Informative Inventory Report

about Belgium's air emissions submitted under the Convention on Long Range Transboundary Air Pollution CLRTAP

and National Emission Ceiling Directive NECD

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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 2022 (resubmission 15 March 2022) under the Convention on Long Range Transboundary Air Pollution (CLRTAP) of the United Nations Economic Commission for Europe (UNECE) and in the framework of the revised National Emission Ceilings Directive (NECD 2016/2284/EU).

This report follows the recommended structure for Informative Inventory Report (Annex II to the revised 2013 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 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 2014 (ECE/EB.AIR/125). For the reporting, the new NFR2019 templates provided by the EMEP Centre on Emission Inventories and Projections[1] were used. The submission of March 2022 contains emissions from 1990-2019 (recalculated) and 2020 (first reporting) as well as activity data. Emission projections for 2020, 2025 and 2030 have been reported on 15 March 2021. The 2022 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, PCB). Belgium reports also black carbon emissions.

Belgium reports road transport emissions based on fuels sold. However, the emissions based on fuels used will be used for compliance checking in accordance with the EMEP reporting guidance.

The improvement of the emission inventory and the IIR is a constant and progressive work. The tuning and information exchange between the regions is taken care of in the bosom of the CCIEP Working Group 'Emissions'. Additionally, 'routine' consultation moments take place concerning the practical harmonisation of emission calculations between the regions. The recommendations made by the TERT in the previous NECD reviews were carefully studied and implemented in the extent possible. The major recalculations and plans for improvement are summarized here. More details are in the sectoral chapters and Chapter 8. Table 0-1 resumes the recommendations of the TERT with the reference where to find more information in the IIR regarding the follow up. Table 0-2 summarizes per sector whether the condensable component of PM10 and PM2.5 is included or not, with reference to the emission factors used. This table is also reported as Annex 6.

Recalculations and new emission estimations are described in detail in the sector chapters.

Improvements are described in detail in the sector chapters.

[1] www.ceip.at

Table 0-1 Follow up on recommendations from the NECD Reviews and their status of implementation in the inventory submission of 2022.

Observation	Improvement made/planned	Reference in IIR
BE-1A4ciii-2021-0001	Implemented	3.5.2.5
BE-1A5a-2021-0001	Implemented	-
BE-2D3c-2021-0001	Will be implemented in next submission	
BE-5A-2021-0003	NE reported	6.1
BE-1A1a-2017-0003	Implemented	Table 3-4 Evolution of SO2 emissions from combustion of natural gas at power stations in Flanders.
BE-2C2-2017-0001	Not implemented following study	4.2.3.2
BE-2C3-2017-0001	Not implemented following study	4.2.3.3
BE-3B1a-2020-0001	Implemented	5.2.1
BE-3B1a-2021-0001	Implementation planned	
BE-3B1b-2020-0002	Implemented	5.2.1
BE-3B1b-2021-0001	Implementation planned	
BE-5C1bi-2021-0001	Implemented	6.2
BE-5-2020-0006	Implemented	6.4
BE-2C1-2021-0001	Will be implemented in next submission	
BE-LPS-GEN_2020-0002	To be updated on May 1st 2025 at the latest	
BE-LPS-GEN_2020-0004	To be updated on May 1st 2025 at the latest	
BE-LPS-GEN-2021-0002	To be updated on May 1st 2025 at the latest	
BE-LPS-GEN-2021-0003	To be updated on May 1st 2025 at the latest	
BE-LPS-B-1-2021-0001	No correction submitted yet	
BE-GRID-GEN-2020-0002	To be updated on May 1st 2025 at the latest	

Table 0-2 Information on filterable or total particulate matter emissions (also included in Annex 6).

LEGEND	*x = The condensable component is included/excluded* *p = The condensable component is partially included/excluded* *u = It is unknown if condensables are included/excluded*				
NFR	**Source/sector name**	**included**	**excluded**	**EF reference**	**Comments**
1A1a	Public electricity and heat production		x	IIR tables 3-2, 3-3, 3-5	
1A1b	Petroleum refining		x	emissions and measuring method via integrated environmental	

				reports	
1A1c	Manufacture of solid fuels and other energy industries		x	IIR table 3-19	
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		p	EMEP Guidebook 2019; IIR table 3-24	Walloon region: IPCC companies: filterable. Remainder en Flanders: unknown (from EMEP GB, except for renewable solid fuels where 'highest standards' are used
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		p	EMEP Guidebook 2019, IIR table 3-27 and table 3-21	Walloon region: IPCC companies: filterable. Remainder in Flanders: unknown (from EMEP GB, except for cokes, coals and renewable solid fuels where 'highest standards' are used)
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		p	EMEP Guidebook 2019, IIR table 3-27 and table 3-21	Walloon region: IPCC companies: filterable. Remainder in Flanders: unknown (from EMEP GB, except for cokes, coals and renewable solid fuels where 'highest standards' are used)
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print		p	EMEP Guidebook 2019, IIR table 3-27 and table 3-21	Walloon region: IPCC companies: filterable. Remainder in Flanders: unknown (from EMEP GB, except for cokes, coals and renewable solid fuels where 'highest standards' are used)
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco		p	EMEP Guidebook 2019, IIR table 3-27 and table 3-21	Walloon region: IPCC companies: filterable. Remainder en Flanders: unknown (from EMEP GB, except for cokes, coals and renewable solid fuels where 'highest standards' are used)
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		p	EMEP Guidebook 2019, IIR table 3-30 and table 3-21	Walloon region: IPCC companies: filterable. Remainder en Flanders: unknown (from EMEP GB, except for other fuels where 'highest standards' are used)

1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	x		based on emission factors of TREMOD model (2004)	
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)		p	EMEP Guidebook 2019, IIR table 3-34 and table 3-21	Walloon region: IPCC companies: filterable. Remainder en Flanders: unknown (from EMEP GB, except for cokes, coals and renewable solid fuels where 'highest standards' are used)
1A3ai(i)	International aviation LTO (civil)	x		PM non volatile + PM volatile-org + PM volatile-sul. (EUROCONTROL) IIR table 3-38, 3-39	
1A3aii(i)	Domestic aviation LTO (civil)	x		PM non volatile + PM volatile-org + PM volatile-sul. (EUROCONTROL) IIR table 3-38, 3-40	
1A3bi	Road transport: Passenger cars	x		EMEP Guidebook 2019	
1A3bii	Road transport: Light duty vehicles	x		EMEP Guidebook 2019	
1A3biii	Road transport: Heavy duty vehicles and buses	x		EMEP Guidebook 2019	
1A3biv	Road transport: Mopeds & motorcycles	x		EMEP Guidebook 2019	
1A3bv	Road transport: Gasoline evaporation	x		EMEP Guidebook 2019	
1A3c	Railways	u	u	IIR table 3-41 (exhaust), 3-43 (non-exhaust), 3-44	
1A3di(ii)	International inland waterways	u	u	Dutch EMS Protocol (Oonk 2003), IIR 3.4.2.4	
1A3dii	National navigation (shipping)	u	u	Oonk et al. (2003) till 2007, CCNR-standards from 2007 on; IIR table 3-45, 3-46	
1A3eii	Other (please specify in the IIR)	x		based on emission factors of TREMOD model (2004)	
1A4ai	Commercial/institutional: Stationary	p	p	IIR table 3-48, table 3-49 and Annex 3	
	wood	x			
	natural gas		x		
	gasoil	u	u		
	coal	u	u		
1A4aii	Commercial/institutional: Mobile				IE in 1A3eii

1A4bi	Residential: Stationary	p	p	IIR table 3-50, table 3-51 and Annex 3	
	wood	x			
	natural gas	u	u		
	gasoil		x		
	coal	u	u		
1A4bii	Residential: Household and gardening (mobile)	u	u		
1A4ci	Agriculture/Forestry/Fishing: Stationary	u	p	EMEP Guidebook 2019, Tier 2: dependent on technology and fuel filterable or unclear whether ef represent filterable or total	
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	u	u	based on emission factors of TREMOD model (2004) (IIR 3.5.2.4)	
1A4ciii	Agriculture/Forestry/Fishing: National fishing	u	u	Dutch EMS Protocol (Oonk 2003), IIR 3.5.2.5	
1A5b	Other, Mobile (including military, land based and recreational boats)	x		IIR table 3-55, ef partly based on emission factors of TREMOD model (2004), partly based on EMEP Guidebook 2019, partly based on Eurocontrol	
1B1b	Fugitive emission from solid fuels: Solid fuel transformation		x	IIR table 3-56	
2A1	Cement production		x	IIR table 4-1	
2A2	Lime production		x	IIR table 4-2	
2A3	Glass production		x	IIR table 4-3	
2A5a	Quarrying and mining of minerals other than coal		x	IIR table 4-4	
2A5b	Construction and demolition		x	IIR table 4-5	
2A5c	Storage, handling and transport of mineral products				IE in 2A6
2A6	Other mineral products (please specify in the IIR)	u	u	IIR 3.7.2.1; emissions are reported by the industrial companies via the integrated environmental reports	
2B6	Titanium dioxide production				IE in 2B10a
2B10a	Chemical industry: Other (please specify in the IIR)	u	u	IIR 4.2.2.3: Emissions reported by industries via environmental reporting obligations	

2B10b	Storage, handling and transport of chemical products (please specify in the IIR)				IE in 2B10a
2C1	Iron and steel production		x	IIR 4.2.3.1	
2C2	Ferroalloys production				IE in 2C7c
2C3	Aluminium production				IE in 2C7c
2C4	Magnesium production				IE in 2C7c
2C5	Lead production				IE in 2C7c
2C6	Zinc production				IE in 2C7c
2C7a	Copper production				IE in 2C7c
2C7b	Nickel production				IE in 2C7c
2C7c	Other metal production (please specify in the IIR)	u	u	IIR 4.2.3.5: Emissions reported by industries via environmental reporting obligations	
2C7d	Storage, handling and transport of metal products (please specify in the IIR)		x	IIR 4.2.3.6: Emissions reported by industries via environmental reporting obligations or by using default EF.	
2D3b	Road paving with asphalt	u	p	IIR 4.2.4.2: Emissions reported by industries via environmental reporting obligations + Tier1 EF Guidebook 2013 (table 3-1)	Wallonia : filterable
2G	Other product use (please specify in the IIR)	u	u	EMEP/EEA guidebook 2016 table 3-15 (tobacco use); table 3-14(fireworks)	
2H2	Food and beverages industry	u	u	IIR table 4-9: Study Schrooten & Van Rompaey (2002)	
2I	Wood processing				IE in 2L
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)	u	u	IIR 4.2.9: Emissions reported by industries via environmental reporting obligations	
5A	Biological treatment of waste - Solid waste disposal on land	u	u	IIR 6.1: EMEP/EEA Guidebook 2016 in Flanders (not found in Guidebook 2016); TIER 3 in Wallonia	
5C1a	Municipal waste incineration	u	p	Emissions reported by industries via environmental reporting obligations	
5C1bi	Industrial waste incineration	u	p	Emissions reported by industries via environmental	

				reporting obligations	
5C1bv	Cremation	u	u	EMEP/EEA Guidebook 2019, table 3-1	
5C2	Open burning of waste	u	u	EMEP/EEA Guidebook 2016	
5E	Other waste (please specify in IIR)	u	u	EMEP/EEA Guidebook 2019, table 3-2 to 3-6	

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), revised in 2014 (ECE/EB.AIR/125) for application in 2015 and subsequent years. The in 2019 revised Nomenclature For Reporting (NFR2019-v1) was used as template for the reporting. The submission of the Belgian emission inventory under CLRTAP and under the revised NECD contains emission and activity data of the years 1990-2018 (recalculated) and 2019 (new).

The Belgian inventory contains emission estimates for NO_x, SO_x, NMVOC, NH_3, CO, particulate matter (PM2,5, PM10, TSP, BC), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn), dioxins, PAH, HCB 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 Interministerial 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 Interministerial 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 (fig. 1.1).

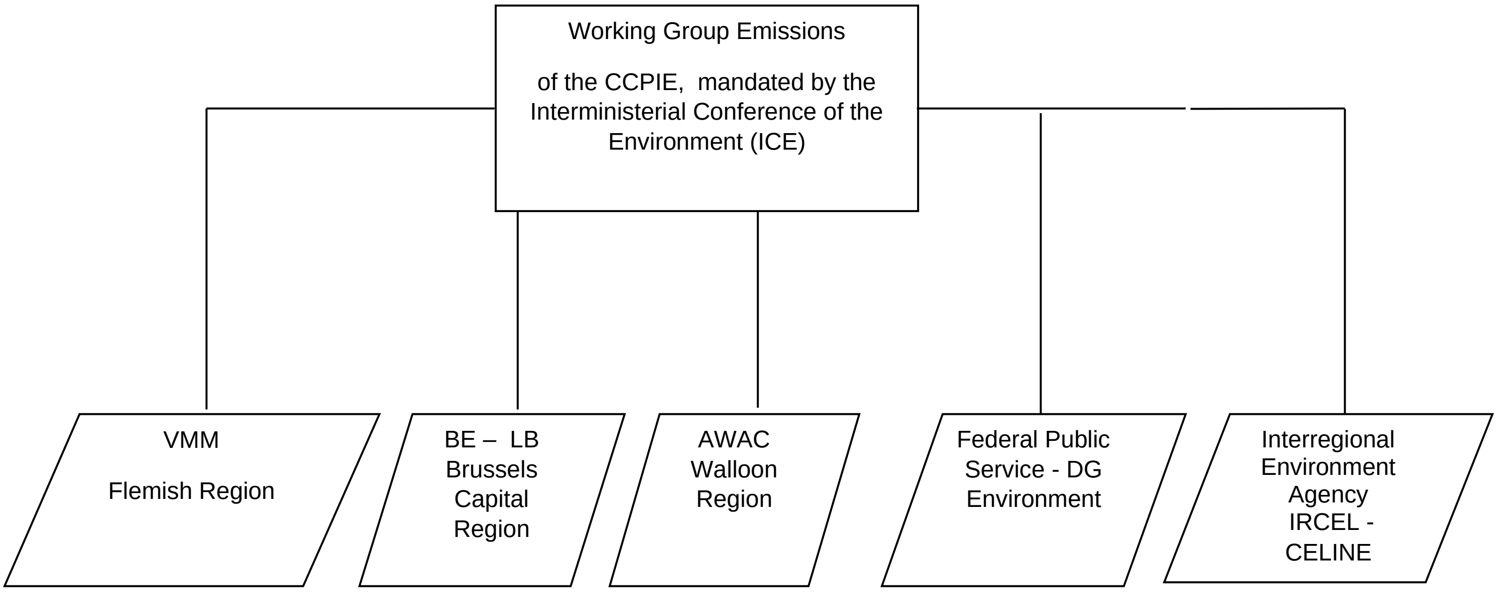


Figure 1-1 Overview of the entities responsible for the constitution and performance of the Belgian Inventory System

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 of the Flemish Environment Agency (VMM) in the Flemish Region (Flemish emissions and projections);
- The Walloon Agency for Air and Climate (AWAC) in the Walloon Region;
- Brussels Environment (BE- LB) in the Brussels Capital Region.

Each region has its own legal and institutional arrangements, which are detailed in the National Inventory System (NIS 2017).

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 February in NFR-tables to IRCEL-CELINE, the national inventory compiler. IRCEL-CELINE compiles the three regional inventories into the national one, in the right template by 10 February. 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 (upload to CDR with notification mail and officially sent to the EC) and to the UNECE secretariat (upload to CDR with notification mail to the UNECE secretariat) by 15 February. An overview of the inventory preparation process in Belgium is given in Figure 1-2.

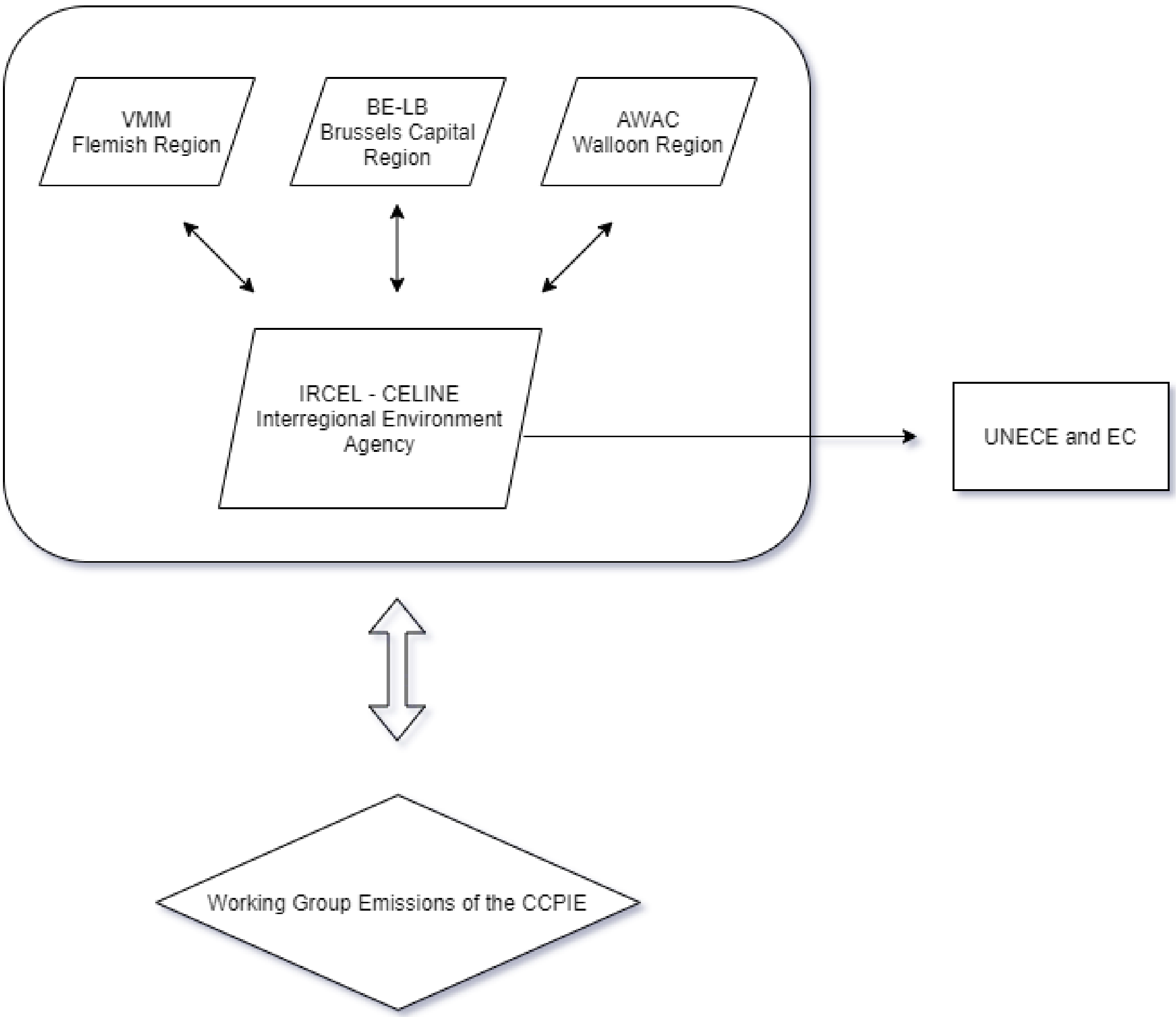


Figure 1-2 Overview of the inventory preparation process in Belgium

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 below 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 below). 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, the waste sector is described in Chapter 6.

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 by the EISSA-B model. A more detailed description of the methodologies used can be found in section 3.5.2. The methodologies that are used to calculate **transport** emissions are described in section 3.4. Emissions of road transport are calculated with a harmonized methodology between the 3 regions (based on COPERT). Air transport emissions are calculated by emission factors from the EMEP/EEA Guidebook or other internationally accepted emission factors; in Flanders a tool EMMOL was used to calculate aviation emissions. The emissions of railway traffic are estimated by a region specific approach. Flanders uses the EMMOSS model, whereas emissions in Wallonia and the Brussels Capital region 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 are calculated by the same mathematical model OFFREM (Off-road emission model) in the three regions. Emissions are calculated for machinery used in industry and building (category 1A2gvii), for machinery used in defence (category 1A5b), in harbours, airports and trans-shipment companies (category 1A3eii), in households (category 1A4bii) and in agriculture, forestry and green area (category 1A4cii). Exhaust emissions as well as non-exhaust emissions are calculated. Activity data as input for the model are 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 4.

The **agricultural sector** includes the emissions originating from animal manure, the use of synthetic N-fertilizer, N-excretion on pasture and from manure processing and emissions from agricultural soils. The methodologies that are used to calculate the emission data are given in detail in Chapter 5. 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 (category 1A4c) is included in Section 3.5.2. Stationary emissions (1A4ci) are calculated by multiplying the activity data (energy consumption data from the regional energy balances) of the sector with emission factors (e.g. from the EMEP/EEA Guidebook or region specific emission factors) by the EISSA-B model. Off-road emissions by the agricultural sector (1A4cii) are calculated by OFFREM.

Although NMVOC emissions of biogenic nature are not included in the national total, the methodology is written out in detail in chapter 8 due to the importance of the emissions in absolute figures.

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 and non-ferro 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).

The Brussels Capital region

The emission inventory in the Brussels-Capital region is compiled by Brussels Environment (BE-LB) 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 regional Energy Balance performed annually.

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).

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 2019 (see Chapter 2: 'Key category analysis and methodological choice') 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.

Table 1-2 to Table 1-6 show the results of the level assessment for 2020 for the main pollutants and PM2.5. For the results of the key source level assessment of all the pollutants, we refer to Annex 1A.

Table 1-2 Key source level assessment for NO_x, 2020

NOx **Source Code**	**Source Category**	**Gg NO_2**	**Level ass.**	**2020** **Cum.Total**
1A3bi	Road transport: Passenger cars	20.655	15.3%	15.3%
1A3bii	Road transport: Light duty vehicles	13.039	9.7%	25.0%
1A3biii	Road transport: Heavy duty vehicles and buses	12.088	9.0%	34.0%
1A1a	Public electricity and heat production	8.975	6.7%	40.6%
1A4bi	Residential: Stationary	8.536	6.3%	47.0%
2A1	Cement production	6.841	5.1%	52.0%
3Da1	Inorganic N-fertilizers (includes also urea application)	6.289	4.7%	56.7%
3Da2a	Animal manure applied to soils	5.707	4.2%	60.9%
2B10a	Chemical industry: Other (please specify in the IIR)	4.953	3.7%	64.6%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	3.898	2.9%	67.5%
1A3dii	National navigation (shipping)	3.585	2.7%	70.2%
2C1	Iron and steel production	3.455	2.6%	72.7%
1A4ai	Commercial/Institutional: Stationary	3.278	2.4%	75.2%

1A1b	Petroleum refining	3.231	2.4%	77.6%
1A4ci	Agriculture/Forestry/Fishing: Stationary	2.890	2.1%	79.7%
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	2.388	1.8%	81.5%

Table 1-3 Key source level assessment for NMVOC, 2020

NMVOC Source Code	Source Category	Gg NMVOC	Level ass.	2019 Cum.Total
2D3a	Domestic solvent use including fungicides	20.675	18.3%	18.3%
3B1b	Manure management - Non-dairy cattle	12.641	11.2%	29.5%
2D3d	Coating applications	8.666	7.7%	37.2%
3B1a	Manure management - Dairy cattle	8.456	7.5%	44.7%
1A4bi	Residential: Stationary	7.733	6.8%	51.5%
2B10a	Chemical industry: Other (please specify in the IIR)	7.242	6.4%	57.9%
2D3g	Chemical products	4.457	3.9%	61.9%
1A3bv	Road transport: Gasoline evaporation	3.954	3.5%	65.4%
3B4gii	Manure management - Broilers	3.757	3.3%	68.7%
2H2	Food and beverages industry	3.100	2.7%	71.4%
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	2.684	2.4%	73.8%
1A4ci	Agriculture/Forestry/Fishing: Stationary	2.390	2.1%	75.9%
2D3i	Other solvent use (please specify in the IIR)	2.052	1.8%	77.7%
3B4gi	Manure management - Laying hens	2.009	1.8%	79.5%
1A3bi	Road transport: Passenger cars	1.835	1.6%	81.1%

Table 1-4 Key source level assessment for SO_x, 2020

SOx Source Code	Source Category	Gg SO_2	Level ass.	2020 Cum.Total
1A1b	Petroleum refining	3.738	15.5%	15.5%
2C1	Iron and steel production	3.543	14.7%	30.2%
2A1	Cement production	2.511	10.4%	40.6%
2B10a	Chemical industry: Other (please specify in the IIR)	2.273	9.4%	50.0%

2A6	Other mineral products (please specify in the IIR)	2.256	9.4%	59.4%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	2.028	8.4%	67.8%
2C7c	Other metal production (please specify in the IIR)	1.612	6.7%	74.5%
1A4bi	Residential: Stationary	1.065	4.4%	78.9%
1A1a	Public electricity and heat production	0.999	4.1%	83.0%

Table 1-5 Key source level assessment for NH_3, 2020

NH3 Source Code	Source Category	Gg NH3	Level ass.	2020 Cum.Total
3B3	Manure management - Swine	13.302	19.6%	19.6%
3Da2a	Animal manure applied to soils	12.480	18.4%	37.9%
3B1b	Manure management - Non-dairy cattle	11.354	16.7%	54.6%
3Da3	Urine and dung deposited by grazing animals	6.981	10.3%	64.9%
3B1a	Manure management - Dairy cattle	6.580	9.7%	74.6%
3Da1	Inorganic N-fertilizers (includes also urea application)	5.486	8.1%	82.6%

Table 1-6 Key source level assessment for PM2.5, 2020

PM2.5 Source Code	Source Category	Gg PM10	Level ass.	2020 Cum.Total
1A4bi	Residential: Stationary	7.828	46.7%	46.7%
1A3bvi	Road transport: Automobile tyre and brake wear	1.009	6.0%	52.8%
5E	Other waste (please specify in the IIR)	0.893	5.3%	58.1%
2A5a	Quarrying and mining of minerals other than coal	0.697	4.2%	62.3%
1A3bvii	Road transport: Automobile road abrasion	0.521	3.1%	65.4%
2C1	Iron and steel production	0.492	2.9%	68.3%
2A6	Other mineral products (please specify in the IIR)	0.454	2.7%	71.0%
2G	Other product use (please specify in the IIR)	0.409	2.4%	73.5%
1A1a	Public electricity and heat production	0.351	2.1%	75.6%
1A3bi	Road transport: Passenger cars	0.343	2.1%	77.6%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	0.281	1.7%	79.3%

1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	0.231	1.4%	80.7%

Table 1-7 gives an overview of the key source level assessment for 2020.

Table 1-7 Key source analysis (level assessment) for 2020

2020	Key source categories (sorted from high to low, from left to right)															
NOx (as NO2) Cum.: 81.5%	1A3bi 15.3%	1A3bii 9.7%	1A3biii 9.0%	1A1a 6.7%	1A4bi 6.3%	2A1 5.1%	3Da1 4.7%	3Da2a 4.2%	2B10a 3.7%	1A4cii 2.9%	1A3dii 2.7%	2C1 2.6%	1A4ai 2.4%	1A1b 2.4%	1A4ci 2.1%	1A2e 1.8%
NMVOC Cum.: 81.1%	2D3a 18.3%	3B1b 11.2%	2D3d 7.7%	3B1a 7.5%	1A4bi 6.8%	2B10a 6.4%	2D3g 3.9%	1A3bv 3.5%	3B4gii 3.3%	2H2 2.7%	1B2b 2.4%	1A4ci 2.1%	2D3i 1.8%	3B4gi 1.8%	1A3bi 1.6%	
SOx (as SO2) Cum.: 83%	1A1b 15.5%	2C1 14.7%	2A1 10.4%	2B10a 9.4%	2A6 9.4%	1B2c 8.4%	2C7c 6.7%	1A4bi 4.4%	1A1a 4.1%							
NH3 Cum.: 82.6%	3B3 19.6%	3Da2a 18.4%	3B1b 16.7%	3Da3 10.3%	3B1a 9.7%	3Da1 8.1%										
PM2.5 Cum.: 80.7%	1A4bi 46.7%	1A3bvi 6.0%	5E 5.3%	2A5a 4.2%	1A3bvii 3.1%	2C1 2.9%	2A6 2.7%	2G 2.4%	1A1a 2.1%	1A3bi 2.1%	1A2gviii 1.7%	1A4cii 1.4%				
PM10 Cum.: 80.1%	1A4bi 31.4%	2A5a 8.8%	1A3bvi 7.1%	2A5b 5.6%	3Dc 4.8%	1A3bvii 3.8%	5E 3.5%	3B4gii 2.7%	2C1 2.6%	3B3 2.3%	2L 2.0%	3B4gi 1.9%	2A6 1.8%	2G 1.7%		
TSP Cum.: 81.4%	1A4bi 19.1%	2A5b 10.8%	2A5a 10.1%	3B3 9.0%	1A3bvi 5.6%	3B4gi 5.2%	2L 4.7%	1A3bvii 4.4%	3B4gii 3.2%	1A2gvii 2.8%	3Dc 2.8%	5E 2.0%	2C1 1.8%			
BC Cum.: 81.6%	1A4bi 46.6%	1A3bi 12.0%	1A3bii 6.3%	1A3bvi 5.2%	1A4cii 5.0%	1A2gvii 3.6%	1A3biii 2.9%									
CO	2C1	1A4bi	1A3bi	1A4bii	2A1	1A4cii										

Cum.: 80.7%	39.0%	21.0%	9.2%	6.5%	2.7%	2.3%										
Pb	2C7c	2C1	1A3bvi	1A4bi	2G	2A1	1A2d	1A1a								
Cum.: 82.2%	22.8%	21.2%	18.7%	5.7%	5.3%	2.9%	2.9%	2.8%								
Cd	1A4bi	2G	1A1a	1A2d	2C1	2C7c	1A2c	1A2gviii								
Cum.: 82.2%	27.4%	12.9%	12.6%	7.1%	6.9%	5.5%	5.1%	4.8%								
Hg	2A1	1A1a	2C1	2C7c	1A2c	1A4bi	5C1bi	2A3	1B2aiv							
Cum.: 81.2%	25.2%	17.7%	9.0%	8.9%	6.1%	5.9%	3.0%	2.8%	2.5%							
As	2C7c	1A1a	1A2c	1A4ai	2C1	2A3	1A3bvi	1A2d								
Cum.: 82.4%	29.0%	21.8%	12.0%	6.1%	4.3%	3.2%	3.0%	3.0%								
Cr	2C1	1A3bvi	1A4bi	2A1	1A1a	2G	1A2a	1A2d								
Cum.: 80.5%	20.4%	17.7%	11.4%	11.1%	6.3%	5.8%	4.6%	3.3%								
Cu	1A3bvi	2G	1A3c													
Cum.: 87.3%	49.1%	29.3%	8.8%													
Ni	2G	2C1	1B2aiv	1A1a	1A2c	2A1	1A2f	1A4ai	2C7c	1A3bvi	1A2b					
Cum.: 80.1%	14.5%	10.5%	9.5%	9.0%	8.4%	6.8%	5.6%	4.8%	4.3%	4.0%	2.6%					
Se	1A1a	2A3	1A2c	2A1												
Cum.: 82.6%	33.2%	29.8%	11.4%	8.2%												
Zn	2C7c	1A4bi	1A3bvi	2G	1A2d	2C1	1A1a									
Cum.: 83.6%	22.1%	20.6%	14.5%	11.2%	6.2%	4.5%	4.4%									
PCDD/ PCDF (dioxins/ furans)	5E	1A4bi	2C1	1A1a												

Cum.: 86.5%	31.6%	25.4%	21.1%	8.4%												
benzo(a) pyrene Cum.: 82.3%	1A4bi 76.7%	1A4ci 5.6%														
benzo(b) fluoranthene Cum.: 82.2%	1A4bi 70.5%	1A4ci 6.1%	1A4ai 5.6%													
benzo(k) fluoranthene Cum.: 84.9%	1A4bi 62.7%	1A4ai 8.4%	1A4ci 7.1%	1A3bi 6.7%												
Indeno (1,2,3-cd) pyrene Cum.: 84.7%	1A4bi 77.9%	1A3bi 6.8%														
PAHs Cum.: 83.9%	1A4bi 72.6%	1A4ci 5.7%	1A4ai 5.6%													
HCB Cum.: 89.7%	5C1bi 43.5%	2C1 24.2%	1A1a 22.0%													
PCBs Cum.: 88.8%	2K 57.6%	2A1 20.9%	2C1 10.3%													

1.5.2. Trend assessment

The trend assessment is a quantitative analysis of the change in emission of each category compared to the change in total national emissions (EMEP GB2019, Chapter 2, equation 2). 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.

Table 1-8 to Table 1-12 show the key source trend analyses for the main pollutants and PM2.5 (base year – 2019). The results for all pollutants are presented in Annex 1B.

Table 1-8 Key source trend assessment for NO_x

NOx (as NO2)	NFR Category	1990	2020	trend Ass.	contrib	cum.total
1A3bi	Road transport: Passenger cars	118.81	20.66	0.340	33%	33%
1A3biii	Road transport: Heavy duty vehicles and buses	73.79	12.09	0.214	21%	54%
1A1a	Public electricity and heat production	60.03	8.98	0.177	17%	71%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	15.64	1.16	0.050	5%	75%
2A1	Cement production	14.72	6.84	0.027	3%	78%
1A4bi	Residential: Stationary	15.29	8.54	0.023	2%	80%

Table 1-9 Key source trend assessment for NMVOC

NMVOC	NFR Category	1990	2020	trend Ass.	contrib	cum.total
1A3bi	Road transport: Passenger cars	78.57	1.83	0.320	28%	28%
2D3d	Coating applications	49.26	8.67	0.169	15%	43%
2B10a	Chemical industry: Other (please specify in the IIR)	29.56	7.24	0.093	8%	52%
1B2aiv	Fugitive emissions oil: Refining and storage	16.93	1.74	0.063	6%	57%
2D3h	Printing	14.50	1.69	0.053	5%	62%
2D3a	Domestic solvent use including fungicides	9.56	20.67	0.046	4%	66%
1A3bv	Road transport: Gasoline evaporation	15.00	3.95	0.046	4%	70%
1B2av	Distribution of oil products	11.14	0.88	0.043	4%	74%

2D3g	Chemical products	13.55	4.46	0.038	3%	77%
1A4bi	Residential: Stationary	14.36	7.73	0.028	2%	80%
3B1b	Manure management - Non-dairy cattle	18.73	12.64	0.025	2%	82%

Table 1-10 Key source trend assessment for SO_x

SOx (as SO2)	NFR Category	1990	2020	trend Ass.	contrib	cum.total
1A1a	Public electricity and heat production	94.08	1.00	0.273	28%	28%
1A1b	Petroleum refining	40.90	3.74	0.109	11%	39%
1A4bi	Residential: Stationary	31.22	1.06	0.089	9%	48%
1A4ci	Agriculture/Forestry/Fishing: Stationary	28.30	0.49	0.082	8%	56%
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	18.17	0.34	0.052	5%	61%
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	16.03	0.11	0.047	5%	66%
2B10a	Chemical industry: Other (please specify in the IIR)	17.39	2.27	0.044	5%	71%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	12.76	0.08	0.037	4%	75%
2A3	Glass production	11.97	0.94	0.032	3%	78%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	8.87	0.44	0.025	3%	80%

Table 1-11 Key source trend assessment for NH_3

NH3	NFR Category	1990	2020	trend Ass.	contrib	cum.total
3Da2a	Animal manure applied to soils	67.78	12.48	0.87	73%	73%
3B3	Manure management - Swine	18.54	13.3	0.082	7%	79%
3B1a	Manure management - Dairy cattle	10.37	6.58	0.06	5%	84%

Table 1-12 Key source trend assessment for PM2.5

PM2.5	NFR Category	2000	2020	trend Ass.	contrib	cum.total
2C1	Iron and steel production	6.26	0.49	0.248	25%	25%

1A3bi	Road transport: Passenger cars	4.24	0.34	0.168	17%	42%
1A4bi	Residential: Stationary	11.28	7.83	0.149	15%	57%
1A3biii	Road transport: Heavy duty vehicles and buses	2.38	0.09	0.099	10%	67%
1A3bii	Road transport: Light duty vehicles	1.56	0.17	0.060	6%	73%
1A1a	Public electricity and heat production	1.25	0.35	0.039	4%	77%
1A1b	Petroleum refining	0.56	0.02	0.023	2%	79%
2A6	Other mineral products (please specify in the IIR)	0.95	0.45	0.021	2%	81%

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 2019 based on level (L1) or trend (T1) assessment

2020	NOx (as NO2)	NMVOC	SOx (as SO2)	NH3	PM2.5	PM10	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF (dioxins/ furans)	PAHs	HCB	PCBs	#
1A1a	L1, T1		L1, T1		L1, T1	T1	T1			L1, T1	L1, T1	L1, T1	L1, T1	L1	T1	L1, T1	L1, T1	L1, T1	L1, T1		L1, T1		16
1A1b	L1		L1, T1		T1	T1																	4
1A2a	T1		T1						T1					L1									4
1A2b																L1							1
1A2c			T1								L1	L1	L1			L1, T1	L1						6
1A2d										L1	L1		L1	L1				L1					5
1A2e	L1		T1													T1							3
1A2f																L1							1
1A2gvii							L1	L1															2
1A2gviii			T1		L1						L1					T1							4
1A3bi	L1, T1	L1, T1			L1, T1	T1	T1	L1, T1	L1, T1	T1													8
1A3bii	L1				T1	T1	T1	L1, T1															5
1A3biii	L1, T1				T1	T1	T1	L1, T1															5
1A3bv		L1, T1																					1
1A3bvi					L1	L1	L1	L1		L1			L1	L1	L1, T1	L1		L1					10
1A3bvii					L1	L1	L1																3
1A3c															L1								1
1A3dii	L1																						1
1A4ai	L1												L1			L1				L1			4
1A4bi	L1, T1	L1, T1	L1, T1		L1, T1	L1, T1	L1, T1	L1	L1	L1	L1	L1		L1				L1	L1	L1, T1			15
1A4bii									L1														1
1A4ci	L1	L1	T1																	L1			4
1A4cii	L1				L1			L1	L1														4
1B2aiv		T1										L1				L1							3
1B2av		T1																					1
1B2b		L1																					1
1B2c			L1																				1
2A1	L1, T1		L1			T1	T1		L1	L1		L1		L1		L1	L1				T1	L1	12
2A2						T1	T1										T1						3
2A3			T1									L1	L1				L1, T1						4
2A5a					L1	L1	L1																3
2A5b						L1	L1																2
2A6			L1		L1, T1	L1																	3
2B10a	L1	L1, T1	L1, T1									T1											4
2C1	L1		L1		L1, T1	L1, T1	L1, T1		L1, T1	L1, T1	L1	L1	L1, T1	L1, T1	T1	L1, T1		L1, T1	L1, T1	T1	L1, T1	L1, T1	18
2C7c			L1							L1, T1	L1, T1	L1	L1, T1		T1	L1		L1, T1					8
2D3a		L1, T1																					1
2D3d		L1, T1																					1
2D3g		L1, T1																					1
2D3h		T1																					1
2D3i		L1																					1
2G					L1	L1				L1	L1			L1	L1	L1		L1					8
2H2		L1																					1
2K																						L1	1
2L						L1	L1, T1																2
3B1a		L1		L1, T1																			2
3B1b		L1, T1		L1																			2
3B3				L1, T1		L1	L1																3
3B4gi		L1				L1	L1																3
3B4gii		L1				L1	L1																3
3Da1	L1			L1																			2
3Da2a	L1			L1, T1																			2
3Da3				L1																			1
3Dc						L1	L1																2
5C1a											T1	T1		T1	T1	T1		T1	T1				7
5C1bi												L1									L1		2
5E					L1	L1	L1												L1				4
#	17	18	15	6	15	21	19	7	7	9	9	11	8	9	7	14	5	8	5	4	4	3	

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 per pollutant over the period 1990-2020 will be discussed in Chapter 2.

By comparing the key sources (level assessment) between 1990 and 2020 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:* Emissions of NO_x, SO_x, particulate matter and (heavy) metals decreased 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. Therefore, the relative contribution of this sector to the national total has decreased since 1990 for all pollutants, except for HCB for which 1A1a is the main key sector.
- *1A2a Iron and steel:* disappears as key source for NOx, SOx and CO. Lower SOx emissions due to lower S-content in the fuels, slightly lower NOx and CO content due to the installation of scrubbers in the nineties. It is a key source in 2019 for Cr due to a part of process emissions allocated in the combustion sector.
- *1A2c Chemicals:* is a key source in 2019 for Cd, Hg, As, Ni and Se. Relative changes in the key sources for heavy metals can be attributed to an optimised methodology that is applied from 2000 on in Flanders.
- *1A2d Pulp, paper and print:* is as a key source for some heavy metals in 2019 due to the increased use of renewable fuels (mainly wood waste)
- *1A2e Food processing, beverages and tobacco:* is no longer a key source for SOx and Ni. The proportion of the Ni emissions from this sector to the national total decreased strongly. The reduction of Ni emissions is due to the reduction of the residual oil as fuel.
- *1A3bi Road transport (Passenger cars):* Is not a key sector anymore for Pb and has a very much lower relative importance for NMVOC, CO and particulate matter in 2019 compared to 1990 (2000) 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. It remains the largest source of NOx emissions.
- *1A3bii Road transport: Light duty vehicles:* the relative share of the light duty vehicle emissions has become more important due to the strong increase of this type of vehicles.
- *1A3bv Gasoline evaporation:* The relative importance for NMVOC decreases due to the decrease of gasoline use between 1990 and 2019.
- *1A3bvi Automobile tyre and brake wear:* this is the most important key source for Cu emissions. The sector is as a key source for heavy metals and particulate matter. This is due to the increase in mobility and for the heavy metals due to the optimised methodology to estimate heavy metals from the year 2000 on in Flanders.
- *1A3bvii Automobile road abrasion:* The relative importance of the sector increases slightly for particulate matter. This is due to the increase in mobility and so the increase in road distance travelled.
- *1A4ai Commercial/Institutional: Stationary:* This is key source for As, Ni, NOx and PAHs in 2019. The relative importance of this sector for PAH's increases due to large emission reductions in the Iron and steel production sector and the discontinuation of 1B1b.
- *1A4bi Residential:* Stationary plants: The relative importance of this sector for NOx, NMVOC, CO, PAH's and particulate matter increases in 2019 compared to 1990 (2000). 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 the most important key source for particulate matter, dioxins and PAH's due to the high contribution of wood for residential heating. It becomes also a key source for heavy metals. Since the absolute heavy metal emissions remain rather stable, this is mainly due to emission changes in other sectors.

- *1A4ci Agriculture/Forestry/Fishing: Stationary:* is no longer a key source for SO_x due to the decreasing emissions in the greenhouse culture (more natural gas and less heavy fuel).
- *1B1b Solid fuel transformation:* this source does not exist anymore. The activities of the Brussels and Flemish coke ovens have been terminated respectively in 1993 and 1996. The last coke oven in Wallonia was taken out of service in 2014.
- *1B2aiv Refining/storage:* appears as a key source for Ni in 2019 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 Vl*arem 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:* is no longer a key source for NMVOC due to the obliged vapour recycling during the refuelling of petrol stations and during tanking (the so-called Stage I and Stage II measures)
- *2A1 Cement production:* is no longer a key source for PM10 and TSP. A significant emission reduction was obtained due to new dust purification systems of some plants in 2008, 2010 and 2012. The sector is key source for NOx, $SO_{x,}$ Hg, Cr, Ni, PCB and HCB in 2019. It becomes the second most important source for PCB and HCB emissions in 2019 due to the large decrease of PCB emissions in the iron and steel sector. The absolute SO_2 and Hg emissions decrease little between 1990 and 2018 while emissions of other sectors have decreased stronger.
- *2A3 Glass production:* this sector is an important source of Se emissions.
- *2A5a Quarrying and mining of minerals other than coal:* Particulate matter emissions remain stable throughout the time series. As a consequence of reductions in other sectors, the relative importance of this sector increases in 2019 compared to 2000.
- *2A6 Other Mineral products:* appears as key source for SO_x in 2019 compared to 1990. The relative contribution for particulate matter in 2019 slightly decreases 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.
- *2C1 Iron and steel production:* disappears as a key sector for BC, Cu, Zn, PAH, PCB and HCB in 2019 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. These were emission sources of PAH and HCB. 2C1 appears as a key sector for Hg and NOx and remains an important (key) source for most metals, SOx, CO and dioxins. This sector remains an important sector in Belgium.
- *2C7c Other metal production:* disappears as key source for Cu and dioxins due to changes in other sectors. It is key sector for As, Hg, Cd, Ni, Pb, Zn and SOx.
- *2D3a Domestic solvent use including fungicides:* is the most important sector for NMVOC in 2019. Because emissions are largely depending on the population, the absolute emissions of NMVOC have increased.

- *2G Other product use:* becomes a key source for several heavy metals and also the relative share for Cu increases. This is due to the use of lubricants in the transport sector.*2H2 Food and beverages industry:* appears as a key source for NMVOC. This can be attributed to emission changes in the other sectors.
- *2K Consumption of POPs and heavy metals:* this is the most important source for PCB in 2019.

- *3B1b Manure management Dairy Cattle:* this is an important key sector for NMVOC because absolute emissions from the chemical and coating sector decreased strongly since 1990.
- *3B3 Manure management Swine:* is the most important key source for NH_3 emissions.
- *3Da2a Animal manure applied to soils*: Emissions of animal manure applied to soils decreased in 2019 compared to 1990, but this sector is the second most important key sector for NH3 emissions.
- *3Da3 Urine and dung deposited by grazing animals*: appears as a key source for NH3.
- *5C1a Municipal waste incineration:* In 1994, this sector has undergone a (structural) reorganisation, 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.
- 5E Other waste: This is key sector in 2019 for dioxins due to the emissions of building and car fires. It becomes the second most important key source for dioxins because of the large decrease in emissions in the energy and cement production sector.

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 1.15).
The emissions of the categories that are IE (included elsewhere) are explained in Table 1-16.

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), 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 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 (http://www.ceip.at/) 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. In 2014, a study for calculating uncertainty values related to the emissions reported for NEC and LRTAP is conducted in the three Belgian regions by an independent consultant. Uncertainty analysis was done for the emission levels in 2010 and for the 1990-2010 trend in emissions on Tier 1 and Tier 2 level for the pollutants covered in the NEC directive, for the key sectors. Uncertainty for the other LRTAP pollutants was done on Tier 1 level for the key sectors. The results are available in the technical report 'Uncertainty Analysis of Emission Inventories of NEC/LRTAP Air Pollutants'. The methodology used in this report was the basis for the uncertainty analysis of 2019.

To assess the uncertainty in the air pollutant emission inventory, the methodology provided in the *EMEP/EEA emission inventory Guidebook (2013)* and the *IPCC Guidelines for National Greenhouse Gas Inventories chapter 3 (2006)* were used. The uncertainty calculation is applied on the three regional air pollution emission inventories for the year 2019 and base year- for the trend uncertainty. Subsequently, the uncertainties were aggregated on the national level by the error propagation equation from the Good Practice Guidance, in order to produce one single table 6.1 per pollutant (as expressed in the guidelines).

As most of the data suppliers in Belgium do not provide any information on the associated uncertainty, inventory experts were consulted to give their expert estimation. If this information was not available, either the consortium members' expert judgement was applied or default uncertainties were applied as described in the EMEP/EEA Guidelines.

A comparison of the Tier 1 and Tier 2 results for uncertainty in annual emissions show that there is only a minor difference for the mean emissions. Therefore, no further investments were made for uncertainty calculations on Tier 2 level.

According to the available references, in most member states the ultimate choice of an uncertainty estimate is often based on expert judgement and is therefore also rather uncertain. However, as stressed by the IPCC Good Practice Guidance, uncertainty calculation is a mean to provide inventory users with quantitative judgements on the inventory quality and enables the inventory preparation team to identify and prioritise improvement activities.

The results of the Tier 1 analysis for 2019 for the overall uncertainty per pollutant are given in Table 1-14.

Table 1-14 : Summary of uncertainties in the national total emissions per pollutant (Reporting year 2019)

Pollutant	Total Emissions in Base Year	Total Emissions in Reporting Year	Change in total emissions (Reporting Year - Base Year)	Uncertainty in Reporting Year inventory (%)	Uncertainty in trend (Reporting Year - Base Year) (%)
NOx (as NO2)	423.12	134.78	-288.34	22.51	5.33
NMVOC	352.95	112.96	-239.99	23.73	7.25
SOx (as SO2)	364.55	24.11	-340.43	15.41	0.61

Pollutant	Total Emissions in Base Year	Total Emissions in Reporting Year	Change in total emissions (Reporting Year - Base Year)	Uncertainty in Reporting Year inventory (%)	Uncertainty in trend (Reporting Year - Base Year) (%)
NH3	131.56	68.00	-63.56	40.49	25.94
CO	1508.42	265.84	-1242.59	28.69	9.18
Pb	252.69	11.79	-240.91	82.99	7.60
Cd	6.02	1.03	-4.99	110.36	17.83
Hg	6.07	0.99	-5.08	39.42	9.70
As	6.67	0.85	-5.82	51.24	7.18
Cr	35.98	4.57	-31.40	97.79	13.05
Cu	51.97	35.91	-16.06	199.05	64.40
Ni	76.80	3.27	-73.52	73.41	3.40
Se	5.22	2.20	-3.02	133.08	25.26
Zn	230.24	54.57	-175.67	104.76	22.21
PCDD	545.62	28.35	-517.27	229.60	5.61
BaP	15.33	1.88	-13.45	288.85	27.38
BbF	18.00	2.10	-15.89	257.94	24.52
BkF	9.97	0.90	-9.07	234.43	18.01
IP	7.43	1.05	-6.39	296.70	30.82
Total PAH	50.73	5.93	-44.80	270.61	25.10
HCB	40.14	3.25	-36.88	141.86	10.08
PCB	118.96	8.73	-110.23	310.87	28.78
PM 2.5	39.97	16.74	-23.23	17.24	7.28
PM 10	54.96	25.53	-29.44	20.06	7.27
TSP	82.91	44.08	-38.83	27.32	8.08
BC	8.66	2.14	-6.52	24.93	9.09

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, BC), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn) and POP's (PCDD/PCDF, PAH, HCB, PCB's). In the 2022 submission, recalculations were made for 1990-2019. 2020 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 2019 emission inventory, as well as the sub-sources accounted for in reporting codes 'other' are summarized in Table 1-15 to Table 1-17.

An overview of the basis that is used to estimate emissions from mobile sources (fuels sold versus fuels used) is given in Table 1-18.

Table 1-15 Explanation to the Notation key NE

NFR code	Substance(s)	Reason for not estimated
1A1b	NH3, PAH	No data available from the facilities
1A2b	HCB	No emission factors available to calculate the emissions
1A2gvii	PCDD/F	No emission factors available to calculate the emissions
1A3ai(i) 1A3aii(i)	NH3, dioxins	No emission factors available to calculate the emissions
1A3aii(ii) 1A3ai(ii)	NH3, dioxins	No emission factors available to calculate the emissions
1A3bvi	Hg, PCDD/F, PAH, HCB, PCBs	No COPERT output
1A3bvii	heavy metals, HCB, PCBs	Considering the diversity of the road coatings, no estimate was made
1A3di(ii)	Cr, dioxins	No emission factors available to calculate the emissions
1A3ei	NH3	No data available from the facilities
1A3eii	Hg, As, dioxins	No emission factors available to calculate the emissions
1A4aii	Hg, As, dioxins	No emission factors available to calculate the emissions
1A4bii	Hg, As, dioxins	No emission factors available to calculate the emissions
1A4ciii	Cr ,dioxins	No emission factors available to calculate the emissions
1A5b	Hg, As, dioxins	No emission factors available to calculate the emissions
1B1b	NMVOC, NH3, PAH	No data available from the facilities
1B2aiv	NOx, CO, PAH	No data available from the facilities
1B2c	NH3	No detailed data available
1B2d	NMVOC, CO	No detailed data available
2A6	NH3, Cu, Zn, PAH	There are no data available or the EF aren't available
2B1	Sox, NH3	No data available from the facilities
2B2	SOx, CO	There are no data available or the EF aren't available
2B6	Hg	No data available from the facilities
2B10a	Se	No emission factors available to calculate the emissions
2B10b	Heavy metals, dioxins, PAHs	There are no data available or the EF aren't available
2C2	all	There are no data available
2C3	NOx, SOx, NH3, CO, PAHs	No data available from the facilities or no emission factors available
2C4	Cr, Se, PAHs	No activity data available
2C5	PAHs	No data available from the facilities or no emission factors available
2C6	Se, PAHs	No data available from the facilities or no emission factors available
2C7a	PAHs	No data available from the facilities or no emission factors available
2C7b	Se, PAHs	No data available from the facilities or no

		emission factors available
2C7c	NH3, PCB	No data available from the facilities or no emission factors available
2C7d	NOx, SOx, Hg, Ni, Se, PAH	No data available from the facilities or no emission factors available
2D3c	NOx, SOx, particulate matter, CO, Pb, dioxins, PAHs	No activity data available
2D3d	heavy metals	No data available from the facilities
2D3e	NOx, SOx, NH3, CO, heavy metals	No data available from the facilities
2D3g	heavy metals, PAH	No data available from the facilities
2D3h	NH3, Hg	No data available from the facilities
2H1	NH3, particulate matter, heavy metals	No data available from the facilities or no emission factors available
2H2	NH3, Pb, Hg	No data available from the facilities
2H3	All	No activity data available
2I	SOx, NH3, BC, Pb, Cd, As, Cr, Cu, Ni	No data available from the facilities or no emission factors available
2J	PAHs, HCB, PCBs	No activity data available
2K	Heavy metals, dioxins, PAHs, HCB	No data available from the facilities or no emission factors available, POPs emissions probably not relevant
2L	NOx, NMVOC, SOx, CO, Cd, Hg, As, Se, PCBs	No activity data available
3Dd	particulate matter	No data available
3I	NH3	No activity data available
5A	NOx, SOx, BC, CO	No emission factors available to calculate the emissions
5B1	NOx, particulate matter, CO	No activity data available or no emission factors available
5C1bi	dioxins, PAHs, PCBs	POP's emissions probably not relevant
5C1bii	PAHs	There are no detailed data available or the EF aren't available
5C1biii	PAHs, PCB	There are no detailed data available or the EF aren't available
5C1biv	PAHs	There are no detailed data available or the EF aren't available
5C1bv	NH3, BC	No emission factors available to calculate the emissions
5C1bvi	NMVOC, NH3, particulate matter, heavy metals, dioxins, PAHs, HCB, PCBs	There are no detailed data available or the EF aren't available
5C2	NH3, Hg, Ni	No emission factors available to calculate the emissions
5D1	NH3	There are no data available or the EF aren't available
5D2	NMVOC, SOx, Hg	There are no data available or the EF aren't available or data not provided by the facility

5D3	Main pollutants, CO	There are no data available or the EF aren't available or data not provided by the facility
5E	SOx, CO, Se	No activity data available
1A3d i(i)	dioxins, Cr	No emission factors available

Table 1-16 Explanation to the Notation key IE

NFR code	Substance(s)	Included in NFR code
1A1c	NMVOC, Particulate matter, heavy metals, POPs	2C1
1A2f	HCB	2A1
1A4aii	all	1A3eii
1A5a	all	1A1, 1A2, 1A4
1B1b	NOx, SOx	
1B2ai	NMVOC	1B2av
2A5c	particulate matter	2A6
2B1	NMVOC, particulate matter	2B10a
2B6	Particulate matter	2B10a
2B10b	Main pollutants, particulate matter, CO	2B10a
2C2	Particulate matter	2C1
2C3	all	2C7c
2C4	all	2C7c
2C5	all	2C7c
2C6	all	2C7c
2C7a	all	2C7c
2C7b	all	2C7c
2C7d	NMVOC	2C7c
2I	Particulate matter	2L
3B4f	NOx, NMVOC, NH3, particulate matter	3B4e
3B4giii	NOx, NMVOC, NH3, particulate matter	3B4giv
3Da3	NOx	3Da2a
3Dc	NH3	3B
5B2	Main pollutants, CO	1A1a
5C1bi	BC, Heavy metals	1A1a (E-recup)
5C1bii	all	5C1bi or 1A1a (E-recup)
5C1biii	All	5C1bi or 1A1a (E-recup)

5C1biv	All	5C1bi or 1A1a (E-recup)

Table 1-17 Sub-sources accounted for in reporting codes 'other'

NFRcode	Substance(s) reported	Sub-source description
1 A 2 gviii	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 eii	all except Hg, As, dioxins, HCB, PCBs	Off-road emissions of harbours, airports and trans-shipment companies
1 A 5 a	-	NE, cfr. Table 1-15, military source
1 A 5 b	all except Hg, As, dioxins, HCB, PCBs	Military aviation in Wallonia and in the Flemish Region + off-road defense
1 B 1 c	-	NO
2 A 6	NO_x, SO_x, NMVOC, particulate matter, CO, heavy metals, dioxins	Manufacture and processing of flat and hollow glass, glass fibres and other glass (only in Flanders for PM and heavy metals from 2000), 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 10 a	all except Se, HCB, 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 10 b	pollutants included in 2B10a	IE or NE
2 C 7 c	all except NH3, HCB, PCB	galvanization, non-ferro
2 C 7 d	particulate matter, CO, Pb, Cd, As, Cr, Cu, Zn, PCB	metallurgic activities, including (iron) foundries and galvanization activities
2 D 3 i	NMVOC	Process emissions of vegetable oil extraction, gluing, wood preservation, recuperation of waste solvents
2 G	NO_x, NMVOC, SO_x, NH_3, particulate matter, CO, heavy metals, dioxins, PAHs	application of glues and adhesives, plant oil extraction, wood preservation, recuperation of waste solvents, estimation of tobacco smoke (PM) and fireworks (Cu), production of (suit)cases, production of mica paper, production of plastic packaging products
2 H 3		NE
2 L	NO_x, NH_3, Particulate matter, all heavy metals except Hg, As and Se, PAHs	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 mattresses, recycling of metal and non-metal waste and scraps, industrial cleaning,

3 B 4 g iv	NO_x, NMVOC, NH_3	hens for multiplication and austriches
3 B 4 h	NO_x, NMVOC, NH_3, particulate matter	rabbits and minks
3 D a 2 c		NO
3 I	-	NE
5 C 1 b iv		IE or NE
5 D 3		NE
5 E	NMVOC, SO_x, TSP, Pb, Cd, Hg, Cr, Cu, Ni, Zn	Waste recuperation, compost, car and building fires
6 B		NO
11 C	NMVOC	Forest and grassland

Table 1-18 Basis for estimating emissions from mobile sources

NFR 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	X	Reporting of emissions of road transport based on fuel sold, emissions based on fuel used are also supplied for compliance purposes,
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 the years in the 2022 LRTAP-submission. The absolute difference as well as the relative difference are calculated between 2020 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 2020. 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 and 2013 due to the cold winter periods.

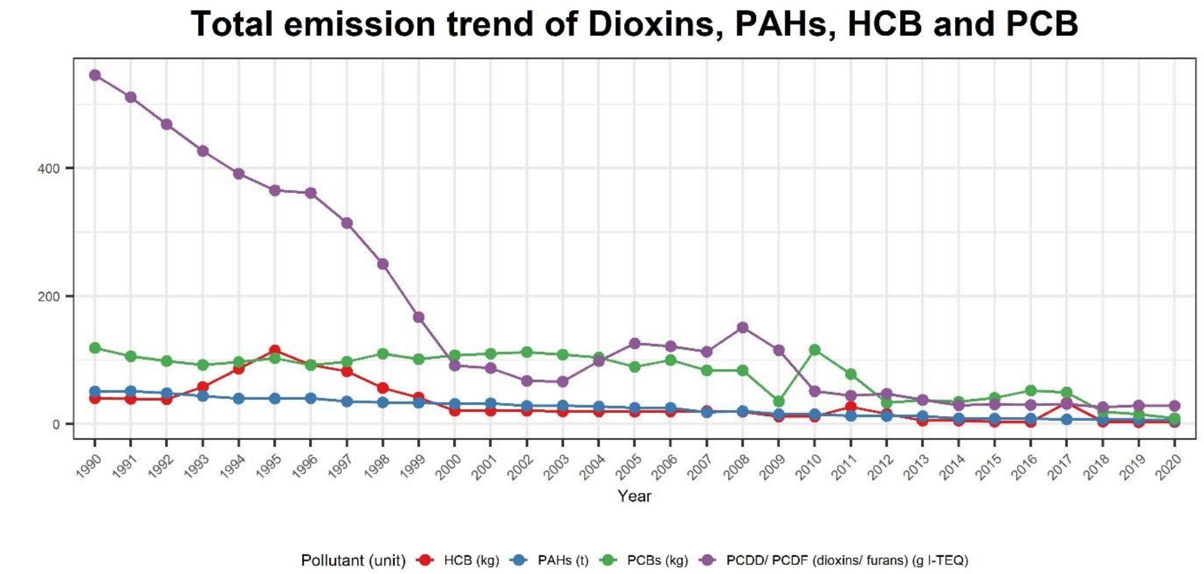
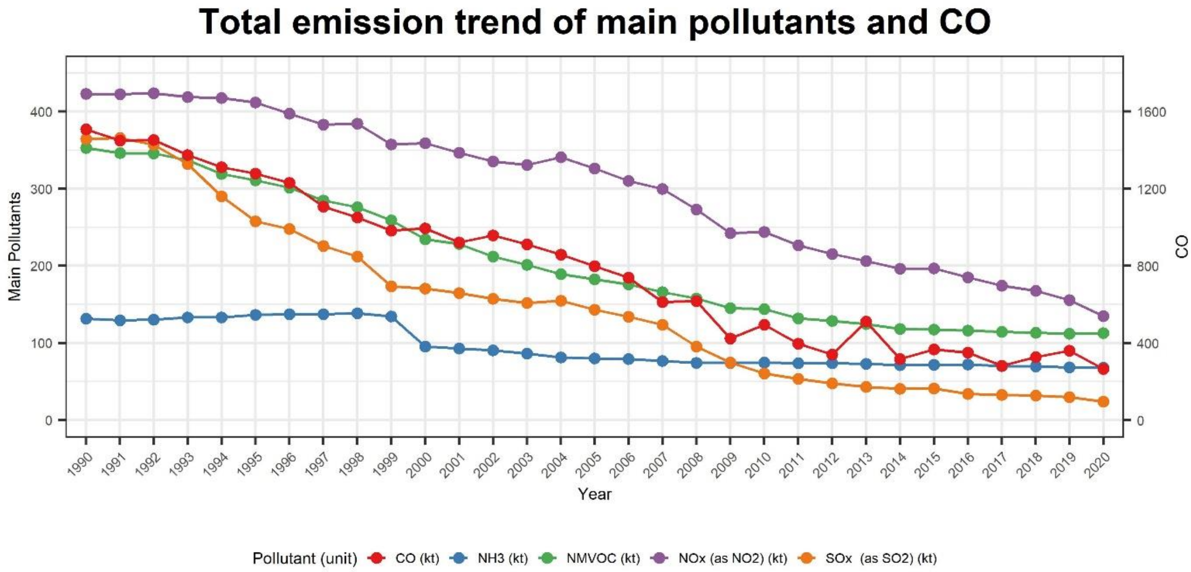


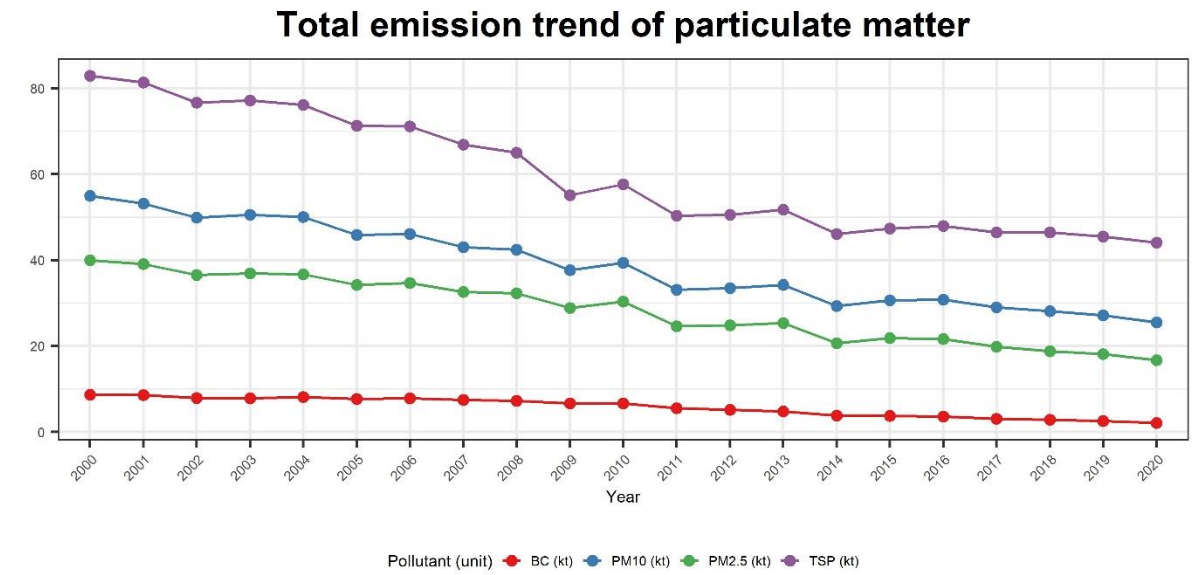
Figure 2-1

Table 2-1 Absolute total emissions and absolute and relative differences for the time series 1990-2020

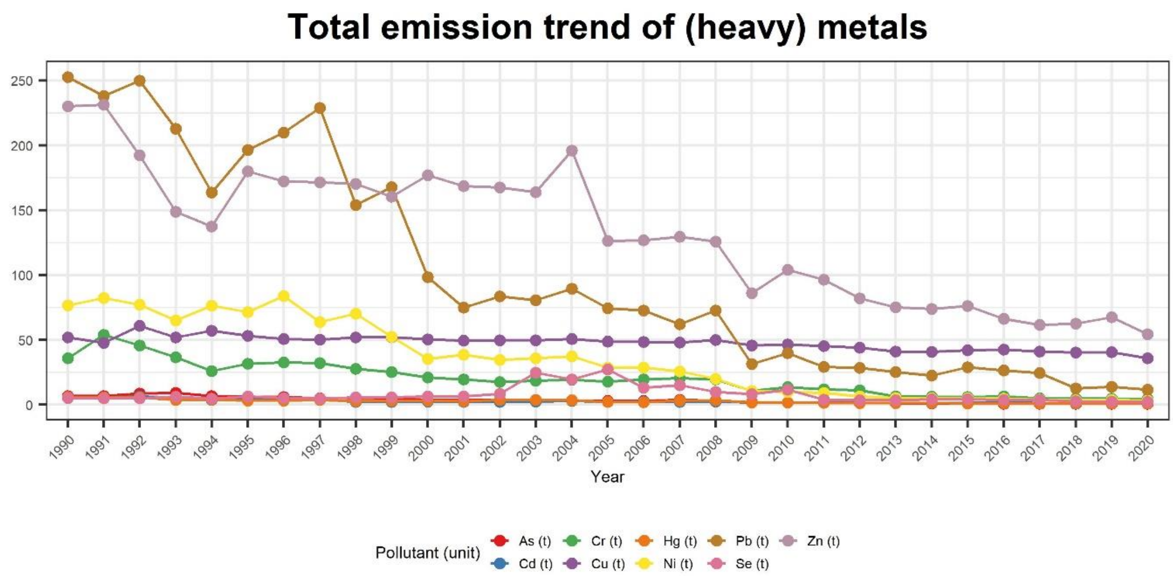
Pollutant	Unit	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	absolute difference base-2020	relative difference base-2020
NOx	**Gg as NO2**	423	359	326	310	300	273	242	244	227	215	206	196	197	185	174	168	156	135	-288	-68%
NMVOC	**Gg**	353	234	183	176	166	158	145	144	132	128	125	118	117	116	114	113	112	113	-240	-68%
SOx	**Gg as SO2**	365	171	143	134	123	95	74	61	53	47	43	41	41	34	32	32	30	24	-340	-93%
NH3	**Gg**	132	95	80	79	77	74	74	75	74	74	73	71	72	72	70	70	68	68	-64	-48%
PM2.5	**Gg**	0	40	34	35	33	32	29	30	25	25	25	21	22	22	20	19	18	17	17	-58%
PM10	**Gg**	0	55	46	46	43	42	38	39	33	33	34	29	31	31	29	28	27	26	26	-54%
TSP	**Gg**	0	83	71	71	67	65	55	58	50	51	52	46	47	48	46	46	46	44	44	-47%
BC	**Gg**	0	9	8	8	7	7	7	7	6	5	5	4	4	4	3	3	3	2	2	-75%
CO (right axis)	**Gg**	1508	995	798	739	612	617	423	494	396	340	511	317	366	350	282	327	359	266	-1243	-82%
Pb	**Mg**	253	99	74	73	62	73	31	40	29	29	25	23	29	26	25	13	14	12	-241	-95%
Cd	**Mg**	6	3	2	2	2	3	2	2	2	1	1	1	2	3	1	1	1	1	-5	-83%
Hg	**Mg**	6	3	2	2	3	4	2	2	2	1	1	2	1	1	1	1	1	1	-5	-84%
As	**Mg**	7	4	3	3	4	3	2	2	2	1	1	1	1	1	1	1	1	1	-6	-87%
Cr	**Mg**	36	21	18	20	21	20	11	14	12	11	6	6	6	7	5	5	5	5	-31	-87%
Cu	**Mg**	52	50	49	48	48	50	46	47	45	44	41	41	42	43	41	40	41	36	-16	-31%
Ni	**Mg**	77	36	29	29	26	20	11	10	9	7	5	5	5	5	4	4	4	3	-74	-96%
Se	**Mg**	5	7	27	13	15	10	8	12	4	4	4	4	4	4	4	3	3	2	-3	-58%
Zn	**Mg**	230	177	126	127	130	126	86	104	96	82	75	74	76	66	62	63	68	55	-176	-76%
PCDD/ PCDF	**g I-Teq**	546	92	126	121	113	151	116	51	44	47	38	30	31	30	32	27	29	28	-517	-95%
benzo(a)pyrene	**Mg**	15	5	8	8	6	7	6	5	5	4	4	3	3	3	2	2	2	2	-13	-88%
benzo(b)fluoranthene	**Mg**	18	11	9	9	6	7	5	5	4	4	4	3	3	3	3	3	2	2	-16	-88%
benzo(k)fluoranthene	**Mg**	10	6	5	5	3	4	2	2	2	2	2	1	1	1	1	1	1	1	-9	-91%
Indeno(1,2,3-cd)pyrene	**Mg**	7	5	4	4	3	3	2	2	2	2	2	2	2	1	1	1	1	1	-6	-86%
PAH (Mg)	**Mg**	51	32	25	25	18	21	15	15	13	12	12	9	9	8	8	7	7	6	-45	-88%
HCB (kg)	**kg**	40	21	19	20	20	19	12	12	27	16	5	5	4	3	33	4	3	3	-37	-92%
PCB (kg)	**kg**	119	108	89	100	84	84	35	116	78	33	37	35	41	53	49	19	15	9	-110	-93%



Total emission trend of main pollutants and CO
Main Pollutants
CO
Year
Pollutant (unit) CO (kt) NH3 (kt) NMVOC (kt) NOx (as NO2) (kt) SOx (as SO2) (kt)



Total emission trend of particulate matter
Year
Pollutant (unit) BC (kt) PM10 (kt) PM2.5 (kt) TSP (kt)



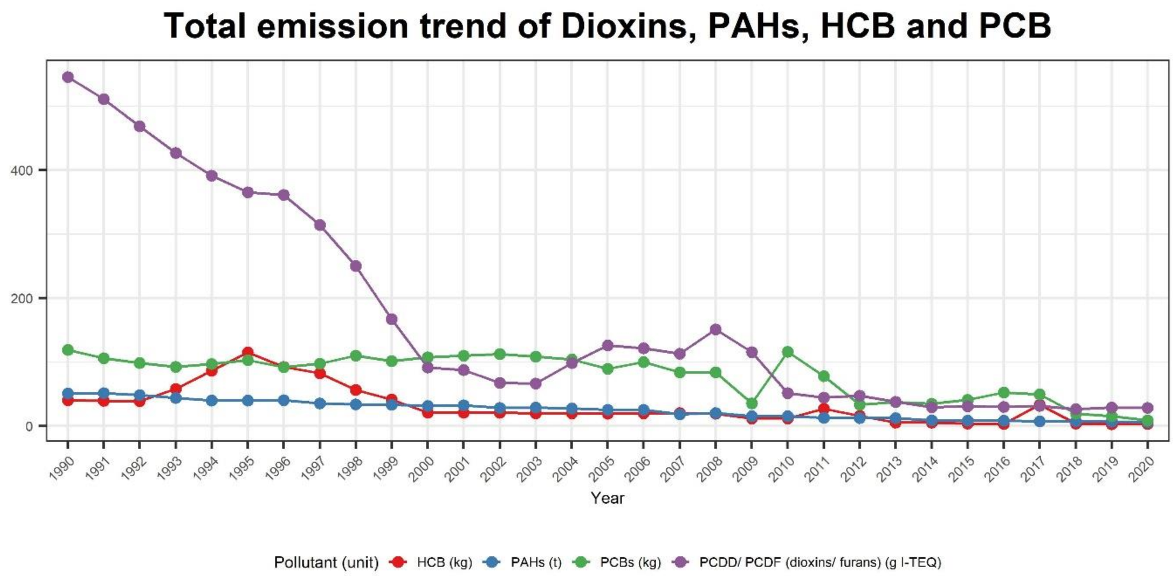


Figure 2-1 Time trends of Belgian national total emissions.

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, 2005, 2008-2013) compared to the other years (1994, 1997, 1999, 2002-2004, 2006-2007). In the former years emissions are available on installation level (NFR code) whereas in the latter years the emissions are available on a less detailed level (facility 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 per facility 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. In the Walloon region, there are no more coal power plant as they were progressively replaced by gas turbines and wood power plant. Emissions of waste incineration with energy recuperation and emissions of CHP installations are allocated to the electricity sector. The decrease of emissions is mainly observed in Flanders. In Flanders, less solid and fluid fuels and more gaseous fuels were used. The use of 'classic' fuels is decreased in 1999 with nearly 9 % compared to 1998, partly due to the good functioning of nuclear units. The choice for a type of fuel depends mostly on the prices and the goals that are assumed in the Environmental Policy Agreement (e.g. coal with a low S content <1%, purchase of extra heavy fuel with maximal S content of 1 %). There is an increasing use of natural gas due to better prices and the continuation of the STEG and CHP programme. Installations are modernised and old coal driven installations are replaced by STEG's. Also technical measures were taken to decrease the NO_x emissions (SCR, specific local measures per installation, old units were closed).
  In the Walloon region, a coal power plant was replaced by a gas turbine in 1999 and the last coal power plant closed in 2009.
- *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). The strong decrease in emissions, particularly from 2008 on, is related to the more stringent emission limit values for SO_2 and NO_x that became valid on 1 January 2010 as one of the main measures that the Flemish Government has taken in the framework of the European national emission ceilings directive (NECD or National Emission Ceilings Directive). Refineries made heavy investments in purification technology (also of influence on the PM emissions) the years before to be compliant with the NECD. Also a more stringent monitoring and control on the contribution of the emissions through flaring and the switchover of high to low sulphur fuel was mentioned as a measure to lower SO_2 emissions. During the years 2004-2006, one refinery had very limited refining activities
- *Manufacture of solid fuels:* decreasing emissions due to the closure of coke ovens in the Brussels Capital region and Flanders, respectively in 1993 and 1996 and closure of the last Flemish mines in 1992. The last coke oven in Wallonia closed in 2014.
- *Stationary combustion in manufacturing industries:* in general decreasing emission trends between 1990 and 2015 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. In category 1A2b strong decrease of some heavy metals because in 1993 a new gas purification installation on a blast furnace of the most polluting facility in this sector reduced strongly the Pb and Cd emissions. In 1A2c, the high Cd emissions in 2016 are coming from the measurements on a biomass boiler in a chemical plant in the Walloon region. The Cd emissions of the boiler are the average of two measurements in the year. One of this measurement shows a very high Cd concentration (2,1 mg/Nm3) in 2016. As the releases to air are reported under E-PRTR, it's also reported in the LRTAP and NECD inventory.

- *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.
- *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.
- *Iron and Steel production:* Pb emissions increase between 1994 and 1997, mainly from 1996 to 1997 due to the emissions by 1 iron and steel facility from 1996 on. The emissions are based on measurements performed according to the measuring liabilities included in the Flemish environmental legislation (Vlarem). Before 1996 there were no measuring and reporting obligations for this plant. Zn emissions peak in 2004. Emissions are obtained from direct measurements in the plants, two in Wallonia and one in Flanders.
- Dioxin emissions of the *metallurgical sector* have decreased significantly due to emission reduction measures and the closing of iron and steel production plants.
- *Cement production*: decrease of CO emissions from 2002 onwards as old kiln generating high CO emissions has been stopped in 2002, decrease of dust emissions from 2004 onwards as one plant generating high dust emissions has installed a new filtration system in 2004, PCB emissions in one plant were very high in 2010 and 2011 because of the use of an alternative raw material containing high concentrations of PCB. The removal of the raw material causing high PCB emissions at the end of 2011 has allowed returning to a normal level of emissions.
- *Lime production*: decrease of SO_x emissions from 2004 onwards as since 2004, there is a progressive reduction of the use of petroleum coke in a lime plant.
- 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 Belgium 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 from 2000 on. For some sectors, this might cause an inconsistency between the years before 2000 and the years from 2000 on.

2.3. *Trends in key sectors of main pollutants, CO, PM10, Pb, dioxins and PAH*

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 NO_x, NMVOC, SO_x ,NH_3, CO, PM10, Pb, dioxins and PAH.

2.3.1. NO_x

The greatest contributors to NO_x emissions are the transport (passenger cars, light 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 423 kt in 1990 to 135 kt in 2020, which is a decline of 68% (Figure 2-2 and Figure 2-3). NO_x emissions from 1A3bii Light duty vehicles have increased due to the strong increase in number of new light duty vehicles (Euro 6).

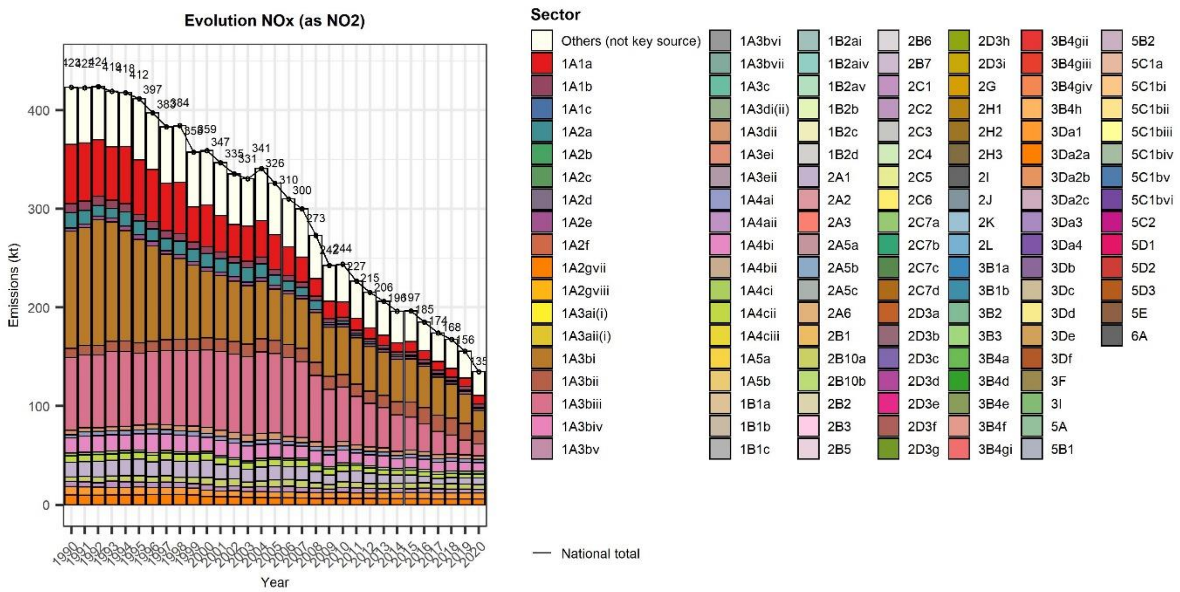


Figure 2-2 Trends in NO_x emissions for the key sectors

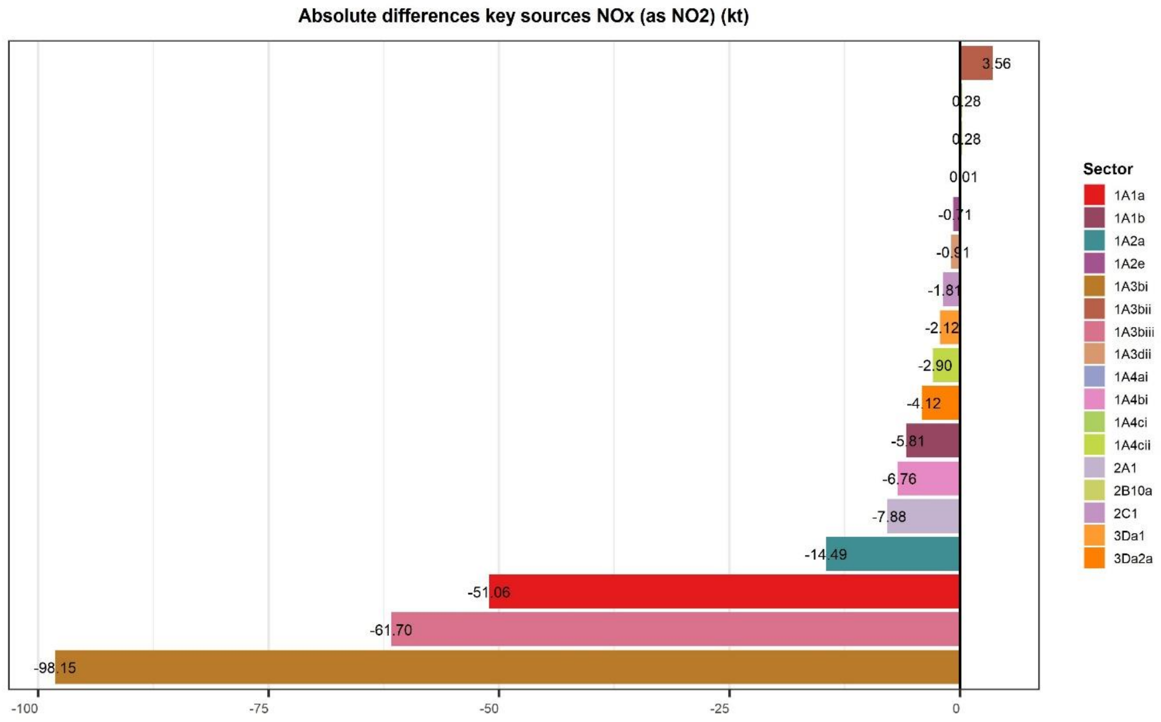


Figure 2-3 Absolute NO_x emission differences from 1990 to 2020 for all key sectors

2.3.2. NMVOC

The emissions of NMVOC show a steady decrease between 1990 and 2020, from 353 kt to 113 kt (-68%, Figure 2-4 and

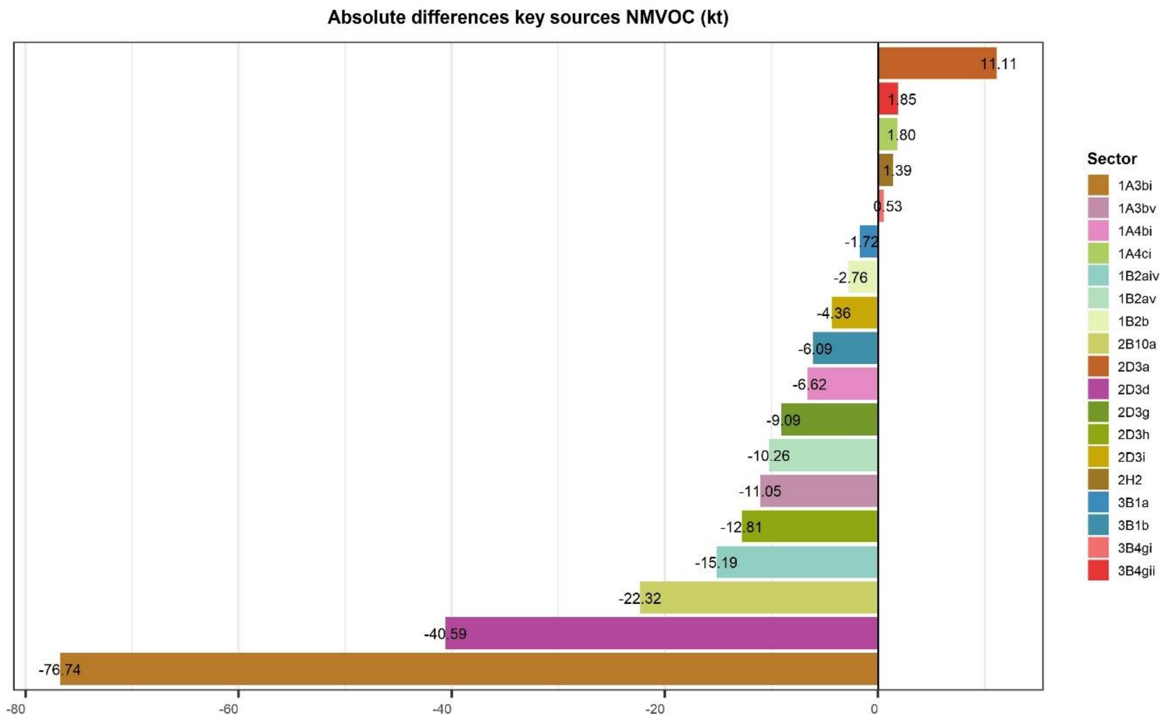


Figure 2-5). The largest absolute emission reductions are made in the transport sector (passenger cars). An explanation is the shift of fuel (gasoline to diesel oil). Other sectors with significant emission reductions are *coating applications* and *Other chemical industry*. A minor increase in the NMVOC

emissions over the period is observed in the *food and beverage industry* and *manure management broilers.* A steady increase from 9.6 kt in 1990 to 20.7 kt in 2020 is observed for the *Domestic Solvent use* sector. This is due to the increasing number of inhabitants; the emission factor and the solvent content of the products remain the same.

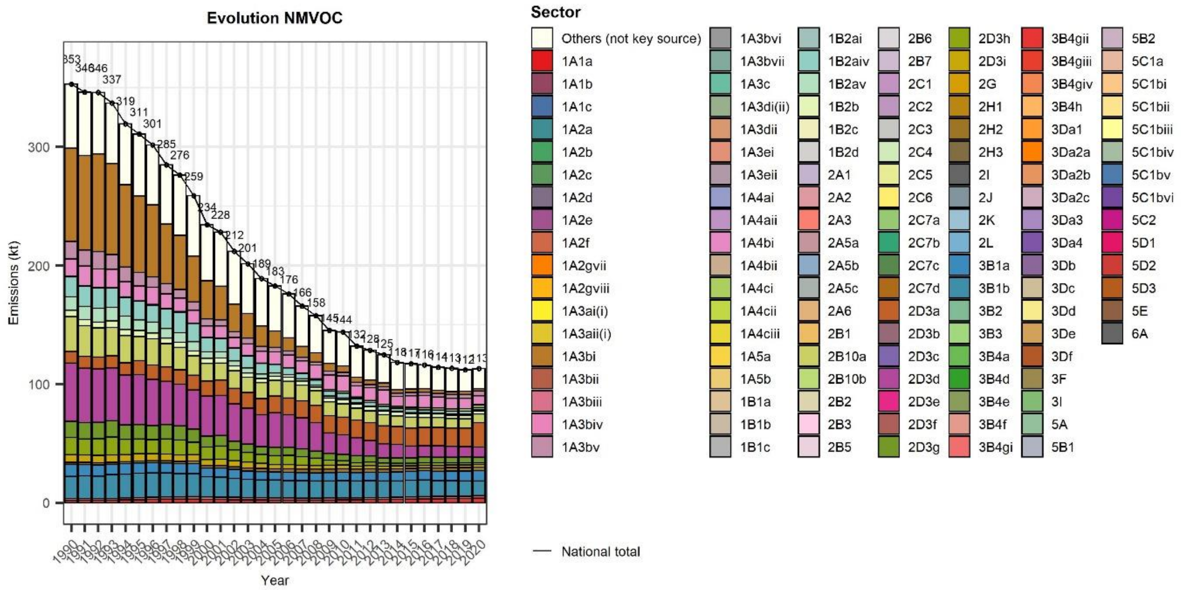


Figure 2-4 Trends in NMVOC emissions for the key sectors

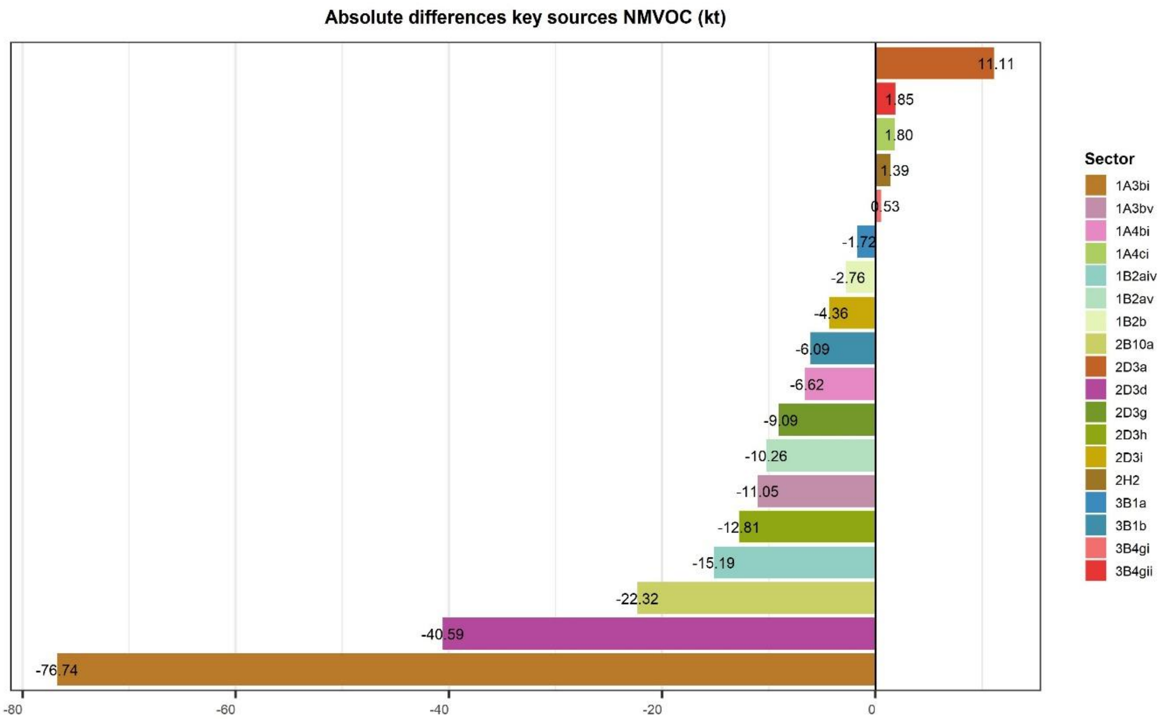


Figure 2-5 Absolute NMVOC emission differences from 1990 to 2020 for all key sectors

2.3.3. SO_x

SO_x emissions declined from 365 kt in 1990 to 24 kt in 2020, a reduction of 93% (Figure 2-6 and Figure 2-7). This is largely due to the use of fuels with less sulphur in combustion in the energy and manufacturing industries.

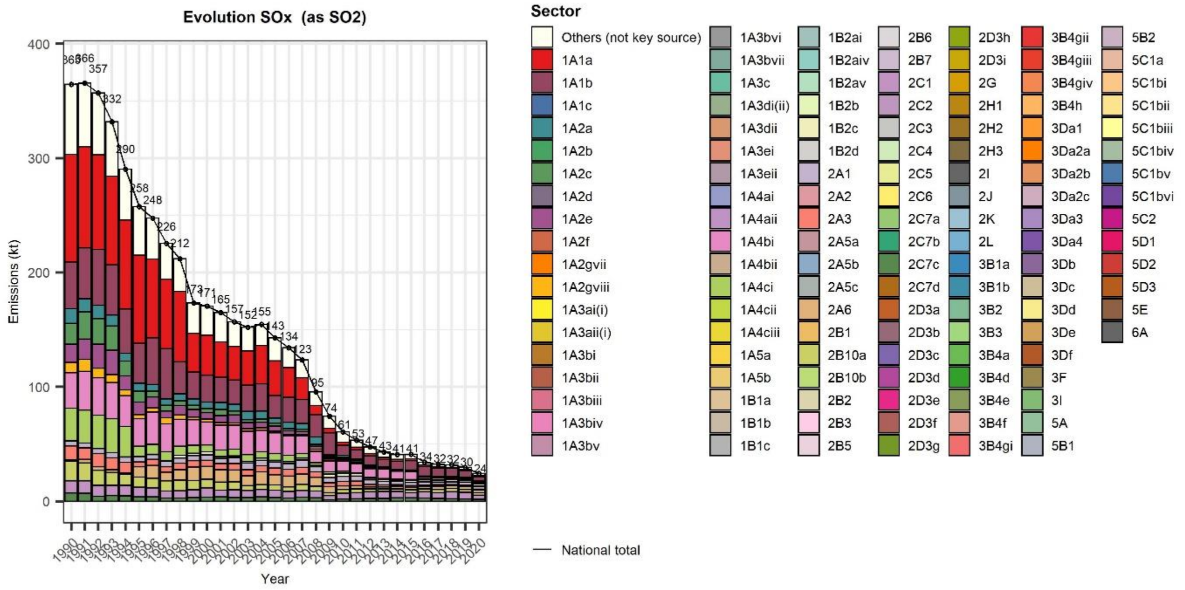


Figure 2-6 Trends in SOx emissions for the key sectors

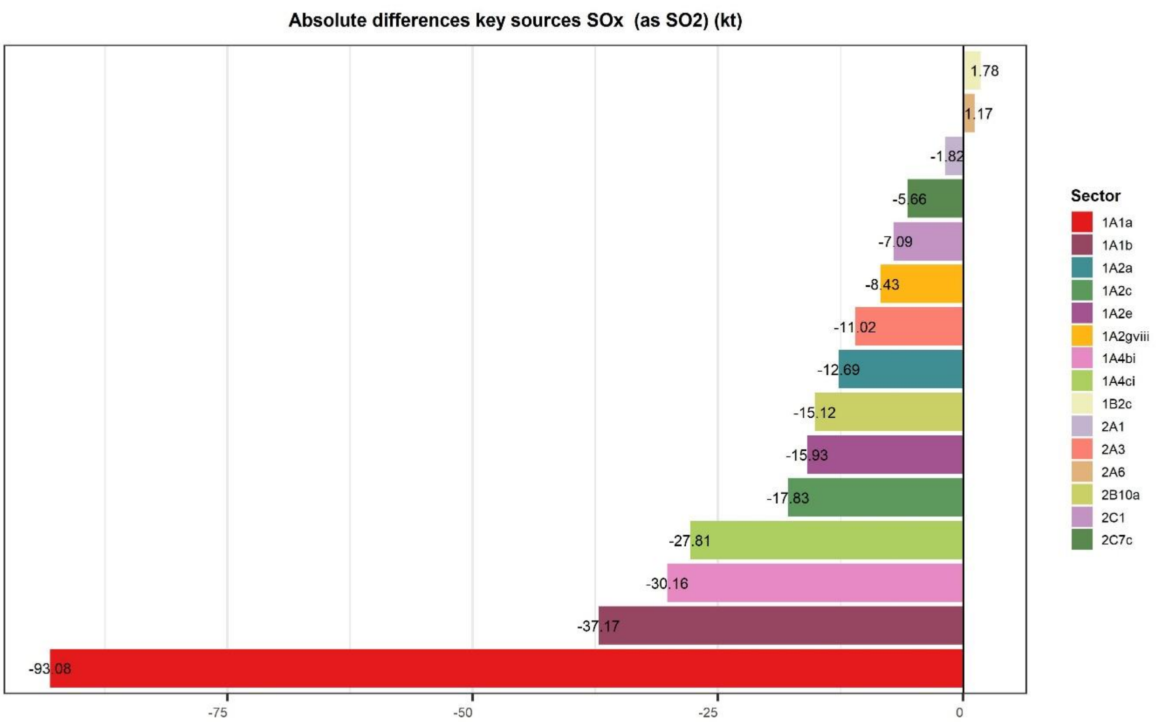


Figure 2-7 Absolute SOx emission differences from 1990 to 2020 for all key sectors

2.3.4. NH_3

In Belgium, over 90% of the NH3 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 48% between 1990 and 2020 (

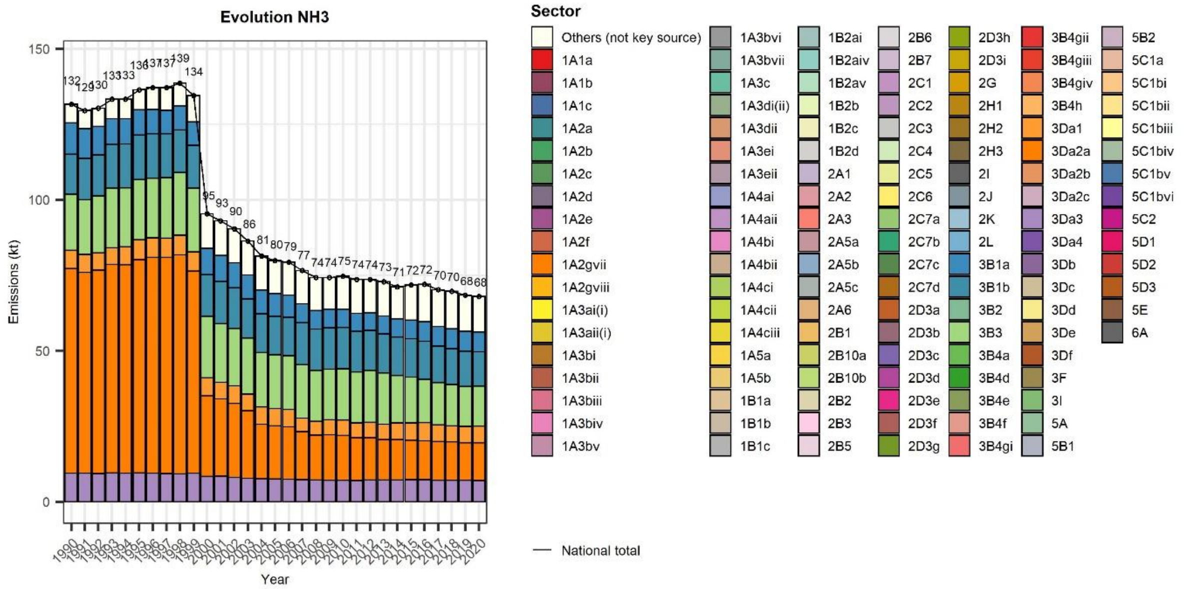


Figure 2-8 and Figure 2-9). In Flanders, more than half of this reduction is attributed to the emission reduction of animal manure applied to soils. In Wallonia, the decrease of emissions is driven by the reduction of livestock on the one hand and on the reduction of use of mineral fertilizer on the 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).

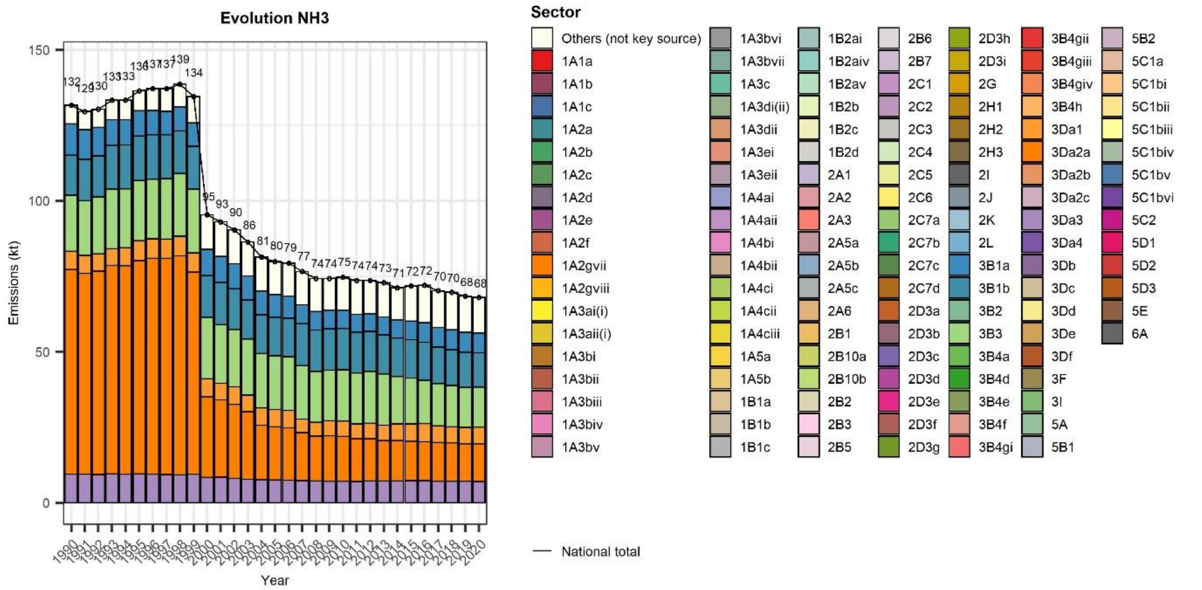


Figure 2-8 Trends in NH_3 emissions for the key sectors

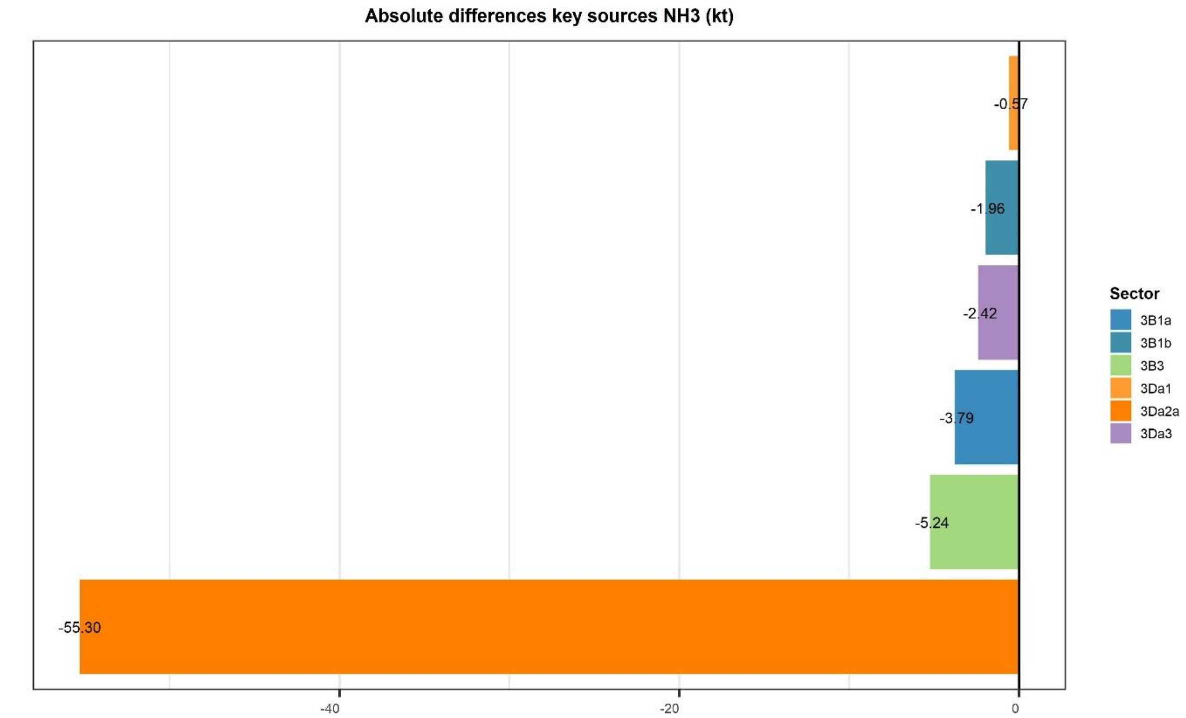


Figure 2-9 Absolute NH_3 emission differences from 1990 to 2020 for all key sectors.

2.3.5. CO

CO emissions decreased from 1508 kt in 1990 to 266 kt in 2020, a reduction of 82% (Figure 2-10 and Figure 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. The sudden increase in 2013 is due to 1 plant where the lime production occurred without oxygen (reducing atmosphere).

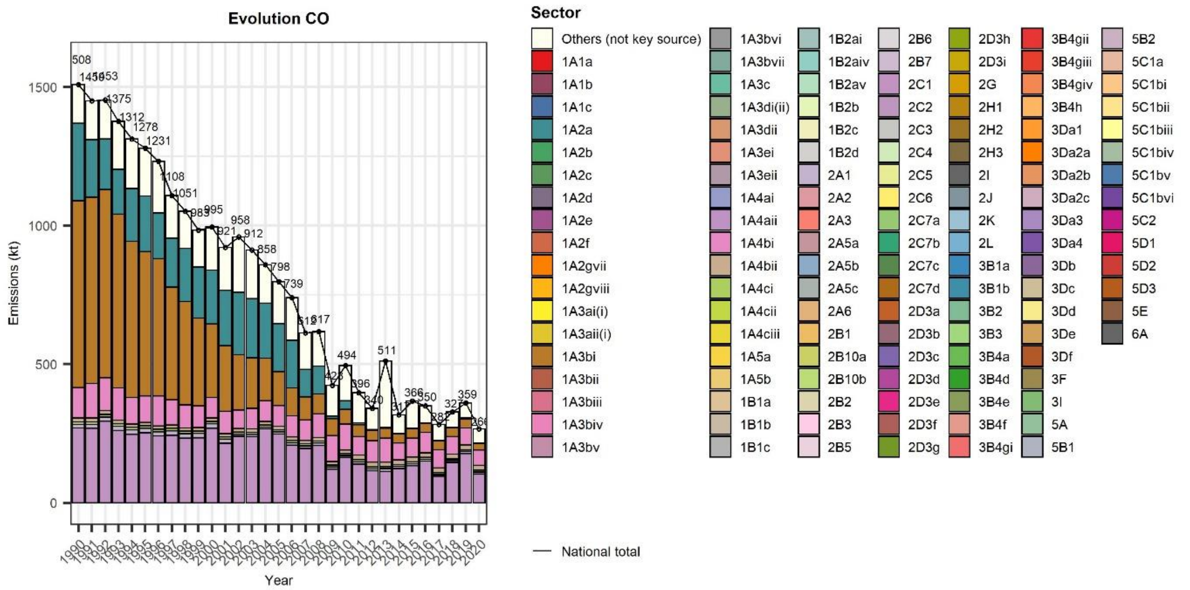


Figure 2-10 Trends in CO emissions for the key sectors

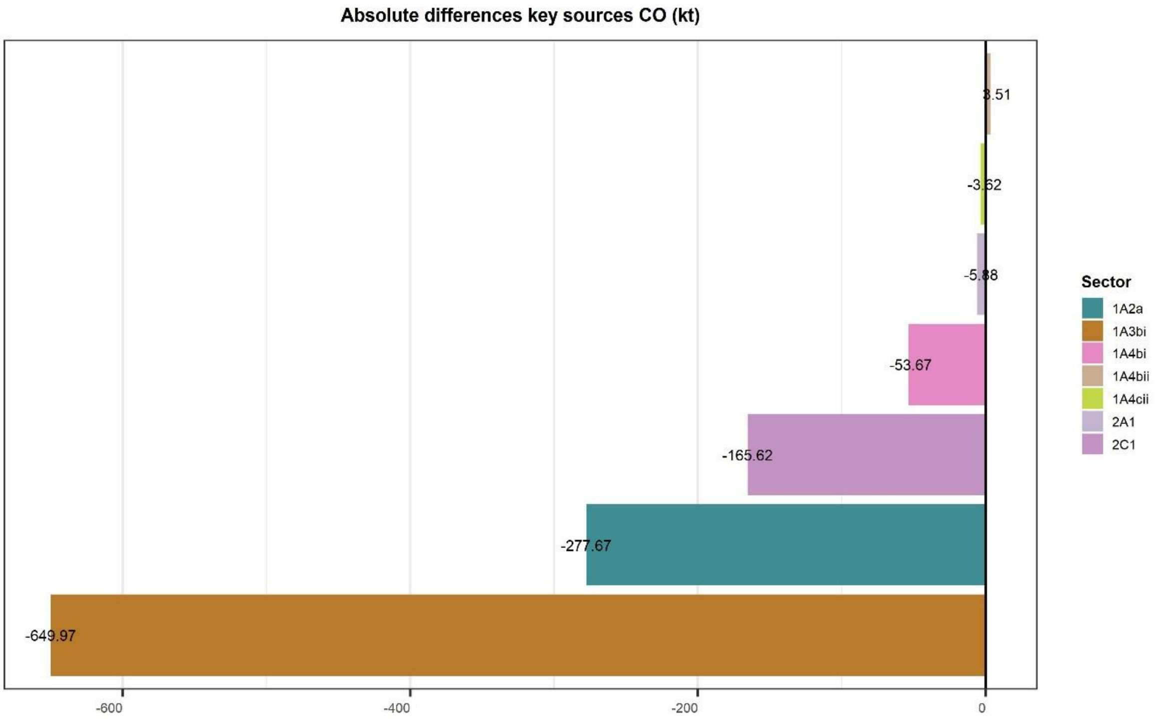


Figure 2-11 Absolute CO emission differences from 1990 to 2020 for all key sectors

2.3.6. PM10

PM10 emissions between 2000 and 2020 declined with 54%, from 55 kt to 26 kt (Figure 2-12 and Figure 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 (exhaust emissions from 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. Non-exhaust emissions from road transport on the contrary, have increased due to the increase in kilometer driven. 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 residential sector remains the largest source of PM10 and emissions are higher in cold years due to the increased use of wood for residential heating.

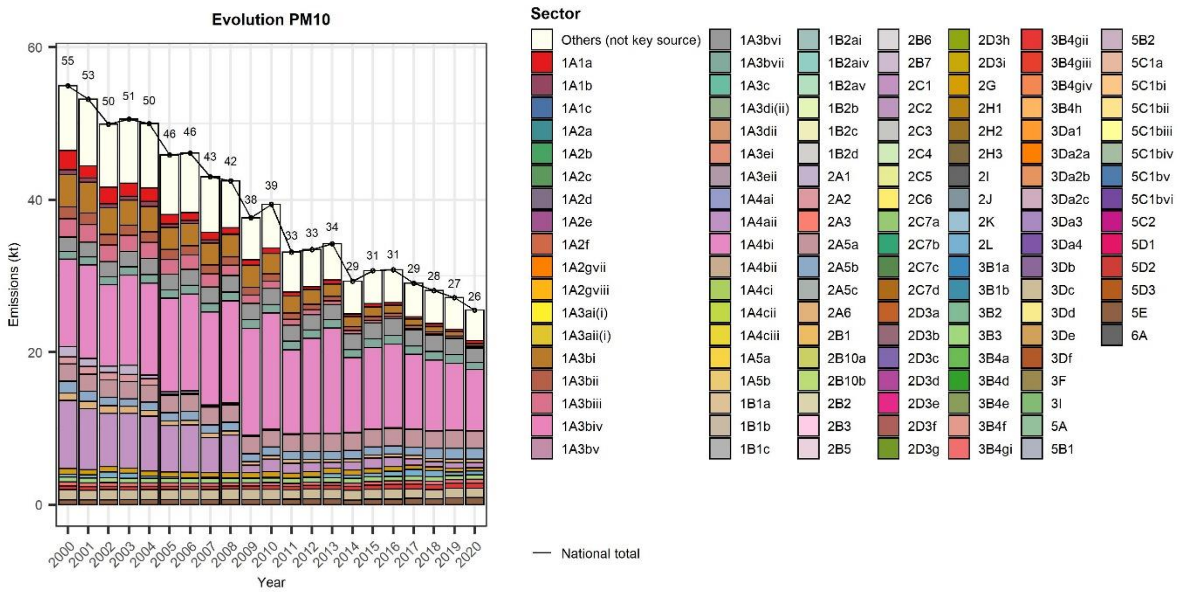


Figure 2-12 Trends in PM10 emissions for the key sectors

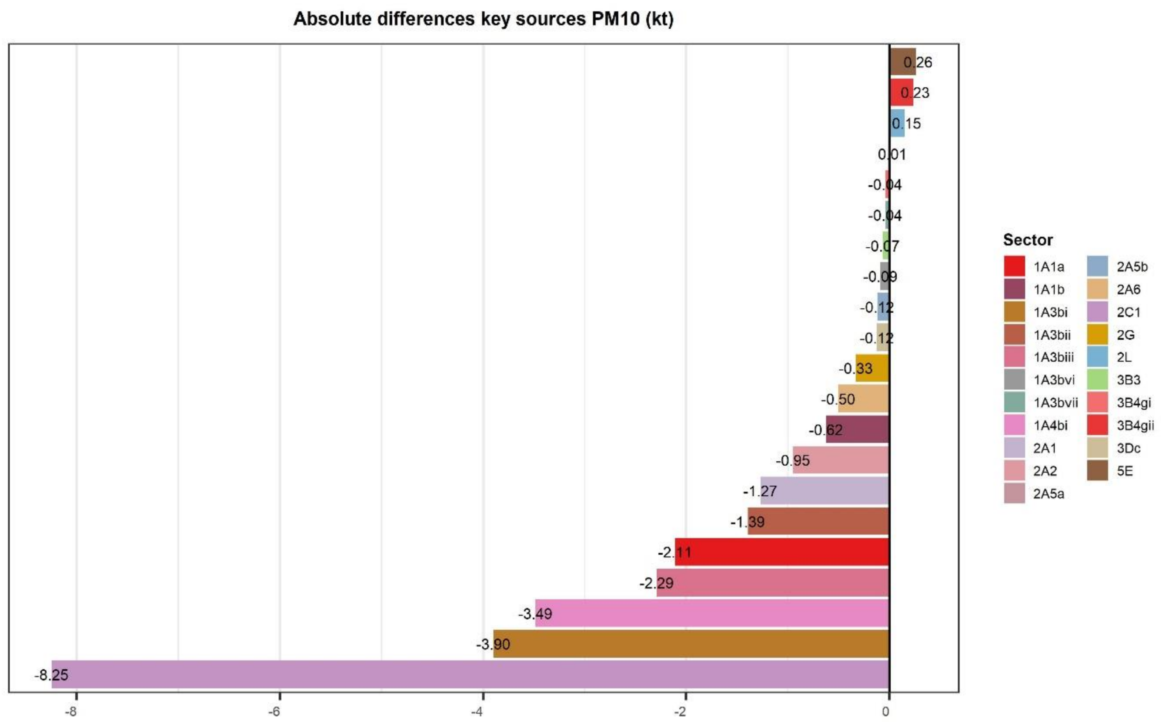


Figure 2-13 Absolute PM10 emission differences from 1990 to 2020 for all key sectors

2.3.7. Pb

Emissions of Pb decreased strongly between 1990 and 2020 with a decline of 95% from 253 tonnes to 12 tonnes (Figure 2-14 and

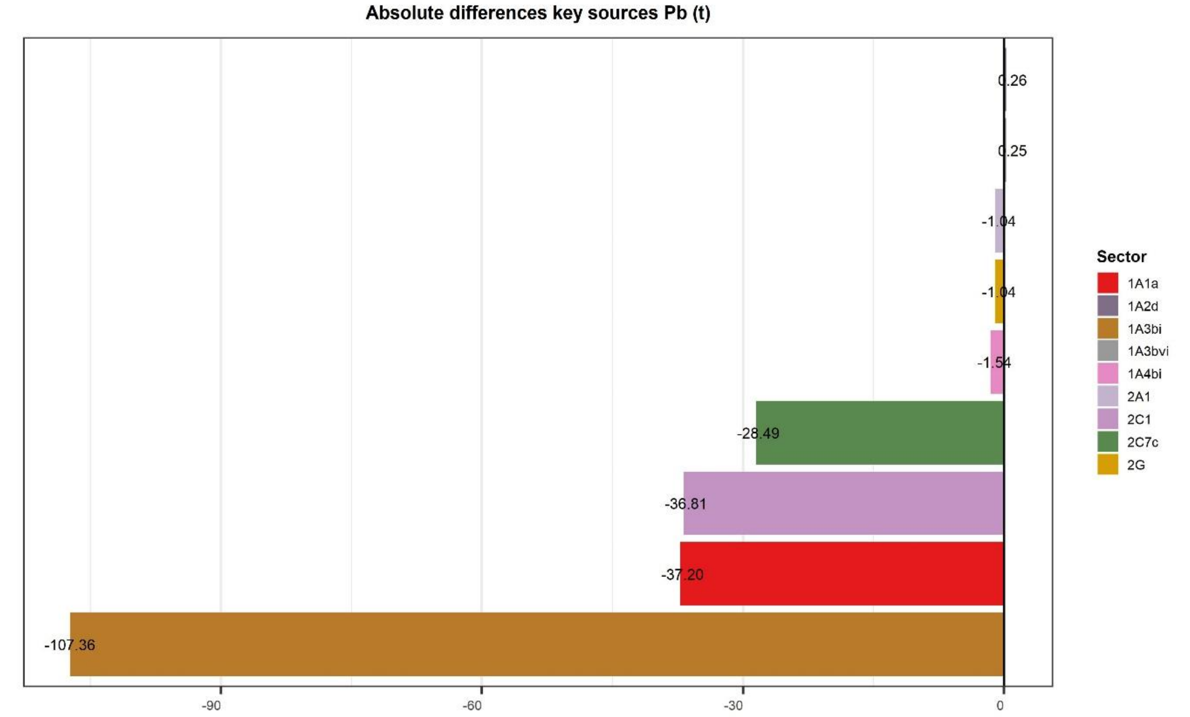


Figure 2-15). The use of unleaded petrol from 2000 on made Pb emissions originated from road transport exhaust very small. *Iron and steel production, public electricity and heat production* and *other metal production* are the other sectors with the greatest emission decreases.

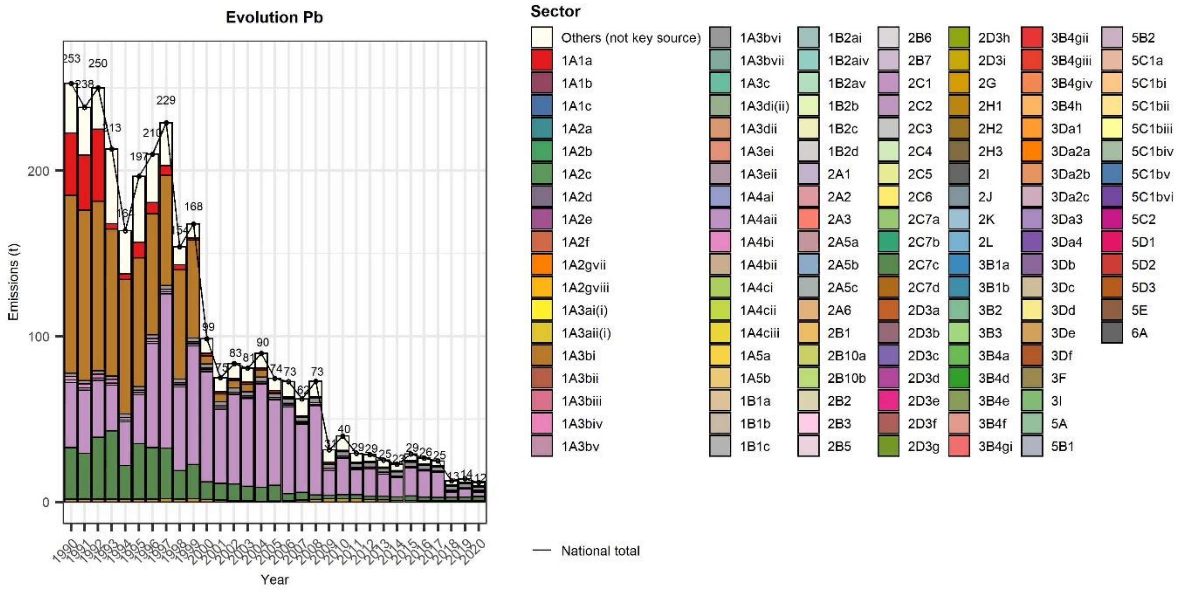


Figure 2-14 Trends in Pb emissions for the key sectors

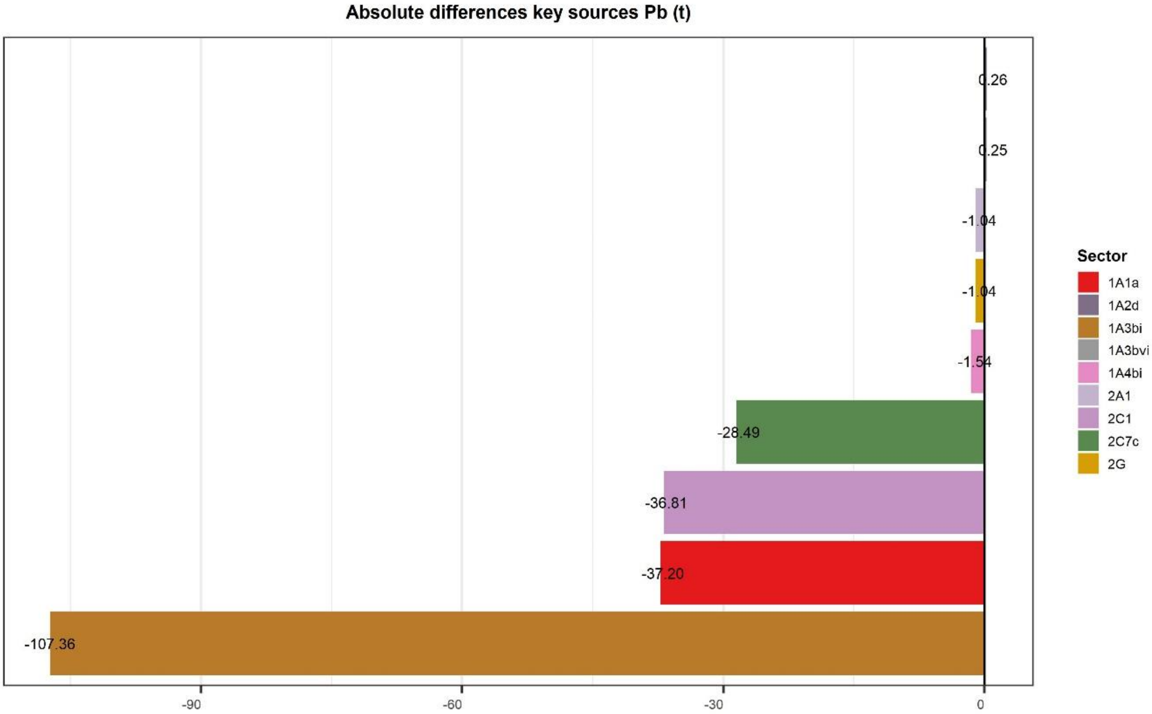


Figure 2-15 Absolute Pb emission differences from 1990 to 2020 for all key sectors

2.3.8. Dioxins and furanes

PCDD-PCDF emissions were high in the early nineties (546 g I-teq), but are greatly reduced in 2020 (28 g I-teq), with a decline of 95% (Figure 2-16 and Figure 2-17). The greatest absolute emission reductions are made in the *energy sector*, the *cement production* sector and the *municipal waste incineration*.

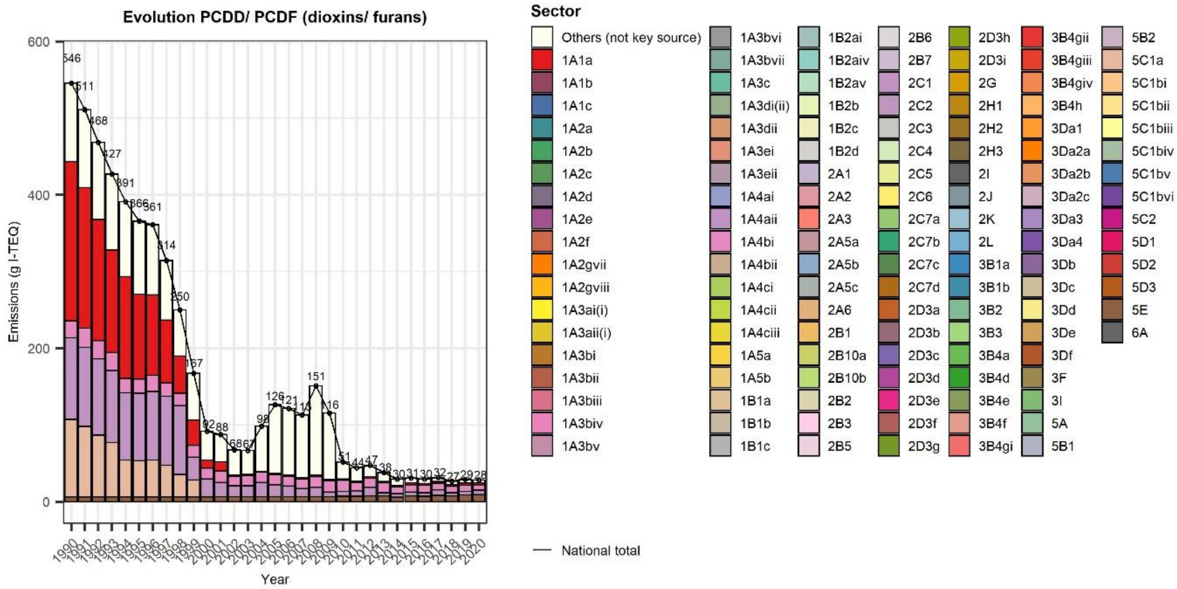


Figure 2-16 Trends in PCDD-PCDF emissions for the key sectors

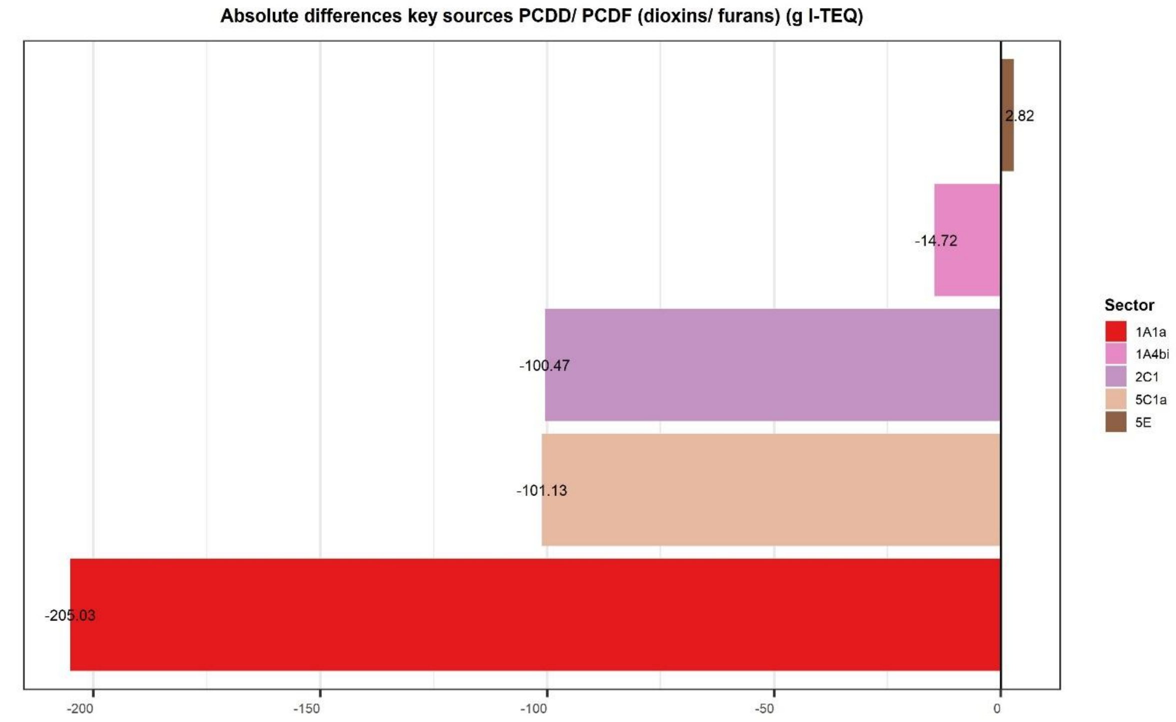


Figure 2-17 Absolute PCDD-PCDF emission differences from 1990 to 2020 for all key sectors

2.3.9. PAHs

Emissions of PAHs decreased from 51 tonnes in 1990 to 6 tonnes in 2020, a reduction of 88% (Figure 2-18 and Figure 2-19). This is largely due to reductions in the iron and steel sector. In the Walloon region, one blast furnace plant closed in 2001 and all the last 3 blast furnace plants and basic oxygen plants have been closed since 2011. PAHs emissions from solid fuel transformations decreased strongly because the activities of the Brussels, Flemish and Walloon coke ovens have been terminated respectively in 1993, 1996 and 2014.

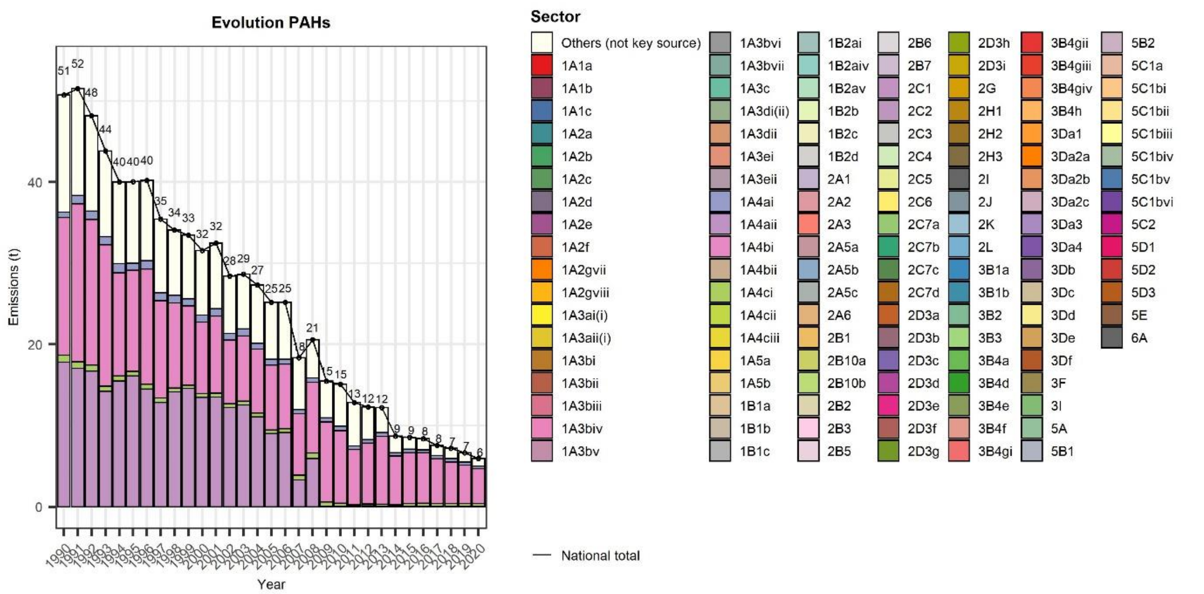


Figure 2-18 Trends in PAH emissions for the key sectors

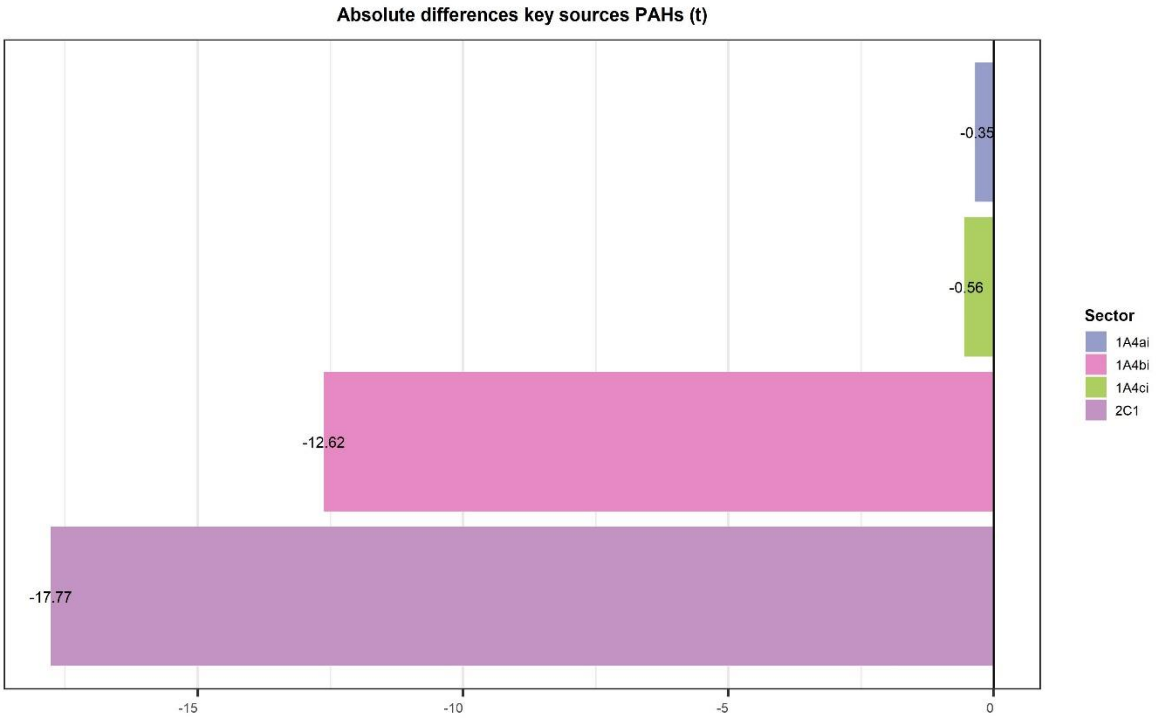


Figure 2-19 Absolute PAH emission differences from 1990 to 2020 for all key sectors.

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. Emission factors originate from the EMEP/EEA air pollutant emission inventory Guidebook, the emission limit values as described in VLAREM II (NO_x, CO) or the S-content of the fuel used (SO_x) (Sleeuwaert F. et al., 2010).

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 and the associated emissions are included in the energy sector, category 1A1a.

The following chart Figure 3-1 shows the trend of the energy consumption in this sector :

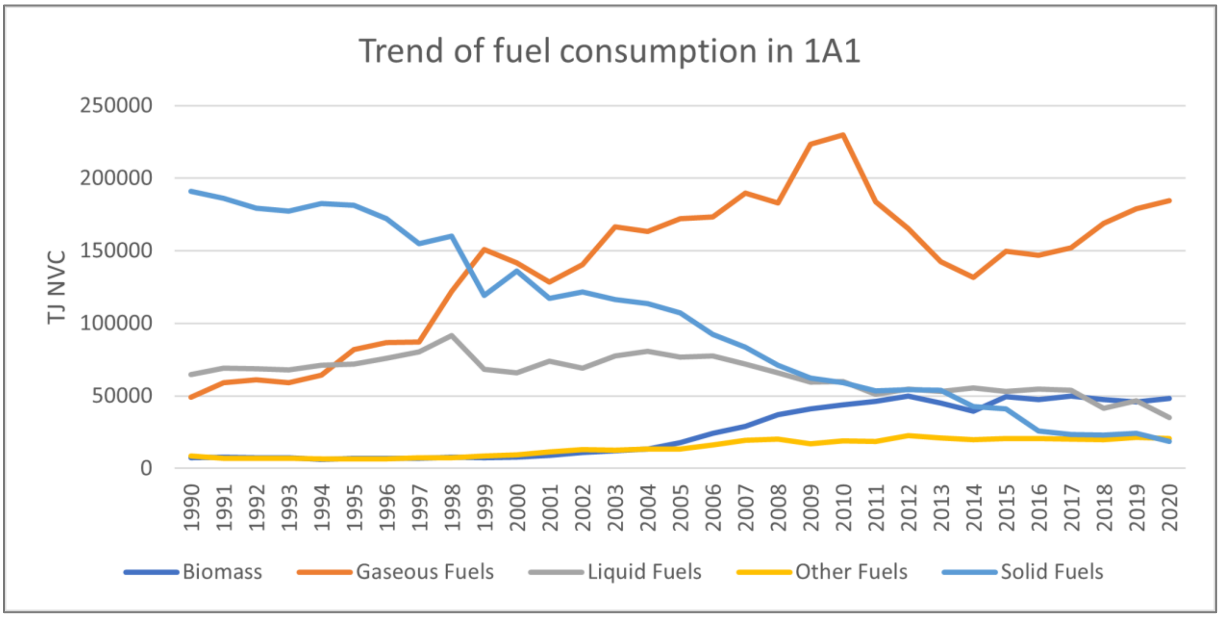


Figure 3-1 Trend of fuel consumption in the energy industries (1A1)

The emissions of the refineries, an activity which takes place only in the Flemish region, are allocated in the category 1A1b (combustion emissions), 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 the Brussels Capital region during the beginning of the nineties and emissions due to some gas transport activities are included in this category 1A1c. Fugitive emissions are reported in category 1B1b.

3.2.2. Methodological issues

3.2.2.1 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 category are the waste incineration installations with energy recuperation (waste incineration installations without energy recuperation are allocated in the sector 5C). Since submission 2021, we made changes to the allocation of emissions with and without energy recovery from waste incineration plants. After a thorough analysis, we obtained alignment between all pollutants. This adjustment affects the allocation between 1A1a and 5C for all pollutants.

During the 2022 submissions, the emissions of a TGV which was in joint venture with an electricity producer have been allocated to the category 1a2c as there is no more joint venture. The chemical plant has bought the TGV.

Category 1A1a is a key category of NO_x, PM2.5, Pb, Cd, Hg, As, Ni, Se, Zn, PCDD/F and HCB emissions in terms of emissions level and trend, a key category of Cr emissions in terms of emission level and a key category of SO_x, PM_{10}, Cu and 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 share of the regional emissions of NOx, SOx and TSP compared to the national emissions for emission year 2019 is presented in the following table (Table 3-1):

Table 3-1 Share to national emissions by regions for the sector 1A1 in 2020

	Flanders	Brussels	Wallonia
NOx	74.5%	2.2%	23.3%
SOx	92.4%	0.0%	7.6%
TSP	17.5%	1.0%	81.5%

Following the table 3-1, Flanders is prominent for NO_X (74.5%), SO_X (92.4%) and Wallonia is prominent for TSP.

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.

The emissions of the public power plants and the waste incineration installations are based on continuous measurements for 66 % for NOx, 33 % for SO_2 and for 10 % for TSP in Wallonia. A part of the SO_2 emissions are coming from the combustion of biogas in waste plants (waste disposals, wastewater treatment plants,...) where emission factors have been used until 2013. In 2014, some analyses (NOx and SO_2) were performed on biogas engines in waste disposals.

During the 2017 NECD Comprehensive Review, the TERT noted that when continuous measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED (Industrial Emissions Directive) and have subtracted the value of the confidence interval although this subtraction must not be applied in the context of reporting annual emissions. This issue relates to an under-estimate of the emissions. The TERT recommended Belgium to organise a survey among operators to identify which ones are reporting under-estimated emissions and try to derive a methodology to adjust national emissions over the time series. Wallonia followed this recommendation and identified 2 operators that reported emissions for NOx, TSP, SO_2, CO and NMVOC after subtraction of the confidence interval since 2008. The emissions of these pollutants have been adjusted to add the confidence interval from 2008 on. Wallonia will prevent under-estimated reporting from operators in the future. Flanders also organised a survey and identified one operator that reported emissions taking into account the confidence interval. These emissions were corrected in the Flemish database.

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 (Table 3-2, Table 3-3).

Concerning the dust measurements and the dust emission factors, the TSP, PM10 and PM2.5 represent filterable PM emissions.

Table 3-2 Emission factors for the sector 1A1a Public electricity and Heat Production in the Walloon region (EMEP/EEA Guidebook 2019 – NH3 and biogas : EPA and Emep 1996 – HM for GC and BFG : average of measurements between 2005 and 2011 on boilers)

FUEL	**SO2**	**NOx**	**NMVOC**	**CO**	**NH3**	**TSP**	**PM10**	**PM2,5**	**BC**
	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
Natural gas (table 3-4)	PS	PS	2.60	39.00	0.60	0.89	0.89	0.89	0.02
Natural gas (in gas turbine) (table 3-17)			1.6	4.8	0.60	0.2	0.2	0.2	0.005

GC (CS)			2.60	39.00	0.87	2.60	1.18	1.18	0.03
BFG (CS)			2.60	39.00	0.60	2.60	1.18	1.18	0.03
Diesel oil (table 3-6)			0.80	16.20	0.10	6.50	3.20	0.80	0.27
Diesel oil (in gas turbine) (table 3-18)			0.19	1.49	0.10	1.95	1.95	1.95	0.65
Heavy fuel oil (table			2.30	15.10	0.10	35.40	25.20	19.30	1.08
Coal (table 3-2)			1.00	8.70	0.40	PS	PS	PS	2.2%of PM2.5
Biogas (in	43.70	88	2.50	13	15				
Wood (table 3-13)	10.80	81	7.31	90	7	172	155	133	4.39

FUEL	As	Cd	Cu	Cr	Ni	Pb	Se	Zn	Hg	Diox	PAH (4)	HCB	PCB
	mg/G	mg/G	mg/G	mg/G	mg/G	mg/G	mg/G	mg/G	mg/G	ng/G	mg/G	yg/G	ng/G
Natural gas	0.12	0.50	0.40	0.001	0.001	0.002	0.01	0.002	0.10	0.50	0.0031		
Natural gas (in gas	0.12	0.0003	7.6E-05	0.0008	0.0005	0.002	0.0112	0.0015	0.1		0.0116		
GC	5.40	2.60	5.30	9.00	7.50	8.40	0.30	9.20	0.10	1.90	0.150		
BFG	5.40	2.60	5.30	9.00	7.50	8.40	0.30	9.20	0.10	1.90	0.150		
Diesel	1.81	1.36	2.72	1.36	1.36	4.07	6.79	1.81	1.36	0.50	0.01		
Diesel oil (in gas	0.002	0.0012	0.17	0.28	0.0023	0.007	0.0023	0.44	0.053				
Heavy fuel oil	3.98	1.20	5.31	2.55	255	4.56	2.06	87.80	0.34	2.50	0.02		
Coal	PS	PS	PS	PS	PS	PS	PS	PS	PS	10	0.07	6.70	3.30
Wood	9.46	1.76	21.10	9.03	14.20	20.60	1.20	181	1.51	50	1.22	5.00	3500

Table 3-3 Emission factors for the sector 1A1a Public electricity and Heat Production in the Brussels Capital Region. (For natural gas and gas oil : EMEP/EEA Guidebook 2019 – NOx, NMVOC, SOx,PM2.5, PM10, TSP, BC, CO, PCDD/PCDF, heavy metals, PAHs; EMEP 1996 – NH3

FUEL	UNIT	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC	CO	PCDD/PCDF*
Natural gas and sludge gas	g/GJ	89	2.6	0.281	0.6	0.89	0.89	0.89	0.02225	39	0.5
Gas oil and rapeseed oil	g/GJ	65	0.8	46.5	0.1	0.8	3.2	6.5	0.268	16.2	0.5
Waste	g/tonne	306	20	0.26	3	6.23	6.23	6.23	0.218	51	61.40
FUEL	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAH(4)**
Natural gas	mg/GJ	0.0015	0.00025	0.1	0.12	0.00076	7.6E-05	0.00051	0.0112	0.0015	0.00308

and sludge gas											
Gas oil and rapeseed oil	mg/GJ	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	0,00692
Waste	mg/tonne	75.72	12.20	12.28	37.97	14.33	8.19	6.14	12	456	47

* ng-TEQ/GJ or ng-TEQ/tonne

In Flanders all NO_x emissions from power plants producing electricity are measured continuously, including the power plants using wood. For turbojets an emission factor of 197 g/GJ is used (for a very limited period of time (some hours per year) the turbojets are authorized.

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 fuels with low sulphur content are natural gas in gas turbines, CHP and gas motors and lamp oil in turbojets. For the other fuels, no EF's are used. Emissions are measured continuously. Natural gas contains little sulphur (source: Eandis[2]), so almost no SO_2 is released during combustion. For lamp oil, there are no emission factors in the EMEP Guidebook .

During the 2017 review the TERT noted that in Flanders no SO_2 emissions from natural gas or lamp oil are estimated. Belgium provided information on the emissions of SO_2 from gas fired power stations not using continuous measurement and showed that these sources make a very small contribution (0.06% of the total SO_2 emission from the Flanders region). In 2020 an estimate was made of these emissions for the entire time series. The emission factor 0,281 g/GJ SO_2 from the EMEP/EEA guidebook 2019 was used. The result of this calculation can be found in Table 3-4.

Table 3-4 Evolution of SO2 emissions from combustion of natural gas at power stations in Flanders.

SO_2 (ton)	
1990	0,915
1991	1
1992	0,435
1993	0,766
1994	5
1995	6
1996	8
1997	8
1998	17
1999	19
2000	15
2001	16
2002	17

2 Eandis offers network solutions for electricity, natural gas, heating and public lighting. Eandis is active in 229 cities and municipalities in Flanders, https://www.eandis.be/en/about-eandis/the-company/who-we-are-and-what-we-do

SO_2 (ton)	
2003	21
2004	21
2005	23
2006	23
2007	26
2008	27
2009	31
2010	31
2011	24
2012	21
2013	17
2014	13
2015	18
2016	19
2017	19
2018	20
2019	20

Due to the high amount of work to put these data in the Flemish data warehouse which provides the inventory in an automated way, this recommendation has not yet been implemented in the 2021 submission. It will be investigated to include these emissions together with the review on methodology of the collective emissions (see section 3.3.2.2). In the end the recommendation has been implemented in the 2022 submission.

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) (Table 3-5). A distinction is made between normal boilers and gas turbines (GT).

Emissions calculation:

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

Table 3-5 Emission factors of NMVOC for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Unit	Emission factor NMVOC - uncontrolled	Emission factor HCB-uncontrolled	RF-FGD	RF-SCR	Source
Coal	g/GJ	0,4	0.00000062	1	0,3	Eurelectric
Water treatment sludge	g/GJ	10	0.000006	1	0,3	VMM + Eurelectric for reduction
Olive stones	g/GJ	10	0.000006	1	0,3	VMM + Eurelectric for reduction

Fuel	Unit	Emission factor NMVOC - uncontrolled	Emission factor HCB-uncontrolled	RF-FGD	RF-SCR	Source
Wood dust	g/GJ	10	0.000006	1	0,3	VMM + Eurelectric for reduction
Wood chips	g/GJ	10	0.000006	1	0,3	VMM + Eurelectric for reduction
Wood pellets	g/GJ	10	0.000006	1	0,3	VMM + Eurelectric for reduction
Biodust	g/GJ	10	0.000006	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 (Table 3-6).

Emissions calculation:

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

Table 3-6 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

Fuel	Unit	Emission factor	RF_{ESP}	RF_{FGD}	RF_{SCR}	Source
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 3-7).

Table 3-7 Percentages of PM10 and PM2,5 as a fraction of TSP per power plant and percentages of EC as a fraction of PM2,5 per power plant

Power Group	%PM10	%PM2,5	Source	%EC* (2016)
EDF Luminus Gent	80	70	VITO	7.01
EDF Luminus Harelbeke	80	70	VITO	/
E.on Langerlo	100	100	CORINAIR	2.02
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	9.66
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	Equally Ruien 3, 4 and 5
Turbojets	100	100	CORINAIR	7
Gas groups	100	100	CORINAIR	7
A&S Energie	71.43	34.30	EMEP/EEA Guidebook	10
Biopower Oostende (before: Electrawinds Biomassa)	80	70	VITO	23.07

* % EC is calculated based on the fuel types of the last year. For an installation that has been inactive during the last year, no % can be calculated.

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.

Calculation of the emission per heavy metal per amount of fuel:

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

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/Nm^3 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 (Table 3-8). 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 (Table 3-8). 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)(Table 3-8). 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 3-8 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 (Table 3-9):

- 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 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[3]	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
Fuel A	Pb	0,192	0,1	0,1	1	US-EPA + CORINAIR for
Fuel A	Se	0,087	0,235	0,24	1	US-EPA + CORINAIR for
Fuel A	Zn	3,693	0,1	0,1	1	US-EPA + CORINAIR for
Gas oil	As	0,074	0,01	0,1	1	US-EPA + CORINAIR for
Gas oil	Cd	0,0555	0,1	0,1	1	US-EPA + CORINAIR for
Gas oil	Cr	0,0555	0,01	0,1	1	US-EPA + CORINAIR for
Gas oil	Cu	0,111	0,01	0,1	1	US-EPA + CORINAIR for
Gas oil	Hg	0,0555	0,965	0,05	1	US-EPA + CORINAIR for
Gas oil	Ni	0,0555	0,01	0,1	1	US-EPA + CORINAIR for
Gas oil	Pb	0,1665	0,1	0,1	1	US-EPA + CORINAIR for
Gas oil	Se	0,2775	0,235	0,24	1	US-EPA + CORINAIR for
Gas oil	Zn	0,074	0,1	0,1	1	US-EPA + CORINAIR for

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 (Table 3-10):

3 Fuel A = heavy fuel. The 'A' is an indication for the S-content (max 1%)

- 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 3-10 Emission factors for heavy metals from gaseous fuels for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel		Emission factor - 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 3-11.

Table 3-11 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-07	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,	8,00E-05	0	0	0	CORINAIR

biodust					
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 (Table 3-12). 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 3-12 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	-	-

<u>Emission calculation:</u>

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

The calculation of the emissions of polychlorinated biphenyls (PCB) is based on emission factors, representing the sum of PCBs (Table 3-13).

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

Table 3-13 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
Biodust	0,0456	ESI
Fuel A	0,0415	ESI
Gas oil	-	-
Paraffin	-	-
Natural gas	0	-
Blast-furnace gas	-	-

Emission calculation :

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

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 3-14, Table 3-15 and Table 3-16.

Table 3-14 Emission factors of NO_x, CO, SO_2 and NH_3 for the industrial CHP installations in joint-venture with the power plants in the Flemish region

Installation	Fuel	Unit	NO_x	CO	SO_2	NH_3	Source
Gas turbine	Natural gas	g/GJ	48	4.8	0.281	0.6	EMEP/EEA Guidebook 2019 *
Gas motor	Natural gas	g/GJ	135	56	0.5	0.6	EMEP/EEA Guidebook 2019*
Gas	Gas oil	g/GJ	398	1.49	46.5	0.1	EMEP/EEA

turbine							Guidebook 2019*
Gas motor	Gas oil	g/GJ	942	130	46.5	0.1	EMEP/EEA Guidebook 2019*
Gas turbine	Biogas/waste gas	g/GJ	88	13	43.7	15	EMEP/EEA Guidebook 2013
Gas motor	Biogas/waste gas	g/GJ	88	13	43.7	15	EMEP/EEA Guidebook 2013

*NH_3 EMEP/EEA Guidebook 2013

Table 3-15 Emission factors of TSP, PM10, PM2,5 and EC for the industrial CHP installations in joint-venture with the power plants in the Flemish region (source: EMEP/EEA Guidebook 2019)

Sector	Fuel	Unit	TSP	% PM10 of TSP	% PM2,5 of TSP	% EC of PM2.5
Chemical industry	Coal	ton/PJ	11,4	68%	30%	0,1
	heavy fuel	ton/PJ	35,4	71%	55%	0,1
	Natural gas	ton/PJ	0,890	100%	100%	0,07
	Gas oil	ton/PJ	6,50	49%	12%	0,45
	Biogas	ton/PJ	0,890	100%	100%	0,07
	Ind. Waste	ton/PJ	0,890	100%	100%	0,07
Food, drinks and beverages	Natural gas	ton/PJ	0,890	100%	100%	0,07
	biogas	ton/PJ	0,890	100%	100%	0,07
Paper	Natural gas	ton/PJ	0,890	100%	100%	0,07
Textile, leather and clothing	Natural gas	ton/PJ	0,890	100%	100%	0,07
Gas distribution	Natural gas	ton/PJ	0,890	100%	100%	0,07
	Gas oil	ton/PJ	6,500	100%	100%	0,45

Table 3-16 Emission factors of heavy metals for the industrial CHP installations in joint-venture with the power plants in the Flemish region (source: EMEP/EEA Guidebook 2019)

CHP installations	Fuel	Unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Chemical industry	coal	mg/GJ	7,3	0,9	1,4	7,1	4,5	7,8	4,9	23	19
Chemical industry	heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8

	Chemical industry	natural gas	mg/GJ	0,002	0,0003	0,1	0,12	0,001	0,0001	0,001	0,011	0,002
	Chemical industry	gas oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
	Chemical industry	biogas	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Chemical industry	industrial waste	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Food, drinks and tabacco	natural gas	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Food, drinks and tabacco	biogas	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Paper industry	natural gas	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Textile, leather and clothing industry	natural gas	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Gas distribution	natural gas	mg/GJ	0,002	3E-04	0,1	0,12	8E-04	8E-05	5E-04	0,011	0,002
	Gas distribution	Gas oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81

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 3-17).
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 3-18).

Table 3-17 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 3-18 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	µg/tonne	45.2	EMEP/CORINAIR Guidebook (2013)

Emissions of CHP installations in the service and agricultural sector are calculated based on the energy data (energy balance) and emission factors, as given in Annex 2 due to the abundance of the tables. Annex 2 also contains the NOx-emission factors for the CHP installations in the greenhouse horticulture sector, reported in sector 1A1a Public electricity and Heat Production in the Flemish region.

3.2.2.2 Petroleum refining (category 1A1b)

Category 1A1b is a key category of SO_x emissions in terms of emissions level and trend and of NOx in terms of emissions level and of PM2.5, TSP and PM10 in terms of trend.

The activity data of the petroleum refining are taken from the Flemish energy balance as petroleum refining only occurs in Flanders (5 refineries).

Combustion emissions 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), EC emissions are calculated as a fraction of PM2.5 (Table 3-19):

Table 3-19 Percentages of PM10 and PM2,5 as a fraction of TSP and percentage EC as a fraction of PM2.5 for petroleum refineries

Fuel	% PM10 of TSP	% PM2,5 of TSP	% EC of PM2.5	Source
Refinery gas	100	100	7	Study VMM/TNO
Light fuel	100	100	45	Study VMM/TNO
Heavy fuel	80	70	10	Study VMM/TNO
Cokes	60	35	10	Study VMM/TNO

The SO_2 implied EF shows a decrease between 2009 and 2010 since from 1 January 2010, the emission limit for SO_2 from refinery installations was decreased from 800 mg/Nm³ to 350 mg/Nm³ by the Flemish legislation (VLAREM). Therefore, the refineries made great investments to reduce their SO_2 emissions, like using fuel with low sulphur content and installation of wet gas scrubber.

Following a question raised during the NEC review concerning the reporting of NH_3 emissions in this sector, the emissions are reported by the facility. The NH_3 measurements are performed using photometric flow analysis according to the LUC/III/003 standard. When a facility does not report emissions for a specific year because the emissions are below the reporting threshold (in this case the emissions are very low, on average 1.5 ton over all years), emissions are not estimated individually for that facility but the emission gap is estimated in a collective way when activity data and emission factors are available. However, the guidebook does not provide emission factors for NH_3 for the sector 1A1b for any of the fuels. Flanders plans to perform a study to revise the methodology to estimate missing emissions in a collective way in the future. The company mentions there is no measurable presence of NH_3 in 2015. The missing emission is below the threshold of significance and moreover within the margin of error.

3.2.2.3 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 2014) and the only plant active in the Brussels region was closed in 1993.

In Wallonia, the emission factors for all main pollutants are plant specific. The non-diffuse NH_3 emissions are estimated by using the default emission factors (coke gas, 0,87 g/GJ). Following the recommendation of the review team, Wallonia estimated the non-diffuse emissions of heavy metals and dioxins in the category 1A1c on the complete time series. The emission factors from the table 5-1 from the guidebook were used with a proportional calculation with the regional TSP emission factor. For one coke plant, the emissions have been plant specific since 2002.

Concerning the dust measurements and the dust emission factors, the TSP, PM10 and PM2.5 represent filterable PM emissions.

There was a coke plant in the Brussels region until 1993. The emission factors used are those included in the EMEP/EEA guidebook 2019 for all the pollutants except for NH_3 which is the same as used in Wallonia Table 3-20.

Table 3-20 Emissions factors for the coke oven gas in Brussels in the sector 1A1c

Fuel	UNIT	NOx	SOx	NH3	PM2.5	PM10	TSP	CO	PCDD/PCDF*		

Coke oven gas	g/GJ	21	91	0,87	55	79	82	6	26		
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**Total HAP**
Coke oven gas	mg/GJ	28	1.6	30	11	5.7	25	5.2	2.9	46	0.295

* ug-TEQ/ton

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.

Emissions of TSP are provided by the facility. Emissions of PM10, PM2.5 and EC are calculated as resp. 50 % (of TSP), 20 % (of TSP) and 49 % (of PM2.5).

The notation key of particulate matter is IE because these emissions are included in 2C1.

The emission factors for heavy metals, used till 1999, are given in Table 3-21.

Table 3-21 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	0.38	0,007	0,012	0,013	0.17	0.048	0,12	0.016	0.22	EMEP/EEA Guidebook 2016

From 2000 on, for the heavy metals, the notation key is IE because from that year on the emissions are included in 2C1.

Following the recommendation of the review team, the notation key of NMVOC is corrected to IE from 2015 on, the notation key for NH_3 is NE since no NH_3 emissions are estimated by the steel plant that has a coke oven.

Emissions of coal mining activities were reported in 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 facilities. The mining industries have disappeared with the closure of the last coalmines in 1992.

Flemish PCDD/F emissions in the sector 1A1c originate from mining activities and one coke plant until 1995. These emissions disappear due to the closure of the mines and the coke plant. From 1996 on a notation key IE is used: the emissions of the coke oven situated at the steel plant are included in 2C1.

Also some emissions due to gas transport activities are included in this sector. The emission data are provided by the facilities.

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), non-metallic minerals (1A2f) and other industries (1A2g).

The following industries are integrated in category 1A2g (Other industries): metal products, textile, leather and clothing and other industry (wood industry, rubber and synthetic material, manufacturing of furniture, recycling and construction).

The industrial sector is not very developed in the Brussels Capital 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 1A2g 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. Figure 3-2 shows the trend of the energy consumption in this sector:

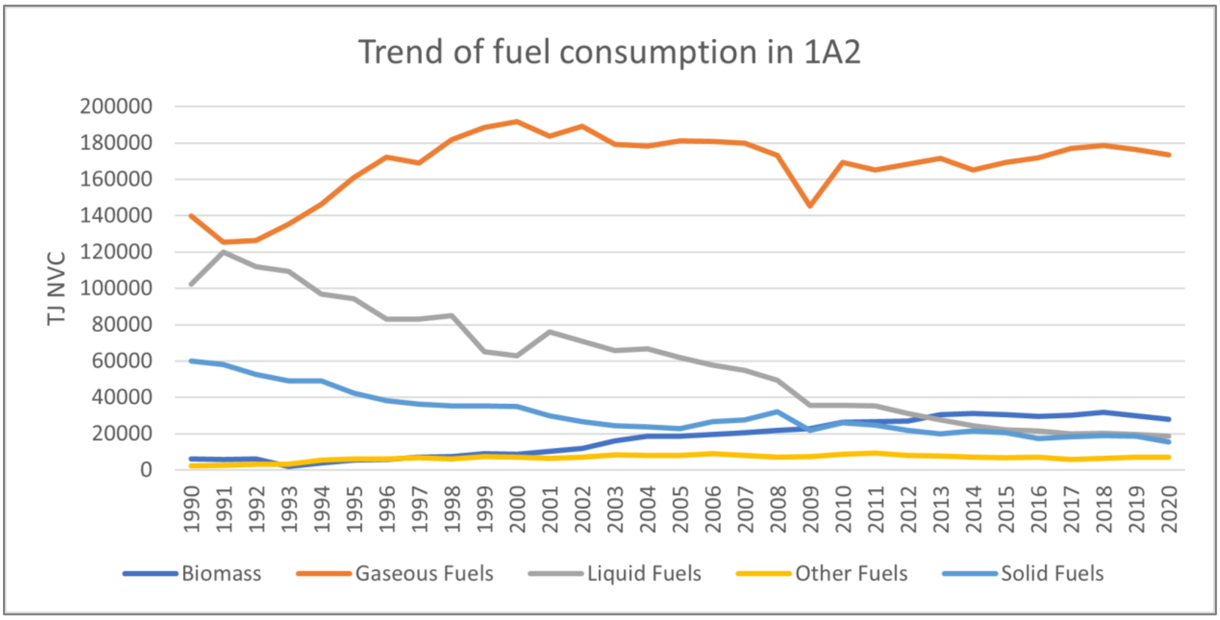


Figure 3-2 Trend of fuel consumption in the manufacturing Industries and construction.

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 below.

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 (Table 3-22 and Table 3-23) 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.

Following the EMEP guidebook, it is unclear whether the emission factors represent filterable PM or total PM.

Table 3-22 Emission factors for the sector 1A2 Manufacturing Industries and Construction in the Walloon region (EMEP/EEA Guidebook 2019 – NO_x diesel: calculated with the maximum norm in the plants permits for diesel boilers – Biogas and NH_3 : EPA and Emep 1996 – HM for GC and BFG : average of measurements between 2005 and 2011 on boilers)

	SO2	**NOx**	**NMVOC**	**CO**	**TSP**	**PM10**	**PM2,5**	**BC**	**NH3**
	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
Natural gas (1A2 T3-3, 1A4 T3-27)	0.5	74	2	29	0.45	0.45	0.45	0.02	0.6
Biogas	43.7	88	2.5	13					15
Diesel oil (1A2 T3-4 and 1A1		**163**	25	66	20	20	20	11.2	0.1
Fuel (1A2 T3-4 and 1A1 T3-5)		163	25	66	20	20	20	11.2	0.1
Coal (table 3-2)	900	173	88	931	124	117	108	6.912	0.4
Coke (table 3-2)	540	173	88	931	124	117	108	6.912	0.4
Wood (table 3-	11	91	300	570	150	143	140	39.2	37
BFG (CS)	70	74	2.5	25	2.60	1.18	1.18	0.03	
Coke gas (CS)	70	74	2.5	25	2.60	1.18	1.18	0.03	0.87
LPG (1A2 T3-3, 1A4 T3-27)		74	2	29	0.45	0.45	0.45	0.02	0.6
Petroleum coke (table 3-2)	540	173	88	931	124	117	108	6.912	

	As	**Cd**	**Cu**	**Cr**	**Ni**	**Pb**	**Se**	**Zn**	**Hg**	**Dioxins**	**PAH**	**PCB**	**HCB**
	mg/GJ									ng/GJ	mg/GJ	µg/GJ	µg/GJ
Natural	0.1	0	8E-	8E-	0	0	0.011	0.002	0.1	0.5	0.003		
Diesel oil	1.8	1.36	2.72	1.36	1.36	4.1	6.79	1.81	1.36	1.4	20.1		

Fuel	4	1.2	5.31	2.55	255	4.6	2.06	87.8	0.34	1.4	20.1		
Coal	4	1.8	17.5	13.5	13	134	1.8	200	7.9	203	146.6	170	0.62
Coke	4	1.8	17.5	13.5	13	134	1.8	200	7.9	203	146.6	170	0.62
Wood	0.2	13	6	23	2	27	0.5	512	0.56	100	35	0.06	5
BFG	5.40	2.60	5.30	9.00	7.50	8.40	0.30	9.20	0.10	1.90	0.1500		
Coke gas	5.40	2.60	5.30	9.00	7.50	8.40	0.30	9.20	0.10	1.90	0.1500		
LPG	0.1	0	8E-	8E-	0	0	0.011	0.002	0.1	0.5	0.003		
Petroleum coke	4	1.2	12	15	1030	4.6		49	0.11				

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
	2016	0.005	2.4

Table 3-23 Emission factors for the sector 1A2 Manufacturing Industries and Construction in the Brussels Capital Region.

Fuel	**UNIT**	**NOx**	**NMVOC**	**SOx**	**NH3**	**PM2.5**	**PM10**	**TSP**	**BC (EC)**	**CO**	**PCDD/PCDF***
Natural gas	g/GJ	74	23	0.67	0.6	0.78	0.78	0,78	0.0312	29	0.52
Gas oil	g/GJ	513	25	47	0,1	20	20	20	11.2	66	1,4
Butane/Propane	g/GJ	74	23	0.67	0.6	0.78	0.78	0.78	0.0312	29	0.52
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAH(4)**
Natural gas	mg/G	0.01	0.0009	0.5	0.1	0.013	0.002	0.01	0.058	0.7	0.0058
Gas oil	mg/G	0.08	0.006	0.1	0.0	0.2	0.22	0.00	0.11	29	0.0201
Butane/Propane	mg/GJ	0.011	0.0009	0.54	0.1	0.013	0.0026	0,013	0.058	0.73	0.0058
	* ng-TEQ/GJ										

3.3.2.1 Iron and steel sector (category 1A2a)

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

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 are 5 electric arc furnace plants and 7 iron foundries. 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. Four electric arc furnaces are operational in 2015.

In Wallonia, 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 of the sector 1A2.

A recalculation was performed this year for two plants with reheating furnaces without plant measurements for NOx and CO. Older emission factors had been used and were replaced by the EF from the 2019 guidebook (table 3-10) for the emissions of NOx and CO.

The dust emissions represent filterable PM for the IPCC companies but it is not clear for the remaining fuel combustion in the guidebook.

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.

To calculate the remainder of the emissions (emissions not reported directly by the individual companies) from the iron and steel sector in Flanders a methodology described by Sleeuwaert et al. (2010) is used. For this methodology 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 3-24) the estimated emission is calculated.

Table 3-24 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	SO_x	NO_x
Coal	g/GJ	82	683	242
Cokes	g/GJ	82	683	242
LPG	g/GJ	62	0.0000435	90
Gas and diesel oil	g/GJ	67	47	166
Heavy fuel	g/GJ	67	493	180
Natural gas and mine gas	g/GJ	59	0.0000450	46
Cokes gas	g/GJ	40	0,4690	58

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2019 are used, except for emissions of renewable solid fuels. This emission factor is based on the highest standard for this type of fuel. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP. EC is calculated as a fraction of PM2.5. (Table 3-25).

Table 3-25 Emission factors of TSP, PM10, PM2.5 and EC for the sector 1A2a Iron and steel in the Flemish region

Iron and steel	unit	TSP	% PM10 of TSP	% PM2,5 of TSP	% EC of PM2.5
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas- en diesel oil	ton/PJ	6,50	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Cokes gas	ton/PJ	1	100%	100%	7%
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source Renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO

Also the emissions of heavy metals are based on calculations. The emission factors to calculate the emissions of heavy metals for the iron and steel sector are given in Table 3-26.

Table 3-26 Emission factors of heavy metals for the sector 1A2a Iron and steel production in the Flemish region (Source: EMEP/EEA Guidebook 2019)

Iron and steel	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
Gas-en diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Cokes oven gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512

3.3.2.2 Category 1A2b to 1A2e

Category 1A2b is not a key category.

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

Category 1A2d is a key category of Pb, Cd, As, Cr and Zn emissions in terms of emissions level.

Category 1A2e is a key category of SO_x and Ni 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 methodology described by Sleeuwaert et al. (2010) is used. For a description of this methodology see above in section iron and steel (1A2a). For this collective approach, for each sector in these categories and each fuel type a specific corresponding emission factor is used.

During the review, the review team noted that the NO_X implied EF is not consistent through the time series. Belgium explained that the high IEF values of NO_X in 2014 and 2015 originate from high emissions in these years for the chemical sector in Flanders (combustion emissions), estimated via the collective approach (description of the methodology in the IIR p. 6 and p. 68). For each year and for each company and for each pollutant, missing emissions are identified. When a company reports emissions, the fuel consumption of this company is subtracted from the total energy consumption in the regional energy balance. When the company does not report emissions, it is assumed that the energy consumption is part of the total energy consumption. When a company implements abatement measures and the emissions fall below the reporting threshold set by the Flemish legislation (VLAREM), the energy consumption will not be subtracted from the total energy consumption. The emissions that are estimated on a collective basis are calculated by multiplying the total energy consumption (minus the energy consumption of the companies that report emissions) with an emission factor. Emission factors originate from the 2016 EMEP/EEA Guidebook or the emission limit values as described in VLAREM II (NO_X, CO) (Sleeuwaert F. et al., 2010). This results in relatively high emissions of the component estimates from the remaining energy consumption.

At the moment the current model is not fit to take into account the abatement technologies for individual facilities and to calculate more accurate emissions. This can only be obtained by a revision of the model. Therefore a feasibility study was conducted in 2020 and finalized in 2021. The aim of this study was to identify flaws and information gaps in the current method. Additionally, this study tried to set out a new approach for developing a more accurate and complete calculation of the collective emissions. The study focused on the quality of the current method with regard to all emissions, both individual and collective. It remained inconclusive to the fact that a new approach should be developed and emphasized the level of quality of the current method. Though, several suggestions were made to improve the industrial emissions inventory and after thorough analysis and discussions within the emission inventory team, these suggestions couldn't be implemented in the near future because of time and budgetary constraints and would imply a complete makeover of the current method or legislative changes. Therefore, the team decided to maintain the current methodology. The emission factors currently used in the collective approach are given in Table 3-27 and will be updated if needed to.

Table 3-27: Emission factors of CO, SO2 and NOx for the sectors 1A2b Non-ferro, 1A2c Chemistry, 1A2d Pulp, paper and print and 1A2e Food processing, beverages and tobacco in the Flemish region used in the collective approach

Industrial sector	Fuel type	CO (g/GJ)	SOx as SO2 (g/GJ)	NOx as NO2 (g/GJ)
Non ferro	Cokes (GJ)	82	683	252
Non ferro	LPG (GJ)	66	0	94
Non ferro	Gas- en diesel oil (GJ)	70	47	176
Non ferro	Heavy fuel (GJ)	69	493	183
Non ferro	Petroleum cokes (GJ)	76	637	235
Non ferro	Natural gas and mine gas (GJ)	63	0	47
Non ferro	Other fuels (GJ)			
Non ferro	Coal (GJ)	82	683	252
Chemistry	Refinery gas (GJ)	61	0	89
Chemistry	LPG (GJ)	62	0	90
Chemistry	Gas- en diesel oil (GJ)	67	47	166
Chemistry	Heavy fuel (GJ)	67	493	180
Chemistry	Petroleum cokes (GJ)	76	637	226
Chemistry	Natural gas and mine gas (GJ)	59	0	46
Chemistry	Other fuels (GJ)	63	23	106
Chemistry	Renewables - solid (GJ)	156	13	260
Chemistry	Renewables - liquid (GJ)	76	1	189
Chemistry	Renewables - gaseous (GJ)	54	9	79
Food processing, beverages and tobacco	Cokes (GJ)	82	683	252
Food processing, beverages and tobacco	LPG (GJ)	66	0	94
Food processing, beverages and tobacco	Gas- en diesel oil (GJ)	70	47	176
Food processing, beverages and tobacco	Lamp petroleum (GJ)	69	46	175
Food processing, beverages and tobacco	Heavy fuel (GJ)	69	493	183
Food processing, beverages and tobacco	Natural gas and mine gas (GJ)	63	0	47

Industrial sector	Fuel type	CO (g/GJ)	SOx as SO2 (g/GJ)	NOx as NO2 (g/GJ)
Food processing, beverages and tobacco	Renewables - solid (GJ)	156	13	260
Food processing, beverages and tobacco	Renewables - liquid (GJ)	79	1	200
Food processing, beverages and tobacco	Renewables - gaseous (GJ)	58	9	83
Paper and print	Coal (GJ)	82	683	214
Paper and print	LPG (GJ)	49	0	77
Paper and print	Gas- en diesel oil (GJ)	61	47	136
Paper and print	Heavy fuel (GJ)	61	493	172
Paper and print	Natural gas and mine gas (GJ)	47	0	44
Paper and print	Renewables - solid (GJ)	156	13	260
Paper and print	Renewables - gaseous (GJ)	43	9	68

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2019 are used, except for emissions of cokes, coal and renewable solid fuels. These emission factors are based on the highest standard for these type of fuels. Activity data are taken from the Flemish energy balance. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP. The EC emissions are calculated as a fraction of PM2.5 (Table 3-28).

Table 3-28 Emission factors of TSP, PM10,PM2,5 and EC for combustion in the sectors of non-ferro, chemistry, pulp and paper and food and drinks in the Flemish region

Non-ferro 1A2b	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2.5
Cokes	ton/PJ	62.7	94%	87%	10%
Coal	ton/PJ	62.7	94%	87%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Petrol cokes	ton/PJ	20	75%	45%	10%
Gas-and diesel oil	ton/PJ	6,50	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%

Natural gas	ton/PJ	0,45	100%	100%	7%
Other fuels	ton/PJ	3,475	75%	56%	26%
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source cokes, coal, renewable fuels -solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Chemical sector 1A2c	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2.5
Petroleum cokes	ton/PJ	20	75%	45%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas and diesel oil	ton/PJ	6,50	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Other fuels	ton/PJ	3,48	75%	56%	26%
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Renewable fuels - liquid	ton/PJ	6.5	49%	12%	45%
Renewable fuels - gaseous	ton/PJ	0,45	100%	100%	7%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Pulp and paper 1A2d	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2.5
Coal	ton/PJ	company specific	94%	87%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas and diesel oil	ton/PJ	6,5	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Other fuels	ton/PJ	6.5	100%	100%	7%
Renewable fuels - solid	ton/PJ	company specific	95%	93%	10%

Renewable fuels -	ton/PJ	0,45	100%	100%	7%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Food, drinks and tobacco 1A2e	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2.5
Cokes	ton/PJ	62.7	94%	87%	10%
Coal	ton/PJ	company specific	94%	87%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas-and diesel oil	ton/PJ	6,50	49%	12%	45%
Lamp petrol	ton/PJ	6.5	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Renewable fuels -	ton/PJ	0,45	100%	100%	7%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source cokes, renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO

Also the emissions of heavy metals are based on calculations. The emission factors to calculate the emissions of heavy metals for the sectors of non-ferro, chemistry, pulp and paper and food and drinks are given in Table 3-29.

Table 3-29 Emission factors of heavy metals for the sectors of non-ferro, chemistry, pulp and paper and food and drinks in the Flemish region (Source: EMEP/EEA Guidebook 2019)

Non-ferro 1A2b	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Cokes	mg/GJ	134	1,8	7,9	4	13,5	17,5	13	1,8	200
Heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
Petroleum cokes	mg/GJ	4,6	1,2	0,3	3,98	14,8	11,9	773	2,1	49,3
Gas-en diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Other fuels	mg/GJ	2,03575	0,680125	0,73	0,965	0,68038	1,360038	0,680255	3,4005	0,90575
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512

Chemical sector 1A2c	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Petroleum cokes	mg/GJ	4,6	1,2	0,3	3,98	14,8	11,9	773	2,1	49,3
Heavy fuel	mg/GJ	4,56	1,2	0,341	3.98	2,55	5,31	255	2,06	87,8
Gas-en diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Other fuels	mg/GJ	2,03575	0,680125	0,73	0,965	0,68038	1,360038	0,680255	3,4005	0,90575
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512
Renewable fuels - liquid	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
Renewable fuels - gaseous	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

Pulp and paper 1A2d	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Coal	mg/GJ	134	1,8	7,9	4	13.5	17.5	13	1.8	200
Heavy fuel	mg/GJ	4,56	1,2	0,341	3.98	2,55	5,31	255	2,06	87,8
Gas-en diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

Other fuels	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512
Renewable fuels - gaseous	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

Food, drinks and tobacco 1A2e	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Cokes	mg/GJ	134	1,8	7,9	4	13.5	17.5	13	1.8	200
Coal	mg/GJ	134	1,8	7,9	4	13.5	17.5	13	1.8	200
Heavy fuel	mg/GJ	4,56	1,2	0,341	3.98	2,55	5,31	255	2,06	87,8
Gas-en diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512
Renewable fuels - gaseous	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

In Wallonia, all the plants which are under the IPPC directive report their annual emissions. The dust emissions represent filterable PM. The remainder of the emissions is calculated on the basis of the energy balance and the default emissions factors (Table 3-22).

3.3.2.3 Non-metallic minerals (category 1A2f)

Category 1A2f is a key category of Ni emissions in terms of emissions level.

The sector 1A2f includes combustion emissions of the ceramic sector, the lime production in a chemical plant, in sugar plants and in a paper pulp plant. All the emissions of the cement plants, the glass plants and the lime plants are in the category 2A and are plant specific.

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 1A2f in Flanders a methodology described by Sleeuwaert et al. (2010) is used. For a description of this methodology see above in section iron and steel (1A2a). For this collective approach, for each sector in these categories and each fuel type a specific corresponding emission factor is used (Table 3-30).

Table 3-30 Emission factors of CO, SO_x and NO_x in the non-metallic minerals sector used in the collective approach

Non- metallic minerals	Unit	CO	SO_x	NO_x
Coal	g/GJ	82	683	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
Petrol cokes	g/GJ	76	637	226
Other fuels	g/GJ	82	683	242

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2019 are used, except for emissions of other fuels. This emission factor is based on the highest standard for this type of fuel. Activity data are taken from the Flemish energy balance. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP and EC emissions are determined as a fraction of PM2.5 (Table 3-31).

Table 3-31 Emission factors of TSP, PM10, PM2.5 and EC for combustion in the sectors of non-metallic mineral product activities in the Flemish region

Non-metallic mineral products 1A2f	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2,5
Petrol cokes	ton/PJ	20	75%	45%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas and diesel oil	ton/PJ	6,50	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Other fuels	ton/PJ	62.7	94%	87%	10%
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source other fuels, renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO

The emissions of heavy metals are based on calculations (fuel consumed x emission factors per fuel type). Activity data are taken from the Flemish energy balance. Table 3-32 gives an overview of the emission factors that are used to calculate the emissions of the sectors included in category 1A2f.

Table 3-32 Emission factors of heavy metals for combustion in the sector of non-metallic mineral product activities for the Flemish region (Source: EMEP/EEA Guidebook 2019)

Non-metallic mineral products 1A2f	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Cokes	mg/GJ	134	1,8	7,9	4	13,5	17,5	13	1,8	200
Coal	mg/GJ	134	1,8	7,9	4	13,5	17,5	13	1,8	200
Heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
Gas-and diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Other fuels	mg/GJ	134	1,8	7,9	4	13,5	17,5	13	1,8	200
Renewable fuels - solid	mg/GJ	27	13	0.56	0.19	23	6	2	0.5	512

In Wallonia, all the plants which are under the IPPC directive report their annual emissions. The dust emissions represent filterable PM. The remainder of the emissions is calculated on the basis of the energy balance and the default emissions factors (Table 3-22).

In the case of asphalt concrete plants, the NOx, CO and SOx emissions are calculated with the emission factors of the table 3-25 of the EMEP/EEA Guidebook 2019. VOC and dust are included in the process sector. Heavy metals and dioxins emission factors are coming from the ULg study, see Table 3-33.

Table 3-33 Emission factors of heavy metals and dioxins for combustion in the sector of asphalt concrete plants

	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Diox
Production	mg/Gg	0.37	0.42	0.23	0.33	0.45	0.18	2.1	0.046	0.34	3.4 ng/Gg

3.3.2.4 Other industries (category 1A2gviii)

Category 1A2gviii is a key category of TSP, BC and Cd in terms of emissions level and of SOx and Ni emissions in terms of emissions 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 1A2gviii in Flanders a methodology described by Sleeuwaert et al. (2010) is used. For a description of this methodology see above in section iron and steel (1A2a). For this collective approach, for each sector in these categories and each fuel type a specific corresponding emission factor is used (see Table 3-34).

Table 3-34 Emission factors of CO, SO_x and NO_x in the other industries used in the collective approach

Metal products 1A2gviii	Unit	CO	SO_x	NO_x
Cokes	g/GJ	82	683	204
LPG	g/GJ	44	0.0000435	73
Gas and dieseloil	g/GJ	59	47	126
Gasoline	g/GJ	57	46	123
Heavy fuel	g/GJ	58	493	170
Natural gas	g/GJ	43	0.0000450	43
Renewable fuels - solid	g/GJ	156	13	260
Renewable fuels - fluid	g/GJ	67	0.53	143
Textile, leather and clothing 1A2gviii	Unit	CO	SO_x	NO_x
LPG	g/GJ	66	0.0000435	94
Gas and dieseloil	g/GJ	70	47	176
Heavy fuel	g/GJ	69	493	183
Natural gas	g/GJ	63	0.000045	47
Other industries 1A2f				
Coal	g/GJ	82	683	233
LPG	g/GJ	58	0.0000435	86
Gas and dieseloil	g/GJ	65	47	156
Heavy fuel	g/GJ	65	493	178
Natural gas	g/GJ	55	0.000045	46
Renewable fuels - solid	g/GJ	156	13	260
Other industries 1A2gviii	Unit	CO	SOx	NOx
Coal (GJ)	g/GJ	82	683	233
LPG (GJ)	g/GJ	58	0	86
Gas- en diesel oil (GJ)	g/GJ	65	47	156
Lamp petroleum (GJ)	g/GJ	65	46	155
Heavy fuel (GJ)	g/GJ	65	493	178
Natural gas and mine gas (GJ)	g/GJ	55	0	46
Renewables - solid (GJ)	g/GJ	156	13	260

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2019 are used, except for emissions of cokes, coal and renewable solid fuels. These emission factors are based on the highest standard for these type of fuels. Activity data are taken from the Flemish energy balance. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP and EC emissions are determined as a fraction of PM2.5 (Table 3-35).

Table 3-35 Emission factors of TSP, PM10, PM2.5 and EC for combustion in the sectors of metal products, textile, leather and clothing and other industries in the Flemish region

Metal products 1A2gviii	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2,5
Cokes	ton/PJ	62.7	94%	87%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas and diesel oil	ton/PJ	6,50	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Other fuels (i.e. H_2)	ton/PJ	-	-	-	-
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Renewable fuels - liquid	Ton/PJ	6,50	49%	12%	45%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source cokes, renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO

Textile, leather and clothing 1A2gviii	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2,5
Heavy fuel	ton/PJ	35,40	71%	55%	10%
Gas and diesel oil	ton/PJ	6,50	49%	12%	45%
Lamp petrol	ton/PJ	6,5	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Renewable fuels - solid	ton/PJ	77.9	95%	93%	10%
Renewable fuels - gaseous	ton/PJ	0.45	100%	100%	7%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO

Other industries 1A2gviii	Unit	TSP	%PM10 of TSP	%PM2,5 of TSP	%EC of PM2,5
Coal	ton/PJ	62.7	94%	87%	10%
Heavy fuel	ton/PJ	35,40	71%	55%	10%

Gas and diesel oil	ton/PJ	6,50	49%	12%	45%
Petrol	ton/PJ	6,5	49%	12%	25%
Lamp petrol	ton/PJ	6,5	49%	12%	45%
LPG	ton/PJ	0,45	100%	100%	7%
Natural gas	ton/PJ	0,45	100%	100%	7%
Other fuels	ton/PJ	0,45	100%	100%	7%
Renewable fuels- solid	ton/PJ	77.9	95%	93%	10%
Source		EMEP/EEA Guidebook	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO
Source coal, renewable fuels - solid		standard	EMEP/EEA Guidebook	EMEP/EEA Guidebook	TNO

The emissions of heavy metals are based on calculations (fuel consumed x emission factors per fuel type). Activity data are taken from the Flemish energy balance. Table 3-36 gives an overview of the emission factors that are used to calculate the emissions of the sectors included in category 1A2gviii.

Table 3-36 Emission factors of heavy metals for combustion in the sectors of metal products, textile, leather and clothing and other industries in the Flemish region (Source: EMEP/EEA Guidebook 2019).

Metal products 1A2gviii	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Cokes	mg/GJ	134	1,8	7,9	4	13,5	17,5	13	1,8	200
Heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
Gas-and diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512
Renewable fuels - liquid	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81

Textile, leather and clothing 1A2gviii	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
Gas-and diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512
Renewable fuels - gaseous	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015

Other industries 1A2gviii	unit	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Coal	mg/GJ	134	1,8	7,9	4	13,5	17,5	13	1,8	200
Heavy fuel	mg/GJ	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
Gas-and diesel oil	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
Petrol	mg/GJ	4,07	1,36	1,36	1,81	1,36	2,72	1,36	6,79	1,81
LPG	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Natural gas	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Other fuels	mg/GJ	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,011	0,0015
Renewable fuels - solid	mg/GJ	27	13	0,56	0,19	23	6	2	0,5	512

In Wallonia, all the plants which are under the IPPC directive report their annual emissions. The dust emissions represent filterable PM. The emissions of the area source is calculated on the basis of the energy balance and the default emission factors for the sector 1A2.

In the Brussels Capital Region, the emissions from industry are based on the energy consumptions described in the regional energy balance and the emission factors mentioned in Table 3-23.

3.3.2.5 Mobile Combustion in manufacturing industries and construction (category 1A2gvii)

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 1A2gvii). Activity data used: the fleet of fork-lift trucks and 25 other types of machines in the manufacturing industries and construction sector are obtained from sale statistics 1991-2019 (http://sigmafederation.be/nl/home/), technical data and activity data of the vehicles and machines are obtained via a technical workshop with experts (2005).

During the 2021 submission the emissions of these sectors are recalculated. Input data of machines used for construction activities, obtained by the federation of Sigma, are still the basis for the calculation of emissions in the construction industry. A distribution key was used for dividing the national emissions in the 3 regions. Data about real started construction sites, used for dividing the emissions at the regional level, were no longer available by the National Bank since 2015. Consequently a new methodology was used during this submission for splitting the emissions into the 3 regions. The distribution key is now calculated based on the amount of building permits reached out in each region and the corresponding space per (re)built building. These data are obtained by the Belgian statistical offices. These changes lead to an increase of the emissions in the Flemish region and a decrease of emissions in the Walloon and Brussels regions.

In Wallonia, some plants (cement plant, carriers,...) report their off-road emissions which are also included in 1A2gvii. These emissions aren't included in the Offrem model. There are HM EF used for these emissions. During the 2019 submission, Wallonia calculated the As, Pb and Hg emissions from the use of liquid fuels in this category. The emission factors were taken from the Emep Guidebook 2009 – table 3-38 – fuel=gasoil. As = 1,81 mg/GJ; Hg = 1,36 mg/GJ; Pb = 4,07 mg/GJ. Nevertheless, these EF are too high, there are new EF in the emep guidebook 2019 (1A4 table 3-31): As = 0,06 mg/GJ; Hg = 0,11 mg/GJ and Pb = 0,15 mg/GJ. Due to lack of resources, it has not be changed this year but it will be changed in the next submission.

Concerning the trend, the problem is the consistency of these activity data for the whole time series. For some years, plants didn't give the fuel consumption of the mobile machinery and all the emissions were included in 1A2f for these plants.

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. 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. The impacts to the environment and health resulting from the emissions from road traffic are significant. Goods (without pipelines) are transported by railways for 7.7% of total achieved ton-kilometers in Belgium, on navigable waterways for 15.9% and by road transport for 76.4% (2016[4]).

The reported emissions in the transport sector are reported in the categories 1A3a Civil aviation, 1A3b Road transport, 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 harbors, airports and due to storage and handling.

No civil aviation takes place in the Brussels Capital Region, Brussels Airport is located in the Flemish region.

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)

Category 1A3bi-vii is a key category of NOx, NMVOC, PM2.5, PM10, TSP, BC, CO, Pb, As, Hg, Cr, Cu, Ni, Zn and PAH emissions.

4 Bureau fédéral du Plan, Base de données transport (consultée le 11/03/2019)

Until the 2013 submission, the 3 regions used COPERT methodologies in specific regional models (previous versions of COPERT4 were used in the Walloon and the Brussels Capital 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 harmonized and each Region in Belgium calculates its own part of the emission inventory for road transport, using the COPERT software. To assure the consistency between these separate calculations, the methodologies to produce input for COPERT have been harmonized and common calculation tools have been developed: a vehicle stock module, and a module for the processing of road transport statistics (to calculate the vehicle kilometers driven by each combination of vehicle type, size, fuel and EURO).

Belgium uses an Entity-Mode COPERT version for fuel balancing the 3 Belgian Regions within the same year (fuel sold emissions). EMISIA made a COPERT 5 version in 'Entity mode' to make it possible to perform a fuel balance for all entities (=3 Regions in case of Belgium) within the same year, based on the fuel used COPERT runs of the Regions and the federal petroleum statistics.

COPERT 5 uses an equilibrium methodology based on energy while COPERT 4 was based on vehicle-kilometers. As a consequence, the real energy content for biomass is now taken into account and a slight increase in energy consumption (in comparison with COPERT4) is now observed since 2009. This is essentially due to biogasoline content in the blend (less energy content than fossil gasoline) for the same kilometers driven in the "fuel used" calculations. As the final impact on pollutant emissions depends also on the ratio" fuel sold /fuel used" the consequences are not so obvious.

Emission factors used in the COPERT model can be found in the EMEP/EEA Guidebook 2019.

Dust emissions exhaust: Following the EMEP/EEA Guidebook 2019 PM contains a large fraction of condensable species. Hence, PM mass emission factors in this chapter are considered to include both filterable and condensable material.

Dust emissions non-exhaust: no information on condensables in EMEP/EEA Guidebook 2019.

There's a difference in emissions for all pollutants between submission 2020 and submission 2021 due to

- Use of other COPERT version: for submission 2021 COPERT 5.4.36 was used, for submission 2022 there was a switch to COPERT 5.5.1Listing of different COPERT-versions: https://www.emisia.com/utilities/copert/versions/. An Entity-Mode COPERT version is used to 'fuel balance' the 3 Belgian regions within the same year (fuel sold emissions).

The CO_2 correction-option in COPERT is no longer used because of uncertainty about methodology and suitability of our possible input.

COPERT 5.5.1

An overview of some input parameters in COPERT 5:

- For environmental information, the 3 Belgian Regions use the same information for Min and Max Temperatures and humidity from the Royal Meteorological Institute of Belgium.
- Trip characteristics are Region dependent, and are taken e.g. from research on travel behavior.

- Fuel specifications: for H:C and O:C data no country specific data are available (despite the many questions sent to the Belgian Fund for the Analysis of Petroleum Products (Fapetro)). H:C, O:C = COPERT 5 data = data in EMEP/EEA air pollutant emission inventory guidebook 2019, p. 43, table 3-29. Density and heavy metals in fuel: default COPERT values. Content S and Pb is country specific. Only biogasoline has been adapted with country-specific values since 2017 because the composition has evolved (large amounts of ETBE and MTBE).
- LHV: COPERT default values are used but as for fuel specifications, LHV of biogasoline has been adapted since 2017.
- Lubricants Specification: no country specific information is available
- Reid Vapor Pressure: country specific values, same in the 3 Regions
- Fossil fuel fraction in bio: the exact amount of C fossil in biomass (using data from Federal Public Service Economy, SMEs, Self-employed and Energy) and following the recommendations of the WG1 of the CCC.
- Stock & Activity data: changes relative to most recent stock data
- Circulation activity: country specific, no information on the share urban peak and off peak (50%/50% is used)
- A/C usage: default COPERT values are used
- Blend share: country specific information used (data from Federal Public Service Economy, SMEs, Self-employed and Energy)

Changes in vehicle stock module

The main aim of the update was to adapt the existing vehicle stock module to allow the transition from COPERT4 to COPERT5 for the emission inventory calculations. To build a basis stock/fleet for COPERT the database of the registration of all Belgian Vehicles is used (DIV = Directorate Registration Vehicles; part of Federal Public Service Mobility). Some calculations/assumptions had to be made to use the fields from this database for classification of vehicles in tune with COPERT stock.

The main changes relative to the stock module since COPERT 5 are:

- changes in vehicle classification to allow conversion into COPERT 5-format: e.g. LDV now 3 size classes based on Reference Weight (N1-I, N1-II and N1-III) in COPERT, in the tool now split up by using the fields ‘reference mass’, ‘mass in running order’ and ‘tare’.

Also the vehicle category naming for CAR has changed in mini, small, medium and large-SUV-Executive. Emisia (COPERT) does not define how the distinction should be made in the categories. Thinking that a classification based on the mass/weight of the car would be the best solution to tackle this problem, some analysis of time trends in the averages of [MASS_IN_RUNNING_ORDER] were done for the COPERT 4 size classes (according to cylinder capacity). But the conclusion was that it was very difficult to set mass limits for the DIV-data that accurately determine the new size classes (Mini, Small, Medium, Large-SUV-EXECUTIVE) as defined by COPERT5. For CAR still the size class based on cylinder capacity as defined by COPERT 4 is used, with <0.8 l = mini, 0.8-1.4 l = small, 1.4-2.0 l = medium and > 2.0l = Large-SUV-executive.

- new DIV extracts requested because of lack of some data fields (needed for the new methodology) in the extracts used for the COPERT 4 calculation. Every time an extract is made from the DIV database, this gives a photo of the registered vehicles for a certain year at the time of the survey. Asking an extract for a certain year at another time can therefore result in a slightly different fleet.

- using the new DIV data field [FIRST_KNOWN_USE_DATE]: Starting from inventory year 2015 (DIV-extract “DIV16”), a new database field [FIRST_KNOWN_USE_DATE] is available. The main reason for the addition of this data field, was the introduction of the compulsory registration of mopeds (vehicle category “MP”), both for new mopeds and mopeds that were already in use. The field [FIRST_KNOWN_USE_DATE] was added to make sure that the correct age can be determined for the mopeds that are registered after already being in use for some time.

- a correction procedure for old inactive vehicles was developed (≠ oldtimers): it was noticed that the number of (very) old vehicles in the DIV-database is unrealistically high, in particular for gasoline passenger cars. Some old vehicles which are no longer in use are still present in the DIV-database (this was checked with data available from LEZ and tax authorities). Vehicles officially registered as an oldtimer are still in the stock, they can be identified by their plate, starting with an ‘O’.

- adapted determination of vehicle category: It was noticed that there were some mismatches in defining a vehicle category when not taking into account the size (based on vehicle weight) of a vehicle.

- new procedure to fill missing values for EURO classification and adding a filter to remove unrealistic EURO-values. The new procedure works on the basis of the full registration data, while the old procedure only took ‘the year of registration = year of building’ into account. And sometimes the introduction dates of the emission standards depend on the size class of the vehicle (e.g. for LDV). Where necessary the new procedure takes the size class of the vehicle.

- new procedure for urban buses: in the old module the data for urban buses was estimated on data from the public transport providers and their subcontractors, with a second step to calculate the number of coaches (= total number of buses in DIV – number of urban buses estimated). For COPERT 5 the stock urban buses is identified based on the VIN (vehicle identification number).

- Since COPERT 5.4.36 gasoline and gasoil Plug-in Hybrid Electric Vehicles (PHEV) are included for the first time as well as hybrid busses as a new car category.

Changes in vehicle mobility module (named MAM = mobility allocation module)

The main aim of the update was to adapt the module of allocation of vehicle kilometers to the different vehicle categories, to allow the switch from COPERT4 to COPERT5. Fleet data produced with the new fleet module serve as a base for MAM.

The main changes relative to the mobility module used since COPERT 5 are:

- all vehicles produced with the stock module taken into account: vehicles not (yet) included in COPERT (electric vehicles) are taken along for calculations in the mobility module (important for non-exhaust emission calculation).

- new correction for activity by foreign heavy duty vehicles: there is a high share of foreign heavy duty vehicles that drive on Belgian highways, vehicles who are not registered in the database of the Federal Public Service Mobility. Their age (EURO) has to be estimated. In the COPERT 4 module the difference in age between foreign and domestic vehicles is estimated based on fleet composition in TREMOVE, and there is an estimated relative increase of the fleet to account for the number of foreign vehicles. Since 01/04/2016 there is a kilometer charge for all vehicles with transport of goods above 3,5t (HDV) in Belgium. A dataset with registered trips from the OBU (on board unit) of these HDV made is possible to have a view on the age and the amount of foreign HDV.

- Some changes related to input sources for some vehicle categories: which year to use in data from authorized car inspection companies, which mileage profile to use for LPG, …

- Some changes made to the classification in EURO, made by the stock module: The stock module only makes the translation of an encrypted database of registered cars from Federal Public Service Mobility into a fleet, without making a division in further COPERT classes of vehicles (this to be sure that all vehicles are taken into account, even these not (yet) taken along in COPERT). Distribution in detailed COPERT vehicle categories is done by MAM module. These vehicles must be allocated a number of vehicle kilometers driven. One of the data sources for this is the dataset with average mileage (calculated from the odometers of vehicles) per vehicle type per year of construction, registered by authorized car inspection companies. In this dataset no longer the figures from column 'Km traveled the last year (on an annual basis)' are used, but a value that more closely matches 'Km traveled the last year (real)', which takes into account that vehicles were deregistered during the year, and that most new vehicles were not in use for a full year. This change has noticeably changed the shares of the EURO classes in the MAM results.
- Due to implementation of LEZ in whole Brussels Region, data of ANPR cameras there is used to calibrate stock of CAR and LDV for this Region

3.4.2.2 Air transport (1A3a)

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

Flemish Region

From the 2017 submission on, a new tool, EMMOL (Vanhove, 2016), was used to define the emissions for air transport.

EUROCONTROL 'fuel and emissions inventory' calculates the emissions for all EU Member States. Fuel and emission values were made available for all Belgian airports for flights arriving or leaving to/from Belgium. Half of October 2021 EUROCONTROL made available the dataset with emissions for years 2020 and a document with the explanation about the changes made. A flight category has been added in the EUROCONTROL data : a number of flights are 'undetermined' in their calculations. For the Belgian data of EUROCONTROL, all these *undetermined* are domestic flights. The *undetermined* are flights that depart from and arrive at the same airport. Previously they were not included in their calculations, but are now kept in the 'undetermined' category. Certainly in 2020 there will be many of those flights. Aircrafts could not fly, but were sometimes sent into the air to be operational and to be able to maintain them technically, and so they departed and arrived at the same airport. In the emission calculation 2020, this category is included as domestic flights.

International LTO and cruise

We assume that for international flights on kerosene (as well LTO as cruise) EUROCONTROL emissions can be taken without further edits.

To calculate international emissions LTO and cruise from airplanes on AvGas, statistics with movements in the airports are used, and emission factors from the EMEP/EEA Guidebook 2013 (for turboprops the Guidebook 2006, and for piston engines a combination of EF from Swiss FOCA (Federal Office of Civil Aviation), EPA AP-42 Volume II and EMEP/EEA Guidebook 2006_table 8.5 B851 vs2.3spreadsheet2-1).

Domestic LTO

For the smaller airports a significant part of the air traffic consists of small aircrafts (VRF) and helicopters, which are not taken into account in EUROCONTROL calculations or the BELGOCONTROL database. To calculate emissions for domestic LTO air traffic, statistics with movements in the airports are used, and emission factors from the EMEP/EEA Guidebook 2013 (for turboprops the Guidebook 2006, and for piston engines a combination of EF from Swiss FOCA (Federal Office of Civil Aviation), EPA AP-42 Volume II and EMEP/EEA Guidebook 2006_table 8.5 B851 vs2.3spreadsheet2-1).

Domestic cruise

To calculate emissions from domestic cruise, first the fuel consumption is calculated by subtracting fuel consumption domestic LTO from the total fuel sold amount ‘domestic’ per airport. Emission factors used to calculate the emissions for domestic cruise are average EFs calculated on the EUROCONTROL emission files Oct. 2015, an average over time-series 2010-2014. Cruise emissions are reported for the first time in Flanders in the 2018 submission.

<u>Emission factors</u>

The emission factors to calculate domestic LTO and domestic cruise emissions are given in Table 3-37 and Table 3-38.

Table 3-37 Emission factors for piston engines, helicopters and turboprops (kg/LTO)

airplane type	name	NOx	CO	NMVOS	SOx	PM25	Engines	Engine Type	Aircraft Type	EF based on :
EN28	ENSTROM 280C	0.01	6.59	0.09	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EXEC	ROTORWAY EXEC 90	0.01	5.12	0.08	0.00	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
H269	SCHWEIZER 269C	0.01	6.59	0.09	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
HU30	HUGHES 300	0.01	6.59	0.09	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
R22	R22 BETA	0.01	6.21	0.09	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
R44	R44 RAVEN	0.02	8.79	0.11	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
SCOR	ROTORWAY SCORPION	0.01	4.52	0.07	0.00	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
SYCA	BRISTOL SYCAMORE	0.06	34.83	0.31	0.03	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
C150	Cessna 150	0.01	2.08	0.05	0.00	0.00	1	P	Landplane	EPA, AP-42 volume II (1985) + FOCA Piston Engine Database + bijkomende aannames
DHC	De Havilland DHC-3 Turbo-Otter	0.17	0.26	0.01	0.03	0.00	1	P	Landplane	Emission Inventory Guidebook December 2006 + FOCA Piston Engine Database + bijkomende aannames
PA28	Piper Warrior	0.01	5.00	0.09	0.00	0.00	1	P	Landplane	EPA, AP-42 volume II (1985) + FOCA Piston Engine Database + bijkomende aannames
PA31	Piper Navajo Chieftain	0.01	24.72	0.47	0.02	0.00	2	P	Landplane	EPA, AP-42 volume II (1985) + FOCA Piston Engine Database + bijkomende aannames
SK61	Sea King, S61 Shortsky	1.37	6.14	2.79	0.20	0.00	2	TS	Helicopter	EPA, AP-42 volume II (1985)
default_MTO1	gelijk aan PA28	0.01	5.00	0.09	0.00	0.00	1	P	Landplane	
default_MTO2	gelijk aan PA28	0.01	5.00	0.09	0.00	0.00	1	P	Landplane	
default_MTO3	gelijk aan PA31	0.01	24.72	0.47	0.02	0.00	2	P	Landplane	

default_MTO4	gelijk aan E110	0.27	0.37	0.02	0.04	0.00	2	TP	Landplane	
default_MTO6	gelijk aan E110	0.27	0.37	0.02	0.04	0.00	2	TP	Landplane	
AT43	ATR 42-320	1.02	0.86	0.00	0.10	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
AT72	ATR 72-200	1.45	0.72	0.00	0.12	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
B190	Beech 1900C Airliner	0.25	2.20	0.56	0.05	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
JS31	BAe Jetstream 31	0.37	0.51	0.04	0.04	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
JS41	BAe Jetstream 41	0.47	0.82	0.08	0.05	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
BE20	Beech Super King Air 200B	0.24	0.76	0.11	0.04	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
C130	Lockheed C-130H Hercules	1.89	1.88	0.78	0.23	0.00	4	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
D328	Dornier 328-110	1.19	0.71	0.00	0.10	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
DH8D	Dash 8 Q400 4580 hp	2.33	1.13	0.00	0.17	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
E110	Embraer 110P2A	0.27	0.37	0.02	0.04	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
F27	Fokker 27 Friendship	0.33	7.45	1.54	0.14	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
F50	Fokker 50 Srs 100	1.24	0.72	0.00	0.10	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
SB20	Saab 2000 3740 hp	1.06	0.84	0.03	0.13	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
SF34	Saab 340B	0.50	0.43	0.20	0.06	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames
SH36	Shorts 360-300	0.40	3.18	0.61	0.07	0.00	2	TP	Landplane	Emission Inventory Guidebook December 2006 + bijkomende aannames

A109	AGUSTA A109	0.18	1.12	0.77	0.03	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
A119	AGUSTA A119	0.19	0.31	0.22	0.02	0.01	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
A139	AGUSTA A139	0.38	0.97	0.68	0.05	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
ALO2	ALOUETTE II	0.08	0.50	0.35	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
ALO3	SA316B ALOUETTE III	0.11	0.39	0.28	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
AS32	SUPER PUMA	0.65	0.68	0.49	0.07	0.02	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
AS35	AS 350	0.16	0.34	0.24	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
AS50	AS 550 FENNEC	0.15	0.35	0.24	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
AS55	AS 355	0.17	1.15	0.79	0.03	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
AS65	AS 365 DAUPHIN	0.23	0.97	0.68	0.04	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B06	BELL 206	0.09	0.45	0.31	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B06T	Bell TWIN RANGER	0.14	1.25	0.86	0.03	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B105	BO 105	0.13	1.33	0.91	0.03	0.00	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B222	BELL 222	0.24	0.94	0.66	0.04	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B407	Bell 407	0.13	0.37	0.26	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B412	Bell 412	0.64	0.69	0.49	0.06	0.02	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B430	Bell 430	0.24	0.95	0.66	0.04	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table +

										bijkomende aannames
BK17	BK117	0.24	0.94	0.65	0.04	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EC20	EC 120	0.08	0.48	0.33	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EC30	EC 130 B4	0.18	0.32	0.22	0.02	0.01	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EC35	EC 135	0.21	1.03	0.71	0.03	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EC55	EC 155	0.31	0.83	0.58	0.04	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EN48	ENSTROM 480	0.08	0.48	0.34	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
EXPL	MD 900	0.20	1.04	0.72	0.03	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
GAZL	SA341/SA342 GAZELLE	0.12	0.38	0.27	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
H500	HUGHES 500/501/MD 500N	0.07	0.51	0.35	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
H53	SIKORSKY CH-53G (S-65)	1.69	0.43	0.32	0.11	0.04	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
H53S	SIKORSKY SUPER STALLION	2.53	0.65	0.47	0.16	0.06	3	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
H60	SIKORSKY BLACK HAWK	0.57	0.74	0.52	0.06	0.02	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
KA27	KA-32A12	0.81	0.60	0.43	0.07	0.02	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
KMAX	K-1200	0.39	0.26	0.19	0.04	0.01	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
LAMA	SA315B LAMA	0.11	0.40	0.28	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
MD52	MD 520N	0.08	0.50	0.35	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames

MD60	MD 600N	0.13	0.37	0.26	0.02	0.00	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
MI8	MIL MI-8	0.53	0.78	0.55	0.06	0.02	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
S76	SIKORSKY S76	0.28	0.88	0.61	0.04	0.01	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
S92	SIKORSKY S92A	1.07	0.53	0.38	0.08	0.03	2	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
UH1	BELL UH-1H	0.36	0.27	0.20	0.04	0.01	1	TS	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
UH12	HILLER UH-12A	0.03	12.31	0.14	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames
B47G	Bell 47G	0.02	8.82	0.11	0.01	0.00	1	P	Helicopter	FOCA Helicopter Emissions Table + bijkomende aannames

Table 3-38 Emission factors domestic cruise (g/kg fuel)

Fuel_type	POL	DOM or INT	Airport	EF (g/kg fuel)	based on :
AvGas	NOx	any	any	4	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-14
AvGas	SOx	any	any	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-14
AvGas	CO	any	any	1000	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-14
AvGas	BENZENE	any	any	0.04	average of EUROCONTROL-emissions 2010-2014 (version okt 2015) (2.97g BENZENE per kg HC)
AvGas	HC	any	any	12	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-14
AvGas	PM25	any	any	0	average of EUROCONTROL-emissions 2010-2014 (version okt 2015)
Jet A1	NOx	DOMESTIC	EBAW	9.4	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3

Jet A1	NOx	DOMESTIC	EBBR	16.1	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	NOx	DOMESTIC	EBKT	9.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	NOx	DOMESTIC	EBOS	19.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	DOMESTIC	EBAW	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	DOMESTIC	EBBR	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	DOMESTIC	EBKT	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	DOMESTIC	EBOS	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	DOMESTIC	EBAW	10.3	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	DOMESTIC	EBBR	2.9	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	DOMESTIC	EBKT	17.9	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	DOMESTIC	EBOS	7	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	BENZENE	DOMESTIC	EBAW	0.007	average of EUROCONTROL-emissions 2010-2014 (version okt 2015) (2.97g BENZENE per kg HC)
Jet A1	BENZENE	DOMESTIC	EBBR	0.001	average of EUROCONTROL-emissions 2010-2014 (version okt 2015) (2.97g BENZENE per kg HC)
Jet A1	BENZENE	DOMESTIC	EBKT	0.008	average of EUROCONTROL-emissions 2010-2014 (version okt 2015) (2.97g BENZENE per kg HC)
Jet A1	BENZENE	DOMESTIC	EBOS	0.001	average of EUROCONTROL-emissions 2010-2014 (version okt 2015) (2.97g BENZENE per kg HC)
Jet A1	HC	DOMESTIC	EBAW	2.3	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	HC	DOMESTIC	EBBR	0.4	average of EUROCONTROL-emissions 2010-2014 (version okt 2015);

					Guidebook2013 table 3-3
Jet A1	HC	DOMESTIC	EBKT	2.8	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	HC	DOMESTIC	EBOS	0.4	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	DOMESTIC	EBAW	0.11	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	DOMESTIC	EBBR	0.13	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	DOMESTIC	EBKT	0.17	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	DOMESTIC	EBOS	0.12	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	NOx	INTERNATIONAL	EBAW	12.3	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	NOx	INTERNATIONAL	EBBR	14.6	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	NOx	INTERNATIONAL	EBKT	8.8	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	NOx	INTERNATIONAL	EBOS	15.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	INTERNATIONAL	EBAW	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	INTERNATIONAL	EBBR	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	INTERNATIONAL	EBKT	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	SOx	INTERNATIONAL	EBOS	0.84	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	INTERNATIONAL	EBAW	7.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	INTERNATIONAL	EBBR	1.7	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3

Jet A1	CO	INTERNATIONAL	EBKT	12.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	CO	INTERNATIONAL	EBOS	1.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	BENZENE	INTERNATIONAL	EBAW	0.004	average of EUROCONTROL-emissions 2010-2014 (version okt 2015)
Jet A1	BENZENE	INTERNATIONAL	EBBR	0.001	average of EUROCONTROL-emissions 2010-2014 (version okt 2015)
Jet A1	BENZENE	INTERNATIONAL	EBKT	0.008	average of EUROCONTROL-emissions 2010-2014 (version okt 2015)
Jet A1	BENZENE	INTERNATIONAL	EBOS	0.001	average of EUROCONTROL-emissions 2010-2014 (version okt 2015)
Jet A1	HC	INTERNATIONAL	EBAW	1.3	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	HC	INTERNATIONAL	EBBR	0.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	HC	INTERNATIONAL	EBKT	2.7	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	HC	INTERNATIONAL	EBOS	0.2	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	INTERNATIONAL	EBAW	0.1	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	INTERNATIONAL	EBBR	0.15	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	INTERNATIONAL	EBKT	0.19	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3
Jet A1	PM25	INTERNATIONAL	EBOS	0.12	average of EUROCONTROL-emissions 2010-2014 (version okt 2015); Guidebook2013 table 3-3

The non-exhaust emissions for PM are calculated based on a formula reported in 'Method for estimating particulate emissions from aircraft brakes and tyres' [Richard J Curran, Febr. 2006]. Emissions are calculated in function of weight of an airplane :

PM10 non exhaust = 4,76 * 10^{-7} * MTOW - 0.00874 kg per landing.

MTOW : maximum take-off weight. In Belgocontrol database the field 'MTOWAV' is available per LTO.

Non-exhaust emissions for heavy metals are not calculated.

The dust emissions represent the sum of PM non volatile + PM volatile-org + PM volatile-sul. (Eurocontrol)

Walloon Region

In Wallonia, since 2017 Submission, the data from EUROCONTROL 'fuel and emissions inventory' has been used to calculate the emissions. Fuel and emission values were made available for all Belgian airports for flights arriving or leaving to/from Belgium from 2005 to 2018.

In Wallonia, the two main airports (Liège and Charleroi) report yearly the number of LTO (domestic and international) and report also the jet fuel and the gasoline consumptions for the domestic and for the international activities. The energy balance reports also the fuel consumption in very small airports. Some information on the Walloon total number of LTO is available (Liège and Charleroi airports flights, training flights,..).

A comparison was made between the international LTO and the total fuel consumption between regional data and the Eurocontrol data. The difference between the two approaches is assumed to be VFR flights (small aircraft used for leisure, agriculture, taxi flights, etc.). These aircraft used for civil VFR flights are generally equipped with turboprop or piston engines.

The specific energy consumption by LTO is assumed to be 20 kg fuel/LTO and the emission factors are presented in Table 3-39.

Table 3-39 Average of EMEP/EEA Guidebook 2019, table 3-10: Examples of emission factors for piston-engined aircraft.

	g/kg fuel
CO	977
NOx	3.28
SOx	0.27
VOC	17.11

The total emissions are the emissions coming from Eurocontrol and the emissions coming from the VFR flights. The same approach is used for domestic flights.

The dust emissions represent the sum of PM non volatile + PM volatile-org + PM volatile-sul. (Eurocontrol)

The heavy metal emissions are determined from the metal content of kerosene or gasoline. The metal content of kerosene is the same as the emission factors used for the liquid fuel in the residential combustion. These emission factors are coming from Pulles, T. et al. (2012). The other general emission factors for liquid fuels combustion in stationary combustion (Tier1) are the average of Tier2 emission factors comprising also heavy fuel oil emission factors which differ greatly from kerosene. The metal content of gasoline is the same as the combustion of gasoline in cars (EMEP/EEA Guidebook 2013, table 3-103) except for lead as lead is added to aviation gasoline to increase the octane number. The lead content is higher than in leaded car gasoline, a value of 0.6 g of lead per litre of gasoline is used as the default value.

The emissions from domestic LTO and international LTO are reported under the category 1A3ai(i) and 1A3aii(i), while emissions from cruise activities are reported under 'Memo items" 1A3ai(ii) and 1A3aii(ii).

3.4.2.3 Railways

Category 1A3c is a key category of Cu and TSP emissions in terms of emissions level.

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

Flemish Region

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

Emission calculation:

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

Emission factors are derived from ISO 8178/F test cycles for CO, NO_x, TSP and VOC (Table 3-40).

Table 3-40 Emission factors for different train types (g/kWh) 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 3-41). SO_2 and heavy metals are fuel-specific (SO_2 calculated dependent on content of S in fuel).

Table 3-41 Emission factors from Klein (2006) (NL) in Flemish Region

Pollutant	EF(g/g or %)	calculation base off
NH_3	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 NFR category 1A3c (railways).

For PM and heavy metals there are also emissions calculated for non-exhaust. Emissions of PM10 and PM2,5 are calculated as a fraction of TSP. There are no emissions of EC. The PM-emissions are calculated for wear of brakes, wheels, overhead wires and rails, Emission factors for brakes come from expert judgement by VITO, the other emission factors are taken from a study performed by VITO under the authority of VMM (Schrooten et al., 2002) and from Carbotech. For heavy metals only emissions of overhead wires are calculated with an emission factor taken from a study performed by VITO under the authority of VMM (Sleeuwaert et al., 2009). The emission factors are in Table 3-42.

Table 3-42 Emission factors for non-exhaust emissions from rail transport for PM and Cu

	TSP (g/km)	% PM10 of TSP	% PM2.5 of TSP	Cu (mg/GJ)
Brakes	7.4	29%	29%	0
Wheels	1.53	50%	0%	0
Overhead wires	0.187	100%	100%	961
Rails	6.732	50%	25%	0

Walloon and Brussels Capital Region

In Wallonia and in the Brussels Capital Region, 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 the Brussels Capital regions is based on the Belgian data of gasoil consumption and the regional information on driven train- and ton-kilometers of persons and goods. The emissions are estimated by multiplying the train's fuel consumption by the fuel specific emission factors (Table 3-43). The NCV considered is 42,7 GJ/t.

Table 3-43 Emission factors in the railways sector (EMEP/EEA Guidebook 2019 except for SOx – Table 3-22)

Fuel	**UNIT**	**NOx**	**NMVOC**	**SOx**	**NH3**	**PM2.5**	**PM10**	**TSP**	**BC (EC)**	**CO**	**PCDD/PCDF***
Gas oil	g/GJ	1219	108.2	2.4	0.163	31.87	33.49	35.36	20.72	248.9	
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**Total HAP**
Gas oil	mg/GJ		0.233			1.163	39.54	1.628	0.233	23.26	1.861
* ng-TEQ/GJ											

In Wallonia, total HAP is 2.8 mg/GJ. This EF is estimated by using the EF for B(k)f & Indeno (1,2,3-cd) pyrene corresponding to old technology heavy duty vehicles from the Exhaust Emissions from Road Transport chapter as recommended in the railways chapter. Dioxins EF is 1442.8 ng/GJ by using the same methodology.

Following the study of VITO on Heavy Metals, it must also take into account the wear catenary (Cu : 961 mg/GJ), which is responsible for a significant Cu emission.

It's unclear if the dust emissions represent filterable, condensable or total emissions.

3.4.2.4 Navigation

Category 1A3di(ii) International inland waterways is a key category of NO_x emissions in terms of emissions level.

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 1A3di(i) '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 :

- NO_x, VOC, TSP, CO : Dutch EMS protocol (Oonk, 2003)
- NH_3, 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 nautical 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 is shown below.

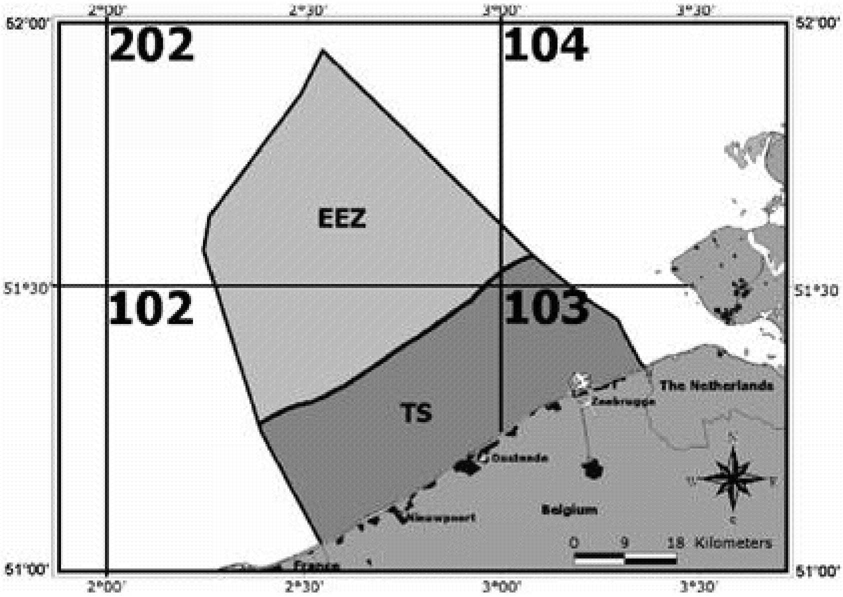


Figure 3-3 Map of the Belgian maritime areas

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 and Ni emissions in terms of emissions level.

Emission factors for NO_x, PM, CO, NMVOC are derived from Oonk et al. (2003), and from 2007 on derived from the CCNR-standards (Central Commission for the navigation of the Rhine), see Table 3-44. Other emission factors come from the EMEP/EEA Guidebook. For the 2020 submission emission factors from the 2019 Guidebook are used, containing other emission factors for heavy metals (Table 3-44). This leads to a change in emissions for Cu, Ni, Zn and Pb relative to 2019 submission.

Table 3-44 Emission factors dependent on year class of the engines (g/kWh)

Date of construction	NO_x	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	6	0,2	1,3	0,2
2011-2015	6	0,2	1,3	0,2
2015-2020	6	0,2	1,3	0,2
2020-2030	6	0,2	1,3	0,2

.

Table 3-45 Emission factors based on fuel used (g/kg fuel)

	Emission factor	Source

SO_2	20*S%	Base stoichiometric conversion
NH_3	0,007	EMEP-EEA guidebook
Cd	0,00001	EMEP-EEA guidebook
Cr	0,00005	EMEP-EEA guidebook
Cu	0,00088	EMEP-EEA guidebook
Ni	0,001	EMEP-EEA guidebook
Pb	0,000013	EMEP-EEA guidebook
Zn	0,0012	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 the EMEP/EEA Guidebook 2019.

In the 2021 submission, Wallonia recalculated the Pb and Hap. The emission factors were taken from the Emep Guidebook 2009 – table 3-38 – fuel=gasoil. As = 1,81 mg/GJ; Hg = 1,36 mg/GJ; Nevertheless, there are new EF in the emep guidebook 2019 (table 3-2): As = 0,94 mg/GJ; Hg = 0,7 mg/GJ. Due to lack of resources, it has not be changed this year but it will be changed in the next submission.

It's unclear if the dust emissions represent filterable, condensable or total emissions.

3.4.2.5 Other transportation (pipeline compressors 1A3ei and off-road 1A3eii)

1A3ei

Category 1A3ei includes the emissions from the pipeline compressors. In Flanders emissions are provided by the operators of the plants, except for NMVOC. The NMVOC emissions are calculated by multiplying the activity data (energy consumption data from the regional energy balances) of the sector with emission factors (a study performed by VITO: Lodewijks et al. (2005)).

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 3-46). These default emission factors are used for the years before 2008 and for the area part after 2008.

Table 3-46 Emission factors for pipeline compressors in the Walloon region

Pollutant	Unit	EF
NOx	g/GJ	177
CO	g/GJ	260

Since the 2017 review, all the emissions (other pollutants) of the pipeline compressors are included in the sector 1A3ei in the Brussels Capital Region also. According to the guidebook, some guidance are given in the chapter 1A4 for these installations but without clear information of which emission factors have to be used. Without guidance, the tier 1 methodology from the chapter 1A4 and the table 3-8 were used to calculate the emissions.

1A3eii

As a result of the in-country review in September 2012 of the greenhouse gas Belgium inventory and to be coherent with this greenhouse gas inventory, the off-road emissions of the following sectors are included in the category 1A3eii: ground activities in airports, harbours and trans-shipment activities.

Off-road emissions are calculated by the same mathematical model OFFREM (Off-road emission model) in the three regions.

In OFFREM the emissions in different economic sectors are calculated using a tier 3-basis. OFFREM uses sales data for different types of mobile machinery and survival rates for different types of machinery to estimate the active fleet. Combined with assumptions on the average use (annual operating hours) and the fuel consumption per hour of operation for the different types of machinery, total fuel consumption and emissions of NRMM is estimated.

The original study of July 2009 was optimized in December 2019 (Vanhulsel et al. 2019).

The sector seaports includes mobile machines and vehicles for general use (service vehicles, generators, cranes, sweeper machines, fork and scissor lifts), for containers (forklift trucks outside/telehandlers and portal trucks), for dry bulk (loading shovels), for RoRo (RoRo tractors) and for total RoRo (Tractors).

User specific input data include data on the yearly traffic per type (general cargo, containers, roro and dry bulk) for each port.

A further optimization of the OFFREM-model occurred during the 2021 submission. A correction was made in input data for all categories that use gasoline in the vehicles:blend % biofuels were corrected based on data used for emission calculation for road traffic;

Furthermore, the module for seaports accounts for four ports in Wallonia: Liège, Charleroi, Namur and Centre et de l'ouest. Yearly traffic statistics are still inserted for these four ports together, and distributed over them according to a fixed percentage. Considering the difference in size between the Walloon and Brussels ports and the Antwerp port, the emissions from the containers handling are based on a specific consumption of 0.1904 GJ/container.

3.5. ***Other sectors (sector 1A4)***

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 1A4b and 1A4c (additionally to 1A2gvii, 1A3e and 1A5b).

3.5.2. Methodological issues

3.5.2.1 Commercial/institutional sector (stationary, category 1A4ai)

Category 1A4ai is a key category of NO_x, As, Ni and PAH 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 cause 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.

Figure 3-4 shows the trends of the energy consumption in the commercial/institutional sector.

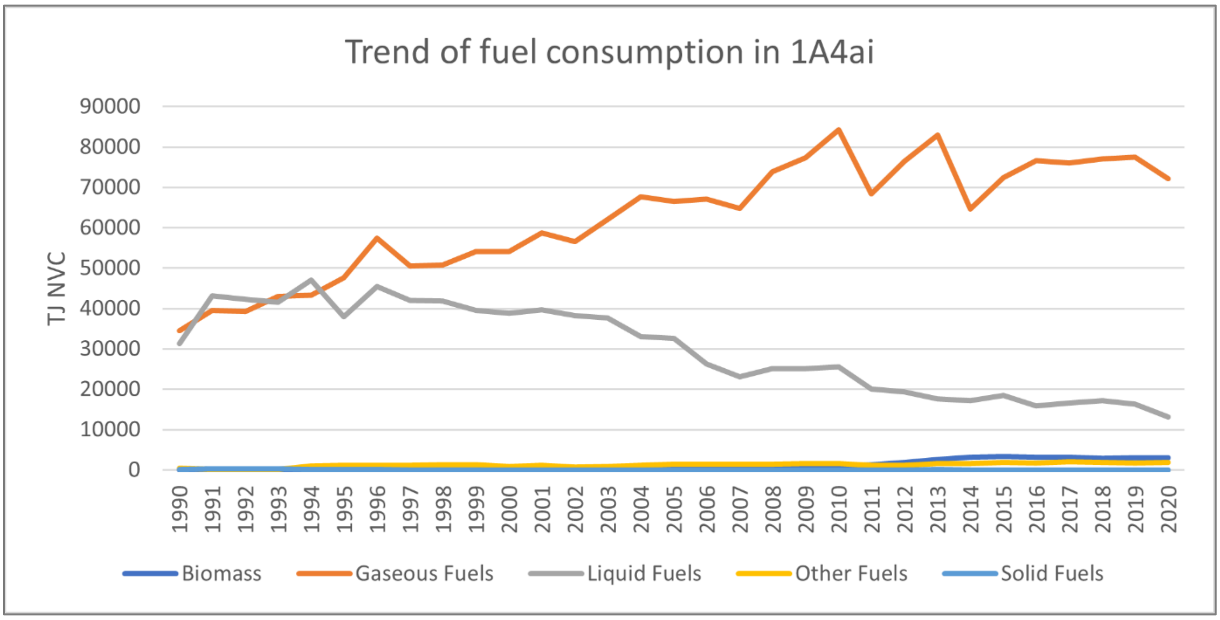


Figure 3-4 Trend on fuel consumption in the commercial/institutional sector

In Flanders, emissions by heating systems of buildings are calculated on a collective basis by the EISSA-B model (Veldeman et al., 2017). 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 natural gas, fuel, heavy fuel, solid fuels (coal), propane/butane/LPG, electricity, other (mainly waste) and renewable fuels, for some years also lamp petrol. SO_2 emission calculations are based on the S-content of the fuels , other emission factors (CO, NMVOC, NO_x, particulate matter, heavy metals and NH_3) are taken from the EMEP/EEA Emission Inventory Guidebook 2019.

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 (renewable fuels) is included. A distinction is made between autoproducers and non-autoproducers.

In 2019 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. An overview of the emission factors for the sector 1A4i in Flanders is given in Annex 3A. Emission factors used to calculate emissions from the CHP in the Agricultural and commercial/institutional sectors is given in Annex 3D.

During the 2020 NECD review. The TERT noted that significant recalculations have been applied (>20% change) for the key category 1A4ai Commercial/institutional: Stationary for the pollutant BaP and year 2017. The TERT could not find a clear description of this recalculation in the 2020 IIR (p.114-115). In response to a question raised during the review, Belgium explained that during the submission 2019, the energy balances for the year 2017 were provisional. (see above) The final energy balances were used for the 2020 submission and led to a recalculation of the emissions.

For the submission 2021, SO_2 emission factors are re-examined based on information provided by Informazout (https://informazout.be, personal communication). The S content of fuel oil is maximum 50 ppm from 2016 on (which corresponds to an emission factor of 2.4 ton/PJ), from 2018 on 1/3 of the fuel oil sold has a S content of 50 ppm while 2/3 has a S content of 10 ppm (which corresponds to a global emission factor of 1.1 ton/PJ).

In the 2022 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For gas-fired CHP installations and autoproducers with a construction year > 2017, the emission limit values are no longer used as EF.

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 %)). The emissions factors are those from the EMEP/EEA Emission Inventory Guidebook 2016_update july2017.

In the Brussels Capital Region, the consumption of the tertiary sector is based on the regional energy balance. For natural gas consumption, a top-down approach is used. Total consumption is known and then it is split in subsectors using NACE codes or historic information. For other fuels, the estimation of energy consumption until 2013 is based on the fuel/natural gas ratio and the Belgian consumptions. Starting from 2014, the regional energy balance is done by a different consultant, due to the lack of precise information about consumption of oil-products several hypotheses have been used to estimate final consumption in the commercial sector.

Emission factors used to calculate the emissions of stationary combustion in the commercial sector in the Walloon and Brussels regions are given below (Table 3-47 to Table 3-48).

During this submission, the emissions from charcoal in the Walloon region were added to the inventory by using the emission factors from the table 3-46 (guidebook 2019).

Concerning the dust emissions, the emissions can represent filterable or total emissions following the fuel :

- Wood : total emissions
- Natural gas : filterable
- Gasoil : unclear in the guidebook
- Coal : unclear in the guidebook.

Table 3-47 Emission factors for the sector 1A4ai in the Walloon region (EMEP/EEA Guidebook 2019 tier 2 except NO_x for diesel and natural gas (ECONOTEC study 2010 for NOx)).

	SO_2	**NOx**	**NMVOC**	**CO**	**TSP**	**PM10**	**PM2,5**	**BC**	**NH3**
	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
Coal (T3-20)	600	160	200	2000	200	190	170	10.88	0.4
Wood (T 3-46)	11	91	156	435	105	100.5	98.5	25.61	37
Diesel oil(T3-24)	2.4	**41.95-43**	15	40	3	3	3	0.9	0.1

Natural gas(T3-26)	0.5	**34-40.3**	0.36	24	0.45	0.45	0.45	0.02	0.6
LPG (T 3-26)		**40**	0.36	24	0.45	0.45	0.45	0.02	0.6

	As	**Cd**	**Cu**	**Cr**	**Ni**	**Pb**	**Se**	**Zn**	**Hg**	**Diox**	**PAH**	**PCB**	**HCB**
	mg/GJ									ng/GJ	mg/GJ	µg/GJ	µg/GJ
Coal	5	3	30	15	20	200	2	300	7	400	320	170	0.62
Wood	0.19	13	6	23	2	27	0.5	512	0.56	100	35	0.03	5
Diesel oil	0.002	0.001	0.13	0.2	0.005	0.012	0.002	0.42	0.12	10	26		
Natural gas	0.12	0.00025	8E-05	0.0008	5E-04	0.0015	0.011	0.0015	0.1	0.0005	0.003		
LPG	0.12	0.00025	8E-05	0.0008	5E-04	0.0015	0.011	0.0015	0.1	0.0005	0.003		

Table 3-48 Emission factors for the sector 1A4ai in the Brussels Capital Region (EMEP/EEA Guidebook 2019 except for NOx (ECONOTEC 2010 heating study).

Fuel	**UNIT**	**NOx**	**NMVOC**	**SOx**	**NH3**	**PM2.5**	**PM10**	**TSP**	**BC (EC)**	**CO**	**PCDD/PCDF***
Natural gas	g/GJ	32.84	23	0.67	0.6	0.78	0.78	0.78	0.0312	29	0.52
Gas oil	g/GJ	41.30	20	94	0.1	18	21	21	10.08	93	6
Wood	g/GJ	91	300	11	37	160	163	170	44.8	570	100
Butane/Propane	g/GJ	40	23	0.67	0.6	0.78	0.78	0.78	0.031	29	0.52
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**Total HAP**
Natural gas	mg/GJ	0.011	0.0009	0.54	0.1	0.013	0.0026	0.013	0.058	0.73	0,0058
Gas oil	mg/GJ	8	0.15	0.1	0.5	10	3	125	0.1	18	0.0066
Wood	mg/GJ	27	13	0.56	0.19	23	6	2	0,5	512	35
Butane/Propane	mg/GJ	0.011	0.0009	0.54	0.1	0,013	0.0026	0.013	0.058	0.73	0.0058
* ng-TEQ/GJ											

3.5.2.2 Residential sector (stationary, category 1A4bi)

Category 1A4bi is a key category for SO_x, $PM_{2,5}$, PM_{10}, TSP and PAH emissions in terms of emission level and trend and of NO_x, NMVOC, BC, CO, Pb, Cd, Hg, Cr, Zn and PCDD/F in terms of emission 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 cause 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)

Figure 3-5 shows the trends of the energy consumption in the residential sector.

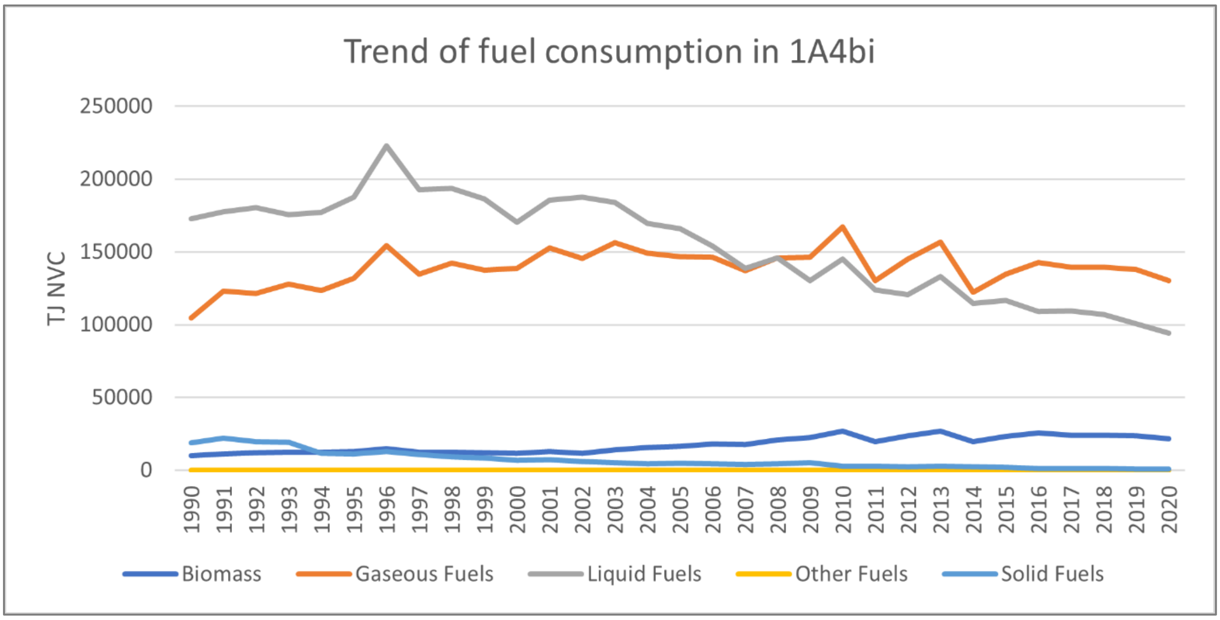


Figure 3-5 Trend of fuel consumption in the residential sector

In Flanders, emissions by heating systems of buildings are calculated on a collective basis by the EISSA-B model (Veldeman et al., 2017). The database consists of emissions due to residential combustion (heating by households). Emissions are calculated by multiplying the energy use and emission factors (Tier 2).

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, renewable fuels (mainly wood) are included. SO_x emission calculations are based on the S-content of the fuels, other emission factors are taken from the EMEP/EEA Guidebook 2019. In 2019 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. An overview of the emission factors used in the sector 1A4bi in the Flemish region is given in Annex 3B.

For the submission 2021, SO_2 emission factors are re-examined based on information provided by Informazout (https://informazout.be, personal communication). The S content of fuel oil is maximum 50 ppm from 2016 on (which corresponds to an emission factor of 2.4 ton/PJ), from 2018 on 1/3 of the fuel oil sold has a S content of 50 ppm while 2/3 has a S content of 10 ppm (which corresponds to a global emission factor of 1.1 ton/PJ).

In the 2021 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For stoves with year of construction> = 2017, the EF based on the emission limit value were replaced by the EF from table 3.42 of the EMEP/EEA guidebook 2019.

In the 2021 submission, emission factors for B(a)P, B(b)Flu, B(k)Flu, IP are re-examined. For stoves and cassettes built from 2000 to 2013, EF from table 3.41 of the EMEP / EEA guidebook 2019 is now used.

Finally, an update was made of the stoves for non-wood firing based on data from the Flanders 2018 energy balance.

In the 2022 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For boilers built >=2017 burning piece of wood, the EF of table 3.46 from the guidebook are now used.

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). During this submission, the liquid fuel activity data were recalculated since 2010 to take into account the Belgium biennial surveys on the household sector consumptions. It leads to an increase of the gasoil consumption in the sector 1A4bi and an increase of the emissions.

In the Brussels Capital Region, the information about energy consumption in the household sector is compiled in the regional energy balance. Then the consumption is multiplied by the emission factors described Table 3-50 (emission factors for 2019). The emission factors for NO_x change each year in the residential sector as they follow the evolution of boilers (park and performance) in this sector. This is also the case for wood combustion emissions.

Emission factors used to calculate the emissions of stationary combustion in the residential sector in the Walloon and Brussels regions are given below (Table 3-49 and Table 3-50).

Concerning the dust emissions, the emissions can represent filterable or total emissions following the fuel :

- Wood : total emissions
- Natural gas : unclear in the guidebook
- Gasoil : unclear in the guidebook
- Coal : unclear in the guidebook.

Table 3-49 Emission factors for the sector 1A4bi in the Walloon region (EMEP/EEA Guidebook 2019 except NO_x for diesel and natural gas (ECONOTEC study 2010 for NOx)

	SO2	**NOx**	**NMVOC**	**CO**	**TSP**	**PM10**	**PM2,5**	**BC**	**NH3**
	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ	g/GJ
Diesel oil (T 3-18)	2.4	42.4-43	0.17	3.7	1.5	1.5	1.5	0.06	0.1
Natural gas (T3-16)	0.3	30-40	1.8	22	0.2	0.2	0.2	0.011	0.6
LPG(T3-4)	0.3	40	1.9	26	1.2	1.2	1.2	0.1	0.6
Wood	11	80	358	2431	341	324	316	46	45

	As	**Cd**	**Cu**	**Cr**	**Ni**	**Pb**	**Sé**	**Zn**	**Hg**	**Dio**	**HAP**	**PCB**	**HCB**
	mg/GJ									ng/GJ	mg/GJ	ug/GJ	ug/GJ
Diesel oil	0.002	0.001	0.13	0.2	0.005	0.012	0.002	0.42	0.12	1.8	0.35		
Natural gas	0.12	0.0003	7.6E-05	0.0008	0.00051	0.0015	0.011	0.002	0.1	1.5	0.003		
LPG	0.12	0.0003	7.6E-05	0.0008	0.00051	0.0015	0.011	0.002	0.68	1.5	0.003		
Log Wood	0.19	13	6	23	2	27	0.5	512	0.56	253	110	0.02	5

Table 3-50 Emission factors for the sector 1A4bi in the Brussels Capital Region (Source for the emission factors: ECONOTEC study 2010 for NO_x; EMEP 1996 for NH_3 and EMEP/EEA 2019 for the other pollutants except wood, Inventory peer-audit 2020)

Fuel	**UNIT**	**NOx**	**NMVOC**	**SOx**	**NH3**	**PM2.5**	**PM10**	**TSP**	**BC (EC)**	**CO**	**PCDD/PCDF***
Natural gas	g/GJ	25.7	1.9	0.3	0.6	1.2	1.2	1.2	0.065	26	1.5
Gas oil	g/GJ	40.4	0,69	70	0.1	1.9	1.9	1.9	0.1615	57	5.9
Wood	g/GJ	88.72	274.7	11	37.76	201.27	206.32	216.96	20.13	2537.76	163.26
Coal	g/GJ	104.4	484	900	0,3	398	404	444	25,472	4600	800
Butane/Propane	g/GJ	40.0	1.9	0.3	0.6	1.2	1.2	1.2	0.065	26	1.5
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**Total HAP**
Natural gas	mg/GJ	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.011	0.0015	0.00308
Gas oil	mg/GJ	0.012	0.001	0,12	0.002	0,2	0,13	0.005	0.002	0.42	0.35
Wood	mg/GJ	27	13	0.56	0.19	23	6	2	0,5	512	152.94
Coal	mg/GJ	130	1.5	5.1	2.5	11.2	22.3	12.7	120	220	800
Butane/Propane	mg/GJ	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.011	0.0015	0.00308
* ng-TEQ/GJ											

Concerning the wood and the coal combustion in the Walloon region, a study was realized in 2020 to estimate the consumption of wood and coal by technology in the residential sector. The result of this study is used in this submission to improve the emissions from the combustion of solid fuels. New emission factors were established by using the regional energy balance (total consumption and share of pellets and wood logs) and the park with the evolution of the type of installations. The tier 2 methodology from the EMEP/EEA Guidebook 2019 was used. The average EF for log wood and coal are presented in Table 3-51. For the coal used, a distinction is made between boiler and stoves. The EF for log wood and stove coal change with the age of the installation.

The Vito EF are the same EF as in Flanders. The EF for pellets are the EF from Guidebook 2019, table 3.44.

Table 3-51 Emission factors for log wood and coal in the Walloon region

		Guidebook 2019
<2000	stove wood	Table 3.40
2000-2013	stove wood	Table 3.41
2014-2016	stove wood	Table 3.42
>=2017	stove wood	Vito
<2000	boiler wood	Table 3.43
2000-2013	boiler wood	Vito
2014-2016	boiler wood	Vito

>=2017	boiler wood	Vito
<2000	fire place	Table 3.39
2000-2013	fire place	Table 3.39
2014-2016	fire place	Table 3.39
>=2017	fire place	Table 3.39
<2000	Stone wood	Table 3.41
2000-2013	Stone wood	Table 3.41
2014-2016	Stone wood	Table 3.42
>=2017	Stone wood	Vito
<2000	stove coal	Table 3.14
2000-2013	stove coal	Table 3.14
2014-2016	stove coal	Table 3.19
>=2017	stove coal	Vito
	boiler coal	Table 3.15

During this submission, the emissions from charcoal in the Walloon region were added to the inventory by using the emission factors from the table 3-40 (guidebook 2019).

For the Brussels Capital Region, in the 2021 submission, new emission factors for wood combustion were established considering the available information of the park and the evolution of equipment. The main sources are: regional energy balance (Split main and secondary heating installation, Energy performance buildings certificates (number of households and type of equipment), households evolution (census and other statistical information), and, the French sharing of boilers, stoves and other fireplaces.

The detail information concerning wood appliances allows the Brussels-Capital Region to use the Tier 2 emission factors of EMEP/EEA Guidebook 2019. The emission factors presented in Table 3-50 represent the average emission factors for Brussels.

During the 2017 NECD review, the TERT raised the remark that the SO_2 implied EF shows a decrease between 2007 and 2008. The decrease in SO_2 emissions is largest in Flanders and is mainly due to the decrease of maximum S-content in gasoil from 0.2% to 0.1% set by law.

3.5.2.3 Agriculture/forestry/fishery (stationary, category 1A4ci)

Category 1A4ci is a key category of SO_x emissions in terms of emissions trend.

Agricultural fuel consumption is estimated from statistical information concerning area used, etc., combined with specific energy consumption from literature. Figure 3-6 shows the trends of the energy consumption in the agricultural sector.

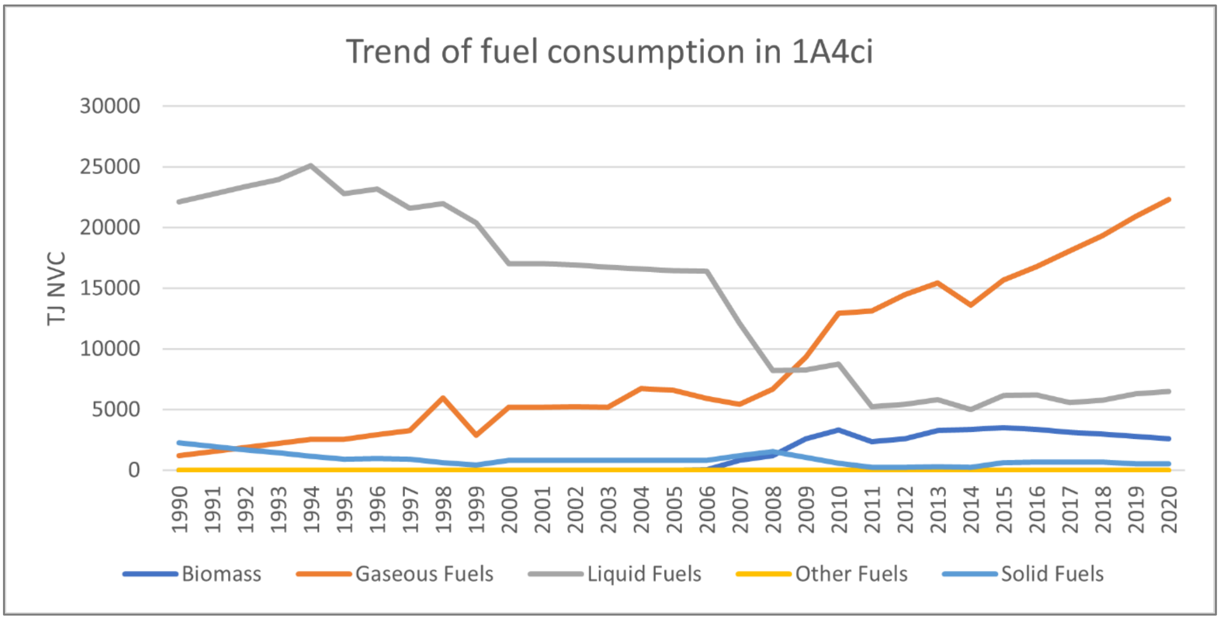


Figure 3-6 Trend of fuel consumption in the agricultural sector

The sector 1A4ci Agriculture/Forestry/Fishing (stationary combustion) includes the emissions originating from greenhouse culture, arable farming, intensive livestock breeding, remaining crops – soil-bound agriculture and pasture and combined heat-power installations (CHP). The emissions are calculated by the EISSA-B model (Veldeman et al., 2017). The activity data (energy consumption data) of the sectors 1A4ci are taken from the regional energy balances.

SO_2 emission calculations are based on the S-content of the fuels , other emission factors (CO, NMVOC, NO_x, particulate matter, heavy metals and NH_3) are taken from the EMEP/EEA Emission Inventory Guidebook 2019.

An overview of the emission factors used in the sector 1A4ci in the Flemish region is given in Annex 3C. Emission factors used to calculate emissions from the CHP in the Agricultural and commercial/institutional sectors is given in Annex 3D.

Table 3-52 gives an overview of the emission factors used in Wallonia.

Table 3-52 Emission factors for the sector 1A4ci in the Walloon region (EMEP/EEA Guidebook 2016)

		Gasoil
SO_2	g/GJ	48
NOx	g/GJ	163
COVNM	g/GJ	10
CO	g/GJ	66
TSP	g/GJ	5.0
PM10	g/GJ	3.9
PM2,5	g/GJ	3.0
BC	g/GJ	1.7
NH3	g/GJ	0.1
As	mg/GJ	0.03
Cd	mg/GJ	0.006
Cu	mg/GJ	0.22
Cr	mg/GJ	0.2
Ni	mg/GJ	0.008

Pb	mg/GJ	0.08
Sé	mg/GJ	0.11
Zn	mg/GJ	29
Hg	mg/GJ	0.12
Dio	ng/GJ	1.4
HAP	mg/GJ	0.0201

In the Brussels Capital Region, all emissions from agricultural activities (category 1A4c) correspond to off-road activities and are accordingly accounted for in 1A4cii.

3.5.2.4 Off-road sector (category 1A4bii and 1A4cii)

Category 1A4cii is a key category of NO_x and NMVOC emissions.

The off-road emissions are calculated for the 3 regions by the mathematical model OFFREM (Off-road emission model). Emissions are calculated for machinery used in defence (category 1A5b), harbours, airports and trans-shipment companies (category 1A3eii), in households (category 1A4bii), in agriculture, forestry and green area (category 1A4cii). Exhaust emissions as well as non-exhaust emissions are calculated.

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 COPERT.

Forestry and green area maintenance: for one city data on working hours of the machines used in forestry, and for 4 cities data on machines used and hectares of forestry are available. By combining these data, working hours per type of machine and per hectare of forestry are obtained. The hectares of forestry for the 3 Belgian Regions are used. Agriculture: activity data are technical data on cultivations, soil use, size of parcels farm land, technical characteristics machines and vehicles. From the 2015 reporting on, off-road emissions originating from agriculture (combustion emissions from tractors) are taken from OFFREM, as well as off-road emissions in forestry and green area and reported in the category 1A4cii. The agricultural emissions are calculated for arable farming, remaining crops, pasture, intensive livestock and soil-bound agriculture. Emission factors from TREMOD model are used for NO_x, CO, NMVOC and TSP. NH_3 emission factors are EMEP/EEA Guidebook (Table 3-53).

Table 3-53 Emission factors for the sector 1A4cii Agriculture (tractors) in the Flemish region.

			NO_x	CO	NMVOC	NH_3	TSP
large farm tractor	<1981	kg/GJ	1,592	0,114	0,109	0,000183	0,058
	1981-1990	kg/GJ	1,152	0,118	0,076	0,000190	0,054
	1991-Stage I	kg/GJ	1,082	0,123	0,039	0,000197	0,028
	Stage I	kg/GJ	0,734	0,074	0,024	0,000197	0,014
	Stage II	kg/GJ	0,502	0,074	0,024	0,000197	0,007
	Stage IIIA	kg/GJ	0,319	0,074	0,024	0,000197	0,007
	Stage IIIB	kg/GJ	0,174	0,074	0,013	0,000197	0,001
medium sized farm tractor	<1981	kg/GJ	0,906	0,220	0,141	0,000176	0,087

	1981-1990	kg/GJ	1,064	0,198	0,118	0,000184	0,065
	1991-Stage I	kg/GJ	1,260	0,169	0,093	0,000193	0,027
	Stage I	kg/GJ	0,767	0,072	0,031	0,000193	0,014
	Stage II	kg/GJ	0,493	0,072	0,023	0,000193	0,014
	Stage IIIA	kg/GJ	0,313	0,072	0,023	0,000193	0,014
	Stage IIIB	kg/GJ	0,284	0,072	0,013	0,000193	0,001
small farm tractor	<1981	kg/GJ	0,641	0,255	0,163	0,000170	0,109
	1981-1990	kg/GJ	0,755	0,238	0,143	0,000179	0,076
	1991-Stage I	kg/GJ	1,068	0,213	0,114	0,000190	0,054
	Stage I	kg/GJ	0,715	0,104	0,045	0,000190	0,027
	Stage II	kg/GJ	0,511	0,104	0,030	0,000190	0,014
	Stage IIIA	kg/GJ	0,353	0,104	0,030	0,000190	0,013
	Stage IIIB	kg/GJ	0,279	0,104	0,013	0,000190	0,001

A complete detailed description about the methodology used can be found in annex 3 of the National Inventory Report (NIR) 2017 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.

During the 2020 submission, the OFFREM-model was optimized for all subsectors (version OFFREM 2). Some functional and methodological corrections were made to this tool f.i. adding of stage V (machinery) and EURO 6, 6c and 6d norms (vehicles), emission factor and energy consumption factors of off road vehicles and quads were updated with most recent COPERT data and data from the EMEP/EEA Guidebook 2019, calorific values were updated, TAF-factors (Transient Adjustment Factor) were updated according to the EMEP/EEA Guidebook 2019.

More specific for the category 1A4 the following corrections to the OFFREM-model were made:

- residential sector/households: revision of the geographical spreading of total energy consumption of squads and total calculated emissions for squads for Belgium to the 3 regions. For the subcategory ‘recreation’ a correction of the energy consumption data for moto-vehicles ad squads based on resp. the COPERT 4 and COPERT 5 models took place.
- Forestry: the hectares of forest is made year-dependent and consistent with the surfaces reported in the LULUCF-sector.
- Landscaping: update of the surfaces in the 3 regions on the basis of the landuse-maps.

A further optimization of the OFFREM-model occurred during the 2021 submission. A correction was made in input data for all categories that use gasoline in the vehicles:

- blend % biofuels were corrected based on data used for emission calculation for road traffic;

- densities and calorific values of fuels were taken over from emission calculation for road traffic.

During this 2021 submission the starting point of coming into force for the Stage II for chainsaws is corrected and age distribution is implemented for these chainsaws.

For the residential sector: the number of households and the number of inhabitants are actualised with most recent data for the years 2017 and 2018.

During the 2022 submission further optimization of the OFFREM-model took place :

- Optimization of the model to calculate the off-road emissions (OFFREM-model) in the category 1A4b (households): residential sector: the size of the gardens in the Brussels-Capital Region was actualised for the entire time series with more accurate data.
- 1A4c (forestry) : Walloon Region has revised the entire time series for forest area. Because OFFREM first calculates emissions and fuel consumption for Belgium, and then calculates regional figures via the areas per region, the emission (and fuel consumption) of forestry in Flanders also changes for the entire time series.

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 2019 (table 3.1).

Dust emissions represent total emissions.

Calculation of emissions of heavy metals from agriculture in Belgium will be further examined in the course of 2020 and harmonized between the various regions.

3.5.2.5 National fishing (sector 1A4ciii)

The sector 1A4ciii contains the emissions of Agriculture/Forestry/Fishing (national fishing). The activity data (energy consumption data) of the sector 1A4ciii are taken from the regional energy balances. From the 2016 submission on, emissions of sea fishery are calculated with the model EMMOSS (same model as to calculate emissions from maritime navigation). The emission factors to calculate the emissions for the sector 1A4ciii are these from maritime navigation (but only these for the category of ships ‘fuel MDO, type ‘other’, < 100 m length, 4-stroke engine). 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).

For the emission calculation of the fishery activities, activity data about average days at sea per fleet segment, number of vessels and fleet fuel data are needed. These data are only available until year -2 (i.e. 2020 data only available in the course of 2022 and consequently reported during 2023 submission).

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)

3.6. *Other (category 1A5a and 1A5b)*

In this section the emissions originating from the military transport and off-road emissions of machinery used in defence are included (category 1A5b).

The emissions in the category 1A5a are included elsewhere as the energy consumption (stationary) has been distributed across sectors 1A1, 1A2 and 1A4.

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 2009 by using the Dutch emission factors (nature of flight: average).

In the Flemish Region there are several airports for military aviation : 6 airports between 1990 and 1996 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek, Sint-Truiden and Goetsenhoven) and 4 airports for military aviation from 1997 until 2015 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek). Emission calculation for military flights consist of 2 parts :

- emission calculation for Melsbroek, that is the biggest one and situated near Brussels Airport, and a second part for the smaller military airports. For Melsbroek emissions can be calculated on statistics of movements (split into LTO/cruise domestic/international available). For methodology, see 3.4.2.2 Air transport (1A3a).

- For the 4 smaller airports emissions are calculated based on fuel sold as reported by the General Staff of the Belgian Airforce (Flemish Energy Balance). No distinction can be made for LTO/cruise domestic/international. Emission factors are used from EMEP/EEA Guidebook 2016 Update July 2017 (table 3-11 : NL average) for kerosene, and averages from EUROCONTROL files (civil aviation) for airplanes on AvGas, see Table 3-54.

Table 3-54 Emission factors for airplanes on AvGas

Fuel_type		EFactor (g per kg fuel)
Jet A1	CO2	3150
Jet A1	NOx	15,8
Jet A1	HC	4
Jet A1	CO	126
Jet A1	SOx	0,2
Jet A1	BENZENE	0,01188
Jet A1	N2O	0,1
Jet A1	PM25	0,2
AvGas	CO2	3050
AvGas	NOx	4
AvGas	HC	12
AvGas	CO	1000
AvGas	SOx	0,84
AvGas	BENZENE	0,04
AvGas	N2O	0,1
AvGas	PM25	0

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, all the plants are closed (one in 1995, a second in 2000, a third in 2005 and a fourth in 2014). The emissions factors are summarized in Table 3-55 (ULg 1998):

Concerning the dust emissions, the emissions represent filterable dust emissions.

Table 3-55 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	4010	mg/Mg PRODUCT

In the 2020 submission, the PAH emissions were recalculated by using the ULg EF (6 from Borneff) and converting in 4 from Arrhus with the US-EPA repartition (coke production).

In the Brussels Capital Region the plant closed in 1993. The emission factors presented in Table 3-56 come from the Guidebook 2019

Table 3-56 Emission factors for the fugitive emissions in the Brussels coke plant in the sector 1B1b

Fuel	UNIT	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC (EC)	CO	PCDD/PCDF*
Coke	g/ton	0,9	7,7	0,8	138	61	146	347	29,89	460	3
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**Total HAP**
Coke	g/ton	0,38	0,007	0,012	0,013	0,17	0,048	0,12	0,016	0,22	0,53
	* ug-TEQ/ton										

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 service stations (1B2av).

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

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

3.7.2.1 Refineries (1B2aiv)

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. The emissions are reported by the industrial companies via the integrated environmental reports. The detailed information of these reports is highly confidential. If no distinction between fugitive and combustion emissions is possible, emissions of sector 1B2aiv are allocated in 1A1b.

For the HM a study has been performed in 2009 to establish a complete heavy metal emission inventory but only from 2000 onwards. That explains that in some years before 2000 emissions are reported as ‘NE’.

The implied emission factor for NMVOC for the total refinery sector is 0,08 kg NMVOC/Mg crude oil. The used measuring methods are LDAR, IR absorption and FID.

3.7.2.2 Service stations (1B2av)

In the Walloon and Brussels region, since the 2018 submission, the EMEP/CORINAIR methodology Tier 2 has been used to estimate fugitive NMVOC emissions from the service stations. The activity data is the amount of gasoline in the road transport sector in the Walloon and Brussels energy balance. To calculate the emission factor, two country specific properties are needed : the average mean temperature (11 °c) and the RVP (72 – average 2010-2015). The timetable for the implementation of Stage 1B and Stage 2 vapour collection and recovery equipment is the following :

- From June 1996 for new service stations (stage 1B)
- From 1 January 1999 for existing service stations with a turnover over 1000 m^3 (stage 1B)
- From 1 January 2002 for service stations with a turnover over 500 m^3 (stage 1B)

- From 1 January 2005 for all service stations (stage 1B)
- From 1 January 2012 for all service stations (stage 2)

In this time series, Tier 2 emission factors without abatement were used before 1996. A linear interpolation was made between 1996 and 2004. In 2005, tier 2 emission factors with abatement were used (stage 1B) and a linear interpolation was made between 2005 and 2011. In 2012, tier 2 emission factors with abatement were used (stage 2). The emission factors are 2,852 kg/t without abatement system, 1,8668 kg/t for stations equipped with stage 1B systems and 0,5078 kg/t for stations equipped with stage 2 systems. In the case of the depots, an emission factor of 0,4 kg/t has been taken until 1996 (Econotec 1998). Since 1996, a new emission factor of 0,15 kg/tonne has been used 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 ». The activity data was estimated via an inquiry in 1996 and recalculated with the annual consumption each year.

For Brussels Capital Region the whole time series has been calculated with this methodology.

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 & Vercaemst, 1999).

3.7.3. Natural gas (category 1B2b)

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

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 emissions of NMVOC originating from the gas distribution (category 1B2biv) are calculated for all the regions in Belgium. 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 2071271 for the year 2020. 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 the Brussels Capital Region, the number of pipelines is estimated at 191 546 for the year 2020. 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 1,4 kg/m^3. The NMVOC content of natural gas distributed is 8 %. In de Flemish region detailed information of supplied gas types and its content is used to calculate the emission factor of NMVOC.

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.

3.7.4. Other fugitive emissions from energy production (category 1B2d)

This section deals with geothermal energy extraction.

2 wells are present in Wallonia but since these 2 active geothermal wells are operating at low temperatures (70 degrees), there are no emissions to air.

There is no geothermal well in the Brussels-Capital and Flemish regions.

3.8. *Recalculations and planned improvements*

Recalculations

In the three regions:

- Optimization of the regional energy balances for the year 2019 as the regional energy balances for the year 2019 were provisional in the 2021 submission. Recalculation of the emissions.
- optimization and revision of the OFFREM model (activity data and methodology) : Optimization of the model to calculate the off-road emissions (OFFREM-model) in the category 1A4b (households): residential sector: the size of the gardens in the Brussels-Capital Region was actualised for the entire time series with more accurate data.
- 1A4c (forestry) : Walloon Region has revised the entire time series for forest area. Because OFFREM first calculates emissions and fuel consumption for Belgium, and then calculates regional figures via the areas per region, the emission (and fuel consumption) of forestry in Flanders also changes for the entire time series.
- Recalculation of road transport emissions 1990-2019 : see chapter Transport.

In the Brussels Capital Region following recalculations were made in the Energy sector:

- There have been recalculations of historical series in the energy balance, especially for the period 2014-2019

- In 1A1a, revision of the emission factors of the municipal waste incinerator from 2006 on based on data available from the PRTR reporting and measurement campaigns, and adjustments of the data from the energy balance from 2008 on.
- In 1A4bii, revision of the size of gardens as input to the OFFREM model resulting in a decrease of the emissions from the off-road residential sector for the whole time series.

In the Walloon region, following recalculations were made:

- In 1A1a and 1A2a, change of allocation of emissions of a TGV from 1A1c to 1A2c.
- In 1A2a, recalculation of NOx and CO in two plants with reheating furnaces by using the guidebook emission factors (table 3-10).
- In 1A2d, revision of the emission factors when using biomass in a boiler in a paper and pulp plant
- In 1A4bi, recalculation of the activity data for the use of charcoal

In Flanders following recalculations were made:

- The EISSA-B_v2 was used to calculate the emissions for the CHP installations in the service and agricultural sector, for the commercial/institutional sector and the residential sector. The emission factors of the EMEP/EEA Guidebook 2019 were applied.
- Fishery : Activity data fuel cost, fuel amount, fleet, average days at sea became available for 2019, what results in a recalculation of the emissions fishery for that year (submission 2021 provisional data for that year was used)
- In 2020 an estimate was made of the SO_2-emissions from natural gas combustion at the power stations for the entire time series.1A1a: Since submission 2022, we made changes to the allocation of emissions from flaring. We allocated the emissions from flaring to 5C1bi instead of 1A1a as recommended in the EMEP guidebook.
- 1A1a: Since submission 2022, we allocated the emission of one waste incineration company to 5C1bi instead of 1A1a because the company produces its own energy and therefore to be allocated to the waste sector itself.
- In 1A4ai, SO_2 emission factors are re-examined based on information provided by Informazout (https://informazout.be, personal communication). The S content of fuel oil is maximum 50 ppm from 2016 on (which corresponds to an emission factor of 2.4 ton/PJ), from 2018 on 1/3 of the fuel oil sold has a S content of 50 ppm while 2/3 has a S content of 10 ppm (which corresponds to a global emission factor of 1.1 ton/PJ).
- In 1A4ai, adjustment of energy consumption (natural gas, fuel oil and LPG) in the energy balance Flanders 1990-2019 from 2014.
- In 1A4bi, SO_2 emission factors are re-examined based on information provided by Informazout (https://informazout.be, personal communication). The S content of fuel oil is maximum 50 ppm from 2016 on (which corresponds to an emission factor of 2.4 ton/PJ), from 2018 on 1/3 of the fuel oil sold has a S content of 50 ppm while 2/3 has a S content of 10 ppm (which corresponds to a global emission factor of 1.1 ton/PJ).
- In 1A4bi, TSP, PM_{10}, $PM_{2.5}$, EC factors are re-examined. For stoves with year of construction> = 2017, the EF based on the emission limit value were replaced by the EF from table 3.42 of the EMEP/EEA guidebook 2019.

- In 1A4bi, B(a)P, B(b)Flu, B(k)Flu, IP factors are re-examined. For stoves and cassettes built from 2000 to 2013, EF from table 3.41 of the EMEP / EEA guidebook 2019 is now used.
- In 1A4bi, an update was made of the stoves for non-wood firing based on data from the Flanders 2018 energy balance.
- In 1A4bi, adjustment of energy consumption (natural gas and LPG) in the energy balance Flanders 1990-2019 from 2016.
- In 1A1a and 1A4ai: In the 2022 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For gas-fired CHP installations and autoproducers with a construction year > 2017, the emission limit values are no longer used as EF.
- In 1A4bi: In the 2022 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For boilers built >=2017 burning piece of wood, the EF of table 3.46 from the guidebook are now used.

Improvements

- Improvement and modification of the energy balance methodology is taking place in the Brussels Capital Region. Some changes of data are possible.
- For some plants in Wallonia, the emission factors are not consistent throughout the time series. Indeed, from 2005, companies must report their emissions and these emissions are included in the inventory but in previous years, emission factors were sometimes used. For the next submission, emission factors will be calculated on the basis of company data (2005-2015) or on the basis of the guidebook and used on the entire time series 1990-2004.
- In the Walloon region, recalculation of the As, Hg and Pb emissions in the offroad sectors and navigation.
- In Flanders a study has been done to optimize the number of stoves and boilers using wood.
- In Flanders the model to calculate the industrial emissions of facilities that are not obliged to submit an annual report in a collective way was revised. The study remained inconclusive and could not guarantee an improved calculation method without impairing the functionality of the total emission inventory. It showed that the current method displays a few flaws indeed but still has high level of significance.
- SO_2 emissions from the use of natural gas in gas fired power stations are included in the reporting.
- The EMMOSS model to calculate emissions from maritime navigation in all ports and in Belgian part of the sea will be revised in 2022-2023.
-
- The EMMOSS model to calculate emissions for national navigation will be replaced by a new model (EISS). The methodology and model are currently being developed.

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 the Brussels Capital Region 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.

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 Capital Region, the emissions are calculated by using different sources: average emission factors, surveys and information collected from the sector. A 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.

Tables with detailed NMVOC emissions for 2005, 2010, 2015-2020 and the Tier methods used are provided for the three regions in Annex 4.

Belgium only reports activity data for a limited number of sectors in the NFR tables because part of the activity data is confidential. Also some source categories consist of several sources and the different activity data are sometimes expressed in different units so it is not possible to show aggregated activity data for these categories.

Allocation of emissions

The industrial processes in Belgium are covered by

- categories 2A1 (cement production), 2A2 (lime production), 2A3 (glass production), category 2A5 (quarrying and mining of minerals other than coal, construction and demolition and storage, handling and transport of mineral products) and 2A6 (other mineral products),
- categories 2B1 (ammonia production), 2B2 (nitric acid production), 2B6 (titanium dioxide production) and category 2B10a (other chemical industry), including 2B10b (storage, handling and transport of chemical products),
- categories 2C1 (metal production i.e. iron and steel industry), 2C5 (lead production), 2C7c (other metal production) and 2C7d (storage, handling and transport of metal products),
- categories 2D3 (domestic solvent use, road paving with asphalt, coating applications, degreasing, dry cleaning, chemical products, printing and other solvent use),

- category 2G (other product use),
- category 2H (pulp and paper and food and drink),
- category 2I (wood processing),
- category 2K (consumption of POPs and heavy metals),
- category 2L (other production, consumption, storage, transportation or handling of bulk products).

4.2. ***Methodological issues***

The main process emissions 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, 2005, 2008-2020) compared to the other years (1994, 1997, 1999, 2002-2004; 2006-2007). In the former years emissions are available on installation level (NFR code), whereas in the latter years the emissions are available on a less detailed level (facility level). A thorough exercise was made to update and improve if necessary all IPCC codes for the years where information is available on a detailed level. By means of the data warehouse, it was possible to use a partition key of the IPCC codes per facility in the most recent year when detailed information is available and use it for the same facility in the years when information is available on an aggregated level (e.g. for emission data of 1999, the distribution used in 1998 is applied to divide the emissions of 1999 between the various codes).

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 NOx and HCB emissions in terms of emissions level and trend, of SOx, Hg, Cr, Ni and PCB in terms of emission level and of PM10, TSP in terms of emission trend.

In Belgium, cement production (5 plants) only takes place in Wallonia. One of the 5 plants has stopped his activity at the end of June 2014.

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 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 whole time-series 1990-2001.

During the 2017 NECD Comprehensive Review, the TERT noted that when continuous measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED (Industrial Emissions Directive) and have subtracted the value of the confidence interval although this subtraction must not be applied in the context of reporting annual emissions. This issue relates to an under-estimate of the emissions. The TERT recommended Belgium to organise a survey among operators to identify which ones are reporting under-estimated emissions and try to derive a methodology to adjust national emissions over the time series. Wallonia followed this recommendation and it appears that no cement plant subtracts the value of the confidence interval to estimate the annual emissions of the pollutants measured continuously. So there is no under-estimation for this sector.

Since 2010, the emissions of HCB and PCB are estimated on the basis of stack measurement. The emissions before 2010 are calculated on the basis of an average emission factor calculated with the measurements of 2010-2011. Emissions of PCB in 2010 and 2011 are significantly higher than other years because of one plant which used an alternative raw material containing high concentrations of PCB in 2010 and 2011. The removal of the raw material causing high PCB emissions at the end of 2011 has allowed returning to a normal level of emissions. The emissions of HCB in 2017 are significantly higher than previous years because of one plant which used an alternative raw material containing high concentrations of HCB in 2017.

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.

Concerning the dust emissions, the emissions represent filterable emissions.

Table 4-1 Cement production in Wallonia.

	1990	**1995**	**2000**	**2005**	**2010**	2015	2016	2017	2018	2019	2020
Clinker production (kt)	5292	6055	6089	5555	4740	4396	4458	4238	4605	5038	4817
IEF clinker (kg NOx/t)	2,78	2,74	2,87	2,57	2,24	1,87	1.49	1,29	1,35	1,20	1,42
NOx emissions (kt)	14,7	16,6	17,5	14,3	10,6	8,21	6.64	5,47	6,22	6,06	6,84
IEF clinker (kg SOx/t)	0,81	0,78	0,80	0,94	0,99	0,66	0.63	0,54	0,54	0,58	0,52
SOx emissions (kt)	4,3	4,7	4,9	5,2	4,7	2,9	2.79	2,27	2,48	2,94	2,51
IEF clinker (kg PM10/t)			0,20	0,06	0,02	0,0068	0,0062	0,0093	0,0039	0,0116	0,0093
PM10 emissions (kt)			1,2	0,33	0,1	0,03	0,03	0,04	0,02	0,06	0,04

4.2.1.2 Lime production (2A2)

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

Production of lime also occurs only in the Walloon region.

The emissions of lime production (category 2A2) are estimated by using plant-specific emission data for all pollutants except for 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.

Concerning the dust emissions, the emissions represent filterable emissions.

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 and IEF in Wallonia.

	2000	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Lime + dolomite lime (kt)	2640	2601	2116	2234	2091	2034	2110	2079	2009	1997	2660	1804	1530
IEF (kg PM10/t)	0,96	0,62	0,34	0,03	0.01	0.008	0.012	0.005	0.015	0.02	0.011	0.01	0.008
PM10 emissions (kt)	0,36	0,24	0,16	0,01	0.026	0.017	0.025	0.01	0.03	0,04	0.03	0.004	0.0120
IEF (kg NOx/t)	0.918	2.338	1.092	1.226	1.309	1.745	1.264	1.109	1.124	1.296	1.254	1.202	0.919
NOx emissions (kt)	2.737	6.077	2.31	2.739	2.735	3.549	2.666	2.305	2.2594	2.587	2.496	2.168	1.40

The evolution of the NO_x emissions from the lime sector shows a jump in 2004 and 2005. This jump is explained by the production of over-burned dolomite during these two years in one company which produces lime and dolomite. Since 2006, there has been a modification of the cooking level of this dolomite following a change of the customer specification. The burning being more "soft", the quantity of NO_x produced has therefore decreased.

The PCB emissions were recalculated this submission for the years 1990-2013 by using an average emission factor.

4.2.1.3 Glass production (2A3)

This source is a key category of Se emissions in terms of emissions level and trend, of NOx in terms of emission level and of SOx in terms of emission trend

The emissions of glass production (category 2A3) are estimated by using plant-specific emission data. The emissions of this category are the sum of combustion and process emissions. The emissions are calculated directly by the plant for the PRTR purposes.

The activity data is glass production and is collected directly from individual plants.

Table 4-3 shows the glass production and the NO_x implied emission factor and the SO_x implied emission factor in the Walloon region. The shift of the residual fuel by natural gas explains decrease of the SO_x emissions and the installation of SCR the decrease of the NO_x emissions.

Concerning the dust emissions, the emissions represent filterable emissions.

Table 4-3 Glass production and IEF in Wallonia.

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Glass (kt)	1 503	1 574	1 587	1 644	1 560	1 461	1 209	1239	1503	1195	947

IEF (kg NOx/t)	4.87	5.94	4.069	4.166	2.356	1.716	2.56	2.51	2.39	2.64	1.8
IEF (kg SOx/t)	7.87	2.377	3.17	3.457	2.37	0.93	0.91	1.1	0.73	0.84	0.96

The sharp decrease of Pb emissions in 2010 is due to the installation of an electrostatic precipitator in a Walloon glass plant in 2009.

In Flanders the emissions under 2A3 are mostly taken from reports from the industry. For particulate matter and heavy metals, 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. The high Pb emissions in 1994-1997 are due to a Flemish glass production plant that was active only during this period. The company did not produce an annual industrial report in 1998 and stopped activities in 1999.

4.2.1.4 Quarrying and mining of minerals other than coal (2A5a)

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

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 to report to PRTR since 2007. From 2000 to 2006, the estimation of the emissions was also provided by the study on dust.

Concerning the dust emissions, the emissions represent filterable emissions.

The evolution of the PM10 emissions is presented in the Table 4-4.

Table 4-4 PM10 emissions in 2A5a

	PM10 (ton) (2000-2006)	PM10 (ton) (2007-2020)
Storage of mineral products	1957	1957
Quarrying	301	Plant specific emissions

Since the 2020 submission TSP and PM2.5 emissions are in line with the PM proportion of the EMEP guidebook : TSP 100 %, PM10 50 % and PM2.5 5 %.

4.2.1.5 Construction and demolition (2A5b)

The category includes the construction emissions in the three regions distinguishing the residential housing (houses and apartments) and the non-residential housing.

The estimations of the emissions are based on the US EPA tier 1 methodology. This method involves multiplication of a specific emission factor for each type of construction with the total area affected by that specific type of construction and the average duration of the construction.

The estimation uses the following equation:

$$EM_{PM10} = EF_{PM10} \times A_{affected} \times d \times (1\text{-}CE) \times (24/PE) \times (s/9\%)$$

Where :

EM_{PM10} = PM_{10} emission (kg)

$A_{affected}$ = area affected by construction activity (m2)

EF_{PM10} = the emission factor for this pollutant emission (kg/(m^2xyear))

d = duration of construction (year)

CE = efficiency of emission control measures

PE = Thornthwaite precipitation-evaporation index

s = soil silt content (%)

The parameters of the equation are presented in Table 4-5.

The dust emissions represent filterable emissions.

Table 4-5 Parameters for PM10, PM2.5 and TSP emission calculation in 2A5b

<table>
<tr><th rowspan="2" colspan="2"></th><th rowspan="2">d</th><th rowspan="2">CE</th><th rowspan="2">PE</th><th rowspan="2">s (%)</th><th rowspan="2">A_{affected}</th><th colspan="3">EF</th></tr>
<tr><th>TSP</th><th>PM10</th><th>PM2.5</th></tr>
<tr><td rowspan="3">Houses</td><td>terraced</td><td>0.5</td><td>0</td><td>120</td><td>20</td><td>120</td><td rowspan="3">0,29</td><td rowspan="3">0,086</td><td rowspan="3">0,0086</td></tr>
<tr><td>semi-detached</td><td>0.5</td><td>0</td><td>120</td><td>20</td><td>188</td></tr>
<tr><td>detached single family</td><td>0.5</td><td>0</td><td>120</td><td>20</td><td>300</td></tr>
<tr><td colspan="2">Apartments</td><td>0.75</td><td>0</td><td>120</td><td>20</td><td>65</td><td>1</td><td>0,3</td><td>0,03</td></tr>
<tr><td colspan="2">Non residential constructions</td><td>0.883</td><td>0.5</td><td>120</td><td>20</td><td>800</td><td>3,3</td><td>1</td><td>0,1</td></tr>
</table>

The area affected is calculated on the basis of the TSTABEL cadastral data and construction permit data published every year for the three regions. The construction permits data provides the number of houses, apartments and non-residential constructions. The cadastral data allows to estimate the types of houses constructed.

4.2.1.6 Other mineral products (2A6)

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

The category includes the emissions of the clay processing industry (bricks, expanded clay, tiles and glazed stoneware pipes), 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 process emissions originating from the production of ammonia are obtained by monitoring results or calculation with plant specific factors.

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

Figure 4-1 shows the trend of the ammonia production in Belgium:

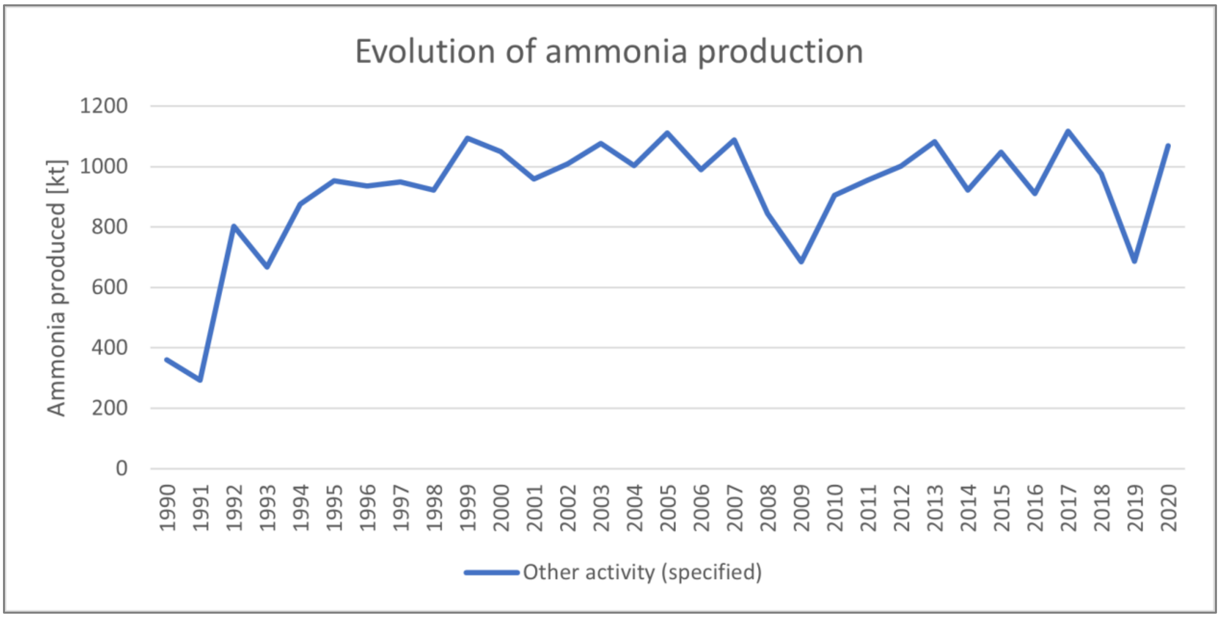


Figure 4-1 Trend of ammonia production.

4.2.2.2 Nitric acid production (2B2)

Despite the closure of two nitric acid plants (one in 1995 and another in 2000), the production of nitric acid in the two remaining plants still increases in 2019 compared with 1990 (after a sharp decline in 2009). In parallel, these plants have taken measures to reduce emissions from their processes (use of catalysts since 2003 with a drop of the emissions in 2011 by the placement of new catalysts on two installations at the end of 2010). NO_x emissions are provided by the plants involved and based on measurements. In Flanders the emissions of SO_2, NH_3 and CO originating from the production of nitric acid are obtained by monitoring results.

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 are two installations with an abatement technology (SCR) installed in 1996 which lead also in a strong increase of the production in 1996. There is also an installation called Dupont which has a SNCR technology for the treatment of NO_x in its tail gas. This installation consumes natural gas to remove NO_x and residual N_2O. NH_3 is one of the products of this reaction in excess. It is called the ammonia 'slip'. The reporting of NH_3 emissions from the Dupont facility has only been made since 2012 as the presence of ammonia appeared during the IPPC revision of the environmental permit. Since the 2018 submission, a recalculation has been performed to calculate the NH_3 emissions since 2002 (start-up year of the installation).

The following chart (Figure 4-2) shows the trend of the nitric acid production:

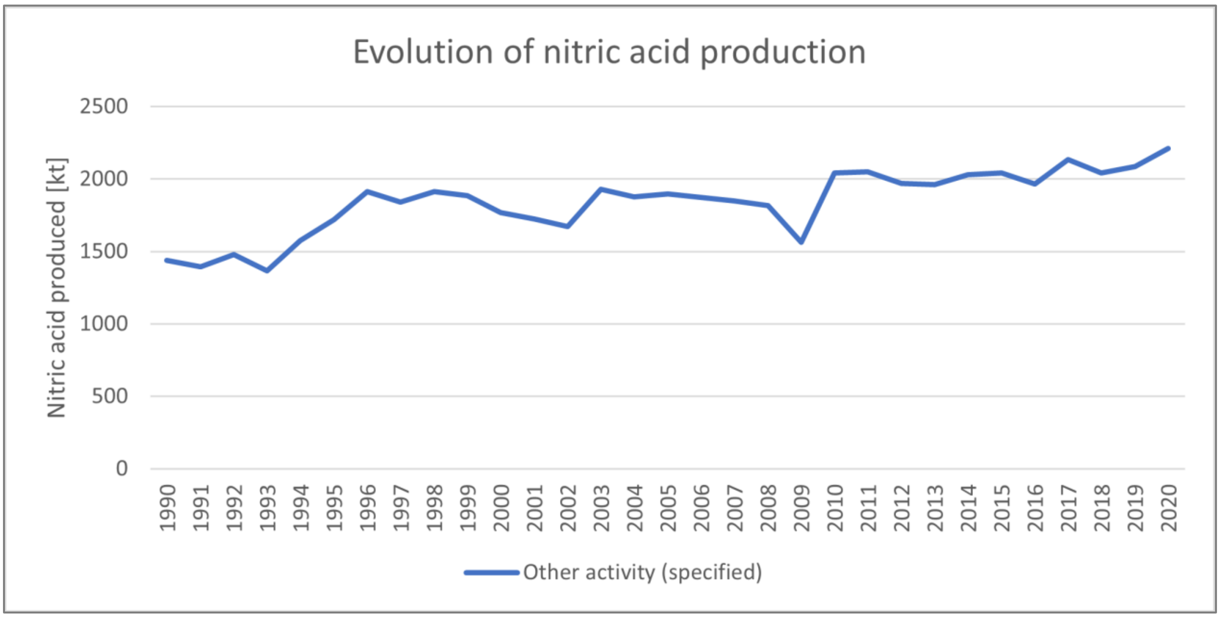


Figure 4-2 Trend of nitric acid production.

4.2.2.3 Other chemical industry (2B10a)

This source is a key category of NOx, NMVOC and SO_x in terms of emission level and trend and of NO_x (level) and Hg emissions (trend).

This category involves all the chemical industry in Belgium which produces 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. Also the emissions of the category 2B10b (Storage, handling and transport of chemical products) are included.

The emissions under 2B10a 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 NMVOC emissions is estimated based on a survey performed by Ecolas authorized by the Environmental Department of the Flemish Government (Bogaert et al, 2004).

In the Walloon region, a part of the NH_3 emissions are coming from the ammonium nitrate production. In previous submissions, no NH_3 emissions were reported before 2000. In the 2019 submission, an average NH_3 emission factor has been estimated and is applied on the time-series 1990-2001.

4.2.3. Metal production (category 2C)

4.2.3.1 Iron and steel production (2C1)

This source is a key category of all pollutants except NMVOC, NH_3 and Se.

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. The dust emissions represent filterable emissions.

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 4-6.

Table 4-6 Emission factors of HCB for the sector 2C1 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, the last integrated iron and steel plant (blast furnace-oxygen furnace) was closed in 2011. An electric arc furnace was closed in 2013 and now, four electric arc furnaces are operational.

Before 2011, iron was produced through the reduction of iron oxides (ore) with metallurgical coke (as the reducing agent) in a blast furnace to produce pig iron. Steel was made from pig iron and/or scrap steel using electric arc or basic oxygen.

All process emissions from sinter production (until 2011), blast furnaces (until 2011), rolling mills, steel production (until 2011) and electric arc furnaces are included. The emissions from electric arc furnaces include all the emissions (combustion and process).

The process emissions from iron and steel production are based on monitoring results provided by the companies.

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

Following the 2017 NEC review, the TSP and the PM2,5 emission factors used for the BOF production in Wallonia in 2005 were revised. In Wallonia, the primary emissions of BOFs (conversion) were abated by a scrubber and not by an ESP (EMEP/EEA Guidebook 2016). These abated emissions represented, according to the study of Professor GERMAIN, about 1/5 of the emitted dust.

The secondary emissions of BOFs (charging, casting, fugitive) were not abated at all, whereas the EF of the EMEP/EEA Guidebook 2016 does include *a limited capturing of secondary dust emissions.* According to Professor GERMAIN, the secondary emissions (not abated) represented about 4/5 of the total of the emitted dust.

There was on the way an adjustment of the initial EF provided by Prof. GERMAIN for the primary emissions of TSP (200 g/t) by the high end value from the 2001 I&S BREF of 80 g/t, to be multiplied by 5 to take into account the not abated secondary emissions. The total EF for TSP used for BOF was 400 g/t.

In 2004, one plant performed analyses (plant 2) to estimate emissions in the context of the introduction of a new environmental permit. The emission factors were 55 g/t for the primary emissions and 153 g/t for the secondary emissions following the methodology in the LECES study (*Guide méthodologique pour l'évaluation des émissions dans l'air des installations de production et de transformation de l'acier*). The total EF for TSP used in the inventory for this plant was 200 g/t in 2005. This plant closed in 2008.

In the case of the plant 1, in 2005, the EF used was 400 g/t in the previous submission. But since 2006, in the context of EPRTR, plant 1 had performed analyses on the primary dust emissions. These emissions were multiplied by 5 to take into account the not abated secondary emissions. Following the review, the dust emissions in 2005 are now recalculated by using an average EF from 2006 to 2011, 144 g/t. This plant closed in 2011.

All of these emissions factors are in the same order of magnitude of the Emission Inventory Guidebook in December 2006 (Table 8.3 Emission factor for dust and heavy metals from basic oxygen furnace production as reported by several countries/authors (in kt/ton oxygen steel)):

Table 4-7 PM emission factors in basic oxygen furnace plant.

Technology	Abatement	TSP	PM10	PM2.5
Conventional installation of average age	Primary dedusting by ESP, wet scrubbing; limited capturing of secondary dust emission	0.35	0.3325	0.315
Modern plant (BAT)	High efficiency ESP or added fabric filter to control primary sources; extensive secondary dedusting using fabric filter	0.12	0.12	0.12
Older plant	Primary dedusting by scrubber with removal efficiency around 97%; limited capturing of secondary dust emission	0.6	0.57	0.54

The dust emission factors in the Emep guidebook 2013 are too low and don't reflect the real emission of old installations without abatement of secondary dust emission.

Concerning the ratio: PM2.5/TSP, it is the ratio of the EMEP guidebook 2006 where the emission factor is in the same order of magnitude as the emission factor used in the Walloon inventory.

The dust emissions represent filterable emissions.

Following the 2018 NEC review, the HAP emission factor used in two blast furnace plants in Wallonia for the pig iron tapping was revised. The emission factor changed over the year with new studies but no recalculation was performed. During this submission, the same emission factor is applied on the whole time series : 607 mg/t (0,176 *(fraction 6 HAP Borneff suivant EPA)* x FE 10 HAP Emep guidebook 2006 Table8.2).

Following the 2019 NEC review, the HAP emission factor were recalculated from 1990 to 2010. The PAH emissions factors were taken from the EMEP guidebook 2019 when no analyse was available.

The default emission factors used are presented in Table 4-8:

Table 4-8 PAHs emission factors in 2C1.

	Total 4 PAHs

Electric arc furnace stell plant	0.48 g/Mg steel
Sinter production	0.3 g/Mg steel
Blast furnace charging	2.5 g/Mg steel
Basic oxygen furnace	0.1 g/Mg steel

In 2009, the two last blast furnaces in the Walloon region were closed and it explains the drop of the HAP emissions between 2008 and 2009.

4.2.3.2 Ferroalloys production (2C2)

For NFR category 2C2 Ferroalloys Production the TERT noted during the NEC review that SO_2, NO_X and CO emissions are not available from the producer for the years 2008-2015. When a facility does not report emissions for a specific year, emissions are not estimated individually for that facility, but the emission gap is estimated in a collective way when activity data and emission factors are available. However the EMEP/EEA Guidebook does not provide emission factors for SO_2, NO_x and CO. A feasibility study was conducted in 2020 and finalized in 2021. The aim of this study was to identify flaws and information gaps in the current method. Additionally, this study tried to set out a new approach for developing a more accurate and complete calculation of the collective emissions. The study focused on the quality of the current method with regard to all emissions, both individual and collective. It remained inconclusive to the fact that a new approach should be developed and emphasized the level of quality of the current method. Though, several suggestions were made to improve the industrial emissions inventory and after thorough analysis and discussions within the emission inventory team, these suggestions couldn't be implemented in the near future because of time and budgetary constraints and would imply a complete makeover of the current method or legislative changes. Therefore, the team decided to maintain the current methodology.

Belgium (Flanders) also explained that particulate emissions from ferroalloys production cannot be separated from other production processes and are therefore included under NFR 2C1 Iron and Steel Production. The notations keys recommended by the TERT for particulate emissions (i.e. IE) are included in the NFR-tables.

4.2.3.3 Aluminum production (2C3)

During the NEC review Belgium explained that NO_X and SO_2 emissions for 2009-2019 and 2004-2019 respectively are unavailable from the producers for NFR category 2C3 Aluminum Production. When a facility does not report emissions for a specific year, emissions are not estimated individually for that facility, but the emission gap is estimated in a collective way when emission factors and activity data are available. At the moment the necessary activity data are not available. A feasibility study was conducted in 2020 and finalized in 2021. The aim of this study was to identify flaws and information gaps in the current method. Additionally, this study tried to set out a new approach for developing a more accurate and complete calculation of the collective emissions. The study focused on the quality of the current method with regard to all emissions, both individual and collective. It remained inconclusive to the fact that a new approach should be developed and emphasized the level of quality of the current method. Though, several suggestions were made to improve the industrial emissions inventory and after thorough analysis and discussions within the emission inventory team, these suggestions couldn't be implemented in the near future because of time and budgetary constraints and would imply a complete makeover of the current method or legislative changes. Therefore, the team decided to maintain the current methodology.

Belgium (Flanders) also explained that particulate emissions from aluminum production are included under NFR 2C7c Other Metal Production. The TERT notes that emissions from both primary and secondary aluminum production should be reported under NFR category 2C3. However, most aluminum producing facilities also produce other metals (only one produces only aluminum) and it is not possible to split up the emissions between the several subsectors.

In Flanders the HCB-emissions are negligible because of the installation of high efficiency abatement. Therefore the emission factor in the 2016 EMEP/EEA Guidebook cannot be used. A second consultation of the sector provides the following information: processing of contaminated scrap with afterburner, additive injection, bag filter or processing of unpolluted scrap.

4.2.3.4 Lead production (2C5)

The PCB emissions in Flanders are calculated based on the Tier 2 method in the EMEP Guidebook 2016. The unabated emission factor for PCB is used combined with the abatement efficiencies.

4.2.3.5 Other metal production (2C7c)

This category is a key category of SOx and all heavy metals except Se and Cr and includes emissions from the following activities:

- Surface treatment of metals (galvanizing, electroplating,..)
- Emissions from non-ferro activities (in Flanders).

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

The decrease in Pb emissions between 1995 and 2000 was mainly due to certain measures taken in two large plants in Flanders. At one plant, a number of installations were taken out of service at the end of 1997 (electric kiln, agglomeration and roasting) and the ore park was evacuated. This led to a significant decrease in Pb, Cd and Zn emissions.

4.2.3.6 Storage, handling and transport of metal products (2C7d)

The emissions from handling of metal products in the Brussels Capital Region are based on monitoring provided by the company. The company involved ended its activities in September 2013.

The emissions in Flanders are calculated based on a collective approach for SO_2 and CO. Reported emissions of particulate matter, heavy metals or POP's are partly provided by the facilities or estimated by multiplying activity data with a default emission factor.

4.2.4. Solvent and product use (category 2D)

4.2.4.1 Domestic Solvent Use Including Fungicides (category 2D3a)

<u>Domestic solvent use</u>

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

A study (2010) in the Brussels Capital 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 population based 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 Capital Region for 2008. The emission factors have been slightly adapted for Flanders and Wallonia. For the Flemish, Walloon and the Brussels Capital Region, the global emission factors are respectively 1,324, 1,412 and 1,219 kg/person for 2008 (Table 4-9). The increase of the ethanol consumption in 2020 due to the use of hand sanitizer because of the Covid-19 crisis (whose emissions are attributed to domestic use of solvents (2D3a)) results in an increase of the emission factor for domestic use of solvents.

Table 4-9 Region specific emission factors based on the Arcadis study in 2010, and the European Solvents Industry Group (ESIG) data for the use of hand sanitizer introduced from the year 2020

	Emission factors (kg NMVOC/capita)		
Product groups	FLANDERS	BRUSSELS	WALLONIA
Office products	0.003	0.003	0.003
Leather and furniture care	0.026	0.030	0.027
Cosmetics and personal care	0.521	0.522	0.522
Cleaning products	0.304	0.336	0.289
Car products	0.423	0.273	0.523
Adhesives / DIY - consumer	0.016	0.018	0.016
Insecticides & plant protection products	0.031	0.036	0.032
Use of hand sanitizer (new EF introduced in 2020)	0.443	0.443	0.443
Total	1.767767	1.662662	1.855855

According to the Arcadis 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 (2009-2020), the emission factors can be assumed to remain constant.

During the 2017 and 2018 NECD reviews, the TERT recommended that Belgium investigates the possibilities for using AD, such as used products and/or used solvents, and to calculate emissions based on these AD. This will enable a compile Tier 2 estimates using methods in the EMEP/EEA Guidebook and to compare the country specific EFs with those in the EMEP/EEA Guidebook. In response to the TERT recommendation, Belgium explained that it has tried to collect other data but so far without success.

Since the 2018 NECD review, the inventory experts of the 3 regions have met the DETIC (Belgian-Luxembourg Association of producers and distributors of soaps, cosmetics, detergents, cleaning products, hygiene and toiletries, glues, and related products) which has already helped collecting the data for the Arcadis study in 2010. Since the meeting in October 2018, DETIC has tried to collect some quantitative data that could be used to improve the inventory.

DETIC has started the data gathering for the category of detergents and cleaning products with the European experts. Belgium is not the only Member State that needs this kind of data for its inventory. Most of the companies that produce detergents and cleaning products do not only market their products in Belgium but also in other European countries. So in order to get consolidated data at the European level and their evolution for the last 10 years it will take some time.

For the car products, DETIC must work directly with the companies because these products are not marketed by the same big actors that market the detergents and cleaning products.

For the cosmetics, DETIC will focus on the deodorants and hair styling products which are the most emissive products. For these 2 categories, the last 10 years have seen significant changes both in the composition and the way of using them. DETIC must contact their members specialized in this kind of products.

DETIC is also trying to get more recent statistics on glues: consumption, solvent content, proportion of solvent based products.

In December 2019, DETIC has provided some data on detergents, cleaning products, cosmetics and adhesives and sealants for the years 2017 and 2018 but these data could not be used for the 2020 submission. In March 2020, DETIC has provided some clarifications on the figures provided in December 2019 but the new data have not yet been taken into account to actualize the domestic solvent use inventory for the 2021 and 2022 submissions. For some products, quantitative data on solvent content have been received but there is no data on product consumption. For other products, there are data on the product consumption but no data on solvent content. And for some products (as cosmetics), the consumption of sprays is known but not the product content in each spray. More exchanges with DETIC will be necessary to be able to actualize the inventory.

In December 2021, the European Solvent Industry Group (ESIG) has finalised its 2020 solvent volatile organic compounds (VOC) emission inventory and has sent the detailed breakdown for Belgium + Luxemburg. In 2020, new emissions are generated because of the ethanol consumption due to the use of hand sanitizer because of the Covid-19 crisis. ESIG considers an emission factor of 0,9 kg NMVOC/kg product for the use of hand sanitizer. The Belgian emissions of NMVOC due to the use of hand sanitizer are equal to 5087 tons. These emissions are attributed to domestic use of solvents 2D3a. This results in an increase of 0,443 kg NMVOC/capita of the emission factor for domestic use of solvents in 2020.

Fluorescent tubes

As a result of the 2018 NECD review, it was recommended that Belgium includes mercury emissions from fluorescent tubes. This category was included for the first time in the 2019 submission. The emission factor used for calculating Hg emissions was the one from the EMEP/EEA Guidebook 2016, Table 3-6: Tier 2 Hg emission factors for source category 2.D.3.a Domestic solvent use including fungicides. However in the 2019 version of the Guidebook it is indicated that due to the uncertainty around the emissions of Hg from the use of fluorescent tubes, this source is currently not considered in the Guidebook. As Belgian experts were not able to find available information to what extent this source could be estimated, this source has been removed from the Belgian inventory since the 2020 submission.

4.2.4.2 Road paving with asphalt (2D3b)

An important source for the emissions in Flanders is the yearly reporting obligation by the industrial companies via the integrated environmental reports. About 60% of the Flemish NMVOC emissions is collected in this way for these activities.

The other part of the emissions in Flanders are calculated based on:

- Production figures known per company

- Tier 1 emission factors of the EMEP/EEA Guidebook 2019, table 3-1

The emissions in Wallonia are calculated based on the emission factors from table 3-1 Tier 1 emission factors of the 2013 EMEP guidebook with an abatement efficiency of 99 % for dust. This abatement efficiency is coherent with the dust limit value in the environmental permits of the plants concerned.

In Wallonia, an average PAHs emission factor was calculated by using some plant analyses: 11,22 mg/t.

4.2.4.3 Asphalt roofing (2D3c)

This category covers emissions from the asphalt roofing industry.

In the Walloon region, there is only one plant producing asphalt roofing and the VOC emissions have been reported since the 2017 submission. The estimated releases (20 t NMVOC/y) come from an application for an environmental permit of the company in 2013. The company produces bituminous waterproofing membranes (8,000,000 m2/year) using 18000 t bitumen as raw materials. Discharges of the process are sent to scrubbers and then activated carbon filters. There is no dust emitted by the process (scrubbers). As this plant is not an IPPC company, they don't have to report their emissions each year. A constant emission is assumed for all years.

4.2.4.4 Coating Applications (category 2D3d)

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

It includes emissions from construction, building and domestic use, car repairing, wood, manufacture of automobiles, other industrial and non-industrial application.

Construction, building and domestic use

A study (2010) in the Brussels Capital 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).

Car Repairing

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. Since the year 2017 DuPont Refinish Belgium no longer wants to provide us with the activity data for reasons of confidentiality. Finally we received the data from IVP (Industry of paints, varnishes and inks),

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 the Brussels Capital Region.

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 the Brussels Capital Region, an emission factor per company has been established. The AD is the number of companies in the region[5].

Wood

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.

Manufacture of automobiles

In the Flemish and in the Brussels Capital 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.

Other Industrial Application

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).

In Wallonia, part of the emissions of other industrial coating is the yearly reporting obligation by the industrial companies via the integrated environmental reports. The remainder of the emissions is estimated. The activity data comes from IVP (Industry of paints, varnishes and inks). An estimation for the sales of paint for industrial applications in Belgium is assumed. According to IVP, the sales of paint have decreased by 20% between 2009 and 2013, were stable between 2013 and 2014, have decreased by 6% between 2014 and 2015 and increased by 3% between 2015 and 2016. Due to a lack of data, an increase of 3% is assumed between 2016 and 2017. The number of workers in the metal fabrication industry is then used as allocation key to calculate the Walloon sales.

[5] SPF Economie (NACE 45.204: Carrosserie)

The solvent content in the paints comes from IVP. An average of 40% of solvent has been assumed.

Until 2010, the emission factor for the emissions not reported annually is 1 kg NMVOC/kg solvent used. Since 2010, this emission factor is calculated on the basis of the solvent mass balances reported annually by the industrial companies, assuming no abatement technique exists for the emissions not reported annually.

In the Brussels Capital Region, the source for estimating these emissions is the yearly reporting obligation by the industrial companies via the integrated environmental reports.

<u>Other Non-Industrial Application</u>

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 2010: 6000 t of paint (200 t of water based – 5800 t of solvent based). These figures have been actualized in 2014: 5000 t of paint (250 t of water based – 4750 t of solvent based) and they are stable in 2015-2019.

It is assumed that the water-based paints do not contain solvent. The solvent content of the solvent based paints in 2010 comes from Ökopol (the Institute for Environmental Strategies): 25%. In 2014, this figure has been actualized on the basis of the COPRO document PTV 883 (Technical prescriptions for road marking paints): 15%.

The NMVOC emissions of road marking for Belgium are 1450 t in 2010 (870 t for Flanders and 580 t for Wallonia). For 2014-2019, the NMVOC emissions of road marking for Belgium are 713 t (428 t for Flanders and 285 t for Wallonia). In 2020, we observed a decrease in the use of solvent-based paints for road marking, the NMVOC- emissions of road marking for Belgium are 630 t (378 t for Flanders and 252 t for Wallonia).

4.2.4.5 Degreasing (category 2D3e)

The sales figures of methylene chloride, trichloroethylene and perchloroethylene in UEBL (Economic Union of Belgium and Luxembourg) were 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...) was also given by ECSA for Benelux (Belgium, Netherland, Luxembourg) for the 3 chlorinated solvents. Unfortunately no sales figures have been published for the recent years due to the new rules about competition. CEFIC has stopped to collect any figures in 2015. We contacted each member of ECSA in order to collect the data ourselves. Unfortunately, we received a negative answer. So, we have assumed that the sales figures are equal to 2013.

The following allocation key is used in Flanders:

- monetary value of sales figures for metal degreasing (De Roo et al, 2009);

The following allocation key is used in Wallonia:

- Workers in the metal fabrication industry for metal degreasing (adjusted annually);

In the 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. 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, part of the emissions of metal degreasing is the yearly reporting obligation by the industrial companies via the integrated environmental reports. The rest of the emissions is estimated. Until 2013, the consumption of chlorinated solvent for metal degreasing is calculated on the basis of data received from ECSA. Since 2014, the consumption of chlorinated solvent has been derived from the global sales of chlorinated solvents given by ESIG for the years 2013 and 2015. Since 2016, chlorinated solvents are excluded from the ESIG inventories as the sector claims not to have any VOC emissions (market decline and all remaining applications are using closed systems). Due to the lack of data, it is assumed that the consumption of chlorinated solvents for the years after 2015 is equal to the consumption in 2015 (conservative approach). 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. Until 2010, for emissions not reported annually, it was assumed that 90% of the solvent was lost to air and 10% to other media (water, soil). Since 2010, this emission factor for the emissions not reported annually is calculated on the basis of the solvent mass balances reported annually by the industrial companies, assuming no abatement technique exists for the emissions not reported annually.

In the Brussels Capital Region, the source for estimating these emissions is the yearly reporting obligation by the industrial companies via the integrated environmental reports. The reports are available from 2003, the years before are considered constant and equal to the first available year.

4.2.4.6 Dry Cleaning (category 2D3f)

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. Unfortunately no sales figures have been published for the recent years due to the new rules about competition. CEFIC has stopped to collect any figures in 2015. We contacted each member of ECSA in order to collect the data ourselves. Unfortunately, we received a negative answer. So, since 2014, we assume that the sales figures are equal to 2013.

The following allocation key is used in Flanders:

- numbers of dry cleaning companies for dry cleaning (Federation of Belgian textile care; adjusted annually)

The following allocation key is used in Wallonia:

- Population for dry cleaning (adjusted annually);

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. 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, until 2013, the consumption of chlorinated solvent (perchloroethylene) for dry cleaning is calculated on the basis of data received from ECSA. Since 2014, the consumption of chlorinated solvent has been derived from the global sales of chlorinated solvents given by ESIG for the years 2013 and 2015. Due to the lack of data since 2016, it is assumed that the consumption of chlorinated solvents for the years after 2015 is equal to the consumption in 2015 (conservative approach). 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 the Brussels Capital region, dry cleaning emissions are calculated on the basis of the emission factor of 5.31 g NMVOC/capita determined in 2002, combined with the evolution of the total population.

<u>Other Industrial Cleaning (category 2D3e)</u>

In Wallonia, until 2013, the consumption of chlorinated solvent for other industrial cleaning is calculated on the basis of data received from ECSA. Since 2014, the consumption of chlorinated solvent has been derived from the global sales of chlorinated solvents given by ESIG for the years 2013 and 2015. The consumption of non-chlorinated solvent is not determined for this sector. The consumption figures of solvent are confidential.

The following allocation key is used in Wallonia:

- Workers in industry for the other applications (adjusted annually).

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

4.2.4.7 Chemical Products, Manufacture and Processing (NFR 2D3g)

The category 2D3g is a key category of NMVOC emissions.

<u>Polyester Processing</u>

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.

<u>Polyvinyl Chloride Processing (PVC)</u>

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.

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).

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. The emission factor is 60 g NMVOC/kg polystyrene foam processed (Guidebook EMEP 2016). In 2016, the all-time series has been actualized on the basis of new activity data provided by STYFABEL (Belgian association for expanded polystyrene processing). Since 2005, there is only one plant performing this activity in Wallonia. The emission factor has been validated by the plant on the basis of the pentane content in the expandable polystyrene.

Rubber processing

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 (60% in 2015).

In Wallonia, 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. Since 2002, there is no tyre manufacturer in Wallonia, only one company performs remoulding of tyres. The emissions are calculated on the basis of a solvent management plan and provided each year by the plant.

Pharmaceutical Products Manufacturing

In the Flemish region the emissions of the pharmaceutical products manufacturing include 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.

Coating Manufacture: Paint

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) ;
- 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 IVP data;

- 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, 2009,2013, 2014, 2015 and 2016);
- 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), car refinish paints (adjusted each year - 35% in 2010) and industrial paints (40% - estimation of IVP in 2013). The average solvent content in the paint is 30% in 2010. An emission factor of 4,4% of the solvent consumption is assumed (IVP).

Inks Manufacturing

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.

Glues Manufacturing

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 2B10a. Since 2008, emissions of only one producer are reported under 2D3g.

Adhesive and Magnetic Tapes, Film and Photographs Manufacturing

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

Leather tanning

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.

Other Chemical Product Manufacturing or Processing

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.10.a. The emissions of only one producer are allocated here. The NMVOC emissions are calculated on the basis of a solvent management plan.

Asphalt Blowing

For the Flemish region there are asphalt blowing activities. In the second half of 2018, after the NEC review of 2018) a lot of efforts were made together with the industry to calculate the B(a)P-emissions. But no estimation of B(a)P-emission has been made because measurements indicates that the detection limits for B(a)P were not exceeded. There are two Flemish companies with asphalt blowing activities. Since 2017 one company has no longer asphalt blowing activities. From 1990 to 2016 there was an afterburner. The B(a)P-concentrations were lower than the detection limit from 1990 until 2016. The other company has semi blowing activities. Measurements of the B(a)P-concentrations of the semi blowing activity indicates that the detection limit was also not exceeded. Therefore we do not report B(a)P-emissions for Flanders for this category.

There are no asphalt blowing activities in the other two regions.

4.2.4.8 Printing (category 2D3h)

This source is a key category of NMVOC emissions. 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 70% 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, part of the emissions of the printing industry is the yearly reporting obligation by the industrial companies via the integrated environmental reports. The rest of the emissions is estimated. 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 used to come from IVP but since 2007 these data could not be actualized. The average solvent content of the ink for each printing technique were obtained by IVP in 2000 and have been partially actualized in 2009 on the basis of the Guidance on VOC Substitution and Reduction for Activities Covered by the VOC Solvents Emissions Directive (March 2009, Final Report, European Commission – DG Environment). On the basis of these data, the Walloon solvent consumption can be calculated. The abatement efficiency for each printing technique also comes from the Guidance on VOC (see reference above). 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 the Brussels Capital Region, for big printing establishments, the emissions are estimated on the basis of NMVOC balances (yearly obligation). For small businesses, the emissions are estimated with an average emission factor and the number of companies.

4.2.4.9 Application of Glues and Adhesives (category 2D3i)

This source is a key category of NMVOC emissions (emission level).

In the Flemish region (2D3i) 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 are 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 since 2002.

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 since 2002.

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

<u>Preservation of Wood (category 2D3i)</u>

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 2018 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.

Fat, edible and no-edible oil extraction (category 2D3i)

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 emissions of one producer are reported under category 2D3g.

4.2.5. Other product use (2G)

The category 2G is a key category of PM2.5, Pb, Cd, Cr, Ni, Cu and Zn emissions.

Emissions of the main pollutants originate from facilities of several sectors (production of (suit)cases, production of mica paper, production of plastic packaging products) and are reported by the facilities via the integrated environmental reports.

Emissions of heavy metals from the use of lubricant in the road transport sector as calculated by COPERT5 are also included in this sector. In 2020 submission, these were wrongly allocated in the 2D3i sector.

Use of tobacco

The three regions estimate these emissions by multiplying the regional tobacco consumption with the emission factors coming from the EMEP/EEA Guidebook 2019 (Table 3-15). The regional tobacco consumption is calculated from the Belgian tobacco consumption, taking into account the number of households and the average spending; see Table 4-10.

Following the guidebook, it's unclear if the emissions represent filterable or total emissions.

Table 4-10 Activity data for tobacco smoking

Type of product	Region	Activity data for 2020	Reference
cigarettes	Belgium	8 880 525 124 cigarettes	statbel
cigars and cigarillos	Belgium	241 241 413 cigars and cigarillos	Statbel
tobacco	Belgium	5 175 002 875 grams	Statbel

Use of fireworks

For its 2019 submission, Belgium reported for the first time emissions from fireworks. As Belgian experts could not find activity data despite several requests and research in different institutions, emissions were estimated using the ratio of the Netherlands' emissions per inhabitant as emission factor for the following pollutants: TSP, PM_{10}, $PM_{2,5}$, SO_2, CO, Cu and Zn.

After the recommendation of the NECD review in 2019, since the 2020 submission, Belgium estimates the emissions by using activity data from fireworks based on Eurostat statistics for fireworks use and emission factorsTier 2 from the 2019 EMEP/EEA Guidebook (Table 3-14). Following the 2019 NEC Review, the TERT recommends Belgium to improve the activity data time series by using a moving average for all years. This new methodology allows the estimation of additional emissions of NOx, As, Cd, Cr, Hg, Ni and Pb.

4.2.6. Pulp and paper (2H1)

This category includes process emissions from the following activities:

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

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

4.2.7. Food and drink (2H2)

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

This category includes process 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, SO_2 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 in Table 4-11.

In Wallonia and in the Brussels Capital Region, the emissions are calculated with the activity data and the emission factors given in Table 4-11.

Table 4-11 AD and EFs used in 2H2

Type of products	region	Activity data	Emission factor	Reference
Bread	Flanders, Wallonia and Brussels	Belgian production	4500 g NMVOC/t	AD : Prodcom EF : EMEP guidebook 2019

Biscuits	Flanders	77% x Belgian production	1000 g NMVOC/t	AD : Prodcom EF : EMEP guidebook 2019
Biscuits	Wallonia and Brussels	23% x Belgian production	1000 g NMVOC/t	AD : Prodcom EF : EMEP guidebook 2019
Beer	Flanders	74% x Belgium production	0,035 kg NMVOC/hl beer	AD : Beerparadise EF : Emep guidebook 2019
Beer	Wallonia	26 % x Belgium production	0,035 kg NMVOC/hl beer	AD : Beerparadise EF : Emep guidebook 2016
Fish smoking	Flanders	Prodcom statistics	0.080 kg TSP/ton	Study Schrooten & Van Rompaey (2002)
Meat cooking	Flanders	51.07kg/hab.year	1.30 kg TSP/ton	Study Schrooten & Van Rompaey (2002)
Barbecue (meat cooking)	Flanders	130 g/hab.year	40 kg TSP/ton	Study Schrooten & Van Rompaey (2002)
Barbecue (charcoal emissions)	Flanders	165 g/hab.year	2.40 kg TSP/ton	Study Schrooten & Van Rompaey (2002)

4.2.8. Consumption of POPs and heavy metals (category 2K)

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

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 (Table 4-12), the PCB-emissions can be calculated.

Table 4-12 Emission factors of PCB for sector 2K in the Flemish region

	Unit	Value	Reference
PCB transformer	kg/ton PCB	0,06	EMEP guidebook 2016
PCB capacitor	kg/ton PCB	1,6	EMEP guidebook 2016

Emissions from metal shredders

An estimation of the PCB emissions from metal shredders is realized for the first time in the Walloon region. Following their environment permit, metal shredders have to perform measurements each year since 2017. These data are also reported under the E-PRTR reporting. However, these data were not yet integrated in the LRTAP inventory as the emissions data have only existed for some years. Furthermore, the recalculation between 1990 and 2006 is difficult as there is no activity data before 2007. An average EF is calculated for each plant with 2 years of analyses data (2016-2017) and is used to calculate the PCB emission from each plant from 2007 to 2015. The EF is calculated only on 2 years as after 2017, some plants have installed a filter on the chimney.

As there is no activity data before 2007, the activity data and the emission of 2007 is supposed to be the same from 1990 to 2007.

Table 4-13 Emissions of PCB from metal shredders in Wallonia.

	1990	2007	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AD (t)	502	502	510	506	527	566	580	717	614	903	915	899	Conf
emissions (kg)	20.0	20.0	21.6	20.9	23.8	32.1	23.2	37.6	46.9	46.8	14.2	10.7	5.02
FE (g/t)	40.0	40.0	42.3	41.2	45.3	56.7	40.0	52.4	76.4	51.8	15.6	11.9	/

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

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

For particulate matter and heavy metals, process emissions originating from the wood, textile, rubber and plastic handling, automobile, electrotechnical industry and storage and handling of bulk products are allocated in this sector. These emissions are reported by the facilities in the annual industrial reports.

4.3. *Recalculations and improvements*

Recalculations

For the three regions:

-
- 2D3a: The increase of the ethanol consumption in 2020 due to the use of hand sanitizer because of the Covid-19 crisis (whose emissions are attributed to domestic use of solvents results in an increase of the emission factor for domestic use of solvents.

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

- 2A3/2A6: NMVOC-emissions from one company allocated to 2A3 instead of 2A6.
- 2C5 Aluminium production: PCB emissions have been estimated for the whole time series.
-
- 2D3g: recalculations of NMVOC-emissions for 2010-2019 based on new information from several companies.
- metals
- 2G use of tobacco: emissions of SOx for 1990-1999 are included for the first time.
-
-

In Wallonia, the following recalculations have been performed:

2A1 *Cement production*: The activity data (clinker production) and the IEF in 2019 have been corrected because of an error in the clinker production of one plant. No changes have been made in the emissions of pollutants.

- 2A2 Lime production: The PCB emissions were recalculated this submission for the years 1990-2013 by using an average emission factor.
- 2B1 Ammonia production : an ammonia slip occurred from 2011 to 2020 which wasn't in the inventory. The problem was resolved in 2021.
- 2D3d Coating applications: Correction of the VOC emissions of domestic use of paint and paint application for construction and buildings in 2018.
- 2D3g Chemical products: Revision of the VOC emissions of pharmaceutical products manufacturing from 2016 to 2019 to take into account a revision in the emissions of one plant.
- 2D3g Chemical products: Revision of the VOC emissions of paints manufacturing in 2018 and 2019.
- 2D3h Printing: Revision of the VOC emissions in 2019.

In Brussels, the following recalculations have been performed:

- 2A5b construction and demolition: Revision of the activity data for 2019
- 2D3a Domestic solvent use: Update of Stabel population data for the years 1994, 1995, 1996 et 2008
- 2D3d Coating Applications: Update of Stabel population data for the years 1994, 1995, 1996 et 2008 and bupdate of the historical data on the number of households slightly impacting the emissions
- 2D3e Degreasing: Revision of one company's data for 2017
- 2D3f Dry cleaning: Update of Stabel population data for the years 1994, 1995, 1996 et 2008
- 2D3h Printing: Update of COV data from COV balance of National Bank for the years 2003 to 2019

Improvements

In the Flemish region, the following improvements are planned:

- 2D3a domestic solvent use: recalculation of NMVOC-emissions for recent years based on activity data per product type (DETIC data).

- Revision of the NMVOC-emissions from dry cleaning for 2015-2020 on the basis of the survey performed by the Belgian textile federation in order to collect the solvent consumption figures.

In Wallonia, the following improvements are planned:

- Revision of the VOC emissions from domestic solvent use on the basis of the data collected by DETIC;
- Revision of the VOC emissions for Wood paint application ;
- Revision of the VOC emissions for non-chlorinated solvents for Metal degreasing, Dry cleaning and Other industrial cleaning;
- Revision of the VOC emissions for Polyester processing, Polyvinylchloride processing, Polyurethane processing;
- Estimation of the missing VOC emissions (NE) for Textile finishing, Glass wool enduction, Mineral wool enduction ;
- Revision of the emissions from key sources in order to move from Tier 1 to Tier 2 methodology when necessary.

In Brussels, the following improvements are planned:

- Revision of the VOC emissions from domestic solvent use on the basis of the data collected by DETIC.

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. Numerous contacts take place with the plant operators as well as with the federations involved. In exceptional cases the inspection services are contacted.

Chapter 5. **Agriculture (NFR sector 3)**

5.1. ***Overview***

5.1.1. Allocation of emissions

The agricultural sector includes the emissions originating from animal manure management (NFR sector 3B), the use of synthetic N-fertiliser (NFR sector 3Da1), animal manure applied to soils (NFR sector 3Da2a), organic fertilisers applied to soils (NFR sector 3Da2c), urine & dung deposited by grazing animals (NFR sector 3Da3), agricultural crops (NFR sector 3Dc), manure processing (NFR sector 3Dd) and from cultivated crops (NFR sector 3De). 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 3 are based on calculations using specific regional information. The categories 3B1a and 3B1b (cattle dairy and non-dairy), 3B3 (swine), 3Da1 (Inorganic N-fertilizers), 3Da2a (animal manure applied to soil) and 3Da3 (urine and dung deposited by grazing animals) are key categories for NH_3, either in terms of emission level, trend or both level and trend. The categories 3B3, 3B4gi (laying hens), 3Dc and 3B4gii are key categories for PM10 or TSP in terms of emission level or trend. For NMVOC, the categories 3B1a, 3B1b and 3B4gii (dairy cattle, non-dairy cattle, swine and broilers resp.) are key categories in terms of emission level. The categories 3Da1 (Inorganic N-fertilizers) and 3Da2a (animal manure applied to soil) are key categories for NOx in terms of emission level.

5.1.2. Description of the sector

The land used for agriculture in 2020 in Belgium extends to 1367082 hectares. In 2020, the number of agricultural and horticultural businesses amounted to 35996. This number had dropped by 42% since 2000. The disappearance of small businesses is a general trend in the sector. Additionally in Flanders, this can be partly 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 2020 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 27 ha per farm in the Flemish region and 58 ha per farm in the Walloon region. The agricultural activities on the Brussels territory are extremely limited compared to the 2 other regions in Belgium. The agricultural area or animal number do not exceed 0.2% of the national figure.

5.1.3. Climate:

With an average temperature of 12.2°C in 2020 (https://www.meteo.be/nl/klimaat/klimaat-van-belgie/klimatologisch-overzicht/2016-2020/2020/jaar), Belgium as a whole has a ‘cool’ climate. The average temperature (over different years) in Belgium is 10.2°C.

5.1.4. 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 slightly changed.

At present, 75% 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.

However, since 2015, the agricultural census is not as detailed as needed. Therefore, Wallonia uses regional statistics for some data from 2013 on. Flanders uses from 2000 on data from the Manure Bank of the Flemish Land Agency (VLM) as pointed out in 5.1.4.1 (https://www.vlm.be/en). In Brussels, the evolution of agricultural surfaces and livestock numbers shows a significant statistical break in 2011 in Statbel data due to a methodological change attributing agricultural surfaces and livestock by operator headquarters, instead of where the activity effectively takes place. In order to overcome the dropout of the Statbel data for the region, the following calculation method is applied: the Statbel data is used for the period 1990-2010, the 2011 data equals to the previous five-year average, and then the Belgian evolution as published by Statbel is applied.

Further details on the agricultural census methodology and QA/QC issues can be found on the Statbel website:

https://statbel.fgov.be/nl/enquete/algemene-landbouwenquete

5.1.4.1 Livestock

The livestock numbers are the primary activity data used in the calculation of agricultural emissions.

Table 5-1 gives an overview of the origin of livestock number in the two regions for the different time periods.

Table 5-1 Origin of the livestock number in the three regions

Livestock numbers	Flanders	Wallonia	Brussels
1990-1999	STATBEL	STATBEL	STATBEL
2000-2012	Manure Bank (VLM)	STATBEL	STATBEL until 2010. 2011 data equals to the previous five-year average. From 2011 the Belgian evolution as published by Statbel is applied.
2013-2020	Manure Bank (VLM)	STATBEL + Walloon Statistics (DGO3 – Agriculture Administration)	Evolution based on the Belgian total as published by Statbel.

In Flanders, from 2000 on, input data such as animal number, N-production a.o. are obtained by the Manure Bank of the Flemish Land Agency (VLM; https://www.vlm.be/en). 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 (Emission Model Ammonia Flanders (EMAV) 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. To be consistent between different models used (NH_3, NOx, NMVOC, PM, N_2O, CH_4) Flanders decided to use the VLM data source for animal number and N-excretion for all models starting in 2000. For 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 true that the animal number between Statbel and the manure bank is not exactly the same. Statbel collects data on the 1st of May, which means that farmers give the animal number present at the farm at the 1st of May. For the manure bank farmers give the average animal population 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.

From 2013 onwards, Wallonia uses also complementary activity data from regional statistics (DGO3 – Direction générale opérationnelle de l'Agriculture, des Ressources naturelles et de l'Environnement) as Statbel give no more details on some animal categories (Goats and Sheeps). For cattle, pigs, poultry and horses, the Statbel activity data are used.

For Brussels, STATBEL values are used until 2010. After 2010 there is a break in the data series of STABEL following the application of a new methodology for the allocation of the agricultural activities by region. To overcome this break, the 2011 values in Brussels equal the average of the previous five years. Then the evolution at the Belgian level as published by STABEL is applied.

5.1.4.2 N-excretion factors (Nex)

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 2019 are described in https://www.vlm.be/nl/SiteCollectionDocuments/Publicaties/mestbank/bemestingsnormen_2020.pdf. . Unfortunately no translation in English is available. For dairy cattle, the 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, Nex factors are derived from the information in the PGDA, the Walloon program for sustainable use of nitrogen built for the implementation of the EU Nitrates Directive 91/676 (see annexes of the decree downloadable on https://protecteau.be/resources/shared/publications/legislatif/PGDAIII.pdf). The figures in the PGDA represent the Nex after deduction of the atmospheric losses. To estimate the Nex including the atmospheric losses, it is assumed a mean atmospheric loss of 25%. During the ESD review of June 2020, new values for "Other cattle" were available in the last PGDA (2014), so new emission factors have been updated based on these parameters. From the 2021 submission, the Nex evolution follows the values of the different PGDA (<2007, 2008-2014, >2015).

The region of Brussels-Capital applies the N-excretion factors of Wallonia.

Table 5-2gives an overview of the livestock number and N-excretion factors (weighted average) used in both regions in 2020.

Table 5-2 Animal number and weighted average of nitrogen excretion factors for each animal category in Flanders and Wallonia (2020).

Category	**Population**			**Weighted Average Nex (kg N/head.yr)**	
	Flanders	*Wallonia*	*Brussels*	*Flanders*	*Wallonia and Brussels*
Dairy Cattle	311847	186896	72	122.58	120.54
Brood cows	136250	212797	28	65.0	88.39

Category	Population			Weighted Average Nex (kg N/head.yr)	
	Flanders	*Wallonia*	*Brussels*	*Flanders*	*Wallonia and Brussels*
Other cattle	830299	669303	165	41.93	54.41
Fattening Pigs	3990155	254873	0	10.56	6.03
Other Swine	1935092	130330	3	5.84	8.43
Sheep	65921	57402	24	8.37	6.95
Goats	62413	16794	36	9.10	7.58
Horses/mules and asses	58284	24459	31	48.10	77.01
Rabbits and fur animals	37116	NE	NE	3.30	-
Laying Hens	10388981	1787322	225	0.66	0.8
Broilers	28468939	6321857	691	0.55	0.36
Other Poultry	421582	377359	29	1.50	0.6

The allocation of animals to animal waste management system (AWMS) in Wallonia and Brussels (see Table 5-3) 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. Experts from the sector have been contacted and they confirm that these figures are still valuable in the absence of new detailed information.

The allocation of animals to AWMS in Flanders originates from the Department of Agriculture and Fisheries (Table 5-3).

Table 5-3 Allocation of animals to AWMS for each category in Wallonia and Brussels (2020)

	Solid storage	**liquid storage**
Bovines under 6 months	87%	13%
Bovines between 6 months and 1 year: male	90%	10%
Bovines between 6 months and 1 year: female	87%	13%
Bovines more than 1 year for fattening: male	87%	13%
Bovines more than 1 year for reproduction: male	77%	23%
Bovines more than 1 year: female	77%	23%
Dairy cows	56%	44%
Brood cows	91%	9%
Swine (included piglet & fattening pigs)	25%	75%

Sows	42%	58%
Breeding males	43%	57%
Lambs	100%	0%
Sheep	100%	0%
Goat	100%	0%
Horses	100%	0%
Broilers	89%	11%
Laying hens	6%	94%
Other poultry	26%	74%

Table 5-4 Allocation of animals to AWMS for each category in Flanders (2020)

	Solid storage (%)	**Liquid storage (%)**
Bovine		
Slaughter calves	0	100
Bovines under 1 year	93	7
Bovines under 1yr for replacement	84	16
Bovines from 1 to 2 year	86	14
Bovines from 1 to 2 yr for replacement	41	59
Bovines more than 2 year	78	22
Dairy cows	37	63
Brood cows	80	20
Swine		
Piglet from 7 to 20 kg	1	99
Fattening pigs from 20 to 110 kg	1	99
Fattening pigs more than 110 kg	1	99
Boars	25	75
Sows including piglets less than 7 kg	1	99
Sheep	100	0
Goats	100	0
Horses	100	0
Rabbits and fur animals	100	0
Poultry	With litter	Without litter

Broilers (for breeding)	100	0
Broilers (for fattening)	100	0
Laying hens (for breeding)	32	68
Laying hens	31	69
Ostriches	100	0
Turkeys	100	0
Other poultry	100	0

5.2. *Animal husbandry and manure management (category 3B)*

5.2.1. 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 5.1.4.2). 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 three regions differ and are individually described below.

In Flanders, for the entire time series, the EMAV2.1-model (Broekaert & Bakelants, 2019) was used. As described in 5.1.4.1 this model calculates the NH_3 emission in different emission stadia, taking into account the manure flow throughout the farm. 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. These data are collected by the Flemish Land Agency on a yearly basis. For a summary in English of the EMAV2.1 model see Annex 5A. During the different calculation steps of EMAV2.1, quality control checks are performed. At different steps pop ups appear to verify whether the right input data is used (e.g. version of calculation factors, Figure 5-1) or to inform the user something unusual has been detected (e.g. empty rows or columns, Figure 5-2) or an overview of the result of the programmed controls performed (Figure 5-3).

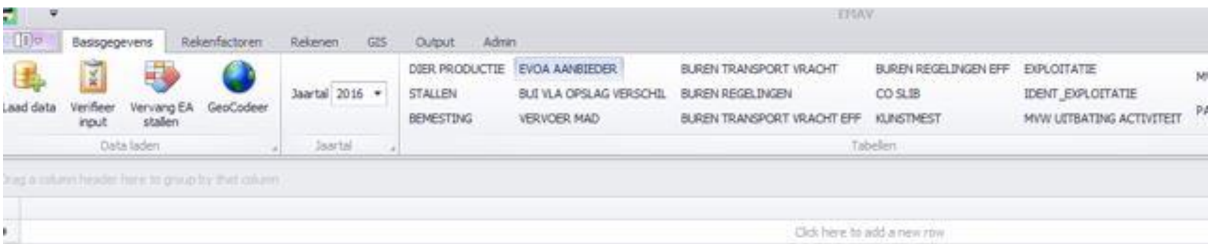


Figure 5-1 Pop up in the EMAV2.1 model to verify whether the correct version of the calculation factors is selected

Figure 5-2 Pop up in the EMAV2.1 model to verify whether empty rows can be deleted.

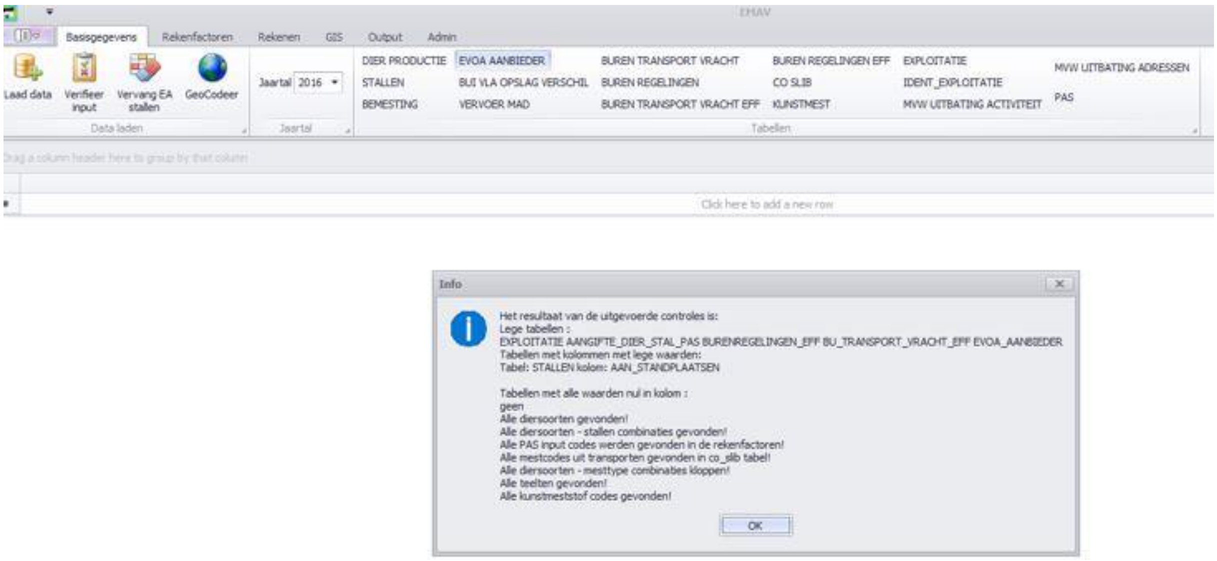


Figure 5-3: Pop up in the EMAV2.1 model giving an overview of the results of the automatic checks.

In 2020 an external validation of the EMAV2.1 model was carried out by the Flemish Institute of Technical Research (VITO) on behalf of VMM. A summary in English is given in annex 5B. The outcome of the validation will be prioritized and integrated in the model during the following years/revisions.

There is a significant decrease in NH_3 emissions from 3B1a, 3B1b and 3B3 between 1999 and 2000. This decrease is mainly due to the implementation of the successive Manure Action Plans in Flanders. Since 2003 all newbuilt stables for swine and poultry have to be constructed in an ammonia emission poor way (AEA-stables). The licensed stables are inventoried by the manure bank of the Flemish Land Agency based on the amount and type of ammonia emission-poor stables. Therefore, it is possible to adjust the stable emission factors for swine and poultry yearly, depending of the implementation of NH_3 emission poor stables in Flanders. In EMAV2.1 it is possible to integrate all types of ammonia emission poor stables for swine and poultry and in the future for different animal categories as well. For the years 2000 till 2006 the EMAV2.1 model cannot make a distinction between dairy cattle and brood cows for the calculation of the NH_3-emissions on the level of the stable. Therefore, dairy cattle and brood cows are reported together in the NFR-tables and an average emission factor is used. From 1990 till 1999 and from 2007 on, a distinction can be made. Due to the lack of detailed activity data for the years 2000 till 2006, the recommendation by the TERT cannot be implemented.

In Flanders, the emission factors used for dairy cows are based on the RAV (Regeling Ammoniak en veehouderij), used in the Netherlands (Dutch legislation). The Netherlands are a neighbouring country with comparable stable types as the Flemish region. The RAV gives an overview of emission factors for each animal category and this for each relevant stable type. The RAV can be found by following link: http://wetten.overheid.nl/BWBR0013629/2017-04-12. The emission factors are revised on a frequent basis when new information becomes available. The described emission factors are derived from a series of measurements in different stable types. Because the stable types used in Flanders are very similar, although not identical, to those used in the Netherlands, the emission factors were analysed by the Scientific Commitee in Flanders and compared to the Flemish situation. The emission factors are written in Flemish Legislation: 'MER richtlijnen handboek landbouwdieren' (Environmental Impact assessment - guidebook for livestock - Flemish legislation) and can be found by following link: **https://omgeving.vlaanderen.be/sites/default/files/atoms/files/20210201_RLB%20Landbouwdieren_bijlage%20emissiefactoren.pdf**. In 2018 ILVO has been doing a revision of the implied emission factors used for cattle and poultry in Flanders (Zwertvaegher et al., 2018). From 2016 on, for dairy cattle an emission factor of 13kg NH_3/cow.yr is used, from 2000 till 2016 this is 11kg NH_3/cow.yr and from 1990 till 1999 9.5kg NH_3/cow.yr. This evolution is caused by the evolution in stable type, feed management, etc and has been reviewed and suggested by the scientific team of the ILVO (Research Institute for Agriculture,Fishery and Food).

Furthermore, in Flanders, since 2017, farmers can and in some cases are obliged to reduce the NH_3-emissions on their farm/exploitation. This is in order to reduce the impact of the agricultural processes on the N-deposition of surrounding Natura 2000 areas. This obligation is implemented in Flemish legislation and is named the programmatic approach nitrogen (PAS). Farmers can choose between different ammonia reducing measures and techniques (PAS-list - https://ilvo.vlaanderen.be/nl/pas-lijst). The above-mentioned ammonia-emission poor stables (AEA-list) can be considered PAS-measures as well. Each measure or technique from the AEA- or PAS-list has its own reduction% or emission factor. Also these data are collected by the Manure Bank (VLM). An overview of the Agricultural Waste Management System NH_3 emission factors used in Flanders is given in Annex C.

Also in Flanders NH_3 emissions from storage of manure on the farm are reported in category 3B. These emissions are calculated using the EMAV2.1 model.

In Wallonia, the emissions are calculated using the Tier 2 methodology described in the EMEP/EEA Guidebook 2019. The methodology allows improving the coherency with the GHG inventory and takes also into account some recent data on existing measures to reduce emissions: e.g. the building equipment systems and manure application practices.

Indeed, since 2002, farmers have to incorporate solid manure within 24hours. Furthermore, thanks to a survey realised in 2017, data have been collected on slurry application practices: application near the soil have increased since 2003. This led to a decrease of the emissions of manure application (see section on Direct soils emissions for more details).

Data on analyses of organic fertilisers (sludge, compost and digestates) have been integrated in the submission to improve the estimation of N content and thus NH_3 emissions since 2013.

Finally, we have also a rough idea of the swine buildings equipped with scrubbers or biofilters. But this doesn't represent a significative reduction of the global Walloon buildings emissions as swine is not the biggest source in the category 3 B in Wallonia (less than 10% of the 3B emissions) and only a little part of swine are located in such buildings (less than 10% of the swine livestock).The emission factor reductions used come from the UNECE publication 'Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions' (2015). For the building emissions reduction, the abatement factor is 70%. This factor is applied on the emissions from swine categories housing (equations 15 & 16 in step 6, pp 23 of the 2019 EMEP Guidebook).

For the Brussels-Capital region the nitrogen emissions are calculated according to the Tier 2 methodology of the EMEP / EEA 2019 guidebook.

5.2.2. Particulate matter

In Wallonia, the dust emissions for the category 3B are calculated by using the Tier 1 emission factors coming from the EMEP/EEA Guidebook 2019 (*Chap. 3.B Manure management*, table 3-5, p19) and the activity data from national and Walloon statistics.

In Flanders, the dust emissions for the category 3B are also calculated by using emission factors from the EMEP/EEA Guidebook 2019. (*Chap. 3.B Manure management*, table 3-5, p19) and activity data from Flemish statistics (see also 5.2.1 for the explanation on the distinction between dairy and brood cows before and after 2007).

The IEF of TSP, PM10 and PM2,5 for the fattening pigs in Flanders is derived from a study performed by the Institute for Agricultural and Fisheries Research (Van Ransbeeck, 2013), see Table 5-5.

Table 5-5 Emission factors for the calculation of TSP, PM10 and PM2.5 emissions of fattening pigs in the Flemish region

Livestock	unit	TSP	PM10	PM2,5
Fattening pigs	kg/year/animal	0,749	0.0999	0.0078

Emissions of PM2.5, PM10 and TSP from 3B4giv Other poultry are not estimated from 2007 on. Following a question raised by the review team, it was explained that in Flanders ducks and geese are no longer included in statistics by the Flemish Land Agency from 2007 on (see also 5.1.4.1 for some more explanation on the livestock numbers), so emissions cannot be provided for these animal categories. The category 3B4giv however includes emissions from turkeys, to be consistent with Wallonia where emissions from turkeys cannot be reported separately.

In the Brussels-Capital region these emissions are calculated by applying the Tier 1 methodology of the EMEP/EEA 2019 guidebook (table 3-5 page 19). Emission factors in kg/animal/year for PM10, PM2.5 and TSP are allocated to each animal category.

5.2.3. NOx

In Flanders, the NO_x emissions for the category 3B are calculated by using the Tier 1 emission factors coming from the EMEP/EEA Guidebook 2019 (*Chap. 3.B Manure management,* table 3-3) and the activity data from the Flemish Land Agency (VLM).

In Wallonia and Brussels, the NO_x emissions are derived from the NH_3 calculations as described in the tier 2 methodology in the EMEP/EEA Guidebook 2019.

5.2.4. NMVOC

The NMVOC emissions for the category 3B are calculated by using the activity data from national and Walloon statistics (Wallonia) and the Flemish Land Agency (Flanders).

In the three regions, the Tier 2 methodology from the EMEP/EEA Guidebook 2019 (table 3.11 and 3.12) is followed for the cattle and swine and the Tier 1 emission factors (table 3.4) are used for the other animals.

5.3. ***Direct soil emission (category 3D)***

5.3.1. Synthetic fertilizer use (category 3Da1)

5.3.1.1 NH_3

In Flanders, the NH_3 emissions from fertilizer use are calculated using the same EMAV2.1-model as described above in which the amount and type of fertilizer used (kg N/exploitation) is multiplied by the corresponding emission coefficient. Depending of the type of mineral fertilizer, a different emission coefficient is used. Till 2006, the relative amount of different types of mineral fertiliser used in Belgium originate from the *International Fertilizer Industry Association (IFA)* and from 2007 on from the Manure Bank. The emission coefficients (%) for the different types of fertilizer are given in Table 5-6 and are kept constant for the entire time series.

For the amount of fertilizer use the *Department Agriculture and Fisheries* and the *Institute for Agricultural and Fisheries Research* conduct surveys on a representative sample of the different types of agricultural businesses and produces yearly weighted average values on the fertilizer use, taking into account the manure pressure (Campens & Lauwers, 2002). Also the Flemish Land Agency collects data of fertilizer use per exploitation (level of the farm). Both sources are combined in the EMAV2.1 model.

In Wallonia, the NH_3 emissions are calculated by multiplying the quantity of fertilizer use (Walloon statistics) by an updated emission factor, derived from the EMEP/EEA Guidebook 2019 (*Chapter 3D Crop production & agricultural soils,* Table 3-2, p 15) and the same relative amount of different types of mineral fertilizer as in Flanders. With this update, the emission factor is equal to 3.9%.The data on the use of mineral fertilizer come from the Agricultural Economy Analysis Department of the region. The use of mineral fertilizer is decreasing since 1990. The amount of synthetic fertilizer used in Wallonia in 2020 is 94.18 kg N per ha.

In the Brussels-Capital region the amount of synthetic fertilizer in Kg N per ha of Wallonia is used for the estimation of the NH3 emissions which are calculated by applying the Tier 1 emission factor of the 2019 EMEP/EEA Guidebook (3D, table 3.1, page 12).

Table 5-6 The amount (kg N) of the total synthetic fertilizer used (2019) and the emission coefficient for each fertilizer type in the Flemish Region.

	Synthetic Fertilizer use (kg N)	**Emission Coëfficiënt (%)**
Flanders	87573634.95	
Urea		15
Ammonium sulphate		4
Ammonium nitrate		2
Nitrogen solutions		9

5.3.1.2 NOx

In Wallonia, Flanders and the Brussels-Capital region, NOx emissions are calculated following the Tier 1 methodology of EMEP/EEA Guidebook 2019 (Table 3-1, p 12). Data on synthetic fertilizer use is obtained by the Agricultural Economy Analysis Department in Wallonia and from the *Department Agriculture and Fisheries* and the *Flemish Land Agency* in Flanders *(see NH_3).*

5.3.2. Animal manure applied to soils (category 3Da2a)

5.3.2.1 NH_3

In Wallonia, manure application to land counts for 20% of the NH_3 agricultural emissions in 2020. NH_3 emissions from manure application are calculated following the Tier 2 methodology of the EMEP/EEA Guidebook 2019. Thanks to information coming from a Walloon survey on the application of slurry, data concerning the practices and the use of precise equipment (injectors) are integrated. The activity data are coming from regional statistics & abatement factors are coming from the UNECE publication 'Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions' (2015).

Emissions from the application of animal manure in Wallonia dropped in 2002 by roughly 5% because of the legislation on Sustainable management of the Nitrogen (PGDA): the incorporation of slurry manure has to be done within 24 hours. In 2003, there was an additional decrease because it is the first year with data on injectors and the decrease is going on with the multiplication of the use of injectors (from 14% of the equipment sold in 2003 to 30% in 2013). The survey lead by the experts from Agra-Ost has provided new information on injectors practices in 2016. Table 5-7 gives an overview of the parameters used in the Walloon region.

Table 5-7 Abatement techniques and factors used in Wallonia in 2019.

Agricultural abatement techniques		Abatement factors (UNECE guidebook)
Repartition of slurry spreading systems in Wallonia		
in surface	65%	-
near the soil	19%	39%
in the soil (injection)	16%	75%
Integration of solid manure in the 24h *(mandatory since 2002 in Wallonia)*		30%

The abatement factors are applied on the emissions from field application (equations 39 & 40 in step 12, pp 27 of the 2019 EMEP Guidebook).

In Flanders, as described under 5.2.1, NH_3 emissions from the application of manure to soils are calculated using the EMAV2.1 model. The amount of animal manure applied to soils is calculated following the N-flow on the farm (from production to application), taking into account other N-losses (NO, N_2O, N_2) in the different emission stadia, the amount of animal manure that is imported and/or exported on the level of the farm and other. Data on the method of manure application (manure injection, broadcast application, …) are obtained on the regional level. Emission coefficients for each application technique are region specific. Annex 5D gives an overview of the parameters used in Flemish region.

There is a strong reduction from NH_3 emissions in Flanders from 1990 to 2020. This decrease is mainly due to the implementation of the successive Manure Action Plans in Flanders. Because of the severe manure surplus in Flanders (mainly before 2000), a Manure Action Plan (MAP) has been set up. The first in 1991 with the manure decree which reduced the period in which manure can be spread and foresees for the first time in the emission poor application of manure on land. This had a minor impact on the NH_3 emissions. The MAP2bis in 2000 focuses on the reduction of the manure surplus and manure processing in order to reduce the NH_3 emissions from manure application on land. Other MAP's followed. These successive MAP's have a positive effect on the NH_3 emission. Among other things, the MAP describes the amount of manure that a farmer can apply to his agricultural soils. Briefly, this depends on the proportion of the amount manure produced to the available agricultural soils of that farmer. The manure surplus (the part that may not be applied to the soil) must be either exported or processed. On the level of the farmer, exporting can be export to another farmer, to another country, to a manure processor or others. 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 EMAV2.1 model takes (on the level of the farm) into account the maximum amount of N that can be applied on land corresponding to the crop type and the available agricultural soils of that farm. Excess manure (N) has to be processed and/or exported. These data are also known on the level of the farm.

In Flanders, all manure that is transported to or from Flanders, is inventoried by the Flemish Land Agency and is known on the level of the Flemish Farmer. The model used to calculate the ammonia emissions in Flanders, the EMAV2.1 model, takes into account all manure transported to and from a farmer, to and from a manure processing company, to and from a neighbouring country. However, in the EMAV2.1 model, it cannot be detected from which foreign country the manure originates. For each farmer in Flanders a manure balance is made: how much manure is produced on the farm, how much is stored on the farm, how much is exported to another farmer, processing company or other country and how much manure is imported from another farmer, after processing from a processing company or from another country and that for each farmer this balance (produced + imported - exported) is made.

In the Brussels-Capital region NH_3 emissions from manure application are calculated following the Tier 2 methodology of the EMEP/EEA Guidebook 2019 (3B, Table 3.9).

5.3.2.2 NOx

In Wallonia, Flanders and Brussels-Capital region, NOx emissions are calculated following the Tier 1 methodology of EMEP Guidebook 2019 (Table 3-1 p 12).

5.3.3. Sewage sludge applied to soils (category 3Da2b)

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

In Wallonia, the use of sewage sludge on agricultural soils is allowed under conditions (http://environnement.wallonie.be/legis/solsoussol/sol002.htm). Activity data are coming from the Walloon Soils Protection Direction. The emissions are calculated following emission factors derived from the EMEP Guidebook 2019 (Table 3-1 p.12) and, since 2013, analysis of sludge which allow to estimate the N content and the proportion of N-NH4.

NH_3: emission factor is calculated following the assumptions of the appendix A1 of the EMEP Guidebook 2019 (p.27): EF NH_3 = N content in sludge (%N/MS) x (%N-NH4/Ntot) x 1/3 x 17/14. The EF is varying between 0.0202 kg NH_3/kg N sludge applied in 1990 (kept constant until 2012) and 0.0245 kg NH_3/kg N sludge applied in 2020.

NO_2: the default EF (0.04 kg NO2/kg waste N applied) of the Tier 1 methodology is used (EMEP Guidebook 2019, Table 3.1 p.12)

The use of sewage sludge does not occur in the Brussels-Capital region.

5.3.4. Other organic fertilizers applied to soils (category 3Da2c)

5.3.4.1 NH_3

NH_3 emission from compost is calculated using the Tier 1 methodology. Input data of amount compost applied originate in Flanders from the VLM. Emission factors are default values from the EMEP Guidebook 2019 (Table 3.1, p12).

In Wallonia, compost and digestate emissions occur since 2013 and the input data are coming from the Walloon Soils Protection Direction. The emissions are calculated in the same way as sludge, i.e. following emission factors derived from the EMEP Guidebook 2019 (Table 3.1, p.12) and analysis of compost and digestate which allow to estimate the N content and the proportion of N-NH4.

EF NH_3 = N content in compost and digestate (%N/MS) x (%N-NH4/Ntot) x 1/3 x 17/14. For compost, the EF is around 0.036 kg NH_3/kg N compost applied. For digestate, the EF is varying between 0.341 kg NH_3/kg N digestate applied in 2013 and 0.188 kg NH_3/kg N digestate applied in 2020.

5.3.4.2 NO_x

NO_x emission from compost is calculated using the Tier 1 methodology. Input data of amount compost applied originate in Flanders from the VLM and from the Walloon Soils Protection Direction in Wallonia. Emission factors are default values from the EMEP Guidebook 2019 (Table 3.1, p12). In Wallonia, NO_x digestate emissions are also calculated since 2013, with the same default emission factor (0.04 kg NO_2/kg N applied) and data coming from the Walloon Soils Protection Direction.

5.3.5. Urine and dung deposited by grazing animals (category 3Da3)

NH_3 emissions from grazing are following the trends of the livestock evolution.

In the three regions, the ammonia emission from grazing is estimated taking into account the number of days in pasture and the nitrogen excreted by each animal category. In the Walloon and Brussels-Capital Regions, the emission factors originate from table 3.9 of the 2019 EMEP Guidebook (update of February 2020) using a Tier 2 methodology. The EF in table 3.9 is expressed as % (kg NH_3-N as a proportion of TAN).

In Flanders a Tier 3 methodology is used. The region-specific emission factor for grazing of 8% is used (Van der Hoek et al. 2002). This emission factor in Flanders is based on micrometeorological field measurements performed in the Netherlands (a neighbouring country with similar agricultural practices as Flanders) and expressed as NH_3-N/N. In Table 5-8 an overview is given of the different factors used in both regions and for the different grazing animal categories.

NO_2 emissions from grazing are included under 3Da2a.

Table 5-8 The days in pasture (%/yr), nitrogen excreted on pasture (ton) and the emission factor used for each grazing category in 2020.

	Days in pasture (% of year)	Nitrogen excreted on pasture (ton)	Emission factor (%)
Flanders			
bovine	± 27	27 972	8
Sheep	80	442	8
Horses	50	1 405	8
Wallonia			
Non dairy cattle	50	27 622	14
Dairy cattle	56	9 875	14
Sheep & goats	50	245	9

Horses	50	944	35

5.3.6. Farm-level agricultural operations (category 3Dc)

PM emissions from agricultural operations are estimated and reported in the category 3Dc. For this submission, for the first time a Tier 2 methodology of the EMEP/EEA Guidebook 2019 (Tables 3-5 and 3-7) is used. The same methodology is applied in the 3 regions. The crop types and emission factors from table 3-5 and 3-7 of the EMEP/EEA Guidebook 2019 are used.

In the three regions, the cultivated area originates from the Statbel.

5.3.7. Manure processing (category 3Dd)

5.3.7.1 NH_3

For Flanders, under 3Dd, emissions from processing of animal manure are reported (= handling of animal manure). The processing occurs off-farm. Manure processing leads to ammonia emissions and is very common in Flanders and is in many cases obliged. As described above, 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. A farmer who has excess manure (more manure-N than he is allowed to apply on the land) is, in other words, in most of the cases obliged to transport the manure to a processing company. 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 2020 account for 3% of the total NH_3-emission from agriculture 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 EMAV2.1 model. Based on data collected by the Manure Bank of the Flemish Land Agency, the amount and type of processed manure and the corresponding emission coefficient, the NH_3 emission from manure processing can be calculated. Depending on the processing technique used, different emission factors for NH_3 exist. The techniques used are composting, fermentation, biological treatment, fysico-chemical treatment, drying technique or a combination of those. Table 5-9gives an overview of the activity data and emission factors used in 2020.

Table 5-9 The emission factors (%) and N-processed (kg N) for each manure processing technique in Flanders (2020)

Processing Technique	Emission Factor % (NH_3-N/processed N)	N processed (kg N)
Composting	5.63	17149201
fermentation	0.05	800574
biological treatment	0.05	23024782

fysico-chemical treatment	0.03	
Drying	1.33	

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 stabilized for the period 2008-2012, and increased again till 2018. The NH_3 emission in 2020 is a bit higher dan 2019, but considerably lower than the years 2016 till 2018. This fluctuation is due to the techniques used. Since 2007 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%). In 2020 there is considerably more manure processed in a biological treatment compared to composting.

5.3.8. Cultivated crops (category 3De)

5.3.8.1 NMVOC

NMVOC emissions are calculated following the Tier 1 Methodology of the EMEP Guidebook 2019 (Table 3-1 p 12). The activity data are the number of ha of cropped area originating from the national statistics in the Walloon and Brussels-Capital regions and the Flemish Land Agency (VLM) for the Flemish region.

5.3.9. Use of Pesticides (category 3Df)

Notation key is 'NO' given that production and use of HCB is prohibited in Belgium since 1974. Therefore no emission is calculated for Flanders. Source: Ontwikkeling en optimalisatie van een emissie-inventaris Persistente Organische Polluenten (POP's), VITO, 2012.

5.3.10. Field burning of agricultural residues (category 3F)

Field burning of agricultural residues is not occurring in Belgium (NO). Field burning of agricultural residues is forbidden by law.

In Wallonia, here is the extract of the legislation: Arrêté du Gvt Wallon du 13 juin 2014 fixant les exigences et les normes de la conditionnalité en matière agricole : *Art. 22. L'agriculteur ne brûle pas les pailles, chaumes et autres résidus de récolte produits sur ses parcelles. Dans des cas exceptionnels justifiés par des motifs phytosanitaires avérés, le Ministre peut accorder des dérogations à l'interdiction énoncée à l'alinéa 1er par voie de décision individuelle.* This concerns more than 95% of the farmers.

In Flanders fieldburning practices are forbidden since 2014 (https://navigator.emis.vito.be/mijn-navigator?woId=62333). This legislation replaced earlier legislation in which burning in open air was forbidden. In a study (2002) performed by the VITO (Flemish Institute of Technological Research) based on data of the Institute of Agricultural and Fisheries Research (ILVO) it was assumed that the amount of field burning was negligible to not occurring.

5.4. *Recalculations and improvements*

Recalculations

In Wallonia:

- NH_3 Emission factors for grazing has been updated with the update of the 2019 EMEP Guidebook in February 2020. This has increased the grazing emissions on the whole time series: from 1.4 kt NH_3 in 2019 to 1.8 kt in 1990.
- There was an update on the number of swine in building equipped with NH_3 abatement systems between 2014 and 2016. This has limited impacts in the NH_3 emissions in 3B3 and 3Da2a (+3 ton in 2014 , -7 ton in 2015 and +2 ton in 2016) and very limited impacts in NOx emissions (-0.1 ton in 2014 , +0.3 ton in 2015 and -0.1 ton in 2016)
- Activity data on compost in 2019 has been updated (data provisional last year) : + 18 ton NH_3 and +18 ton NOx in 3Da2c.
- Between 2013 and 2019, the NH_3 emissions needed for NMVOC calculations have been corrected (results of previous recalculations). It results in a slight decrease from 6 ton NMVOC in 2013 to 5 ton NMVOC in 2019.

In Flanders, following recalculations were made:

- For NMVOS emission, a revision of the gross energy uptake occurred. This results in a small decrease of the emissions for the entire time series (category 3B).
- For NO_2 emission, a correction of the emission factor of goats occurred. This results in a minor decrease of the emissions for the entire time series (category 3B).
- For NO_2 emission, an update of the amount of applied inorganic fertilizer for 2019 occurred. This results in an increase of the emissions for 2019 (category 3Da1).
- For NO_2 emission, an update of the amount of applied compost for 2019 occurred. This results in an increase of the emissions for 2019 (category 3Da2c).
- For NH3 emissions, an update of the amount of applied inorganic fertilizer for 2019 occurred. This results in an increase of the emissions for 2019 (category 3Da1).

In the Brussels-Capital region:

- The number of animals has been updated from 2011 on
- For NMVOC emissions for the category 3B, a Tier 2 methodology is used instead of Tier 1 for the cattle and swine
- The emission factors for direct N_2O-N emissions from manure management has been revised in line with latest version of EMEP/EEA Guidebook 2019 Table 3.8 page 27

Improvements

In Flanders, during 2021-2022, The EMAV2.1 model will be extended with methodologies to calculate the CH_4, N_2O and NO_2 emissions. For NO_2, the methodology to calculate the emissions from manure management and agricultural soils will be revised. This new integrated model will calculate NH_3, N_2O, CH_4 and NO_2-emissions and therefore follow the N-flow throughout the farm in an integrated way. The study started in 2021, is performed by ILVO and is commissioned by the VMM. The kick-off of the study was given January 18, 2021. The end of the study, as well as the results, is scheduled for June 30, 2022. An English summary will be provided. The study will result in an entire new time series. The new time series will be reported February 2023. Time will be needed and taken to validate the new time series.

Also in Flanders, the EMAV2.1 model is subject to continuous review processes. In 2020 an external validation of the EMAV2.1 model was carried out by the Flemish Institute of Technical Research (VITO) on behalf of VMM. A summary in English is given in annex 5B. The outcome of the validation will be prioritized and integrated in the model during the following years/revisions. Due to the above mentioned study (development of the integrated model), the outcome of the external validation was not yet implemented in the existing EMAV2.1 model. They will be implemented during the study (development of the integrated model). Also each year, when relevant, the results of the Review of National Air Pollutant Emission Inventory Data are taken into account. Taking into account results of new scientific research, outcome of NECD review 2020, etc. This can lead to an update of the EMAV2.1 model. Depending of the content of the update, this can result in new emission data.

Chapter 6. **Waste (NFR sector 5)**

Waste sector emissions are classified into 5 categories as described in Table 6-1.

Table 6-1 Main emissions of the 5 waste categories in Belgium

Waste categories	*Main emissions*
Solid waste disposal sites (5A)	NMVOC, PM2.5, PM10, TSP
Biological treatment of waste: composting and anaerobic digestion (5B)	NMVOC
Waste incineration, cremation and open burning of waste (5C)	NO_x, NMVOC, SO_2, PM2.5, PM10, TSP, heavy metals, PCDD/F, PAH(4), HCB
Wastewater handling (5D)	NMVOC, NH_3
Other (5E): car and house fires	NMVOC, NO_x, SO_2, PM2.5, PM10, TSP, heavy metals, PCDD/F

6.1. ***Solid waste disposal on land (category 5A)***

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

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

In Flanders and Wallonia, NMVOC emissions calculations are based on Tier 1 methodology of the 2016 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 2006 IPCC Guidelines. The emission factor used for NMVOC is 5.65 g NMVOC/m^3 landfill gas, coming from the 2016 EMEP/EEA Guidebook. In the 2019 EMEP/EEA Guidebook, the emission factor is expressed in g NMVOC/Mg waste. However, the composition of solid waste disposed is changing every year and by the way, the content in NMVOC is supposed to change too. We must also take into account the volume of biogas recovered. So it is preferred to use the net volume of biogas (calculated following the IPCC methodology) and the emission factor of 5.65 g NMVOC/m^3 landfill gas, which corresponds to the 1.56 kg/Mg waste (2019 EMEP/EEA Guidebook) with the hypothesis of a default methane content of 50% (value close to the Walloon situation). The conversion of ton CH_4 into m^3 biogas is done by this formula: kg CH_4 x 22.4/16/0.5 = m^3 biogas, using the default concentration of 50% of CH_4 in the biogas. More information can be found in the NIR (National Inventory Report) chapter 7.2, Solid Waste Disposal.

PM emissions (PM2.5, PM10 & TSP) are calculated following the Tier 1 methodology of the EMEP/EEA Guidebook 2019 in Flanders and following the Tier 3 methodology of the EMEP/EEA Guidebook 2019 in Wallonia.

The Tier 3 methodology allows taking into account the average wind speed in Belgium (3.7 m/s) measured by the Royal Institute of Meteorology. The EF for Wallonia are the following: 0.214 g TSP/Mg waste, 0.101 g PM10/Mg and 0.015 g PM2,5/Mg.
In Wallonia, CO emissions related to flaring in SWDS are very limited and activity data are not always available: most of time, the data available are the biogas burnt in motors for energy purposes. These emissions are reported in energy sector. For example, in 2020, the only data available is the CO emissions in one SWDS and linked to the use of two motors (33 ton CO). There is no information about flaring. So the notation key NE is used for CO emissions in Wallonia.

Landfills (Flanders) report emissions of CO for several years in their integrated environmental reports. The emissions are below the reporting threshold. For the other years no emissions are reported and therefore notation key ‘NE’ has been used.

6.2. *Biological treatment of waste (category 5B)*

NH_3 emissions from compost production, allocated in category 5B1 are estimated in the three regions using regional activity data combined with a default emission factor of 0,24 kg NH_3/ton compost (EMEP/EEA Guidebook 2019, table 3.1)..

Regarding 5B2 Biological treatment of waste - Anaerobic digestion at biogas facilities, it is considered that all the biogas is burned and emissions are integrated in 1A1a. All NH_3-emissions are reported in Manure processing 3Dd (that includes not only anaerobic digestion, but also other processing techniques)(see also Chapter 5 Agriculture §5.3.7).

6.3. *Waste incineration (category 5C)*

The waste incineration category (category 5C) includes incineration of municipal and industrial waste, incineration of hospital waste and incineration of corpses (crematoria) as well as open burning of waste. The emissions of the waste incineration plants with energy recovery are allocated to the category 1A1a.

The category 5C1a is key category for Cd, Hg, Cr, Ni, Zn and PCDD/F in terms of emission trends.

6.3.1. Waste incinerators

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 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. 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 annual emissions of NO_x, NMVOC, SO_2, NH_3, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni and PCDD/PCDF are calculated on the basis of stack measurement. The emissions of PM2.5 and PM10 are assumed to be equal to the emissions of TSP. For BC, we use the emission factor of the EMEP Guidebook 2016 (3.5% of PM2.5). For Se, Zn and PCB, one plant performs stack measurement and the emissions of other plants are based on plant specific emission factors calculated on the basis of stack measurement from previous years. For PAHs, the emissions are calculated on the basis of the Tier 1 emission factors given in the EMEP Guidebook 2016 for source category 5C1a Municipal waste incineration.

The entire HCB time series has been corrected in 2019 to use the emission factor from the 2016 guidebook: 0.0452 mg/t rather than a very high emission factor of 2 mg/t which was based on a measurement in 1996. The emission factor of 0.0452 is used to estimate the HCB emissions of 3 plants. The HCB emissions of the 4th plant are calculated on the basis of stack measurements.

During the 2017 NECD Comprehensive Review, the TERT noted that when continuous measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED (Industrial Emissions Directive) and have subtracted the value of the confidence interval although this subtraction must not be applied in the context of reporting annual emissions. This issue relates to an under-estimate of the emissions. The TERT recommended Belgium to organise a survey among operators to identify which ones are reporting under-estimated emissions and try to derive a methodology to adjust national emissions over the time series. Wallonia followed this recommendation and identified 2 operators that reported emissions for NO_x, TSP, SO_2, CO and NMVOC after subtraction of the confidence interval since 2008.

For the 2018 submission, the emissions of these pollutants have been adjusted to add the confidence interval from 2008 to 2016. No recalculation was needed for pre-2008 years because the operators did not use the continuous measurements to estimate their annual emissions before 2008. They used periodic measurements without subtraction of the confidence interval to estimate their annual emissions before 2008. Wallonia will prevent under-estimated reporting from operators in the future.

For the 2019 submission, the emissions of NMVOC from 2008 to 2016 have been adjusted for one plant to subtract the confidence interval that was erroneously added for the previous submission. Indeed, the plant did not use the continuous measurements to estimate their emissions of NMVOC from 2008 to 2016. They still used the periodic measurements without subtraction of the confidence interval.

The ranges of implied emission factors in 2020 are presented in Table 6-2 for each pollutant and compared to the emission factors of the EMEP Guidebook 2016.

Table 6-2 Implied emission factors in 2020 in Wallonia compared to EMEP Guidebook 2016

Pollutant	Unit	EMEP 2016	EF range in 2020
NOx (as NO_2)	g/ton	1071	460-729
NMVOC	g/ton	5.9	1-10
SOx (as SO_2)	g/ton	87	59-297
NH_3	g/ton	3	7-26
$PM_{2.5}$	g/ton	3	0.8-10.5
PM_{10}	g/ton	3	0.8-10.5
TSP	g/ton	3	0.8-10.5
BC	g/ton	0.105	0.03-0.366
CO	g/ton	41	37-93
Pb	mg/ton	58.0	16-573
Cd	mg/ton	4.6	1-48
Hg	mg/ton	18.8	3-33
As	mg/ton	6.2	1-44
Cr	mg/ton	16.4	14-235
Cu	mg/ton	13.7	17-396
Ni	mg/ton	21.6	14-471
Se	mg/ton	11.7	7-22
Zn	mg/ton	24.5	24-1830
PCDD/ PCDF	ng/ton	52.5	20-93
Benzo(a)pyrene	µg/ton	8.4	8.4
Benzo(b)fluoranthene	µg/ton	17.9	17.9
Benzo(k)fluoranthene	µg/ton	9.5	9.5

Indeno(1,2,3-cd)pyrene	µg/ton	11.6	11.6
PAHs (Total 1-4)	µg/ton	47.4	47.4
HCB	mg/ton	0.0452	0.02-0.0452
PCBs	µg/ton	0.0034	0.036-720

For category 5C1bi Industrial Waste Incineration, PM2.5 for 2010-2019, the TERT noted that the PM2.5 estimate is equal to the estimate for PM10, whereas for this category PM10 estimates would be expected to be higher than (rather than equal to) PM2.5 estimates. In response to a question raised during the review, Belgium explained that emissions for this category come from a single incinerator plant in the Walloon region. This activity corresponds to flaring in chemical industry and not to municipal waste incineration. Since no solid or liquid waste but only gas waste is incinerated there, the EFs in the waste chapter are not suitable for this type of waste. The EFs are supposed to be the same for PM2.5, PM10 and TSP as per the combustion of gaseous fuels in the 1A2 combustion in industry chapter. In absence of emission measurements for PM10 and PM2.5, Wallonia assumes a conservative approach where emissions are the same for PM2.5, PM10 and TSP. The TERT noted that the issue is below the threshold of significance for a technical correction (emissions in 2019 are only 1.046 t).

For the calculation of PM2,5 and PM10 emissions of municipal waste incinerators (reported in category 5C1a for the part of waste incinerated without energy recovery), the same approach is used: only TSP is measured at the stack, so Wallonia assumes that PM2.5 and PM10 emissions are equal to the emissions of TSP. That explains why the emission factors in Table 6-2 are identical for PM2.5, PM10 and TSP.

The only hospital waste incinerator has closed since 2005. Some hospital waste is incinerated in the municipal waste incineration plants. These emissions are thus included in the incineration plants, in category 5C1a “Municipal waste incineration”. The non-hazardous hospital waste (A&B1) can be incinerated in the 4 municipal waste incineration plants. However, only one municipal waste incineration plant is authorized to incinerate hazardous hospital waste (B2). The notation key “IE” is used for all the pollutants in category 5C1biii “Clinical waste incineration”.

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 5C1a, when waste is incinerated without energy recovery because of occasional problems in the energy recovery systems. In 2010, 2011 and 2012 this represents 1.5% to 2% of the incinerated waste. In 2013, this represents 20% of the incinerated waste. In 2013, the fraction of waste that has been incinerated without energy recovery is higher than the previous years because the turbine of 2 of the 4 waste incineration plants in Wallonia had to be stopped during more than 6 months for repair. From 2014 to 2020, the incinerated waste without energy recovery represents 2% to 4% of the incinerated waste. Table 6-3 presents the amount of wastes incinerated with and without energy recovery in Wallonia.

Table 6-3 Amount of wastes incinerated with and without energy recovery in Wallonia

	Amount of wastes incinerated in Wallonia (ton)		
	With energy recovery (1A1a)	**Without energy recovery (5C)**	**TOTAL**
1990	199 249	157 614	356 863
1995	210 217	181 914	392 131

2000	242 817	82 042	324 859
2005	476 685	21 716	498 401
2010	859 075	17 231	876 306
2011	893 029	13 426	906 455
2012	919 463	12 600	932 063
2013	786 350	193 331	979 681
2014	979 868	19 249	999 118
2015	1 005 808	20 823	1 026 631
2016	979 461	39 667	1 019 128
2017	991 595	20 612	1 012 207
2018	962 695	44 769	1 007 463
2019	990 362	33 394	1 023 756
2020	962 021	19 207	981 229

Because of the high amount of wastes incinerated without energy recovery in 2013, the emissions reported in 5C1a are much higher for this specific year.

In Flanders, the plants are obliged to report their emissions yearly in an emission report. These data are integrated in the emission inventory. Emissions of NO_x, SO_2, TSP and heavy metals are provided by the facilities or are calculated by means of plant specific emission factors. Emissions of PM10 and PM2.5 are calculated as a fraction of TSP.

As in Wallonia, Flanders conducted a survey among operators of waste incineration plants to identify which ones are reporting underestimated emissions because the confidence interval is subtracted. Only 33% of the operators reported real emissions. The companies were urged to report the actual emissions in future. The correction of the historical data is completed.

All (intermunicipal) waste incineration plants produce electricity since 2005. The emissions are allocated in the category 1A1a when energy is recycled or in the appropriate category of 5C when there is no energy recovery.

In Flanders the PCDD/F emissions for the years 1990-1999 (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 6-4).

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 6-5).

Table 6-4 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 6-5 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/EEA Guidebook (2009)
Domestic waste	µg/tonne	45.2	EMEP/EEA Guidebook (2013)

All (intermunicipal) waste incineration plants produce electricity since 2005. The emissions are allocated in the category 1A1a when energy is recycled or in the appropriate category of 5C when there is no energy recovery. Emissions due to clinical waste incineration (category 5C1biii) are included in category 5C1bi (industrial waste incineration).

Since submission 2021, we made changes to the allocation of emissions with and without energy recovery from waste incineration plants. After a thorough analysis, we obtained alignment between all pollutants. This adjustment affects the allocation between 1A1a and 5C of all NEC pollutants.

In the Brussels Capital Region, the last waste incinerator without energy recovery has been closed in 1998. Historical emissions from the incineration of sewage sludge in one of the two wastewater treatment plants for the period 2004 to 2009 were included for the first time for the 2022 submission. Emission factors for TSP, PM10, PM2.5, SO_2, CO and NO_x are derived from stack measurements. For other pollutants the emission factors of the EMEP/EEA Guidebook 2019, Table 3-2 Tier 2 emissions factor for source category 5C1biv Sewage sludge incineration.

6.3.2. Emissions by cremation

For Flanders: the activity data are derived from the yearly statistics of crematoria [6](Table 6-6). For dioxins, an emission factor of 0.069 µg TEQ/cremation is used (results of measurements made by the Flemish government – Department Omgeving/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 the Brussels Capital Region, the emission factor for dioxins is 27 ng TEQ/cremation as stated in the EMEP/EEA 2019 guidebook. The number of cremations comes from the crematorium itself.

Table 6-6 Number of cremations in the Belgian regions for the period 1990-2020

	Flanders	**Brussels**	**Wallonia**
1990	9866	7217	3790
1995	17076	5477	6529
2000	23133	5463	7197
2001	23459	5439	7890
2002	25667	5619	8373
2003	26698	6154	8719
2004	26998	6206	8856
2005	28128	6026	9288
2006	28905	6116	9318
2007	29877	6007	9779
2008	31690	6356	10372
2009	32667	6348	10282
2010	33619	6121	11069
2011	34203	6049	11720
2012	36860	5651	13170
2013	38977	5334	14560
2014	39086	5152	14748
2015	41935	5563	16009
2016	41657	5283	16538
2017	43215	5231	16774
2018	44547	5096	17600
2019	44862	5033	17890
2020	52442	5901	21863

6 http://statbel.fgov.be/fr/statistiques/chiffres/population/autres/cremations/

For Wallonia: new emission factors have been calculated thanks to measurements on site. It concerns NO_X, CO, SO_2, COV, PM, Pb, Hg & dioxins. The new emission factors are lower than previously but it's the result of modification of the exploitations to satisfy the legislation. The new EF are applied from 2013 on. Emissions from the other pollutants are estimated using the emission factors of the EMEP/EEA guidebook 2016. The number of corpses is coming from the United Network of Public Crematoria (http://vnoc.be/).

Table 6-7 Emission factors used for crematoria in Wallonia, before 2013 and after 2013.

Pollutants	***Units***	**<2013**	**>2013**
NOX	*g/CAPITA*	825	414,3
NMVOC	*g/CAPITA*	13	14,98
SO2	*g/CAPITA*	113	1,782
PM25	*g/CAPITA*	34,7	0,505
PM10	*g/CAPITA*	34,7	0,505
TSP	*g/CAPITA*	38,56	0,505
CO	*g/CAPITA*	140	45,38
Pb	*mg/CAPITA*	30,03	20,06
Cd	*mg/CAPITA*	5,03	5,03
Hg	*mg/CAPITA*	2000	6,878
As	*mg/CAPITA*	13,61	13,61
Cr	*mg/CAPITA*	13,56	13,56
Cu	*mg/CAPITA*	12,43	12,43
Ni	*mg/CAPITA*	17,33	17,33
Se	*mg/CAPITA*	19,78	19,78
Zn	*mg/CAPITA*	160,12	160,12
DIOX	*microgr/CAPITA*	0,027	0,005
Benzo(a)	*microgr/CAPITA*	13,2	13,2
Benzo(b)	*microgr/CAPITA*	7,21	7,21
Benzo(k)	*microgr/CAPITA*	6,44	6,44
Indeno	*microgr/CAPITA*	6,99	6,99
PAH	*microgr/CAPITA*	33,84	33,84
HCB	*mg/CAPITA*	0,15	0,15
PCBs	*mg/CAPITA*	0,41	0,41

6.3.3. Open combustion of waste (small scale waste burning) (category 5C2)

Only Flanders estimates emissions of combustion in open barrels of particulate matter, dioxins, PAH's, heavy metals and since submission 2020 also of NO_x, NMVOC, SO_2 and CO. Since submission 2021 also emissions of heavy metals are estimated for 1990-1999.

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.

Since the year 2011 the amount of waste incinerated decreases. In Flanders only under strict conditions combustion in open barrels is allowed. A sensitization campaign of the Flemish government 'Stook Slim' (smart heating, https://omgeving.vlaanderen.be/stook-slim) informs the public about the ban.

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 heavy metals, NMVOC, TSP, PM10, PM2.5, BC, SO_2, NO_x and CO are taken from EMEP/EEA guidebook 2019, table 3-1.

In Wallonia, these emissions are not estimated.

6.4. ***Wastewater treatment (category 5D)***

For 5D1 Domestic wastewater handling, Flanders used to estimate previously NH_3 emissions from septic tanks using a country specific emission factor, however the reference of this emission factor from septic tanks couldn't be traced anymore. Following Corsi et al. (2000) (https://www.epa.gov/sites/production/files/2015-08/documents/eiip_areasourcesnh3.pdf) Flanders may assume that emissions from residential septic systems are negligible and on recommendation of the review team emissions of waste water treated in septic tanks are not included in the inventory anymore since the 2018 submission. The 2016 EMEP/EEA Guidebook proposes a NH_3 emission factor only for latrines (and not septic tanks) but no activity data of latrines are available in Flanders (Flanders Environment Agency, Department of Data Management Sewage Infrastructure, personal communication).

Also emissions of wastewater treatment, reported by the facilities in the integral environmental report are reported under 5D.

For NH_3, SO_2 and NO_X emissions, the TERT noted that there is a lack of transparency regarding peaks of pollutant emissions for some years depending on the pollutant. In response to a question raised during the review, Belgium explained that for certain years no emissions are reported by the facilities because they are below the reporting threshold. The TERT thinks that there is a time series inconsistency and recommends that Belgium estimate facilities pollutant emissions for all years and not only when emissions are above the reporting threshold.

The SO_2 emission is due to a boiler running on biogas and was assigned to 1A2e. The remaining NO_x emissions in sector 5D are now negligible. (the reporting threshold is 50 ton)

The company reporting NH_3 was contacted. It will split the total reported NH_3 emissions for all years into process emissions and emissions due to water treatment.

The NMVOC emissions from domestic wastewater handling have been calculated for the whole time series since the 2019 submission. The emissions are calculated based on the emission factor from Table 3-1 of the EMEP/EEA Guidebook 2019. The activity data is the wastewater volume treated in the stations.

In Flanders, the types of wastewater treatment plants (5D2) are mechanical, biological, sludge drying, biogas steam boiler, incinerator, stripping. For certain years no emissions are reported by the facilities because they are below the reporting threshold.

6.5. *Other (5E)*

This source is a key category of PM2.5, PM10, TSP and PCDD/F in terms of emission level.

6.5.1. Car and house fires

Emissions originating from car and house fires are estimated for PM2.5, PM10, TSP and PCDD/F. For heavy metals only emissions originating from house fires are estimated. The same methodology is used for the three regions in Belgium.

For 2012 to 2020 the number of fires is obtained from the Belgian fire brigade (www.civieleveiligheid.be). For the other years the number of fires is calculated based on the average number of fires per inhabitant; then this is multiplied by population of a given year. A split between detached and undetached house fires is calculated based on country/region specific figures for numbers of houses per type (www.ibsa.be).

Table 6-8 Split between detached and undetached house fires in 2020

region	Detached houses	Undetached houses
Flemish region	42%	58%
Walloon region	39%	61%
Brussels Capital region	5%	95%

The emissions are calculated based on emission factors from the Tables 3-2, 3-3, 3-4, 3-5, 3-6 Tier 2 emission factors of the EMEP/EEA Guidebook 2019 for car fires, detached house fires, undetached house fires, apartment building fires and industrial building fires respectively. Table 6-9 shows the number of fires in Belgium per type of fire.

Table 6-9 Activity data per type of fire in Belgium

Year	Detached house	Undetached house	Appartement	Industrial building	Vehicle
1990	2093	3250	1920	415	1965
1991	2103	3264	1923	418	1973
1992	2112	3279	1923	419	1979
1993	2124	3295	1929	421	1989
1994	2131	3305	1933	422	1995
1995	2138	3315	1938	425	2001
1996	2142	3320	1939	425	2003
1997	2148	3329	1950	427	2009

1998	2153	3336	1949	427	2013
1999	2157	3342	1952	428	2017
2000	2162	3351	1958	429	2022
2001	2167	3358	1965	430	2027
2002	2179	3367	1978	431	2037
2003	2190	3377	1994	434	2045
2004	2201	3385	2003	435	2055
2005	2215	3398	2014	436	2064
2006	2231	3415	2029	439	2077
2007	2250	3434	2045	442	2092
2008	2268	3456	2067	446	2109
2009	2287	3479	2091	449	2125
2010	2305	3502	2114	452	2143
2011	2326	3534	2146	456	2166
2012	2650	4040	1860	524	2199
2013	2664	4020	2317	451	2064
2014	2055	3123	1634	531	2308
2015	2554	3891	2030	559	2496
2016	2467	3722	1986	417	2908
2017	2729	4187	3630	500	2925
2018	2503	3792	2296	577	2563
2019	2938	4437	3241	564	3098
2020					

6.5.2. Other sources

The other emissions in this sector come from the annual environment report of waste companies in Flanders and Wallonia (other than incinerators). In Wallonia, 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. Flemish data in this sector are obtained from the annual reports the facilities have to provide.

6.6. *Recalculations and improvements*

Recalculations

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

- 5C: Since submission 2022, we made changes to the allocation of emissions from flaring. We allocated the emissions from flaring to 5C1bi instead of 1A1a as recommended in the EMEP guidebook.
- 5C: Since submission 2022, we allocated the emission of one waste incineration company to 5C1bi instead of 1A1a because the company produces its own energy and therefore to be allocated to the waste sector itself
- 5E: emissions of PM2.5, PM10, TSP, heavy metals and PCDD/F have been calculated for the whole time series. The recalculation is based on new activity data from the Belgian fire brigade.
- 5D: The company reporting NH3 was contacted. It will split the total reported NH3 emissions for all years into process emissions and emissions due to water treatment.
- 5C: crematoria: emissions from 1990-1994 were recalculated to make the time series consistent.

In Wallonia, no recalculations were performed:

In the Brussels Capital region, following recalculations were done:

- 5C1biv Sewage sludge incineration: Historical emissions from the incineration of sewage sludge in one of the two wastewater treatment plants for the period 2004 to 2009 were included for the first time for the 2022 submission.
- 5E fires: Retropolated and extrapolated activity data adjusted to most recent data available.

Improvements

No improvements planned

6.7. *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. In exceptional cases the inspection services are contacted.

Chapter 7. **Other and natural emissions**

7.1. ***Biogenic emissions***

Flanders

NMVOC emissions of different forest types and of grassland are reported under IPCC code 11C. 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 1000 µmol/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 7-1.

Table 7-1 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/m²/s)	Monoterpenes (ng/m²/s)	Other VOC (ng/m²/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 70's, or densities measured in neighboring regions (North of France and the Netherlands). For other species, the values used in France (Luchetta et al., 2000) were included (Table 7-2).

Table 7-2 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	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 et al. (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 7-3).

Table 7-3 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	1 May	30 October
Alnus glutinosa	0,1	3,4	1,5	1 May	30 November
Betula pendula	0,01	2,9	1,5	15 March	15 October
Carpinus betulus	0	0,1	1,5	15 April	15 October
Castanea sativa	0	13,66	1,5	15 April	15 October
Fagus sylvatica	0,1	0,47	1,5	15 April	30 October
Fraxinus excelsior	0,1	0	1,5	1 June	30 October
Larix decidua	0,1	8,2	1,5	15 March	15 October
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	1 May	30 September
Prunus avium	0	0,3	1,5	1 May	30 October

Pseudotsuga menziesii	0,45	14,8	1,5		
Quercus rubra	37,9	1,8	1,5	1 May	30 October
Quercus sp	57,3	0,46	1,5	1 May	15 November

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 8. **Recalculations and improvements**

8.1. ***Recalculations and improvements in the energy sector***

<u>Recalculations</u>
In the three regions:

- Optimization of the regional energy balances for the year 2019 as the regional energy balances for the year 2019 were provisional in the 2021 submission. Recalculation of the emissions.
- optimization and revision of the OFFREM model (activity data and methodology) : Optimization of the model to calculate the off-road emissions (OFFREM-model) in the category 1A4b (households): residential sector: the size of the gardens in the Brussels-Capital Region was actualised for the entire time series with more accurate data.
- 1A4c (forestry) : Walloon Region has revised the entire time series for forest area. Because OFFREM first calculates emissions and fuel consumption for Belgium, and then calculates regional figures via the areas per region, the emission (and fuel consumption) of forestry in Flanders also changes for the entire time series.
- Recalculation of road transport emissions 1990-2019 : see chapter Transport.

In the Brussels Capital Region following recalculations were made in the Energy sector:

- There have been recalculations of historical series in the energy balance, especially for the period 2014-2019
- In 1A1a, revision of the emission factors of the municipal waste incinerator from 2006 on based on data available from the PRTR reporting and measurement campaigns, and adjustments of the data from the energy balance from 2008 on.
- In 1A4bii, revision of the size of gardens as input to the OFFREM model resulting in a decrease of the emissions from the off-road residential sector for the whole time series.

In the Walloon region, following recalculations were made:

- In 1A1a and 1A2a, change of allocation of emissions of a TGV from 1A1c to 1A2c.
- In 1A2a, recalculation of NOx and CO in two plants with reheating furnaces by using the guidebook emission factors (table 3-10).
- In 1A2d, revision of the emission factors when using biomass in a boiler in a paper and pulp plant
- In 1A4bi, recalculation of the activity data for the use of charcoal

In Flanders following recalculations were made:

- The EISSA-B_v2 was used to calculate the emissions for the CHP installations in the service and agricultural sector, for the commercial/institutional sector and the residential sector. The emission factors of the EMEP/EEA Guidebook 2019 were applied.
- Fishery : Activity data fuel cost, fuel amount, fleet, average days at sea became available for 2019, what results in a recalculation of the emissions fishery for that year (submission 2021 provisional data for that year was used)
- In 2020 an estimate was made of the SO_2-emissions from natural gas combustion at the power stations for the entire time series.1A1a: Since submission 2022, we made changes to the allocation of emissions from flaring. We allocated the emissions from flaring to 5C1bi instead of 1A1a as recommended in the EMEP guidebook.
- 1A1a: Since submission 2022, we allocated the emission of one waste incineration company to 5C1bi instead of 1A1a because the company produces its own energy and therefore to be allocated to the waste sector itself.
- In 1A4ai, SO_2 emission factors are re-examined based on information provided by Informazout (https://informazout.be, personal communication). The S content of fuel oil is maximum 50 ppm from 2016 on (which corresponds to an emission factor of 2.4 ton/PJ), from 2018 on 1/3 of the fuel oil sold has a S content of 50 ppm while 2/3 has a S content of 10 ppm (which corresponds to a global emission factor of 1.1 ton/PJ).
- In 1A4ai, adjustment of energy consumption (natural gas, fuel oil and LPG) in the energy balance Flanders 1990-2019 from 2014.
- In 1A4bi, SO_2 emission factors are re-examined based on information provided by Informazout (https://informazout.be, personal communication). The S content of fuel oil is maximum 50 ppm from 2016 on (which corresponds to an emission factor of 2.4 ton/PJ), from 2018 on 1/3 of the fuel oil sold has a S content of 50 ppm while 2/3 has a S content of 10 ppm (which corresponds to a global emission factor of 1.1 ton/PJ).
- In 1A4bi, TSP, PM_{10}, $PM_{2.5}$, EC factors are re-examined. For stoves with year of construction> = 2017, the EF based on the emission limit value were replaced by the EF from table 3.42 of the EMEP/EEA guidebook 2019.
- In 1A4bi, B(a)P, B(b)Flu, B(k)Flu, IP factors are re-examined. For stoves and cassettes built from 2000 to 2013, EF from table 3.41 of the EMEP / EEA guidebook 2019 is now used.
- In 1A4bi, an update was made of the stoves for non-wood firing based on data from the Flanders 2018 energy balance.
- In 1A4bi, adjustment of energy consumption (natural gas and LPG) in the energy balance Flanders 1990-2019 from 2016.
- In 1A1a and 1A4ai: In the 2022 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For gas-fired CHP installations and autoproducers with a construction year > 2017, the emission limit values are no longer used as EF.
- In 1A4bi: In the 2022 submission, emission factors for TSP, PM_{10}, $PM_{2.5}$ and EC are re-examined. For boilers built >=2017 burning piece of wood, the EF of table 3.46 from the guidebook are now used.

Improvements

- Improvement and modification of the energy balance methodology is taking place in the Brussels Capital Region. Some changes of data are possible.

- For some plants in Wallonia, the emission factors are not consistent throughout the time series. Indeed, from 2005, companies must report their emissions and these emissions are included in the inventory but in previous years, emission factors were sometimes used. For the next submission, emission factors will be calculated on the basis of company data (2005-2015) or on the basis of the guidebook and used on the entire time series 1990-2004.
- In the Walloon region, recalculation of the As, Hg and Pb emissions in the offroad sectors and navigation.
- In Flanders a study has been done to optimize the number of stoves and boilers using wood.
- In Flanders the model to calculate the industrial emissions of facilities that are not obliged to submit an annual report in a collective way was revised. The study remained inconclusive and could not guarantee an improved calculation method without impairing the functionality of the total emission inventory. It showed that the current method displays a few flaws indeed but still has high level of significance.
- SO_2 emissions from the use of natural gas in gas fired power stations are included in the reporting.
- The EMMOSS model to calculate emissions from maritime navigation in all ports and in Belgian part of the sea will be revised in 2022-2023.
-
- The EMMOSS model to calculate emissions for national navigation will be replaced by a new model (EISS). The methodology and model are currently being developed.

8.2. *Recalculations and improvements in the sector of industrial processes and products use*

Recalculations

For the three regions:

-
- 2D3a: The increase of the ethanol consumption in 2020 due to the use of hand sanitizer because of the Covid-19 crisis (whose emissions are attributed to domestic use of solvents results in an increase of the emission factor for domestic use of solvents.

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

- 2A3/2A6: NMVOC-emissions from one company allocated to 2A3 instead of 2A6.
- 2C5 Aluminium production: PCB emissions have been estimated for the whole time series.
-
- 2D3g: recalculations of NMVOC-emissions for 2010-2019 based on new information from several companies.
- metals
- 2G use of tobacco: emissions of SOx for 1990-1999 are included for the first time.
-
-

In Wallonia, the following recalculations have been performed:

2A1 *Cement production*: The activity data (clinker production) and the IEF in 2019 have been corrected because of an error in the clinker production of one plant. No changes have been made in the emissions of pollutants.

- 2A2 Lime production: The PCB emissions were recalculated this submission for the years 1990-2013 by using an average emission factor.

- 2B1 Ammonia production : an ammonia slip occurred from 2011 to 2020 which wasn't in the inventory. The problem was resolved in 2021.

- 2D3d Coating applications: Correction of the VOC emissions of domestic use of paint and paint application for construction and buildings in 2018.

- 2D3g Chemical products: Revision of the VOC emissions of pharmaceutical products manufacturing from 2016 to 2019 to take into account a revision in the emissions of one plant.

- 2D3g Chemical products: Revision of the VOC emissions of paints manufacturing in 2018 and 2019.

- 2D3h Printing: Revision of the VOC emissions in 2019.

In Brussels, the following recalculations have been performed:

- 2A5b construction and demolition: Revision of the activity data for 2019
- 2D3a Domestic solvent use: Update of Stabel population data for the years 1994, 1995, 1996 et 2008
- 2D3d Coating Applications: Update of Stabel population data for the years 1994, 1995, 1996 et 2008 and bupdate of the historical data on the number of households slightly impacting the emissions
- 2D3e Degreasing: Revision of one company's data for 2017
- 2D3f Dry cleaning: Update of Stabel population data for the years 1994, 1995, 1996 et 2008
- 2D3h Printing: Update of COV data from COV balance of National Bank for the years 2003 to 2019

Improvements

In the Flemish region, the following improvements are planned:

- 2D3a domestic solvent use: recalculation of NMVOC-emissions for recent years based on activity data per product type (DETIC data).

- Revision of the NMVOC-emissions from dry cleaning for 2015-2020 on the basis of the survey performed by the Belgian textile federation in order to collect the solvent consumption figures.

In Wallonia, the following improvements are planned:

- Revision of the VOC emissions from domestic solvent use on the basis of the data collected by DETIC;

- Revision of the VOC emissions for Wood paint application ;
- Revision of the VOC emissions for non-chlorinated solvents for Metal degreasing, Dry cleaning and Other industrial cleaning;
- Revision of the VOC emissions for Polyester processing, Polyvinylchloride processing, Polyurethane processing;
- Estimation of the missing VOC emissions (NE) for Textile finishing, Glass wool enduction, Mineral wool enduction ;
- Revision of the emissions from key sources in order to move from Tier 1 to Tier 2 methodology when necessary.

In Brussels, the following improvements are planned:

- Revision of the VOC emissions from domestic solvent use on the basis of the data collected by DETIC.

8.3. *Recalculations and improvements in the agricultural sector*

Recalculations

In Wallonia:

- NH_3 Emission factors for grazing has been updated with the update of the 2019 EMEP Guidebook in February 2020. This has increased the grazing emissions on the whole time series: from 1.4 kt NH_3 in 2019 to 1.8 kt in 1990.
- There was an update on the number of swine in building equipped with NH_3 abatement systems between 2014 and 2016. This has limited impacts in the NH_3 emissions in 3B3 and 3Da2a (+3 ton in 2014 , -7 ton in 2015 and +2 ton in 2016) and very limited impacts in NOx emissions (-0.1 ton in 2014 , +0.3 ton in 2015 and -0.1 ton in 2016)
- Activity data on compost in 2019 has been updated (data provisional last year) : + 18 ton NH_3 and +18 ton NOx in 3Da2c.
- Between 2013 and 2019, the NH_3 emissions needed for NMVOC calculations have been corrected (results of previous recalculations). It results in a slight decrease from 6 ton NMVOC in 2013 to 5 ton NMVOC in 2019.

In Flanders, following recalculations were made:

- For NMVOS emission, a revision of the gross energy uptake occurred. This results in a small decrease of the emissions for the entire time series (category 3B).
- For NO_2 emission, a correction of the emission factor of goats occurred. This results in a minor decrease of the emissions for the entire time series (category 3B).
- For NO_2 emission, an update of the amount of applied inorganic fertilizer for 2019 occurred. This results in an increase of the emissions for 2019 (category 3Da1).
- For NO_2 emission, an update of the amount of applied compost for 2019 occurred. This results in an increase of the emissions for 2019 (category 3Da2c).

– For NH3 emissions, an update of the amount of applied inorganic fertilizer for 2019 occurred. This results in an increase of the emissions for 2019 (category 3Da1).

In the Brussels-Capital region:

- The number of animals has been updated from 2011 on
- For NMVOC emissions for the category 3B, a Tier 2 methodology is used instead of Tier 1 for the cattle and swine
- The emission factors for direct N_2O-N emissions from manure management has been revised in line with latest version of EMEP/EEA Guidebook 2019 Table 3.8 page 27

Improvements

In Flanders, during 2021-2022, The EMAV2.1 model will be extended with methodologies to calculate the CH_4, N_2O and NO_2 emissions. For NO_2, the methodology to calculate the emissions from manure management and agricultural soils will be revised. This new integrated model will calculate NH_3, N_2O, CH_4 and NO_2-emissions and therefore follow the N-flow throughout the farm in an integrated way. The study started in 2021, is performed by ILVO and is commissioned by the VMM. The kick-off of the study was given January 18, 2021. The end of the study, as well as the results, is scheduled for June 30, 2022. An English summary will be provided. The study will result in an entire new time series. The new time series will be reported February 2023. Time will be needed and taken to validate the new time series.

Also in Flanders, the EMAV2.1 model is subject to continuous review processes. In 2020 an external validation of the EMAV2.1 model was carried out by the Flemish Institute of Technical Research (VITO) on behalf of VMM. A summary in English is given in annex 5B. The outcome of the validation will be prioritized and integrated in the model during the following years/revisions. Due to the above mentioned study (development of the integrated model), the outcome of the external validation was not yet implemented in the existing EMAV2.1 model. They will be implemented during the study (development of the integrated model). Also each year, when relevant, the results of the Review of National Air Pollutant Emission Inventory Data are taken into account. Taking into account results of new scientific research, outcome of NECD review 2020, etc. This can lead to an update of the EMAV2.1 model. Depending of the content of the update, this can result in new emission data.

8.4. ***Recalculations and improvements in the waste sector***

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

- 5C: Since submission 2022, we made changes to the allocation of emissions from flaring. We allocated the emissions from flaring to 5C1bi instead of 1A1a as recommended in the EMEP guidebook.
- 5C: Since submission 2022, we allocated the emission of one waste incineration company to 5C1bi instead of 1A1a because the company produces its own energy and therefore to be allocated to the waste sector itself
- 5E: emissions of PM2.5, PM10, TSP, heavy metals and PCDD/F have been calculated for the whole time series. The recalculation is based on new activity data from the Belgian fire brigade.
- 5D: The company reporting NH3 was contacted. It will split the total reported NH3 emissions for all years into process emissions and emissions due to water treatment.
- 5C: crematoria: emissions from 1990-1994 were recalculated to make the time series consistent.

In Wallonia, no recalculations were performed:

In the Brussels Capital region, following recalculations were done:

- 5C1biv Sewage sludge incineration: Historical emissions from the incineration of sewage sludge in one of the two wastewater treatment plants for the period 2004 to 2009 were included for the first time for the 2022 submission.
- 5E fires: Retropolated and extrapolated activity data adjusted to most recent data available.

Improvements

No improvements planned

Chapter 9. **Projections**

Projections have been reported for 2020, 2025, 2030 under a 'With measures' scenario and a ‘With 'additional measures' scenario on 15 March 2021.

Belgian emission projections are the sum of the regional projections for stationary and mobile sources.

9.1. ***Energy***

9.1.1. Stationary combustion

Flanders

Emission projections from energy-related stationary sources have been aligned with projections for greenhouse gases, as reported under Article 14 of Regulation (EU) 525/2013 in March 2020.

For buildings and agriculture, the same greenhouse gas projections will be reported in March 2021 as in March 2020, meaning that the reported projections for air pollutants are fully aligned with projections for GHG. For details on the assumptions, we refer to the reporting under Article 18 of Regulation (EU) 2018/1999 in March 2021.

For industry, some minor changes are expected in the GHG-projections for March 2021 compared to March 2020. These changes result from small changes in the calculation methodology and not from changes in the assumptions behind the calculations. Therefore, the impact on projections for air pollutants is expected to be negligible. For the transformation sector, GHG projections reported in March 2021 are expected to differ slightly from the projections reported in March 2020. This is mainly due to new assumptions for import of electricity.

Both for industry and the transformation sector, the calculation of projections for greenhouse gasses and for air pollutants are included in the same model. This model is currently being revised strongly and the inclusion of the air pollutants in the new model is not yet finished. Therefore we cannot calculate projections for air pollutants aligned with the latest projections for GHG, but have to revert to the GHG projections as reported under the MMR in March 2020. For more details on the assumptions, we refer to the reporting under Article 14 of Regulation (EU) 525/2013 from March 2020.

9.1.1.1 Energy Industries (NFR 1A)

Power Sector (NFR 1A1a)

Flanders

Description of the model used

A Flemish simulation model has been developed in 2014 to construct short term projections for Flanders for the power sector and the industry. The simulation model is a projection model for energy demand, greenhouse gas emissions and emissions of air pollutants (SO_2, NO_x, PM and VOC). This simulation model works as a “bottom-up” type, i.e. explaining energy consumptions and emissions from activity variables expressed as far as possible in physical units, and the main determining factors of the evolution of energy demand and emissions.

The model, which includes a database on the energy consumption, emission factors, activity data and reduction effects of climate & energy and air quality policy measures, can be used in particular for:

- the construction of a reference scenario (business as usual), representing the expected future evolution in the absence of any new emission reduction policy based on expected economic and demographic evolutions;

- constructing emission reduction scenarios, based on the implementation of a combination of reduction measures;
- assessing the impact of existing or draft legislations on energy consumption and emission levels.

The model starts from reference year data:

- energy demand per industrial sector;
- emissions per industrial sector;
- large combustion plants and all electricity producing plants are included at installation level (energy consumption, electricity production and emissions);
- detailed information on the evolution of the installed power for electricity generation (including electricity import);
- Share of the emissions, per sector, that comes from processes (and thus is not related to fuel consumption).

For industry, major assumptions are the evolution of industrial activity and energy efficiency (yearly growth rate per sector), the share of CHP per sector and the lifetime of installations (since new installations mostly can respect lower emission levels than the existing ones). This leads to a projection on energy consumption and electricity.

Electricity demand from all sectors (including buildings and transport) is the main driver for the electricity part of the model. The model searches for the most cost optimal mix of electricity generating installations (including import) to produce the necessary electricity, taking into account different time slices (electricity demand is not equal in winter and in summer, neither during night or day), based on production efficiencies and fuel cost. The model has the possibility to install additional production capacity (CCGT or gas turbine). This evaluation is done on the Belgian (and thus not on the Flemish) level.

For all energy consuming sectors, energy consumption is translated into emission projections through emission factors (per fuel) that reflect policy (either current policy or additional measures). For industry and electricity production, current emission factors are compared to the emission factors based on policy and the lowest of both is used (installations that already comply with future emission standards don’t need to realize additional reductions).

Assumptions

Assumptions are aligned with the reporting under Article 14 of Regulation (EU) 525/2013 from March 2020. The only exception is the import in the WAM scenario: where the MMR-calculations assume a lower import than under WM, this would lead to higher emissions of air pollutants than under WM. We therefore assume the same import of electricity in our WAM scenario.

Table 9-1 shows the demand and supply data of the electricity sector for Belgium (TWh) for both the WEM and WAM scenario.

Table 9-1 Electricity demand and supply for Belgium (TWh)

		WM			***WAM***		
	2016	***2020***	***2025***	***2030***	**2020**	**2025**	**2030**

Final consumption Belgium	84,3	82,9	86,1	89,1	82,9	86,9	91,5
Distribution losses and own use	7,2	5,6	5,4	5,7	5,1	6,9	8,3
Net import (balance export – import)	6,2	5,9	16,9	17,8	5,9	16,9	17,8

The trans-boundary electricity trading is considered exogenous in the modelling of the electricity production. The net import levels in the Belgian projections up to 2030 are based on existing scenario reports of the Belgian power system. The actual evolution of the net-import will mainly depend on new trans-boundary transport capacities, commercial opportunities and the location of new production plants.

The WEM and WAM scenarios integrate the phase-out of nuclear energy in Belgium. On 31st January 2003, the Federal Government decided the progressive phase-out of the production of electricity using nuclear fission energy by limiting the operating lives of existing nuclear power plants to 40 years and prohibited the construction of new nuclear power plants. In July 2012, the Federal Government confirmed this timetable except for one nuclear unit, Tihange 1, whose operation lifetime was extended by 10 more years. This decision was confirmed in a law (18th December 2013). On 18th June 2015, another extension was approved (for the Doel 1 and Doel 2 units) through an amendment of the law of 31st January 2003. The timetable for the nuclear power phase-out between 2022 and 2025 mentioned in Table 9-2 (as inscribed in article 4 of this law) has been taken into account in the WEM and WAM scenarios.

Table 9-2 Nuclear phase out (according to the law of 18th June 2015)

Nuclear unit	***Capacity (MW)***	***Closing date***
Doel 1	433	15th February 2025
Doel 2	433	1st December 2025
Doel 3	1.006	1st October 2022
Doel 4	1.039	1st July 2025
Tihange 1	962	1st October 2025
Tihange 2	1.008	1st February 2023
Tihange 3	1.046	1st September 2025

An increase in the offshore wind capacity after 2020 has been assumed in the WAM scenario (Table 9-3).

Table 9-3 Offshore wind capacity WEM and WAM scenario (MW)

	2020	***2025***	***2030***
WAM scenario	2261	2261	4011
WEM	2261	2261	2261

scenario

The WM and WAM projections with regard to electricity production from renewable sources, as mentioned in the final Flemish Energy and Climate Plan 2021-2030[7], haven been taken into account.

Table 9-4 Renewable electricity Flanders in WEM and WAM scenario (TWh)

	WM			***WAM***		
	2020	*2025*	*2030*	*2020*	2025	2030
Solar	3,2	4,4	5,5	3,2	4,7	6,2
Wind onshore	2,7	2,7	2,7	2,7	3,9	5,0
Hydro	0,01	0,01	0,01	0,01	0,01	0,01
Biomass	2,9	1,7	0,5	2,9	1,7	0,5
Biogas	0,8	0,8	0,9	0,8	0,9	1,0
Total	9,7	9,7	9,6	9,7	11,2	12,8

Wallonia

<u>WEM and WAM scenarios</u>

The impact of support for green electricity production ("green certificate") is taken into account based on pre-defined "envelopes" until 2024[8] for the WEM scenario. Several measures (green certificate mechanism revision, regulation, …) increase electricity renewable energy targets in the WAM scenario around 10 TWh in 2030, in accordance with targets of the Walloon contribution to National Energy and Climat Plan 2021-2030.

Waste incineration remains stable until 2040 and reduces in the WAM scenario.

In the case of gas combined heat and power production system (CHP), the estimation considers "envelopes" from green certificate until 2024 and after, technology choice is based on the result of the optimisation after the definition of a realistic potential of deployment.

Brussels-Capital Region

<u>WEM scenario</u>

Regarding electricity and heat production, the estimations are based on historic evolution of the waste incinerator from the regional energy balance; this is also the case for the waste water handling installations. In the case of the CHP (combined heat and power production system which are the cogeneration system), the estimation considers the average operating hours and the average annual

7 https://omgeving.vlaanderen.be/vlaams-energie-en-klimaatplan-2021-2030

8 « Envelopes » are defined until 2030 since april 2019. Nevertheless, because some implementation modalities are still to be defined, the impact is taken into account in WAM scenario

evolution of the installed power between 2009 and 2018. The WEM scenario considers that biomass CHP will phase out on 2025.

Concerning heat pumps, solar and photovoltaic panels' production projections, the WEM scenario assumes that the projected evolution follows the historic trend from energy balances. Finally, the scenario considers that the turbojet will work until 2038.

WAM scenario

In addition to the measures included in the WEM scenario, a small anaerobic digestion plant is planned to be implemented in 2025. "Green certificates" will not be granted after 2030 meaning the end of the CHP production at the year 2040.

Petroleum refineries (NFR 1A1b)

The projection of the emissions of this sector is based on the information (emission projections) that was received from every individual plant.

Manufacturing of solid fuels

In Flanders the WAM and WAM scenario assumes one coke production plant in steel industry operating at maximum capacity in the period 2016-2030.

Wallonia

In Wallonia, the last coke factory was closed in 2014 and it is not expected that a new plant will be built.

9.1.1.2 Manufacturing Industries and Construction (NFR 1A2)

Flanders

For the model description: see chapter on the power sector.

The energy consumption in the industrial sector in the WEM has been modelled taking into account the expected energy efficiency improvement, based on current energy agreements, and activity projections. Increased energy efficiency and additional fuel shift assumptions have been considered in the WAM scenario.

A yearly economic growth of 1,35% has been assumed up to 2020, beyond 2020 this decreases to 0,95%. Known investments in new plants have been taken into account individually.

The evolution of the emission limit values (reflecting a.o. implementation of the IED and BREFs and the MCP-directive) have been taken into account. The WAM-scenario includes a strengthening of the elv's for stationary engines.

Wallonia

WEM and WAM scenarios

The future evolution of demands for industry is driven by a simple hypothesis: each industrial sub-sector[9] level of activity in Wallonia will stay the same until 2040 as it was before (the industrial activity is defined as the average activity over the last years (2014-2018)). This hypothesis is dictated by the lack of prospective study on the Walloon industry in the long term and the uncertainties driven by the COVID-19 crisis. This hypothesis could be updated in the next months. Investment projects and equipment closures that have taken place or have been announced have been considered.

All major industries are involved in ‘second generation’ branch agreements whereby they are committed to improve their energy/CO_2 efficiency by 2023. Until 2023, an improvement of energy efficiency of 0.95% per annum has been assumed (except CHP). After that, until 2040, a natural improvement of 0.29% per annum is considered. For the development of CHP in the industrial sector, the assumptions are described in the power generation sector.

Wallonia is currently developing a new projection model (TIMES). The baseline scenario has been produced with this model. The WAM for the other sectors has been produced with a previous projection tools used in the previous report. For the industry sector, it is not possible to use these previous tools because the working hypotheses (notably for activity drivers) between WEM and WAM are too different. Therefore, for these projections, the WAM has been assumed to be equal to the WEM.

Brussels Capital Region

<u>WEM and WAM scenarios</u>

The projections are calculated on the basis of energy intensity. Industry sector in Brussels Capital Region faced an important decrease from the year 2000. Between 2008 and 2018, it has stabilized, representing approximately 3% of final energy consumption in the region. The perspectives of a future expansion are very low. The projections assume that the gross added value will progress according to the middle term projections 2020-2025[10]; from 2025 until 2040 this value remains constant.

The 8th December 2016 a decree has been approved concerning energy audits obligations[11]. This decree is included in the WEM scenario. The objective is to diminish total energy consumption of the biggest industrial companies located in the region, so companies consuming more than 28 GWh per year in primary energy must do an energy audit.

9.1.1.3 Other stationary combustion (NFR 1A4ai, 1A4bi, 1A4ci)

Flanders

For assumptions on the evolution of the energy consumption in the residential sector, the tertiary sector and the greenhouse horticulture, we refer to the reporting under Article 18 of Regulation (EU) 2018/1999 in March 2021. Projections are driven by assumptions on degree days in the future.

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9 The industrial sector is divided into 20 subsectors : milk, sugar, transformed potatoes, other food industry, cement, lime, hollow glass,flat glass, bricks, ceramics, other non-metallic minerals, ammonia, other chemicals, wood industry, pulp and paper, iron and steel, non-ferrous metals, non-energy consumption (chemicals and others) and other industries

10https://www.plan.be/uploaded/documents/202007171231410.FOR_HermReg_2020_12182_F.pdf

11 Arrêté du Gouvernement de la Région de Bruxelles-Capitale relatif à l’audit énergétique des grandes entreprises et à l’audit énergétique du permis d’environnement approuvé en troisième lecture le 8 décembre 2016.

For the residential sector, this includes projections on the number of new dwellings and their energy level and improvement and fuel switch in existing dwellings. Policies on energy efficiency are taken into account. The WM projections for the greenhouse horticulture take into account an extension of current subsidies for energy efficiency and renewable energy measures. In the WAM scenario additional energy saving measures and energy agreements have been taken into account.

For wood combustion, underlying activity data differ from the reporting under Regulation 2018/1999. Where that reporting assumes that wood use will decline with about 50% by 2030, we stick to projections based on degree days, population and urbanisation combined with energy consumption per household.

Emission factors have been taken from the EISSA-B model that is used for the historical inventory (the model includes trends that can be extrapolated to the future). Future changes (f.e. more stringent ecodesign standards) are taken into account. See chapter 3.5 for a description of the model. The same emission factors have been used in the WM and WAM scenario. These emission factors take into account the use of different types of boilers and stoves. On top of this, the WAM-scenario takes into account the goal of a green deal of wood combustion, that aims for a reduction of PM and NMVOC-emissions with 50% by 2030 with respect to 2016.

Wallonia

Tertiary (NFR 1A4ai)

WEM scenario

Different energy services (heating, hot water, cooling, and other services including cooking, private and public lighting, refrigeration, and other electrical devices) and technologies are defined for 7 subsectors (education, health, culture and sports, shops, private offices, public offices, datacentres).

The evolution of the demands is linked to GDP growth[12].

Some renovations are assumed, according to the results from support policies (UREBA, …).

For electric equipment, new technologies are described according to the best available technologies.

During the period 2018-2040, the shares of oil in final consumption is supposed to slightly decrease (from 17% to 13%), in favor of gas and renewable energy (with a growing share of biomassa mainly).

WAM scenario

WAM scenario for tertiary sector includes different measures:

- For new building, energy autonomy will go further (through voluntary measures and studying regulatory requirement strengthening).
- For all buildings, more heat will be produced by renewable energy (biomass, heat pumps, ….), in accordance with targets of the Walloon contribution to National Energy and Climat Plan 2021-2030.
- For existing buildings, the targets of the “Long term Renovation Strategy”[13] and its intermediate objectives are taken into account. It will reduce the environmental impact of existing buildings. This strategy defines different objectives for energy efficiency of the envelope and the equipments of the existing buildings.

12 GDP growth comes from regional projection (BFP et al., 2020) for the short term and from European projections (recommended parameters provided by the European Commission for the mandatory reporting of national GHG projections) for the medium and long term.

13 https://energie.wallonie.be/fr/strategie-de-renovation.html?IDC=9580

This scenario wil require the implementation of new measures or the improvement/widening of some measures taking place in the WEM scenario.

Residential (NFR 1A4bi)

WEM scenario

- *Space heating and hot water*

For new dwellings, the heat demand takes into account the current EPB regulation in Wallonia with the following requirements from 2021 : Ew = 45; Espec = 85 kWh/m²/year (where E_w is the "primary energy consumption level" and E_{spec} is the "specific primary energy consumption level").

For existing dwellings, 20 different categories of existing buidings are taken into account. For each category, the surfaces and net needs are described. Retrofitting options (roof, wall, floor and window) are also differentiated according to the 20 categories of buildings defined above. A decrease of specific energy consumption of existing housing is calculated based on energy savings per type of renovation and a number of annual renovations coherent with the results from energy grant system.

Concerning the fuel mix, a set of technologies is described in the model through standard parameters (efficiency, lifetime, …) which can evolve (improved performance, …). Installation switch from fuel oil to natural gas heating systems[14] (so that the share of fuel oil in the total residential mix decreases from 46% in 2018 to 28% in 2030) and share of renewable energy (mainly biomassa and heat pumps) slightly increases in the fuel mix (thanks to EPB requirements for new houses, …).

- *Other uses*

The demand for other energy services for the residential sector including lighting, cooking, refrigeration and freezing, cloth washing and drying, dish washing, and other electricity services follows the evolution of the number of households.

For electric equipment, new technologies are described according to the best available technologies.

WAM scenario

The WAM scenario for residential sector includes different measures:

- For new building, energy autonomy should go further (through voluntary measures or studying regulatory requirement strengthening, …).
- For all buildings, more heat is produced by renewable energy (biomass, heat pumps, …), in accordance with targets of the Walloon contribution to National Energy and Climat Plan 2021-2030.
- For existing buildings, the targets of the "Long term Renovation Strategy"[15] and its intermediate objectives are taken into account. It will reduce the environmental impact of existing buildings. This strategy defines different objectives for energy efficiency of the envelope and the equipments of the existing buildings.
- Some behavioural changes.

This scenario wil require the implementation of new measures or the improvement/widening of some measures taking place in the WEM scenario.

Agriculture (NFR 1A4ci)

For this sector, the emissions are supposed to stay constant for the WEM and WAM scenarios.

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14 Taking into account some limits linked to gas infrastructure, barriers to system change, …

15 https://energie.wallonie.be/fr/strategie-de-renovation.html?IDC=9580

Brussels-Capital Region

WEM scenario

The 1A4 sector emission projections consider the historic trends between 2001 and 2018 on energy consumption, household size, and population. The projections also reflect the application of the Brussels Capital Region Government's Decree[16] regarding Energy Performance of Buildings. This decree considers that all new buildings will be nearly passive (15kWh/m^2.yr) and heavy renovated buildings will consume 30kWh/m^2.yr. This measure is applied for office and education buildings; it starts in 2018. All new buildings are considered nearly passive (15kWh/m^2.yr) and all the heavy renovated buildings must reach a very low energy level (45kWh/m^2.yr).

In addition, the WEM scenario includes the measures adopted in the Brussels Code on Air, Climate and Energy Control (COBRACE, French acronym) and the Air, Climate and Energy plan (PACE, French acronym). The COBRACE reorganizes the Brussels legislation in these areas with a cross-cutting approach. This Code includes measures assuring the improvement of air quality, energy performance of buildings, mobility evolution and citizens awareness. The PACE describes the Brussels Capital Region long term objectives and measures to be implemented for the 5 forthcoming years concerning air, energy, climate change mitigation and adaptation. Finally, some measures, sufficiently mature, included in the PNEC are included in this scenario.

The second measure focuses on the big energy consumers. It contemplates the requirement of an energy audit in order to obtain the renewal of the environmental permit for establishments exceeding 3500 m^2 [(17)]. The energy audit allows a reduction of 13% of final energy consumption. The decree concerning energetic audits has been approved the 8th December 2016[18]. According to this framework, the big companies, defined by the number of employees and its energy consumption, must do an energy audit starting on 2018, this means in average 18 additional audits per year. In addition, the target is enlarged for commercial establishments, starting from 2018; commercial establishments with a surface over 1500m^2 must do an energy audit.

In addition, there is the mandatory implementation of the local action and energy management plans (PLAGE, French acronym) in private buildings which surface exceeds 100.000 m^2 and public buildings with an area bigger than 50.000 m^2. The objectives of the PLAGE are to implement energy management measures, handle energy invoices, increase users comfort, improve air quality and reduce GHG emissions. This action starts on 2019. The first phase lasts 6 years and the subsequently phases have a duration of 4 years. The objective of the PLAGE is to obtain a reduction on final energy consumption of 10% per phase.

Other measures taken into account in the WEM scenario are related with the energy management and technical installations in buildings. The technical reception of a new boiler installation is one of these measures. In fact, when a new boiler is installed, the entire heating system must be controlled by a

16 21 décembre 2007.- Arrêté du Gouvernement de la Région de Bruxelles – Capitale déterminant des exigences en matière de performance énergétique des bâtiments et du climat intérieur des bâtiments tel que modifié par l'arrêté du 5 mai 2011.

17 30 janvier 2012.- Arrêté du Gouvernement de la Région de Bruxelles-Capitale rélatif à un audit énergétique pour les établissements gros consommateurs d'énergie.

18 Arrêté du Gouvernement de la Région de Bruxelles-Capitale relatif à l'audit énergétique des grandes entreprises et à l'audit énergétique du permis d'environnement approuvé en troisième lecture le 8 décembre 2016.

certified technician; this action allows 25% reduction from heating consumption. Boiler replacement rate was estimated from the data provided by the Thermal Technique Belgian Association (ATTB, French acronym) and it was deduced from the boilers replaced with energy grants.

The phasing out of fossil fuels such as coal and gasoil is considered in the WEM scenario. Starting from 2021, it will not be allowed to install any equipment using coal as fuel. Whilst this will be the case for gasoil installations from 2025.

The mandatory control is applied for boilers that are part of a heating system with a nominal power higher than 20kW that uses non-renewable fuel (gasoil and natural gas), and whose heat transfer fluid is water. An annual control is established for oil boilers and natural gas boilers should have a control every two years since 2019. This control generates energy gains around 1% for gas boilers and 2% for oil ones. This measure lasts the whole projected period but the measures reaches only 10% of the total target.

Another measure considered in the WEM scenario is the energy grant system. The energy gains are estimated considering the average gain of 2009 to 2018 for building's isolation, double glazing implementation, heating regulation systems and boilers replacement. The energy gain is considered to last 20 years. This gain is multiplied by the annual budget; the WEM scenario considers the budget proposed by the Government from 2019 (16.9M€) to 2024 (38.7M€). After this period, the scenario considers the end of the grant system.

Moreover, the energy gains due to the household's support are also estimated. This measure considers a variety of actions realized by households thanks to the advice of the household's support. Actions like the change of the traditional shower head towards an eco-shower, the isolation of pipes and hot water tank, and the installation of thermostat or regulator clocks, among others are considered. Each action has a specific energetic gain that allows determining an average gain. The project came to an end in 2019, however, the gains are assumed to last 14 years which is the average lifetime of the considered actions.

Finally, Brussels Capital Region promoted from 2007 to 2013 the "Exemplary Buildings Project" (BatEx). The objective of the project was to promote ecological construction and passive buildings. The project allowed the construction and renovation of approximately 214.000 m^2 in the residential sector and 396.000 m^2 in the tertiary sector. The energy gain is estimated to last 20 years.

WAM scenario

The WAM scenario considers the improvement or the widening of some measures taking place in the WEM scenario for the residential and tertiary sector. This is the case for the boiler's control, in the WAM scenario, the effectiveness of the measure increases to 25%. The energy grant system increases the budget progressively until 2030, for this year the budget will be 45M€.

Finally, the strategy for reducing the environmental impact of existing buildings, known as "Renovation Strategy" is considered in this scenario. The assumptions are based on the implementation of the 4 main measures of building renovation: Roof, walls, floor insulation, and windows replacement. These actions are executed according to the phases established in it, so the energy reduction will increase progressively and the first results will start in 2030.

9.1.2. Mobile combustion

9.1.2.1 Road transport (NFR 1A3b)

Flanders

Assumptions

The evolution of road-transport vehicle-kilometers of the WM-scenario is based on grow estimations made for a business-as-usual scenario by the federal Belgian plan bureau (FPB). The WAM scenario is based on the Flemish Mobility figures.

The growth rates for both scenarios are shown in Table 9-5:

Table 9-5 Mobility growth rates for Flanders

	WM			WAM		
Growth rate compared to 2019	2020	2025	2030	2020	2025	2030
Passenger cars	5%	10%	13%	2%	-3%	-16%
Light commercial vehiclescategory	-14%	-4%	4%	-19%	-23%	-34%
Heavy duty trucks	3%	13%	23%	2%	7%	11%
Busses and Coaches	-4%	-4%	-3%	-2%	-2%	-2%
Two wheelers	-25%	-25%	-24%	-24%	-24%	-24%
Totaal	**2%**	**8%**	**12%**	**-1%**	**-5%**	**-16%**

The projections of the vehicle fleet are calculated using survival curves based on the historic inventory data and introduction of new technologies. The consecutive directives and regulations on emissions to air for road transport have been taken into account.

The evolution of the share of the fuels in the total fleet per vehicle category is based on the predictions in Table 9-6:

Table 9-6 Evolution of share of the fuels in the total fleet

Total fleet		**WM**	**WM**	**WM**	**WAM**	**WAM**	**WAM**
category	**Fuel**	2020	2025	2030	2020	2025	2030
Passenger cars	Diesel	46,5%	34,4%	24,8%	46,4%	31,4%	18,4%
Passenger cars	Diesel hybrid CS	0,2%	0,1%	0,1%	0,2%	0,1%	0,1%
Passenger cars	Diesel hybrid PHEV	0,1%	0,5%	0,9%	0,1%	0,2%	0,2%
Passenger cars	Petrol	48,9%	54,0%	52,4%	48,9%	53,4%	48,0%
Passenger cars	Petrol hybrid CS	1,8%	3,5%	5,8%	1,8%	4,0%	7,6%
Passenger cars	Petrol hybrid PHEV	1,2%	3,8%	7,4%	1,2%	4,0%	7,7%

Passenger cars	LPG	0,2%	0,2%	0,2%	0,2%	0,2%	0,1%
Passenger cars	Electric	0,7%	2,6%	7,0%	0,7%	4,4%	13,2%
Passenger cars	Fuel Cell H2	0,0%	0,0%	0,1%	0,0%	0,0%	0,0%
Passenger cars	CNG	0,4%	0,8%	1,4%	0,4%	2,2%	4,7%
Light commercial vehicles	Diesel	92,8%	90,0%	82,2%	92,8%	85,4%	70,3%
Light commercial vehicles	Diesel hybrid CS	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Light commercial vehicles	Diesel hybrid PHEV	0,0%	0,0%	0,3%	0,0%	0,0%	0,0%
Light commercial vehicles	Petrol	4,8%	5,3%	5,0%	4,8%	8,0%	11,0%
Light commercial vehicles	Petrol hybrid CS	0,0%	0,3%	1,0%	0,0%	0,0%	0,0%
Light commercial vehicles	Petrol hybrid PHEV	0,0%	0,5%	3,7%	0,0%	1,2%	4,0%
Light commercial vehicles	LPG	1,5%	1,2%	0,8%	1,5%	1,1%	0,8%
Light commercial vehicles	Electric	0,2%	1,5%	4,5%	0,2%	2,0%	7,4%
Light commercial vehicles	Fuel Cell H2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Light commercial vehicles	CNG	0,6%	1,3%	2,4%	0,6%	2,4%	6,4%
Heavy duty trucks	Diesel	98,9%	96,5%	92,8%	98,9%	94,9%	85,8%
Heavy duty trucks	Diesel hybrid CS	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Heavy duty trucks	Diesel hybrid PHEV	0,0%	0,1%	0,5%	0,0%	0,0%	0,0%
Heavy duty trucks	Petrol	0,1%	0,0%	0,0%	0,1%	0,0%	0,0%
Heavy duty trucks	Electric	0,0%	0,3%	0,9%	0,0%	0,0%	1,3%
Heavy duty trucks	CNG	0,7%	0,9%	1,1%	0,6%	1,0%	2,1%
Heavy duty trucks	LNG	0,2%	1,3%	2,8%	0,2%	1,3%	3,9%
Heavy duty trucks	Dual fuel	0,1%	0,9%	1,9%	0,1%	2,7%	6,9%
Buses	Diesel	97,2%	94,2%	90,0%	97,2%	82,7%	59,4%
Buses	Diesel hybrid CS	2,6%	5,6%	9,8%	2,6%	13,6%	25,5%
Buses	Diesel hybrid PHEV	0,0%	0,0%	0,0%	0,0%	1,2%	4,7%
Buses	Electric	0,1%	0,2%	0,1%	0,1%	1,4%	6,2%
Buses	CNG	0,0%	0,1%	0,1%	0,0%	1,0%	4,2%

Two-wheelers	Petrol	95,8%	94,3%	92,3%	95,8%	92,9%	84,8%
Two-wheelers	Electric	4,2%	5,7%	7,7%	4,2%	7,1%	15,2%

Calculations

Emissions have been calculated using the COPERT V model version 5.4. For Euro 6dtemp and Euro 6d (both CAR and LCV) a correction factor is introduced for NOx to take into account the RDE-regulation and the latest insight of real emission measurements of such new vehicles.

Wallonia

WEM scenario

The projections of the overall mobility are calculated using the principle of mobility demand (projections of the Federal Planning Bureau[19]). The projections of the vehicle fleet are calculated using survival curves based on historic inventory data and on European legislations in force (Regulations 2019/631 and 2019/1242). The emission factors for existing vehicles are calculated from historic inventory data (year 2018) and emission factors for new technologies are estimated in the Sibyl baseline model.

For passenger cars, despite an augmentation of electric and petrol hybrid vehicles, conventional vehicles remain the main technologies operating up to 2030. In 2040, the situation is different, there are more electric and hybrid petrol vehicles than conventional ones (seeTable 9-7) due to the different European legislations in force.

Table 9-7 Share in passenger car fuel in Wallonoia

% Stock vehicle	2018	2030	2040
Electricity	0.0%	12.1%	26.0%
CNG	0.1%	0.5%	0.4%
Diesel	55.6%	39.1%	20.0%
Diesel hybride	0.0%	0.0%	0.0%
Fuel cell electric vehicle	0.0%	0.7%	3.2%
LPG	0.2%	1.6%	0.9%
Petrol	43.1%	29.5%	17.2%
Petrol hybrid	1.0%	16.4%	32.3%

For heavy duty and light commercial vehicles, diesel conventional models remain dominant (respectively 87.7% and 80% of the stock in 2030 and 65% and 56% in 2040). The tonnes.km between today and 2040 will increase.

19 For more information see: https://www.plan.be/databases/database_det.php?lang=fr&ID=41

WAM scenario

WAM scenario includes the FAST[20] vision and the regional strategy of mobility[21] (passengers and freight). FAST vision identifies different objectives for the future mobility in Wallonia in 2030[22] and the strategy of mobility defines how these objectives will be achieved. This scenario wil require the implementation of new measures or the improvement/widening of some measures taking place in the WEM scenario.

For passenger cars, demand decreases under the impulsion of a decreasing modal share of cars (from 83% in 2017 to 62% in 2030), a rise in the car occupancy rate (from 1.3 in 2017 to 1.5 in 2030) and a reduction of 5% of the global demand for passenger transport. The stock of electric, petrol hybrid and CNG vehicles rises in 2030 (respectively to 21%, 20% and 20% in 2030).

Total demand for freight transport is kept constant for the whole period and the modal share by road is 77% in 2030 (84% in 2016).

Wallonia is in a transition period and is currently developing new projection models to estimate transport (TIMES, Sibyl). The baseline scenario has been produced with these models. The WAM has been produced with a previous projection tools used in the previous report. Ultimately, the idea is to perform all the scenarios with the same tool(s), while best linking the different models used. Regularly updating models on the basis on the best available data collected through studies or actors is an important point of attention.

Brussels-Capital Region

<u>WEM scenario</u>

Projections of road transport emissions are calculated using a bottom-up approach (*fuel used* basis). The correction to *fuel sold* is applied as final step, according to the methodology described in chapter 3.4.

The calculation of atmospheric pollutants emissions and fuels consumption for road transport is based on the European COPERT IV approach. The main input data required for COPERT simulations (vehicles fleet and mobility) comes from a regional transport model, developed on the basis of literature data (TREMOVE projections[23] and INRETS study[24]), and recalibrated to the actual situation in the Brussels Region using emission inventories and outputs from a detailed traffic model (MUSTI).

The policies and measures taken into account for the simulations refer to WEM scenario. For road transport, the WEM scenario notably considers the implementation of a Low Emission Zone (LEZ), at the regional level, which implies that the vehicles that do not respect the established thresholds (based on fuel and EURO standards) are banned. This measure has a significant influence on some pollutants affecting local air quality, but a rather limited impact on GHGs emissions and climate change. The impact of trucks freight transport pricing is also included.

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20 Vision de la mobilité wallonne à 2030 : http://mobilite.wallonie.be/files/eDocsMobilite/politiques%20de%20mobilit%c3%a9/FAST%20Mobilite%20Wallonie%202030.pdf

21 http://mobilite.wallonie.be/home/politiques-de-mobilite/politique-de-mobilite-regionale-wallonne/strategie-regionale-de-mobilite.html

22 The 2030 results are kept constant until 2040

23 https://www.tmleuven.be/en/navigation/TREMOVE

24 **INRETS.** *Transport routier - Parc, usage et émissions des véhicules en France de 1970 à 2025.* s.l. : Institut National de Recherche sur les Transports et leur Sécurité (INRETS), 2004.

WAM scenario

The "Good Move" Plan[25] is the regional mobility plan. Developed through a dynamic and participatory process, Good Move defines the Region's mobility objectives and actions at the 2030 horizon. It focuses on six frames and is based on the implementation of fifty measures. According to preliminary estimates, the Good Move plan could contribute to a 21% reduction of vehicle-kilometers of light vehicles in the Brussels Capital Region from 2018 to 2030. The priority objectives of Good Move regarding energy and climate are to reduce the use and ownership of cars, increase the modal shift, and green the fleet.

In addition to the « Good Move » Plan, the government of the Brussels Capital Region has decided to implement a progressive phasing-out for fossil fuels-based thermic motors in the Region. Diesel light vehicles will be banned from 2030 on, and gasoline and GPL light vehicles from 2035 on.

9.1.2.2 Other transport (NFR 1A3a,c,d,e)

Flanders

Emission projections for off-road sector have been calculated using the OFFREM-model (see description in the chapters 3.4 and 3.5). The model allows extrapolation to the future. Where input is needed for activity data, data for 2019 have been kept constant. The only exception to this are the harbours, where projects under development (mainly in the harbour of Antwerp) have been taken into account.

For rail transport and air transport, projections are based on the scenario reported under Article 18 of Regulation (EU) 2018/1999 in March 2021. Emission factors have been kept constant at the 2018 level.

Emission factors for sea shipping in EMMOSS, by construction year of the ship, for the pollutants NO_x, NMVOC and PM_{10} have been taken from the study 'Emissiefactoren van zeeschepen voor de toepassingen in de jaarlijkse emissieberekeningen' (Netherlands, Oonk, 2003).

Growth of inland shipping is based on estimations by the federal Belgian plan bureau (Table 9-8).

Table 9-8 Growth rate of inland shipping

% growth for tonkm	2020 compared to 2010	2025 compared to 2010	2030 compared to 2010
	+17%	+31%	+47%

The yearly growth rate is applied to the tonkilometers reported for inland shipping in 2013 and have been calibrated on historic emissions for 2019.

For inland shipping, 30 ship types have been taken into account. Per shiptype the engine build year classes are taken into account (per 5 years), using per class the correlated emission factor. The ships are classified using the emission standards of the Central Commission for the Navigation of the Rhine (CCR) and the EU. Table 9-9 shows the expected evolution of the share of energy use for the three inland vessel types in the period 2015 – 2030.

25 https://goodmove.brussels/fr/

Table 9-9 Expected evolution of share of energy use for the three inland vessel types

%	2015	2020	2025	2030
No emission standards	22.4	7.3	2.0	0.5
CCR I	30.9	15.1	5.2	1.5
CCR II – EU fase III	46.7	77.6	92.4	84.9
EU fase V	0.0	0.0	0.2	13.0
Total	100	100	100	100

Wallonia

WEM scenario

Rail transport

We assume an increase of the emissions due to the increase of transport by rail.

Navigation

The demand increases for inland vessel transport of good.

Aviation

Demand for aviation is assumed to be related to the increase in households and population.

Pipeline transport and other (NFR 1A3ei and 1A3eii)

The projections of off-road emissions for the categories pipeline transport and other are calculated with the OFFREM model. This model has been developed for the 3 Regions in Belgium on the basis of a detailed bottom-up approach.

The emissions have been considered the same in the WEM and the WAM scenario.

WAM scenario

Rail transport

The modal share for rail in the whole passenger transport rises until 15.7% in 2030 (9% in 2017). For freight transport, the modal share of train rises until 13% of the total freight transport in 2030 (9% in 2016).

Navigation

For navigation, the modal share for freight transport rises until 10% of the total tonnes.km in 2030 (7% in 2016).

Aviation

As for the WEM scenario, demand for aviation is assumed to be related to the increase in households and population.

Brussels-Capital Region

WEM scenario and WAM scenario

Rail transport

For railways, the evolution of liquid fuel (gasoil) consumption is derived from the evolution of freight transport demand at the Belgian level. The starting point of the projections (2018) comes from the regional energy balance. The GHG emissions increase of about 26 t CO_2 eq. between 2015 and 2020, and reach 3.4 kt CO_2-eq in 2040. Passengers transport (trains, metro and tramways) is driven by electricity; the increase on electricity consumption projected between 2020 and 2040 is 34%, this evolution was estimated with the data provided by Bruxelles Mobilité.

Navigation

For inland navigation, the evolution of liquid fuel (gasoil) consumption is derived from the evolution of freight transport demand at the Belgian level. The starting point of the projections comes from the regional energy balance. Projections show an increase of GHG emissions. In 2020, emissions from inland navigation will be 1.98 kt CO_2-eq, and in 2040 they will be 2.23 kt CO_2-eq.

Natural gas transport

The emissions originating from natural gas transport are kept constant and equal to the emissions of year 2018 for the entire projection period since there are not available projections for this sector. It is important to mention that this sector represent in 2018 0.05% of total natural gas consumption.

Off-road emissions

The projections of off-road emissions for all sectors and vehicles categories are calculated with the OFFREM model. This model has been developed for the 3 Regions in Belgium on the basis of a detailed bottom-up approach.

9.1.2.3 Other mobile combustion (NFR 1A4aii, 1A4bii, 1A4cii, 1A4ciii)

Wallonia

WEM and WAM scenarios

The projections of off-road emissions for these categories are calculated with the OFFREM model. This model has been developed for the 3 Regions in Belgium on the basis of a detailed bottom-up approach.

The emissions have been considered the same in the WEM and the WAM scenario.

9.2. *Industrial processes and product use*

9.2.1. Industrial processes (NFR 2A,B,C,H,I,J,K,L)

Flanders

These emissions are included in the emission projections model for the industry and electricity production that was described earlier. In the WAM scenario, two important additional reduction techniques have been taken into account:

– a wet scrubber on a sinter plant

– an acid scrubber on a fertilizer production plant

Wallonia

WEM and WAM scenarios

Main non-energetic uses of fuels in Wallonia:

- coal in the iron and steel industry and selected applications of engineering (metallic works);
- petroleum products in several sectors, notably in the chemical industry;
- natural gas for ammonia production (carbon converted to CO_2 emissions)

Emissions from processes considered in Wallonia are the following:

- CO_2 produced by the decomposition of limestone in cement and lime productions;
- CO_2 produced by the decomposition of methane to produce ammonia (and considered separately from CO_2 emitted by the actual combustion of methane)

Projections of CO_2 process emissions are linked to growth rates of activity and have therefore been kept constant.

The emissions have been considered the same in the WEM and the WAM scenario.

Brussels-Capital Region

WEM and WAM scenario

Emissions are considered equal to the last inventory available and it is kept constant for the whole period since there is not information about the evolution of these sectors.

9.2.2. Product use (NFR 2D,G)

Flanders

For all pollutants but NMVOC, these emissions have been kept constant at the 2018 level.

Most of NMVOC emissions are emitted by domestic use of solvents in products. The activity used to calculate these emissions is the population. Therefore projections are made using projections in population.

Another important share of these emissions is emitted by industrial use of solvents. These activities are regulated with general binding rules (e.g. based on the IED directive). Trend analysis shows that emissions are stabilising in recent years after a long period of decline (1990 – 2012) due to the envrinomental general binding rules. Therefore these emissions are kept constant in the period 2019 – 2030.

Wallonia

WEM and WAM scenario

Most of the facilities falling under the Solvent Directive have already implemented the VOC reductions. When the activity data is related to population, the emissions have been assumed to follow the evolution of population between 2018 and 2030. For other sectors, the emissions have been considered the same as 2018.

Brussels-Capital Region

WEM and WAM scenario

Emissions due to the use of solvents are estimated in the BCR inventory considering a constant consumption per inhabitant. The emission projections of solvents use are based on population data from the Federal Planning Bureau. Due to the lack of information about the evolution of the other sectors the last historic value has been considered constant for the entire projection period.

9.3. *Agriculture*

Flanders

WM

Emission projections for NH3 from animals and fertilizers have been calculated using the same model as for the emission inventory. See chapter 5 for the description of the EMAV model. This model calculates NH3 emissions based on nitrogen mass balances and taking into account all possible sources (grazing, housing, spreading of manure, processing of manure).

For the projections a number of assumptions have been made:

- Animal numbers and the amount of manure (ton nitrogen) that can be spread on the land have been kept constant at the 2015 level
- The relative number of animals in the different housing systems has been kept constant, except where the numbers in low emission stables (LES) need to increase – see next table. Projections for LES and air scrubbers have been calculated using a replacement and renovation rate for stables of 2%.
- All manure from cattle, horses and other animals (goats, sheep, rabbits) will be spread and all manure from poultry is sent to manure processing or exported.

Table 9-10 Share of the animals that is housed in a low emission stable or in a stable with an air scrubber

	2015	2020	2025	2030
Horses and other animals	0	0	0	0
Cattle in binding stables	10%	8%	6%	5%
Laying hens	83.14%	86%	88%	91%
Broilers	23.28%	38%	49%	60%
Pigs	23.9%	34%	44%	55%

WAM

Additional measures included in the WAM-scenario are:

- Removal efficiency of new air scrubbers of 80% instead of 70%
- Strengthening of low emission application of manure on arable land:

- On grassland no more use of drag hoses
- The share of manure injection goes up from 26% to 50%
- 50% of the spreaded manure is incorporated as fast as possible rather than within 2 hours

Wallonia

WEM scenario

The activity data (heads of animals, crop areas and fertiliser use) are mainly estimated from the historic trends:

- livestock: a global decrease for cattle and an increase for all the other animal categories;
- agricultural area: kept constant up to 2030;
- fertilizer uses: a reduction of mineral fertilisers and an increase for the organic fertilisers.

For some parameters, the mean values of the last years are maintained up to 2030, in absence of any other information (e.g. Nex, levels of implementation of agricultural practices, ...).

The calculations follow the methodology of NEC & LRTAP inventories, detailed in the Informative Inventory Report of the 2021 submission.

WAM scenario

The activity data used in the WAM scenario are the same as those used in the WEM scenario. The differences are coming from a different level of implementation of different measures:

- NH_3 from buildings and storage: in the WEM scenario, only 9% of swine are located in buildings equipped with air treatment system. In the WAM, we expect 50% of the 2050 swine population.
- Slurry application: in the WAM, more slurry is applied with more precise equipment (near or in the soil)
- Solid application: in the WAM, solid manure is incorporated more quickly after spreading in the soils.
- Uses of mineral fertiliser: the reduction of use is already significant in the WEM scenario. No more reduction is added in the WAM scenario.

Brussels-Capital Region

WEM and WAM scenario

Air emissions in the agricultural sector mainly consist of emissions originated from animal husbandry (enteric fermentation and manure management) and direct and indirect emissions from managed soils. The emissions of the agricultural sector are very low in Brussels Capital Region. The stabilization of the sector is assumed since further expansion is not possible; thus the values remain constant.

9.4. ***Waste (NFR5)***

Flanders

Emissions in this category are mainly PM emissions from fires (houses, cars). These emissions have been kept constant.

Wallonia

WEM and WAM scenarios

Concerning the projections of emissions from waste sector (NOx, NMVOC, PM2.5, SO_2 & NH_3), the hypothesis followed is conservative and the emissions have been considered the same as 2018.

Brussels-Capital Region

WEM and WAM scenario

Waste sector takes into account the emissions from water treatment plants, composting installations, and cremation. Due to the lack of information about the evolution of these sectors the last historic value has been considered constant for the entire projection period. The waste incinerator of Neder-Over-Heembeek is not included in the waste sector due to the energy recovery process; this installation is included in the energy sector.

Chapter 10. **Gridded Data and LPS**

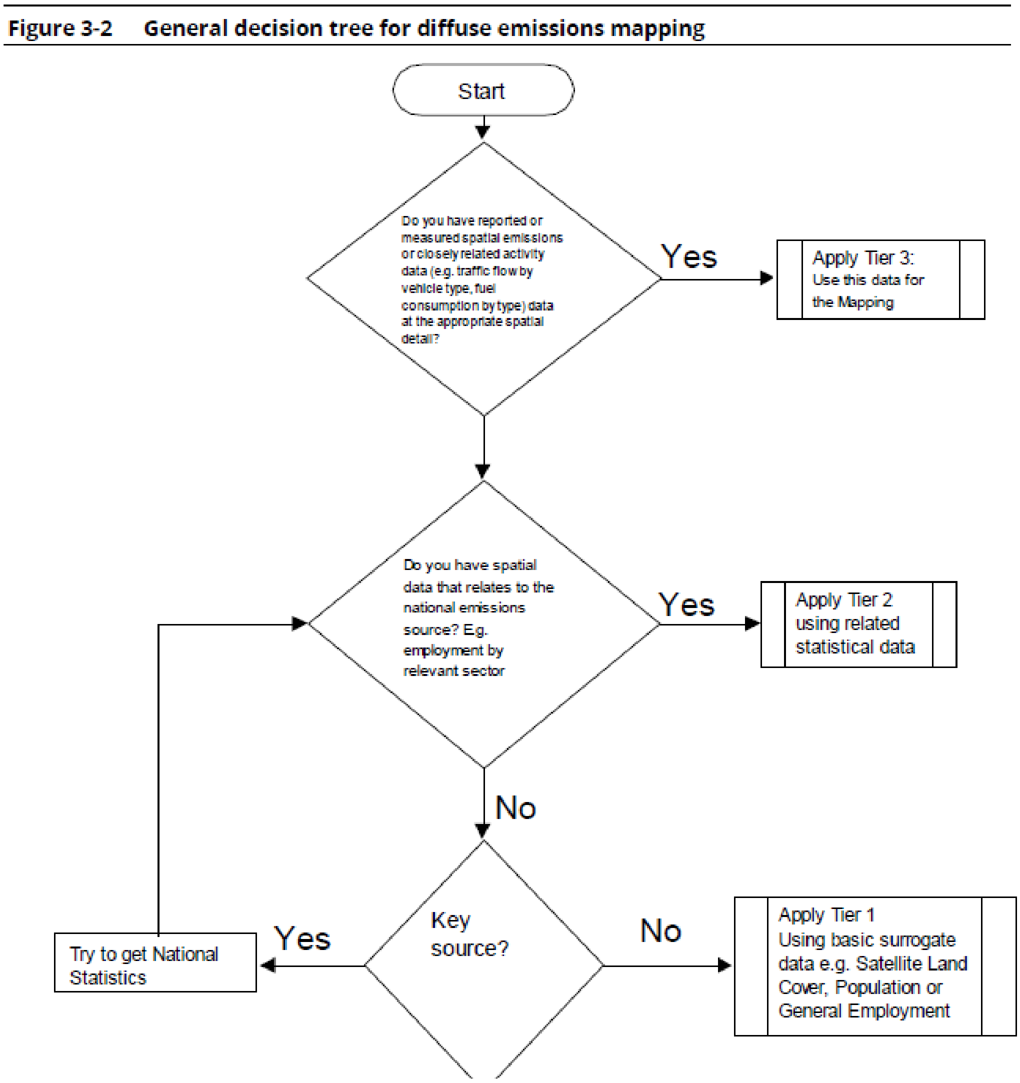
10.1. *Introduction*

According to the Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125) and the revised NEC Directive (2016/2284/EC), Belgium is required to report four-yearly its gridded emissions and emissions from LPS for the year x-2, starting in 2017.

By the 1st of May 2021, Belgium submitted LPS emission data of 2019 for all substances referred to in table 1 of the Guidelines taking into account the defined thresholds and being consistent with reporting under E-PRTR. Gridded emissions of 2019 were reported in the aggregated NFR sectors (GNFR) for NO_x, NMVOC, SO_x, NH_3, PM2.5, PM10, BC, CO, Pb, Cd, Hg, dioxins and furans, PAHs, HCB and PCBs.

According to the 36th EMEP Steering Body decision on gridded data, Belgium uses the new EMEP grid with a spatial resolution of 0.1º x 0.1º longitude-latitude in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84.

The methodology for spatialization of emissions is based on the guidelines provided in the EMEP/EEA Guidebook 2019. Following the decision tree from the guidebook (Figure 10-4) and analysing the available information, a tiered approach was used. This means that when point sources were known, these were chosen to map the emissions (Tier 3). In the cases where the emissions can be linked to statistical data, the emissions are spatialized using it (Tier 2). For sectors where little or no information is available for mapping, more general information is used for the spatialization such as population or surface (Tier 1).



Source: EMEP/EEA Guidebook 2019. Part A Chapter 7.Spatial mapping of emissions

Figure 10-4 Decision tree for choosing tiered approach

In addition to this analysis, the three Belgian regions try as much as possible to harmonize the methodologies for the common sectors. Where available, point sources are privileged.

The GNFR sectors accounting for the national totals are summarized in Figure 10-5.

In addition, gridded emissions for the memo-items N_Natural and P_IntShipping were reported.

	Sectors for reporting of gridded data	SNAP	Comments
1	A_PublicPower	1	Public power plants
2	B_Industry	1+3+4+5+6	Industrial combustion and industrial process
3	C_OtherStationaryComb	2	Small combustion
4	D_Fugitive	4+5+9	
5	E_Solvents	6	
6	F_RoadTransport	7	
7	G_Shipping	8	
8	H_Aviation	8	Only LTO
9	I_Offroad	8	Including rail
10	J_Waste	9	Including waste water and waste incineration
11	K_AgriLivestock	10	
12	L_AgriOther	10	
13	M_Other	5	

Figure 10-5. GNFR sectors to be reported in 2021

Next sections describe each GNFR sector, the methodologies applied for the spatialization and some examples of the results for the national totals.

10.2. *Mapping Methodologies*

10.2.1. GNFR A : Public power

This sector considers only the public electricity and heat production activities. Methods for gridding the emissions per region are summarized in Table 10-1.

Table 10-1. NFR Tier method and surrogates used for gridding of emissions in GNFR sector A_PublicPower

GNFR	Tier	surrogates for gridding		
		Flanders	Brussels	Wallonia
A_PublicPower	Tier 3	Point Sources		
	Tier 2	-	Installed power of CHP in each municipality	-

In Brussels Capital Region, the spatial distribution of the emissions is based on the one hand at the exact locations at the municipal level of the municipal waste incinerator and turbojets, on the other hand the emissions of CHP are split proportionally to the installed power in each municipality.

In Wallonia, the spatial distribution of the emissions is based on the location of point sources, for both E-PRTR plants and other plants (CHP). For the E-PRTR plants, detailed emissions are available by plant and for the other plants (CHP), energy data are available and the emissions are calculated by using emission factors.

In Flanders, all emissions of the power plants, the municipal waste incinerators with energy recovery and the industrial CHP installations are allocated as a point source. The CHP installations of the tertiary and the agricultural sector are geocoded on the address.

10.2.2. GNFR B : Industry

Sector GNFR B considers the combustion activities of the industrial sectors in NFR sector 1A as well as the process activities of NFR sector 2A to 2L excluding the solvents use. Methods for gridding emissions per region are summarized in Table 10-2.

Table 10-2. Tier method and surrogates used for gridding of emissions in GNFR sector B_Industry

GNFR	Tier	surrogates for gridding		
		Flanders	**Brussels**	**Wallonia**
B_Industry	Tier 3	Point Sources		
	Tier 2	Number of jobs in the particular sector	-	Municipality energy balances/Industrial zones
	Tier 1	Land use/surface of industrial zones. Emissions are distributed proportionally to a specific industrial zone (chemical, iron and steel, …) via the ratio of that industrial zone over the total industrial area in Flanders.	surface area of industrial zones	Sectorial land use (2H2, 2A5b, 2A5c)

The emissions in Brussels Capital region are gridded using the information concerning the industrial area per municipality. Most of industrial activity in Brussels is small sized, thus the emissions are split proportionally to this area.

In Wallonia, the emissions are gridded by using the energy balances by municipality. For each municipality, detailed emissions and energy consumptions from the E-PRTR point sources are known and also for ETS plants, the locations and the energy consumption is known, as well as the location and the emissions for beer production plants. The aggregated site specific energy consumption is subtracted from the energy balance of the municipality and the residual energy consumption is used to calculate the emissions. These collective emissions are mapped by using industrial economic zone as surrogate. The emissions from the production of bread (2H2), from construction and demolition (2A5b) and storage of mineral products (2A5c) are mapped by using the part of the Sector Plan concerning the habitat zone and the economic zones.

In Flanders, emission calculation and distribution methodologies differ by pollutant. All emissions (except NMVOC, POPs, particulate matter and heavy metals) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. The emissions that are estimated in a collective way (below the threshold, see IIR Chapter 1) encompass emissions of several sectors (1A2a, 1A2b, 1A2c, 1A2d, 1A2e, 1A2f and 1A2gviii) and these are all spatialized based upon a Tier 1 approach: emission distribution per industrial zone relative to the total industrial zone area in Flanders.
Emissions of NMVOC and POPs are allocated by the EISSA tool (Emission Inventory Support System Air, Sleeuwaert et al., 2012), either as point sources or by a spatial pattern. NMVOC emissions are mapped as point sources (1A1b, 1A2a,1A2b, 2A3, 2C1, 2C7c, 2D3b) or by the

number of jobs in the particular subsector (1A2gviii, 1A2c, 1A2d, 1A2f, 1A2e, 2H2). POP emissions are also mapped as point source if available or else spatialized based upon proxy (number of employees in relevant subsector). Emissions of particulate matter and heavy metals are allocated as a point source (facilities with emissions above the threshold) or by a spatial pattern per sector (industrial zones, pattern of chemical facilities, pattern of iron and steel sector, …).The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

BE-GRID-GEN-2020-0002: *The TERT notes with reference the reported emissions of gridded and LPS data that there are a number of grid cells where the LPS and gridded data are inconsistent. The TERT has compared the gridded emissions for each grid cell with the LPS emissions (allocated to the corresponding grid cell of the 0.1°x0.1° grid). In this comparison, the TERT has identified multiple occasions where LPS emissions in a certain grid cell exceed the gridded emissions total in that same grid cell.[…].*

In response to this question of the TERT, we have made a significant improvement for the gridded data in Flanders. In the previous reporting, emissions were first allocated to the 1x1 km² grid cells and then converted to the EMEP grid. This resulted in location errors for point sources. Since this submission, the point sources were exactly assigned to the EMEP grid without intermediate step. In the LPS reporting we re-evaluated the GNFR codes. These two corrections result in an alignment between the gridded data and LPS reporting for A_PublicPower, B_Industry, E_Solvents, D_Fugitive and J_Waste.

Nevertheless, several cases remain where LPS emissions in a certain grid cell exceed the gridded emissions total in that same grid cell. This is caused by the fact that the gridded data are based on point source locations (of the emission points) whereas the LPS reporting is based on facility level in the EU registry. That is why in several cases the emissions are assigned to a neighbor grid cell.

In the Walloon region, the geographical coordinates are now the same for the LPS, the gridded data and the E PRTR registry.

10.2.3. GNFR C: Other stationary combustion

The sector GNFR C includes the emissions from the combustion in the commercial, the residential and agriculture sectors. The methods for gridding emissions per region are summarised in Table 10-3.

Table 10-3. Tier method and surrogates used for gridding of emissions in GNFR sector C Other stationary combustion

GNFR	NFR	Tier	surrogates for gridding		
			Flanders	**Brussels**	**Wallonia**
C_OtherStationaryComb	1A4ai	Tier 2	energy balance per municipality (or the Flemish energy balance in the case of coal, waste, lamp petroleum, biogas and sludge disaggregated according to the "Floor area" combined with land use.	Office surfaces	energy balance of each municipality distributed on commercial and institutional surface by municipality

C_OtherStationaryComb	1A4bi	Tier 2	Energy consumption per municipality disaggregated according to "Residential Floor Area"; the residential floor area map. Since the fuel types used vary greatly according to the character of the region (rural versus urban), 3 variants of the map were derived.	Population data	Energy balance of each municipality distributedon residential building area
C_OtherStationaryComb	1A4ci	Tier 2	A part of the emissions are distributed based on landuse/landcover data (sub-sector dependent). Another part of the emissions originates form point sources (XY)	-	Emissions are distributed on the basis of the agricultural plot distribution.

In Brussels Capital Region, there are emissions for sectors 1A4ai and 1A4bi. The distribution of emissions for the commercial sector is based on the office surfaces per municipality since service sector represents the main activity of the tertiary sector in the region. Regarding the residential sector, the distribution is based on the population data.

In Wallonia, the emissions are gridded by using the energy balances by municipality. The distribution of emissions is made on the E-PRTR plants locations and on the commercial and institutional surface by municipality (1A4ai), on the basis of the residential buildings locations (1A4bi) and on the basis of the agricultural plots (1A4ci) (1).

In Flanders, the emissions of the commercial/institutional sector (1A4ai), the residential sector (1A4bi) and the agricultural sector (1A4ci) are gridded by the EISSA-B tool.

EISSA-B was developed in 2017 and within this project an update and expansion of the emission inventory due to building heating in the residential, the tertiary and the agriculture and horticulture sector in Flanders was envisaged. On the one hand, the calculation of emissions needed to be performed at a Tier 2 level, implying that the emission factors should not only depend on the fuel type but also on the type and the age of the heating installations. On the other hand, the emissions of the pollutants had to be geographically allocated, both at municipality level and at km² resolution, and this in the most accurate way possible, making use of specific map layers and algorithms. Both, emission calculation and geographical allocation of the emissions was required per fuel type for the residential, the tertiary, and the agricultural and horticultural sector.

To achieve this goal, VITO developed a quantitative database and GIS based model based on EISSys, which is a software framework that, in a continuous process, is being developed within VITO's GEOFlex product line (https://geoflex-solutions.eu/) and of which the EISSA model for POPs, currently already being used by Emissie Inventaris Lucht, is also an application. The newly developed tool was named EISSA-B. Herein, EISSA stands for 'Emission Inventory Support System Air', the platform in which, in the long term, the calculation, geographical allocation and analysis of *all* emissions to air ideally should be brought together. The -B stands for Buildings, as the current application is intended to calculate, allocate and analyse all emissions to air due to building heating.

The EISSA-B tool is a combination of two existing tools, namely WoET and GEOGREMIS. Indeed, in addition to calculation and allocation of emissions due to wood combustion (WoET), emissions due to building heating based on all other fuels (GEOGREMIS) can also be calculated and geographically allocated. However, EISSA-B has been optimized with respect to the existing WoET and GEOGREMIS tools: energy consumption can be imported by the user, additional fuels / pollutants can be added easily, calculations from 1990 have become possible, ... Moreover, the tool has also been updated as compared to the existing tools: the current tool for instance allows to include recent knowledge about environmental legislation, assumptions, emission factors, ... The user-friendly and transparent tool provides results in the form of tables, charts and maps, according to user settings, expectations and specifications (cf. spatial resolution, compatibility with the data warehouse being used by Emissie Inventaris Lucht, ...). Furthermore, in the long term the tool eventually can be used for scenario management.

Prior to the development of the actual tool, a thorough analysis on how to develop the methodological / scientific core for calculating emissions due to building heating was performed. This was essentially done in 4 steps. Initially, the level of detail was determined. This level of detail relates to the substances, the sectors and subsectors, the fuel types and the installation types. Then a methodology was developed to refine the Flemish energy consumption, known per fuel type from the Energy Balance, according to the specified level of detail. In other words, a methodology to assign shares of the Flemish energy consumption to the different installation types within the fleet. In order to allow calculation of emissions starting from the energy consumption, distributed over the installation fleet, in a third phase a compilation of emission factors was made. Finally, the geographical distribution of energy consumption and emissions was completely revised.

Energy consumption for Flanders is disaggregated according to energy consumption per municipality. This is done by means of an Excel tool developed by VITO at sector level in the context of the Covenant of Mayors [http://www.burgemeestersconvenant.eu]. The obtained energy consumption per municipality (or the Flemish energy consumption in the case of coal, waste, lamp petroleum, biogas and sludge; due to no match with the Covenant of Mayors) are then further disaggregated according to the "Floor area" combined with land use (1A4ai). For the residential sector (1A4bi), the residential “Floor area” is used. Since the fuel types used vary greatly according to the character of the region (rural versus urban), 3 variants of the map were derived. In the agricultural sector, a part of the emissions from other stationary combustion practices is based on landuse/landcover data. The selection of parcels based on land use/land cover is sub-sector dependent. In general, the emissions of each agricultural sub-sector are spatially distributed among these selected parcels/area with each hectare of the selected parcels being allocated the same amount of emissions. There is no distinction made between the different fuel types used. Another part of the emissions originates form point sources (XY). The spreading pattern for the point sources differs for each sub-sector and fuel type.

Within this project Flemish emissions due to building heating were calculated and geographically allocated with the EISSA-B tool. This was done for all pollutants, all sectors and all fuel types, for the time window 1990 - 2019.

The review question *BE-GRID-GEN-2020-0001* has been solved by the adjustment of the method of geographic distribution.

The locations of the emissions that are gridded by a detailed spatial pattern are converted to the EMEP grid by means of a datawarehouse.

10.2.4. GNFR D : Fugitive

The sector GNFR D gathers fugitive emissions from different activities involving solid, liquid and gaseous fuels. The methods for gridding the emissions per region are detailed in Table 10-4.

Table 10-4. Tier method and surrogates used for gridding of emissions in GNFR sector D Fugitive

GNFR	NFR	Tier	surrogates for gridding		
			Flanders	**Brussels**	**Wallonia**
D_Fugitive	1B2av	Tier 3	Point Sources	-	Point Sources
	All, except 1B2av	Tier 2	Number of jobs in the particular sector	-	Gas consumption by municipality and gridded on gas canalizations per municipality
		Tier 1	Population	Uniform distribution over Brussels area	-

Brussels Capital Region reports emissions for the distribution of oil products and the transmission and distribution of natural gas. Emissions are uniformly distributed over the regional area since there is no more precise data concerning this sector.

In Wallonia, the locations of the petroleum stocks are known. The 'PICC' data (Mapping project in the Walloon region) (1) are used to localize petroleum stations. Concerning the gas transportation, the emissions are disaggregated by municipality by using gas consumption by municipality as surrogate and then mapped on the municipality with the grid of gas canalizations.

In Flanders, all emissions (except NMVOC and POPs) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. Emissions of NMVOC and POPs are allocated by the EISSA tool, either as point sources or by a spatial pattern. NMVOC and POP emissions are mapped as point sources (1B2c, 1B2aiv), by population (1B2av) and by the number of jobs in the particular subsector (1B2b).

The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

10.2.5. GNFR E : Solvents

The sector GNRF E includes the use of solvent products. Methods for gridding the emissions per region are summarized in Table 10-5.

Table 10-5. Tier method and surrogates used for gridding of emissions in GNFR sector E Solvents

GNFR	NFR	Tier	surrogates for gridding		
			Flanders	**Brussels**	**Wallonia**
E_Solvents	All, except 2G Lubricants (Heavy metals)	Tier 3	Point Sources	-	Point Sources
		Tier 2	number of jobs in the particular subsector	-	-
		Tier 1	Population	Uniform distribution over Brussels area	Population
	2G Lubricants (Heavy metals)	Tier 3	Gridded emissions are included in GNFR F	method from GNFR F	Population

The solvents sector includes a variety of activities. In the Brussels Capital Region, heavy metal emissions from the use of lubricants in road transportation were gridded by the same method as the road transport sector described in the section GNFR F. A simplified method has been chosen to grid emissions from the other activities, being a uniformly distribution over the regional area.

For Wallonia, the emissions coming from the yearly reporting obligation by the industrial companies via the integrated environmental report are located on the basis of the geographic coordinates of the companies. The other emissions mainly coming from domestic solvent use are gridded on the basis of the population data (2).

In Flanders, all emissions (except NMVOC and POPs) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. Emissions of NMVOC and POPs are allocated by the EISSA tool, either as point sources or by an allocation pattern. NMVOC-emissions are mapped as point sources (part of 2D3d, 2D3g, part of 2D3h), by population (2D3a, part of 2D3d) or by number of by number of jobs in the particular sector (2D3f, part of 2D3h). POP emissions are spatialized by number of employees in this particular sector (2D3b) and by population patterns (smoking of tobacco). Emissions of particulate matter and heavy metal emissions (due to firework and smoking of tobacco) are gridded based on the population pattern.
The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

Difference between gridded data (annex v) and total of NFR table (annex I): For Flanders, the emissions of heavy metals from the use of lubricants in the road transportation are allocated under category 1A3b (GNFR F) instead of 2G (GNFR E) for the gridded data. Due to a technical difficulty, the gridded data from 2G could not be separated from the other road traffic emissions in the output of the data warehouse. We are working on a solution so that the emissions can be split up at the next submission.

10.2.6. GNFR F : Road transport

Road transport emissions reported under GNFR F include NFR sectors 1A3bi to 1A3bvii. Methods for gridding the emissions per region are summarized in Table 10-6.

Table 10-6. Tier method and surrogates used for gridding of emissions in GNFR sector F Road transport

GNFR	Tier	surrogates for gridding		
		Flanders	**Brussels**	**Wallonia**
F_RoadTransport	Tier 3	road segments with share of light and heavy traffic and split by urban, rural and highway roads	Combination of road transport information (road structure, mobility data) and specific emissions factors by driving mode from COPERT (highway, rural/suburban and urban)	road segments with share of light and heavy traffic and split by urban, rural and highway roads

The submitted gridded data are based on fuel sold.

Brussels Capital Region uses a combination of road transport information (road structure, mobility data) and specific emissions factors by driving mode from COPERT in order to generate the gridded emissions for GNFR F sector. The first step is to determine mobility data per road according to the 3 driving modes used in COPERT (highway, rural/suburban and urban) in each municipality. For each driving mode, the total emissions at the regional level are affected to a given municipality proportionally to the cumulated mobility data in the municipality compared to the whole Region. Finally, the emissions from the 3 driving modes are summed for each municipality and attributed to the road segment network.

The methodology in Wallonia is similar to the Brussels Capital Region. The emissions are first calculated by road segment of the Walloon road network. These emissions result from a combination of volume of traffic (light and heavy), length and driving mode (urban/rural/highway) of the road segments, and the associated emission factors by driving mode from COPERT. These emissions are then added together within the EMEP gridcells and rescaled to reach the total emissions from NFR-code 1A3b.

In Flanders, also the split by driving mode from COPERT is used to generate gridded data of the road transport sector. The COPERT-calculated emissionsare distributed along the road network of Flanders, for which the share of total traffic volumes is known per road segment, disaggregated for light and heavy traffic. The emissions from CAR + LDV + L-category are spread according to the share of light traffic on the road segments, whereas HDV and BUS / Coach emissions according to the share of heavy traffic. In addition, for every road segment the driving mode is known, so COPERT emissions by driving mode are attributed accordingly.

Difference between gridded data (annex V) and total of NFR table (annex I): For the assignment, split factors emissions/road segment are calculated in a data warehouse. Due to rounding off during this calculation it is possible that a slight difference occurs between the total gridded data of the road transport sector and the sum of totals of the NFR-codes 1A3b reported in annex I. For Flanders, the gridded emissions of heavy metals from the use of lubricants in the road transportation are allocated under category 1A3b instead of 2G. Due to a technical difficulty, the gridded data from 2G could not be separated from the other road traffic emissions in the output of the data warehouse. We are working on a solution so that the emissions can be split up at the next submission.

10.2.7. GNFR G : Shipping

The GNFR G sector includes international inland waterways and national navigation. Methods for gridding the emissions per region are summarized in Table 10-7.

Table 10-7. Tier method and surrogates used for gridding of emissions in GNFR sector G Shipping

GNFR	Tier	surrogates for gridding		
		Flanders	**Brussels**	**Wallonia**
G_Shipping	Tier 3	Amount of tonkm per waterway, geographic dataset of ship movements on shipping routes and in harbours	-	-
	Tier 2	-	Length of the canal	navigable rivers

Brussels Capital Region only reports emissions from sector 1A3dii. Emissions are distributed according to the length of the canal among the Brussels EMEP grid cells. The canal is the only navigable waterway in the region.

In Wallonia, the emissions for inland waterway transport are allocated to the navigable rivers.

For the Flemish Region, the spatialized emissions of the sector G_Shipping are calculated via the EMMOSS model (see also § 3.4.2.4).

Emissions from inland shipping are spread over the length of the navigable waterways. Emissions from maritime shipping (shipping routes mainly in the North Sea that are not part of the EMEP grid, and ports) are distributed in proportion to a geographic dataset of ship movements.

Because a part of the emissions of the sector 1A3di(ii) falls outside the grid attributed to Belgium, a difference between the gridded data and the data reported for the NFR-code 1A3di(ii) in annex I occurs.

10.2.8. GNFR H : Aviation

The GNFR H sector includes emissions from LTO from aviation activities. Methods for gridding the emissions per region are summarized in Table 10-8.

Table 10-8. Tier method and surrogates used for gridding of emissions in GNFR sector H Aviation

GNFR	Tier	surrogates for gridding		
		Flanders	**Brussels**	**Wallonia**
H_Aviation	Tier 3	flight data: EUROCONTROL DDR2 database	Not applicable	flight data: EUROCONTROL DDR2 database

There is no aviation activity in Brussels Capital Region. Brussels International Airport is located in Flanders region.

In Wallonia, the emissions for each airport are allocated to the area of the airports on the grid (two commercial airports and six tourism airports). The LTO areas of the two commercial airports were estimated with the help of Belgocontrol. The emissions of the six airports are allocated to the EMEP cells where the tourism airports are situated.

In the Flemish Region the gridded emission data due to aviation activity are calculated with the EMMOL model. The calculation is based on EUROCONTROL/BELGOCONTROL data from airports and fuel amounts.

LTO emissions consist of different flight phases. For the emissions at the airport itself (landing + taxi in + taxi out + take off), a uniform distribution over the polygon (territory) of the airport was assumed.

For the geographic spread of the LTO sub-phases final approach and climb out, an average spread was calculated based on detailed flight data from the EUROCONTROL DDR2 database. It contains all IFR flights, with a time resolution of a few minutes. By calculating the share of each 1x1 km^2 grid cell for each flight, and then aggregating it over all flights, the average share of each grid cell (1x1 km^2) in the emissions can be calculated.

The processing (separate for zone_approach and zone_climb_out) consists of a number of steps. The main steps are:

1. select all flight segments below 3000 feet (FL <30, the flight altitude limiting the LTO cycles)

2.select the flight segments that fall within a certain radius around the airport

3. divide all selected flight segments over the 1x1 km2 grid

4. determine the sum of the segment lengths for each grid cell; the share of the grid cell in the emissions is the division of this sum of segment lengths by the sum of all segment lengths considered.

Difference between gridded data (annex V) and total of NFR table (annex I): a very small amount of the emissions of military aviation is allocated under 1A3aii(i) (GNFR H) instead of 1A5b (GNFR I). Due to a limitation of de model used, the small amount of the emissions could not be separated.

10.2.9. GNFR I : Off road

Sector GNFR I includes a variety of sectors: industry, agriculture, residential, railways and pipelines transport. Methods for gridding the emissions per region are summarized in Table 10-9.

Table 10-9. Tier method and surrogates used for gridding of emissions in GNFR sector I_Offroad

GNFR	NFR	Tier	surrogates for gridding		
			VLA	**BRU**	**WAL**
I_Offroad-	1A2gvii	Tier 3	-	-	Point Sources
		Tier 2	Pattern based on land use	-	Industrial areas by municipality
		Tier 1	-	Uniform distribution over Brussels area	-
	1A3c	Tier 2	-	-	Railway sections on which the oil-fuelled trains run
		Tier 1	Railway network	Length of railway network per municipality	-
	1A3ei	Tier 3	Point sources	-	Point Sources (gas compression plants)
		Tier 1	-	Uniform distribution over Brussels area	-
	1A3eii (incl. 1A4aii)	Tier 3	-	-	Point Sources (harbours, air ports,..)
		Tier 2	Pattern based on land use	-	-
		Tier 1		Uniform distribution over Brussels area	-
	1A4bii	Tier 2	Pattern based on land use	-	Garden areas by municipality
		Tier 1		Uniform distribution over Brussels area	
	1A4cii	Tier 2	Pattern based on land use	-	Agricultural plots and Sector Plan covering forests and parks
		Tier 1		Uniform distribution over Brussels area	
	1A4ciii		Not gridded. Emissions take place in the North Sea, outside of BE EMEP grid domain	Not applicable	Not applicable
	1A5b	Tier 3	-	-	Military airports
		Tier 2	Pattern based on land use	-	-

The emissions of the offroad sector in Brussels Capital Region are distributed uniformly over the Region's surface area, except for the NFR sector1A3c for which emissions are distributed using the length of the rail network per municipality.

In Wallonia, the sector 1A2gvii is distributed by using offroad emissions from industrial point sources and the industrial areas by municipality (LPS emissions subtracted). Emissions from sector 1A3c are distributed using railway sections on which the oil-fuelled trains run. The gridding of the sector 1A3ei is based on point sources emissions (gas compression plants, harbours and air ports). The sector 1A4bii is distributed using garden areas (garden areas = residential areas – residential buildings areas) and the sector 1A4cii is distributed using the data of the agricultural plot (3) and the Sector Plan covering forests and parks (4) (5). The sector 1A5b is distributed by using offroad emissions from industrial point sources.

In Flanders emissions are also gridded withdifferent spatial patterns according to the sector. The emissions are distributed using a pattern based on the land use and the degree of industrialization (1A2gvii), harbours (1A3eii), urbanization (1A4bii), agricultural area and forestry (1A4cii) and defense area (1A5b) (Decoene, 2012).
To spread the railways emissions (1A3c) the network of railway segments is used. At the borders of Flanders, the fraction of the railway segment that is situated in Flanders is calculated, and this split factor is used to calculate the fraction of the emissions that can be attributed to Flanders. Due to this methodology it is possible that a slight difference occurs between the gridded railways emission data (annex V) and the total emissions reported in the NFR-code 1A3c annex I).
Emissions reported in the sector 1A3ei are allocated to point sources.
Emissions of military aviation (also reported in 1A5b) are calculated with the EMMOL model. Emissions from Melsbroek military airport are included in the distribution pattern (civil aviation) LTO of Brussels Airport. The emissions from the other military airports are evenly spread over Flanders.
Emissions of national fishing (1A4ciii) are part of the EMMOSS model and are calculated in Flanders. Because all emissions of national fishing take part in the Channel (North Sea), and this sea falls outside the grid attributed to Belgium, the emissions of national fishing are not included in the gridded data.

Difference between gridded data (annex V) and total of NFR table (annex I): a very small amount of the emissions of military aviation is allocated under 1A3aii(i) (GNFR H) instead of 1A5b (GNFR I). Due to a limitation of de model used, the small amount of the emissions could not be separated.

The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

10.2.10. GNFR J : Waste

Sector GNFR J considers the NFR waste sectors. The emissions from municipal incinerators with energy recovery are included in sector GNFR A. Methods for gridding the emissions per region are summarized in Table 10-10.

Table 10-10. Tier method and surrogates used for gridding of emissions in GNFR sector J_Waste

GNFR	NFR	Tier	surrogates for gridding		
			Flanders	**Brussels**	**Wallonia**
J_Waste	All, except 5D1 and 5E	Tier 3	Point Sources		
	5D1	Tier 2	Number of Jobs in the particular sector	-	-
		Tier 1	Population		
	5E	Tier 3	Point Sources (NMVOC, POP)	-	-
		Tier 1	Population		

Brussels Capital Region reports emissions from several activities and according to the sector a different methodology is applied. For composting, cremation and wastewater treatment, the emissions are allocated to the municipality where the installation is located. For sector 5E, corresponding to fires, the distribution of the emissions is based on the population.

In Wallonia, the spatialization of the emissions is based firstly on the location of point sources. This is the case for the E-PRTR plants, the solid waste disposal sites, the incineration and cremation facilities and the composting units. For the emissions of wastewater (5D1) and fires (5E), as it is not related to point sources, the emissions are spatialized following the Walloon municipalities population (2).

In Flanders, all emissions (except NMVOC and POPs) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. Waste incineration facilities have energy recovery, hence the emissions are allocated in the GNFR-sector A_PublicPower. Emissions of NMVOC and POPs are allocated by the EISSA tool, either as point sources or by an allocation pattern. NMVOC-emissions are mapped as point sources (5E) and by number of jobs in the particular sector (5D1). POP emissions are also mapped as point sources (5E and 5C1bv) or by inhabitants in rural areas (5C2).
The emissions due to Open burning of waste and emissions from house and car fires are spread according to the same method that was used to spatialize the off-road emissions by households (pattern based on the land use and the degree of urbanization) (Decoene, 2012).

The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

10.2.11. GNFR K : Agriculture - Livestock

Methods for gridding the emissions per region for GNFR sector K Agriculture – Livestock are summarized in Table 10-11.

Table 10-11. Tier method and surrogates used for gridding of emissions in GNFR sector K_AgriLivestock

GNFR	Tier	surrogates for gridding		
		Flanders	**Brussels**	**Wallonia**
K_AgriLivestock	Tier 3	Point Sources (animal number and manure management system on farm level)	-	Point sources
	Tier 2	-	-	Agricultural plots (point sources subtracted)
	Tier 1	-	Agricultural surfaces	-

Brussels Capital Region reports emissions from agriculture livestock. Emissions are allocated according to agricultural surfaces per municipality.

In Wallonia, emissions of NH_3, NOx, NMVOC and PM coming from the livestock (NFR sector 3B) have been spatially distributed firstly with the location of the intensive agricultural exploitations (pigs and poultry farms) and secondly across the municipalities, thanks to national and regional statistics giving the number of heads by municipalities(6). If there are intensive farms in the municipality, the number of heads of the intensive farms are subtracted from the number of the municipality. The numbers of animals are not available for every year. So we used the latest information available (2019 for cattle, poultry, swine, 2016 for ovines, goats and horses) and these partitions were used with the 2019 regional activity data for Wallonia. Once the emissions of livestock have been calculated by municipality, the agricultural plot has been used to distribute the emissions according to the type of land used (agricultural emissions occur only on crop and pasture) (3).

In Flanders, the emissions (NH_3) are spread following the detailed geographic level of input data (XY-coordinate). the ammonia emissions of manure management are calculated with the EMAV2.1 model (see also IIR Chapter 5). Input data (animal number, manure management system, e.o.) is available on the level of the farm. Therefore the calculation and geographical spreading of the NH_3-emission can occur on this same level (XY-coordinate). The emissions of NO (reported as NOx) and NMVOS are spread according to a pattern of animals per location (XY-coordinate) that originates from the EMAV2.1 model.

10.2.12. GNFR L : Agriculture Other

Methods for gridding the emissions per region for GNFR sector L Agriculture – Other are summarized i Table 10-12.

Table 10-12. Tier method and surrogates used for gridding of emissions in GNFR sector L_AgriOther

GNFR	Tier	surrogates for gridding		
		Flanders	Brussels	Wallonia
L_AgriOther	Tier 3	Point Sources	-	-
	Tier 2	-	-	Agricultural plots
	Tier 1	-	Agricultural surfaces	-

Brussels Capital Region reports emissions from agricultural soils. Emissions are allocated according to agricultural surfaces per municipality.

In Wallonia, emissions of NH_3, NOx, NMVOC and PM coming from the agricultural soils (NFR sector 3D) have been distributed following the same approach as emissions of livestock. The 2019 Belgian statistics provide the agricultural area by municipality. This allows calculations of grazing, manure application and fertilizing emissions by municipality. The sum of these emissions is than distributed thanks to the agricultural plot across the crop and pasture areas (3).

In Flanders, the ammonia emissions coming from agricultural soils (3D) are calculated and geographically spread with the EMAV2.1 model (see also IIR Chapter 5). This calculation and spreading occurs on the level of the farm (XY-coordinate). The emissions of NO (reported as NOx) and NMVOS are spread according to a pattern of manure-N applied, inorganic N-fertilizer applied, or the available cropland/grassland per location (XY-coordinate).

10.2.13. GNFR M : Other

Belgium does not estimate emissions in the GNFR sector M Other.

10.2.14. GNFR N : Natural

Methods for gridding the emissions per region for GNFR sector N Natural are summarized in Table 10-13.

Table 10-13. Tier method and surrogates used for gridding of emissions in GNFR sector N_Natural

GNFR	Tier	surrogates for gridding		
		Flanders	Brussels	Wallonia
N_Natural	Tier 2	Forest and grassland statistics	Not applicable	Forest and grassland statistics

In Wallonia, this sector is distributed using the Sector Plan covering forests.

In Flanders, the emissions of this sector are distributed based on the available cropland/grassland and forest areas in Flanders.

10.2.15. GNFR O : AviCruise

The mapping of the sector “Aviation cruise” wasn’t estimated following the EMEP guidebook: “Emissions from domestic cruise and from international aircraft flights should be excluded from the mapping as these are estimated centrally by EMEP”.

10.2.16. GNFR P : IntShipping

GNFR	Tier	surrogates for gridding		
		Flanders	Brussels	Wallonia
P_IntShipping	Tier 3	geographic dataset of ship movements on shipping routes and in harbours	Not applicable	Not applicable

Emissions of international fishing (1A3di(i)) are part of the EMMOSS model, and are calculated in Flanders. Because all emissions of international fishing take part in the Channel (North Sea), and this sea falls outside the grid attributed to Belgium, the emissions of national fishing are not included in the gridded data.

Emissions from maritime shipping (shipping routes mainly in the North Sea that are not part of the EMEP grid, and ports) are distributed in proportion to a geographic dataset of ship movements.

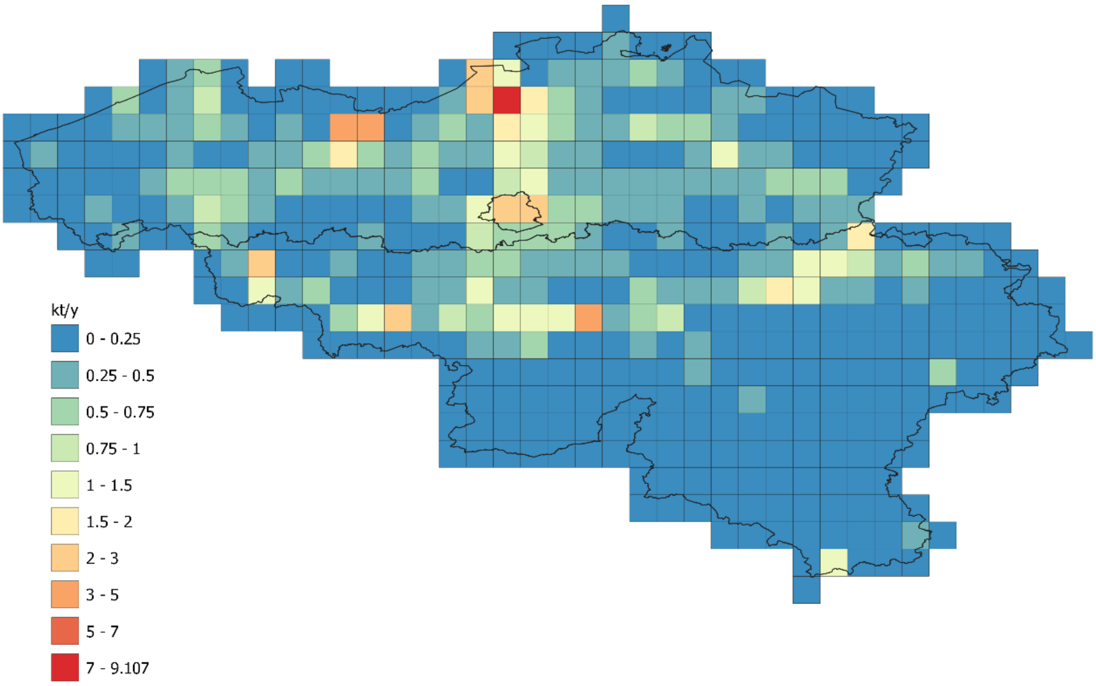
Because a part of the emissions of international maritime navigation (1A3di(i)) falls outside the grid attributed to Belgium, a difference between the gridded data (annex v) and the data reported for the NFR-code 1A3di(i) (annex I) occurs.

10.3. *Gridded emissions: Results*

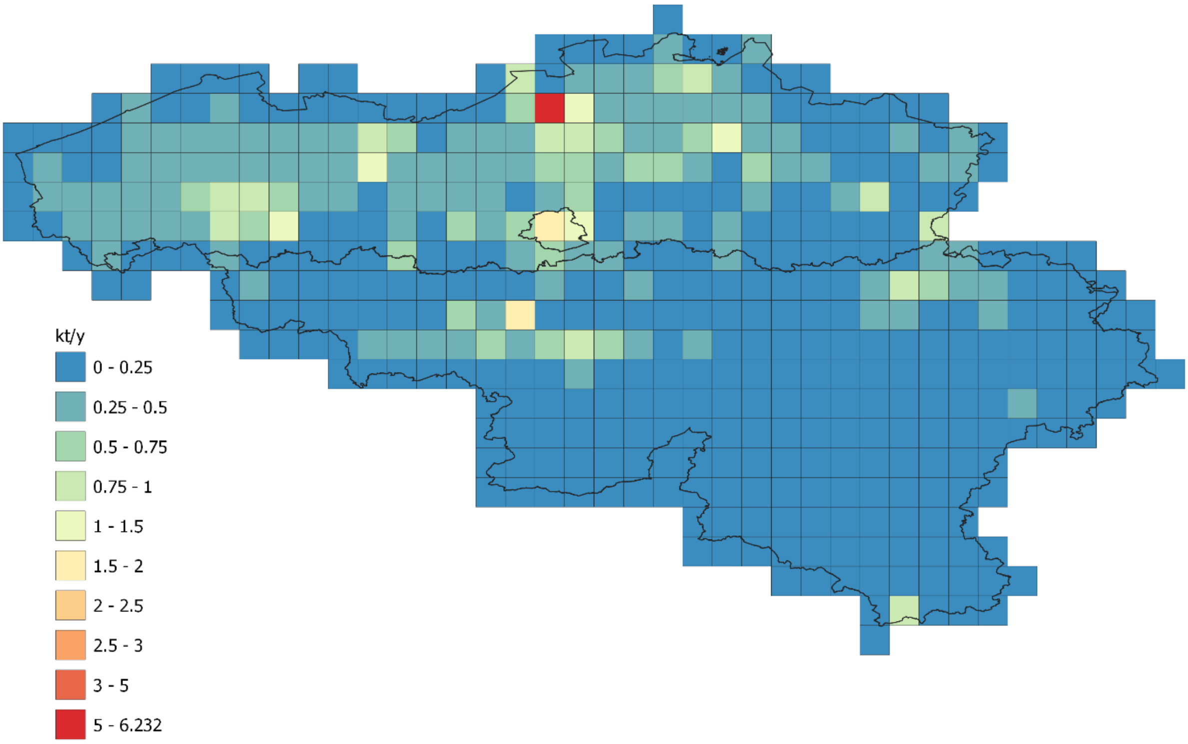
The following figures show the gridded national totals for NO_x, NMVOC, SO_x, NH_3 and PM2.5. In general the largest parts of the emissions are located in the most densely populated regions in the

North of Belgium. Antwerp is a hot spot for most pollutants due to its great industrial, urban and traffic activities. For NH_3, the greatest source is agriculture, with a large activity in the North West of Belgium. Large PM emissions in the Ghent harbour are coming from 1 industrial company.

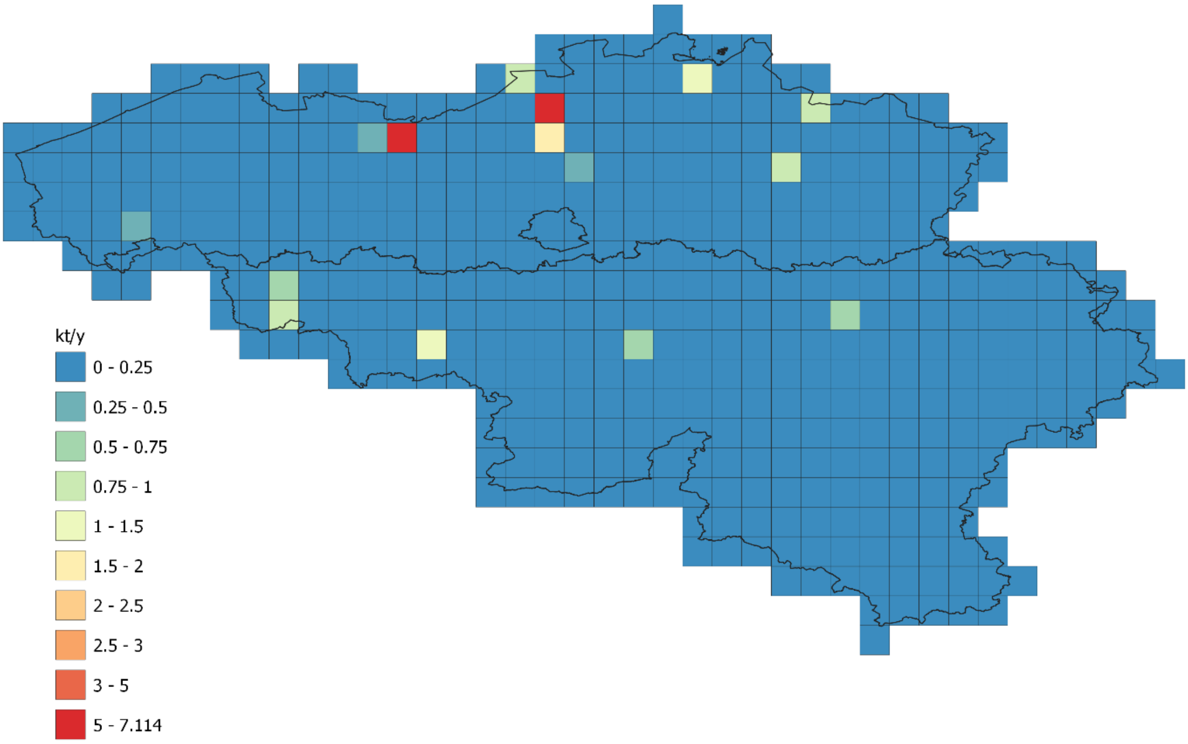
National Total NOx, 2019



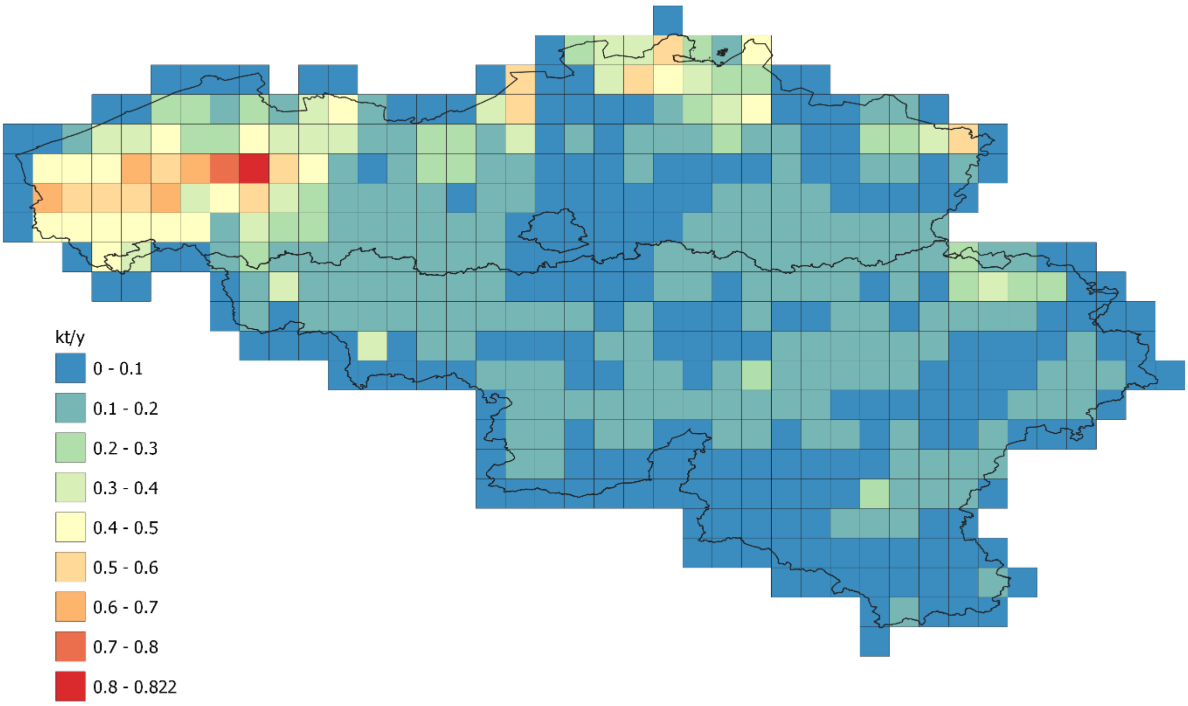
National Total NMVOC, 2019



National Total SOx, 2019



National Total NH3, 2019



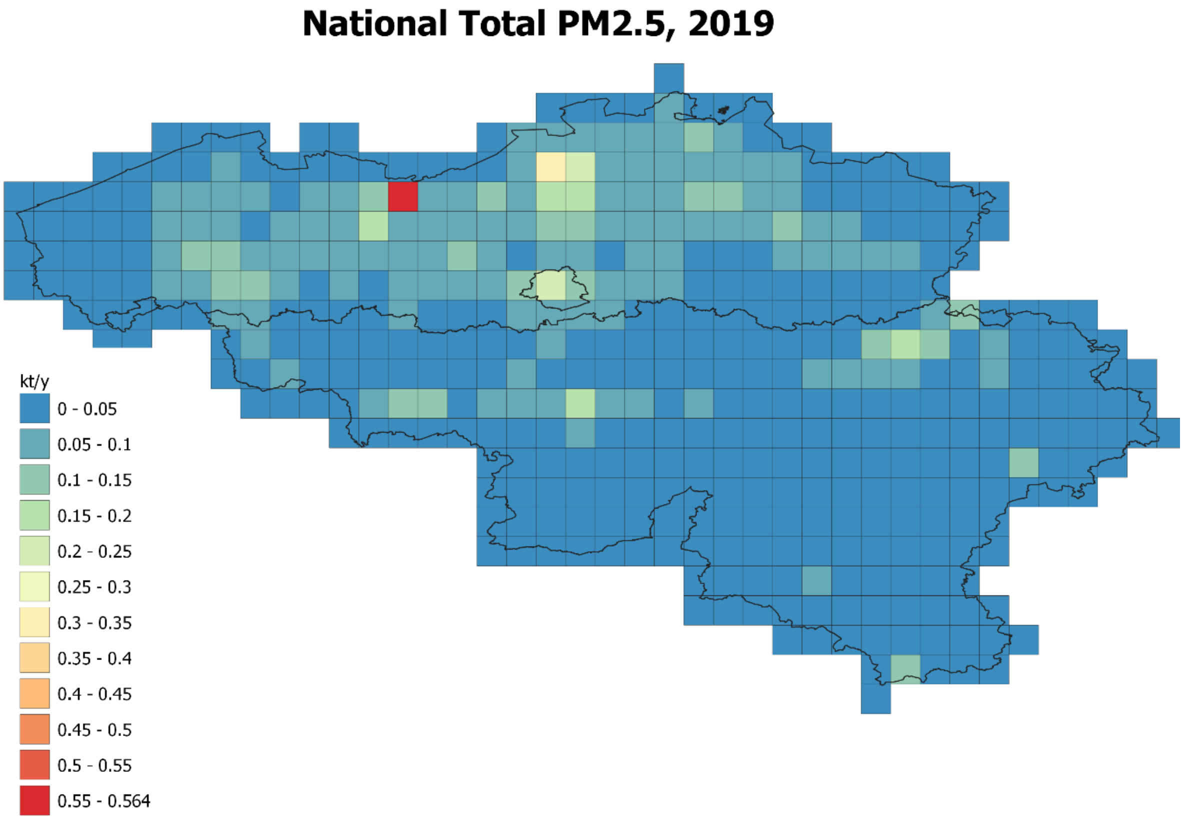


Figure 10-6: Gridded national total emissions for NOx, NMVOC, SOx, NH3 and PM2.5 in 2019.

10.4. *LPS data*

Large Point Sources are defined as facilities whose combined emissions, within the limited identifiable area of the site premises, exceed at least one of the threshold values for the 14 pollutants identified in table 1 of the EMEP Reporting Guidelines. Belgium reported LPS data for 2019 according to this definition, including information on stack height class.

Belgium reported emissions for 2019 from 316 facilities, of which 229 in Flanders, 2 in the Brussels Capital Region and 85 in Wallonia. Most facilities are from the industrial or agricultural sectors. All the Walloon agricultural plants under the PRTR are now reported as LPS (21 plants).

With regard to review question BE-LPS-E-2020-0001, emissions with sub-threshold values for PRTR and/or LPS, are included in NECD reporting and were not retained in LPS reporting. This approach is applied for all emissions of pollutants which have sub-threshold values for LPS/PRTR.

The LPS emissions are used directly in the national inventory (NECD). There is no divergence between LPS and the NECD (BE-LPS-GEN-2020-0002).

For the LPS reporting, only those emissions above the threshold are reported. Under the NECD all emissions are reported (BE-LPS-E-2020-0001).

In response to the review question BE-GRID-GEN-2020-0002 we made corrections to both LPS reporting and reporting of the gridded data. For more information see section 1.2.2. GNFR B: Industry.

Table 10-14: Share of National Total emissions as covered by LPS emissions (BE-LPS-GEN-2020-0006)

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH3	PM2.5	PM10	CO	Pb	Cd	Hg	PCDD/PCDF	PAHs	HCB	PCBs
	kt	kt	kt	kt	kt	kt	kt	t	t	t	g I-Teq	t	kg	kg
National Total Emissions														
Belgium (2019)	160.22	112.82	29.50	66.50	18.41	27.38	369.02	14.59	1.19	1.03	29.04	6.71	3.07	14.26
LPS Emissions														
Belgium (2019)	39.05	16.82	25.09	2.95	1.17	1.92	198.00	7.07	0.30	0.63	7.19	0.32	0.62	13.83
Flanders (2019)	21.58	12.50	19.99	1.55	0.63	1.10	180.66	6.13	0.21	0.18	4.88			
Wallonia (2019)	17.31	4.20	5.10	1.40	0.54	0.83	17.34	0.94	0.10	0.45	2.32	0.32	0.62	13.83
Brussels (2019)	0.16	0.12												
Share LPS as % of National Total Emissions														
Belgium (2019)	24.37	14.91	85.05	4.43	6.36	7.02	53.66	48.47	25.49	61.46	24.77	4.79	20.34	96.99
Flanders (2019)	13.47	11.08	67.75	2.33	3.41	4.00	48.96	42.04	17.50	17.27	16.79			
Wallonia (2019)	10.81	3.73	17.30	2.10	2.95	3.02	4.70	6.43	8.00	44.20	7.98	4.79	20.34	96.99
Brussels (2019)	0.10	0.10												

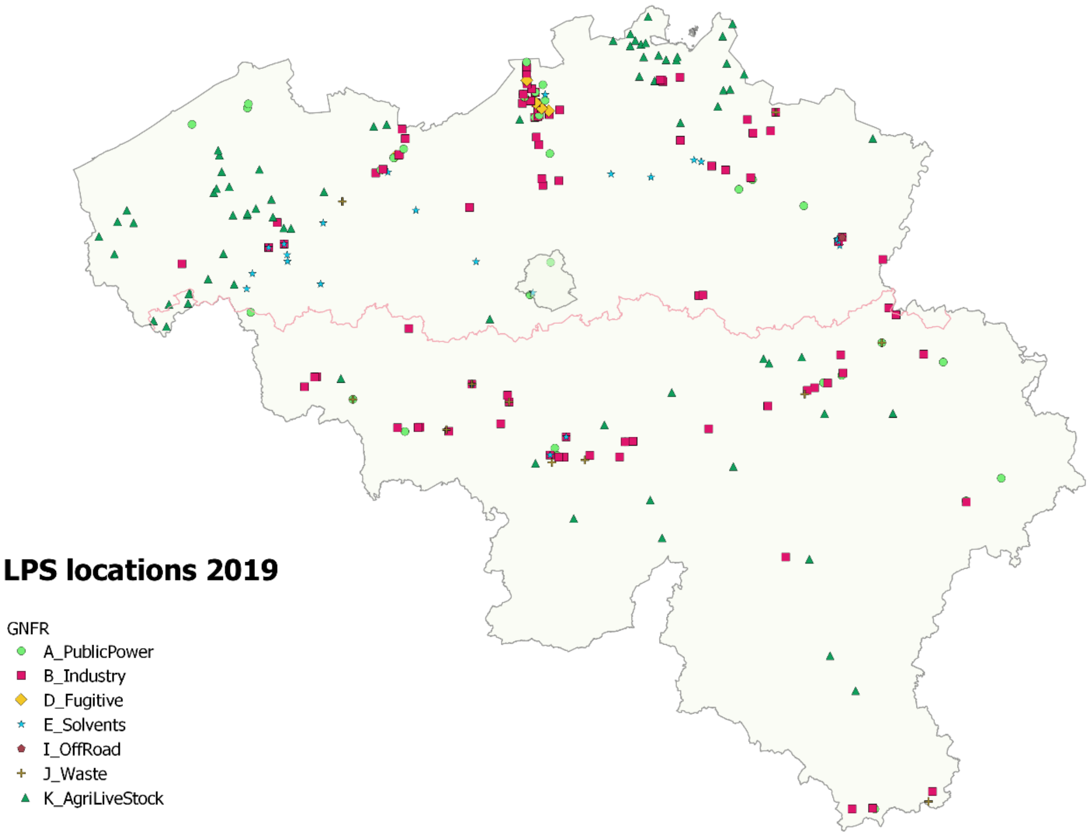


Figure 10-7: Location of LPS in 2019

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Chapter 11. **Adjustments**

11.1. ***Adjustments - summary***

Belgium signed and ratified the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level ozone (Gothenborg Protocol) and Belgium as EU Member State adopted the National Emission Ceiling Directive (2001/81/EC) in 2001, in 2016 replaced by the revised NECD (2016/2284/EU). Hereby, Belgium committed itself to national emission reductions for SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$ in accordance with tables A and B in Annex II of the NECD. The commitments are reproduced in Table 11-1. Belgium has not yet ratified the amended Gothenburg Protocol (2012).

Table 11-1 National emission reduction commitments Belgium under NECD

	SO_2	**NO_2**	**NMVOC**	**NH_3**	**$PM_{2.5}$**
For any year from 2020 to 2029	43 %	41 %	21 %	2 %	20 %
For any year from 2030	66 %	59 %	35 %	13 %	39 %
***compared with 2005**					

Table 11-2 summarizes the emission totals, based on fuels used, for 2005 and 2020. Belgium fulfils the commitment under the NECD for 2020 for all pollutants and reports emissions below the 2030 emission cap for NO_x, NH_3 and $PM_{2.5}$ already.

Table 11-2 Compliance checking with NECD

	SO_2	**NO_2**	**NMVOC**	**NH_3**	**$PM_{2.5}$**
Emissions 2005 [Gg]	142.97	299.11	150.16	79.58	33.57
Reduction commitment (2020 – 2029)	43 %	41 %	21 %	2 %	20 %
Reduction commitment (2030 –)	66 %	59 %	35 %	13 %	39 %
Emission cap (2020 – 2029) [Gg]	81.49	176.47	118.63	77.99	26.86
Emission cap (2030 –) [Gg]	48.61	122.63	97.61	69.23	20.48
Emissions 2020 [Gg]	24.11	131.08	112.49	67.91	16.57

Belgium submits no new applications for adjustments.

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