consumption is taken from the regional energy balances.In Flanders, emissions from maritime navigation are calculated with the emission model EMMOSS. The emissions originating from maritime shipping starting and arriving in Belgium (including sand extraction at sea, dredging activities and tugboats) are reported in the category 1A3di(ii) (international inland waterways). The emissions coming from maritime shipping between a Flemish and a foreign harbour (including emissions originating in the Flemish harbour) are reported in the memo item 'international maritime navigation'.

Emissions are calculated using emission factors from the Dutch methodology, taking into account IMO Tier II and Tier III NO_x limits as stated in Marpol Annex VI (for maritime navigation).

The source of emission factors :

- NOx, VOC, TSP, CO : Dutch EMS protocol (Oonk, 2003)
- NH3, PAH : Dutch study Klein, 2006

- PM2.5 and PM10 : % of TSP from Visschedijk et al. (Nl)

The Belgian maritime zones comprise the territorial sea (TS) and the Exclusive Economic Zone (EEZ). The former consists of an area extending 12 nautic miles into the North Sea, measured from the base line. The latter comprises that part of the North Sea the contour of which consists of lines connecting following points in the order of numeration:

1. 51°16’09” N – 02°23’25” O
2. 51°33’28” N – 02°14’18” O
3. 51°36’47” N – 02°15’12” O
4. 51°48’18” N – 02°28’54” O
5. 51°52’34.012” N – 02°32’21,599” O
6. 51°33’06” N – 03°04’53” O

A map of the Belgian maritime areas (Figure 3.4 Map of the Belgian maritime areas) is shown below

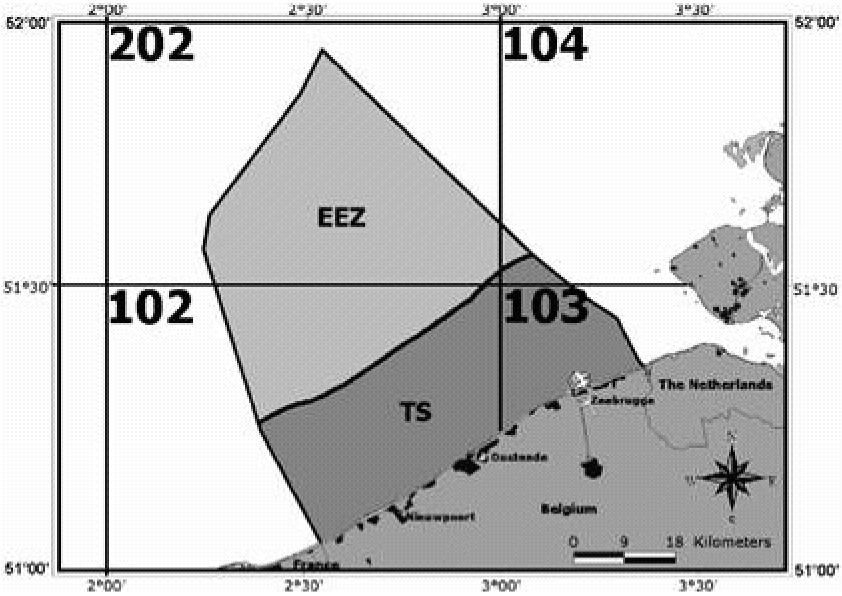


Figure 3.4 Map of the Belgian maritime areas

In Flanders the emissions originating from inland shipping are also estimated by the EMMOSS model and are reported in the IPCC category 1A3dii (national navigation). Category 1A3dii is a key category of NO_x emissions in terms of emissions trend.

Emission factors for NOx, PM, CO, VOS are derived from Oonk et al. (2003), and from 2007 on derived from the CCNR-standards (Central Commission for the navigation of the Rhine). Other are emission factors of the EMEP/EEA handbook (tables 3.35 and 3.36).

Table 3.35 Emission factors dependent on year class of the engines (g/kWh)

Motorbouwjaar	NOx	PM	CO	NMVOC
< 1974	10	0,6	4,5	1,2
1975-1979	13	0,6	3,7	0,8
1980-1984	15	0,6	3,1	0,7
1985-1989	16	0,5	2,6	0,6
1990-1994	14	0,4	2,2	0,5
1995-2001	11	0,3	1,8	0,4
2002-2007	8	0,3	1,5	0,3
2007-2011[2]	6	0,2	1,3	0,2
2011-2015[3]	6	0,2	1,3	0,2
2015-2020[3]	6	0,2	1,3	0,2
2020-2030[3]	6	0,2	1,3	0,2

.

Table 3.36 Emission factors based on fuel used (g/kg fuel)

	Emission factor	
SO2	20*S%[2]	Base stoichiometric conversion
NH3	0,007	EMEP EEA guidebook
Cd	0,00001	EMEP EEA guidebook
Cr	0,00005	EMEP EEA guidebook
Cu	0,0017	EMEP EEA guidebook
Ni	0,00007	EMEP EEA guidebook
Pb	0,01	EMEP EEA guidebook
Zn	0,001	EMEP EEA guidebook

The emissions from inland navigation are estimated in the Walloon and Brussels region by multiplying the sector's fuel consumption by the fuel specific emission factors. The emission factors are those described in table 8.1 of the EMEP/EEA guidebook 2006.

3.4.2.5 Other transportation (pipeline compressors and off-road)

As a result of the In country review in September 2012 of the GES Belgium inventory and to be coherent with this GES inventory, the off road emissions of the following sectors are now included in this category : ground activities in airports and harbours and trans-shipment activities. Off-road emissions are calculated by the same mathematical model OFFREM (Off-road emission model) (Schrooten et al., 2009) in the three regions.

In the Walloon region, this category includes also the emissions from the pipeline compressors. Since 2008, a IPPC plant has reported CO and NOx emissions and default emission factors have been calculated with these data (table 3.38). These default emission factors are used for the years before 2008 and for the area part after 2008.

Table 3.37 Emission factors for pipeline compressors in the Walloon region

Pollutant	UNIT	EF
NOx	g/GJ	221
CO	g/GJ	261

Also in the Flemish region, this category includes the emissions from the pipeline compressors. CO and NOx emissions are provided by the operators of the plants.

3.5. Other sectors (sector 1.A.4)

3.5.1. Source category description (1A4)

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

For the 3 regions emissions from the off-road sector are included in the categories 1A3e, 1A4b, 1A4c and 1A5b.

3.5.2. Methodological issues

Commercial/institutional sector (category 1A4ai)

Category 1A4ai is a key category of NO_x emissions in terms of emissions level and trend and of Ni emissions in terms of emissions level.The fuel consumption of the stationary combustion in the commercial/institutional sector is based on general statistics of natural gas, supplemented with results from surveys for solid and liquid fuels. The energy use in the commercial/institutional sector is strongly related to the climate (cold winters give cause to a higher energy consumption and hence higher emissions). The relatively warm winter of 2011 is reflected by a lower energy consumption (mostly gaseous and liquid fuels)

The energy consumption of these sectors is published in the regional energy balances

The following chart (Figure 3.5) shows the trends of the energy consumption in the commercial/institutional sector.

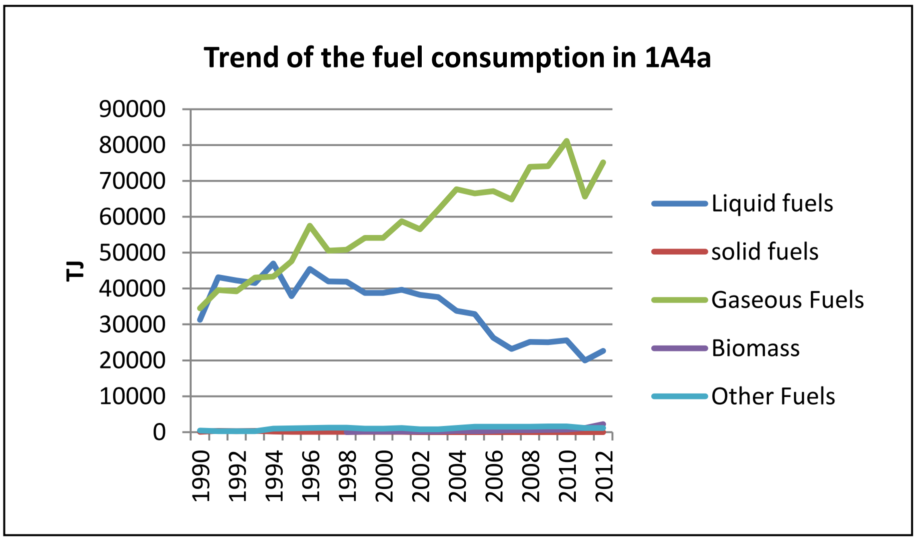


Figure 3.5 Trend of fuel consumption in the commercial/institutional sector.

In Flanders, emissions by heating systems of buildings are calculated on a collective basis. The database consists of emissions due to tertiary combustion (heating by hotels/restaurants, medical services, education, offices and administrative activities, trade, other services and combined heat-power installations (CHP)). Emissions are calculated by multiplying the energy use and emission factors. Data on energy used can be found in the Energy Balance for Flanders. A provisional energy balance is made yearly for year (x-1), whereas a final energy balance is made for year (x-2). The tertiary sector contains energy data on fuel, heavy fuel, solid fuels (coal), propane/butane/LPG, electricity, other (mainly waste) and renewable fuels, for some years also lamp petrol. The emission factors to calculate particulate matter, heavy metals and NMVOC originate from studies, SO_x emission calculations are based on the S-content of the fuels (for SO_x and NO_x, the emission factors are harmonised between the regions), other emission factors (CO and NH_3) are taken from the EMEP/EEA Emission Inventory Guidebook.

Emissions and activity data due to combined heat-power installations in joint venture with the energy sector are allocated in NFR sector 1A1a (see also 3.2.1). For the CHP installations in the tertiary sector energy information on natural gas, fuel and other fuels (biogas) is included. A distinction is made between autoproducers and non-autoproducers.

In 2009 emission factors are re-examined as a result of the release of the revised Guidebook. The emission factors are only adapted when expert analysis reveals that better factors are available or when tuning with the other Belgian regions occurs.

In Wallonia, the main data source for this sector is the energy balance delivered yearly by the Energy and Sustainable Building Department. The energy balance describes the quantities of energy imported, produced, transformed and consumed in the Walloon Region in a given year. The energy consumption in the service sector is calculated using the energy data of different sources (regional data on the amount of natural gas and electricity sold in this sector (CWaPE), annual survey carried out by ICEDD for all consumers ‘high voltage’ (4800 establishments with a respond of 58 %)).

In Brussels, the consumption of the tertiary sector is based on two approaches: one for the ‘high voltage customers’ and the other for the ‘low voltage customers’. For ‘high-voltage customers’, the energy consumption is calculated using the energy data based on a survey and direct contacts with ‘high voltage’ consumers and big international public organisms. For ‘low-voltage customers’, the energy consumption is calculated by the ‘top down’ method and the consumption of oil-products is estimated from the fuel/natural gas ratio and the Belgian consumptions.

Emission factors used to calculate the emissions of stationary combustion in the commercial sector for the year 2012 in the three regions are given below (tables 3.38 to 3.40).

Table 3.38 Emission factors for the sector 1A4a in the Walloon region (EMEP/EEA Guidebook except NO_x and PM10).

Fuel	UNIT	SOx	NOx	NMVOC	CO	NH_3	TSP	PM10	PM2,5
Coal	g/GJ	600	104	89	931	0.4	107	101	93,2
Wood	g/GJ	6	77.9	146	1600	7	135	129	128
diesel	g/GJ	48	41.86	10	40	0.1	5	3.9	3
natural	g/GJ		35.26	2.5	25	0.6	0,3	0.3	0,3
LPG	g/GJ		40	5	50				
Source		S-content and regional tuning	Study	EMEP/EEA	EMEP/EEA	EMEP/EEA	Study	Study	Study

Fuel	As	Cd	Cu	Cr	Ni	Pb	Se	Zn	Hg	Dio	PAH (4)	HCB	PCB
UNIT	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ	µg/GJ	µg/GJ
Coal	2.5	1.5	22	11	13	130	1.2	220	5.1	203	150	0.62	170
Wood	1.4	1.8	4.6	6.5	2	25	0.5	114	0.7	326	156	6	60

diesel oil	1.8	1.4	2.7	1.4	1.4	4.1	6.8	1.8	1.4	10	18		
natural gas	0.1	0.5	0.4	0.7	1	1	0.01	13.6	0.2	2	0.003		
LPG	0.1	0.5	0.4	0.7	1	1	0.01	13.6	0.2				

Table 3.39 Emission factors for the sector 1A4a in the Flemish region.

Fuel	UNIT	SO_2*	NO_x*	COV	CO	NH_3	TSP*	PM10*	PM2,5*
coal	g/GJ	600	104,442	200,00	4600	-	107	53,5	26.750
wood	g/GJ	6	78,978	500,00	1600	-	135	128,25	121.5
diesel oil	g/GJ	48	40.990	3,00	40	-	4.591	4,591	4.591
heavy fuel	g/GJ	480	200,000	3,00	40	-	27	17,55	6.750
natural gas	g/GJ	0	28.524	2,00	25	-	0.3	0,3	0.3
LPG	g/GJ	0	40,000	2,00	25	-	0.3	0,3	0.3
Source		S-content and regional tuning	Study FOD	Study VITO	EMEP/ EEA	EMEP/ EEA	Study FOD	Study FOD	Study FOD

*emission factors vary with time. The table shows the emission factors used to calculate emissions 2012

Fuel	UNIT	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
coal	g/GJ	0,13	0,0015	0,0051	0,0025	0,0112	0,0223	0,0127	0,001	0,22
wood	g/GJ	0,0248	0,0018	0,0007	0,0014	0,0065	0,0046	0,002	0,0005	0,114
diesel oil	g/GJ	0,0041	0,0014	0,0014	0,0018	0,0014	0,0027	0,0014	0,0068	0,0018
heavy fuel	g/GJ	0,016	0,0003	0,0001	0,001	0,0128	0,0072	0,26	-	0,008
lamppetroleum	g/GJ	0,0041	0,0014	0,0014	0,0018	0,0014	0,0027	0,0014	0,0068	0,0018
natural	g/	0,00098	0,00051	0,0002	0,000093	0,00065	0,0003	0,0009	0,0000	0,0136

gas	GJ	4	5	34	7	6	98	84	112	
LPG	g/GJ	0,000984	0,000515	0,000234	0,0000937	0,000656	0,000398	0,000984	0,0000112	0,0136
Source		Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO

Fuel	benzo(a) pyreen (kg/TJ)	benzo(b)fluorantheen (kg/TJ)	benzo(k)fluorantheen (kg/TJ)	hexachloorbenzeen (kg/TJ)	indeno(1,2,3-cd)pyreen (kg/TJ)	PCDD/F (mg TEQ/TJ)
natural gas						0,0005
diesel oil	0,000101	5,38E-05	8,19E-05		0,000201	0,0005
heavy fuel	0,002118	0,001108	0,001749		0,004187	0,0025
coal	0,000404	0,000844	0,000618	5,46E-07	0,000167	0,01
LPG						0,0005
wood	0,017	0,014333	0,008833	0,000004	0,010933	0,05
lamp petrol	0,000101	5,38E-05	8,19E-05		0,000201	0,0005
Source	TNO	TNO	TNO	EMEP/CORINAIR	TNO	UNEP

Table 3.40 Emission factors for the sector 1A4a in the Brussels region.

Fuel	UNIT	SOx	NOx	COV	CO	NH_3	PM10
Coal	g/GJ	600	104	200	2000	-	54
Diesel oil	g/GJ	48	42	3	20	-	3.9
Natural gas	g/GJ	0	35	5	48	-	0.3

Residential sector (category 1A4bi)

Category 1A4bi is a key category of NO_x, NMVOC, SO_x, CO and PM2,5, PM10, TSP, Cd, Hg, As, Cr, Ni, Zn, PCDD/F and HCB emissions in terms of emissions level and trend and of NH3, Pb and Se emissions in terms of emissions level or trend.The fuel consumption of the stationary combustion in the residential sector is based on general statistics of natural gas, supplemented with results from surveys for solid and liquid fuels. The energy use in the households is strongly related to the climate (cold winters give cause to a higher energy consumption and hence higher emissions). The relatively warm winter of 2011 is reflected by a lower energy consumption (mostly gaseous and liquid fuels)

The following chart (Figure 3.6) shows the trends of the energy consumption in the residential sector.

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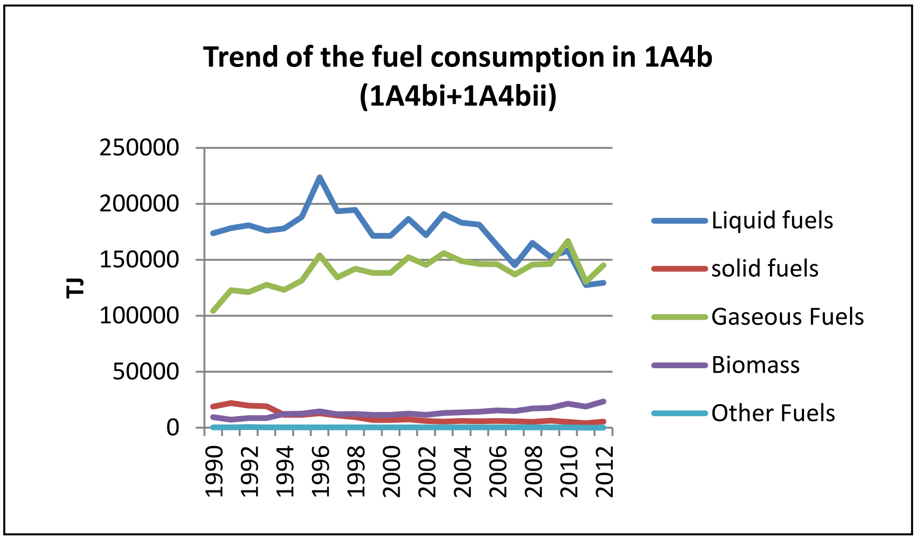

Figure 3.6 Trend of fuel consumption in the residential sector.

In Flanders, emissions by heating systems of buildings are calculated on a collective basis. The database consists of emissions due to residential combustion (heating by households). Emissions are calculated by multiplying the energy use and emission factors.

Data on energy used can be found in the Energy Balance for Flanders. A provisional energy balance is made yearly for year (x-1), whereas a final energy balance is made for year (x-2). For households energy data on electricity use, natural gas, fuel, solid fuels (coal), propane/butane/LPG, other (mainly wood) and renewable fuels are included., SO_x emission calculations are based on the S-content of the fuels (for SO_x and NO_x, the emission factors are harmonised between the regions), other emission factors (CO and NH_3) are taken from the EMEP/EEA Emission Inventory Guidebook. In 2009 emission factors are re-examined as a result of the release of the revised Guidebook. The emission factors are only adapted when expert analysis reveals that better factors are available or when tuning with the other Belgian regions occurs.

In Wallonia, the main data source for this sector is the energy balance delivered yearly by the Energy and Sustainable Building Department. The energy balance describes the quantities of energy imported, produced, transformed and consumed in the Walloon Region in a given year. The energy consumption of the household sector is calculated on the basis of regional data on the amount of natural gas and electricity sold in this sector (CWaPE), on the basis of national data (liquid fuels and solid fuels), on the basis of the socio-economic survey of 2001 (size, isolation,…) and on the basis of weather data (degree-days).

In Brussels , the information about energy consumption in the household sector is compiled in the regional energy balance. Then the consumption is multiplied for the emission factors described in Table 3.43. The emission factors presented here are the emission factors used in 2012. The emission factors for NO_x and PM change each year in the residential sector as they follow the evolution of boilers (park and performance) in this sector.

For the 2014 submission, the three regions agreed to use the emission factors for wood combustion form the Guidebook 2013 for estimating the wood emissions for the residential sector.

Emission factors used to calculate the emissions of stationary combustion in the residential sector for the year 2012 in the three regions are given below (tables 3.41 to 3.43).

Table 3.41 Emission factors for the sector 1A4bi in the Walloon region for 2012 (EMEP/EEA Guidebook 2009 except NO_x and PM10-EMEP/EEA Guidebook 2013)

Fuel	**UNIT**	**SOx**	**NOx**	**NMVOC**	**CO**	**NH_3**	**TSP**	**PM10**	**PM2,5**
Coal	g/GJ	600	104	200	4600	0.3	107	97	95
Wood	g/GJ	11	80	600	4000	70	800	760	740
diesel oil	g/GJ	48	41.3	15	46	0.1	5	3.1	3.1
natural gas	g/GJ		30.51	10.5	31	0.6	0,3	0,3	0,3
LPG	g/GJ		40	5	50				

Fuel	As	Cd	Cu	Cr	Ni	Pb	Se	Zn	Hg	Diox	HAP (4)	HCB	PCB
UNIT	mg/ GJ	mg/ GJ	mg/ GJ	mg/ GJ	mg/ GJ	mg/ GJ	mg/ GJ	mg/ GJ	mg/ GJ	ng/ GJ	mg/ GJ	µg/GJ	µg/GJ
Coal	2.5	1.5	22	11	13	130	1.2	220	5.1	800	800	0.62	170
Wood	0.19	13	6	23	2	27	0.5	512	0.56	800	345	5	0.06
diesel oil	1.8	1.4	2.7	1.4	1.4	4.1	6.8	1.8	1.4	10	30		
natural gas	0.1	0.5	0.4	0.7	1	1	0.01	13.6	0.2	0.5	0.003		

Table 3.42 Emission factors for the sector 1A4b in the Flemish region.

Fuel	**UNIT**	**SO_2***	**NO_x***	**COV**	**CO**	**NH_3**	**TSP***	**PM10***	**PM2,5***
coal	g/GJ	400	104,442	200	4600	0,3	107	53,5	26.750
Wood**	g/GJ	11	80	600	4000	70	800	760	740
diesel oil	g/GJ	48	40.990	3	46	0	4.591	4,591	4.951
Heavy fuel	g/GJ	480	200				27	17.550	6.750
natural gas	g/GJ	0	28.554	2	31	0	0.3	0,3	0.3
LPG	g/GJ	0	40	2	31	0	0.3	0,3	0.3
Source		S-content and regional tuning	Study FOD	Study VITO	EMEP /EEA guidebook 2009	EMEP /EEA guidebook 2009	Study FOD	Study FOD	Study FOD

*emission factors vary with time. The table shows the emission factors used to calculate emissions 2012

**wood: EMEP/EEA Emission Inventory Guidebook 2013

Fuel	UNIT	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
coal	g/GJ	0,13	0,0015	0,0051	0,0025	0,0112	0,0223	0,0127	0,001	0,22
wood	g/GJ	0,027	0,013	0,0005 6	0,00019	0,023	0,006	0,002	0,0005	0,512
diesel oil	g/GJ	0,0041	0,0014	0,0014	0,0018	0,0014	0,0027	0,0014	0,0068	0,001 8
natur al gas	g/GJ	0,00098 4	0,0005 15	0,0002 34	0,00009 37	0,0006 56	0,0003 98	0,0009 84	0,00001 12	0,013 6
LPG	g/GJ	0,00098 4	0,0005 15	0,0002 34	0,00009 37	0,0006 56	0,0003 98	0,0009 84	0,00001 12	0,013 6
Sourc e		Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO	Study VITO

Fuel	Polluent	Unit	Value	Source
Coal	PCDD/F	µg/GJ	0,070	UNEP Standardized Toolkit; Category 3e1: Power Generation and Heating; Domesting heating - Fossil fuels; Coal fired stoves
Wood	PCDD/F	µg/GJ	0,800	EMEP2013 tier1 residential plants using biomass
Diesel oil	PCDD/F	µg/GJ	0,010	UNEP Standardized Toolkit; Category 3e2: Power Generation and Heating; Domesting heating - Fossil fuels; Oil fired stoves
Natural gas	PCDD/F	µg/GJ	0,0015	UNEP Standardized Toolkit; Category 3e3: Power Generation and Heating; Domesting heating - Fossil fuels; Natural gas fired stoves
LPG	PCDD/F	µg/GJ	0,0015	UNEP Standardized Toolkit; Category 3e3: Power Generation and Heating; Domesting heating - Fossil fuels; Natural gas fired stoves
Coal	HCB	g/GJ	0,000000 55	EMEP/CORINAIR Guidebook (2005)
Wood	HCB	g/GJ	0,000005	EMEP2013 tier1 residential plants using biomass

Fuel	benzo(a)pyreen (kg/TJ)	benzo(b)fluorantheen (kg/TJ)	benzo(k)fluorantheen (kg/TJ)	indeno(1,2,3-cd)pyreen (kg/TJ)	PCB's (polychloorbiphenyls) (kg/TJ)
natural gas					
diesel oil	0,000101	5,38E-05	8,19E-05	0,000201	
coal	0,007006	0,022293	0,019745	0,006688	
LPG					
wood	0,121	0,111	0,042	0,071	6E-08
source	TNO	TNO	TNO	TNO	TNO

Table 3.43 Emission factors for the sector 1A4b in the Brussels region.

Fuel	UNIT	SOx	NOx	COV	CO	NH_3	PM10
Coal	g/GJ	600	104	200	2000	-	54
Wood	g/GJ	11	80	600	4000	-	760
Diesel oil	g/GJ	48	42	3	20	-	3.9
Natural gas	g/GJ	0	30	5	48	-	0.3

Agriculture/forestry/fishery (category 1A4c)

Category 1A4ci is a key category of SO_x and Ni emissions in terms of emissions trend or level.

Agricultural fuel consumption is estimated from statistical information concerning area used, etc., combined with specific energy consumption from literature. The following chart (Figure 3.7 Trend of fuel consumption in the agricultural sector.) shows the trends of the energy consumption in the agricultural sector.

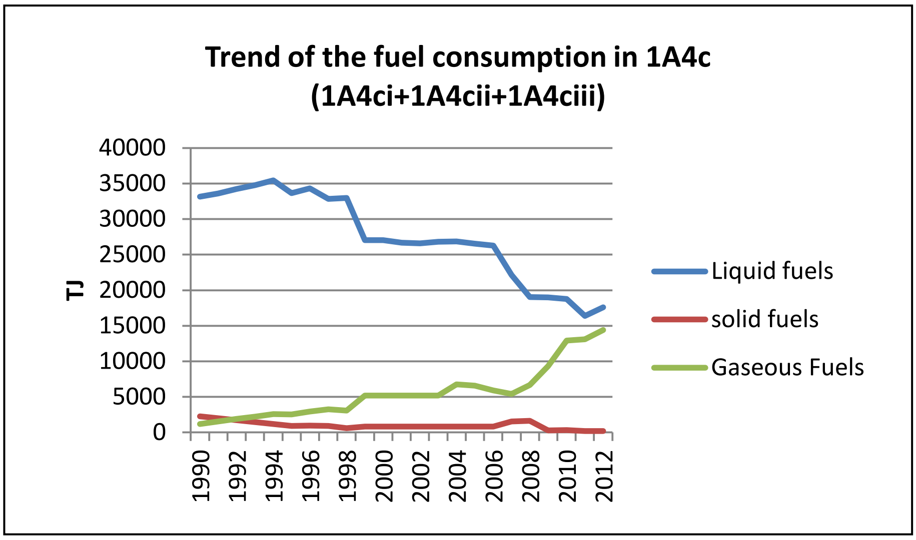

Figure 3.7 Trend of fuel consumption in the agricultural sector.

Combustion emissions in the agricultural sector are calculated by multiplying the energy use (Energy Balance for Flanders) and specific emission factors. Emissions are calculated for arable farming, remaining crops, pasture, intensive livestock, soil-bound agriculture and cultivation under glass.

In Wallonia, emissions from the combustion emissions in the agricultural sector and emissions from farming vehicles are calculated by using the energy use (Energy Balance for Wallonia) and emission factors of the EMEP/EEA guidebook.

The sector 1A4ci Agriculture/Forestry/Fishing (stationary combustion) includes the emissions originating from greenhouse culture and intensive livestock breeding.

The activity data (energy consumption data) of the sectors 1A4ci are taken from the regional energy balances. Emission factors originate from the EMEP/EEA Guidebook, are region specific (NMVOC, TSP, PM10, PM2,5) or derived from the S-content and regional tuning (SO_x). The tables 3.44 to 3.45 give an overview of the emission factors used in 2012 in Flanders.

Table 3.44 Emission factors used for the sector 1A4ci in the Flemish region in 2012.

Greenhouse culture	natural gas	diesel oil	heavy fuel	solid fuels	LPG	palm oil and rape oil	biogas	wood	petrol
CO (kg/TJ)	25	16	40	931	25	16	25	1600	16286,84989
NOx (kg/TJ)	64	50	125	300	40	50	64	150	50
CxHy (kg/TJ)	2	3	3	200	2	2,5	2	146	
stof (kg/TJ)	0,2	5	60	60	0,2	5	0,2	156	336,595546
PM10 (kg/TJ)	0,2	5	49,8	30	0,2	5	0,2	150	319,7657687
SOx (kg/TJ)	0	48	480	648	0	95	0	38,4	95
Pb (kg/TJ)	0,000984	0,004	0,016	0,1342	0,000984	0,004	0,000984	0,0248	0,237
NH3 (kg/TJ)									0,085
As (kg/TJ)	0,002	0,001	0,004	0,000	0,002	0,000	0,001		
Cd (kg/TJ)	0,001	0,001	0,000	0,002	0,001	0,001	0,001	0,002	0,000211416
Cr (kg/TJ)	0,001	0,001	0,013	0,014	0,001	0,001	0,001	0,007	0,001057082
Cu (kg/TJ)	0,000	0,003	0,007	0,018	0,000	0,003	0,000	0,005	0,035940803
Hg (kg/TJ)	0,000	0,001	0,000	0,008	0,000	0,001	0,000	0,001	
Ni (kg/TJ)	0,001	0,001	0,260	0,013	0,001	0,001	0,001	0,002	0,001479915
Se (kg/TJ)	0,000	0,007		0,002	0,000	0,007	0,000	0,001	0,000211416
Zn (kg/TJ)	0,014	0,002	0,008	0,200	0,014	0,002	0,014	0,114	0,021141649
PM2,5 (kg/TJ)	0,200	5,000	40,200	15,000	0,2	5,000	0,200	149	302,936

Intensive livestock	natural gas	diesel oil	heavy fuel	solid fuels	LPG	renewable	palm oil and rape oil	biogas	wood	petrol
CO (kg/TJ)	25	256,1826698	40	931	25	1600	385	407	1600	16286,8499
NOx (kg/TJ)	64	820,68	125	300	40	150	317	165	150	150,465116
CxHy (kg/TJ)	2	170	3	200	2	146	48	50	146	
TSP (kg/TJ)	0,2	336,595546	60	60	0,2	156	5	0,2	156	336,595546
PM10 (kg/TJ)	0,2	319,7657687	49,8	30	0,2	150	5	0,2	150	319,765769
SOx (kg/TJ)	0	92	480	648	0	38,4	95	0	38,4	92
Pb (kg/TJ)	0,000984	0,237	0,016	0,1342	0,000984	0,0248	0,004	0,000234	0,0248	0,237
NH3 (kg/TJ)		0,187								0,085
As (kg/TJ)	0,000		0,001	0,004	0,000	0,001	0,002	0,000	0,001	
Cd (kg/TJ)	0,001	0,000234192	0,000	0,002	0,001	0,002	0,001	0,001	0,002	0,000211416
Cr (kg/TJ)	0,001	0,001170960	0,013	0,014	0,001	0,007	0,001	0,001	0,007	0,001057082
Cu (kg/TJ)	0,000	0,039812646	0,007	0,018	0,000	0,005	0,003	0,000	0,005	0,035940803
Hg (kg/TJ)	0,000		0,000	0,008	0,000	0,001	0,001	0,000	0,001	

Ni (kg/TJ)	0,001	0,001639344	0,260	0,013	0,001	0,002	0,001	0,001	0,002	0,001479915
Se (kg/TJ)	0,000	0,000234192		0,002	0,000	0,001	0,007	0,000	0,001	0,000211416
Zn (kg/TJ)	0,014	0,023419204	0,008	0,200	0,014	0,114	0,002	0,014	0,114	0,021141649
PM2,5 (kg/TJ)	0,200	302,936	40,200	15,000	0,2	149	5,000	0,200	149	302,936

Table 3.45 Emission factors used for the sector 1A4ci (autoproducers in greenhouse culture) in the Flemish region in 2012.

autoproducers agriculture	natural gas	diesel oil	heavy fuel	solid fuels	LPG	palm oil and rape oil	biogas	wood	petrol
CO (kg/TJ)	407	385	385			385	407	1600	
NOx (kg/TJ)	158	307	307			317	165	150	
CxHy (kg/TJ)	47	46	46			48	50	146	
TSP (kg/TJ)	0,2	5	60	60	0,2	5	0,2	156	
PM10 (kg/TJ)	0,2	5	49,8	30	0,2	5	0,2	150	
SOx (kg/TJ)	0	48	480	648	0	95	0	38,4	
Pb (kg/TJ)	0,000234	0,004	0,004			0,004	0,000234	0,0248	
NH3 (kg/TJ)									
As (kg/TJ)	0,000	0,002	0,002			0,002	0,000	0,001	
Cd (kg/TJ)	0,001	0,001	0,001			0,001	0,001	0,002	
Cr (kg/TJ)	0,001	0,001	0,001			0,001	0,001	0,007	
Cu (kg/TJ)	0,000	0,003	0,003			0,003	0,000	0,005	
Hg (kg/TJ)	0,000	0,001	0,001			0,001	0,000	0,001	
Ni (kg/TJ)	0,001	0,001	0,001			0,001	0,001	0,002	
Se (kg/TJ)	0,000	0,007	0,007			0,007	0,000	0,001	
Zn (kg/TJ)	0,014	0,002	0,002			0,002	0,014	0,114	
PM2,5 (kg/TJ)	0,200	5,000	40,200	15,000	0,2	5,000	0,200	149	

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The table 3.46 gives an overview of the emission factors used in 2012 in Wallonia.

Table 3.46 Emission factors for the sector 1A4ci in the Walloon region (EMEP/EEA Guidebook 2009 except NO_x and PM10)

Fuel	**UNIT**	**SOx**	**NOx**	**NMVOC**	**CO**	**NH_3**	**TSP**	**PM10**	**PM2,5**
diesel oil	g/GJ	48	100	10	40	0.1	27	21	16

Fuel	**As**	**Cd**	**Cu**	**Cr**	**Ni**	**Pb**	**Se**	**Zn**	**Hg**	**Dio**	**HAP (4)**	**HCB**	**PCB**
UNIT	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ	µg/GJ	µg/GJ
diesel oil	1.8	1.4	2.7	1.4	1.4	4.1	6.8	1.8	1.4	10	17		

Off-Road sector (category 1A4bii and 1A4cii)

Category 1A4bii is a key category of CO emissions in terms of emissions level and trend.

Category 1A4cii is a key category of NO_x in terms of emissions level and trend and of NMVOC and PM2,5, PM10 and TSP emissions in terms of emissions level.

The off-road emissions are calculated for the 3 regions by the mathematical model OFFREM (Off-road emission model). Off-road emissions of agricultural nature are not calculated with OFFREM in Wallonia and Flanders. Emissions are calculated for machinery used in defence, harbours, airports and trans-shipment companies (categories 1A3e and 1A5b), in households (category 1A4bii), in forestry and green area (category 1A4cii). Exhaust emissions as well as non-exhaust emissions are calculated.

Activity data as input for the model are statistics from harbours and airports, information about households, data on sales of machinery.

For the calculation of energy use and emissions two groups can be divided: off-road machinery and off-road vehicles. Examples of off-road machinery are fork lifts, scissor lifts, lawn mowers. For these machinery the model generates activity data in kWh and methodology of TREMOD is used. Examples of off-road vehicles are luggage carts, quads, sweepers. For these vehicles the model generates activity data in km and aggregated data from MIMOSA model is used (COPERT based model to calculate emissions from road transport).

A complete detailed description about the methodology used can be found in annex 3 of the National Inventory Report (NIR) 2013 where the Quality Management System of the (greenhouse) gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 ‘Procedure for the main process: setting up the greenhouse gas emission inventory’ this methodology is recorded in annex 7.3.17. with the data acquisition plan for the off-road sector in the Flemish region, which is also used for the emission reporting under CLRTAP.

Emissions of arable farming, remaining cultures, cattle at pasture and soil-bound agriculture are also allocated in the sector 1A4cii Agriculture/Forestry/Fishing (off-road vehicles and other machinery), as well as off-road emissions in forestry and green area (the latter two calculated by OFFREM). The activity data (energy consumption data) of the sectors 1A4cii are taken from the regional energy balances. Emission factors originate from the EMEP/EEA Guidebook, are region specific (NMVOC, TSP, PM10, PM2,5) or derived from the S-content and regional tuning (SO_x). The Table 3.47 give an overview of the emission factors used in 2012 in Flanders.

Table 3.47 Emission factors per subsector for the sector 1A4cii, used in Flanders

Arable farming	natural gas	diesel oil	heavy fuel	solid fuels	LPG	palm oil and rape oil	biogas	wood	petrol
CO (kg/TJ)	25	256,183	40		25,000	385,000	407,000	1600,000	16286,850
NOx (kg/TJ)	64	820,680	125,000		40,000	317,000	165,000	150,000	150,465
CxHy (kg/TJ)	2	170,000	3,000		2,000	48,000	50,000	146,000	0,000
TSP (kg/TJ)	0,2	336,596	60,000		0,200	5,000	0,200	156,000	336,596
PM10 (kg/TJ)	0,2	319,766	49,800		0,200	5,000	0,200	150,000	319,766
SOx (kg/TJ)	0	92,158	479,799		0,000	95,000	0,000	38,400	92,158
Pb (kg/TJ)	0,001	0,237	0,016		0,001	0,004	0,000	0,025	0,237

NH3 (kg/TJ)	0,000	0,187	0,000		0,000	0,000	0,000	0,000	0,085
As (kg/TJ)	0,000	0,000	0,001		0,000	0,002	0,000	0,001	0,000
Cd (kg/TJ)	0,001	0,000	0,000		0,001	0,001	0,001	0,002	0,000
Cr (kg/TJ)	0,001	0,001	0,013		0,001	0,001	0,001	0,007	0,001
Cu (kg/TJ)	0,000	0,040	0,007		0,000	0,003	0,000	0,005	0,036
Hg (kg/TJ)	0,000	0,000	0,000		0,000	0,001	0,000	0,001	0,000
Ni (kg/TJ)	0,001	0,002	0,260		0,001	0,001	0,001	0,002	0,001
Se (kg/TJ)	0,000	0,000	0,000		0,000	0,007	0,000	0,001	0,000
Zn (kg/TJ)	0,014	0,023	0,008		0,014	0,002	0,014	0,114	0,021
PM2,5 (kg/TJ)	0,200	302,936	40,200		0,200	5,000	0,200	149,000	302,936

Remaining crops	natural gas	diesel oil	heavy fuel	solid fuels	LPG	renewable	lamppetroleum	petrol
CO (kg/TJ)	25	256,1826698	40	931	25	1600		16286,8499
NOx (kg/TJ)	64	820,68	125	300	40	150		150,465116
CxHy (kg/TJ)	2	170	3	200	2	146		
TSP (kg/TJ)	0,2	336,595546	60	60	0,2	156		336,595546
PM10 (kg/TJ)	0,2	319,7657687	49,8	30	0,2	150		319,765769
SOx (kg/TJ)	0	92	480	648	0	38,4		92
Pb (kg/TJ)	0,000984	0,237	0,016	0,1342	0,000984	0,0248		0,237
NH3 (kg/TJ)		0,187						0,085
As (kg/TJ)	0,000		0,001	0,004	0,000	0,001		
Cd (kg/TJ)	0,001	0,000234192	0,000	0,002	0,001	0,002		0,000211416
Cr (kg/TJ)	0,001	0,001170960	0,013	0,014	0,001	0,007		0,001057082
Cu (kg/TJ)	0,000	0,039812646	0,007	0,018	0,000	0,005		0,035940803
Hg (kg/TJ)	0,000		0,000	0,008	0,000	0,001		
Ni (kg/TJ)	0,001	0,001639344	0,260	0,013	0,001	0,002		0,001479915
Se (kg/TJ)	0,000	0,000234192		0,002	0,000	0,001		0,000211416
Zn (kg/TJ)	0,014	0,023419204	0,008	0,200	0,014	0,114		0,021141649
PM2,5 (kg/TJ)	0,200	302,936	40,200	15,000	0,2	149		302,936

Cattle at pasture	natural gas	diesel oil	heavy fuel	solid fuels	LPG	palm oil and rape oil	biogas	wood	petrol
CO (kg/TJ)	25	256,1826698		931	25	385	407	1600	16286,84989
NOx (kg/TJ)	64	820,68		300	40	317	165	150	150,4651163
CxHy (kg/TJ)	2	170		200	2	48	50	146	
stof (kg/TJ)	0,2	336,595546		60	0,2	5	0,2	156	336,595546
PM10 (kg/TJ)	0,2	319,7657687		30	0,2	5	0,2	150	319,7657687
SOx (kg/TJ)	0	92		648	0	95	0	38,4	92
Pb (kg/TJ)	0,000984	0,237		0,134	0,000984	0,004	0,000234	0,0248	0,237
NH3 (kg/TJ)		0,187							0,085
As (kg/TJ)	0,000			0,004	0,000	0,002	0,000	0,001	
Cd (kg/TJ)	0,001	0,000234192		0,002	0,001	0,001	0,001	0,002	0,000211416
Cr (kg/TJ)	0,001	0,001170960		0,014	0,001	0,001	0,001	0,007	0,001057082
Cu (kg/TJ)	0,000	0,039812646		0,018	0,000	0,003	0,000	0,005	0,035940803
Hg (kg/TJ)	0,000			0,008	0,000	0,001	0,000	0,001	
Ni (kg/TJ)	0,001	0,001639344		0,013	0,001	0,001	0,001	0,002	0,001479915
Se (kg/TJ)	0,000	0,000234192		0,002	0,000	0,007	0,000	0,001	0,000211416
Zn (kg/TJ)	0,014	0,023419204		0,200	0,014	0,002	0,014	0,114	0,021141649
PM2,5 (kg/TJ)	0,200	302,936		15,000	0,2	5,000	0,200	149	302,936

The sector 1A4ciii contains the emissions of Agriculture/Forestry/Fishing (national fishing). The activity data (energy consumption data) of the sectors 1A4ciii are taken from the regional energy balances. The emission factors to calculate the emissions for the sector 1A4ciii are given in table 3.48.

Table 3.48 Emission factors for the sector 1A4ciii, used in Flanders

		diesel oil	
	unit		source
SO2	kg/TJ	92	Idem agriculture
Nox	kg/TJ	1200	revised IPCC 1996 Guidelines
NMVOC	kg/TJ	200	revised IPCC 1996 Guidelines
CO	kg/TJ	1000	revised IPCC 1996 Guidelines
TSP	kg/TJ	306	VITO
PM10	kg/TJ	290,7	VITO
PM2,5	kg/TJ	275,400	VITO
Pb	kg/TJ	0,001	

3.6. Other (category 1A5a and 1A5b)

In this section the emissions originating from the military transport are included (category 1A5b).

In Wallonia, the Walloon Energy Balance contains the fuel used by military aviation and the emission factors are those described in table 8.8 of the EMEP/EEA guidebook by using the dutch emission factors (nature of flight: average).

In Flanders, the emissions of military aviation are estimated based on plane movements or fuel use and emission factors. Data on air plane movements of military aviation (airports of Sint-Truiden, Goetsenhoven, Koksijde, Kleine-Brogel and Brasschaat) are reported by the General Staff of the Belgian Airforce, but are not available before 1993 and after 1998. The number of military flights in Melsbroek is reported by Brussels Airport. The Flemish Energy Balance contains the fuel use by military aviation. Based on the evolution of the fuel use, the time series 1999-2012 is calculated.

This section contains also the Off road emissions for machinery used in defence. The emissions are calculated for the 3 regions by the mathematical model OFFREM (Off-road emission model). Exhaust emissions as well as non-exhaust emissions are calculated.

The emissions of category 1A5a are supposed to be included in the sectors 1A1 to 1A4 and 1A5b.

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

3.7.1. Solid fuel transformation (category 1B1b)

Emissions during the coke production are caused by the loading of the coal into the ovens, the oven/door leakage during the coking period and by extracting the coke from the ovens.

Activity data (tons of cokes) are delivered by the corresponding industry.

In Wallonia, the emissions factors are the following (ULg 1998)(table 3.50) :

Table 3.49 Emission factors for the fugitive emissions in Walloon cokeries

	EF	UNIT
SOx	21	g/ Mg PRODUCT
NOx	480	g/ Mg PRODUCT
NMVOC	893	g/ Mg PRODUCT
CO	950	g/ Mg PRODUCT
NH3	138	g/ Mg PRODUCT
TSP	1600	g/ Mg PRODUCT
PM2.5	240	g/ Mg PRODUCT
PM10	560	g/ Mg PRODUCT
As	49	mg/Mg PRODUCT
Cd	123	mg/Mg PRODUCT
Cr	418	mg/Mg PRODUCT
Cu	222	mg/Mg PRODUCT
Hg	30	mg/Mg PRODUCT
Ni	160	mg/Mg PRODUCT
Pb	542	mg/Mg PRODUCT
Se	6	mg/Mg PRODUCT
Zn	542	mg/Mg PRODUCT
DIOXINS	300	ng/Mg PRODUCT
PAH	10000	mg/Mg PRODUCT

In Brussels (plant closed in 1993), the emission factor is 21 g SO_2/t and 480 g NO_x/t. In Flanders no fugitive SO_2 and NO_x emissions are estimated.

3.7.2. Fugitive emissions from oil (category 1B2a)

This category includes fugitive emissions from storage and handling in the refinery sector and refinery processes (1B2aiv) as well as emissions originating from petrol stations (1B2av).

Category 1B2aiv is a key category of NMVOC and SOx emissions in terms of emissions level and trend and of Pb, Cd, Hg and Ni in terms of emissions level.

Category 1B2av is a key category of NMVOC in terms of emissions trend.

Petroleum refineries are all situated in Flanders. Estimation of the emissions from the sector petroleum refining is generally provided by the companies based on monitoring results or emission factors. Whereas no distinction between fugitive and combustion emissions is possible, emissions of sector 1B2aiv are allocated in 1A1b.

In Wallonia, the fugitive emissions during the distribution of oil products are coming from the transport and storage of gasoline and also from the service stations.

Concerning the service stations, the activity data is the amount of gasoline in the road transport sector in the Walloon energy balance and the emission factor is 2,88 kg/tonne gasoline (Econotec 1998). For the transport and storage, the activity data was estimated via an inquiry in 1996 and recalculated with the annual consumption each year. The emission factor is 0,15 kg/tonne coming from the following legislation : 23 mai 1996 - Arrêté du Gouvernement wallon portant modification du Règlement général pour la protection du travail, en ce qui concerne les dépôts de liquides inflammables, visant à limiter les émissions de composés organiques volatils lors du stockage de l'essence et de sa distribution des terminaux aux stations-service.

In Flanders, for the calculation of NMVOC emissions from gasoline distribution at service stations activity data (amount delivered gasoline) originate from the Belgian Petroleum Federation (www.petrolfed.be). Gasoline is distributed for 95% at public service stations and 5% at private, small, stations. The assumption is made that all public service stations are equipped with stage II vapor recovery systems and private stations with stage I vapor recovery systems. The emission factors used are 0.510 g NMVOC/L for stage II systems and 1.3 g NMVOC/L for stations equipped with stage I systems. The factors originate from the BREF 'Best Available Techniques for service stations' (Meulepas P., 1999).

3.7.3. Natural gas (category 1B2b)

Category 1B2b is a key category of NMVOC emissions in terms of emissions level and trend.

In the category 1B2b, the fugitive emissions from all transmission, distribution and transport activities of natural gas in Belgium are allocated.

The activity data reported in the category 1B2b is the annual total natural gas amount consumed in Belgium. These activity data originate from SYNERGRID, the federation of the grid operators of gas and electricity in Belgium.

All transmission, distribution and transport activities of gas in Belgium are allocated in this category 1B2b.

The methodology to calculate the emissions of NMVOC originating from the gas distribution (category 1B2b iv/distribution) is completely harmonised for all the regions in Belgium since the submission in 2004. All information is reported by SYNERGRID, the federation of the grid operators of gas and electricity in Belgium. These emissions are determined on the basis of the length of gas distribution pipelines. The lengths of the main pipelines (exclusive additional, service pipelines which are pipelines going to households) per public utility board are available. The number of additional service pipelines in Flanders is estimated at 1 790 000 for the year 2012. In Wallonia, the number of additional pipelines is estimated at 195 000 for the year 2008. The length per additional pipeline is 5 m in the Flemish and the Walloon region. In Brussels, the number of pipelines is estimated at 186 500 for the year 2006 and is relatively stable for the following years (186 565 in 2010). The average length per pipeline is 3 m because of the urban environment. Depending on the material of the pipeline different emission factors are used. These emission factors are based on measurements carried out. In particular 869, 7865, 869 and 95 m^3/y/km for respectively steel, pig iron, fibre cement and synthetic material. The density of NMVOC is 1,42 kg/m^3. The NMVOC content of natural gas distributed is 8 %.

For each material the length of the pipelines is multiplied with the corresponding emission factor. This results in the total natural gas emission in m^3 per year. Multiplying this figure by the NMVOC content and the density of NMVOC, the diffuse NMVOC emission originating from gas distribution in Belgium is obtained.

Emissions of NMVOC (category 1B2biii/transmission) originating from the storage and transport of natural gas in Belgium are calculated and added to the inventory since the 2006 submission.

These emissions are estimated on the basis of measurements and calculations (taken into account pressure, distance, volume) carried out. All necessary interventions in case of problems are known and the amounts of gas blown off are registered as accurate as possible. All information is obtained from Fluxys, the independent operator of the gas network in Belgium.

3.8. Recalculations and planned improvements

Recalculations

- Actualisation of the emission factors in the district heat plants in 1990 (1A1a) following the EMEP Guidebook 2009 in the Walloon region.
- Actualisation of the emissions factors (heavy metals, dioxins, PAH) for the natural gas in gas turbines (1A1a) on the complete time serie following the EMEP Guidebook 2009 in the Walloon region.
- Mistake corrected in 2010 for the AD of a turbo jet (1A1a) in the Walloon region.
- A re-allocation of the emissions of waste incineration between 1A1c an 6C took place in the Walloon region for the complete time series.
- Reallocation of the emissions from pipeline compressors (1A1c to 1A3e) in the Walloon region.
- Actualisation of the emissions factors (heavy metals, dioxins, PAH) for the natural gas (1A2a to 1A2f) in 1990 following the EMEP Guidebook 2009 in the Walloon region.
- Recalculation of the number of LTO to reflect training aircrafts taking off with refuelling.
- Recalculation of the road emissions (time series 1990-2011) with Copert IV v10.0 in Wallonia.
- Actualisation of the emission factors in the railways sector (1A3c) on the complete time series in the Walloon region.
- Actualisation of the emission factors in the commercial sector (1A4ai) following the EMEP Guidebook 2009 in the Walloon region.
- Recalculation of the biomass consumption in the residential sector in the Walloon sector (2002-2010). The emissions in the NFR tables are in phase with these new consumptions but the AD indicated in the NFR tables are false. These AD will be changed during the next submission.

Table 3.50 Correction of a mistake in the NFR tables : biomass consumption in 1a4bi

TJ	2002	2003	2004	2005	2006	2007	2008	2009	2010
NFR tables 2014	11512	13232	13738	14278	15485	14942	17092	17675	21449
NFR tables 2015	11268	13895	15313	15983	17452	17371	20391	21843	26540

- Actualisation of the emission factors in the agricultural sector (1A4ci) on the complete time series in the Walloon region.
- Recalculation of the diesel consumption between the stationary and the mobile part of the agricultural sector (1A4ci and 1A4cii) from 2005 to 2011 following new data from the Walloon Energy Administration (DGO4).
- Recalculation of the Walloon forest sector in OFFREM as the wood surface has changed slightly (1A4cii).
- In Brussels the emissions from road transport have been recalculated (time series 1990-2012) using improved vehicle fleet and mobility data
- In Flemish Region the EMMOSS model used to calculate the emissions of sea navigation will be revised for dredging, tugs and extraction of sand.
- during the 2014 submission the Flemish region updated the gasoil energy activity data from the residential sector. The fuel switch between gasoil and natural gas is now better estimated. This resulted in new emissions for the years 2002-2012.
- during the 2014 submission the Flemish region updated the wood consumption from the residential sector on the base of the Eurostat survey. Before the energy activity data were underestimated.
- The emissions also were underestimated, therefore the emission factors of the EMEP/EEA emission inventory guidebook 2013 (tier 1) were used in the three regions. This resulted in new emissions for the years 1990-2012.
- Redistribution of the off-road emissions from category 1A4aii to categories 1A3e (harbours, airports and transshipment companies) and 1A5b (defence) according to the suggestion of the review team of the GES inventory.

<u>Improvements</u>

- The emission factors of the EMEP/EEA emission inventory guidebook 2013 (tier 2) will be used for wood burning in Flanders.
- Wallonia will evaluate the implementation of recommendations coming from the EMEP/EEA Guidebook 2013 for the next submission.

3.9. QA/QC

All emissions delivered by the plants are validated and verified by a team of people experienced in emission inventories. In addition, each year a trend analysis is carried out for all emissions per industrial plant and sector. If any inconsistencies or problems are detected by the team, the industry involved is contacted. In exceptional cases the inspection services are contacted.

Chapter 4. Industrial processes (NFR sector 2)

4.1. Source category description

The structure of the industrial sector has undergone profound changes over recent decades. The importance of the (heavy) industrial activities gradually decreases in favour of the service sector, transport and trade. The economic core nowadays in Flanders is situated around the harbours, in Brussels the services become more important and in the Walloon region most industry is situated around some cities. The mining industries have disappeared with the closure of the last coal-mines. The metallurgy and textile sectors have been relatively stable, after several waves of closures and restructuring. The economic crisis hit hard from 2008 on with several closures and restructurings. 2011 was a dark year with the closure of two integrated iron and steel plants in the Walloon region. The two other key sectors of industrial activity are the chemical industry and the food processing industry.

In this sector of industrial processes the emissions of industrial activities which are not related to the combustion of fossil fuels are included. The main source of information on the industrial emissions is obtained from the annual industrial reports. To have a total picture of all emissions by industrial activities, also activities with emissions below the threshold are estimated in a collective way, but this forms a minor fraction of the process emissions.

Allocation of emissions

The industrial processes in Belgium are covered by

(1) categories 2.A.1 (cement production) and 2.A.2 (lime production) , 2A6 (road paving with asphalt) and category 2.A.7 (quarrying and mining of minerals other than coal, other mineral products).

(2) categories 2.B.1 (ammonia production), 2.B.2 (nitric acid production), and category 2.B.5 (other industrial in the chemical industry)

(3) category 2.C.1 (metal production i.e. iron and steel industry) and 2C5e (other metal production);

(4) Category 2.D (pulp and paper and food and drink),

(5) category 2.F (consumption of POPs and heavy metals);

(6) category 2.G (other production)

4.2. Methodological issues

The main process emissions of SO_2, NO_x, NH_3 and CO 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, EMEP/EEA handbook, IPCC Guidelines or other specific bibliographies or calculated via measurements carried out by the industrial companies.

In Flanders, there is a different level of data handling in some years (1990- 1993, 1995, 1996, 1998, 2000, 2001, 2008-2012) compared to the other years (1994, 1997, 1999, from 2001 to 2007). In the former years emissions are available on installation level (SNAP code) and are allocated to the correspondent NFR code based on the correspondence table between SNAP and IPCC codes (http://www.eea.europa.eu/publications/EMEPCORINAIR5/BSVI_A.pdf), whereas in the latter years the emissions are available on a less detailed level (facility/sector level). A partition key based on the most recent detailed data (e.g. for emission data of 1999, the partition used in 1998 is applied for 1999) is used to attribute the emissions to the appropriate NFR code for the year where less detailed emission data are available.

4.2.1 Mineral products (category 2A)

The mineral industry is one of the most important sectors of industrial process emissions in Belgium.

4.2.1.1 Cement production (2A1)

This source is a key category of NO_x and SO_x, Hg, Se, HCB and PCB emissions in terms of emissions level and trend and a key category of PM10 emissions in terms of emission trend.

In Belgium, cement production (5 plants) only takes place in Wallonia.

The activity data is the clinker production collected directly from individual plants.

The emissions of all pollutants are estimated by plant-specific emissions (monitoring and calculation by the plant). The emissions are the sum of combustion and process emissions.

Since 2002, the emissions has varied each year and has been calculated directly by the plant for the PRTR purposes.

An average emission factor by plant and by pollutant has been estimated in 2002 and is applied on the whole time-series 1990-2001.

The evolution of the activity data, the NO_x, SO_x, PM10 emissions and the implied emission factors are presented in the table 4.1.

Table 4.1 Cement production in Wallonia.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Clinker production (kt)	5292	5387	5742	5732	5913	6055	5607	5885	5906	5799	6089
IEF clinker (kg NOx/t)	2,78	2,77	2,75	2,74	2,76	2,74	2,66	2,74	2,74	2,78	2,87
NOx emissions (kt)	14,7	14,9	15,8	15,7	16,3	16,6	14,9	16,1	16,2	16,1	17,5
IEF clinker (kg SOx/t)	0,81	0,82	0,78	0,79	0,78	0,78	0,77	0,83	0,76	0,78	0,80

SOx emissions (kt)	4,3	4,4	4,5	4,5	4,6	4,7	4,3	4,9	4,5	4,5	4,9
IEF clinker (kg PM10/t)											0,20
PM10 emissions (kt)											1,2

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Clinker production (kt)	5539	5583	5269	5169	5555	5752	5733	5638	5132	4740	5060	4869
IEF clinker (kg NOx/t)	2,67	2,26	2,45	2,73	2,57	2,24	2,39	2,02	2,22	2,24	2,31	2.16
NOx emissions (kt)	14,8	12,6	12,9	14,1	14,3	12,9	13,7	11,4	11,4	10,6	11,7	10.5
IEF clinker (kg SOx/t)	0,79	0,95	1,08	0,93	0,94	0,85	1,10	0,80	0,88	0,99	0,93	0.8
SOx emissions (kt)	4,4	5,3	5,7	4,8	5,2	4,9	6,3	4,5	4,5	4,7	4,7	3.9
IEF clinker (kg PM10/t)	0,18	0,15	0,23	0,09	0,06	0,06	0,02	0,02	0,03	0,02	0,02	00004
PM10 emissions (kt)	0,99	0,84	1,23	0,49	0,33	0,32	0,14	0,14	0,14	0,1	0,1	0.02

4.2.1.2 Lime production (2A2)

This source is a key category of PM10 and TSP emissions in terms of emission trend.

Production of lime also occurs only in the Walloon region of Belgium.

The emissions of lime production (category 2A2) are estimated by using plant-specific emission data for all pollutants excepted NH_3. The NH_3 emission factor is 5,1 g/t (National Pollutant Inventory in Australia). The emissions of this category are the sum of combustion and process emissions. Since

2002 the emissions have varied each year and have been calculated directly by the plant for the PRTR purposes.

An average emission factor by plant and by pollutant has been estimated in 2002 and is applied on the time-series 1990-2001.

The activity data is the lime and dolomite lime production and is collected directly from individual plants. A part of the lime production is coming from the kraft pulping process.

The evolution of the activity data, the PM10 emissions and the implied emission factors is presented in the table 4.2.

Table 4.2 Lime and dolomite lime production in Wallonia.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*2010*	2011	2012
Lime + dolomite lime (kt)	2640	2593	2681	2611	2778	2601	2774	2677	2586	1783	2116	2234	2091
IEF (kg PM10/t)	0,96	1,19	1,12	1,06	1,01	0,62	0,80	0,54	0,44	0,38	0,34	0,03	0.01
PM10 emissions (kt)	0,36	0,46	0,42	0,40	0,36	0,24	0,29	0,20	0,17	0,21	0,16	0,01	0.026

4.2.1.3 Road paving with asphalt (2A6)

The activity data is constant and is the average production of asphalt in the Walloon region (400 000 t/year).

The emission factors used are given in table 4.3.

Table 4.3 EFs used in NFR 2A6

Pollutant	**NMVOC**	**HAP**
Emission factors	564 g VOC/tonne	25,0 g HAP/tonne
References	ULg 1998	Excoser

NMVOC emissions due to asphalt production in Flanders are allocated in sector 2G.

4.2.1.4 Quarrying and mining of minerals other than coal (2A7a)

This source is a key category of PM2,5, PM10 and TSP emissions in terms of emission level and trend.

The emissions of this category are the sum of the emissions from the quarrying of minerals and the emissions from storage of minerals in the Walloon region.

Estimation of the emissions from storage of minerals was provided by a study on dust (Econotec 2001).

Emissions from the quarrying of minerals are the sum of plant specific emissions. These plants have had to report to PRTR since 2007. From 2000 to 2006, the estimation of the emissions was also provided by the study on dust.

The evolution of the PM10 emissions is presented in the table 4.4.

Table 4.4 PM10 emissions in 2A7a

	PM10 (tonnes) (2000-2006)	PM10 (tonnes) (2007-)
Storage of mineral products	1957	1957
Quarrying	284	Plant specific emissions

Emissions (kt)	2000-2006	2007	2008	2009	2010	2011	2012
2 A 7 a Quarrying and mining of minerals other than coal	2,23989	2,24019	2,3364	2,2127	2,16336	2,238	2.29

4.2.1.5 Other mineral products (2A7d)

This source is a key category of Se emissions in terms of emission level.

The category includes the emissions of the clay processing industry (bricks, expanded clay, tiles and glazed stoneware pipes), glass industry, (flat and bowed glass, glass fiber, glass wool, …) plaster, fibre cement, fluid concrete and asphalt stirring installations.

The emissions are calculated with plant specific emission factors, based on information reported in the environmental annual reports submitted by the operator of the plants or - if this information is not available - on literature data (Schrooten & Van Rompaey, 2002). Emissions of PM10 and PM2,5 are calculated as a fraction of TSP.

4.2.2. Chemical industry (category 2B)

4.2.2.1 Ammonia production (2B1)

Nowadays there is ammonia production in 2 companies in Belgium.

In Flanders the emissions of SO_2, NO_x, CO and NH_3 originating from the production of ammonia are obtained by monitoring results or calculation with plant specific factors. Due to the different level of data handling in some years (see above), emissions of the ammonia production are reported in the sector 2B1 in the years where detailed data handling was performed (installation level) and in the sector 2B5a when data were handled at sector level.

In the Walloon region, the producer of ammonia provides the annual NO_x emissions based on their production and on monitoring.

The following chart (fig. 4.1) shows the trend of the ammonia production :

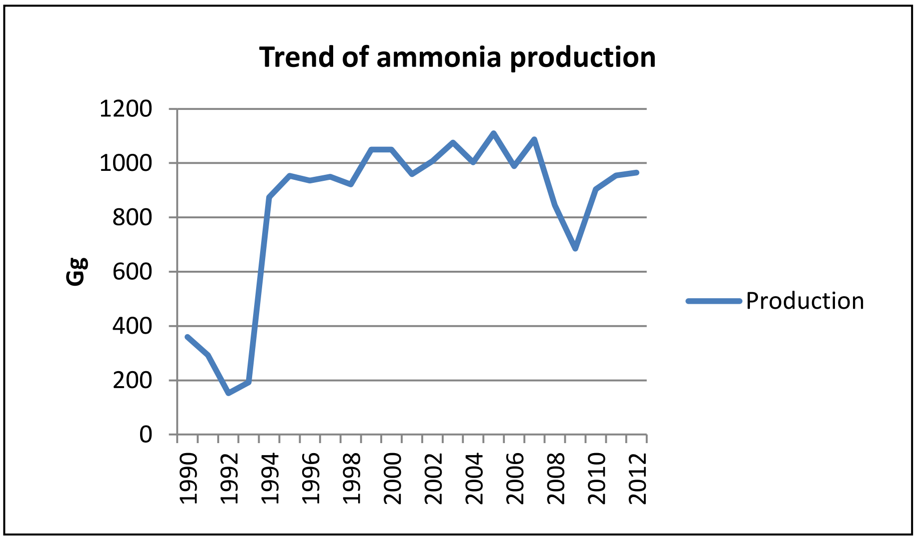

Figure 4.1 Trend of ammonia production.

4.2.2.2 Nitric acid production (2B2)

Despite the closure of 2 plants in the Flemish region, in 1995 and in 2000 respectively, the production of nitric acid still increases. NO_x emissions are also provided by the plant involved and based on measurements. Since 2000 only one plant is involved in this sector. In Flanders the emissions of SO_2, NH_3 and CO originating from the production of nitric acid are obtained by monitoring results, emissions of NO_x are calculated with plant specific factors.

The producer of nitric acid in the Walloon region provides the NO_x emissions based on their production and on monitoring. There are three installations on the plant. There is only one installation with an abatement technology (SCR) installed in 1996 which lead also in a strong increase of the production in 1996.

The following chart (fig. 4.2) shows the trend of the nitric acid production :

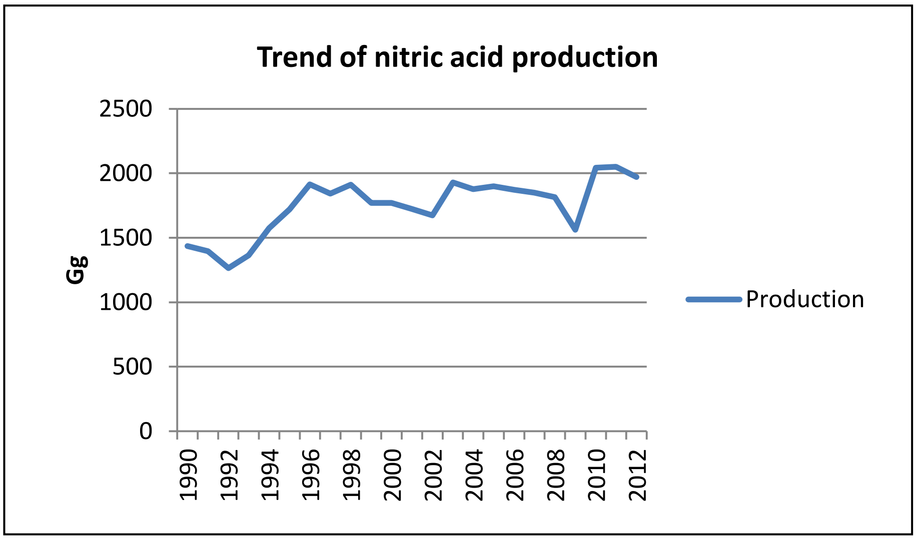

Figure 4.2 Trend of nitric acid production.

4.2.2.3 Other chemical industry (2B5a)

This source is a key category of NMVOC, SOx, Hg and Zn emissions in terms of emission level or trend.

This category involves all the chemical industry in Belgium which produce an environmental report. In the Walloon region, these are in particular the IPPC plants. In Flanders, in addition to the emissions of the chemical plants, also the emissions of the naphtha cracking installation in one refinery is included in this sector.

The emissions under Other chemical industry are mostly taken from reports from the industry.

Industrial plants have to report their emissions of air pollutants from the moment they exceed a defined threshold (in tonne/year) via their yearly environmental reporting obligations. The industry also has the obligation to report the methods used to estimate these emissions.

In the Flemish region an important source for the emissions of the chemical industry is the yearly reporting obligation by the industrial companies via the integrated environmental reports. Nearly all emissions are reported this way. More than 90% of the Flemish NMVOC emission is collected this way for the chemical industry.

The other smaller part of the emissions is estimated based on a survey performed by Ecolas authorized by the Environmental Department of the Flemish Government (Bogaert et al, 2004).

4.2.3. Metal production (category 2C)

4.2.3.1 Iron and steel production (2C1)

This source is a key category of PM2,5, PM10, TSP, Pb, Hg, As, NI, Zn, HCB, PCB and CO emissions in terms of emission level and trend and of NOx, Cd, Cr, Cu, PCDD/F and PAH in terms of emission level or trend.

In Flanders, the process emissions from iron and steel production are based on monitoring results provided by the companies. There is one integrated steel plant, one plant that produces stainless steel and one that handles molybdenum to be used in the production of stainless steel. All process emissions from sinter production, blast furnaces, rolling mills, steal production and electric arc furnaces are included.

In Flanders, the HCB emissions are calculated based on activity data and emission factors. The activity data are reported by the industrial companies via the integrated environmental reports. The emission factors are listed in Table 4.5.

Table 4.5 Emission factors of HCB for the sector 2.C.1 in the Flemish region

	Unit	**Value**	**Reference**
Ferro - coke	ng/tonne	596	Liu et al (2009)
Ferro - sinter	µg/tonne	32	EMEP/CORINAIR Guidebook (2005)

In Flanders, this activity is not significant for PCB-emissions.

In the Walloon region, iron is produced through the reduction of iron oxides (ore) with metallurgical coke (as the reducing agent) in a blast furnace to produce pig iron. Steel is made from pig iron and/or scrap steel using electric arc or basic oxygen.

The emission estimates in this sub-sector include also emissions from the production of steel in basic oxygen type furnaces but not emissions from the combustion of the fuel.

The emissions from electric arc furnaces include all the emissions (combustion and process).

In Wallonia, in 2012, there were only five electric arc furnaces. The last integrated iron and steel plant closed in 2011. The process emissions from iron and steel production are based on monitoring results provided by the companies.

In the sinter plants, the emissions calculated involve combustion and process emissions and are reported in the energy sector.

4.2.3.2 Other metal production (2C5e)

This category is a key category of Cd, As and Zn emissions in terms of emission level and trend and of Pb and Ni emissions in terms of emission level and includes emissions from the following activities :

- Surface treatment of metals (galvanizing, electroplating,..)
- In Flanders emissions from non-ferro activities are included in this sector.

The process emissions are based on monitoring results or calculations provided by the companies.

4.2.3.3 Storage, handling and transport of metal products (2C5f)

The emissions from handling of metal products in Brussels are based on monitoring provided by the companies.

4.2.4. Other production industry (category 2.D)

4.2.4.1 Pulp and paper (2D1)

This category includes process emissions from the following activities :

- Paper pulp plant (kraft process) (NMVOC emissions, no relevant NMVOC emissions in Flanders)
- Graphic sector
- Publishers/press

The process emissions are based on monitoring results provided by the companies.

4.2.4.2 Food and drink (2D2)

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

This category includes emissions from the following activities :

- Bread production
- Production of beer and other drinks (including milk)
- Abattoirs
- Oil production for consumption
- Production of starch
- Industrial fish smoking (PM)
- Meat cooking and barbecue (PM)
- Production of all other food

In Flanders, the process emissions from food and drink production of NO_x and CO are based on monitoring results provided by the companies. Dust and NMVOC emissions are calculated based on activity data and emissions factors, given below in table 4.5.

In Wallonia and Brussels, the emissions are calculated with the activity data and the emission factors given in table 4.5.

Table 4.6 AD and EFs used in 2D2

Type of products	region	Activity data	Emission factor	Reference
Bread	Flanders	111 g/hab.day	4500 g NMVOC/t	AD: Statbel EF: Emep guidebook 2009 Study Van Rompaey (1999)
Bread	Wallonia	130 g/hab.day	4500 g NMVOC/t	AD : Professional union of bakers and Statbel EF : Emep guidebook 2009
Beer	Flanders	74% x Belgium production	0,035 kg NMVOC/hl beer	AD : Beerparadise EF : Emep guidebook 2009
Beer	Wallonia	26 % x Belgium production	0,035 kg NMVOC/hl beer	AD : Beerparadise EF : Emep guidebook 2009
Bread/cookies	Brussels	125 g/hab.day	4500 g NMVOC/t	AD : Statbel EF : Emep guidebook 2009
Fish smoking	Flanders	Prodcom statistics	0.080 kg/ton	Study Schrooten & Van Rompaey (2002)
Meat cooking	Flanders	76 kg/hab.year	1.30 kg/ton	Study Schrooten & Van Rompaey (2002)
Barbecue (meat cooking)	Flanders	130 g/hab.year	40 kg/ton	Study Schrooten & Van Rompaey (2002)
Barbecue (charcoal emissions)	Flanders	165 g/hab.year	2.40 kg/ton	Study Schrooten & Van Rompaey (2002)

4.2.5. Consumption of POPs and heavy metals (category 2F)

4.2.5.1 The use of PCB transformers and capacitors

Directive 96/59/EC on the disposal of PCBs and PCTs aims at disposing completely of PCBs and equipment containing PCBs as soon as possible. This Directive sets the requirements for an environmentally sound disposal of PCBs. Member States have to make an inventory of big equipment containing PCBs, have to adopt a plan for disposal of inventoried equipment, and outlines for collection and disposal of non-inventoried equipment (small electrical equipment very often present in household appliances manufactured before the ban on marketing of PCBs). The PCB Directive further mandates that Member States had to dispose of big equipment (equipment with PCB volumes of more than 5 litres) by the end of 2010 at the latest.

In 2000 the OVAM (Public Waste Agency of Flanders) started a PCB disposal plan for Flanders with a stepwise destruction (based on the year of manufacture) of PCB-containing transformers/capacitors containing more than 1 litre of liquid with more than 0.05% PCBs.

The activity data are obtained from the OVAM:
- the total amount of destroyed and reported transformers and capacitors;
- the amount of liquid volume classified by concentration of PCBs in the liquids.

The emission factors are taken from the EMEP/EEA Emission Inventory Guidebook. Based on the total amount of liquid volumes from the reported transformers and capacitors minus the amount of liquid volumes of the destroyed transformers and capacitors the remaining liquid volume can be calculated. Based on the known PCB content and the emission factors, the PCB-emissions can be calculated.

Table 4.7 Emission factors of PCB for sector 2.F in the Flemish region

	Unit	Value	Reference
PCB transformer	kg/tonne PCB	0.06	Emep guidebook 2009
PCB capacitor	kg/tonne PCB	1,6	Emep guidebook 2009

4.2.6. Other production, consumption, storage, transportation or handling of bulk products (category 2.G)

For particulate matter and heavy metals, process emissions originating from the wood, textile, rubber and plastic handling, automobile, electrotechnical industry are allocated in this sector.

4.3. Recalculations

There was a mistake in the PM10 emissions in 2005 in 2A7a which is corrected.

In the Flemish region the following recalculations were made to optimize the inventory:

- NMVOC: The methodology of the other chemical industry (2B5a) was optimized by using more figures from the companies reported in the yearly environmental reports. By using more detailed information a part of the emissions could be allocated to 3C instead of 2B.

- PCB: a new methodology was developed for the use of PCB in transformers and capacitors (2F).

4.4. QA/QC

All emissions delivered by the plants are validated and verified by a team of people experienced in emission inventories. In addition, each year a trend analysis is carried out for all emissions per industrial plant and sector. If any inconsistencies or problems are detected by the team, the industry involved is contacted. In exceptional cases the inspection services are contacted.

4.5. Planned improvements

Wallonia will evaluate the implementation of recommendations coming from the EMEP/EEA Guidebook 2013 for the next submission.

Chapter 5. Solvent and other product use (NFR sector 3)

5.1. Overview of the Solvent and Other Product Use Sector (NFR 3)

In Belgium the emissions of NMVOC in the source category 'Solvent and other product use' include paint application, production of medicines, paints, inks and glues, domestic use of other products (incl. glues and adhesives), coating processes in general (incl. manufacture of automobiles), printing industry, wood conservation, treatment of rubber, recuperation of solvents, extraction of oil, cleaning, degreasing and dry cleaning.

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

The emissions of NMVOC in Flanders are estimated by using the results of a study started by Ghent University in 1998 and continued by the Flemish Environment Agency (VMM).

In Wallonia, the calculation is based on a methodology established by Econotec.

In the Brussels region, the emissions are calculated by using different sources: average emission factors, surveys and information collected from the sector. A recent study (2010) has compiled all information available for the category 'Decorative coating application' and 'Domestic Solvent Use'. The results gave a better overview of these categories and a better estimation of activity data and emission factors.

5.2. Paint Application (category 3A)

The category 3A1 is a key category of NMVOC emissions in terms of emission level and the category 3A2 is a key category of COV emissions in terms of emission level and trend.

5.2.1. Paint Application: Construction and Building and Domestic Use (category 3A1)

A recent study (2010) in the Brussels region has compiled all information available for the category 'Decorative coating application' and 'Domestic Solvent Use'. Thanks to this study, the NMVOC emissions of paint application for construction and building and domestic use have been completely revised in 2010 and this for the 3 regions in Belgium..

Information is obtained from IVP (Industry of paints, varnishes and inks) on the sales of decorative paint in Belgium, for both water based and solvent based paints. It is assumed that the IVP data represent 85% of the Belgian market. These activity data are confidential.

The key to allocate the Belgian data to each region is calculated using the number of residential and non-residential buildings and the volume of these buildings for construction and building and using the number of households and the expenses for decorative paint per household for the domestic use of paint.

The solvent content of water based and solvent based paints is obtained from CEPE (the European Council of the Paint, Printing Inks and Artists' Colours Industry). The allocation key between Construction and Building and Domestic Use is obtained from RAINS (Regional Air Pollution Information and Simulation model, developed by IIASA).

5.2.2. Paint Application: Car Repairing (category 3A2)

Since the year 2003, information is obtained from DuPont Refinish Belgium on volumes of paints and thinners sold to the car refinishing industry in Belgium (CRB data). It is assumed that the CRB data represent 85% of the Belgian market. The total volume sold to the car refinishing industry in Belgium is confidential.

The key to allocate the Belgian data to each region is calculated on the basis of the number of car refinishing facilities in 2003: 60% for Flanders, 31% for Wallonia, 9% for Brussels.

The solvent content of the different products are available from DuPont Refinish Belgium for the years 2003 and 2007. The solvent content between 2003 and 2007 is assumed to be equivalent to 2003 and the solvent content after 2007 is assumed to be equivalent to 2007.

For Brussels, an emission factor per company has been established. The AD is the number of companies in the region[3].

5.2.3. Paint Application: Wood (category 3A2)

In the Flemish region an important source for estimating these emissions is the yearly reporting obligation by the industrial companies via the integrated environmental reports. Together with a correction factor the total emission is calculated (De Roo et al., 2009).

In Wallonia, the activity data is calculated on the basis of the paint sales for the wood and wooden products industry in Belgium in 1996 (IVP data). It is assumed that the paint sales for this sector have followed the same evolution as the economic activity since 1996 and that IVP represents 85% of the Belgian market. The number of workers in the wood industry is then used as allocation key to calculate the Walloon sales.

The proportion of water based and solvent based paints as well as the solvent content of these paints come from IVP (2001 & 1996): 30% of water based paints, 5% of solvent in water based paint and 40% of solvent in solvent based paint. As the efficiency of the abatement techniques is not known, it is assumed that no abatement technique exists.

In Wallonia the emission figure includes the emissions from degreasing.

5.2.4. Paint Application: Manufacture of automobiles (category 3A2)

In the Flemish and Brussels regions an important source for estimating these emissions is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

In Wallonia, there is no activity for this sector.

5.2.5. Other Industrial Sources (3A2)

In the Flemish region an important source for estimating the emissions from other metal coating is the yearly reporting obligation by the industrial companies via the integrated environmental reports. Together with a correction factor the total emission is calculated (De Roo et al., 2009).

3 http://economie.fgov.be/fr/statistiques/chiffres/economie/entreprises/vie_entreprises/jaarevolutie/

In Wallonia, the activity data used to come from IVP. However, no official figures exist for the last years. Following a discussion with IVP in 2009, an estimation for the sales of paint for industrial applications in Belgium has been assumed . The number of workers in the metal fabrication industry is then used as allocation key to calculate the Walloon sales.

The solvent content in the paints used to come from IVP. However, no official figures exist for the last years. Following the discussion with IVP in 2009, an average of 40% of solvent has been assumed.

In Wallonia the emission figure includes the emissions from degreasing.

5.2.6. Paint Application: Other Non-Industrial Sources (3A3)

The emissions of road marking are included here. The activity data (paint consumption data) was obtained from UBATc (Belgium's authority offering technical approval of construction materials, products, systems and installers) in 2011: 6000 t of paint (200 t of water based – 5800 t of solvent based).

It is assumed that the water based paints do not contain solvent. The solvent content of the solvent based paints comes from Ökopol (the institute for environmental strategies): 25%.

The NMVOC emissions of road marking for Belgium are 1450 t in 2012 (870 t for Flanders and 580 t for Wallonia).

In Wallonia, part of the NMVOC emissions from degreasing is also included here.

5.2.7. Other non-industrial sources (3A3)

The emissions of PM2,5, PM10 and TSP, due to smoking of tobacco in Flanders, used to be reported under 7A, but it was decided to allocate these emissions in the more appropriate sector 3D3, according to the EMEP/EEA Guidebook 2009 (see Chapter 5).
Emissions are calculated by multiplying the tobacco consumption in Flanders (calculated from the Belgian tobacco consumption, taking into account the number of households and the average spending, www.statbel.fgov.be) and an emission factor of 40 kg/ton for TSP, PM10 and PM2,5 (TNO, 2001). The methodology is described in detail in a study performed by VITO under the authority of VMM (Schrooten et al., 2002).

5.3. Degreasing, Dry Cleaning (category 3B)

The sales figures of methylene chloride, trichloroethylene and perchloroethylene in UEBL (Economic Union of Belgium and Luxembourg) are obtained each year from ECSA (European Chlorinated Solvent Association). The allocation key is assumed to be 97% for Belgium. The split of applications (pharmaceutical industry, paint stripping, adhesives, metal degreasing, dry cleaning...) is also given by ECSA for Benelux (Belgium, Netherland, Luxembourg) for the 3 chlorinated solvents.

The following allocation keys are used in Flanders for the different applications:

- monetary value of sales figures for metal degreasing (De Roo et al, 2009);
- numbers of dry cleaning companies for dry cleaning (Federation of Belgian textile care; adjusted annually)

The following allocation keys are used in Wallonia for the different applications:

- Workers in the metal fabrication industry for metal degreasing (adjusted annually);
- Population for dry cleaning (adjusted annually);
- Workers in the metal fabrication industry for paint stripping (adjusted annually);
- Workers in industry for the other applications (adjusted annually).

5.3.1. Metal Degreasing (category 3B1)

The category 3B1 is a key category of COV emissions in terms of emission level.

In de Flemish region the methodology for calculating the NMVOC emission of metal degreasing was optimized in a study conducted by the University of Ghent commissioned by VMM [De Roo et al., 2009]. The consumption of chlorinated solvent for metal degreasing is calculated on the basis of data received from ECSA (see introduction of section 5.3). The consumption of non-chlorinated solvent for metal degreasing is calculated by making assumptions on the share of cleaning products (2011: non-chlorinated solvents 55%; water-based products 30-35%; chlorinated products 10-15%). The consumption figures of solvent are confidential.

The NMVOC emission factor for the activity without the application of an abatement technology is 0,72 t/t. For the different abatement technologies (closed cold cleaner, closed activated carbon filter closed bag system) the degree of implementation, the technical efficiency and the applicability are estimated. This is done for the use of chlorinated and non-chlorinated solvents. (De Roo et al., 2009).

The NMVOC emission for metal degreasing is calculated using the following formula (D'Haene et al., 2002):

$$E_{i,j} = \sum_{t=1}^{n}\left(A_{i,j} \; * \; EF_{i,j} \; * \gamma_{i,j,t} * \left(1-\eta_{i,j,t} \; * \alpha_{i,j,t}\right)\right)$$

with

	$E_{i,j}$	NMVOC emission for activity i and year j
	$A_{i,j}$	total activity figure for activitiy i (t solvent/year)
	t	abatement technology
	$EF_{i,j}$	NMVOC emission factor of activity i without application of an abatement technology
	$\gamma_{i,j,t}$	degree of implementation of the abatement technology for the activity (-)
	$\eta_{i,j,t}$	technical efficiency of the abatement technology t (-)
	$\alpha_{i,j,t}$	applicability of the technology t = the part of the emission on which the technology can be applied

In Wallonia, the consumption of chlorinated solvent for metal degreasing is calculated on the basis of data received from ECSA (see introduction of section 5.3). The consumption of non-chlorinated solvent for metal degreasing is calculated by making assumptions on the type of existing machines (closed machines using chlorinated solvent, opened machines using chlorinated solvent and opened machines using non-chlorinated solvent) and on the solvent recovery of the various types of machines. The ratio between non-chlorinated solvent and chlorinated solvent is then equal 2,76. The consumption figures of solvent are confidential. It is assumed that 90% of the solvent is lost to air and 10% to other media (water, soil).

5.3.2. Dry Cleaning (category 3B2)

In the Flemish region the consumption of chlorinated solvent (PER or perchloroethylene) for dry cleaning is calculated on the basis of data received from ECSA (see introduction of section 5.3). The consumption of hydrocarbon for dry cleaning is calculated by assuming that hydrocarbons are used in 12% of the dry cleaning machines and that 50% less hydrocarbon is used per kilogram of textiles. The amounts of PER-containing waste and hydrocarbon-containing waste collected from dry cleaning activities in Flanders and the share of PER and hydrocarbon in the waste are obtained from SITA Recyper (Belgian waste management, subsidiary of Suez Environnement). These amounts of products are recycled and not emitted into the air.

The total emission of NMVOC is obtained by deducting the quantities of PER and hydrocarbon in the waste from the consumption of PER and hydrocarbon.

In Wallonia, the consumption of chlorinated solvent (perchloroethylene) for dry cleaning is calculated on the basis of data received from ECSA (see introduction of section 5.3). The consumption of non-chlorinated solvent for dry cleaning is calculated by assuming that the chlorinated solvents represent 90% of the total consumption. The consumption figures of solvent are confidential. It is assumed that 90% of the solvent is lost to air and 10% to other media (water, soil).

In Brussels, dry cleaning emissions are calculated on the basis of the emission factor of 5.31 g NMVOC/hab determined in 2002, combined with the evolution of the total population.

5.3.3. Other Industrial Cleaning category

In Wallonia, the consumption of chlorinated solvent for other industrial cleaning is calculated on the basis of data received from ECSA (see introduction of section 5.3). The consumption of non-chlorinated solvent is not determined for this sector. The consumption figures of solvent are confidential.

It is assumed that 90% of the solvent is lost to air and 10% to other media (water, soil).

5.4. Chemical Products, Manufacture and Processing (NFR 3C)

The category 3C is a key category of NMVOC and HCB emissions in terms of emission level.

5.4.1. Polyester Processing

In the Flemish region an important source for the emissions of polyurethane processing is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

In Wallonia, the activity data used to come from Reinforplast (Association of Belgian Manufacturers of Reinforced Plastics/Composites). No statistics of production are available. In 1996, Reinforplast estimated the Belgian production based on information coming from the fiberglass suppliers). A small half of the producers were located in Wallonia but most of the big producers were located in Flanders. In terms of production, this represented 75% for Flanders and 25% for Wallonia.

In 2001 contact was made with Reinforplast, an estimation was made on the Walloon production based on an assumption of the Belgian production and assuming 65% in Flanders and 35% in Wallonia..

In 2010 contact was made with Federplast, the Association of Belgian Manufacturers of Articles in Plastics and Elastomers within Agoria (Belgian Federation for the Technology Industry) and Essenscia (Belgian Federation for Chemistry and Life Sciences Industries). No production figures are available even at European level. There are approximately 400 composites manufacturers in Belgium; half of them are located in Wallonia but all of relatively small size. At European level, the sector is growing but in Belgium it decreases. In the past, 75% of the production was attributed to Flanders but, in 2010, this proportion has decreased to 60% because many big producers have disappeared in Flanders.

In 1996, according to the fiberglass suppliers, the proportion of the different application techniques was: 42% for contact, 12% for filament winding, 35% for projection and 11% for other techniques. The styrene content in the resin depends on the process and can vary between 30 and 50%. A styrene content of 40% was assumed. For each application technique, the following styrene emissions (in % of the styrene used) were assumed: 3.2% for contact (1% in case of LSE resin), 4% for filament winding (2% for LSE resin), 8,3% for projection (3% in case of LSE resin) and 1,3% for other techniques (0,6% for LSE resin). In 1996, the proportion of low styrene emission resin was approximately 20% but this proportion has increased since then and is estimated to 40% in 2010. It is assumed that no abatement techniques are applied.

Emissions from the cleaning agents must be added to the styrene emissions. It is assumed that those emissions represent 40% of the total emissions for the composite production.

5.4.2. Polyvinyl Chloride Processing (PVC)

For the Flemish region, the NMVOC-emissions are included in other categories.

In Wallonia, the activity data for this sector is the consumption of plastic for the manufacture of electric cables. In 1996, this consumption was coming from the CRIF (Centre de Recherche scientifiques et techniques de l'Industrie des Fabrications métalliques – became SIRRIS in 2007). Only part of the plastic consumption must be attributed to flexible PVC but there is a lack of information so it is considered that 100% of the plastic used is PVC.

In 2012 contact was made with SIRRIS (Collective Centre of the Belgian Technology Industry)) to actualize the activity data. Unfortunately, no current global activity data is available. The plastic consumption in 2010 is assumed to be identical to 1996. This assumption is conservative because the plastic activities have decreased since 1996.

The proportion of plasticizers (phthalates as DOP and DEHP) in the resin can vary from 20% to 60% depending on the applications. A proportion of 40% of plasticizers is assumed. The emissions of plasticizers are assumed to be 2,5% of their consumption.

5.4.3. Polyurethane Processing

In the Flemish region an important source for the emissions of polyurethane processing is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

In Wallonia, the activity data for this sector is the production of polyurethane foam. In 1996, the PUR production in Wallonia was estimated on the basis of the following information/assumptions:

- Belgian production of cellular products (INS 1993) ;
- No Belgian production figures for PUR exists, an assumption was made;
- Other plastics can be made cellular (PP, PE), an assumption for the Belgian production was made

- 15% of PUR is produced in Wallonia (based on the number of producers in 1996).

In 2012 contact was made with SIRRIS (Collective Centre of the Belgian Technology Industry)) to actualize the activity data. Unfortunately, no current global activity data is available. The PUR production in 2010 is assumed to be identical to 1996. This assumption is conservative because the plastic activities have decreased since 1996.

The emission factor is 15 kg VOC/t PUR foam (Cahier sectoriel ‘Technologies et Environnement’, volume « Les thermoplastiques », Ministère de la Région wallonne, DGTRE, 1996).

5.4.4. Polystyrene foam processing

In the Flemish region an important source for the emissions of polystyrene foam processing is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

In Wallonia, the activity data for this sector is the production of expanded polystyrene. In 1996 the EPS production in Wallonia was estimated on the basis of the following information/assumptions:

- Belgian production of expanded polystyrene = 20 kT (CRIF 1996);
- 40% of EPS is produced in Wallonia (based on the number of producers in 1996).

In 2012 contact was made with SIRRIS (Collective Center of the Belgian Technology Industry) to actualize the activity data. Unfortunately no current global activity data is available. The PUR production in 2010 is assumed to be identical to 1996. This assumption is conservative because the plastic activities have decreased since 1996.

The emission factor is 33,3 kg VOC/t PUR foam (Cahier sectoriel ‘Technologies et Environnement’, volume « Les thermoplastiques », Ministère de la Région wallonne, DGTRE, 1996).

5.4.5. Rubber processing (category 3C)

In the Flemish region an important source for the emissions of the rubber processing is the yearly reporting obligation by the industrial companies via the integrated environmental reports. More than 80% of the Flemish NMVOC emissions is collected this way for the rubber processing activities.

The other smaller part of the emissions is calculated based on:

- the number of tires produced in Belgium (the Federal Public Service for Economy, General Directorate for Statistics and Information on Economy

- emission factor 100 g/tyre (D’Haene et al., 2002)

- the key to allocate the Belgian data to the Flemish region is calculated on the basis of the number of rubber processing companies (71% in 2012).

In Wallonia, this activity does not exist anymore. From 1990 to 2001, there was only one tyre manufacturer. The NMVOC emissions of this manufacturer have decreased in 1996 due to a modification in the process, In 2001, the company has closed.

5.4.6. Pharmaceutical Products Manufacturing (category 3C)

In the Flemish region the emissions of the pharmaceutical products manufacturing includes the emissions of the synthesis and the formulation. For the synthesis an important source for the emissions of the pharmaceutical products manufacturers is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

The other smaller part of the emissions caused by the formulation is based on a survey performed by Ecolas authorized by the Environmental Department of the Flemish Government (Bogaert et al, 2004).

In Wallonia, the emissions are directly obtained from the pharmaceutical products manufacturers. The NMVOC emissions for Wallonia include the emissions of the cleaning agents.

5.4.7. Coating Manufacture: Paint (category 3C)

In the Flemish region an important source for the emissions of the coating manufacturing is the yearly reporting obligation by the industrial companies via the integrated environmental reports. Since 2007 even 100% of the Flemish NMVOC emissions is collected this way for the coating manufacturing.

For the period 1990-2006, the other smaller part of the emissions is estimated based on the total solvent content in produced coatings in Flanders minus the solvent content of the Flemish companies with a yearly environmental report. An estimation is necessary for those coating manufacturers who have no obligation to report their emissions.

The activity data is the total Flemish paint production. These figures are confidential.

The estimation is based on production figures of decorative and industrial coatings (source IVP, Industry of paints, varnishes and inks). The part of the production allocated to Flanders is 79,4%.

The average solvent content in the paint is calculated on the basis of the solvent content in the coatings: 10% in water based decorative and industrial coatings; 40% in solvent based decorative coatings; 50% in solvent based industrial coatings (source IVP)

An emission factor of 4,4% of the solvent consumption is assumed (IVP).

In Wallonia, the activity data is the Walloon paint production. These figures are confidential. This data is calculated on the basis of the following data:

- Belgian sales of decorative paint (adjusted each year on the basis of IVP data – see section 5.2.1);
- Assumption on the proportion of the decorative paint exportations (contact with IVP, 2009): 90% sold in Belgium – 10% exported ;
- Belgian sales for the car repairing sector (adjusted each year on the basis of CRB data – see section **Fout! Verwijzingsbron niet gevonden.**);
- Assumption on the proportion of car refinish paint exportations (contact with IVP, 2009): 50% sold – 50% exported;
- Assumption on the Belgian sales of paint for other industrial applications (contact with IVP, 2009 – see section 5.2.5);
- Assumption on the Belgian production of paint for other industrial applications (contact with IVP, 2009);
- Assumption on the part of the production that must be allocated to Wallonia: 20%

The average solvent content in the paint is calculated on the basis of the solvent content in the decorative paints (adjusted each year - 9% in 2010 – see section 5.2.1), car refinish paints (adjusted each year - 35% in 2010 – see section 5.2.2) and industrial paints (40% - estimation of IVP in 2009). The average solvent content in the paint is 30% in 2010. An emission factor of 4,4% of the solvent consumption is assumed (IVP).

5.4.8. Inks Manufacturing (category 3C)

In the Flemish region an important source for the emissions of the inks manufacturing is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

In Wallonia, before 2002, IVP data were used to estimate the NMVOC emissions. Since 2002, the data are obtained directly from the inks producers. Most of the producers are located in Flanders. There are few producers in Wallonia. The producers calculate their emissions on the basis of a solvent management plan. The activity data is the solvent consumption. The implied emission factor depends on the type of ink produced and the use of an abatement technique. (It can vary from 1,5 kg NMVOC/ T solvent used to 50 kg NMVOC/T solvent used).

5.4.9. Glues Manufacturing (category 3C)

For the Flemish region the methodology has been optimized in a study performed by the University of Ghent authorized by the VMM (De Roo et al., 2009). The activity data for Flanders are confidential and obtained from the Federal Public Service for Economy (General Directorate for Statistics and Information on Economy). The share of solvent based glues is 7% of the total production figure of glues. The solvent content of the glues is 60%. The emission factor is 1,25%.

The emission of one company is not included in the activity figure and is extracted from the integrated environmental report. The production of urea formaldehyde (UF) based glues is also not included in the activity figure. In Flanders two companies produce UF glues. An emission figure for each company is taken into account, based on the integrated environmental report or a survey performed by the VITO (Lodewijks et al., 2003).

In Wallonia, this activity is not significant. The NMVOC emissions of the few producers are reported under category 2.B.5.a.

5.4.10. Adhesive and Magnetic Tapes, Film and Photographs Manufacturing (category 3C)

In Wallonia, the NMVOC emissions are obtained directly from the only adhesives producer on the basis of a solvent management plan .

5.4.11. Leather tanning (category 3C)

For the Flemish region this activity is not significant. The NMVOC emissions are not estimated.

In Wallonia, the NMVOC emissions are obtained directly from the 2 tanneries. There is no abatement technique. The emissions are equal to the solvent consumptions.

5.4.12. Other Chemical Product Manufacturing or Processing (category 3C)

For the Flemish region no other NMVOC emissions are allocated here.

In Wallonia, most of the NMVOC emissions of other chemical product manufacturing or processing are reported under category 2.B.5.a. The emissions of only one producer are allocated here. The NMVOC emissions are calculated on the basis of a solvent management plan.

5.4.13. Production of solvents (category 3C)

This is a key category of HCB emissions in terms of emissions level.

In Flanders HCB-emissions are caused by the production of tetrachloromethane, trichloroethylene and tetrachloroethylene. The activity data are obtained from ECSA (European Chlorinated Solvent Association) and are confidential. No activity data are obtained for tetrachloromethane. The emission factors are taken from the EMEP/EEA Emission Inventory Guidebook (table 5.1).

Table 5.1 Emission factors for the sector 3C in the Flemish region

	Emission factor	**Reference**
Production of solvents: tetrachloromethane	10 g/ton	EMEP/CORINAIR Guidebook (2005) Sources of HCB
Production of solvents: trichloroethylene	4 g/ton	EMEP/CORINAIR Guidebook (2005) Sources of HCB
Production of solvents: tetrachloroethylene	6 g/ton	EMEP/CORINAIR Guidebook (2005) Sources of HCB

5.5. Other Use of Solvents and Related Activities (NFR 3D)

The categories 3D1 and 3D2 are key categories of NMVOC emissions in terms of emission level and trend and the category 3D3 is a key category of NMVOC emissions in terms of emission level.

5.5.1. Printing (category 3D1)

In the Flemish region an important source for the emissions of the printing industry is the yearly reporting obligation by the industrial companies via the integrated environmental reports. More than 80% of the Flemish NMVOC emissions is collected this way for the printing industry.

The other smaller part of the emissions is estimated. An estimation is necessary for those sheet-fed offset companies who have no obligation to report their emissions. The estimation is based on a survey carried out by FETRA (the Belgian federation of paper- and board manufacturing industries) and Febelgra (the Belgian professional representative federation of the graphic industry).

In Wallonia, the activity data is the Walloon ink consumption. The figures of inks sales in Belgium and Luxembourg are obtained from IVP. It is assumed that 97% of the sales can be attributed to Belgium. The part to be attributed to Wallonia is then calculated on the basis of the number of workers in the printing industry.

The proportion of each printing techniques and the average solvent content of the ink for each printing technique are obtained from an EGTEI document. On the basis of these data, the Walloon solvent consumption can be calculated. The degree of implementation of the abatement techniques for each printing technique were obtained from FETRA-FEBELGRA (Belgian federation of paper and cardboard processing industries & Belgian professional representative federation of the graphic industry) and the emission factors with and without abatement are obtained from an EGTEI document (100% of solvent emitted without abatement – 5% with abatement). On the basis of these data, the Walloon emissions of the solvents in inks can be calculated.

In addition to those emissions, the emissions of the solvents in the cleaning and wetting agents are also estimated on the basis of a technical document about printing that was published in 1996 by the Ministry of the Walloon Region.

In Brussels, the emissions from printing are estimated on the basis of NMVOC balances (big businesses) and estimations from average emissions factors (small businesses).

5.5.2. Domestic Solvent Use (category 3D2)

A recent study (2010) in the Brussels region has compiled all information available for the category ‘Decorative coating application’ and ‘Domestic Solvent Use’ (‘NMVOC emissions through domestic solvent use and the use of paints in the Brussels Capital Region’, Arcadis, 2010). Thanks to this study, the NMVOC emissions of paint application for construction and building and domestic use have been completely revised in 2010.

The activity data is the population. The emission factors for the different product groups (office products, leather and furniture care, cosmetics and personal care, cleaning products, car products, adhesives/DIY – consumer, insecticides & plant protection products) have been determined by the 2010 study of Arcadis for the Brussels region for the year 2008. The emission factors have been slightly adapted for Flanders and Wallonia. For the Flemish, Walloon and Brussels region, the global emission factors are respectively 1,324, 1,412 and 1,181 kg/person for 2008.

According to the study, VOC-contents in household products have not been severely regulated over the past years. There is no legislation that significantly influenced the VOC-contents in cosmetics, cleaning products or other important VOC-containing household products. Evolution is therefore largely depending on activity data and minor VOC-specific changes. Bearing in mind the recent update of the emission registration methodology (and historical recalculations) in the Netherlands, the evolution for the Netherlands has been transferred to Belgium (1990-2008). A similar evolution of activity data can be assumed as it's a neighbouring country and culture and climate closely relate to each other. For the next years (starting 2009-2012), the emission factors can be assumed to remain constant.

5.5.3. Fat, edible and no-edible oil extraction (category 3D3)

In the Flemish region an important source for the emissions of oil extraction is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

In Wallonia, this activity is not significant. The NMVOC emissions are not estimated. The emissions of one producer are reported under category 3C.

5.5.4. Application of Glues and Adhesives (category 3D3)

In the Flemish region the following activities are included:

- bonding (gluing) of wood: the emissions of the chipboard companies are extracted from the integrated environmental reports.
- bonding (gluing) of synthetic material: an important source for estimating the emissions is the yearly reporting obligation by the industrial companies via the integrated environmental reports. Together with a correction factor the total emission is calculated (De Roo et al., 2009).

In Wallonia, the activity data is the glues and adhesives sales. This data is obtained from a study of DETIC (Belgian-Luxembourg Association of producers and distributors of soaps, cosmetics, detergents, cleaning products, hygiene and toiletries, glues, and related products) in 2002. As most of the sales are attributed to the construction sector, the part to be attributed to Wallonia is calculated on the basis of the population figures. According to DETIC, their members represent 70% of the Belgian market for glues and adhesives. On the basis of these data, the Walloon consumption of solvent based glues and adhesives is estimated excluding domestic use) in 2002. Unfortunately, this data is not available annually so the same figure is used from 2002 to 2010.

In addition to providing the sales of solvent based glues and adhesives for different applications, the DETIC study also provided the average solvent content of the glues and adhesives for each application. According to DETIC, the solvents in the solvent based glues and adhesives represent 90% of the total solvents (in both solvent and water based glues and adhesives). On the basis of these data, the Walloon consumption of solvent in glues and adhesives has been estimated for 2002 (excluding domestic use). As the data cannot be adjusted annually, the same figure is used from 2002 to 2010.

It is assumed that the emissions equal the consumptions (emission factor of 1 kg/kg).

5.5.5. Preservation of Wood (category 3D3)

In the Flemish region the emissions are caused by the use of creosote and solvent based products. Creosote B is gradually replaced by creosote C and solvent based products are gradually replaced by water based products. The emissions caused by the use of creosote are collected by a yearly survey. In 2012 there is only one user of creosote in Flanders with negligible emissions. The emissions caused by the use of solvent based products are extracted from the Flemish BAT (Best Available Technology) study Wood manufacturing industry (Polders et al., 2011).

In Wallonia, to estimate the emissions from 1990 to 1999, assumptions have been made on the consumptions of wood impregnation products (ECONOTEC, 2000). A VOC content of 27% has been assumed. This corresponds to the VOC content of creosote B at 40°C. It was assumed that the emissions equal the consumptions (emission factor of 1 kg/kg). Since 2000, as there is a lack of global information on the volume of impregnated wood and the products consumption, contact has been established with the main producers to estimate their emissions on the basis of the product consumption, the VOC content of the different products (depending on the condition of use), the process and the abatement techniques used. Creosote B is gradually replaced by creosote C and solvent based products are gradually replaced by water based products, so the global NMVOC emissions tend to decrease over time.

5.6. Recalculations in the Solvent and Other Product Use Sector

In the Flemish region, the following recalculations have been performed:

- 3C Chemical products:
    - Polyester processing: The sector is allocated in 3C for the first time. The methodology has been modified. More detailed information from the yearly reported integrated environmental reports is used.
    - Polyurethane processing: The sector is allocated in 3C for the first time. The methodology has been modified. More detailed information from the yearly reported integrated environmental reports is used.
    - Polystyrene foam processing: The sector is allocated in 3C for the first time. The methodology has been modified. More detailed information from the yearly reported integrated environmental reports is used.
    - Glues manufacturing: the AD of STATBEL from 2000 to 2011 have been modified due to an estimation of missing and incorrect figures.

- 3D Other Use of Solvents and Related Activities:

- Printing industry: the emissions from 2009 to 2011 have been slightly modified due to corrections of figures in a couple of yearly integrated environmental reports.

In Wallonia, the following recalculations have been performed:

- 3.A Paint application:
  - Construction and buildings and domestic use: Emissions from 1990 to 1999 have been actualized to take into account the results of the recent study (2010) in the Brussels region.
  - Car repairing: Emissions of 1990 have been estimated (they have been assumed equal to those of 1991).
  - Boat building: Emissions of 1999 have been estimated (they have been assumed equal to those of 1991). Emissions from 1994 to 1999 have been actualized in order to ensure the consistency of the time series.
  - Wood: Emissions from 1990 to 1993 have been estimated (they have been assumed equal to 1994). Emissions of 1999 have been actualized to ensure the consistency of the time series. Emissions from 2005 to 2011 have been slightly actualized.
  - Other industrial paint application: Emissions of 1990 have been modified to reflect the change in other sectors. Emissions from 1994 to 1999 have been actualized in order to ensure the consistency of the time series.
  - Other non industrial paint application: Emission of 1990 have been estimated (they have been assumed equal to those of 1991).
  - The emissions from non industrial paint allocation are now included in NFR3A3 and no more in NFR3A1.
- 3.B Degreasing, dry cleaning:
  - Metal degreasing: Emissions from 1994 to 1999 have been actualized in order to ensure the consistency of the time series.
- 3.C Chemical products:
  - Polyester processing: The emissions from 2000 to 2006 have been actualized in order to ensure the consistency of the time series.
  - Paints manufacturing: Emissions for the years 1990 to 1993 have been estimated (they have been assumed equal to those of 1994). Emissions of 2011 have been slightly modified to take into account the change of data in the sector of wood paint application.
  - Inks manufacturing: Emissions for the years 1990 to 1993 have been estimated (they have been assumed equal to those of 1994).
  - Glues manufacturing: Emissions from 1990 to 1995 have been estimated (they have been assumed equal to those of 1996).
- 3.D Other Use of Solvents and Related Activities:
  - Printing industry: AD has been actualized for the years 2007 to 2011on the basis of the IVP data on the inks sales.
  - Preservation of wood: Emissions from 1990 to 1999 have been estimated on the basis of assumptions on the wood impregnation products consumptions Emissions of 2011 have been adapted on the basis of new information on product consumptions coming from one operator.

Brussels has recalculate the AD for car repairing (3A2) and printing (3D1) with new available statistics from the year 2008 to 2011.

5.7. QA/QC

All emissions delivered by the plants are validated and verified by a team of people experienced in emission inventories. In addition, each year a trend analysis is carried out for all emissions per industrial plant and sector. If any inconsistencies or problems are detected by the team, the industry involved is contacted. Numerous contacts take place with the plant operators as well as with the federations involved.

5.8. Planned Improvements

In the Flemish region, the following improvements are planned:

- Fine tuning the emissions of polyurethane processing;
- Fine tuning the emissions of polystyrene foam processing;
- Estimation of the emissions of production of solvents: tetrachloromethane..

In Wallonia, the following improvements are planned:

- Revision of the emissions for Wood paint application and Other industrial paint application ;
- Revision of the emissions for non-chlorinated solvents for Metal degreasing ,Dry cleaning and Other industrial cleaning;
- Revision of the emissions for Polyester processing, Polyvinylchloride processing, Polyurethane processing, Polystyrene processing;
- Estimation of the emissions for Textile finishing;
- Estimation of the emissions for Glass wool enduction, Mineral wool enduction and Fat, edible and non-edible oil extraction;
- Estimation of the emissions for the years 1990-2000 for Preservation of wood;

Chapter 6. Agriculture (NFR sector 4)

6.1. *Overview*

6.1.1. Allocation of emissions

The agricultural sector includes the emissions originating from animal manure (NFR sector 4B), the use of synthetic N-fertiliser (NFR sector 4D1a), N-excretion on pasture (NFR sector 4D1b) and from manure processing (NFR sector 4D2b). More detailed information on emissions due to fuel use in the agricultural sector is included in Chapter 3 Energy (3.5). The emissions reported in NFR sector 4 are based on calculations using specific regional information. The categories 4B1a and 4B1b (cattle dairy and non-dairy), 4B8 (swine), 4B9a and 4B9b (laying hens and broilers), 4D1a are key categories for NH_3, either in terms of emission level, trend or both level and trend. The category 4B8 (swine) is a key category for PM10 in terms of emission level. For TSP, the categories 4B1b, 4B8 and 4B9b (non-dairy cattle, swine and broilers) are key categories in terms of emission level.

6.1.2. Description of the sector

The land used for agriculture in 2011 in Belgium extends to 1333913 hectares. In 2012, the number of agricultural and horticultural businesses amounted to 38559. This number had dropped by 38% since 2000. The disappearing of small businesses being a general trend in the sector. Additionally in Flanders, this partly can be explained due to the subsidized cut down of the number of cattle. This was in 2001 and 2002 only the case for swine. In 2003 however an extension to bovine and poultry occurred. Nevertheless the land area used for agricultural purposes remained more or less the same during this period. In 2012 Wallonia has 54% of the land used for agriculture, but 65% of agricultural businesses are situated in Flanders. The land area used for farming is on average 25 ha per farm in the Flemish region and 54 ha per farm in the Walloon region.

6.1.3. Climate:

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

6.1.4. Data sources

The main activity data are the livestock figures, N-excreted and amount of synthetic fertilizer use. 'Statistics Belgium' (Statbel) publishes data on livestock figures yearly in its agricultural census. As the main statistical authority in Belgium, 'Statistics Belgium' is in charge of collecting, processing and disseminating relevant, reliable and commented statistical and economic information. Until 2008, the agricultural census reached 100% of the farms. Since 2008 (with exception of 2010) this inquiry has changed slightly. 75% (before 2008 this was 100%) of all agricultural businesses (including the biggest farms) have to fill in a form each year about the situation on the farm on the 1st of May of that year.

The other 25% is estimated. To come to this 75%/25% ratio, the farms are divided in two groups: 50% contain the biggest farms, the other 50% the smaller farms. The 50% biggest farms have to fill in the form each year. From the other 50% smaller farms, the half has to fill in the form in year x and the other half is estimated. The next year (x+1) the part of small farms that is not contacted in the year x, is obliged to fill in the form. At this way every two years 100% of the farms are questioned. To be compliant with the European legislation, in the survey 2010 once again 100% of the farms are questioned.

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

6.1.4.1 Livestock

The livestock numbers are the primary activity data used in the calculation of NH_3 emissions. The numbers originate from the agricultural census which is available on:

http://statbel.fgov.be/nl/modules/publications/statistiques/economie/downloads/landbouw_-_landbouwgegevens_van_2012.jsp These data are available for and used by the two regions, Wallonia and Flanders. Table 6.1 gives an overview of the origin of livestock number in the two regions for the different time periods.

Table 6.1: Origin of the livestock numbers in the two regions

Livestock numbers	Flanders	Wallonia
1990-1999	STATBEL	STATBEL
2000-2012	Manure Bank (VLM)	STATBEL

In Flanders, however, from 2000 on, input data as animal number, N-production e.o. are obtained by the Manure Bank of the Flemish Land Agency (VLM; http://www.vlm.be/landtuinbouwers/mestbank/aangifte/Pages/default.aspx). This information is available on the level of the stable as necessary for the NH_3-model. In 2009, in Flanders, a new model for the calculation of the NH_3 emissions was developed. This model calculates the NH_3 emission in different emission stadia taking into account the manure flow. This is done on the level of the stable. Therefore data (animal number, manure transport, N-excretion) were necessary on this detailed level. These data are inventoried by the Manure Bank from the Flemish Land Agency (VLM). The VLM, a Flemish government agency, is among other things, responsible for the execution of the Flemish Manure Policy. Statbel can provide data on animal number, only on the level of municipality. This is not detailed enough for the NH_3-model. On the other hand, data from the Manure Bank are only available from 2000 on. To be consistent between different models used (NH_3, N_2O, CH_4) Flanders decided to use the VLM data source for animal number and N-excretion for all models and from 2000 on. From 1990-1999 Flanders uses the Statbel numbers, which also means that NH_3 emissions in this period can only be calculated on the level of the municipality.

It is of course true that the animal number between Statbel and the manure bank is not exact the same. Statbel collects data on the 1^{st} of May, which means that farmers give the animal number present at the farm at the 1^{st} of May. For the manure bank farmers give the average animal population of the past year. This difference explains differences in animal number between the two data sources. The differences between the data sets do not exceed 10%, which is the uncertainty level for the animal population data from STATBEL.

6.1.4.2 N-excretion factors

For the N-excretion factors of swine and poultry in Flanders, a farmer can choose to use the standard excretion factors (no special effort to reduce N and/or P production) . Or they can choose (or in some cases are obliged) to use the other systems (regressive balance, animal feed covenant, a complete fodder (input-output) balance). These data are obtained by the Manure Bank of the Flemish Land Agency. The N-excretion factors of cattle, sheep, goats, horses, mules and rabbits used in 2011 are described in the manure decree of December 2006 (or MAP3):

http://www.vlm.be/SiteCollectionDocuments/Publicaties/mestbank/bemestingsnormen_2013.pdf.
Unfortunately no translation in English is available.

For dairy cows, in MAP3, these N-excretion factors depend on the average milk production per cow. Till 2006 the N-excretion factors of the manure action plan (MAP2bis) is used.

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

Tables 6.2 and 6.3 give an overview of the livestock numbers and N-excretion factors used in both regions in 2012.

Table 6.2 Animal number and nitrogen excretion factors for each animal category in Flanders (2012)

Category	**Population Size**	**Nex (kg N/head.yr)**
Bovine		
Slaughter calves	172761	10,5
Bovine under 1 year	168049	22.3
Bovine under 1yr for replacement	102991	33
Bovine from 1 to 2 year	160428	58
Bovine from 1 to 2yr for replacement	99927	58
Bovine more than 2 year	190170	77
Dairy cows	246528	116
Brood cows	170750	65
Sheep		
Sheep under 1 year	21714	4,36
Sheep more than 1 year	33533	10,5
Goats		
Goats under 1 year	5888	4.36
Goats more than 1 year	16829	10.5
Swine		
Piglet from 7 to 20 kg	1628726	2.29
Fattening pigs from 20 to 110 kg	4084224	11.14
Fattening pigs more than 110 kg	76061	21.49
Boars	5862	21.36

Sows including piglets less than 7 kg	426167	21.50
Horses		
Horses and pony less than 200 kg	8706	35
Horses and pony from 200 to 600 kg	33779	50
Horses more than 600 kg	3880	65
Rabbits (animal category 'other')		
Rabbits closed housing	10183	7.42
Rabbits for breeding	1109	3.16
Rabbits for fattening	5436	0.658
poultry		
Broilers (for breeding)	888134	0.44
Broilers (for fattening)	17782006	0.53
Laying hens (for breeding)	2075974	0.33
Laying hens	6546823	0.80
Ostriches (for breeding)	309	18
Ostriches (for fattening)	188	8.6
Ostriches (0-3 months)	226	3.5
Turkeys (parental animals)	4756	2
Turkeys (for fattening)	218746	1.70

Table 6.3 Animal number, nitrogen excretion factors and allocation of animals to AWMS for each category in Wallonia (2012)

	Population Size	**Nex (kg/head.yr)**	**Solid storage**	**liquid storage**	**% stable vs pasture**
Bovines under 6 months	175 574	13,4	87%	13%	50%
Bovines between 6 months and 1 year: male	39 008	37,5	90%	10%	50%
Bovines between 6 months and 1 year: female	80 575	30,8	87%	13%	50%
Bovines more than 1 year for fattening: male	56 230	97,8	87%	13%	50%

Bovines more than 1 year for reproduction: male	19 151	84,4	77%	23%	50%
Bovines more than 1 year: female	319 211	58,9	77%	23%	50%
Dairy cows	205 757	120,5	56%	44%	56%
Brood cows	318 806	97,8	91%	9%	50%
Piglet under 20 kg	62 210	4,7	25%	75%	100%
Piglet between 20 and 50 kg	89 472	10,4	25%	75%	100%
Fattening pigs more than 50 kg	236 775	16,1	25%	75%	100%
Sows	14 030	37,5	42%	58%	100%
Breeding males	3 597	42,9	43%	57%	100%
Lambs	6 800	4,4	100%	0%	100%
Sheep <1 year	15 356	4,4	100%	0%	50%
Sheep >1year	27 170	8,8	100%	0%	50%
Goats <1year	2 770	4,4	100%	0%	50%
Goat > 1 year	7 035	8,8	100%	0%	50%
Horses	14 473	75,0	100%	0%	50%
Broilers	3 724 845	0,4	89%	11%	100%
Laying hens	1 365 733	0,8	6%	94%	100%
Other poultry	376 654	0,6	26%	74%	100%

The allocation of animals to animal waste management system (AWMS) in Wallonia (see table 6.3) comes from Statbel, the agricultural census of 1992 and 1996, where those data were collected by animal type. Those data are not collected on a yearly basis by Statbel given their slow pace of change. However, an update of the 1996 data would likely be useful in the near future. So far we have no information about Statbel planning regarding this update.

The allocation of animals to AWMS originate in Flanders from the Manure Bank of the Flemish land Agency (VLM).

6.2. Animal husbandary and manure management (category 4B)

6.2.1. NH_3

The NH_3 emission estimation from livestock is based on the amount of gross nitrogen excreted by each animal category, estimated through local production factors (see 6.1.3). The calculation takes into account the different stable types, the number of days in pasture, the different manure management systems, the manure application on land. The models used in the two regions differ and are individually described hereunder.

In Flanders, for the entire time series, the EMAV-model (Foqué & Demeyer, 2009) is used. As described in 6.1.3 this model calculates the NH_3 emission in different emission stadia taking into account the manure flow. From 1990 to 1999 the NH_3 emission is calculated on the level of the municipality, using livestock numbers from Statbel. From 2000 on this is done on the level of the stable, using detailed input data, as animal number, stable type and N-production, on the level of the farm of the Flemish Land Agency.

There is a significant decrease in NH_3 emissions from 4.B.1a, 4.B.1b and 4.B.8 between 1999 and 2000. This decrease is mainly due to the implementation of the successive Manure Action Plans in Flanders.

In 1991 there was the first Manure Decree. One of the items of this Decree was the reduction of the period (months) in which manure can be applied to land. This had a minor impact on the NH_3 emissions. The Manure Action Plan2bis in 2000 focussed on the reduction of the manure surplus. Among others this was done by reducing the amount manure that can be applied to land and furthermore the obligation to apply manure in an emission poor way. Also the regulation concerning manure processing had an impact on the NH_3 emission. Since 2003 all new stables for swine and poultry have to be constructed in an emission poor way. The licensed stables are inventoried by the manure bank of the Flemish Land Agency. Based on the amount of ammonia emission-poor stables, the stable emission factors for swine and poultry are yearly adjusted.

In Flanders, the use of sewage sludge on agricultural soils is forbidden. This is described in the manure decree (article 13, paragraph 8:

http://navigator.emis.vito.be/milnav-consult/plainWettekstServlet?wettekstId=17942&lang=nl).
Unfortunately no translation in English is available.

In Wallonia, the emissions are calculated using a model developed by a consultant agency Siterem. Different data are used as input in the model which then calculates NH_3 emissions. 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. The data on sludge spreading on agricultural soils are available on the website of DGRNE (http://www.environnement.wallonie.be/).

In Wallonia, the first drivers of the decrease of emission in category 4B is the reduction of livestock, especially regarding bovine.

6.2.2. Dust

In Wallonia, the dust emissions are only calculated for the category 4B by using emission factors (table 6.4) (CEPMEIP Emissions factors for particulate matter, TNO-MEP).

Table 6.4: Emission factors in Wallonia

		PM10	PM2,5	TSP
poultry, chickens	g/year/animal	37,4	8,3	80,0
poultry, other poultry	g/year/animal	249	55	600
stock, cattle	g/year/animal	398,6	88	900
live stock, pigs	g/year/animal	353	78	800

In Flanders, the TSP emissions are calculated for the category 4B by using emission factors as described in table 6.5 (Sleeuwaert & Polders, 2006). PM10 and PM2,5 are calculated as a percentage of TSP. The IEF of TSP, PM10 and PM2,5 for the fattening pigs is derived from a study recently performed by the Institute for Agricultural and Fisheries Research (Van Ransbeeck, 2013). The subdivision per NFR subcategory (dairy/non-dairy, laying hens/broilers/turkeys/other poultry) is performed by taking into account the animal numbers given in table 6.2.

Table 6.5 Emission factors for the calculation of TSP emissions and fraction of PM10 and PM2,5 of livestock breeding in Flanders

		TSP	%PM10	%PM2,5
poultry	g/year/animal	49.4	49	14
cattle	g/year/animal	394	44	11
Fattening pigs	g/year/animal	227	44	3
Other swine	g/year/animal	446	44	10

6.3. Direct soil emission (category 4D)

6.3.1. Synthetic fertilizer use (category 4D1a)

In Flanders, the NH_3 emission from fertilizer use is calculated using the same EMAV-model in which the area of a certain agricultural zone is multiplied with the respective fertiliser use (kg N/ha) and emission coefficient. Depending of the type of mineral fertiliser, a different emission coefficient is used. The relative amount of different types of mineral fertiliser used in Belgium originate from the *International Fertilizer Industry Association (IFA).* The emission factor (%) in table 6.3 is the average of all emission coefficients.

For the amount of fertilizer use the *Department Agriculture and Fishery* and the *Institute for Agricultural and Fisheries Research* conducts surveys on a representative sample of the different types of agricultural businesses and produces yearly weighted average values on the fertiliser use, taking into account the manure pressure (Campens & Lauwers, 2002).

In Wallonia, the NH_3 emissions from mineral fertilizers account for the nitrogen volatilised as NH_3 and N_2O. The model uses a volatilisation rate ($Frac_{GASF}$) from mineral nitrogen to NH_3 and N_2O. In Wallonia the average rate of 2.3 % is based on the default values recommended by IIASA for different types of fertilisers.

The data on the use of mineral fertiliser come from the Agricultural Economy Analysis Department of the region. The use of mineral fertilizer is decreasing since 1990, The amount of synthetic fertilizer use and emission factors per region is shown in table 6.6.

Table 6.6 The amount (kg N) of synthetic fertilizer use (per ha) (2012) and the emission factor used in each Region

	Synthetic fertilizer use (kg N /ha)	Synthetic fertilizer use (ton N)	Emission Factor (%)
Flanders			
Dunes	139	1319	4.56
Kempen area	98	13433	4.56
Sandy area	107	21610	4.56
Sand Loam area	105	19355	4.56
Loamy area	106	3380	4.56
Polders	139	13777	4.56
Luikse Meadow area	98	259	4.56
Wallonia	98	70182	2.3

6.3.2. Manure processing (category 4D2b)

As described above in chapter 6.1, Flanders has a severe manure surplus. Therefore successive manure action plans (MAP) are implemented. Among other things, the MAP describes the amount of manure that a farmer can apply to his agricultural soils. Briefly, this depends on the proportion of the amount manure produced to the available agricultural soils of that farmer. The manure surplus (the part that may not be applied to the soil) must be either exported or processed. This amount (net export and amount processed) is inventoried by the Manure Bank of the VLM. NH_3 -emissions from manure processing in Flanders in 2012 account for 1% of the total NH_3-emission in Flanders. The emissions for manure processing are calculated using the same model as used for the calculation of ammonia emission from livestock and synthetic fertilizer: the EMAV-model. The Flemish coordination centre for manure processing (VCM, http://www.vcm-mestverwerking.be/organisation/detail_en.phtml?id=1) inventories and publishes yearly the operational manure processing companies and the techniques used. Based on this information, the amount and type of processed manure and the corresponding emission coefficient, the NH_3 emission from manure processing can be calculated.

NH_3 emissions from manure processing in Flanders are taken into account from 2000 on. Before 2000 manure processing was rare. The amount of processed manure from 2000 on increases significantly. However, the NH_3 emission stabilizes since 2008. This is due to the techniques used. Since 2008 more manure is processed in a biological treatment. This technique has a significant lower emission coefficient (0.05%) than e.g. biothermal drying (5.63%). The amount of manure processed by biothermal drying has stabilized.

6.3.3. N-excretion on pasture (category 4D2c)

In both regions, the ammonia emission from grazing is estimated, taking into account the number of days in pasture, the nitrogen excreted by each animal category, and the EEA emission factor of 8%. In table 6.7 an overview is given of the different factors used in both regions and for the different grazing animal categories.

Table 6.7 The days in pasture (%/yr), nitrogen excreted on pasture (ton) and the emission factor used for each grazing category in 2012

	Days in pasture (% of year)	Nitrogen excreted on pasture (ton)	Emission factor (%)
Flanders			
bovine	± 50	13493	8
Sheep	80	358	8
Horses	50	1127	8
Wallonia			
Bovine	50	41453	8
sheep	50	155	8
horses	50	544	8

6.4. The use in pesticides (4G)

In Flanders HCH-emissions are calculated for the past. There is a ban on the use of HCH in Belgium from 2002. The activity data are taken from a study performed by VITO/TNO under the authority of VMM (Sleeuwaert, 2012).

6.5. Recalculations

In Flanders, during this submission February 2014, NH_3 emissions from 2011are updated. In the submission of February 2013, NH_3-emissions 2011 were reported as the same as NH_3 emissions from 2010. This was due to lack of activity data on the time of reporting.

Also in Flanders a new IEF of TSP, PM10 and PM2,5 for fattening pigs is used for the entire time series. This results in a decrease of the TSP and PM10 emission of ± 30% and for PM2.5 of ±50%.

6.6. Planned improvements

In Flanders, no improvements are planned in the near future.

Wallonia will evaluate the implementation of recommendations coming from the EMEP/EEA Guidebook 2013 for the next submission.

Chapter 7. Land use and land use change (NFR sector 5)

No emissions are reported for LRTAP or NEC. The sector is not included in the NFR tables.

Chapter 8. Waste (NFR sector 6)

Waste sector emissions are classified into 4 categories as described in Table 8.1.

Table 8.1. Main emissions of the 4 waste categories in Belgium

Waste categories	Main emissions
Solid waste disposal sites	NMVOC
Waste water treatment	NH_3
Waste incineration & cremation	Hg, Dioxins & furans, HCB
Other	NH_3, PMs

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

The NMVOC emissions from land disposal of solid waste are calculated in Flanders and in Wallonia.

The methodology applied by the Flemish region to estimate NMVOC emissions is the same methodology as the one used to calculate the CH_4-emissions (see description in NIR of March 2014, Chapter 8.2.). Just one factor is different: biogas contains 2420 ppm NMVOC (D'Haene et al., 2002).

No waste disposal sites are located in the Brussels Capital Region in Belgium.

In Wallonia, NMVOC emissions calculations are based on Tier 1 methodology of the 2009 EMEP/EEA Guidebook. The volume of landfill gas resulted from the IPCC model used for GHG inventory and from the recovery data of the sites managers. The methodology is the one described in the 2000 IPCC Good Practices Guidance (see description in NIR of March 2013, Chapter 8.2.). The emission factor used for NMVOC is 5.65 g NMVOC/m³ landfill gas, coming from the 2009 EMEP/EEA Guidebook. The fig. 8.1 (left) shows evolutions of the amounts of waste disposed each year in Wallonia. From these amounts of waste, theoretical biogas production is calculated using IPCC methodology. Net emissions of biogas are estimated by subtracting the biogas recovery from the theoretical biogas production. The fig. 8.1 (right) shows evolutions of these values.

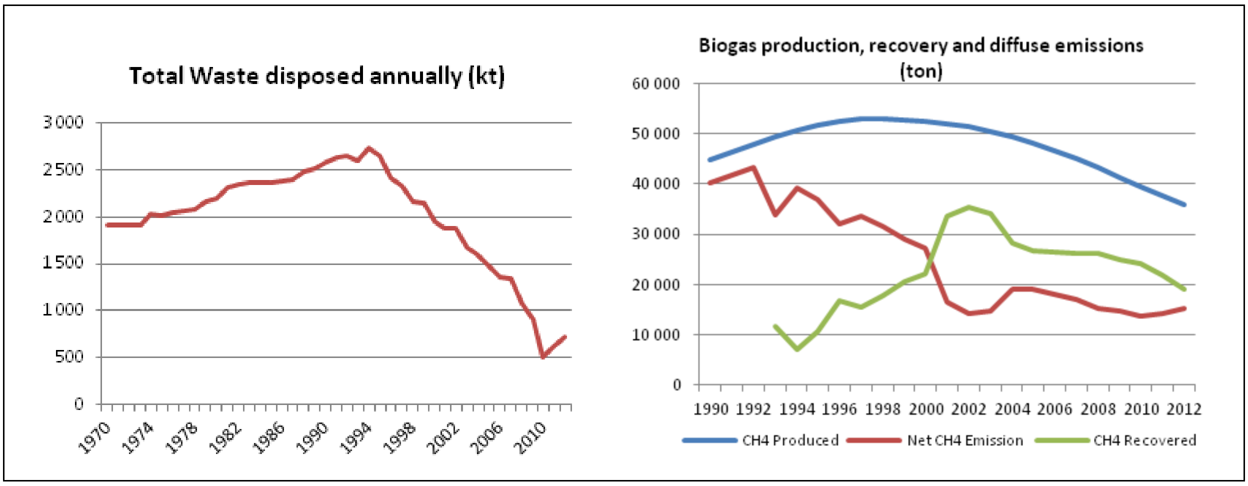

Figure 8.1 Evolutions of amounts of waste disposed and biogas production, recovery and net emissions in Wallonia.

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8.2. Wastewater treatment (category 6B)

In Belgium, emissions originating from septic tanks are estimated by multiplying the emission factor (an NH_3 emission factor of 750 g/person is used) by the number of inhabitants not connected to a municipal wastewater treatment plant.

8.3. Waste incineration (category 6C)

The waste incineration category (category 6C) includes incineration of municipal and industrial waste, incineration of hospital waste and incineration of corpses (crematoriums). The emissions of the waste incineration plants with energy recovery are allocated to the category 1A1a.

The category 6Cb is a key category of PCDD/F and HCB emissions in terms of emission trend. The category 6Cc is a key category of Pb, Cd, Hg, Cr, Ni, Zn and PCDD/F emissions in terms of emission trend. The category 6Ce is a key category of PCDD/F emissions in terms of emission level and trend.

<u>Waste incinerators</u>

In Wallonia, following a legal decree in 1998, the air emissions from municipal waste incineration were measured in 1998 by ISSEP and the results were validated by a Steering Committee. Since 2004, the amount of incinerated waste (in ton) and the annual emissions are reported annually by the operators in a software dedicated to environmental reporting, called REGINE, in the context of PRTR. The annual emissions are calculated on the basis of stack measurement (when they are available) or emission factors (when stack measurement are not performed annually).

The only hospital waste incinerator has closed since 2005.

Since 2000, a continuous measurement of dioxins has been put in place for the 4 incinerators: http://environnement.wallonie.be/data/air/dioxines/menu/menu.htm

In the early 1990s, about 45% of the waste was still incinerated without energy recovery. Since 2006, the 4 municipal waste incineration plants are fully equipped to produce electricity. The emissions with energy recovery are allocated in the energy sector, category 1A1a. A small part of the emissions from municipal waste incineration is still allocated in the waste sector, category 6C, when waste is incinerated without energy recovery because of occasional problems in the energy recovery systems. In 2010, this represents 2% of the incinerated waste.

In Flanders, the plants are obliged to report their emissions yearly in an emission report. These data are integrated in the emission inventory. All waste incineration plants produce electricity since 2006. The emissions are allocated in the category 1A1a when energy is recycled or in 6Cb (industrial waste incineration) or 6Cc (municipal waste incineration) before energy recycling took place. Based on information by OVAM (Public Waste Agency of Flanders, 2008) a distribution of 73 % municipal waste versus 27 % industrial waste is used.

In Flanders the PCDD/F emissions of 1990 and 1995 (industrial and domestic waste) are based on the results of a study performed by VITO under the authority of VMM (Polders et al., 2003). Since 2000 the emissions of domestic waste incineration are reported in the yearly environmental reports. Since 2000 the emissions of industrial waste incineration are calculated by using activity data and emission factors. The activity data are the amount of waste obtained from OVAM (Public Waste Agency of Flanders). The emission factors are taken from the UNEP Standardized Toolkit for PCDD/F (Table 8.2).

The HCB emissions are calculated by using activity data and emission factors. The activity data are the amount of waste obtained from OVAM (Public Waste Agency of Flanders). The emission factors are taken from the EMEP/CORINAIR Guidebook for HCB (Table 8.3).

Table 8.2 Emission factors of PCDD/F for the sector 1A1a Incineration of waste in the Flemish region

Fuel	Unit	Value	Reference
Industrial waste	µg TEQ/tonne	0.5	UNEP Standardized Toolkit; Category 1a4: Waste incineration; Municipal solid waste incineration; High tech. combustion, sophisticated APCS
Hazardous waste	µg TEQ/tonne	0,75	UNEP Standardized Toolkit; Category 1b4: Waste incineration; Hazardous waste incineration; High tech. combustion, sophisticated APCS
Clinical waste	µg TEQ/tonne	1	UNEP Standardized Toolkit; Category 1c4: Waste incineration; Medical/hospital waste incineration; High tech, continuous, sophisticated APCS
Sewage sludge	µg TEQ/tonne	0,4	UNEP Standardized Toolkit; Category 1e3: Waste incineration; Sewage sludge incineration; State-of-the-art, full APCS

Table 8.3 Emission factors of HCB for the sector 1A1a Incineration of waste in the Flemish region

Fuel	Unit	Value	Reference
Industrial waste	g/tonne	0.0001	EMEP/CORINAIR Guidebook (2005)
Hazardous waste	g/tonne	0.01	EMEP/CORINAIR Guidebook (2005)
Clinical waste	g/tonne	0.019	EMEP/CORINAIR Guidebook (2005)
Sewage sludge	g/tonne	0.002	EMEP/CORINAIR Guidebook (2009)
Domestic waste	g/tonne	0.001	EMEP/CORINAIR Guidebook (2005)

Emissions due to clinical waste incineration are allocated in category 6Cb (industrial waste incineration).

In Brussels, the last waste incinerator without recuperation of energy has closed in 1998.

Emissions by cremation

For Flanders: the activity data is 36860 cremations in 2012 (derived from the yearly statistics of crematoria), for dioxins an emission factor of 0,069 µg TEQ/cremation is used (Results of measurements made by the Flemish government – Department Leefmilieu/Afdeling Milieu-inspectie). The calculation of particulate matter (TSP, PM10, PM2,5) is done with an emission factor of 0.005 kg/cremation and for Hg an emission factor of 0.049 g/cremation is used.

For Wallonia: for dioxins, the emission factor from the Netherlands of 4µg TEQ/corpse, reported in EMEP (Emission Inventory Guidebook December 2006 B991-9) is applied. A specific emission factor is used for Hg emissions. This emission factor is equal to 2 g/corpse and is coming from measurements and analysis made in a Walloon crematorium.

Emissions from the other pollutants are estimated using the emission factors of the EMEP/EEA guidebooks 2006 & 2009. For the next submission, emission factors will be harmonized with the values coming from the EMEP/EEA Guidebook 2013. The number of corpses is coming from the national Belgian statistics available on the website of STATBEL[4].

For Brussels, the emission factor for dioxins is 7.9 µg TEQ/cremation. The number of cremations comes from national statistics[5]. The AD was modified for 2001 and 2004 due to a data review.

Open combustion of waste (small scale waste burning) (category 6Ce)

Only Flanders estimates emissions of combustion in open barrels of particulate matter, dioxins and PAHs. These emissions are allocated in sector 6Ce. To make the calculation, it is assumed that 5% of the average amount of municipal waste is burnt in open barrels (Van Rompaey et al., 2001) . The amount of municipal waste per household can be found on the website of the Public Waste Agency of Flanders (www.ovam.be). The number of households can be found on www.statbel.fgov.be. The emission factor of TSP is taken from a study performed by VITO under the authority of AMINAL/Aminabel (Wevers, 2002). The emission factors of dioxins and PAH's are taken from a study performed by VITO/TNO under the authority of VMM (Sleeuwaert, 2012). Emission factors for PM10 and PM2,5 are taken from TNO (2001). Other combustion emissions are not estimated.

In Wallonia, these emissions are not estimated.

8.4. Other

NH_3 emissions from compost production, allocated in category 6D, are estimated in Wallonia using regional activity data combined with a default emission factor of 0,24 kg NH_3/ton compost (EMEP/EEA Guidebook 2009).

The emissions of PM2,5 and PM10, due to smoking of tobacco in Flanders, used to be reported under 7A, but it was decided to allocate these emissions in the more appropriate sector 3D3, according to the EMEP/EEA Guidebook 2009 (see Chapter 5).

In Wallonia and Flanders, the other pollutants emissions come from the annual environment report of waste companies (other than incinerators). Each year, companies have to fulfil an integrated environmental survey in the context of PRTR. The data in the air emissions section are used to compile the Walloon emissions.

8.5. Recalculation

A re-allocation of the emissions of waste incineration between 1A1c an 6C took place in the Walloon regin for the complete time series.

[4] http://statbel.fgov.be/fr/statistiques/chiffres/population/autres/cremations/

[5] http://statbel.fgov.be/fr/statistiques/chiffres/population/autres/cremations/

Modifications on the number of cremations for the year 2001 and 2004 were done on the Brussels inventory due to a data review.

Chapter 9. Other and natural emissions

9.1. *Biogenic emissions*

Flanders

NMVOC emissions of different forest types and of grassland are reported under IPCC code 7B. These biogenic emissions are substantial and can account up to nearly 20 % of the total reported NMVOC emissions.
The methodology to calculate the collective estimation of the biogenic NMVOC emissions is described in Van Hyfte & Van Langenhove (2000) and based on a model by Guenther et al. (1993).

The basic formula used to calculate the biogenic emissions is:

$$E = \sum_{y=1}^{z} N_y \,(D_y . \varepsilon_y . \gamma_y)$$

with: N_y: the total area taken by ground cover y (m^2/year)

z: the number of species of ground cover y

D_y: leaf density (kg dry matter/m^2)

ε_y: VOC emission factor for ground cover y at 30°C and light intensity of 1000µmol/m^2s(µg/m^2hour)

γ_y: correction factor for real leaf temperature and light intensity

The ground cover in Flanders is defined by the wood mapping performed by the Flemish Region, based on visual reading of coloured infrared aerial views taken during the period 1981-1992 and ground monitoring. After handling the information this results in a ground accuracy to within 1 are. The ground cover is corrected based on the LUC matrix. The LUC matrix is determined by the Gembloux University (Gembloux Agro Bio Tech), a study conducted specifically for the LULUCF reporting in Belgium (Bauwens et al., 2011).

The emission factors give the emissions in µg per hour in terms of the leaf density (g dry matter/m^2 ground cover). Emission factors are taken from literature and are specified for different compounds of NMVOC (isoprene, monoterpenes and other VOC) and for different kinds of ground cover. An overview of the emission factors used is given in table 9.1.

Table 9.1 emission factors for isoprene, monoterpenes and other VOC for different species of ground cover in Flanders based on Simpson et al. (1999)

Ground cover	Isoprene ($ng/m^2/s$)	Monoterpenes ($ng/m^2/s$)	Other VOC ($ng/m^2/s$)
Broadleaf trees			
Beech	8.89	57.78	192.78
Oak/American oak	5333.33	17.78	192.78
Poplar	5333.33	0.00	192.78
Other	5333.33	17.78	242.22
Mixed broadleaf			
Beech	20.56	152.22	285.28
Oak	5298.61	112.50	285.28
Poplar	5298.61	95.00	285.28
Other	5298.61	112.50	317.50
Mixed conifers			
Larch	1349.44	91.11	197.22
Scots pine	2492.22	168.06	305.56
Black pine	2492.22	321.67	605.56
Spruce	4658.33	302.78	572.78
Douglas	3349.44	225.83	572.78
Other (default)	2492.22	321.67	258.89
Conifers			
Larch	8.33	125.00	192.78
Scots pine	19.44	291.67	359.72
Black pine	19.44	583.33	359.72
Spruce	388.89	583.33	770.83
Douglas	27.78	416.67	770.83
Other	19.44	583.33	287.78
Grassland	0.00	11.11	23.33

The leaf density of a tree species expresses the amount of dry matter (g) of a tree in terms of the ground area, taken by this species. The leaf density can vary significantly in the course of the seasons. Since several factors can influence the leaf density, the calculations are made with average leaf densities (already taken in account in table 9.1).

Since the leaf temperature and the light intensity are the most important factors that influence VOC emissions, a correction factor (specified for isoprene and terpene emissions) is taken from literature.

Wallonia

Methodology

The methodology used by the AWAC is based on Simpson and Guenther (EMEP / CORINAIR atmospheric Emission Inventory Guidebook, 1999). The mass emission time of a plant species occupying a given area is given by the relation :

Hourly mass emission (g / h) = S * B * C * FE (T °, Light)

S = Surface in m²

EF = emission factor standard of the species (g / gh)
B = foliar biomass of the species (g / m²)

C (T °, Light): VOC emissions are highly dependent on temperature and sometimes light, depending on the considered VOCs. This is taken into account by the correction factor dimensionless. This factor can be calculated on an hourly basis, but the calculation has been done here on a monthly basis, which here constitutes a good compromise between the accuracy of the estimate and the availability of data (data on PAR, photosynthetically active radiation from 400 to 700 nm, are not available on an adequate scale for the Walloon Region). This simplification increases the error of the order of 20%, which is far less than the uncertainties in the emission factors.

Isoprene emissions depend on both temperature and light intensity. The correction factor is then:

C = CL * CT

CL = Number of days per month * Number of hours of daylight the month (depending on latitude)

CT = Exp ((95000 * (T-Ts)) / (8.314 * T * Ts) / (1 + exp ((230000 * (T-314)) / (8.314 * T * Ts)))

T = temperature in Kelvin foliar experimental (measured)
Ts = temperature reference leaf (very generally 303 K or 30 ° C) at which the emission factor is determined
The other figures are empirical coefficients and the ideal gas constant.

For monoterpenes and other VOC, emission depends only on the temperature and the relationship becomes:

C = CL * CT

CL = Number of days per month * 24 (hours)

CT = Exp (0.09 * (T-Ts))

T = temperature in Kelvin foliar experimental (measured)
Ts = temperature reference leaf (very generally 303 K or 30 ° C) at which the emission factor is determined.

Forest area

The area of forest is taken from the forest inventories. The first Walloon forest inventory was conducted between 1979 and 1984 (central year is 1981). The current permanent systematic sampling of the permanent forest inventory was conducted between 1994 and 2008 (central year is 2001) and covers each year 10 % of the approximately 11000 sampling points (Lecomte & Rondeux, 1994). The third cycle of the forest inventory started in 2009 and first results were made available by the end of 2011 (central year is 2010).

Biomass

Regarding leaf biomass, Simpson and Guenther (1995) strongly recommend the use of local data if they are available. For the main Walloon forest species (oak, beech, spruce, Douglas fir, pine), we therefore sought densities measured in Belgium, including those compiled by Duvigneaud et al in the 70s, or densities measured in neighboring regions (North of France and the Netherlands). For other species, the values used in France Luchetta (2000) were included (table 9.2).

Table 9.2 Leaf biomass for the main Walloon forest species

Species (latin name)	Leaf biomass (kg/ha)	Country of measure	Source
Acer pseudoplatanus	3300		in Luchetta et al, 2000
Alnus glutinosa	2800	B	in Luchetta et al, 2000
Betula pendula	3200	B	Duvigneaud et al ,1977
Carpinus betulus	3500	F	in Luchetta et al, 2000
Castanea sativa	3600	F	in Luchetta et al, 2000
Fagus sylvatica	3118	B,F,NL	Chapter 10. Duvigneaud et al 1977 ; Gloaguen et al, 1982 ; Bartelink 1997
Fraxinus excelsior	2700	DK	in Luchetta et al, 2000
Larix decidua	3300		in Luchetta et al, 2000
Picea abies	16390	B, F	Duvigneaud et al ,1977 ; Teller, 1983 ; Guns, 1990 ; Belkacem et al 1992 ; Ranger et al, 1981 ;
Pinus nigra laricio	8133	B, F	Neirynck et al 1998 ; Bonneau, 1995
Pinus nigra nigra	9400	F	in Luchetta et al, 2000
Pinus sylvestris	8000	F	in Luchetta et al, 2000
Populus sp	3300		in Luchetta et al, 2000
Prunus avium	3300		in Luchetta et al, 2000
Pseudotsuga menziesii	12633	B, F	Duvigneaud et al ,1977 ; Ponette et al, 2000, Ranger et al, 1996
Quercus rubra	3200		in Luchetta et al, 2000
Quercus sp (robur + petrae)	3290	B, F	Duvigneaud et al ,1977 ; Gloaguen et al, 1982

Emission factors

No emission factor determined in Belgium has been found in the literature. Emission factors are essentially the compilation made by Luchetta (2000) for France. The consistency of these emission factors with those taken in the compilation of Hewitt (2001), which includes the emission factors of more than 1200 species, has been systematically verified. Factors proposed by Hewitt (2001) were used for three species: red oak (not treated with Luchetta), chestnut (the figure seems Luchetta underestimated), beech (Luchetta used for monoterpenes a factor of 21.7, based on a measurement made in France, which strongly deviates values quoted in 6 other references) (table 9.3).

Table 9.3 Emission factors for a number of species

Species	Emission factor isoprene (µg/g*h)	Emission factor monoterpene (µg/g*h)	Emission factor Other VOC (µg/g*h)	Vegetation period	
Acer pseudoplatanus	0	0	1,5	1er mai	30 oct
Alnus glutinosa	0,1	3,4	1,5	1er mai	30 nov
Betula pendula	0,01	2,9	1,5	15 mars	15 oct
Carpinus betulus	0	0,1	1,5	15 avr	15 oct
Castanea sativa	0	13,66	1,5	15 avr	15 oct
Fagus sylvatica	0,1	0,47	1,5	15 avr	30 oct
Fraxinus excelsior	0,1	0	1,5	1er juin	30 oct
Larix decidua	0,1	8,2	1,5	15 mars	15 oct
Picea abies	1,1	2,1	1,5		
Pinus nigra laricio	13,2	0	1,5		
Pinus nigra nigra	13,2	0	1,5		
Pinus sylvestris	0,1	7,9	1,5		
Populus sp	51	4,6	1,5	1er mai	30 sept
Prunus avium	0	0,3	1,5	1er mai	30 oct
Pseudotsuga menziesii	0,45	14,8	1,5		
Quercus rubra	37,9	1,8	1,5	1er mai	30 oct
Quercus sp	57,3	0,46	1,5	1er mai	15 nov

Correction factors

The average monthly temperatures of IRM were coded for each of the stations. The provincial averages was then calculated. For light, monthly data proposed by Guenther, depending only on the latitude, were used, based on an average latitude of 50 ° N for the Region. These two parameters were used to calculate correction factors CT and CL on a monthly basis at the level of provinces and districts.

Vegetation period

Dates of budburst and leaf fall are listed in ‘Ecological Species File’ published by the DGRNE (MRW-Walloon Region Ministry, 1999). When calculating emissions from deciduous factor 0, ½, or 1 is included in the equation as the leaves are absent or present during 15 days present during all the month.

Chapter 11. Recalculations and improvements

11.1. Recalculations and improvements in the energy sector

- Actualisation of the emission factors in the district heat plants in 1990 (1A1a) following the EMEP Guidebook 2009 in the Walloon region.
- Actualisation of the emissions factors (heavy metals, dioxins, PAH) for the natural gas in gas turbines (1A1a) on the complete time series following the EMEP Guidebook 2009 in the Walloon region.
- Mistake corrected in 2010 for the AD of a turbo jet (1A1a) in the Walloon region.
- Reallocation of the emissions from pipeline compressors (1A1c to 1A3e) in the Walloon region.
- Actualisation of the emissions factors (heavy metals, dioxins, PAH) for the natural gas (1A2a to 1A2f) in 1990 following the EMEP Guidebook 2009 in the Walloon region.
- Recalculation of the number of LTO to reflect training aircrafts taking off with refuelling.
- Recalculation of the road emissions (time series 1990-2011) with Copert IV v10.0 in Wallonia.
- Actualisation of the emission factors in the railways sector (1A3c) on the complete time series in the Walloon region.
- Actualisation of the emission factors in the commercial sector (1A4ai) following the EMEP Guidebook 2009 in the Walloon region.
- Recalculation of the biomass consumption in the residential sector in the Walloon sector (2002-2010). The emissions in the NFR tables are in phase with these new consumptions but the AD indicated in the NFR tables are false. These AD will be changed during the next submission.

Table 11.1 Correction of a mistake in the NFR tables: biomass consumption in 1a4bi

TJ	2002	2003	2004	2005	2006	2007	2008	2009	2010
NFR tables 2014	11512	13232	13738	14278	15485	14942	17092	17675	21449
NFR tables 2015	11268	13895	15313	15983	17452	17371	20391	21843	26540

- Actualisation of the emission factors in the agricultural sector (1A4ci) on the complete time serie in the Walloon region.
- Recalculation of the diesel consumption between the stationary and the mobile part of the agricultural sector (1A4ci and 1A4cii) from 2005 to 2011 following new data from the Walloon Energy Administration (DGO4).
- Recalculation of the Walloon forest sector in OFFREM as the wood surface has changed slightly (1A4cii).
- In Brussels the emissions from road transport have been recalculated (time series 1990-2011) using improved vehicle fleet and mobility data
- Brussels will hold an analysis over the EMEP/EEA Guidebook 2013 recommendations in order to look the applicability to its inventory.
- Recalculations in the sectors 1A4ci and 1A4cii are due to changes in the energy balances from 2007 on.
- The emission inventory of Persistent Organic Pollutants (POPs) is optimized by VITO under the authority of VMM (Sleeuwaert et al., 2012).
- during the 2014 submission the Flemish region updated the gasoil energy activity data from the residential sector. The fuel switch between gasoil and natural gas is now better estimated. This resulted in new emissions for the years 2002-2012.

- during the 2014 submission the Flemish region updated the wood consumption from the residential sector on the base of the Eurostat survey. Before the energy activity data were underestimated.
- The emissions also were underestimated, therefore the emission factors of the EMEP/EEA emission inventory guidebook 2013 (tier 1) were used in the three regions. This resulted in new emissions for the years 1990-2012.
- The emission factors of the EMEP/EEA emission inventory guidebook 2013 (tier 2) will be used for wood burning in Flanders.
- Recalculation of the road transport emissions for the whole time series (1990-2012) using a harmonized approach and COPERT IV v10.0 in Brussels region.
- Redistribution of the off-road emissions from category 1A4aii to categories 1A3e (harbours, airports and transhipment companies) and 1A5b (defence) according to the suggestion of the review team of the GES inventory. .
- Wallonia will evaluate the implementation of recommendations coming from the EMEP/EEA Guidebook 2013 for the next submission.
-

11.2. Recalculations and improvements in the sector of industrial processes

- There was a mistake in the PM10 emissions in 2005 in 2A7a which is corrected
- In Flanders the NMVOC emission of the other chemical industry (2B5a) is optimized by using more detailed information from the yearly reported integrated environmental reports. As a result the emissions of the polyurethane processing and polystyrene foam processing are now allocated under category 3C.
- In Flanders the emission inventory of Persistent Organic Pollutants (POPs) is optimized by VITO under the authority of VMM (Sleeuwaert et al., 2012).
- Wallonia will evaluate the implementation of recommendations coming from the EMEP/EEA Guidebook 2013 for the next submission.
-

11.3. Recalculations and improvements in the Solvent and Other Product Use Sector

In the Flemish region the following recalculations have been performed :

- 3.C Chemical products:
    - Polyester processing: The sector is allocated in 3C for the first time. The methodology has been modified. More detailed information from the yearly reported integrated environmental reports is used.
    - Polyurethane processing: The sector is allocated in 3.C for the first time. The methodology has been modified. More detailed information from the yearly reported integrated environmental reports is used.
    - Polystyrene foam processing: The sector is allocated in 3.C for the first time. The methodology has been modified. More detailed information from the yearly reported integrated environmental reports is used.
    - Glues manufacturing: the AD of STATBEL from 2000 to 2011 have been modified due to an estimation of missing and incorrect figures.

- 3.D Other Use of Solvents and Related Activities:
    - Printing industry: the emissions from 2009 to 2011 have been slightly modified due to corrections of figures in a couple of yearly integrated environmental reports.

In Wallonia, the following recalculations have been performed:

- 3.A Paint application:
    - Construction and buildings and domestic use: Emissions from 1990 to 1999 have been actualized to take into account the results of the recent study (2010) in the Brussels region.
    - Car repairing: Emissions of 1990 have been estimated (they have been assumed equal to those of 1991).
    - Boat building: Emissions of 1999 have been estimated (they have been assumed equal to those of 1991). Emissions from 1994 to 1999 have been actualized in order to ensure the consistency of the time series.
    - Wood: Emissions from 1990 to 1993 have been estimated (they have been assumed equal to 1994). Emissions of 1999 have been actualized to ensure the consistency of the time series. Emissions from 2005 to 2011 have been slightly actualized.
    - Other industrial paint application: Emissions of 1990 have been modified to reflect the change in other sectors. Emissions from 1994 to 1999 have been actualized in order to ensure the consistency of the time series.
    - Other non industrial paint application: Emission of 1990 have been estimated (they have been assumed equal to those of 1991).
    - The emissions from non industrial paint allocation are now included in NFR3A3 and no more in NFR3A1.
- 3.B Degreasing, dry cleaning:
    - Metal degreasing: Emissions from 1994 to 1999 have been actualized in order to ensure the consistency of the time series.
- 3.C Chemical products:
    - Polyester processing: The emissions from 2000 to 2006 have been actualized in order to ensure the consistency of the time series.
    - Paints manufacturing: Emissions for the years 1990 to 1993 have been estimated (they have been assumed equal to those of 1994). Emissions of 2011 have been slightly modified to take into account the change of data in the sector of wood paint application.
    - Inks manufacturing: Emissions for the years 1990 to 1993 have been estimated (they have been assumed equal to those of 1994).
    - Glues manufacturing: Emissions from 1990 to 1995 have been estimated (they have been assumed equal to those of 1996).
- 3.D Other Use of Solvents and Related Activities:
    - Printing industry: AD has been actualized for the years 2007 to 2011on the basis of the IVP data on the inks sales.
    - Preservation of wood: Emissions from 1990 to 1999 have been estimated on the basis of assumptions on the wood impregnation products consumptions Emissions of 2011

have been adapted on the basis of new information on product consumptions coming from one operator.

- 3.D Other Use of Solvents and Related Activities:
    - Printing industry: AD has been actualized for 2009 and 2010 on the basis of the IVP data on the inks sales.
    - Preservation of wood: Emissions have been modified from 2000 to 2010 on the basis of new information received from the operators and the product suppliers.

In the Flemish region, the following improvements are planned:

- Fine tuning the emissions of polyurethane processing;
- Fine tuning the emissions of polystyrene foam processing ;
- Estimation of the emissions of production of solvents: tetrachloromethane.
-

In Wallonia, the following improvements are planned:

- Revision of the emissions for Wood paint application and Other industrial paint application ;
- Revision of the emissions for non-chlorinated solvents for Metal degreasing ,Dry cleaning and Other industrial cleaning;
- Revision of the emissions for Polyester processing, Polyvinylchloride processing, Polyurethane processing, Polystyrene processing;
- Estimation of the emissions for Textile finishing;
- Estimation of the emissions for Glass wool enduction, Mineral wool enduction and Fat, edible and non-edible oil extraction;
- Estimation of the emissions for the years 1990-2000 for Preservation of wood;

Brussels has recalculated the AD for the car repairing sector (3A2) and printing (3D1) with new available statistics from 2008 to 2011.

Brussels will hold an analysis over the EMEP/EEA Guidebook 2013 recommendations in order to look the applicability to its inventory.

11.4. Recalculations and improvements in the agricultural sector

In Flanders, during this submission February 2014, NH_3 emissions from 2011are updated. In the submission of February 2013, NH_3-emissions 2011 were reported as the same as NH_3 emissions from 2010. This was due to lack of activity data on the time of reporting.

Also in Flanders a new IEF of TSP, PM10 and PM2,5 for fattening pigs is used for the entire time series. This results in a decrease of the TSP and PM10 emission of ± 30% and for PM2.5 of ±50%.

Wallonia will evaluate the implementation of recommendations coming from the EMEP/EEA Guidebook 2013 for the next submission.

In Flanders, no improvements are planned in the near future.

Chapter 12. Projections

Belgian emission projections are the sum of:

- Emission projections for the stationary sources in each of the three regions;
- Emission projections for mobile sources in Belgium

12.1. Mobile sources

Emissions from mobile sources have been calculated using the results of the CLEVER-study (Van Mierlo et al., 2009) for road transport and OFFREM for off-road.

For road transport the emission model ‘E-motion Road’ was used. Concerning the calculation of historic emissions, detailed historical input data on vehicle fleet, mileages, vehicle kilometers, biofuel blends, etc. were inventoried and converted into emissions and energy consumption values by using the ‘emission factor approach’ from the MIMOSA module. Like most European road transport emission models, MIMOSA belongs to the ‘average speed macroscopic emission models’, expressing emission and fuel consumption rates as a function of average speed (related to the road type). The same emission factor approach was also used to estimate the future emission and energy results for different scenarios and years. As a baseline estimate for future kilometers driven, the forecasts of the Flemish traffic centre were mainly used, taking into account issues like socio-economic prognoses, demographic forecasts and planned transport infrastructure. The growth figures observed in Flanders have been applied to the other regions to forecast their future vehicle kilometers.

Rail and shipping (inland shipping and sea shipping) emissions have been calculated using the EMMOSS model. EMOSS is the emission model for rail and shipping in Flanders. The results for Flanders have been extrapolated to calculate Belgian emissions. Indirect emissions from electrical trains are not included in transport figures and neither are non-exhaust emissions from trains. For fishery (not included in EMMOSS) the evolution of the emissions between 2005 and 2009 has been used as a basis for calculating emission projections.

Emissions from offroad vehicles and machines in Belgium in the categories agriculture, forestry, household, gardening, industry, construction, military, ports, airports, multimodal terminals have been calculated with the OFFREM model. This is the model for non- road mobile machinery that calculates emissions for the 3 regions in Belgium.

For air traffic, projections are based on GAINS projections.

12.2. Stationary sources

12.2.1. Flanders

Emission projections for stationary sources in Flanders have been calculated using the Milieukostenmodel (MKM - Environmental Costs Model) developed by Vito. This is a techno-economic bottom-up model that can be used both for making projections and for calculating optimal solutions based on cost efficiency. MKM consists of a detailed database with information on emission sources and possible reduction techniques on the one hand and an algorithm in MARKAL for the calculations on the other hand.

For the emission projections, energy projections as reported in 2011 under Article 3(2)b of Decision No 280/2004/EC

(http://cdr.eionet.europa.eu/be/eu/ghgpro/envtcv0tg/110506_MM_Article_3_2__Reporting_Template_v5.1_Belgium_2011.xlsx)

have been used as a basis, in combination with information on policies and measures for air pollutants. For the assumptions underlying the energy projections, we refer to the Report by Belgium for the assessment of
projected progress under Decision No 280/2004/EC

(http://cdr.eionet.europa.eu/be/eu/ghgpro/envtcv0tg/110506_Report_assessment_projected_progress_Belgium_2011_final.doc).

Only policies and measures for air pollutions that have already been implemented or taken have been taken into account in the projections.

12.2.2. Walloon region

For Wallonia, new projections of SO2 and NOx emissions up to 2030 have been established using the EPM model developed by ECONOTEC. This model is also a techno-economic bottom-up simulation model. Emission factors values and perspectives have been improved thanks to a recent survey conducted by Tractebel Engineering among large industrial emitters.

Projections for other substances are similar to those reported on in the previous issue.

Projections are established on the basis of energy projections, in combination with the consideration of several abatement measures taken or in project in the Walloon industry, concerning the relevant air pollutants.

The energy projections are those reported in 2013 under Article 3(2)b of Decision No 280/2004/EC in the frameqork of the so-called "with measures scenario", ie a reference situation considering the impact of existing and implemented measures aiming at the reduction of greenhouse gases.

Recent restructuration in iron and steel sector is taken into account . It yields to the complete shutdown of all blast furnaces in Wallonia.

12.2.3. Brussels capital region

Emissions projections for the Brussels Capital Region have been realized using the emission model for stationary sources developed by Brussels environment (IBGE). This bottom-up model is based on a detailed description of specific energy requirements of residential and tertiary buildings combined with projections of socio-economic indicators (population, economic activity). A business as usual (BAU) scenario has been considered to determine the emissions projections of pollutants (no expected new policies and measures were taken into account).

Chapter 13. Emission inventory adjustments

13.1. Introduction

As a party to the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level ozone (Gothenborg Protocol), Belgium committed itself to reduce its emissions of NO_x, SO_2, NMVOC and NH_3. According to the Belgian emission inventory as reported in February 2014, total NO_x emissions in Belgium in 2010 were 218,2 ktonnes, being 37 ktonnes or 20,5% higher than the emission ceiling of 181 ktonnes. In 2011 total NO_X emissions in Belgium were 204,2 ktonnes, being 23,2 ktonnes or 12,8 % higher than the emission ceiling. In 2012 total NO_X emissions in Belgium were 195,4 ktonnes, being 14,4 ktonnes or 8% higher than the emission ceiling. The emission ceilings for the other pollutants were met.

These circumstances were not foreseen when setting the ceilings at the time of the adoption of the Gothenburg Protocol. For this reason **an adjustment** to the reported emissions is applied. In accordance with EB decision 2012/4 of the Gothenburg Protocol allowing the provisional application of article 3, paragraph 11 quinquies of the amended protocol, the NO_x ceiling would be met.

A report with supporting information and documentation was notified in the LRTAP submission of February 15th 2014. The 'Adjustment Emission Inventory Report version 2', submitted together with this IIR [6] lists detailed information required conform paragraph 2 of Decision 2012/12 for a Party applying for an adjustment to its emission inventory or emission reduction commitment and demonstrates that the adjustment is consistent with one or more of the three circumstances listed in paragraph 6 of decision 2012/3, with supporting evidence.

In addition table 7 (Annex VII of the revised Reporting Guidelines) is provided which summarizes the calculations and details on the followed approach.

Non-compliance is entirely related to the transport sector because of the non-delivery of the Euro vehicle emission standards, especially for diesel vehicles in road transport and because of additional non- and off-road sub sectors have been taken into account after the emission ceilings determination in 1999.

13.2. Methodology

13.2.1. Adjustment in road transport

For road transport significantly different emission factors were used for determining emissions from specific source categories:
- 1A3bi Road transport: Passenger Cars,
- 1A3bii Road transport: Light Duty Vehicles,
- 1A3biii Road transport: Heavy Duty Vehicles,
- 1A3biv Road transport: Mopeds and Motorcycles.

The emission inventory is based on the Guidelines for Estimating and Reporting Emission Data under CLRTAP (ECE/EB.AIR/97) revised in 2009 and the COPERTIV v10.0 model. The emission factors used in the recent versions of COPERT are more in line with the real world driving conditions. In 2010,

[6] In version 2 figures of 2011 are corrected in table 3.d and table 5.

the NO_x emissions for road transport are 104,7 ktonnes, using these more recent parameters (EF, removal efficiency) but not the parameters used in the past when the emissions ceilings were set. However, when defining the emission ceiling, it was assumed that real world emissions would follow emission standards, which would have resulted in much lower emissions.

The GAINS model uses fuel activity data as a basis for calculating emissions for mobile sources. In its previous form 'RAINS', this model was used as the basis for setting the ceilings for the 1999 Gothenburg Protocol and the NEC Emission Ceiling for Belgium 2010.

Both emission factors, the emission factor used in 1999 and the most recent emission factors[7] (EF) based on the insights of real emissions, were calculated in GAINS. An evaluation of the NO_X emissions using GAINS model was performed for 2010 using the parameters applied in 1999. The calculated ratio between the GAINS emissions bases on the old (1999) and new (2010) emission factors (in percentages) is applied to the LRTAP emission inventory dataset per source category. The GAINS model can only be used for 2010. To calculate the impact of changed emissions factors for the year 2011 and 2012, the relative difference between both years is applied to the adjusted emissions.

13.2.2. Adjustment in the 'other transport' sector

Emissions in the source category 'other transport' were not modeled in detail in the past. Analyses of the non-road and off-road sector as included in the RAINS model (now GAINS) in 1999 showed that only two sectors were taken into account at that time: other transport with 2-stroke engines (OT_LD2) and other land-based vehicles (OT_LB). These two sectors corresponded with the following subsectors (NFR) reported in the emission inventory:

- 1A 4 c iii Agriculture/Forestry/Fishing: National fishing
- 1A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
- 1 A 3 d ii National navigation (Shipping)
- 1 A 3 c Railways

The methodology for calculating the non-road and off-road emissions in Belgium **has been improved** in recent years and **new source categories** are now included which were not accounted for at the time when the emission reduction commitment was set. The emissions of the off-road (industry, commercial, residential, …) machines is modeled now by the Belgian off-road model OFFREM, calculating emissions for 10 subcategories of the off road sector by using detailed information on engines. The emissions of inland waterways and seagoing vessels is modeled by the EMMOSS model in Flanders (see 3.4.2.4).
In addition to the NFR subsectors listed above, non-road and off-road emissions are now also more detailed available for the following subsectors:

- 1 A 2 f ii Mobile Combustion in manufacturing industries and construction:
- 1 A 3 d i (ii) International inland waterways
- 1 A 3 a i (i) International aviation (LTO)
- 1 A 3 a ii (i) Civil aviation (Domestic, LTO)
- 1A3e Pipeline Compressors (this sector includes also other mobile sources and machinery)

[7] Based on GAINS-scenario: TS-REF-August 12 – data calculated 2013-01-31 (IIASA,2013)

- 1 A 4 a ii Commercial / institutional: Mobile
- 1 A 4 b ii Residential: Household and gardening (mobile)
- 1 A 5 b Other, Mobile (including military, land based and recreational boats)

13.3. Results

In the following paragraphs, an overview is given of the adjustments calculated for the road transport sector and the 'other' transport sector. These adjustments are in accordance with the adjustments given in table Annex VII of the Revised Reporting Guidelines (negative values).

13.3.1. Adjustment results for road transport

The adjustment for road transport is mainly due the underestimation of NO_x-emission factors of Euro 3 and 4 diesel light duty vehicles & cars and EURO III and IV diesel heavy duty vehicles in previous road transport models.

Table 13.1 compares emission estimates made using the original and the updated emission factors.

Table 13.1: Comparison of yearly emissions of 2010, 2011 and 2012 for road transport due to different emission factors (old (1999) and new 'real' (2010) EF).

Ktonnes NO_x	*LRTAP (2010)* 15.02.2014	*LRTAP _2010* With old EF (RAINS ,1999) 15.02.2014	**LRTAP (2010)** Adjustment 15.02.2014	*LRTAP (2011)* 15.02.2014	*LRTAP _2011* With old EF (RAINS ,1999) 15.02.2014	**LRTAP (2011)** Adjustment 15.02.2014	*LRTAP (2012)* 15.02.2014	*LRTAP _2012* With old EF (RAINS ,1999) 15.02.2014	**LRTAP (2012)** Adjustment 15.02.2014
1 A 3 b i Road transport: Passenger cars	44,49	16,75	**-27,74**	45,44	17,10	**-28,34**	46,12	17,36	**-28,76**
1 A 3 b ii Road transport: Light duty vehicles	9,91	4,25	**-5,66**	9,55	4,09	**-5,46**	9,48	4,06	**-5,41**
1 A 3 b iii Road transport:, Heavy duty vehicles	49,92	32,85	**-17,07**	45,17	29,73	**-15,45**	39,88	26,24	**-13,64**
1 A 3 b iv Road transport: Mopeds & motorcycles	0,36	1,39	**1,03**	0,35	1,37	**1,01**	0,35	1,36	**1,01**
Subtotal 'Road Transport'	**104,69**	**55,24**	**-49,45**	**100,52**	**52,29**	**-48,22**	**95,83**	**49,02**	**-46,81**

The adjustment for road transport as given in table Annex VII of the Revised Reporting Guidelines are estimated at **-49 ktonnes NO_x in 2010, -48 ktonnes NO_x in 2011 and -47 ktonnes NO_x in 2012.,**

The adjustment shows that the change is significant and demonstrates that the change in emission factors contributes being unable to meet the reduction commitment.

13.3.2. Adjustment result for 'other transport sector'

Table 13.2 summarizes emission estimates made :

- using the original emission source categories of other transport at the time the commitment was set (subtotal 1)
- using the current emission source categories and methodologies as reported in the emission inventory anno 2014 (sum of subtotal 1 and subtotal 2)

Table 13.2 : Initial categories of 'other transport ' in 1999 and list of new categories in emission inventory reporting anno 2014.

LRTAP, reporting year 2014 – year of emissions :	2010	2011	2012
1A 4 c iii Agriculture/Forestry/Fishing: National fishing	0,07	0,07	0,07
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and	6,28	5,62	5,88
1 A 3 d ii National navigation (Shipping)	3,95	3,95	3,75
1 A 3 c Railways	1,68	1,62	1,46
Subtotal 1	**11,99**	**11,26**	**11,16**
1 A 2 f ii Mobile Combustion in manufacturing industries and	4,25	4,13	3,49
1 A 3 d i (ii) International inland waterways	3,83	3,77	3,64
1 A 3 a i (i) International aviation (LTO)	2,16	2,21	2,10
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	0,05	0,05	0,05
1 A 4 a ii Commercial / institutional: Mobile	IE	IE	IE
1 A 4 b ii Residential: Household and gardening (mobile)	0,18	0,19	0,19
1 A 5 b Other, Mobile (including military, land based and	0,39	0,36	0,36
1 A 3 e Pipeline compressors (incl. other mobile sources and	0,58	0,53	0,47
Subtotal 2 = Adjustment	**11,44**	**11,23**	**10,29**
Total of 'other transport' :non road and off-road	23,43	22,49	21,45

Several non-road and off-road sectors, emitting **11,44 ktonnes NO_x in total in 2010, 11,23 ktonnes NO_x in total in 2011 and 10,29 ktonnes NO_x** in total in 2012 were not taken into account when the emission ceilings were defined. The adjustment shows that the change is significant and demonstrates that the new source categories and improvement of methodology contributes being unable to meet the reduction commitment.

13.3.3. Overview of adjustment (difference) for Belgium

Table 13.3 gives an overview of adjustment (difference) per source category for the years 2010, 2011 and 2012.

Table 13.3 : overview of adjustments for per source category for 2010-2012

Ktonnes NO_x to be adjusted	***2010***	***2011***	***2012***
1 A 3 b i Road transport: Passenger cars	*-27.74*	*-28.34*	*-28.76*
1 A 3 b ii Road transport: Light duty vehicles	*-5.66*	*-5.46*	*-5.41*
1 A 3 b iii Road transport:, Heavy duty vehicles	*-17.07*	*-15.45*	*-13.64*
1 A 3 b iv Road transport: Mopeds & motorcycles	*1.03*	*1.01*	*1.01*
'Road Transport'	***-49.45***	***-48.22***	***-46.81***
1 A 2 f ii Mobile Combustion in manufacturing industries and construction	-4.25	-4.13	-3.49
1 A 3 d i (ii) International inland waterways	-3.83	-3.77	-3.64
1 A 3 a i (i) International aviation (LTO)	-2.16	-2.21	-2.10
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	-0.05	-0.05	-0.05
1 A 4 b ii Residential: Household and gardening (mobile)	-0.18	-0.19	-0.19
1 A 5 b Other, Mobile (including military, land based and recreational boats)	-0.39	-0.36	-0.36
1 A 3 e Pipeline compressors (incl. other mobile sources and machinery)	-0.58	-0.53	-0.47
Other transport	**-11.44**	**-11.23**	**-10.29**
Total	**-60.89**	**-59.46**	**-57.10**

13.4. Compliance check

As shown above the reason for non-compliance is significant and can be explained by changes in the emission inventory methodology reflecting the non-delivery of European vehicle emission standards and the inclusion of new subcategories for non and off-road not accounted for at the time when the NO_X ceiling was adopted.

In case reported emissions would be adjusted to account for the changes in the EF for road transport and the new inventoried sub-categories for off road and non-road, the following values would be obtained for the year 2010, 2011 and 2012: 157,3 ktonnes NO_X , 144,7 ktonnes NO_X and 138,3 ktonnes $NO_{X,}$ so the Gothenborg Protocol ceiling of 1999 for NOx of 181 ktonnes would have been met since 2010.

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Annex 1: Key category analysis

1.A Level assessment

The following tables show the level assessment for 2012 for all reported pollutants.

NO_x Source category	Gg NO2	Level ass.	2012 Cum. Total
1 A 3 b i Road transport: Passenger cars	46,121	23,6%	23,6%
1 A 3 b iii Road transport:, Heavy duty vehicles	39,881	20,4%	44,0%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	13,943	7,1%	51,1%
1 A 1 a Public electricity and heat production	11,447	5,9%	57,0%
1 A 4 b i Residential: Stationary plants	11,212	5,7%	62,7%
2 A 1 Cement production	10,521	5,4%	68,1%
1 A 3 b ii Road transport:Light duty vehicles	9,478	4,9%	73,0%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	5,881	3,0%	76,0%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	5,2	2,7%	78,7%
1 A 4 a i Commercial / institutional: Stationary	3,855	2,0%	80,6%

NMVOC Source category	Gg	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	16,629	15,9%	15,9%
3 D 2 Domestic solvent use including fungicides	14,804	14,2%	30,1%
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	10,319	9,9%	40,0%
3 A 2 Industrial coating application	8,163	7,8%	47,8%
3 C Chemical products	5,345	5,1%	53,0%
3 A 1 Decorative coating application	4,234	4,1%	57,0%
1 A 3 b i Road transport: Passenger cars	3,497	3,4%	60,4%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	3,164	3,0%	63,4%
1 B 2 b Natural gas	3,08	3,0%	66,4%
2 D 2 Food and drink	3,039	2,9%	69,3%
1 B 2 a iv Refining / storage	2,913	2,8%	72,1%
3 D 1 Printing	2,638	2,5%	74,6%
3 D 3 Other product use	2,571	2,5%	77,0%
1 A 3 b v Road transport: Gasoline evaporation	2,385	2,3%	79,3%
3 B 1 Degreasing	2,217	2,1%	81,5%

SOx Source category	Gg SO2	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	7,745	15,8%	15,8%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	7,093	14,5%	30,3%
1 B 2 a iv Refining / storage	5,791	11,8%	42,2%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	5,649	11,6%	53,7%
2 A 1 Cement production	3,928	8,0%	61,8%
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	3,507	7,2%	68,9%
1 A 1 a Public electricity and heat production	2,427	5,0%	73,9%
1 A 1 b Petroleum refining	1,835	3,8%	77,7%
1 B 2 c Venting and flaring	1,443	3,0%	80,6%

NH_3 Source category	Gg	Level ass.	2012 Cum. Total
4 B 8 Swine	22,122	32,4%	32,4%
4 B 1 b Cattle non-dairy	16,799	24,6%	57,1%
4 B 1 a Cattle dairy	10,595	15,5%	72,6%
4 D 1 a Synthetic N-fertilizers	5,291	7,8%	80,4%

PM2,5 Source category	Gg	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	18,085	56,9%	56,9%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	1,488	4,7%	61,5%
1 A 3 b i Road transport: Passenger cars	1,426	4,5%	66,0%
1 A 3 b vi Road transport: Automobile tyre and brake wear	0,985	3,1%	69,1%
2 C 1 Iron and steel production	0,98	3,1%	72,2%
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,832	2,6%	74,8%
2 A 7 a Quarrying and mining of minerals other than coal	0,801	2,5%	77,3%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,753	2,4%	79,7%
1 A 3 b iii Road transport:, Heavy duty vehicles	0,72	2,3%	82,0%

PM10 Source category	Gg	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	18,663	48,2%	48,2%
2 A 7 a Quarrying and mining of minerals other than coal	2,294	5,9%	54,1%
1 A 3 b vi Road transport: Automobile tyre and brake wear	1,836	4,7%	58,9%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	1,624	4,2%	63,0%
1 A 3 b i Road transport: Passenger cars	1,426	3,7%	66,7%
2 C 1 Iron and steel production	1,21	3,1%	69,9%
1 A 3 b vii Road transport: Automobile road abrasion	1,004	2,6%	72,4%
4 B 8 Swine	0,962	2,5%	74,9%
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,865	2,2%	77,2%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,838	2,2%	79,3%
1 A 3 b iii Road transport:, Heavy duty vehicles	0,72	1,9%	81,2%

TSP Source category	Gg	Level ass.	2012 Cum. Total
1 A 4 b i Residential: Stationary plants	19,906	37,0%	37,0%
2 A 7 a Quarrying and mining of minerals other than coal	6,973	13,0%	50,0%
1 A 3 b vi Road transport: Automobile tyre and brake wear	2,421	4,5%	54,5%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	2,217	4,1%	58,6%
4 B 8 Swine	2,18	4,1%	62,7%
1 A 3 b vii Road transport: Automobile road abrasion	2,008	3,7%	66,4%
1 A 3 b i Road transport: Passenger cars	1,426	2,7%	69,1%
2 C 1 Iron and steel production	1,354	2,5%	71,6%
1 A 2 f ii Mobile Combustion in manufacturing industries and construction: (Please specify in your IIR)	1,242	2,3%	73,9%
4 B 1 b Cattle non-dairy	1,237	2,3%	76,2%
4 B 9 b Broilers	1,207	2,2%	78,4%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,952	1,8%	80,2%

CO Source category	Gg	Level ass.	2011 Cum. Total
1 A 4 b i Residential: Stationary plants	127,81 3	32,6%	32,6%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	81,908	20,9%	53,4%
1 A 3 b i Road transport: Passenger cars	37,394	9,5%	63,0%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	23,469	6,0%	68,9%
2 C 1 Iron and steel production	20,635	5,3%	74,2%
1 A 4 b ii Residential: Household and gardening (mobile)	12,91	3,3%	77,5%
1 A 3 b iii Road transport:, Heavy duty vehicles	12,599	3,2%	80,7%

Pb Source category	Mg	Level ass.	2012 Cum. Total
2 C 1 Iron and steel production	17,457	54,3%	54,3%
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	2,837	8,8%	63,1%
1 A 3 b vi Road transport: Automobile tyre and brake wear	2,108	6,5%	69,6%
1 A 4 b i Residential: Stationary plants	1,866	5,8%	75,4%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	1,138	3,5%	79,0%
1 B 2 a iv Refining / storage	1,091	3,4%	82,3%

Cd Source category	Mg	Level ass.	2012 Cum. Total
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	0,704	28,4%	28,4%
1 A 4 b i Residential: Stationary plants	0,526	21,2%	49,7%
2 C 1 Iron and steel production	0,263	10,6%	60,3%
1 B 2 a iv Refining / storage	0,223	9,0%	69,3%
1 A 1 a Public electricity and heat production	0,171	6,9%	76,2%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,098	4,0%	80,2%

Hg Source category	Mg	Level ass.	2012 Cum. Total
2 A 1 Cement production	0,248	14,8%	14,8%
1 B 2 a iv Refining / storage	0,232	13,8%	28,5%
2 C 1 Iron and steel production	0,231	13,7%	42,2%
1 A 4 b i Residential: Stationary plants	0,214	12,7%	54,9%
2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)	0,189	11,2%	66,2%
1 A 1 a Public electricity and heat production	0,12	7,1%	73,3%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,08	4,7%	78,1%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,063	3,8%	81,8%

As Source category	Mg	Level ass.	2012 Cum. Total
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	0,663	34,8%	34,8%
2 C 1 Iron and steel production	0,311	16,3%	51,1%
1 A 4 b i Residential: Stationary plants	0,223	11,7%	62,8%
1 A 1 a Public electricity and heat production	0,206	10,8%	73,6%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,084	4,4%	78,0%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,068	3,6%	81,6%

Cr Source category	Mg	Level ass.	2012 Cum. Total
2 C 1 Iron and steel production	4,85	44,3%	44,3%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	1,996	18,2%	62,5%
1 A 4 b i Residential: Stationary plants	0,833	7,6%	70,1%
1 A 3 b vi Road transport: Automobile tyre and brake wear	0,773	7,1%	77,2%
1 A 1 a Public electricity and heat production	0,635	5,8%	83,0%

Cu Source category	Mg	Level ass.	2012 Cum. Total
1 A 3 b vi Road transport: Automobile tyre and brake wear	16,864	58,2%	58,2%
1 A 3 c Railways	3,454	11,9%	70,1%
3 D 3 Other product use	2,896	10,0%	80,1%

Ni Source category	Mg	Level ass.	2012 Cum. Total
2 C 1 Iron and steel production	0,958	15,4%	15,4%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,848	13,6%	29,0%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,668	10,7%	39,7%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,452	7,3%	47,0%
1 A 4 b i Residential: Stationary plants	0,392	6,3%	53,3%
1 B 2 a iv Refining / storage	0,386	6,2%	59,5%
1 A 1 a Public electricity and heat production	0,329	5,3%	64,8%
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	0,322	5,2%	69,9%
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	0,276	4,4%	74,4%
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	0,264	4,2%	78,6%
1 A 4 a i Commercial / institutional: Stationary	0,227	3,6%	82,3%

Se Source category	Mg	Level ass.	2012 Cum. Total
2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	1,066	32,6%	32,6%
1 A 4 b i Residential: Stationary plants	0,704	21,5%	54,2%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)	0,375	11,5%	65,7%
2 A 1 Cement production	0,308	9,4%	75,1%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,254	7,8%	82,9%

Zn Source category	Mg	Level	2012 Cum.

		ass.	Total
2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)	28,677	32,0%	32,0%
1 A 4 b i Residential: Stationary plants	15,106	16,9%	48,9%
1 A 3 b i Road transport: Passenger cars	7,97	8,9%	57,7%
1 A 3 b vi Road transport: Automobile tyre and brake wear	7,825	8,7%	66,5%
2 C 1 Iron and steel production	6,825	7,6%	74,1%
1 A 1 a Public electricity and heat production	4,031	4,5%	78,6%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	3,856	4,3%	82,9%

Diox **Source category**	**g I-Teq**	**Level ass.**	**2012 Cum. Total**
1 A 4 b i Residential: Stationary plants	21,673	41,9%	41,9%
2 C 1 Iron and steel production	11,157	21,6%	63,5%
6 C e Small scale waste burning	9,516	18,4%	81,9%

PAH total 1-4 **Source category**	**Mg**	**Level ass.**	**2012 Cum. Total**
3 D 3 Other product use	12,058	35,0%	35,0%
1 A 4 b i Residential: Stationary plants	11,095	32,2%	67,2%
1 B 1 b Fugitive emission from solid fuels: Solid fuel transformation	5,757	16,7%	83,9%

HCB **Source category**	**kg**	**Level ass.**	**2012 Cum. Total**
3 C Chemical products	9,711	34,4%	34,4%
2 C 1 Iron and steel production	7,722	27,3%	61,7%
2 A 1 Cement production	6	21,2%	82,9%

HCH **Source category**	**kg**	**Level ass.**	**2012 Cum. Total**
3 D 3 Other product use	177,32	100,0 %	100,0%

PCB **Source category**	**kg**	**Level ass.**	**2012 Cum. Total**
2 C 1 Iron and steel production	4,59	46,7%	46,7%
2 A 1 Cement production	3,75	38,2%	84,9%

The following tables show the results of the key category analysis (level assessment) per year.

1990	Key source categories (sorted from high to low, from left to right)												Total
NOx	1A3bi	1A3bii	1A1a	1A2fi	1A4bi	1A2a	2A1	1A3bii					81,0%
	26,1%	18,1%	16,3%	5,9%	4,4%	4,0%	4,0%	2,1%					
NMVOC	1A3bi	3A2	2B5a	1B2aiv	1A3bv	3C	3D1	1B2av	1A4bi	3A1	3D2	3B1	82,3%
	20,3%	14,2%	10,3%	6,0%	5,4%	4,8%	4,3%	4,0%	3,9%	3,4%	3,3%	2,5%	
SOx	1A1a	1A2fi	1A1b	1A4ci	1A4bi	2B5a	1A2a	1A1c					83,2%
	26,4%	17,2%	11,4%	7,9%	7,6%	5,0%	4,4%	3,3%					
NH3	4B8	4B1b	4B1a	4D1a									84,0%
	42,0%	20,2%	17,8%	4,1%									
CO	1A3bi	2C1	1A2a	1A4bi									87,9%
	37,9%	20,4%	19,8%	9,9%									
Pb	1A3bi	2C1	1A1a	6Cc	2C5e								82,7%
	34,6%	20,0%	15,3%	6,7%	6,2%								
Cd	1A2b	1A1a	2C1	6Cc	1A4bi	2C5e							82,9%
	26,8%	17,0%	14,0%	12,3%	6,6%	6,2%							
Hg	1A1a	1A2e	2B5a	1A2fi	6Cc	1A2c							85,0%
	19,7%	19,1%	17,0%	14,3%	9,1%	5,7%							
As	2C1	1A1a	2C5e	1A4bi									82,1%
	30,5%	30,4%	15,3%	6,0%									
Cr	2C1	6Cc	1A1a	1B1b									83,7%
	42,0%	28,5%	8,6%	4,6%									
Cu	1A3bvi	2C1	1A1a	2C5e	1A2b	6Cc							83,1%
	32,8%	18,2%	14,4%	7,0%	6,4%	4,3%							
Ni	1A2c	1A2e	1A2fi	6Cc	2C1	1A1a							86,0%
	21,9%	19,3%	12,2%	11,0%	10,8%	10,8%							
Se	1A1a	1A2fi	1A4bi										81,0%
	42,8%	20,5%	17,7%										
Zn	2C1	2C5e	1A1a	2B5a	6Cc	1A2fi							80,3%
	16,7%	15,3%	15,1%	15,0%	10,3%	7,8%							
PCDD/ PCDF	2C1	1A1a	6Cc	6Cb									85,7%
	27,4%	26,8%	17,1%	14,5%									
PAH	1B1b	2C1	1A4bi	3D3									92,7%
	36,2%	27,2%	16,1%	13,2%									
HCB	3C	6Cb	2C1										84,7%
	40,5%	30,4%	13,8%										
HCH	4G												99,2%
	99,2%												
PCB	2C1												88,2%
	88,2%												

2000	Key source categories (sorted from high to low, from left to right)																Total
NOx	1A3biii	1A3bi	1A1a	1A2fi	2A1	1A2a	1A4bi	1A3bii	1A4cii								81,7%
	23,9%	15,9%	13,5%	7,6%	5,5%	5,2%	4,7%	3,2%	2,1%								
NMVOC	3A2	1A3bi	2B5a	3D2	1B2aiv	3A1	1A4bi	3D1	3C	1B2av	3D3	1A3bv	3B1	1A3biii			80,3%
	12,4%	9,7%	8,2%	7,1%	6,5%	5,7%	5,6%	5,6%	5,2%	3,4%	2,9%	2,9%	2,8%	2,2%			
SOx	1A1a	1A2fi	1A1b	1A4bi	1A2a	2B5a	2A2	1A4ci	2A1								81,0%
	20,2%	14,3%	13,4%	11,6%	7,1%	4,9%	3,4%	3,3%	2,8%								
NH3	4B8	4B1b	4B1a	4D1a													80,6%
	33,3%	24,6%	16,9%	5,7%													
PM2,5	1A4bi	2C1	1A3bi	1A3biii	1A4cii	1A1a	1A3bii	1A2fi	2A7d	1A3bvi	2A7a	1A1b					81,0%
	24,0%	18,9%	10,6%	5,9%	4,9%	3,2%	2,9%	2,8%	2,5%	2,3%	1,9%	1,4%					
PM10	1A4bi	2C1	1A3bi	1A1a	1A3biii	2A7a	1A4cii	1A3bvi	1A2fi	2A1	1A3bii	2A7d	4B8	2A2	1A3bvii		80,8%
	19,0%	18,5%	8,1%	4,8%	4,5%	4,3%	4,1%	3,2%	2,4%	2,3%	2,2%	2,0%	1,9%	1,8%	1,8%		
TSP	2C1	1A4bi	2A7a	1A3bi	1A1a	1A4cii	1B1b	1A3biii	1A3bvii	4B8	2A2	1A3bvi	4B1b	1A2fi	2A1	1A2fii	81,7%
	20,8%	13,9%	7,8%	5,5%	5,3%	3,5%	3,3%	3,1%	2,9%	2,9%	2,8%	2,4%	1,9%	1,9%	1,9%	1,8%	
CO	1A2a	1A3bi	2C1	1A4bi	1A2fi												82,1%
	37,6%	17,4%	10,9%	9,8%	6,3%												
Pb	2C1	2C5e															81,6%
	69,6%	12,0%															
Cd	2C1	2C5e	1A4bi	1B2aiv	1B1b	1A1a											80,4%
	36,7%	13,4%	11,6%	6,9%	6,1%	5,7%											
Hg	2B5a	2C1	1A1a	2A1	1A4bi	1B2aiv											81,7%
	20,6%	19,3%	16,9%	9,3%	8,8%	6,7%											
As	2C1	2C5e	1A1a	1A4bi	1A2fi												82,5%
	37,7%	27,3%	7,3%	7,2%	3,0%												
Cr	2C1	1A2fi	1A1a	1A3bvi	1B1b												83,4%
	63,1%	8,8%	4,0%	3,9%	3,6%												
Cu	1A3bvi	2C1	1A3c	2C5e	3D3												86,6%
	42,6%	15,0%	11,2%	10,6%	7,3%												
Ni	1A1b	2C1	1B2aiv	1A2e	1A4ci	1A2c	1A2fi										84,8%
	28,2%	18,5%	10,1%	7,6%	7,0%	7,0%	6,5%										
Se	2A7d	1A2fi	1A4bi	2C5e	1A1a	2C1											81,5%
	21,1%	20,1%	14,2%	11,1%	10,3%	4,8%											
Zn	2C1	2C5e	1A2fi	1A3bi	1A3bvi	1A4bi											83,4%
	41,5%	20,8%	9,0%	4,5%	4,0%	3,5%											
PCDD/ PCDF	2C1	6Ce	1A4bi														82,6%
	49,0%	20,5%	13,0%														
PAH	1B1b	3D3	1A4bi	2C1													87,3%
	31,9%	23,0%	19,5%	12,8%													
HCB	3C	2A1	2C1														89,8%
	50,9%	21,3%	17,6%														
HCH	4G																95,2%
	95,2%																
PCB	2C1																91,3%
	91,3%																

2001	Key source categories (sorted from high to low, from left to right)																Total
NOx	1A3biii	1A3bi	1A1a	1A2fi	1A4bi	1A2a	2A1	1A3bii	1A4cii								81,4%
	24,9%	16,1%	11,8%	7,8%	5,4%	5,0%	4,9%	3,4%	2,1%								
NMVOC	3A2	1A3bi	2B5a	3D2	1B2aiv	1A4bi	3A1	3D1	3C	1B2av	3D3	1A3bv	3B1	1A3biii			80,1%
	12,6%	8,7%	8,0%	7,3%	6,3%	6,3%	6,1%	5,9%	5,2%	3,4%	3,0%	2,8%	2,5%	2,1%			
SOx	1A1a	1A2fi	1A1b	1A4bi	1A2a	2B5a	1A4ci	2A2	2A1								81,3%
	18,6%	15,3%	13,3%	13,1%	7,0%	4,7%	3,4%	3,3%	2,7%								
NH3	4B8	4B1b	4B1a	4D1a													81,1%
	33,1%	25,4%	17,2%	5,4%													
PM2,5	1A4bi	2C1	1A3bi	1A3bii	1A4cii	1A2fi	1A3bii	2A7d	1A3bvi	1A1a	2A7a	1A2c					80,3%
	27,7%	15,0%	10,3%	5,9%	4,9%	3,2%	2,9%	2,5%	2,4%	2,0%	2,0%	1,5%					
PM10	1A4bi	2C1	1A3bi	1A3bii	2A7a	1A4cii	1A3bvi	1A1a	1A2fi	1A3bii	2A7d	2A2	2A1	1A3bvi	4B8	1B1b	81,7%
	21,7%	16,3%	7,8%	4,4%	4,4%	4,0%	3,4%	3,2%	2,8%	2,2%	2,0%	2,0%	2,0%	1,9%	1,9%	1,8%	
TSP	2C1	1A4bi	2A7a	1A3bi	1A1a	1A4cii	1B1b	2A2	1A3bvi	1A3bii	4B8	1A3bvi	1A2fi	4B1b	1A2fii	2A7d	80,9%
	18,5%	15,9%	8,0%	5,3%	3,7%	3,5%	3,5%	3,3%	3,1%	3,0%	2,9%	2,6%	2,1%	2,0%	1,8%	1,8%	
CO	1A2a	1A3bi	1A4bi	2C1	1A2fi												81,5%
	38,3%	16,4%	11,3%	10,2%	5,2%												
Pb	2C1	2C5e	1A3bi														81,5%
	65,9%	11,6%	4,0%														
Cd	2C1	2C5e	1A4bi	1B2aiv	1B1b	1A1a											80,6%
	31,4%	16,7%	13,7%	7,8%	6,7%	4,3%											
Hg	1A1a	2C1	2B5a	1A4bi	2A1	1B2aiv	2C5e										84,3%
	17,4%	16,9%	16,3%	11,0%	10,0%	7,9%	4,9%										
As	2C5e	2C1	1A4bi	1A1a	1A2fi												83,1%
	33,1%	32,1%	7,8%	6,6%	3,5%												
Cr	2C1	1A3bvi	1B1b	1A2fi	1A1a												82,2%
	67,3%	4,3%	3,9%	3,4%	3,3%												
Cu	1A3bvi	2C1	1A3c	2C5e	3D3												85,7%
	45,2%	13,1%	11,6%	8,2%	7,7%												
Ni	1A1b	2C1	1B2aiv	1A2e	1A2c	1A1a	1A2fi										81,0%
	25,8%	16,3%	10,7%	7,6%	7,2%	6,7%	6,6%										
Se	2A7d	2C5e	1A4bi	1A2fi	1A1a												80,0%
	22,2%	18,8%	15,9%	13,9%	9,3%												
Zn	2C1	2C5e	1A2fi	1A3bi	1A3bvi	1A4bi											82,8%
	40,7%	19,2%	9,7%	4,7%	4,3%	4,1%											
PCDD/ PCDF	6Ce	2C1	1A4bi	1A1a													88,5%
	29,4%	26,2%	21,2%	11,7%													
PAH	1B1b	3D3	1A4bi	2C1													87,3%
	32,5%	23,1%	21,1%	10,5%													
HCB	3C	2A1	2C1														89,7%
	50,8%	20,3%	18,5%														
HCH	4G																94,1%
	94,1%																
PCB	2C1																93,1%
	93,1%																

2002	Key source categories (sorted from high to low, from left to right)																Total
NOx	1A3biii	1A3bi	1A1a	1A2fi	1A4bi	1A2a	2A1	1A3bii	2B5a	1A4cii							81,7%
	25,5%	16,4%	11,2%	5,3%	5,2%	4,9%	4,3%	3,5%	3,1%	2,2%							
NMVOC	3A2	2B5a	3D2	1A3bi	1B2aiv	3A1	1A4bi	3D1	3C	1B2av	3D3	3B1	1A3bv	1A3bii	1A4cii		81,5%
	12,0%	9,1%	7,9%	7,9%	6,4%	6,3%	6,0%	5,1%	4,6%	3,1%	3,1%	2,8%	2,7%	2,2%	2,1%		
SOx	1A1a	1A1b	1A4bi	1A2fi	1A2a	2B5a	1A2e	2A2	1A4ci								81,5%
	18,7%	13,6%	13,0%	11,3%	7,4%	5,7%	4,5%	3,7%	3,6%								
NH3	4B8	4B1b	4B1a	4D1a													81,4%
	33,5%	25,1%	17,0%	5,8%													
PM2,5	1A4bi	2C1	1A3bi	1A3biii	1A4cii	1A2fi	1A3bii	1A1a	2A7d	1A3bvi	2A7a	2G	1A3bvii				81,2%
	25,9%	15,5%	9,4%	5,7%	5,1%	3,1%	2,9%	2,9%	2,8%	2,6%	2,1%	2,0%	1,4%				
PM10	1A4bi	2C1	1A3bi	2A7a	1A1a	1A3biii	1A4cii	1A3bvi	1A2fi	2A7d	1A3bii	2A2	1A3bvi	4B8	2A1	2G	81,0%
	20,3%	15,9%	7,1%	4,6%	4,5%	4,3%	4,2%	3,6%	2,7%	2,3%	2,2%	2,0%	2,0%	1,9%	1,7%	1,6%	
TSP	2C1	1A4bi	2A7a	1A1a	1A3bi	1A4cii	1A3bvi	2A2	1B1b	4B8	1A3bii	1A3bvi	1A2fi	2A7d	4B1b	1A2fii	80,8%
	18,3%	14,7%	8,3%	5,3%	4,8%	3,6%	3,2%	3,1%	3,0%	3,0%	2,9%	2,7%	2,0%	2,0%	2,0%	1,8%	
CO	1A2a	1A3bi	2C1	1A4bi	2A2												80,4%
	40,5%	14,4%	10,8%	10,0%	4,6%												
Pb	2C1	2C5e	1A3bi														80,7%
	63,7%	12,9%	4,1%														
Cd	2C1	1A4bi	2C5e	1B2aiv	1A1a	1B1b											80,3%
	32,0%	16,2%	11,9%	8,1%	6,4%	5,7%											
Hg	1A1a	2C1	2A1	2B5a	1A4bi	1B2aiv											85,5%
	34,0%	20,5%	9,2%	8,1%	7,7%	6,0%											
As	2C1	2C5e	1A4bi	1A1a													82,2%
	38,1%	29,5%	7,7%	6,8%													
Cr	2C1	1A3bvi	1A4bi	1A1a	1B1b												81,8%
	66,5%	4,3%	3,8%	3,8%	3,3%												
Cu	1A3bvi	2C1	1A3c	2C5e	3D3												86,2%
	46,1%	12,6%	10,7%	9,1%	7,7%												
Ni	1A1b	2C1	1B2aiv	1A2e	1A4ci	1A2c	1A1a										82,0%
	24,4%	15,9%	13,0%	10,0%	7,2%	6,4%	5,0%										
Se	1A2fi	2A7d	2C5e	1A4bi	1A1a												82,4%
	33,1%	17,7%	14,9%	12,2%	4,4%												
Zn	2C1	2C5e	1A4bi	1A2fi	1A3bi												81,4%
	47,9%	18,6%	5,4%	4,8%	4,7%												
PCDD/ PCDF	6Ce	2C1	1A4bi	1A1a													88,5%
	32,8%	23,0%	22,4%	10,3%													
PAH	1B1b	3D3	1A4bi	2C1													86,0%
	31,6%	27,0%	20,4%	7,0%													
HCB	3C	2C1	2A1														89,2%
	50,5%	19,8%	18,9%														
HCH	4G																92,3%
	92,3%																
PCB	2C1																93,3%
	93,3%																

2003	Key source categories (sorted from high to low, from left to right)																Total
NOx	1A3biii	1A3bi	1A1a	1A2a	1A4bi	1A2fi	2A1	1A3bii	2B5a								80,2%
	25,2%	16,0%	12,4%	5,8%	5,4%	4,9%	4,4%	3,6%	2,5%								
NMVOC	3A2	3D2	2B5a	1A3bi	1A4bi	1B2aiv	3A1	3D1	3C	1B2av	3D3	1A3bv	1A3bii	1A4cii	3B1		81,1%
	12,1%	8,3%	8,2%	7,3%	7,3%	6,4%	6,4%	4,7%	4,6%	3,3%	3,2%	2,8%	2,2%	2,2%	2,1%		
SOx	1A1a	1A1b	1A4bi	1A2fi	1A2a	2B5a	1A4ci	2A1	2A2								81,4%
	19,5%	15,0%	13,2%	10,8%	8,1%	4,0%	3,7%	3,7%	3,5%								
NH3	4B8	4B1b	4B1a	4D1a													81,2%
	33,3%	25,1%	17,1%	5,7%													
PM2,5	1A4bi	2C1	1A3bi	1A3biii	1A4cii	1A2fi	1A3bii	2A7d	1A3bvi	2A7a	1A1a	2G					80,4%
	29,9%	15,0%	8,5%	5,2%	4,9%	3,5%	2,7%	2,5%	2,5%	2,0%	1,9%	1,7%					
PM10	1A4bi	2C1	1A3bi	2A7a	1A4cii	1A3biii	1A3bvi	1A1a	1A2fi	2A1	1A3bii	2A7d	1A3bvi	1B2aiv	2A2		80,3%
	23,4%	15,6%	6,4%	4,5%	4,0%	4,0%	3,5%	3,5%	3,0%	2,5%	2,1%	2,0%	1,9%	1,9%	1,9%		
TSP	2C1	1A4bi	2A7a	1A1a	1A3bi	1A4cii	1A3bvi	2A2	1B1b	4B8	1A3biii	1A3bvi	1A2fi	2A1	1B2aiv	4B1b	81,0%
	18,2%	17,1%	8,1%	4,5%	4,4%	3,5%	3,1%	3,0%	2,9%	2,8%	2,7%	2,6%	2,3%	2,0%	1,9%	1,9%	
CO	1A2a	1A3bi	1A4bi	2C1	2A2												82,2%
	41,7%	13,5%	11,4%	11,2%	4,5%												
Pb	2C1	2C5e	1A3bi														80,7%
	64,8%	11,7%	4,2%														
Cd	2C1	1A4bi	2C5e	1B2aiv	1A1a	1B1b											80,7%
	32,0%	16,9%	11,9%	7,8%	6,6%	5,5%											
Hg	1A1a	2C1	2A1	1A4bi	2B5a	1B2aiv											84,1%
	34,4%	17,1%	10,9%	8,2%	7,1%	6,4%											
As	2C1	2C5e	1A4bi	1A1a													81,5%
	40,6%	24,9%	8,0%	8,0%													
Cr	2C1	1A3bvi	1A4bi	1A1a	2A1	1B1b											80,4%
	62,2%	4,1%	4,0%	3,8%	3,2%	3,1%											
Cu	1A3bvi	2C1	1A3c	3D3	2C5e												85,6%
	47,1%	12,1%	10,7%	7,9%	7,8%												
Ni	1A1b	1B2aiv	2C1	1A2c	1A2e	1A4ci	1A1a										83,3%
	24,2%	17,2%	14,0%	7,8%	7,2%	6,9%	6,0%										
Se	1A2fi																80,0%
	80,0%																
Zn	2C1	2C5e	1A4bi	1A3bi	1A3bvi												80,7%
	48,6%	16,5%	6,3%	4,8%	4,5%												
PCDD/ PCDF	6Ce	2C1	1A4bi														81,8%
	30,8%	27,6%	23,4%														
PAH	1B1b	3D3	1A4bi	2C1													87,1%
	31,8%	27,4%	20,7%	7,1%													
HCB	3C	2C1	2A1														88,8%
	51,2%	19,7%	18,0%														
HCH	4G																88,8%
	88,8%																
PCB	2C1																93,4%
	93,4%																

2004	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii	1A3bi	1A1a	1A2a	1A4bi	1A2fi	2A1	1A3bii	2B5a	1A4cii						81,1%
	24,5%	15,5%	12,4%	5,6%	5,0%	4,9%	4,7%	3,6%	2,5%	2,2%						
NMVOC	3A2	2B5a	3D2	1A4bi	1A3bi	3A1	1B2aiv	3D1	3C	1B2av	3D3	1A4cii	1A3bv	1A3bii	3B1	80,7%
	10,9%	9,1%	8,8%	8,3%	6,7%	6,4%	5,9%	4,6%	4,5%	3,2%	2,8%	2,6%	2,5%	2,3%	2,2%	
SOx	1A1a	1A1b	1A4bi	1A2fi	1A2a	2B5a	1A4ci	1A2e								80,3%
	21,2%	15,2%	12,7%	12,3%	8,5%	3,9%	3,6%	3,1%								
NH3	4B8	4B1b	4B1a	4D1a												80,1%
	31,6%	25,4%	17,1%	6,0%												
PM2,5	1A4bi	2C1	1A3bi	1A3bii	1A4cii	1A2fi	1A3biii	1A3bvi	1A1a	2A7d	2A7a					80,6%
	32,5%	14,8%	8,2%	5,0%	4,9%	3,6%	2,7%	2,5%	2,2%	2,1%	2,0%					
PM10	1A4bi	2C1	1A3bi	2A7a	1A4cii	1A3biii	1A3bvi	1A1a	1A2fi	1A3bii	1A3bvi	4B8	2A2	2A7d	1B1b	81,2%
	25,8%	15,6%	6,3%	4,5%	4,1%	3,8%	3,6%	3,6%	3,1%	2,1%	2,0%	1,8%	1,7%	1,7%	1,6%	
TSP	1A4bi	2C1	2A7a	1A1a	1A3bi	1A4cii	1A3bvi	1B1b	4B8	2A2	1A3bvi	1A3bii	1A2fi	4B1b	1A2fii	80,7%
	18,9%	17,7%	8,2%	4,8%	4,3%	3,6%	3,2%	3,2%	2,8%	2,8%	2,7%	2,6%	2,4%	1,9%	1,6%	
CO	1A2a	1A4bi	1A3bi	2C1												81,7%
	45,3%	12,7%	12,3%	11,5%												
Pb	2C1	2C5e	1A3bi													82,3%
	68,3%	10,4%	3,6%													
Cd	2C1	1A4bi	2C5e	1A1a	1B2aiv	1B1b										80,7%
	37,6%	14,8%	9,6%	6,8%	6,7%	5,1%										
Hg	1A1a	2C1	2A1	2B5a	1A4bi	1B2aiv										83,9%
	26,3%	18,4%	15,3%	9,4%	8,1%	6,5%										
As	2C1	2C5e	1A4bi	1A1a												81,8%
	45,8%	22,1%	7,6%	6,2%												
Cr	2C1	1A2fi	1A1a	1A3bvi	1A4bi											81,2%
	60,1%	8,7%	4,4%	4,1%	4,0%											
Cu	1A3bvi	2C1	1A3c	3D3												81,1%
	47,9%	14,3%	10,9%	7,9%												
Ni	1B2aiv	1A1b	2C1	1A1a	1A2c	1A2e	1A4ci									85,3%
	26,4%	22,2%	10,7%	8,3%	6,2%	5,8%	5,8%									
Se	1A2fi	2A7d	2C5e													85,9%
	70,6%	8,4%	6,9%													
Zn	2C1	2C5e	1A4bi	1A3bi												81,7%
	60,7%	11,2%	5,7%	4,0%												
PCDD/ PCDF	2C1	6Ce	1A4bi													85,8%
	32,4%	28,7%	24,6%													
PAH	1B1b	3D3	1A4bi	2C1												85,8%
	33,0%	26,6%	20,1%	6,1%												
HCB	3C	2A1	2C1													88,4%
	52,4%	18,1%	17,8%													
HCH	4G	3D3														100,0%
	79,8%	20,2%														
PCB	2C1															93,3%
	93,3%															

2005	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii	1A3bi	1A1a	1A4bi	1A2fi	2A1	1A2a	1A3bii	2B5a	1A4cii						81,2%
	25,1%	15,4%	12,2%	5,0%	5,0%	4,9%	4,7%	3,9%	2,8%	2,3%						
NMVOC	3A2	3D2	2B5a	1A4bi	3A1	1A3bi	1B2aiv	3C	3D1	1A3bv	3D3	1A4cii	1A3biii	1B2b	1B2av	80,7%
	11,6%	9,4%	9,1%	8,7%	7,3%	5,9%	5,0%	5,0%	4,6%	2,5%	2,5%	2,4%	2,3%	2,3%	2,3%	
SOx	1A1a	1A1b	1A4bi	1A2fi	1A2a	2B5a	1A4ci	2A1								80,4%
	20,4%	13,9%	13,3%	12,1%	8,5%	4,5%	3,9%	3,6%								
NH3	4B8	4B1b	4B1a	4D1a												80,0%
	31,5%	25,6%	16,8%	6,1%												
PM2,5	1A4bi	2C1	1A3bi	1A4cii	1A3biii	1A2fi	1A3bii	1A3bvi	2A7a	1A1a						80,0%
	36,0%	13,3%	7,5%	5,2%	5,1%	3,7%	2,7%	2,7%	2,1%	1,7%						
PM10	1A4bi	2C1	1A3bi	2A7a	1A4cii	1A3biii	1A3bvi	1A2fi	1A1a	1A3bvi	1A3bii	4B8	1B1b			80,4%
	29,1%	14,2%	5,9%	5,0%	4,4%	4,0%	4,0%	3,3%	2,6%	2,2%	2,1%	2,0%	1,7%			
TSP	1A4bi	2C1	2A7a	1A3bi	1A4cii	1A1a	1A3bvi	1B1b	4B8	1A3bvi	2A2	1A3bii	1A2fi	4B1b	1A2fii	81,7%
	21,0%	16,0%	8,9%	3,9%	3,9%	3,7%	3,5%	3,3%	3,0%	2,9%	2,8%	2,7%	2,5%	2,0%	1,7%	
CO	1A2a	1A4bi	1A3bi	2C1	2A2											83,4%
	43,5%	13,4%	11,3%	10,3%	4,8%											
Pb	2C1	2C5e	1A3bvi													82,6%
	66,3%	13,6%	2,8%													
Cd	2C1	1A4bi	2C5e	1B2aiv	1B1b	1A1a	1A2c									82,5%
	28,2%	17,7%	13,7%	7,8%	5,9%	5,6%	3,6%									
Hg	2C1	1A4bi	2B5a	2A1	1B2aiv	1A1a	2C5e									83,7%
	29,9%	11,6%	11,0%	9,6%	9,4%	7,8%	4,5%									
As	2C1	2C5e	1A1a	1A4bi	1A2fi											81,1%
	28,5%	27,1%	11,6%	9,3%	4,6%											
Cr	2C1	1A1a	1A3bvi	1A4bi	1B1b											81,3%
	62,4%	6,8%	4,5%	4,3%	3,4%											
Cu	1A3bvi	1A3c	2C1	3D3	2C5e											84,3%
	49,1%	11,2%	10,8%	8,1%	5,0%											
Ni	1A1b	1A1a	2C1	1A2c	1A4ci	1A2e	1B2aiv									81,4%
	23,4%	13,2%	13,1%	9,4%	8,9%	7,2%	6,2%									
Se	1A2fi															82,8%
	82,8%															
Zn	2C1	2C5e	1A4bi	1A3bi	1A3bvi	1A1a										81,9%
	41,5%	15,4%	8,9%	6,2%	6,0%	3,9%										
PCDD/ PCDF	6Ce	1A4bi	2C1													87,8%
	31,0%	29,3%	27,4%													
PAH	1B1b	3D3	1A4bi													81,4%
	32,2%	26,8%	22,5%													
HCB	2A1	3C	2C1													81,7%
	29,7%	29,5%	22,5%													
HCH	3D3															100,0%
	100,0%															
PCB	2C1															92,7%
	92,7%															

2006	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii 26,1%	1A3bi 16,0%	1A1a 10,6%	1A2fi 5,6%	1A4bi 5,0%	2A1 4,7%	1A2a 4,5%	1A3bii 4,0%	2B5a 2,9%	1A4cii 2,4%						81,8%
NMVOC	3A2 11,7%	3D2 9,8%	2B5a 9,7%	1A4bi 9,4%	3A1 6,7%	1A3bi 5,1%	3D1 5,0%	3C 4,9%	1B2aiv 4,0%	3D3 2,6%	1A3bv 2,5%	1A4cii 2,4%	1B2b 2,3%	1A3bii 2,3%	2D2 2,1%	80,6%
SOx	1A1a 18,7%	1A1b 16,3%	1A4bi 13,3%	1A2fi 12,9%	1A2a 7,4%	2B5a 4,3%	1A4ci 4,2%	2A1 3,6%								80,9%
NH3	4B8 31,5%	4B1b 25,5%	4B1a 16,4%	4D1a 6,6%	4D2c 3,9%											83,9%
PM2,5	1A4bi 38,0%	2C1 12,6%	1A3bi 7,2%	1A4cii 5,1%	1A3bii 4,8%	1A2fi 3,7%	1A3bvi 2,7%	1A3bii 2,6%	2A7a 2,1%	2A7d 1,7%						80,5%
PM10	1A4bi 31,1%	2C1 13,6%	1A3bi 5,7%	2A7a 4,9%	1A4cii 4,4%	1A3bvi 4,0%	1A3bii 3,8%	1A2fi 3,3%	1A3bvi 2,2%	1A3bii 2,0%	1A1a 2,0%	4B8 2,0%	1B1b 1,7%			80,5%
TSP	1A4bi 22,7%	2C1 15,4%	2A7a 8,8%	1A3bi 3,9%	1A4cii 3,8%	1A3bvi 3,6%	1B1b 3,3%	4B8 3,0%	1A3bvi 3,0%	2A2 2,9%	1A1a 2,7%	1A3bii 2,6%	1A2fi 2,6%	4B1b 2,0%		80,2%
CO	1A2a 37,9%	1A4bi 16,3%	1A3bi 10,9%	2C1 9,8%	2A2 5,1%	1A3biii 2,7%										82,7%
Pb	2C1 70,0%	2C5e 6,8%	1A3bvi 2,9%	2G 2,9%												82,6%
Cd	2C1 35,1%	1A4bi 17,0%	2C5e 8,4%	1B2aiv 7,5%	1B1b 5,8%	1A1a 5,0%	1A2c 3,4%									82,1%
Hg	2C1 28,6%	2B5a 12,6%	1A4bi 11,7%	1B2aiv 10,0%	2A1 9,9%	1A1a 5,3%	2C5e 5,0%									83,0%
As	2C5e 33,1%	2C1 30,3%	1A4bi 8,7%	1A1a 4,8%	1A2fi 3,9%											80,8%
Cr	2C1 67,8%	1A3bvi 4,1%	1A4bi 4,0%	2A1 3,3%	1A2a 3,3%											82,5%
Cu	1A3bvi 50,4%	1A3c 12,1%	2C1 11,7%	3D3 8,4%												82,6%
Ni	1A1b 20,1%	2C1 16,3%	1A1a 12,6%	1B2aiv 9,2%	1A4ci 8,8%	1A2c 8,4%	1A2e 5,2%									80,6%
Se	1A2fi 67,8%	2A7d 12,7%														80,6%
Zn	2C1 41,7%	2C5e 16,0%	1A4bi 9,6%	1A3bi 6,2%	1A3bvi 6,1%	1A1a 3,7%										83,3%
PCDD/ PCDF	1A4bi 32,7%	6Ce 30,9%	2C1 23,6%													87,2%
PAH	1B1b 33,7%	3D3 27,7%	1A4bi 22,8%													84,2%
HCB	3C 32,9%	2A1 28,1%	2C1 21,0%													81,9%
HCH	3D3 100,0%															100,0%
PCB	2C1 93,6%															93,6%

2007	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii	1A3bi	1A1a	1A2fi	2A1	1A4bi	1A2a	1A3bii	2B5a	1A4cii						81,7%
	25,7%	16,6%	9,8%	5,9%	5,1%	4,7%	4,3%	4,2%	3,0%	2,4%						
NMVOC	3A2	3D2	2B5a	1A4bi	3A1	3D1	3C	1A3bi	1B2aiv	1A4cii	1B2b	3D3	1A3bv	2D2	1A3bii	81,1%
	12,2%	10,7%	10,0%	9,9%	6,3%	5,3%	4,9%	4,6%	3,2%	2,6%	2,5%	2,4%	2,2%	2,2%	2,2%	
SOx	1A1b	1A1a	1A2fi	1A4bi	1A2a	2B5a	2A1	1A4ci								80,5%
	17,0%	14,7%	13,7%	13,0%	8,3%	5,7%	5,0%	3,1%								
NH3	4B8	4B1b	4B1a	4D1a												81,0%
	32,0%	25,6%	16,3%	7,1%												
PM2,5	1A4bi	2C1	1A3bi	1A4cii	1A3biii	1A2fi	1A3bvi	1A3bii	2A7a	2A7d						80,6%
	39,9%	10,1%	7,5%	5,1%	4,5%	3,9%	3,0%	2,6%	2,2%	1,8%						
PM10	1A4bi	2C1	1A3bi	2A7a	1A4cii	1A3bvi	1A3biii	1A2fi	1A3bvi	4B8	1A3bii	1A1a	1B1b			80,7%
	32,9%	10,6%	6,0%	5,2%	4,5%	4,4%	3,6%	3,5%	2,4%	2,1%	2,1%	1,7%	1,6%			
TSP	1A4bi	2C1	2A7a	1A3bi	1A4cii	1A3bvi	2A2	1A3bvi	4B8	1B1b	1A2fi	1A3bii	4B1b	1A2fii	1A1a	81,7%
	23,9%	12,4%	9,4%	4,1%	3,9%	3,9%	3,3%	3,3%	3,3%	3,1%	2,7%	2,5%	2,1%	1,9%	1,8%	
CO	1A2a	1A4bi	1A3bi	2C1	1A3biii											80,3%
	44,0%	16,0%	9,3%	8,4%	2,6%											
Pb	2C1	2C5e	1A2fi	2G	1A3bvi											83,3%
	63,8%	8,4%	4,3%	3,4%	3,4%											
Cd	2C1	1A4bi	2C5e	1B2aiv	1A1a	1B1b	1A2c									81,8%
	32,5%	17,4%	9,1%	8,1%	5,7%	5,5%	3,5%									
Hg	2C1	2A1	1A4bi	1B2aiv	2B5a											80,9%
	48,9%	11,5%	7,3%	6,8%	6,4%											
As	2C5e	2C1	1A4bi	1A2fi												81,5%
	36,0%	33,6%	6,3%	5,5%												
Cr	2C1	1A2a	1A3bvi													80,5%
	69,2%	7,4%	4,0%													
Cu	1A3bvi	1A3c	2C1	3D3												85,5%
	53,2%	12,4%	11,2%	8,7%												
Ni	1A1b	2C1	1B2aiv	1A2c	1A1a	1A2e	1A2fi	1A4ci								84,4%
	27,5%	18,3%	11,0%	6,0%	5,7%	5,7%	5,3%	4,9%								
Se	1A2fi	2A7d														84,3%
	73,0%	11,3%														
Zn	2C1	2C5e	1A4bi	1A3bvi	1A3bi											81,7%
	50,3%	10,3%	9,1%	6,1%	6,0%											
PCDD/PCDF	1A4bi	6Ce	2C1	1A2a												86,0%
	31,6%	28,5%	19,3%	6,6%												
PAH	1B1b	3D3	1A4bi	2C1												85,0%
	28,5%	26,7%	20,6%	9,1%												
HCB	2A1	3C	2C1	6Cb												92,0%
	29,5%	27,8%	21,4%	13,2%												
HCH	3D3															100,0%
	100,0%															
PCB	2C1															92,3%
	92,3%															

2008	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii	1A3bi	1A2fi	1A1a	1A4bi	2A1	1A2a	1A3bii	1A4cii							81,0%
	23,8%	18,5%	8,5%	7,8%	5,7%	4,8%	4,8%	4,4%	2,7%							
NMVOC	1A4bi	3A2	3D2	2B5a	3A1	3C	3D1	1A3bi	1B2aiv	1A4cii	1B2b	3D3	2D2	1A3bv	1B2av	81,6%
	11,8%	11,4%	11,3%	9,8%	6,3%	5,0%	4,4%	4,1%	3,4%	2,7%	2,5%	2,4%	2,4%	2,1%	1,8%	
SOx	1A2fi	1B2aiv	1A4bi	1A2a	1A1b	1A1a	2B5a	2A1								80,2%
	21,0%	10,8%	10,6%	10,4%	9,5%	8,2%	5,0%	4,6%								
NH3	4B8	4B1b	4B1a	4D1a												81,1%
	32,6%	25,8%	16,1%	6,6%												
PM2,5	1A4bi	2C1	1A3bi	1A4cii	1A2fi	1A3bii	1A3bvi	1A3bii								80,0%
	45,8%	10,7%	6,5%	5,0%	3,5%	3,4%	2,8%	2,3%								
PM10	1A4bi	2C1	2A7a	1A3bi	1A4cii	1A3bvi	1A2fi	1A3bii	1A3bvi	4B8	1A3bii					81,1%
	38,2%	11,4%	5,4%	5,2%	4,4%	4,2%	3,1%	2,7%	2,3%	2,1%	1,9%					
TSP	1A4bi	2C1	2A7a	1A4cii	1A3bvi	1A3bi	4B8	2A2	1A3bvi	1A2fi	4B1b	1A2fii	1B1b			80,5%
	28,0%	12,3%	10,6%	3,9%	3,8%	3,6%	3,3%	3,2%	3,2%	2,5%	2,1%	1,9%	1,9%			
CO	1A2a	1A4bi	2C1	1A3bi	1A2fi											80,4%
	38,1%	17,5%	9,2%	8,1%	7,5%											
Pb	2C1	2C5e	1A2fi													81,0%
	72,7%	4,8%	3,4%													
Cd	2C1	1A4bi	1A1a	2C5e	1B2aiv	1A2c	2A7d									82,2%
	33,7%	17,5%	9,5%	7,7%	7,4%	3,3%	3,2%									
Hg	2C1	2A1	1A4bi	1A1a	1B2aiv											80,2%
	50,0%	11,4%	6,7%	6,0%	6,0%											
As	2C1	2C5e	1A4bi	1A2fi	1A1a											84,0%
	44,7%	21,5%	8,0%	5,2%	4,6%											
Cr	2C1	1A1a	1A2a													80,2%
	69,1%	6,2%	4,8%													
Cu	1A3bvi	2C1	1A3c	3D3												85,9%
	50,6%	14,4%	12,2%	8,6%												
Ni	2C1	1A1b	1B2aiv	1A2fi	1A2c	1A2e	2B5a									81,6%
	21,2%	20,7%	15,8%	8,8%	5,7%	5,0%	4,4%									
Se	1A2fi	2A7d	1A4bi													86,0%
	60,1%	16,2%	9,7%													
Zn	2C1	2C5e	1A4bi	1A3bi	1A3bvi											82,1%
	47,5%	11,6%	10,7%	6,2%	6,1%											
PCDD/ PCDF	1A4bi	6Ce	1A2a	2C1												89,6%
	30,4%	21,5%	19,6%	18,1%												
PAH	3D3	1A4bi	1B1b	2C1												85,0%
	28,3%	26,3%	17,8%	12,6%												
HCB	2A1	3C	2C1	6Cb												91,4%
	29,2%	24,4%	23,6%	14,2%												
HCH	3D3															100,0%
	100,0%															
PCB	2C1															92,3%
	92,3%															

2009	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii	1A3bi	1A1a	1A2fi	1A4bi	1A3bii	2A1	1A4cii	1A2a							81,1%
	23,7%	21,0%	8,6%	7,4%	6,0%	4,8%	4,6%	3,1%	1,9%							
NMVOC	1A4bi	3D2	2B5a	3A2	3C	3A1	1A3bi	1B2aiv	3D1	1A4cii	1B2b	3D3	2D2	1A3bv	3B1	81,8%
	13,9%	12,6%	10,3%	8,8%	5,0%	4,8%	4,0%	3,7%	3,2%	2,8%	2,8%	2,8%	2,6%	2,4%	2,0%	
SOx	1A2fi	1B2aiv	1A4bi	1A1b	2A1	1A1a	1A2a	1B2c	2B5a							82,5%
	20,2%	17,2%	13,5%	8,3%	5,9%	5,8%	4,7%	4,0%	2,9%							
NH3	4B8	4B1b	4B1a	4D1a												81,6%
	32,3%	25,4%	16,0%	7,9%												
PM2,5	1A4bi	1A3bi	1A4cii	1A2fi	1A3bii	1A3bvi	2C1	1A3bii								80,3%
	53,8%	6,6%	5,6%	3,3%	3,1%	3,1%	2,5%	2,4%								
PM10	1A4bi	2A7a	1A3bi	1A4cii	1A3bvi	1A2fi	1A3bvi	1A3bii	2C1	4B8	1A3bii					81,3%
	45,5%	5,7%	5,5%	5,0%	4,7%	3,0%	2,6%	2,6%	2,5%	2,4%	1,9%					
TSP	1A4bi	2A7a	1A4cii	1A3bvi	4B8	1A3bi	1A3bvi	2C1	1A2fi	4B1b	1A2fii	4B9b	1A3biii			81,7%
	35,6%	10,9%	4,8%	4,5%	4,0%	4,0%	3,8%	3,0%	2,5%	2,5%	2,2%	2,0%	1,9%			
CO	1A4bi	1A2a	1A2fi	1A3bi	2C1	2A2	1A3biii									80,5%
	26,9%	16,9%	13,0%	11,1%	5,2%	4,4%	3,0%									
Pb	2C1	2C5e	1A3bvi	1A4bi	1A2fi	2G	1A1a									82,6%
	46,5%	9,7%	6,1%	6,0%	5,5%	4,9%	3,8%									
Cd	1A4bi	2C5e	2C1	1B2aiv	1A1a	1A2c	2A7d									81,5%
	23,2%	19,5%	14,9%	9,5%	6,7%	4,0%	3,5%									
Hg	2A1	1A4bi	2C1	1B2aiv	2B5a	1A1a										80,4%
	26,6%	13,0%	11,9%	11,5%	11,1%	6,4%										
As	2C5e	2C1	1A4bi	1A2fi	1A1a	1A2c										82,3%
	30,7%	19,0%	15,5%	7,0%	6,6%	3,5%										
Cr	2C1	1A1a	1A4bi	1A3bvi	1A2a	2A2										83,4%
	41,1%	11,2%	9,1%	7,6%	7,3%	7,1%										
Cu	1A3bvi	1A3c	3D3	2C1												84,8%
	57,1%	12,8%	9,9%	4,9%												
Ni	1B2aiv	2C1	1A2fi	1A1b	1A2c	1A2e	1A4ci	1A4bi	1A4ai							81,2%
	20,9%	15,5%	10,6%	7,4%	6,9%	5,7%	5,3%	5,3%	3,5%							
Se	1A2fi	2A7d	1A4bi													85,0%
	54,9%	15,8%	14,3%													
Zn	2C1	1A4bi	1A3bi	1A3bvi	2C5e	1A3biii										80,2%
	35,7%	16,8%	9,2%	8,9%	5,5%	4,1%										
PCDD/ PCDF	1A4bi	6Ce	2C1													85,5%
	46,1%	27,3%	12,1%													
PAH	1A4bi	3D3	1B1b													83,1%
	34,7%	34,5%	13,9%													
HCB	3C	2A1	6Cb													87,2%
	46,8%	30,5%	9,9%													
HCH	3D3															100,0%
	100,0%															
PCB	2C1	2A1														87,8%
	69,8%	18,0%														

2010	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3biii	1A3bi	1A2fi	1A1a	1A4bi	2A1	1A3bii	1A2a	1A4cii	1A2fii						81,7%
	22,9%	20,4%	7,5%	7,4%	6,2%	4,9%	4,5%	3,2%	2,9%	1,9%						
NMVOC	1A4bi	3D2	2B5a	3A2	3C	3A1	1A3bi	1B2aiv	1B2b	3D3	1A4cii	3D1	2D2	3B1	1A3bv	81,6%
	16,0%	12,5%	10,0%	8,6%	4,8%	4,3%	3,7%	3,4%	3,0%	2,8%	2,8%	2,7%	2,5%	2,3%	2,2%	
SOx	1A2fi	1A4bi	1B2aiv	1A2a	2A1	2B5a	1A1b	1A1a	1B2c							80,5%
	20,3%	14,2%	9,0%	8,5%	7,7%	6,2%	5,0%	4,9%	4,4%							
NH3	4B8	4B1b	4B1a	4D1a												80,9%
	32,2%	25,1%	15,7%	7,9%												
PM2,5	1A4bi	1A3bi	1A4cii	2C1	1A3bii	1A3bvi	1A2fi	2A7a								81,5%
	57,3%	5,4%	4,8%	3,8%	2,8%	2,8%	2,5%	2,1%								
PM10	1A4bi	2A7a	1A3bi	1A4cii	1A3bvi	2C1	1A2fi	1A3bvi	1A3bii	4B8						80,3%
	49,1%	5,0%	4,5%	4,3%	4,3%	3,8%	2,4%	2,3%	2,3%	2,2%						
TSP	1A4bi	2A7a	1A4cii	1A3bvi	2C1	4B8	1A3bvi	1A3bi	4B1b	1A2fii	1B1b	1A2fi				80,1%
	39,1%	9,4%	4,3%	4,2%	4,0%	3,8%	3,5%	3,3%	2,3%	2,2%	2,0%	2,0%				
CO	1A4bi	1A2a	1A3bi	1A2fi	2A2	2C1										80,5%
	26,6%	23,5%	8,5%	8,4%	6,9%	6,6%										
Pb	2C1	2C5e	2A2	1A3bvi	1A4bi	2G										80,8%
	53,6%	7,6%	5,5%	4,8%	4,8%	4,5%										
Cd	2C5e	1A4bi	2C1	1B2aiv	1A1a	1A2c	1B1b									82,4%
	21,5%	20,3%	20,1%	7,5%	6,4%	3,6%	3,0%									
Hg	2C1	1A4bi	1B2aiv	2A1	2B5a	1A1a	1A2c	2A2								81,8%
	22,3%	12,5%	11,5%	11,3%	9,9%	7,7%	3,9%	2,9%								
As	2C5e	2C1	1A4bi	1A1a	1A2fi	1A2a	1A2c									82,8%
	24,5%	23,9%	11,3%	9,6%	5,4%	4,1%	3,9%									
Cr	2C1	1A2a	1A4bi	1A3bvi	2C5e											81,0%
	49,9%	13,3%	7,1%	5,7%	5,1%											
Cu	1A3bvi	1A3c	3D3	2C1												82,9%
	54,3%	11,6%	9,4%	7,6%												
Ni	2C1	1B2aiv	1A2fi	1A2c	1A2a	1A2e	1A4ci	2B5a	1A4bi							81,4%
	24,2%	14,1%	9,4%	8,6%	6,8%	5,2%	4,5%	4,4%	4,3%							
Se	1A2fi	2A7d														81,6%
	69,1%	12,5%														
Zn	2C1	1A4bi	2C5e	1A3bi	1A3bvi	1A2a										80,3%
	35,6%	15,3%	11,5%	7,1%	7,0%	3,8%										
PCDD/ PCDF	1A4bi	6Ce	2C1													81,7%
	46,7%	22,7%	12,2%													
PAH	1A4bi	3D3	1B1b													83,6%
	32,8%	31,4%	19,4%													
HCB	3C	2A1	1A1a													82,0%
	44,5%	26,2%	11,2%													
HCH	3D3															100,0%
	100,0%															
PCB	2A1	2C1														98,0%
	73,7%	24,3%														

2011	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3bi	1A3bii	1A2fi	1A1a	2A1	1A4bi	1A3bii	1A2a	1A4cii	1A2fii						81,3%
	22,3%	22,1%	7,4%	6,3%	5,7%	5,2%	4,7%	2,8%	2,8%	2,0%						
NMVOC	3D2	1A4bi	2B5a	3A2	3C	3A1	1A3bi	1B2aiv	1B2b	1A4cii	2D2	1A3bv	3D1	3D3	3B1	80,8%
	13,9%	12,8%	9,8%	9,1%	5,6%	4,5%	3,4%	3,2%	3,1%	2,9%	2,9%	2,6%	2,6%	2,3%	2,2%	
SOx	1A2fi	1A4bi	1B2aiv	1A2a	2A1	2B5a	1A1b	1A1a	1B2c							80,1%
	17,6%	13,7%	10,3%	8,7%	8,7%	7,5%	5,1%	4,6%	3,9%							
NH3	4B8	4B1b	4B1a	4D1a												80,9%
	32,2%	25,0%	15,7%	8,0%												
PM2,5	1A4bi	1A3bi	1A4cii	2C1	1A3bvi	1A3bii	1A2fi	2A7a	1A2d	1A3bii						81,1%
	50,2%	5,5%	4,9%	3,8%	3,4%	3,0%	2,9%	2,6%	2,5%	2,2%						
PM10	1A4bi	2A7a	1A3bvi	1A3bi	1A4cii	2C1	1A3bvi	1A2fi	4B8	1A3bii	1A2d	1A3bii				80,0%
	41,8%	6,2%	5,1%	4,4%	4,4%	3,7%	2,8%	2,6%	2,6%	2,4%	2,1%	1,8%				
TSP	1A4bi	2A7a	1A3bvi	4B8	1A4cii	1A3bvi	2C1	1A3bi	4B1b	1A2fii	4B9b	1B1b	1A2fi	1A3biii		81,5%
	32,1%	11,8%	4,9%	4,3%	4,3%	4,0%	3,3%	3,2%	2,6%	2,6%	2,3%	2,2%	2,2%	1,7%		
CO	1A4bi	1A2a	1A3bi	1A2fi	2A2	2C1	1A3bii	1A4bii								81,8%
	24,1%	22,7%	9,0%	7,3%	6,3%	6,2%	3,2%	3,0%								
Pb	2C1	2C5e	1A3bvi	1A4bi	1A2a	1B2aiv	1A1a									82,9%
	50,8%	10,3%	6,5%	4,9%	3,8%	3,4%	3,2%									
Cd	2C5e	2C1	1A4bi	1B2aiv	1A1a	1A2c										80,5%
	26,1%	17,8%	17,0%	8,1%	7,5%	4,0%										
Hg	2C1	1A1a	2A1	1B2aiv	2B5a	1A4bi	1A2c									80,2%
	16,5%	13,9%	12,8%	11,7%	10,8%	10,6%	3,9%									
As	2C5e	2C1	1A4bi	1A1a	1A2c	1A2fi										80,6%
	28,4%	23,6%	10,8%	9,9%	4,8%	3,1%										
Cr	2C1	1A2a	1A1a	1A3bvi	1A4bi	2C5e										84,1%
	41,6%	18,0%	7,2%	6,6%	6,1%	4,5%										
Cu	1A3bvi	1A3c	3D3	2C1												84,5%
	55,9%	11,8%	9,7%	7,2%												
Ni	2C1	1A2c	1B2aiv	1A2a	2B5a	1A2e	1A2fi	1A4bi	1A1a							82,9%
	22,4%	18,1%	11,0%	8,8%	5,7%	5,1%	5,0%	3,8%	3,1%							
Se	2A7d	1A4bi	1A2fi	2A1	1A2c											81,8%
	35,9%	19,4%	9,8%	9,2%	7,6%											
Zn	2C1	2C5e	1A4bi	1A3bi	1A3bvi	1A1a	1A2a									83,9%
	32,7%	15,8%	12,0%	7,8%	7,6%	4,1%	3,9%									
PCDD/ PCDF	1A4bi	6Ce	2C1	1A2fi												88,7%
	39,2%	23,7%	16,5%	9,3%												
PAH	3D3	1A4bi	1B1b	1A4cii												82,7%
	33,1%	25,4%	19,1%	5,1%												
HCB	2C1	3C	2A1													85,2%
	44,7%	25,8%	14,8%													
HCH	3D3															100,0%
	100,0%															
PCB	2A1	2C1														97,5%
	78,0%	19,5%														

2012	Key source categories (sorted from high to low, from left to right)															Total
NOx	1A3bi	1A3bii	1A2fi	1A1a	1A4bi	2A1	1A3bii	1A4cii	1A2a	1A4ai						80,6%
	23,6%	20,4%	7,1%	5,9%	5,7%	5,4%	4,9%	3,0%	2,7%	2,0%						
NMVOC	1A4bi	3D2	2B5a	3A2	3C	3A1	1A3bi	1A4cii	1B2b	2D2	1B2aiv	3D1	3D3	1A3bv	3B1	81,5%
	15,9%	14,2%	9,9%	7,8%	5,1%	4,1%	3,4%	3,0%	3,0%	2,9%	2,8%	2,5%	2,5%	2,3%	2,1%	
SOx	1A4bi	1A2fi	1B2aiv	1A2a	2A1	2B5a	1A1a	1A1b	1B2c							80,6%
	15,8%	14,5%	11,8%	11,6%	8,0%	7,2%	5,0%	3,8%	3,0%							
NH3	4B8	4B1b	4B1a	4D1a												80,4%
	32,4%	24,6%	15,5%	7,8%												
PM2,5	1A4bi	1A4cii	1A3bi	1A3bvi	2C1	1A2d	2A7a	1A2fi	1A3biii							82,0%
	56,9%	4,7%	4,5%	3,1%	3,1%	2,6%	2,5%	2,4%	2,3%							
PM10	1A4bi	2A7a	1A3bvi	1A4cii	1A3bi	2C1	1A3bvi	4B8	1A2d	1A2fi	1A3biii					81,2%
	48,2%	5,9%	4,7%	4,2%	3,7%	3,1%	2,6%	2,5%	2,2%	2,2%	1,9%					
TSP	1A4bi	2A7a	1A3bvi	1A4cii	4B8	1A3bvi	1A3bi	2C1	1A2fii	4B1b	4B9b	1A2fi				80,2%
	37,0%	13,0%	4,5%	4,1%	4,1%	3,7%	2,7%	2,5%	2,3%	2,3%	2,2%	1,8%				
CO	1A4bi	1A2a	1A3bi	1A2fi	2C1	1A4bii	1A3biii									80,7%
	32,6%	20,9%	9,5%	6,0%	5,3%	3,3%	3,2%									
Pb	2C1	2C5e	1A3bvi	1A4bi	1A2a	1B2aiv										82,3%
	54,3%	8,8%	6,5%	5,8%	3,5%	3,4%										
Cd	2C5e	1A4bi	2C1	1B2aiv	1A1a	1A2c										80,2%
	28,4%	21,2%	10,6%	9,0%	6,9%	4,0%										
Hg	2A1	1B2aiv	2C1	1A4bi	2B5a	1A1a	1A2c	1A2fi								81,8%
	14,8%	13,8%	13,7%	12,7%	11,2%	7,1%	4,7%	3,8%								
As	2C5e	2C1	1A4bi	1A1a	1A2c	1A2fi										81,6%
	34,8%	16,3%	11,7%	10,8%	4,4%	3,6%										
Cr	2C1	1A2a	1A4bi	1A3bvi	1A1a											83,0%
	44,3%	18,2%	7,6%	7,1%	5,8%											
Cu	1A3bvi	1A3c	3D3													80,1%
	58,2%	11,9%	10,0%													
Ni	2C1	1A2a	1A2c	1A2fi	1A4bi	1B2aiv	1A1a	1A4ci	1A2e	2C5e	1A4ai					82,3%
	15,4%	13,6%	10,7%	7,3%	6,3%	6,2%	5,3%	5,2%	4,4%	4,2%	3,6%					
Se	2A7d	1A4bi	1A2fi	2A1	1A2c											82,9%
	32,6%	21,5%	11,5%	9,4%	7,8%											
Zn	2C5e	1A4bi	1A3bi	1A3bvi	2C1	1A1a	1A2a									82,9%
	32,0%	16,9%	8,9%	8,7%	7,6%	4,5%	4,3%									
PCDD/ PCDF	1A4bi	2C1	6Ce													81,9%
	41,9%	21,6%	18,4%													
PAH	3D3	1A4bi	1B1b													83,9%
	35,0%	32,2%	16,7%													
HCB	3C	2C1	2A1													82,9%
	34,4%	27,3%	21,2%													
HCH	3D3															100,0%
	100,0%															
PCB	2C1	2A1														84,9%
	46,7%	38,2%														

1.B Trend assessment

The following tables show the trend assessment for 2012 for all reported pollutants.

NOx	1990	2012	trend ass.	% contrib	cum. total
1 A 1 a Public electricity and heat production	60,84	11,45	0,055	28,5%	28,5%
1 A 3 b ii Road transport:Light duty vehicles	7,92	9,48	0,014	7,4%	36,0%
1 A 3 b i Road transport: Passenger cars	97,32	46,12	0,013	6,9%	42,9%
1 A 3 b iii Road transport:, Heavy duty vehicles	67,54	39,88	0,012	6,2%	49,0%
2 A 1 Cement production	14,71	10,52	0,008	3,9%	52,9%
1 A 4 b i Residential: Stationary plants	16,26	11,21	0,007	3,7%	56,7%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	14,92	5,20	0,007	3,7%	60,3%
1 A 4 c ii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	6,57	5,88	0,007	3,4%	63,7%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	22,03	13,94	0,006	3,3%	67,0%
1 A 3 d i (ii) International inland waterways	2,67	3,64	0,006	3,1%	70,2%
1 A 1 b Petroleum refining	7,32	1,81	0,005	2,8%	73,0%
1 A 4 a i Commercial / institutional: Stationary	3,50	3,86	0,005	2,8%	75,8%
1 A 3 d ii National navigation (Shipping)	3,86	3,75	0,005	2,4%	78,2%
2 C 1 Iron and steel production	4,04	0,45	0,004	2,3%	80,5%

NMVOC	1990	2012	trend ass.	% contrib	cum. total
1 A 3 b i Road transport: Passenger cars	57,62	3,50	0,062	23,0%	23,0%
1 A 4 b i Residential: Stationary plants	10,98	16,63	0,044	16,4%	39,4%
3 D 2 Domestic solvent use including fungicides	9,41	14,80	0,04	14,8%	54,2%
3 A 2 Industrial coating application	40,21	8,16	0,023	8,6%	62,8%
1 B 2 a iv Refining / storage	16,93	2,91	0,012	4,3%	67,1%
1 A 3 b v Road transport: Gasoline evaporation	15,30	2,39	0,011	4,2%	71,3%
2 D 2 Food and drink	2,16	3,04	0,008	2,9%	74,2%
1 B 2 a v Distribution of oil products	11,38	1,94	0,008	2,9%	77,1%
3 D 1 Printing	12,31	2,64	0,007	2,5%	79,6%
1 B 2 b Natural gas	3,91	3,08	0,006	2,1%	81,7%

SOx	1990	2012	trend ass.	% contrib	cum. total
1 A 1 a Public electricity and heat production	94,89	2,43	0,029	23,1%	23,1%
1 B 2 a iv Refining / storage	0,01	5,79	0,016	12,7%	35,8%
1 A 4 b i Residential: Stationary plants	27,16	7,75	0,011	8,9%	44,7%
1 A 1 b Petroleum refining	40,84	1,84	0,01	8,2%	52,9%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	15,73	5,65	0,01	7,7%	60,7%
2 A 1 Cement production	4,33	3,93	0,009	7,3%	68,0%
1 A 4 c i Agriculture/Forestry/Fishing: Stationary	28,34	1,04	0,008	6,2%	74,2%
1 B 2 c Venting and flaring	0,37	1,44	0,004	3,1%	77,3%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	61,92	7,09	0,004	2,9%	80,2%

NH3	1990	2012	trend ass.	% contrib	cum. total
4 B 8 Swine	50,95	22,12	0,054	30,8%	30,8%
4 B 1 b Cattle non-dairy	24,48	16,80	0,025	14,4%	45,2%
4 D 1 a Synthetic N-fertilizers	4,97	5,29	0,021	11,8%	57,0%
4 B 1 a Cattle dairy	21,54	10,60	0,012	7,2%	64,2%
4 B 9 b Broilers	1,41	2,08	0,011	6,1%	70,3%
1 A 4 b i Residential: Stationary plants	0,69	1,66	0,01	6,0%	76,3%
4 B 9 a Laying hens	4,54	1,59	0,008	4,6%	80,9%

PM2.5	2000	2012	trend ass.	% contrib	cum. total
1 A 4 b i Residential: Stationary plants	9,59	18,09	0,261	43,3%	43,3%
2 C 1 Iron and steel production	7,56	0,98	0,125	20,8%	64,1%
1 A 3 b i Road transport: Passenger cars	4,24	1,43	0,049	8,0%	72,1%
1 A 3 b iii Road transport:, Heavy duty vehicles	2,34	0,72	0,029	4,7%	76,8%
1 A 1 a Public electricity and heat production	1,26	0,30	0,018	2,9%	79,7%
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,17	0,83	0,017	2,9%	82,6%

PM10	2000	2012	trend ass.	% contrib	cum. total
1 A 4 b i Residential: Stationary plants	9,90	18,66	0,217	38,9%	38,9%
2 C 1 Iron and steel production	9,63	1,21	0,114	20,4%	59,3%
1 A 3 b i Road transport: Passenger cars	4,24	1,43	0,033	5,9%	65,2%
1 A 1 a Public electricity and heat production	2,53	0,32	0,03	5,4%	70,6%
1 A 3 b iii Road transport:, Heavy duty vehicles	2,34	0,72	0,02	3,5%	74,1%
2 A 1 Cement production	1,20	0,03	0,016	3,0%	77,0%
1 A 2 d Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	0,20	0,87	0,014	2,5%	79,5%
2 A 2 Lime production	0,96	0,03	0,013	2,4%	81,9%

TSP	2000	2012	trend ass.	% contrib	cum. total
1 A 4 b i Residential: Stationary plants	10,66	19,91	0,162	30,8%	30,8%
2 C 1 Iron and steel production	15,97	1,35	0,129	24,4%	55,3%
2 A 7 a Quarrying and mining of minerals other than coal	5,96	6,97	0,036	6,9%	62,2%
1 A 1 a Public electricity and heat production	4,03	0,35	0,032	6,1%	68,3%
1 A 3 b i Road transport: Passenger cars	4,24	1,43	0,02	3,8%	72,2%
2 A 2 Lime production	2,17	0,05	0,019	3,7%	75,9%
1 A 3 b iii Road transport:, Heavy duty vehicles	2,34	0,72	0,012	2,3%	78,2%
1 A 3 b vi Road transport: Automobile tyre and brake wear	2,22	2,42	0,011	2,1%	80,3%

CO	1990	2012	trend ass.	% contrib	cum. total
1 A 3 b i Road transport: Passenger cars	500,06	37,39	0,084	30,8%	30,8%
1 A 4 b i Residential: Stationary plants	130,66	127,81	0,067	24,7%	55,5%
2 C 1 Iron and steel production	269,12	20,64	0,045	16,5%	72,0%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	6,19	23,47	0,016	6,0%	78,0%
1 A 4 b ii Residential: Household and gardening (mobile)	13,68	12,91	0,007	2,5%	80,4%

Pb	1990	2012	trend ass.	% contrib	cum. total
2 C 1 Iron and steel production	47,38	17,46	0,046	29,0%	29,0%
1 A 3 b i Road transport: Passenger cars	82,00	0,21	0,046	28,7%	57,7%
1 A 1 a Public electricity and heat production	36,23	0,95	0,017	10,4%	68,1%
6 C c Municipal waste incineration (d)	15,89	0,00	0,009	5,7%	73,8%
1 A 3 b vi Road transport: Automobile tyre and brake wear	1,57	2,11	0,008	5,0%	78,8%
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	11,90	0,10	0,006	4,0%	82,7%

Cd	1990	2012	trend ass.	% contrib	cum. total
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	1,76	0,01	0,1	25,1%	25,1%
2 C 5 e Other metal production	0,41	0,70	0,084	21,0%	46,1%
1 A 4 b i Residential: Stationary plants	0,44	0,53	0,055	13,8%	59,9%
6 C c Municipal waste incineration (d)	0,81	0,00	0,046	11,6%	71,5%
1 A 1 a Public electricity and heat production	1,12	0,17	0,038	9,5%	81,1%

Hg	1990	2012	trend ass.	% contrib	cum. total
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages	2,24	0,02	0,026	17,9%	17,9%
1 A 1 a Public electricity and heat production	2,31	0,12	0,018	12,6%	30,5%
2 A 1 Cement production	0,33	0,25	0,017	12,0%	42,5%
2 C 1 Iron and steel production	0,28	0,23	0,016	11,4%	53,9%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	1,67	0,06	0,015	10,5%	64,4%
1 A 4 b i Residential: Stationary plants	0,36	0,21	0,014	9,7%	74,1%
6 C c Municipal waste incineration (d)	1,07	0,00	0,013	9,2%	83,2%

As	1990	2012	trend ass.	% contrib	cum. total
1 A 1 a Public electricity and heat production	2,03	0,21	0,056	26,2%	26,2%
2 C 5 e Other metal production	1,02	0,66	0,055	26,2%	52,4%
2 C 1 Iron and steel production	2,04	0,31	0,04	19,0%	71,4%
1 A 4 b i Residential: Stationary plants	0,41	0,22	0,016	7,6%	79,0%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,08	0,08	0,009	4,2%	83,2%

Cr	1990	2012	trend ass.	% contrib	cum. total
6 C c Municipal waste incineration (d)	9,56	0,00	0,093	38,6%	38,6%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	0,19	2,00	0,058	23,9%	62,5%
1 A 4 b i Residential: Stationary plants	0,75	0,83	0,018	7,2%	69,7%
1 A 3 b vi Road transport: Automobile tyre and brake wear	0,58	0,77	0,017	7,2%	77,0%
1 A 1 a Public electricity and heat production	2,89	0,64	0,009	3,8%	80,8%

Cu	1990	2012	trend ass.	% contrib	cum. total
1 A 3 b vi Road transport: Automobile tyre and brake wear	12,63	16,86	0,191	31,1%	31,1%
1 A 1 a Public electricity and heat production	5,55	0,44	0,097	15,8%	46,9%
2 C 1 Iron and steel production	7,01	1,55	0,097	15,7%	62,7%
1 A 3 c Railways	1,34	3,45	0,063	10,3%	73,0%
1 A 2 b Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	2,47	0,02	0,048	7,8%	80,8%

Ni	1990	2012	trend ass.	% contrib	cum. total
1 A 2 e Stationary combustion in manufacturing industries and construction: Food processing, beverages	15,11	0,28	0,012	17,5%	17,5%
1 A 2 a Stationary combustion in manufacturing industries and construction: Iron and steel	1,42	0,85	0,009	14,0%	31,5%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	17,18	0,67	0,009	13,2%	44,7%
6 C c Municipal waste incineration (d)	8,62	0,00	0,009	13,0%	57,7%
1 A 1 a Public electricity and heat production	8,49	0,33	0,004	6,5%	64,3%
1 A 4 b i Residential: Stationary plants	0,62	0,39	0,004	6,5%	70,8%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	9,55	0,45	0,004	5,8%	76,6%
2 C 1 Iron and steel production	8,50	0,96	0,004	5,4%	82,0%

Se	1990	2012	trend ass.	% contrib	cum. total
1 A 1 a Public electricity and heat production	2,70	0,09	0,208	51,8%	51,8%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	1,29	0,38	0,047	11,6%	63,4%
1 A 2 c Stationary combustion in manufacturing industries and construction: Chemicals	0,05	0,25	0,036	9,0%	72,5%
2 A 1 Cement production	0,16	0,31	0,036	9,0%	81,4%

Zn	1990	2012	trend ass.	% contrib	cum. total
2 C 5 e Other metal production	34,53	28,68	0,066	15,4%	15,4%
2 B 5 a Other chemical industry	33,88	0,42	0,058	13,5%	28,9%
1 A 4 b i Residential: Stationary plants	10,30	15,11	0,049	11,4%	40,3%
1 A 1 a Public electricity and heat production	33,97	4,03	0,042	9,8%	50,1%
6 C c Municipal waste incineration (d)	23,29	0,02	0,041	9,6%	59,6%
2 C 1 Iron and steel production	37,67	6,83	0,036	8,4%	68,1%
1 A 3 b vi Road transport: Automobile tyre and brake wear	5,53	7,83	0,025	5,8%	73,9%
1 A 2 f i Stationary combustion in manufacturing industries and construction: Other	17,56	1,82	0,023	5,3%	79,2%
1 A 3 b i Road transport: Passenger cars	7,14	7,97	0,023	5,3%	84,5%

PCDD/ PCDF	1990	2012	trend ass.	% contrib	cum. total
1 A 4 b i Residential: Stationary plants	19,74	21,67	0,036	29,0%	29,0%
1 A 1 a Public electricity and heat production	145,12	1,34	0,023	18,3%	47,3%
6 C c Municipal waste incineration (d)	92,66	0,00	0,016	12,9%	60,3%
6 C e Small scale waste burning	21,05	9,52	0,014	11,0%	71,3%
6 C b Industrial waste incineration (d)	78,49	0,24	0,013	10,6%	81,9%

PAHs Total 1-4	1990	2012	trend ass.	% contrib	cum. total
2 C 1 Iron and steel production	22,73	0,15	0,11	28,4%	28,4%
3 D 3 Other product use	11,04	12,06	0,09	23,1%	51,4%
1 B 1 b Fugitive emission from solid fuels: Solid fuel transformation	30,30	5,76	0,081	20,7%	72,1%
1 A 4 b i Residential: Stationary plants	13,44	11,10	0,066	17,1%	89,2%

HCB	1990	2012	trend ass.	% contrib	cum. total
6 C b Industrial waste incineration (d)	20,68	2,47	0,09	37,9%	37,9%
2 C 1 Iron and steel production	9,39	7,72	0,056	23,6%	61,5%
2 A 1 Cement production	8,67	6,00	0,035	14,8%	76,3%
1 A 1 a Public electricity and heat production	1,05	2,21	0,026	10,9%	87,2%

HCH	1990	2012	trend ass.	% contrib	cum. total
3 D 3 Other product use	162,18	177,32	0,009	100,0%	100,0%

PCBs	1990	2012	trend ass.	% contrib	cum. total
2 C 1 Iron and steel production	98,55	4,59	0,037	48,4%	48,4%
2 A 1 Cement production	3,26	3,75	0,031	41,1%	89,5%