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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Table of contents

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 2018 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 emissionsThe 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 NFR14-2 templates provided by the EMEP Centre on Emission Inventories and Projections[1] were used. The submission of 15 February 2018 contains emissions from 1990-2015 (recalculated) and 2016 (first reporting) as well as activity data. Emission projections for 2020, 2025 and 2030 were provided 15 March 2017. The 2018 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 2017 NECD review were carefully studied and implemented in the extent possible. The major recalculations and plans for improvement are summarized here. The table resumes the recommendations of the TERT with the reference where to find more information in the IIR regarding the follow up.

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

- Road transport emissions were calculated with COPERT IV v11.4. In the Brussels Capital Region, mobility data was updated for the whole timeseries.
- The emissions of aviation are recalculated in Wallonia with the eurocontrol data and the aircraft types by airport.
- The Wood Emission Tool in Flanders is optimized, updated and expanded to other fuels than wood. The emission model calculates the emissions (from the burning of wood, and other fuels) by the residential sector, the tertiary sectors and agriculture and horticulture.
- The EMAV model in Flanders to calculate emissions from agriculture has been updated.
- Methodologies and emission factors were updated to the Guidebook 2016 instead of Guidebook 2013 if it was not yet implemented in the 2017 submission.

[1] www.ceip.at

- To continue the quality improvement, the notation keys are continuously monitored and corrected when needed.

- Recommandations of the NECD review 2017 were taken into account and implemented in the extent possible (see next Table)

Other smaller recalculations are described in the sector chapters.

Plans for improvement

- Efforts will be made in the road transport sector to prepare and customize input and tools to calculate emissions with COPERT 5. The adaptation of the 'fleet' model to take into account the vehicle categories of COPERT5 is the first step
- Studies or surveys will be started in the three regions to estimate consumption of wood and/or optimize the stove park

- In Flanders, the emission estimation of industry in the collective was will be investigated in the future in order to take into account abatement technologies

- In Wallonia, a revision of the emissions from the key sources in the Industrial sector will be made in order to move from Tier 1 to Tier 2

Other improvements are described in the sector chapters.

Table 0-1 Recommendations from TERT in NECD Review 2017

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Follow-up
BE-0A-2017-0001	Yes	0A National total - National total for the entire territory - Based on fuel sold/fuel used, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 1990-2015	For 0A National total - National total for the entire territory - fuel sold/fuel used, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, Liquid fuels 1990-2015 the TERT noted that emissions estimated based on fuel sold and used for calculating the total emissions is significantly different (e.g. 14% higher in 2015) to the estimate provided as a memo item on fuel used. During the review, Belgium explained that the difference in emissions based on fuel used and fuel sold is due to the road transport sector. Since the 2015 submission, the emissions are reported as "fuel sold". The fuel sold emission values are obtained by scaling up all the emissions with a specific scaling factor per year and per fuel. The scaling factor is obtained by dividing for each year and given fuel (Gasoline, Diesel and LPG), the total amount of fuel from the federal fuel balance report (FOD/SPF Mobility & Transport) by the total fuel used of the 3 regions. Belgium indicated that there is a description of the method in the IIR, paragraph 3.4.2.1. The memo item 1A3 includes the sum of road transport and other transport sectors (1A3ai(i) + 1A3aii(i) + 1A3bi-v + 1A3c + 1A3di(ii) + 1A3dii) based on fuel used. The TERT recommends that Belgium include some explanation on the reason for the differences between the fuel sold and fuel used as the differences are so large in future submissions.	no	3.4.2.1 Road transport, p79
BE-1A1-2017-0001	Yes	1A1 Energy Production, SO_2, NO_X, $PM_{2.5}$, 2005-2015	For NFR 1A1 Energy production (including waste incineration with energy recovery) and 1A2 Stationary Combustion in Manufacturing Industries and Construction for years 2005-2015, the TERT noted that Belgium is estimating NO_X, SO_2 and TSP emissions using annual emissions reported by operators on the basis of stack measurements. When continuously measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED and have used validated average values (after having subtracted the value of the confidence interval) although this subtraction must not be applied in the context of reporting annual emissions. In response to a question raised during the review, Belgium admits that misinterpretation of the IED and use of validated average values (after subtracting the value of the confidence interval) could occur in operators annual reporting. Belgium has already contact the concerned operators and plan to discuss this point with them and make recalculations if necessary in the next submission. In the opinion of the TERT, bottom-up data based on the "validated average values" defined in the IED	no	3.2.2.1 Public electricity and heat production, p49

			cannot be used by the inventory team without adjustment in the framework of a national inventory. The TERT notes that this issue relates to an underestimate, which could correspond to 20% of SO_2, 20% of NO_X, 30% of dust of the sector (depending on the fraction of the operators subtracting confidence interval). The TERT recommends that Belgium continue its discussion with operators to clarify whether any are reporting emissions on the basis of the validated average values and if necessary to derive a methodology to adjust the national emissions over the time series in order to compensate for any under reporting.		
BE-1A1a-2017-0002	Yes	1A1a Public electricity and heat production, NO_X, 2000-2015	For 1A1a Public Electricity and Heat Production, NO_X, 2000-2015, the TERT noted that in the IIR, page 51, table 3-4 presents NO_X EF for 1A1a in the Flemish region in g/MWhe. This unit is not commonly used in inventories and is difficult to compare with other countries or the 2016 EMEP/EEA Guidebook since specific outputs would be needed for the purpose of conversion into g/GJ. Moreover, the TERT understands from table 3-5 that there may be consumption of wood in 1A1a in the Flemish region and that no EF is presented in the IIR. In response to a question raised during the review, Belgium explained that all NO_X emissions from power plants producing electricity are measured continuously, including the power plants using wood. Belgium indicated that the paragraph in the IIR should be deleted, as no EF in g/Mwhe is used, except for turbojets, where the EF 3,000 g/Mwhe (based on measurements) can be converted to 197 g/GJ (only some hours per year are authorised). The TERT agreed with the explanation provided by Belgium. The TERT notes that this issue does not relate to an over or under estimation and recommends that Belgium updates its IIR with correct information in its next submission. The provision of NO_X implied EF based on measurements would also be appreciated in the IIR.	no	3.2.2.1 Public electricity and heat production, p50
BE-1A1a-2017-0003	Yes	1A1a Public electricity and heat production, SO_2, 2000-2015	For 1A1a Public Electricity and Heat Production, SO_2, 2000-2015, the TERT noted that for the Flemish region, the IIR page 51 states that 'the calculation of SO_2 emissions originating from installations not equipped with continuous measurements is not applicable: it concerns gas turbines, CHP (combined heat and power), gas motors or turbojets'. The TERT understands that Belgium considers the SO_2 EF to be zero for fuel with very low sulphur content. In response to a question raised during the review, Belgium explained that fuels with low sulphur content are natural gas in gas turbines, CHP and gas motors and lamp oil in turbojets. For other fuels, no EFs are used because SO_2 emissions are measured continuously. Belgium highlighted a national study which showed that the natural gas consumed contains very little sulphur (source: Eandis), so	no	3.2.2.1 Public electricity and heat production, p50-51

			almost no SO_2 is released during combustion. The TERT acknowledged the explanation provided by Belgium and that any emission would be below the threshold of significance. However, the TERT noted that there are still emissions and therefore there is an under-estimate of SO_2 emissions from natural gas and lamp oil in the Flemish region. The TERT recommends that Belgium considers adding SO_2 emissions from natural gas and lamp oil in the Flemish region in its next submission or provide a clear justification of sulphur free content of natural gas and lamp oil in its IIR.		
BE-1A1a-2017-0004	Yes	1A1a Public electricity and heat production, SO_2, NO_X, $PM_{2.5}$, 2015	For 1A1a Public Electricity and Heat Production, SO_2, NO_X, $PM_{2.5}$, 2015, Belgium presents in its IIR, page 50, table 3-1 a share of regional emissions of NO_X, SO_2 and TSP compared to national emissions for year 2015. The TERT observes that the Flemish region is prominent for NO_X (66%) and SO_X (75%) but this order is reversed for TSP where the Walloon region becomes prominent with 74% of the emissions. In response to a question raised during the review, Belgium explained that in the Walloon region, the emission data are mainly based on environmental annual reports submitted by the operator. For small CHP (combined heat and power) installations < 50MWth, there are no plant specific data and 2016 EMEP/EEA Guidebook emission factors are used to calculate emissions (172 g/GJ wood for TSP - table3-7 2016 EMEP/EEA Guidebook). In Flanders, the emissions data are provided by the operators and no wood is burnt in these CHP installations. The TERT agreed with the explanation provided by Belgium. The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Belgium includes these explanations in the IIR to improve transparency in its next submission.	no	3.2.2.1-Public electricity and heat production, p49
BE-1A1a-2017-0005	No	1A1a Public electricity and heat production, $PM_{2.5}$, 2010	The TERT noted that in the NFR tables, for NFR 1A1a Public Electricity and Heat Production, 2010, emissions of $PM_{2.5}$ appear to be an outlier in the time series. In response to a question raised during the review, Belgium explained that in 2009 and 2010, in the Walloon region, the amount of wood in one wood boiler (>50 MW) was incorrect and the consumption of this plant was over-estimated in the inventory. This led to an under-estimation of the amount of wood burnt in small installations which have a much higher $PM_{2.5}$ emission factor. During the review, Belgium provided a revised estimate for years 2009 and 2010 for all the NECD pollutants. The TERT agreed with the revised estimate provided by Belgium. The TERT recommends that Belgium includes the revised estimate in its next submission.	RE	RE included: 3.8 Recalculations and improvements, p92
BE-1A1b-	Yes	1A1b Petroleum	For 1A1b Petroleum Refining, SO_2, 2009-2010, the TERT noted that in the NFR	no	3.2.2.2-Petroleum refining,

2017-0001		refining, SO_2, 2009-2010	tables emissions are not consistent across the time series. SO_2 emissions are around 20 kt until 2009 and fall to around 6-8 kt from 2010 onwards. In the same time, fuel consumption looks stable. Thus, the SO_2 implied EF show a decrease between 2009 and 2010 and no explanation is given in the IIR. In response to a question raised during the review, Belgium explained that from 1st 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. The TERT agreed with the explanation provided by Belgium. The TERT notes that the issue does not relate to an over- or under-estimate and recommends that Belgium includes this explanation in its next IIR submission in order to improve transparency.		p62
BE-1A1b-2017-0002	No	1A1b Petroleum refining, NH_3, 2015	The TERT noted in 2015 NFR table, for category 1A1b Petroleum Refining, that NH_3 emissions are reported as NE. The TERT noted that for all other years of the period 2005-2014, NH_3 emissions for this category have been estimated in the NFR tables and thus understands that Belgium has a methodology to estimate these emissions. In response to a question raised during the review, Belgium explained that NH_3 emissions are estimated using a single annual measurement and that in 2015, there was no measurable presence of NH_3 registered by the equipment. The TERT acknowledges the explanation provided by Belgium. The TERT notes that the issue is far below the threshold. However, the TERT recommends that Belgium ensures that it can make reliable estimates by applying expert judgement and some form of interpolation or averaging when measurements are not providing the expected results. The TERT also recommends that Belgium provide some additional explanation about the measurements made, their reliability and back-up approaches to ensuring a complete estimate.	no	3.2.2.2-Petroleum refining, p62
BE-1A1c-2017-0001	No	1A1c Manufacture of solid fuels and other energy industries, NH_3, NMVOC, $PM_{2.5}$, 2015	The TERT noted in 2015 NFR table, for category 1A1c Manufacture of Solid Fuels and Other Energy Industries, that NMVOC, NH_3 and $PM_{2.5}$ emissions are reported as NE. The TERT noted that for all other years of the period 2005-2014, these emissions for this category have been estimated in the NFR tables and thus understands that Belgium has a methodology to estimate these emissions. In response to a question raised during the review, Belgium explained that emissions in 1A1c are from the last coke oven in Wallonia which closed in 2014. Belgium also pointed out a mistake in the IIR where it should be written that the	no	3.2.2.3-Manufacture of solid fuels, p62

			last oven closed in 2014 and not in 2010. Belgium also mentioned that in 2015 there is still a coke oven in Flanders but the emissions are included in 2C1 Iron and Steel Production. The notation key in NFR 1A1c will be corrected to IE instead of NE in the next submission. The TERT agreed with the explanation provided by Belgium. The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Belgium clarifies its IIR and uses the correct notation keys in the NFR tables in the next submission.		
BE-1A2c-2017-0001	Yes	1A2c Stationary combustion in manufacturing industries and construction: Chemicals, NO_X, 2014-2015	The TERT noted that in the NFR tables, for NFR 1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals, NO_X implied EF is not consistent through the time series. The NO_X IEF is around 50-75 g/GJ from 2005 to 2013 and rise to 108 g/GJ in 2014 and 2015. The TERT observes no change in the fuel mix (mainly gaseous fuels are consumed). There is no specific explanation in the IIR explaining this rise in NO_X emissions. In response to a question raised during the review, 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 2013 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 from the component estimates from the remaining energy consumption. The TERT thinks that this approach leads to over-estimation where 'default NO_X factor' (EMEP or VLAREM) is applied because the fuel consumption for plant with abatement technology and emissions below threshold is not subtracted. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Belgium revises its methodology in order to avoid IEF variation due to a bias in	no	3.3.2.2 - Category 1A2b to 1A2e, p68

			the approach chosen. The TERT recommends that Belgium: (1) identifies operators with abatement technologies that are under the threshold for annual emissions reporting; (2) subtracts the corresponding consumption from the energy balance; (3) applies to this consumption an appropriate EF corresponding to their real abated emissions (based on previous annual reports or direct annual contact with operators), and estimates emissions for both the plant specific and remaining energy consumption.		
BE-1A3ei-2017-0001	No	1A3ei Pipeline transport, SO_2, NH_3, NMVOC, $PM_{2.5}$, 2000-2015	For 1A3ei Pipeline transport, gaseous fuels, SO_2, NMVOCs and $PM_{2.5}$, years: 2000 - 2015, in response to a question raised during the review Belgium explained that in Flanders pipeline NMVOC emissions are reported in 1A3eii Other. During the review week, Wallonia and Brussels provided estimates of NMVOCs, SO_2 and $PM_{2.5}$ for 2005 and 2015 for 1A3ei. However, a complete revised estimate was not provided. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that emission estimates for this source are completed and included in future submissions.	no	3.4.2.5 Other transportation, p91
BE-1A4bi-2017-0002	Yes	1A4bi Residential: Stationary, SO_2, 2007-2008	For 1A4bi Residential: Stationary, SO_2, 2007-2008, the TERT noted in the NFR tables SO_2 emissions are not consistent through the time series. SO_2 emissions are around 16-18 kt until 2007 and fall to around 7-10 kt from 2008 onwards. In the same time, fuel consumption increases between 2007 and 2008. Thus, the SO_2 implied EF shows a decrease between 2007 and 2008 and no explanation is given in the IIR. In response to a question raised during the review, Belgium explained that 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. The TERT agreed with the explanation provided by Belgium. The TERT noted that the issue does not relate to an over- or under-estimate and recommends that Belgium includes this explanation in the next submission of its IIR.	no	3.5.2.2 - Residential Stationary, p96
BE-1B1b-2017-0001	No	1B1b Fugitive emission from solid fuels: Solid fuel transformation, SO_2, 2005-2015	For category 1B1b Fugitive Emission from Solid Fuels: Solid Fuel Transformation, SO_2 for all years the TERT noted that a reallocation of emissions apparently took place between 1B1b and 1A1c Manufacture of Solid Fuels and Other Energy Industries without a supporting description in the IIR. SO_X and NMVOC emissions seem to have been reallocated between the 2016 and 2017 submission. As an example, for the 2005 emissions the reported emissions in 1B1b are 5.03 kt in 2016 reporting, and 0.37 kt in 2017 reporting, a decrease of 4.67 kt. At the same time, SO_X emissions for 2005 in 1A1c were increased by	no	3.7.1 - Solid fuel transformation, p101

			4.67 kt between the two submissions. In response to a question raised during the review, Belgium explained that the last coke oven closed in 2014 (not in 2010 as indicated in the IIR) but the reason for the reallocation of emissions between the submission was not clear. The TERT recommends that Belgium explains the reason for this apparent reallocation of emissions between 1A1c and 1B1b in the IIR for the next submission.		
BE-1B2aiv-2017-0001	No	1B2aiv Fugitive emissions oil: Refining / storage, NMVOC, 2005-2015	For category 1B2aiv Fugitive Emissions Oil: Refining/Storage and pollutant NMVOC for all years the TERT noted that there is a lack of transparency regarding the way emissions are calculated in the IIR. In response to a question raised during the review, Belgium explained that emissions are taken from the environmental reports of the 4 refineries in Belgium, and that the reports contain many detailed information that are confidential. The TERT recommends that Belgium highlights that the methods are based on the confidential environmental reports and provides some non-confidential information that illustrates that the methods are comparable to those suggested in the 2016 EMEP/EEA Guidebook.	no	3.7.2.1 Refineries, p101
BE-1B2av-2017-0001	No	1B2av Distribution of oil products, NMVOC, 2005-2015	For category 1B2av Distribution of Oil Products and pollutant NMVOC for all years the TERT noted that there was a lack of transparency with regard to the methodology applied to estimated emissions. In response to a question raised during the review, Belgium explained that different methods were applied for the 3 regions. The TERT partly agreed with the explanation, since the TERT noted that significant methodological differences exist between the regions, and that the emission factors between the regions are more than a factor 5 different in 2015. The emission factor applied in Wallonia is higher than the Tier 1 emission factor from the 2016 EMEP/EEA Guidebook, therefore it implies that Stage I controls have not been implemented everywhere. The latter is already in legislation since the mid-1990s (Directive 94/63/EC), which means emissions are likely to be over-estimated in Wallonia. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Belgium develops an improved methodology at least for Brussels and Wallonia regions, taking into account the introduction of legislation and new technologies over time.	no	3.7.2.2 Service stations, p102
BE-2A2-2017-0001	Yes	2A2 Lime production, NO_X, 2005-2015	For category 2A2 Lime Production and pollutant NO_X for 2004 and 2005 the TERT noted that emissions were around 50% higher than for other years, while the activity data did not show this increase. In response to a question raised during the review, Belgium explained that the higher NO_X emissions are	no	4.2.1.2-Lime production, p108

			explained by production of over-burned dolomite during these two years. In addition, Belgium explained that since 2006 there has been a modification of the cooking level of this dolomite following a change of the customer specification, leading to lower NO_X emissions. The TERT agreed with the explanation provided by Belgium and recommends that Belgium include this explanation in the IIR.		
BE-2B2-2017-0001	No	2B2 Nitric acid production, NH_3, 2008-2011	For NH_3 from 2B2 Nitric Acid Production the TERT noted that implied emission factors decreased drastically for the years 2008-2011. In response to a question raised during the review, Belgium explained that NH_3 has been omitted from one nitric acid plant for 2002-2011. Belgium provided a revised estimate for 2002-2011 (i.e. 2005 and 2010) and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Belgium. The TERT recommends that Belgium includes the revised estimate in its next submission.	RE	4.2.2.2- Nitric acid production, p111
BE-2C1-2017-0001	Yes	2C1 Iron and steel production, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2000-2015	For $PM_{2.5}$ emissions from the BOF steel production in Wallonia in 2005 the TERT notes that in response to a technical correction at the end of the review Belgium provided a revised estimate. This estimate is based on measurements from 2006-2011 and aligns the emission data across the time series inconsistency (2005 to 2006). This revised estimate is 403 Mg higher than the technical correction prepared by the TERT and brings the correction just below the threshold of significance (2 % of national total). When asked during the review, Belgium failed to justify for the absence of NMVOC emissions from the sinter plants in Wallonia. Belgium now explained that these emissions are included in the sector 1A2a as these emissions are the sum of combustion and process emissions. The TERT accepts both the revised estimate and the explanation of the allocation of NMVOC emissions and recommends that Belgium includes these in the next NFR/IIR submission.	RE	4.2.3.1- Iron and steel production, p113-114
BE-2C2-2017-0001	No	2C2 Ferroalloys production, SO_2, NO_X, $PM_{2.5}$, 2000-2015	For NFR category 2C2 Ferroalloys Production the TERT noted that in response to a question raised during the review Belgium explained that SO_2, NO_X and CO emissions are not available from the producer for the years 2008-2015. Belgium also explained that particle emissions from ferroalloys production cannot be separated from other production processes and are therefore included under NFR 2C1 Iron and Steel Production. The TERT noted that the issue is below the	no	4.2.3.2- Ferroalloys production, p114

			threshold of significance for a technical correction. The TERT recommends that Belgium completes the time series by estimating emissions for 2008-2015, e.g. using IEFs, AD and an abatement efficiency for the desulphurisation installation. The TERT also recommends that Belgium uses the proper notation keys for particle emissions (i.e. IE) and includes information in the IIR on where particle emissions are allocated.		
BE-2C3-2017-0001	No	2C3 Aluminium production, SO_2, NO_X, $PM_{2.5}$, 2000-2015	For NFR category 2C3 Aluminium Production in response to a question raised during the review Belgium explained that NO_X and SO_2 emissions for 2009-2015 and 2004-2015 respectively are unavailable from the producers. Belgium also explained that particle emissions from aluminium production are included under NFR 2C7c Other Metal Production. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT notes that emissions from both primary and secondary aluminium production should be reported under NFR category 2C3 and recommends that Belgium allocates particle emissions from all aluminium production to the proper NFR category 2C3. The TERT further recommends that Belgium completes the time series by estimating NO_X and SO_2 emissions for 2009-2015 and 2004-2015 respectively, e.g. using IEFs and AD.	no	4.2.3.3- Aluminium production, p114
BE-2D-2017-0001	No	2D Non energy products from fuels and solvent uses, $PM_{2.5}$, 1990-2015	For category 2D3c Asphalt Roofing, $PM_{2.5}$, whole time-series, the TERT noted that $PM_{2.5}$ emissions were not estimated. In response to a question raised during the review, Belgium explained that the company in question "produces bituminous waterproofing membranes (8,000,000 m2/year) using 18,000 t bitumen as raw material. 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. We assume a constant emission for all years.". The TERT accepts the explanation provided by Belgium, and recommends that the reasoning for reporting no $PM_{2.5}$ emissions are included in its next submission.	no	4.2.4.3- Asphalt roofing, p116
BE-2D3a-2017-0001	Yes	2D3a Domestic solvent use including fungicides, NMVOC, 1990-2015	For Key Category 2D3a Domestic Solvent Use, NMVOC, whole time-series, the TERT noted that Belgium used per capita EFs, corresponding to the Tier 1 approach in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Belgium explained that a study (2010) in the Brussels Capital Region 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). From this study, the NMVOC emissions of paint application for construction and	no	4.2.4.1- Domestic solvent use, p115

			building and domestic use have been revised in 2010. The population based EFs 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 EFs have been slightly adapted for Flanders and Wallonia. For the Flemish, Walloon and Brussels Capital Region, the total emission factors are respectively 1.324, 1.412 and 1.219 kg/person for 2008. The TERT recommends 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 2016 EMEP/EEA Guidebook and to compare its country specific EFs with those in the Guidebook. The TERT recommends that Belgium adds the table with calculated EFs for product groups, delivered during the review, to its IIR for its next submission.		
BE-2G-2017-0001	No	2G Other product use, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 1990-2015	For category 2G Other Product Use, NO_X, SO_2, NMVOC, whole time-series, the TERT noted that NE or "0" is reported for potential Key Categories fireworks and tobacco. In response to a question raised during the review, Belgium explained that in the Belgian inventory submitted in 2017, the calculation of dust emissions coming from tobacco consumption was only made in Flanders (AD for Flanders was attached). These emissions were not estimated in the other regions, however, emissions from tobacco smoke will be estimated for Belgium in the next submission assuming that tobacco consumption in Flanders in relation to the total tobacco consumption in Belgium is 55 %. Belgium stated that the AD used with an estimated emission factor of 40 kg $PM_{2.5}$/t (Tier 2 2016 EMEP/EEA Guidebook: 27 kg $PM_{2.5}$/t) is only half of the consumption as it is assumed that only half of the tobacco smoke is emitted outdoors. An estimate of $PM_{2.5}$ emissions using these data for Belgium yields less than 2% of the national total, which is below the threshold of significance. Furthermore, concerning PM emissions from fireworks, it is not possible to find Eurostat data (zero or confidential) and a request for data from PRODCOM was made, but these are at the earliest foreseen by the end of June. The TERT recommends that Belgium provides a reference to the source explaining that tobacco smoke indoors does not affect outdoor air, as this is taken into account in other emission inventories. The TERT furthermore recommends that Belgium include AD, EFs and emissions for tobacco smoke and fireworks in its next submission.	no	4.1.5 Other product use, p127
BE-3B1a-	Yes	3B1a Manure	The TERT noted that the NH_3 IEF for NFR 3B1a dairy cattle was significantly	TC	5.2 - Animal husbandry and

2017-0001		management - Dairy cattle, NH_3, 2005-2015	lower than other comparable European countries. In 2015 the NH_3 IEF for dairy cattle is 6.5 kg NH_3/cow/yr (based on NFR data; 3.915 kt NH_3/603444 cows), and this emission is close to half of the emission in Austria, Denmark, Finland, Germany, Netherlands, Sweden and United Kingdom (refer to attached Excel "NH_3 IEF BE compared with other EU countries"). The TERT noted in response to question raised during the review, that Belgium, for dairy cattle in Flanders, use an average NH_3 emission factor of 7.53 kg NH_3/cow/yr (9.12 for dairy cattle and 5.04 for brood cows) and for Wallonia is used 15-17 kg NH_3/cow/yr. The fact that Flanders does not correctly include the brood cows in NFR 3B1a dairy cattle can in some way explain the lower NH_3 IEF. However, this cannot be the only reason, because the NH_3 emission factor used for both Flanders and Wallonia is higher than the NH_3 IEF. The TERT is aware that the NH_3 emission from housing in Belgium is likely to be lower than the default values. However, Belgium did not provide a clear response to questions from the TERT, to explain the reason why the NH_3 IEF Belgium is significantly lower than other comparable European countries. The TERT therefore decided to calculate a technical correction for NH_3 emission from NFR 3B1a for the years 2005, 2010 and 2015, which was not accepted by Belgium. The estimates demonstrate that the issue is above the threshold of significance. The TERT recommends that Belgium include a revised estimate in its next submission.		Manure management, p136-138
BE-3B1b-2017-0001	Yes	3B1b Manure management - Non-dairy cattle, NH_3, 2006-2007	For the NH_3 from NFR 3B1b Non-dairy Cattle the TERT noted that the emissions increase by 6 % from 2006 to 2007 and this cannot be due to an increase in number of cattle, which only increases by 1 % from 2006 to 2007. The NH_3 IEF varies from 2.58-2.64 kgNH_3/cow/yr and increases from 2007 onwards to a range between 2.77 and 2.84 kgNH_3/cow/yr. In response to a question raised during the review, Belgium explained that the NH_3 emissions from NFR 3B1b should be 0.027745 kt lower. With this change taken into account the NH_3 IEF is still higher (2.79 kg NH_3/cow/yr) (2000 thousand cattle/(5.58-0.0277) kt NH_3) compared to the level 2000-2006. The TERT notes that any change in total NH_3 emission will be below the threshold of significance. The TERT recommends Belgium to check the calculation of NH_3 emissions 2005-2015 from NFR 3B1b with a focus on understanding the changes in IEF from 2006 to 2007.	no	5.2 - Animal husbandry and Manure management, p136-138
BE-3B-2017-0003	Yes	3B Manure management, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005-2015	For 3B Manure Management, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005-2015, the TERT notes a discrepancy in the number of animals in the NFR compared to the CRF 2005-2015. The total number of cattle is the same, but the allocation between dairy cattle and other cattle differ significantly. This discrepancy has an impact	no	5.2 - Animal husbandry and Manure management, p136-138

			on the estimates of emissions which is below the threshold of significance. In response to a question raised during the review, Belgium explained that the difference is due to timing of reporting deadlines and also caused by the structure of the ammonia model (EMAV) used for Flanders, which does not distinguish between dairy and brood cows. The TERT accepted the explanation provided by Belgium and recommend in future to ensure consistency between the number of animal in the NFR and CRF, as far as possible. Furthermore, it is recommended to include a transparent description in IIR justifying any differences in the number of animal between the NFR and CRF.		
BE-3B-2017-0004	No	3B Manure management, $PM_{2.5}$, 2005-2015	For 3B Manure Management, $PM_{2.5}$, 2005-2015, the TERT noted that the IEF $PM_{2.5}$ (0.30 kg $PM_{2.5}$/cow/yr) for NFR 3B1a Dairy Cattle is lower than the default (0.41 kg$PM_{2.5}$/cow/yr) despite Belgium noting in the IIR that the emission is based on a Tier 1 approach. In response to a question raised during the review, Belgium explained that a default EF is used for dairy cattle, but the number of dairy cattle includes brood cows with a lower EF (GB 2016 Table 3.5) and that this lowers the IEF for $PM_{2.5}$. Based on the Belgian response, the TERT can conclude that the estimated $PM_{2.5}$ emission is based on Tier 1 approach and the emission is correct. The TERT recommend Belgium to investigate the possibility of distinguishing between dairy and non-dairy in the EMAV model, so activity data for NFR 3B1a only includes dairy cattle. This will improve the transparency and comparability of the implied emission factor.	no	5.2 - Animal husbandry and Manure management, 5.2.1.2 Particulate matter, p136-138
BE-3B-2017-0005	No	3B Manure management, $PM_{2.5}$, 2000-2015	The TERT notes that for both Flanders and Wallonia 2013 EMEP/EEA Guidebook default Tier 1 is used to estimate the $PM_{2.5}$, PM_{10} and TSP emissions from NFR 3B Manure Management 2005-2015. In response to a question raised during the review, Belgium confirmed that it intends to use updated emission factors from the 2016 EMEP/EEA Guidebook (Table 3.5 or Annex Table A1.6) in the next submission.	no	5.2 - Animal husbandry and Manure management, 5.2.1.2 Particulate matter, p136-138
BE-3B4giv-2017-0001	No	3B4giv Manure management - Other poultry, $PM_{2.5}$, 2005-2015	The TERT noted that the $PM_{2.5}$, PM_{10} and TSP emissions from NFR 3B4giv Other Poultry are not estimated for 2005-2015. The TERT also noted that emissions of NH_3, NO_X and NMVOC are estimated from NFR 3B4giv Other poultry for the years 2015, 2010 and 2005, which indicates that some considerations regarding activity data (by type of poultry) is undertaken for these estimates. During the review, Belgium responded that in Flanders, ducks and geese are no longer included in statistics by the Flemish Land Agency (VLM) from 2007 and for Wallonia, the data for ducks and geese is known and PM emissions will be calculated for the next submission. The TERT recommend Belgium to investigate	no	5.2 - Animal husbandry and Manure management, 5.2.1.2 Particulate matter, p136-138

			the possibility of providing activity data for NFR 3B4giv Other Poultry for both Wallonia and Flanders, so $PM_{2.5}$ emissions can be calculated and included in the next submission.		
BE-3Da1-2017-0001	Yes	3Da1 Inorganic N-fertilizers (includes also urea application), NO_X, NH_3, 2005-2015	For calculation of NH_3 emission from NFR 3Da1 Inorganic N-fertilisers 2005-2015, the description in the IIR is not transparent. In response to a question raised during the review, Belgium provided a time series for 2005-2015 for the total amount of N in inorganic fertilisers, allocation of different fertiliser types and NH_3 EF used – all for Flanders. Based on these data, it is clear that the weighted NH_3 EF is based on a change in the allocation of fertilizer type. However, in the case of Wallonia, an EF of 4.2% is used for all years and no information is provided for this estimate. The TERT recommends that Belgium include information in the IIR for N amount in inorganic fertiliser, allocation of fertiliser types and EF used for each fertiliser type for all years.	no	5.3.1.1 - Synthetic fertilizer use NH3, p139
BE-3Da1-2017-0002	No	3Da1 Inorganic N-fertilizers (includes also urea application), $PM_{2.5}$, 2005-2015	The TERT notes that the IEF for $PM_{2.5}$ emissions 2015, 2010 and 2005 is estimated based on an emission factor of 0.03 kg $PM_{2.5}$ per ha, which is half of the default EF (0.06 kg $PM_{2.5}$/ha – 2013 EMEP/EEA Guidebook Table 3-1). In response to a question raised during the review, Belgium explained that the $PM_{2.5}$ emissions only include emissions from the Walloon region and no emissions from Flanders are estimated. The TERT noted that the issue is below the threshold of significance for technical correction. The TERT recommends that Belgium estimates the $PM_{2.5}$, PM_{10} and TSP emissions for all regions for the next submission. Activity data and 2016 EMEP/EEA Guidebook Tier 1 EF are available.	no	5.3.1.3 - Synthetic fertilizer use PM, p140
BE-3Da1-2017-0003	No	3Da1 Inorganic N-fertilizers (includes also urea application), $PM_{2.5}$, 2005-2015	Belgium has estimated the emissions of $PM_{2.5}$, PM_{10} and TSP from field operations and allocated the emissions to NFR 3Da1 Inorganic N-fertilisers. The 2016 EMEP/EEA Guidebook Table 3.1 clarifies in a more transparent way than the 2013 EMEP/EEA Guidebook Table 3-1, that particle emission related to soil cultivation, harvesting, cleaning and drying should be allocated under the NFR 3Dc Farm-level Agricultural Operations. To ensure comparability of the emissions across the countries, the TERT recommends Belgium to reallocate PM emissions from 3Da1 to 3Dc. In response to a question raised during the review, Belgium confirm that it is planned to provide this reallocation.	no	5.3.5 Farm level agricultural operations, p141
BE-3F-2017-0001	No	3F Field burning of agricultural residues, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005-	The TERT noted that no emissions are estimated for NFR category 3F Field Burning of Agricultural Residues, 2005-2015, and no information is given in IIR. In response to a question raised during the review, Belgium explained that field burning of agricultural residues is forbidden by law in Wallonia and refers to a	no	5.3.8-Field burning of agricultural residues, p142

		2015	specific legislation (Arrêté du Gvt Wallon du 13 juin 2014). The TERT recommends that Belgium include more information in the IIR for the next submission, by referring to legislation in Wallonia and clarify from which year the ban came into force. Information for the situation in Flanders is also needed. Furthermore, it is recommended to inform whether there are derogations for field burning under certain circumstances or for certain crop types. The TERT assumed that NH_3 and $PM_{2.5}$ emission from field burning of agricultural residues in Belgium is below the threshold of significance because field burning of agricultural residues is forbidden in Wallonia, and taking into account that this emission source in other Western Europe countries often accounts for less than 2% of the total NH_3 and $PM_{2.5}$.		
BE-5C-2017-0001	No	5C Waste incineration, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005;2010;2015	For 5C the TERT noted that Belgium is estimating NO_X, SO_2, NMVOC, NH_3 and TSP emissions from waste incinerators with and/or without energy recovery using annual emissions reported by operators on the basis of stack measurements. 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 (IC95) although this subtraction must not be applied in the context of reporting annual emissions. In response to a question raised during the review, Belgium explained that operators have been contacted and that there is evidence that at least a part of them are estimating annual emissions on the basis of measurement concentration data "reduced" of the confidence interval. The TERT notes that this issue relates to an under-estimate, which could correspond, at a maximum, to 20% of SO_2, 20% of NO_X, 30% of dust of the sector, depending on the fraction of the operators subtracting IC95. The TERT is aware that such an analysis cannot be performed during the time scale of the current NECD review and recommends 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. The TERT also encourages Belgium to prevent under-estimated reporting from operators in the future.	no	6.3.1- Waste incineration, p145
BE-5D-2017-0001	No	5D Wastewater Handling, NMVOC, 2005;2010;2015	For 5D the TERT noted that NMVOC emissions are not estimated (NE notation key) although there is a default emission factor proposed in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review Belgium indicated that it assumes, as with the greenhouse gas inventory, that emissions from waste water treatment are not included in the Belgian inventory because	no	6.4- Wastewater treatment, p149

			most of the industrial waste water is treated in an aerobic way. The TERT notes that although emissions of CH4 are dependent on the presence of anaerobic conditions, NMVOC emissions occur from centralised waste water treatment plants whatever the type of treatment. Belgium did not provide a revised estimate but the TERT noted that the issue is expected to be below the threshold of significance for a technical correction. The TERT recommends that Belgium estimates NMVOC emissions from domestic and industrial waste water handled in waste water treatment plants for future submissions.		
BE-5D-2017-0002	No	5D Wastewater handling, NH_3, 2005;2010;2015	For 5D1 Wastewater Handling, the TERT noted that NH_3 emissions from septic tanks are estimated using a country specific EF although the 2016 EMEP/EEA Guidebook proposes a NH_3 EF only for latrines (and not septic tanks). In response to a question raised during the review, Belgium indicated that the reference of the country specific NH_3 EF from septic tanks couldn't be found and proposed to consider that there are no NH_3 emissions from septic tanks. The TERT noted that the issue is below the threshold of significance for a technical correction. As it is consistent with the 2016 EMEP/EEA Guidebook and with what is applied by other Member States, the TERT recommends that Belgium does not include waste water treated in septic tanks in its calculation for 5D1 in its next submission.	no	6.4-Wastewater treatment, p149
BE-5E-2017-0001	No	5E Other waste, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005;2010;2015	For 5E the TERT noted that Belgium doesn't estimate emissions from car and building fires although a default EF is proposed in the 2016 EMEP/EEA GB. In response to a question raised during the review Belgium explained that no information is available regarding the accidental fire data for 2005, 2010 and 2015 and did not provide a revised estimate for car and building fires. The TERT decided to calculate a technical correction for the years 2005, 2010 and 2015 and the estimates done by the TERT demonstrate that the issue is above the threshold of significance. Belgium accepted the TC but noted that the ADs used for the TC may be too high comparing to data available for other years. Following questions from the TERT on NH_3 emissions from sludge spreading, Belgium provided a revised estimate concerning NH_3 emissions from sludge spreading in Wallonia. This revised estimate is below the threshold of significance but has been included in the Technical Revision calculation for 5E. The TERT recommends that Belgium includes an estimation of $PM_{2.5}$ and NH_3 from 5E in its next submission.	TC	6.5.1 Car and house fires- , 6.5.2 Other sources, p149-150

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 revised Nomenclature For

Reporting (NFR14) 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 1990-2015 (recalculated) and 2016 (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).

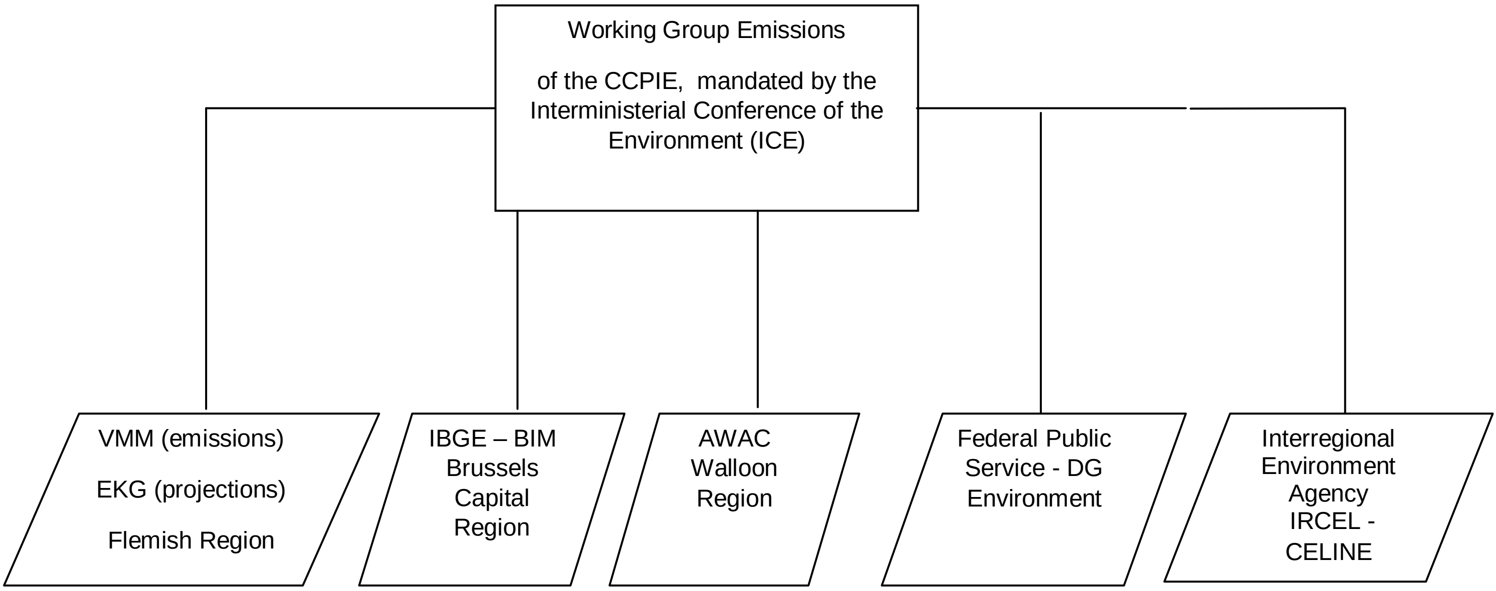


Figure 1-1 Overview of the entities responsible for the constitution and performance of the Belgian Inventory System

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

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

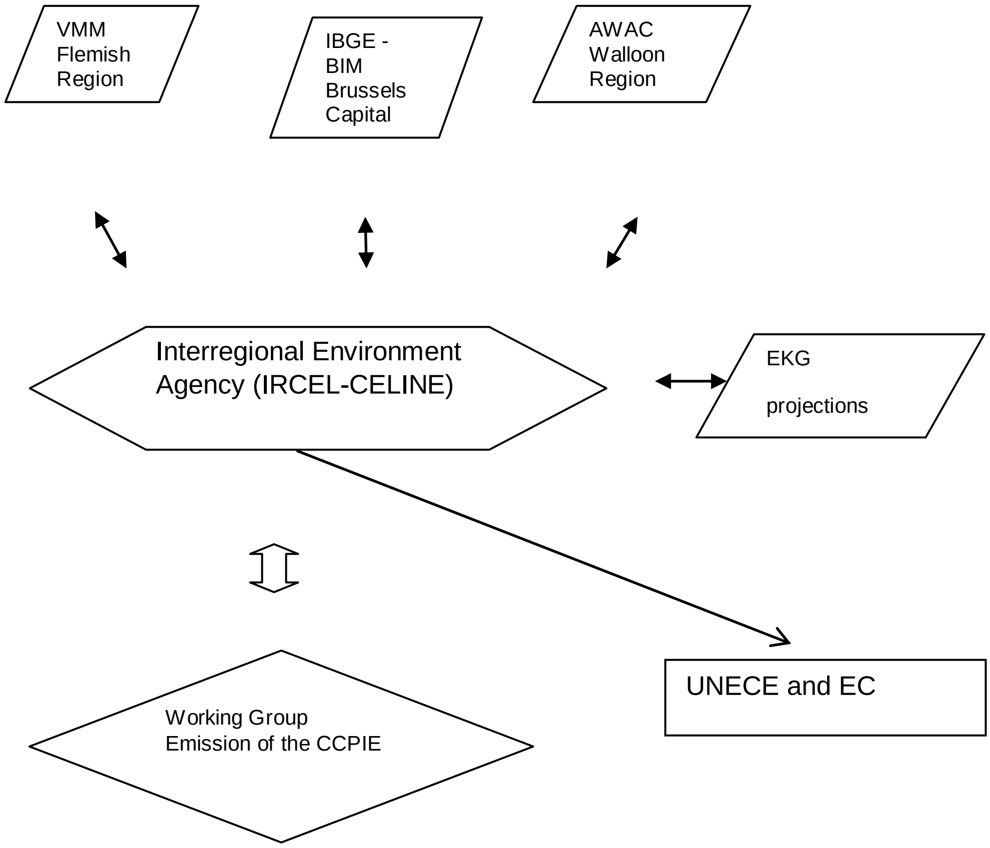


Figure 1-2 Overview of the inventory preparation process in Belgium

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 IV v11.3). 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 IBGE-BIM (the Brussels Institute for Environmental Management) using the EMEP/EEA methodology. The emissions are calculated by multiplying activity data by an emission factor. The activity data are mostly coming from the 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 2016 (see Chapter 2: ‘Key category analysis and methodological choice’, 2.4.1) for both the level assessment and trend assessment. The key category analysis (level and trend) is performed for all reported gases at the least aggregated level of NFR categories.

1.5.1. Level assessment

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

Table 1-2 to Table 1-6 show the results of the level assessment for 2016 for the main pollutants and PM10. For the results of the key source level assessment of all the pollutants, we refer to Annex 1.

Table 1-2 Key source level assessment for NO_x, 2016

NOx **Source Code**	**Source Category**	**Gg NO_2**	**Level ass.**	**2016** **Cum.Total**
1A3bi	Road transport: Passenger cars	44.329	23.0%	23.0%
1A3biii	Road transport: Heavy duty vehicles and buses	31.127	16.1%	39.1%
1A3bii	Road transport: Light duty vehicles	16.301	8.4%	47.5%
1A4bi	Residential: Stationary	10.52	5.4%	53.0%
1A1a	Public electricity and heat production	9.109	4.7%	57.7%
2A1	Cement production	6.637	3.4%	61.1%
3Da2a	Animal manure applied to soils	6.259	3.2%	64.4%
3Da1	Inorganic N-fertilizers (includes also urea application)	6.219	3.2%	67.6%
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	6.042	3.1%	70.7%
2B10a	Chemical industry: Other (please specify in the IIR)	5.526	2.9%	73.6%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	4.703	2.4%	76.0%

2C1	Iron and steel production	4.458	2.3%	78.3%
1A4ai	Commercial/institutional: Stationary	3.804	2.0%	80.3%

Table 1-3 Key source level assessment for NMVOC, 2016

NMVOC **Source Code**	**Source Category**	**Gg NMVOC**	**Level ass.**	**2016** **Cum.Total**
2D3a	Domestic solvent use including fungicides	15.284	13.4%	13.4%
3B1b	Manure management - Non-dairy cattle	13.117	11.5%	24.8%
1A4bi	Residential: Stationary	12.236	10.7%	35.5%
2D3d	Coating applications	9.515	8.3%	43.9%
2B10a	Chemical industry: Other (please specify in the IIR)	8.293	7.3%	51.1%
3B1a	Manure management - Dairy cattle	5.349	4.7%	55.8%
2D3g	Chemical products	4.738	4.1%	59.9%
3B3	Manure management - Swine	4.005	3.5%	63.4%
3B4gii	Manure mangement - Broilers	3.172	2.8%	66.2%
1A3bi	Road transport: Passenger cars	2.85	2.5%	68.7%
2H2	Food and beverages industry	2.752	2.4%	71.1%
1A3bv	Road transport: Gasoline evaporation	2.606	2.3%	73.4%
1B2b	Fugitive emissions from natural gas (exploration. production. processing. transmission. storage. distribution and other)	2.563	2.2%	75.6%
1B2aiv	Fugitive emissions oil: Refining / storage	2.445	2.1%	77.8%
2D3i	Other solvent use (please specify in the IIR)	2.298	2.0%	79.8%
2D3h	Printing	2.15	1.9%	81.6%

Table 1-4 Key source level assessment for SO_x, 2016

SOx **Source Code**	**Source Category**	**Gg SO_2**	**Level ass.**	**2016** **Cum.Total**
1A1b	Petroleum refining	8.398	19.8%	19.8%
1A4bi	Residential: Stationary	8.329	19.7%	39.5%

2C1	Iron and steel production	5.609	13.2%	52.8%
2A1	Cement production	2.792	6.6%	59.4%
2C7c	Other metal production (please specify in the IIR)	2.732	6.5%	65.8%
2B10a	Chemical industry: Other (please specify in the IIR)	2.605	6.2%	72.0%
2A6	Other mineral products (please specify in the IIR)	2.124	5.0%	77.0%
1B2c	Venting and flaring (oil. gas. combined oil and gas)	1.485	3.5%	80.5%

Table 1-5 Key source level assessment for NH_3, 2016

NH3 **Source Code**	**Source Category**	**Gg NH3**	**Level ass.**	**2016** **Cum.Total**
3Da2a	Animal manure applied to soils	15.13	22.26%	22.26%
3B1b	Manure management - Non-dairy cattle	12.824	18.87%	41.14%
3B3	Manure management - Swine	12.481	18.37%	59.50%
3B1a	Manure management - Dairy cattle	6.254	9.20%	68.70%
3Da1	Inorganic N-fertilizers (includes also urea application)	5.816	8.56%	77.26%
3Da3	Urine and dung deposited by grazing animals	5	7.36%	84.62%

Table 1-6 Key source level assessment for PM10, 2016

PM10 **Source Code**	**Source Category**	**Gg PM10**	**Level ass.**	**2016** **Cum.Total**
1A4bi	Residential: Stationary	14.716	43.0%	43.0%
2A5a	Quarrying and mining of minerals other than coal	2.369	6.9%	49.9%
1A3bvi	Road transport: Automobile tyre and brake wear	2.149	6.3%	56.2%
2C1	Iron and steel production	1.229	3.6%	59.7%
1A3bvii	Road transport: Automobile road abrasion	1.175	3.4%	63.2%
3Dc	Farm-level agricultural operations including storage. handling and transport of agricultural products	1.139	3.3%	66.5%
1A3bi	Road transport: Passenger cars	0.998	2.9%	69.4%

2A5b	Construction and demolition	0.795	2.3%	71.7%
2L	Other production. consumption. storage. transportation or handling of bulk products (please specify in the IIR)	0.668	1.9%	73.7%
3B3	Manure management - Swine	0.614	1.8%	75.5%
5E	Other waste (please specify in IIR)	0.588	1.7%	77.2%
3B4gii	Manure mangement - Broilers	0.587	1.7%	78.9%
2G	Other product use (please specify in the IIR)	0.542	1.6%	80.5%

Table 1-7 gives an overview of the key source level assessment for 2016. The results of the key source analysis (level assessment) of other years are presented in Annex 1.

Table 1-7 Key source analysis (level assessment) for 2016

2016	Key source categories (sorted from high to low, from left to right)														
NOx (as NO2)	1A3bi	1A3biii	1A3bii	1A4bi	1A1a	2A1	3Da2a	3Da1	1A2c	2B10a	1A4cii	2C1	1A4ai			
Cum.: 80.3%	23.0%	16.1%	8.4%	5.4%	4.7%	3.4%	3.2%	3.2%	3.1%	2.9%	2.4%	2.3%	2.0%			
NMVOC	2D3a	3B1b	1A4bi	2D3d	2B10a	3B1a	2D3g	3B3	3B4gii	1A3bi	2H2	1A3bv	1B2b	1B2aiv	2D3i	2D3h
Cum.: 81.6%	13.4%	11.5%	10.7%	8.3%	7.3%	4.7%	4.1%	3.5%	2.8%	2.5%	2.4%	2.3%	2.2%	2.1%	2.0%	1.9%
SOx (as SO2)	1A1b	1A4bi	2C1	2A1	2C7c	2B10a	2A6	1B2c								
Cum.: 80.5%	19.8%	19.7%	13.2%	6.6%	6.5%	6.2%	5.0%	3.5%								
NH3	3Da2a	3B1b	3B3	3B1a	3Da1	3Da3										
Cum.: 84.6%	22.3%	18.9%	18.4%	9.2%	8.6%	7.4%										
PM2.5	1A4bi	1A3bvi	1A3bi	2C1	2A5a	1A3bvii	5E	2G	1A3biii							
Cum.: 81.2%	56.7%	4.5%	3.9%	3.8%	3.1%	2.5%	2.3%	2.1%	2.1%							
PM10	1A4bi	2A5a	1A3bvi	2C1	1A3bvii	3Dc	1A3bi	2A5b	2L	3B3	5E	3B4gii	2G			
Cum.: 80.5%	43.0%	6.9%	6.3%	3.6%	3.4%	3.3%	2.9%	2.3%	1.9%	1.8%	1.7%	1.7%	1.6%			
TSP	1A4bi	2A5a	3B3	1A3bvi	2A5b	1A3bvii	3B4gi	2C1	2L	3B4gii	3B1b	3Dc				
Cum.: 80%	28.9%	12.9%	7.7%	5.3%	4.9%	4.4%	4.3%	2.6%	2.6%	2.2%	2.1%	2.1%				
BC	1A4bi	1A3bi	1A3biii	1A3bii	1A4cii											
Cum.: 82.6%	41.6%	19.6%	9.3%	9.0%	3.0%											
CO	2C1	1A4bi	1A3bi	1A4bii	1A3biii											
Cum.: 81.6%	40.7%	24.5%	10.0%	3.5%	2.8%											
Pb	2C1	1A3bvi	2C7c	1A4bi	1A2a											
Cum.: 83.1%	59.1%	9.0%	7.8%	3.6%	3.6%											
Cd	1A2c	2C1	1A4bi	1B2aiv	1A1a	2G										
Cum.: 82.5%	34.2%	18.3%	12.1%	8.5%	5.4%	3.9%										
Hg	2A1	1A1a	2B10a	2C1	2C7c	1A4bi	1A2c	2A2								
Cum.: 82.5%	26.7%	16.5%	11.0%	8.6%	5.6%	5.5%	4.7%	3.9%								
As	1A1a	2C7c	1A2c	2C1	1A4ai	1A2d	1A4bi	1A2a								
Cum.: 82.3%	24.3%	22.4%	12.2%	7.4%	7.0%	3.2%	2.9%	2.9%								
Cr	2C1	1A2a	1A3bvi	1A4bi	1A1a	1A2c	1A2d									
Cum.: 80.9%	24.0%	16.3%	14.5%	10.4%	7.0%	5.7%	2.9%									
Cu	1A3bvi	2G	1A3c													
Cum.: 83.2%	63.4%	10.0%	9.9%													
Ni	2C1	1A2c	1B2aiv	1A1a	1A2f	1A2d	2C7c	1A3bvi	1A2gviii	1A2a	1A2b	2A2				
Cum.: 81.6%	17.0%	16.3%	12.0%	8.2%	5.3%	4.6%	3.8%	3.7%	3.2%	2.8%	2.6%	2.1%				

Se Cum.: 87.7%	2A6 35.5%	1A1a 25.1%	2A3 17.0%	2A1 10.1%												
Zn Cum.: 83.7%	1A4bi 18.2%	2C7c 13.3%	1A3bi 12.2%	1A3bvi 12.0%	2C1 7.7%	1A3biii 5.7%	1A2d 5.7%	1A1a 4.7%	1A2a 4.2%							
PCDD/ PCDF Cum.: 83.4%	1A4bi 44.7%	5E 18.5%	2C1 14.3%	1A3bi 5.9%												
benzo(a) pyrene Cum.: 81%	1A4bi 81.0%															
benzo(b) fluoranthene Cum.: 81.2%	1A4bi 76.8%	1A3bi 4.4%														
benzo(k) fluoranthene Cum.: 80.6%	1A4bi 68.0%	1A3bi 7.6%	1A2d 5.0%													
Indeno (1.2.3-cd) pyrene Cum.: 81.4%	1A4bi 81.4%															
PAHs Cum.: 82.9%	1A4bi 77.6%	1A3bi 5.4%														
HCB Cum.: 80.7%	1A1a 58.5%	5C1bii 22.2%														
PCBs Cum.: 86.1%	2A1 56.1%	2C1 21.2%	1A2b 8.8%													

1.5.2. Trend assessment

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

Table 1-8 to Table 1-12 show the key source trend analyses for the main pollutants and PM10 (base year – 2016). The results for all pollutants are presented in Annex 1.B.

Table 1-8 Key source trend assessment for NO_x, 1990-2016

NOx	Source Code	1990	2016	trend Ass.	% contrib	cum.total
1A1a	Public electricity and heat production	60.79	9.11	0.047	23.2%	23.2%
1A3bii	Road transport: Light duty vehicles	8.66	16.3	0.03	14.6%	37.8%
1A3bi	Road transport: Passenger cars	111.4	44.33	0.02	9.6%	47.4%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	13.54	1.39	0.012	5.9%	53.4%
1A3biii	Road transport: Heavy duty vehicles and buses	73.47	31.13	0.008	4.1%	57.4%
2B10a	Chemical industry: Other (please specify in the IIR)	4.68	5.53	0.008	4.0%	61.4%
1A4bi	Residential: Stationary	15.34	10.52	0.008	3.9%	65.4%
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	5.96	6.04	0.008	3.9%	69.2%
3Da1	Inorganic N-fertilizers (includes also urea application)	8.38	6.22	0.006	2.7%	71.9%
1A4ai	Commercial/institutional: Stationary	3.26	3.8	0.006	2.7%	74.6%
2C1	Iron and steel production	5.3	4.46	0.005	2.3%	77.0%
1A3dii	National navigation (shipping)	4.49	3.8	0.004	2.0%	79.0%
2B2	Nitric acid production	4.34	0.47	0.004	1.9%	80.9%

Table 1-9 Key source trend assessment for NMVOC, 1990-2016

NMVOC	Source Code	1990	2016	trend Ass.	% contrib	cum.total

1A3bi	Road transport: Passenger cars	64.96	2.85	0.059	21.2%	21.2%
2D3a	Domestic solvent use including fungicides	9.56	15.28	0.036	12.9%	34.1%
3B1b	Manure management - Non-dairy cattle	14.76	13.12	0.024	8.6%	42.7%
1A4bi	Residential: Stationary	13.26	12.24	0.023	8.3%	51.0%
2D3d	Coating applications	49.17	9.52	0.023	8.1%	59.1%
1A3bv	Road transport: Gasoline evaporation	17.89	2.61	0.011	3.9%	62.9%
1B2aiv	Fugitive emissions oil: Refining / storage	16.93	2.44	0.01	3.7%	66.6%
1B2av	Distribution of oil products	11.14	0.87	0.009	3.2%	69.9%
2D3h	Printing	14.5	2.15	0.009	3.1%	72.9%
3B4gii	Manure mangement - Broilers	1.82	3.17	0.008	2.7%	75.7%
3B3	Manure management - Swine	4.54	4	0.007	2.6%	78.3%
2H2	Food and beverages industry	2.1	2.75	0.006	2.2%	80.5%

Table 1-10 Key source trend assessment for SO_x, 1990-2016

SOx	Source Code	1990	2016	trend Ass.	% contrib	cum.total
1A1a	Public electricity and heat production	95.21	1.24	0.027	22.9%	22.9%
1A4bi	Residential: Stationary	31.22	8.33	0.013	11.0%	34.0%
2C1	Iron and steel production	10.63	5.61	0.012	10.2%	44.2%
1A1b	Petroleum refining	40.9	8.4	0.01	8.6%	52.8%
1A4ci	Agriculture/Forestry/Fishing: Stationary	28.3	0.68	0.007	6.1%	58.8%
2A1	Cement production	4.33	2.79	0.006	5.4%	64.2%
2A6	Other mineral products (please specify in the IIR)	1.08	2.12	0.005	4.7%	68.9%
2C7c	Other metal production (please specify in the IIR)	7.27	2.73	0.005	4.4%	73.3%

1A2e	Stationary combustion in manufacturing industries and construction: Food processing. beverages and tobacco	16.03	0.31	0.004	3.6%	76.9%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	13.72	0.1	0.004	3.5%	80.4%

Table 1-11 Key source trend assessment for NH_3, 1990-2016

NH3	Source Code	1990	2016	trend Ass.	% contrib	cum.total
3Da2a	Animal manure applied to soils	60.26	15.13	0.148	49.8%	49.8%
3B1b	Manure management - Non-dairy cattle	14.12	12.82	0.041	13.7%	63.5%
3B3	Manure management - Swine	16.4	12.48	0.028	9.3%	72.8%
3Da1	Inorganic N-fertilizers (includes also urea application)	6.06	5.82	0.02	6.7%	79.6%
3B4gii	Manure mangement - Broilers	1	2.32	0.014	4.8%	84.4%
3Da2a	Animal manure applied to soils	60.26	15.13	0.148	49.8%	49.8%

Table 1-12 Key source trend assessment for PM10, 2000-2016

PM10	Source Code	1990	2016	trend Ass.	% contrib	cum.total
1A4bi	Residential: Stationary	11.52	14.72	0.137	30.9%	30.9%
2C1	Iron and steel production	9.13	1.23	0.082	18.6%	49.5%
1A3bi	Road transport: Passenger cars	4.42	1	0.033	7.3%	56.9%
1A1a	Public electricity and heat production	2.52	0.35	0.023	5.1%	61.9%
1A3biii	Road transport: Heavy duty vehicles and buses	2.43	0.52	0.018	4.1%	66.1%
1A3bvi	Road transport: Automobile tyre and brake wear	1.84	2.15	0.018	4.1%	70.2%
2A5a	Quarrying and mining of minerals other than coal	2.24	2.37	0.018	4.0%	74.2%
2A1	Cement production	1.32	0.03	0.015	3.3%	77.5%
2A2	Lime production	0.96	0.03	0.01	2.4%	79.9%
1A3bvii	Road transport: Automobile road abrasion	1.02	1.17	0.01	2.2%	82.1%

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 2016 based on level (L1) or trend (T1) assessment

2016	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ PCDF	PAHs	HCB	PCBs	#
1A1a	L1, T1		T1		T1	T1	T1			T1	L1, T1	L1, T1	L1, T1	L1	T1	L1, T1	L1, T1	L1, T1	T1		L1, T1		**16**
1A1b			L1, T1																				**1**
1A2a	T1		T1						T1	L1			L1	L1, T1		L1		L1					**8**
1A2b																L1						L1	**2**
1A2c	L1, T1										L1, T1	L1, T1	L1, T1	L1		L1, T1	T1						**7**
1A2d													L1, T1	L1		L1, T1		L1, T1					**4**
1A2e			T1													T1							**2**
1A2f																L1, T1							**1**
1A2gviii																L1, T1							**1**
1A3bi	L1, T1	L1, T1			L1, T1	L1, T1	T1	L1, T1	L1, T1	T1								L1, T1	L1	L1			**11**
1A3bii	L1, T1							L1															**2**
1A3biii	L1, T1				L1, T1	T1	T1	L1, T1	L1									L1					**7**
1A3bv		L1, T1																					**1**
1A3bvi					L1, T1	L1, T1	L1, T1			L1, T1				L1, T1	L1, T1	L1, T1		L1, T1					**8**
1A3bvii					L1	L1, T1	L1, T1																**3**
1A3c															L1								**1**
1A3dii	T1																						**1**
1A4ai	L1, T1												L1, T1			T1							**3**
1A4bi	L1, T1	L1, T1	L1, T1		L1, T1	L1, T1	L1, T1	L1, T1	L1, T1	L1	L1, T1	L1	L1	L1, T1				L1, T1	L1, T1	L1, T1			**16**
1A4bii									L1														**1**
1A4ci			T1													T1							**2**
1A4cii	L1							L1															**2**
1B2aiv		L1, T1									L1					L1							**3**
1B2av		T1																					**1**
1B2b		L1																					**1**
1B2c			L1																				**1**
2A1	L1		L1, T1			T1						L1, T1					L1, T1					L1, T1	**6**
2A2						T1	T1					L1				L1	T1						**5**
2A3																	L1, T1	T1					**2**
2A5a					L1	L1, T1	L1, T1																**3**
2A5b						L1	L1																**2**
2A6			L1, T1														L1						**2**
2B2	T1																						**1**
2B10a	L1, T1	L1	L1									L1, T1											**4**
2C1	L1, T1		L1, T1		L1, T1	L1, T1	L1, T1		L1, T1	L1, T1	L1	L1, T1	L1, T1	L1, T1	T1	L1, T1		L1, T1	L1, T1	T1	T1	L1, T1	**18**
2C7c			L1, T1							L1	T1	L1, T1	L1, T1		T1	L1		L1, T1					**8**
2D3a		L1, T1																					**1**
2D3d		L1, T1																					**1**
2D3g		L1																					**1**
2D3h		L1, T1																					**1**
2D3i		L1																					**1**
2G					L1	L1					L1				L1, T1								**4**
2H2		L1, T1																					**1**
2L						L1	L1, T1																**2**
3B1a		L1		L1																			**2**
3B1b		L1, T1		L1, T1			L1																**3**
3B3		L1, T1		L1, T1		L1	L1, T1																**4**
3B4gi							L1																**1**
3B4gii		L1, T1		T1		L1	L1																**4**
3Da1	L1, T1			L1, T1																			**2**
3Da2a	L1			L1, T1																			**2**
3Da3				L1																			**1**
3Dc						L1	L1																**2**
5C1a										T1	T1	T1		T1		T1		T1	T1				**7**
5C1bii																			T1		L1, T1		**2**
5E					L1	L1													L1, T1				**3**
#	16	17	12	7	10	17	16	5	6	8	8	9	8	8	6	16	6	11	7	3	3	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 1990-2016 will be discussed in Chapter 2.

By comparing the key sources (level assessment) between 1990 and 2016 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.
- *1A1b Petroleum refining:* is no longer a key source for NOx and PM2.5 compared to the base year. In 1990, the refining plants (all situated in the Flemish region) were not yet obliged to report their emissions (obligation from 1993 described in the Flemish environmental law Vlarem II). As a result, very little information on emissions at plant level is available before 1993. Emissions were only estimated collectively based on the existing knowledge.
- *1A2a Iron and steel:* 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. Appears as a key source in 2016 for some heavy metals due to a part of process emissions allocated in the combustion sector.
- *1A2c Chemicals:* is a key source in 2016 for NOx, Cd, Hg, Cr, As, Se and Ni. 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:* appears as a key source for Cr, As, Ni and Zn in 2016 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.
- *1A2f Non-metallic minerals:* is a key source for Ni in 2016
- *1A3bi Road transport (Passenger cars):* Is not a key sector anymore for Pb and has a very much lower relatve importance for NMVOC and CO in 2016 compared to 1990 due to the increasing use of catalytic converters and other technical measures. The absolute Pb emissions of passenger cars have strongly decreased due to the removing of leaded petrol. It remains the largest source of NOx emissions.
- *1A3bv Gasoline evaporation:* The relative importance for NMVOC decreases due to the decrease of gasoline use between 1990 and 2016.
- *1A3bvi Automobile tyre and brake wear:* this is the most important key source for Cu emissions. The sector appears as a key source for Pb, Cr, Ni and Zn in 2016 compared to 1990. This is due to the increase in mobility and 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.

- *1A3c Railways:* the relative importance of Cu emissions increases in 2016 compared to the base year. This can be attributed to the optimised methodology to estimate heavy metals since 2000 in Flanders. Cu emissions, due to the abrasion of overhead wires and electric contact withdrawals were estimated in 2016, but not in 1990.
- *1A4bi Residential:* Stationary plants: The relative importance of this sector for NMVOC, SOx, CO, PAH's and particulate matter increases in 2016 compared to 1990. 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 Cd and Ni in 2016 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 in 2016 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:* disappears as 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, Se and PCB in 2016. It becomes the most important source for PCB emissions due to the large decrease of PCB emissions in the iron and steel sector. The absolute SO_2 and Hg emissions remain stable between 1990 and 2016 but the emissions of other sectors have decreased.
- *2A6 Other Mineral products:* appears as key source for SO_x and Se in 2016 compared to 1990. This can be attributed to the optimised methodology to estimate heavy metals for the years from 2000 on in Flanders. The sector disappears as key source for particulate matter in 2016 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, PAH and HCB in 2016 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 remains an important (key) source for most metals and dioxins This sector remains an important sector in Belgium.
- *2C7c Other metal production:* disappears as key source for Cd, Cu and dioxins due to changes in other sectors.
- *2D3a Domestic solvent use including fungicides:* is the most important sector for NMVOC in 2016. Because emissions are largely depending on the population, the absolute emissions of NMVOC has increased.
- *2G Other product use:* appears as a key source for Cd and Cu. This can be attributed to emission changes in the other sectors.
- *2H2 Food and beverages industry:* appears as a key source for NMVOC. This can be attributed to emission changes in the other sectors.

- *3B1b Manure management Dairy Cattle:* this becomes the second most important key sector for NMVOC because absolute emissions from the chemical and coating sector decreased strongly since 1990.
- *3B3 Manure management Swine:* is one *o*f the most important key sources for NH_3 emissions.
- a*3Da2a Animal manure applied to soils*: Emissions of animal manure applied to soils decreased in 2016 compared to 1990, but this sector remains the most important key sector for NH3 emissions.
- *3Da3 Urine and dung deposited by grazing animals*: appears as a key source.
- *5C1a Municipal waste incineration:* In 1994, this sector has undergone a (structural) reorganisat*i*on, 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.
- *5C1bii Hazardous waste incineration:* disappears as a key source for dioxins, appears as a key source for HCB. A (structural) reorganisation of the sector in 1994 led to a strong decline of the emissions. From 2006 on intermunicipal waste incinerators recuperate their energy; the emissions are then allocated in sector 1A1a.
- 5C1biv Sewage sludge incineration: disappears as key source for HCB. Nearly all incineration plants have energy recuperation, emissions are allocated in 1A1a.
- 5E Other waste: This appears as key sector in 2016 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 1.8 (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, 2017), 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 2016.

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 2016 and base year-2016 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 2016 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 2016)

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)	410.65	193.10	-217.55	27.86	3.98
NMVOC	330.44	114.36	-216.08	24.70	7.28
SOx (as SO2)	365.11	42.33	-322.78	17.80	1.15
NH3	122.81	67.96	-54.86	45.91	22.47
CO	1388.69	367.78	-1020.91	31.01	12.38
Pb	254.07	26.87	-227.20	103.75	15.56
Cd	6.23	2.77	-3.46	85.42	37.42
Hg	5.70	1.37	-4.33	32.94	12.41
As	6.26	0.92	-5.34	52.07	7.39
Cr	33.21	6.13	-27.09	74.99	15.96
Cu	40.25	30.60	-9.65	232.84	101.31
Ni	76.20	3.92	-72.28	43.81	2.72
Se	5.00	4.10	-0.90	116.34	76.15
Zn	234.75	75.49	-159.26	95.09	28.37
PCDD	586.12	32.05	-554.07	213.96	10.53
Total PAH	54.91	9.09	-45.81	272.32	41.25
HCB	40.84	5.56	-35.28	109.04	14.56
PCB	107.06	5.91	-101.15	301.75	24.32
PM 2.5	40.67	25.37	-15.30	16.64	15.53
PM 10	54.58	34.25	-20.33	18.59	13.95
TSP	84.56	53.68	-30.89	26.41	16.55
BC	8.62	3.85	-4.76	34.91	10.54

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). Estimations of the individual PAH's could not be made in the Walloon region before 2010, so in the national inventory only the totals of the 4 PAH's are reported in 1990-2009. In the 2018 submission, recalculations were made for 1990-2015. 2016 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 2016 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	PAH	No data available from the facilities
1A1c	NH3, heavy metals, dioxins, PAHs, HCB	No more cokes production from 1996 on
1A2a	PCB	No data available for all years
1A2f	HCB	No emission factors available to calculate the emissions
1A2gvii	Hg, As, 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, PAH, HCB, PCBs	No emission factors available to calculate the emissions
1A3b (i to iv)	Hg, As, HCB, PCBs	No emission factors available to calculate the emissions
1A3bvi	Hg, As, HCB, PCBs	Hg, As, no emission factors
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	NMVOC, SOx, NH3, Hg	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
1A5a	all	There are no data available. The activity data are coming from the military sector (confidentiality).
1A5b	Hg, As, dioxins	No emission factors available to calculate the emissions
1B2aiv	NOx, CO, PAH	No data available from the facilities
1B2c	NH3	No detailed data available
1B2d	NMVOC, CO	No detailed data available
2A6	NH,PAH	There are no data available or the EF aren't available
2B1	SOx	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, Cd,Hg, As, Se, 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	PCB	No data available from the facilities or no emission factors available
2C7d	NOx, NMVOC, SOx, Hg, 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	NH3, heavy metals	No data available from the facilities
2D3e	NOx, SOx, NH3, CO, heavy metals	No data available from the facilities
2D3g	heavy metals	No data available from the facilities
2D3h	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	NMVOC, SOx, CO, PCBs	No activity data available
3Dd	particulate matter	No data available
3Df	Dioxins, PAH, HCB, PCB	No activity data available or no emission factors available
3I	NH3	No activity data available
5A	NOx, SOx, NH3, BC, CO	No emission factors available to calculate the emissions
5B1	NOx, particulate matter, CO	No activity data available or no emission factors available
5B2	Particulate matter	No activity data available or no emission factors available
5C1bi	Heavy metals, PAHs, HCB, PCBs	POP's emissions probably not relevant
5C1bii	PAHs	There are no detailed data available or the EF aren't available
5C1biii	Dioxins, PAHs, HCB, 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	main pollutants, CO, heavy metals	No emission factors available to calculate the emissions
5D1	NMVOC, NH3	There are no data available or the EF aren't available
5D2	NMVOC, 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	NOx, SOx, BC, CO, Se, PAH	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	2C1
1A4aii	all	1A3eii
1B2ai	NMVOC	1B2av
2A3	HCB	1A2f
2A5c	particulate matter	2A6
2B1	NMVOC	2B10a
2B6	Particulate matter	2B10a
2B10b	Main pollutants, particulate matter, CO	2B10a
2C2	Particulate matter	2C7c
2C3	all	2C7c
2C4	all	2C7c
2C5	all	2C7c
2C6	all	2C7c
2C7a	all	2C7c
2C7b	all	2C7c
2H1	CO	1A2d
2I	Particulate matter	2L
3B4f	NOx, NMVOC, NH3, particulate matter	3B4e
3B4giii	NOx, NMVOC, NH3, particulate matter	3B4gi
3Da3	NOx	3Da2a
5B2	Main pollutants, CO	1A1a
5C1bii	NOx, SOx, NH3, particulate matter, CO, heavy metals	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, dioxins	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,	Waste recuperation, compost, car and building fires

	Ni, Zn	
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 recalculated in the 2018 LRTAP-submission. The absolute difference as well as the relative difference are calculated between 2016 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 2016. 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.

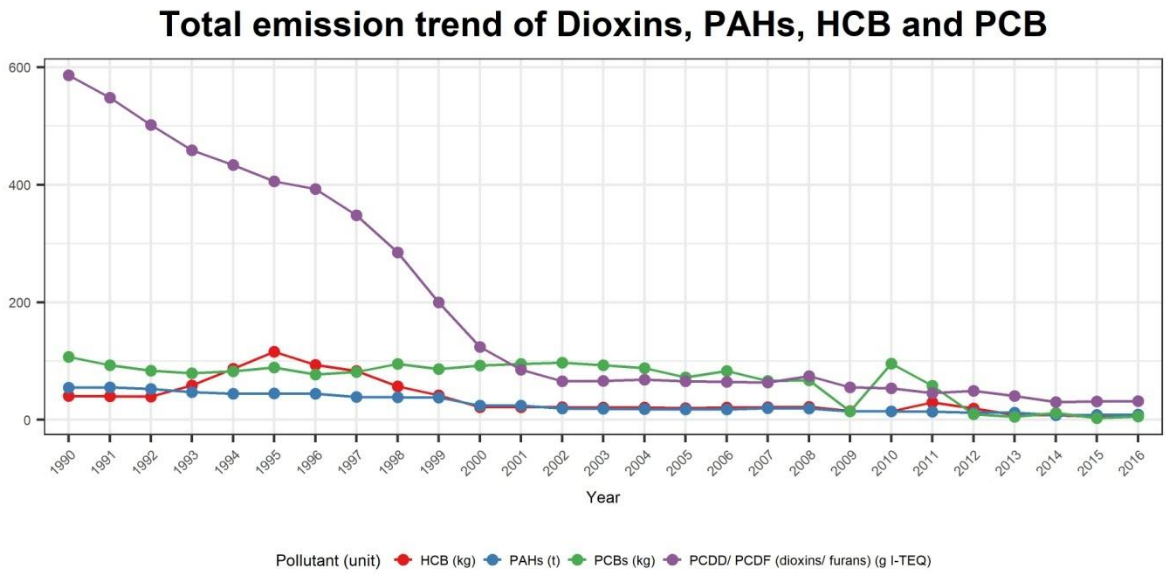
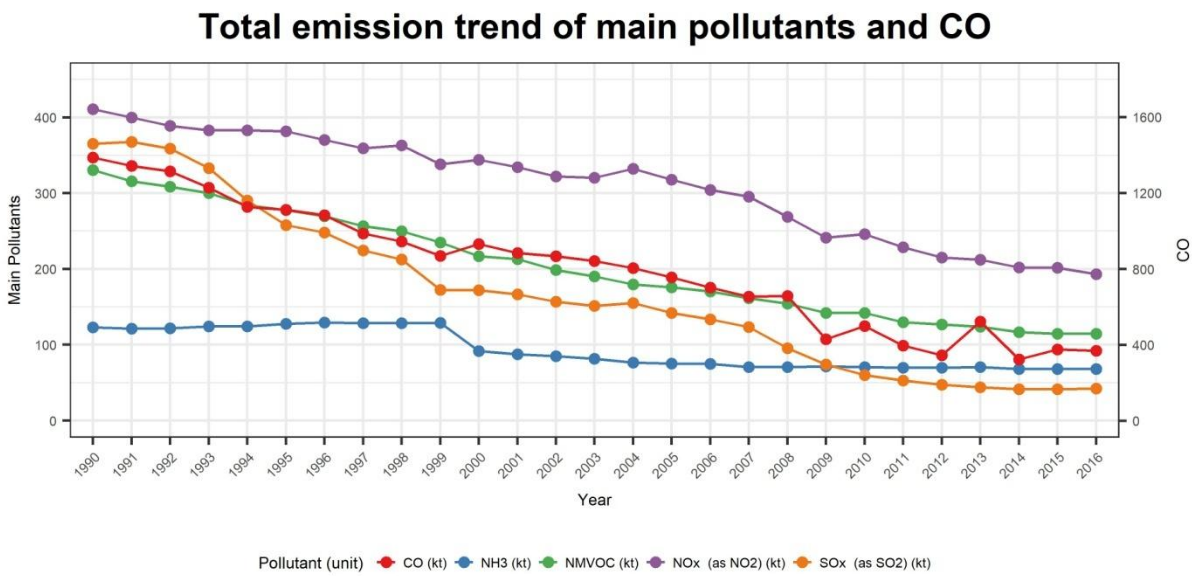
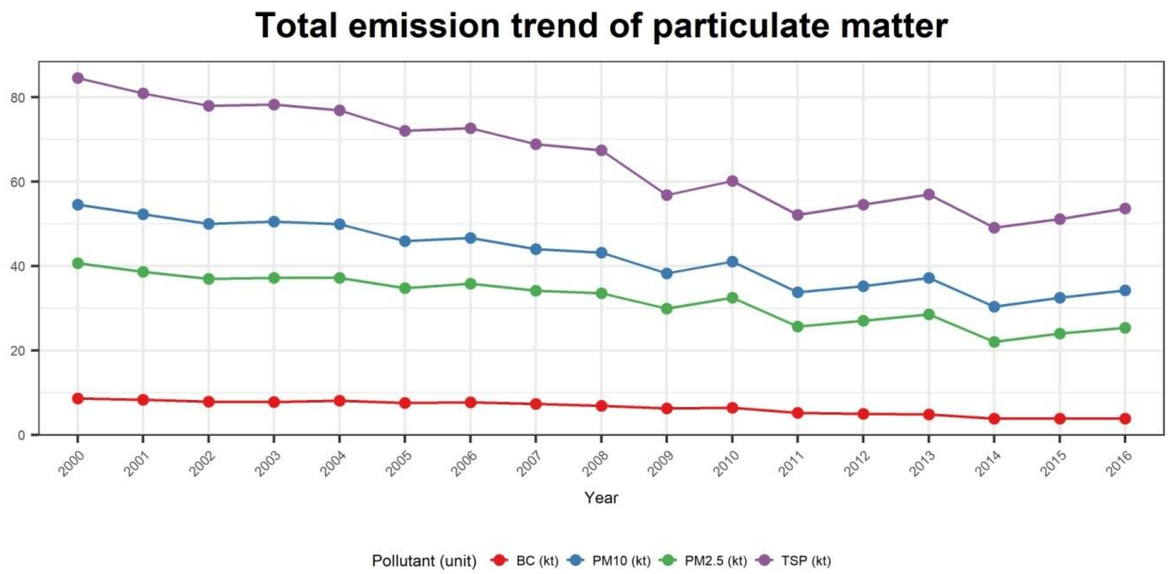


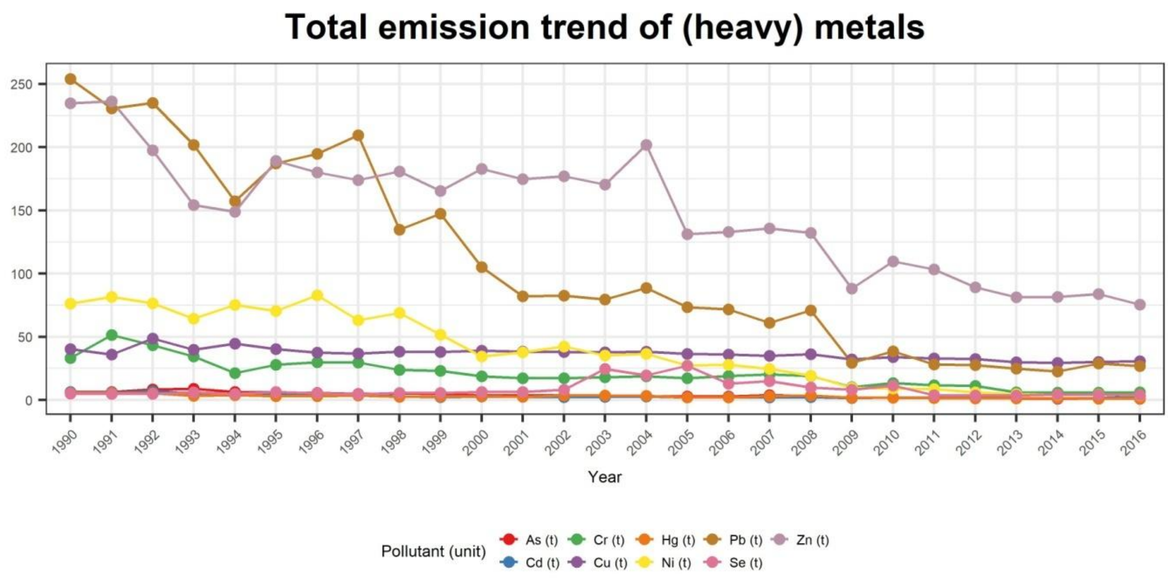
Figure 2-1 shows the trends of the national total emissions per pollutant group. Reasons for the changes in the time series are given in the next paragraphs.

Table 2-1 Absolute total emissions and absolute and relative differences for the time series 1990-2016

Pollutant	Unit	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	absolute difference base-2016	relative difference base-2016
NOx	Gg as NO2	411	344	318	304	295	269	241	246	228	215	212	202	202	193	-218	-53%
NMVOC	Gg	330	217	176	171	162	154	142	142	130	127	124	117	115	114	-216	-65%
SOx	Gg as SO2	365	172	142	133	124	96	74	60	53	47	44	41	41	42	-323	-88%
NH3	Gg	123	92	75	75	71	70	71	71	70	70	71	68	68	68	-55	-45%
PM2.5	Gg	NR	41	35	36	34	34	30	32	26	27	29	22	24	25	-15	-38%
PM10	Gg	NR	55	46	47	44	43	38	41	34	35	37	30	33	34	-20	-37%
TSP	Gg	NR	85	72	73	69	67	57	60	52	55	57	49	51	54	-31	-37%
BC		NR	9	8	8	7	7	6	6	5	5	5	4	4	4	-5	-55%
CO (right axis)	Gg	1389	931	756	701	655	657	429	499	396	345	523	322	375	368	-1021	-74%
Pb	Mg	254	105	73	72	61	71	29	39	28	28	25	22	29	27	-227	-89%
Cd	Mg	6	3	2	2	2	2	2	2	2	1	1	1	2	3	-3	-56%
Hg	Mg	6	3	2	2	3	4	2	2	2	1	1	2	1	1	-4	-76%
As	Mg	6	3	3	3	4	3	2	2	2	1	1	1	1	1	-5	-85%
Cr	Mg	33	19	17	19	20	19	10	13	12	11	6	6	6	6	-27	-82%
Cu	Mg	40	39	36	36	35	36	32	34	33	32	30	29	30	31	-10	-24%
Ni	Mg	76	34	27	28	25	19	10	9	9	6	5	4	4	4	-72	-95%
Se	Mg	5	6	27	13	15	10	8	11	4	4	4	4	4	4	-1	-18%
Zn	Mg	235	183	131	133	136	132	88	110	103	89	81	81	84	75	-159	-68%
PCDD/ PCDF	g I-Teq	586	124	66	65	64	74	55	54	45	49	41	30	31	32	-554	-95%
benzo(a)pyrene	Mg	NE	NE	NE	NE	NE	NE	NE	5	5	4	4	3	3	3	-2	-45%
benzo(b)fluoranthene	Mg	NE	NE	NE	NE	NE	NE	NE	5	4	4	4	3	3	3	-1	-32%
benzo(k)fluoranthene	Mg	NE	NE	NE	NE	NE	NE	NE	2	2	2	2	1	1	1	-1	-39%
Indeno(1,2,3-cd)pyrene	Mg	NE	NE	NE	NE	NE	NE	NE	2	2	2	2	1	1	2	-1	-33%
PAH (Mg)	Mg	55	24	18	18	20	19	14	15	14	12	12	8	8	9	-46	-83%
HCB (kg)	kg	41	22	20	21	21	22	15	15	30	20	9	8	6	6	-35	-86%
PCB (kg)	kg	105	92	71	82	66	67	14	95	57	9	5	11	3	6	-99	-94%


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)



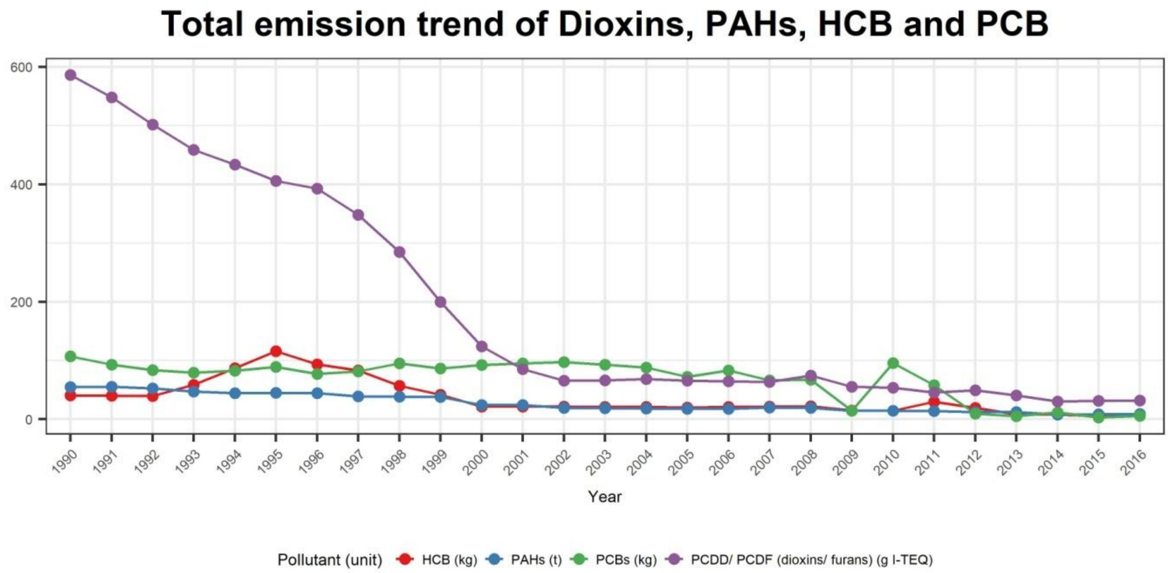


Figure 2-1 Time trends of Belgian national total emissions.

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, 2008-2013) compared to the other years (1994, 1997, 1999, from 2001 to 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.
- *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.
- 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 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 411 kt in 1990 to 193 kt in 2016, which is a decline of 53% (Figure 2-2 and Figure 2-3).

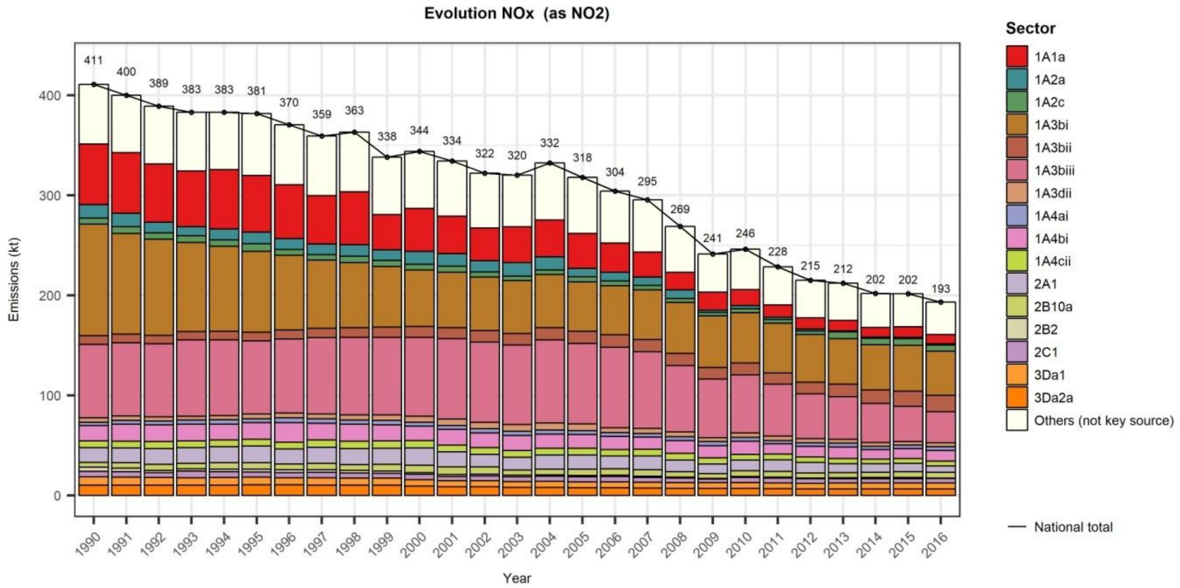


Figure 2-2 Trends in NO_x emissions for the key sectors

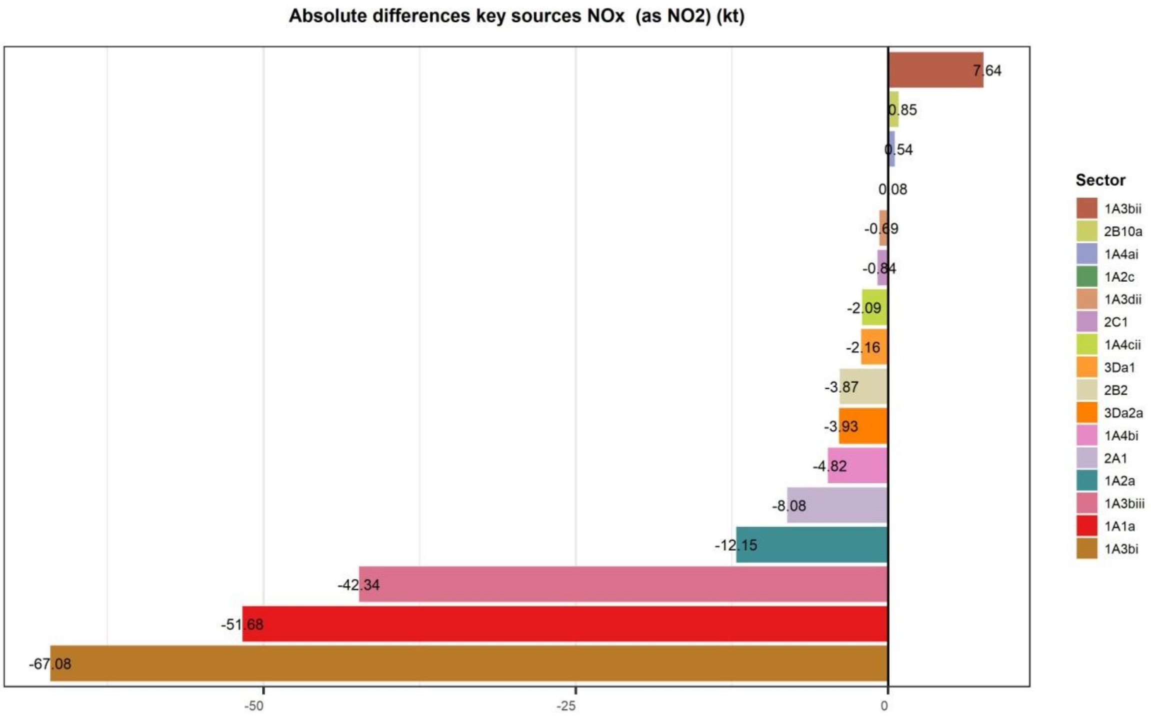


Figure 2-3 Absolute NO_x emission differences from 1990 to 2016 for all key sectors

2.3.2. NMVOC

The emissions of NMVOC show a steady decrease between 1990 and 2016, from 330 Gg to 114 kt (-65%, 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 27-years period is observed in the *food and beverage industry* and *manure management broilers.* A steady increase from 9.6 kt in 1990 to 15.3 kt in 2016 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.

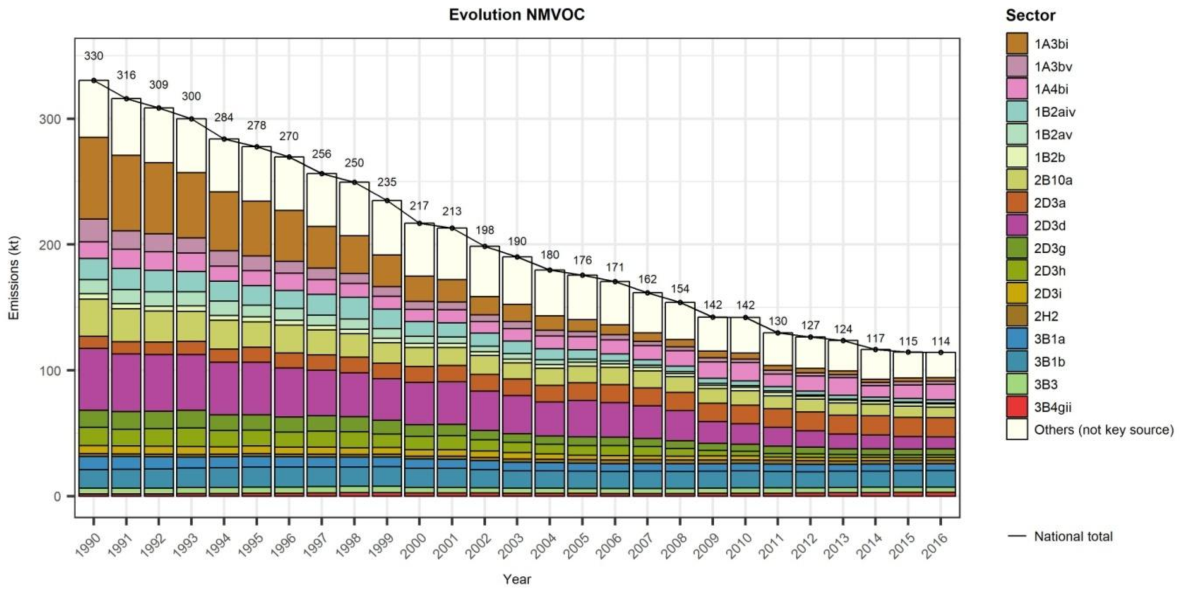


Figure 2-4 Trends in NMVOC emissions for the key sectors

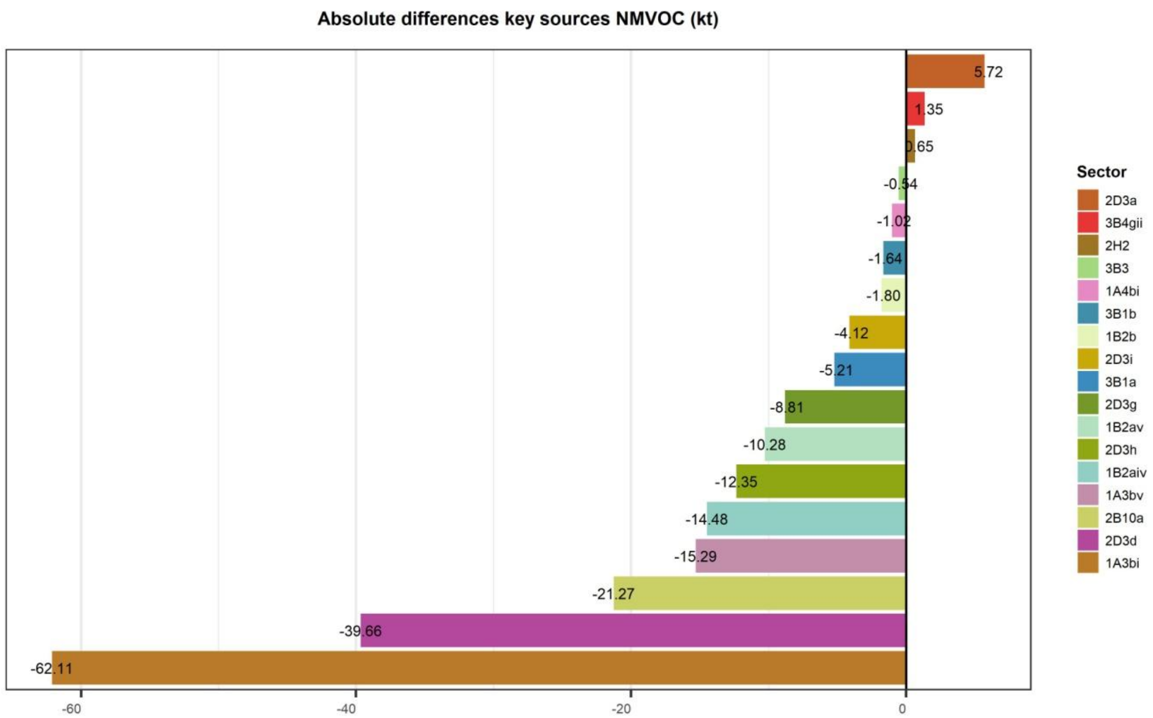


Figure 2-5 Absolute NMVOC emission differences from 1990 to 2016 for all key sectors

2.3.3. SO_x

SO_x emissions declined from 365 kt in 1990 to 42 kt in 2016, a reduction of 88% (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.

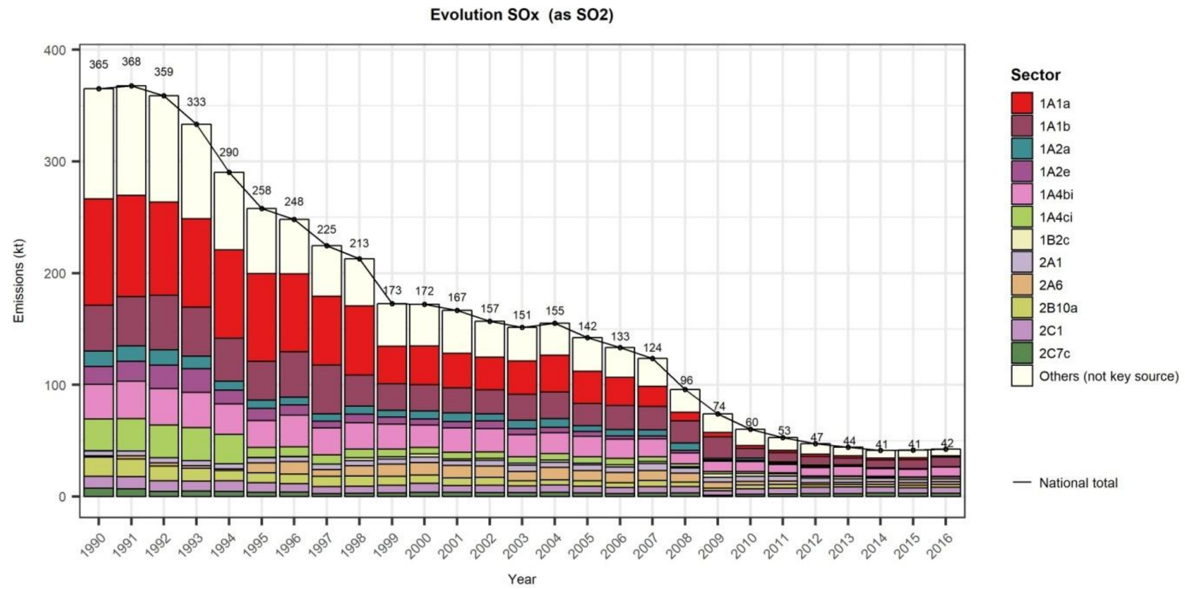


Figure 2-6 Trends in SO_x emissions for the key sectors

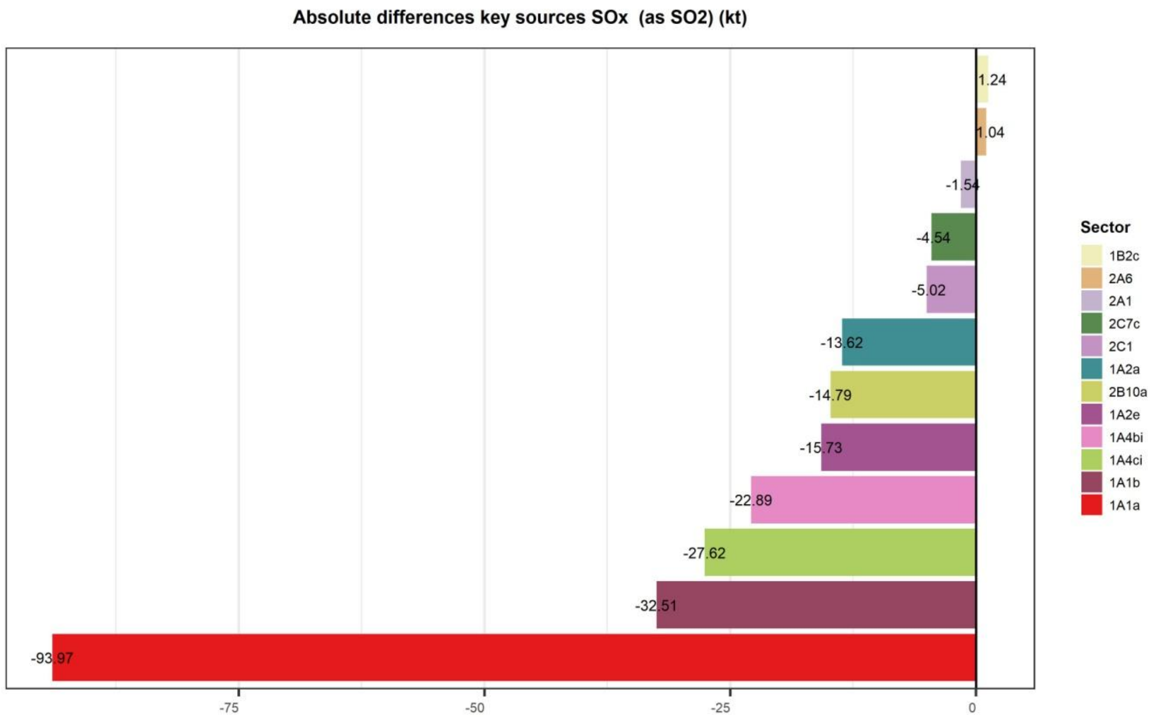


Figure 2-7 Absolute SO_x emission differences from 1990 to 2016 for all key sectors

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 45% between 1990 and 2016 (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).

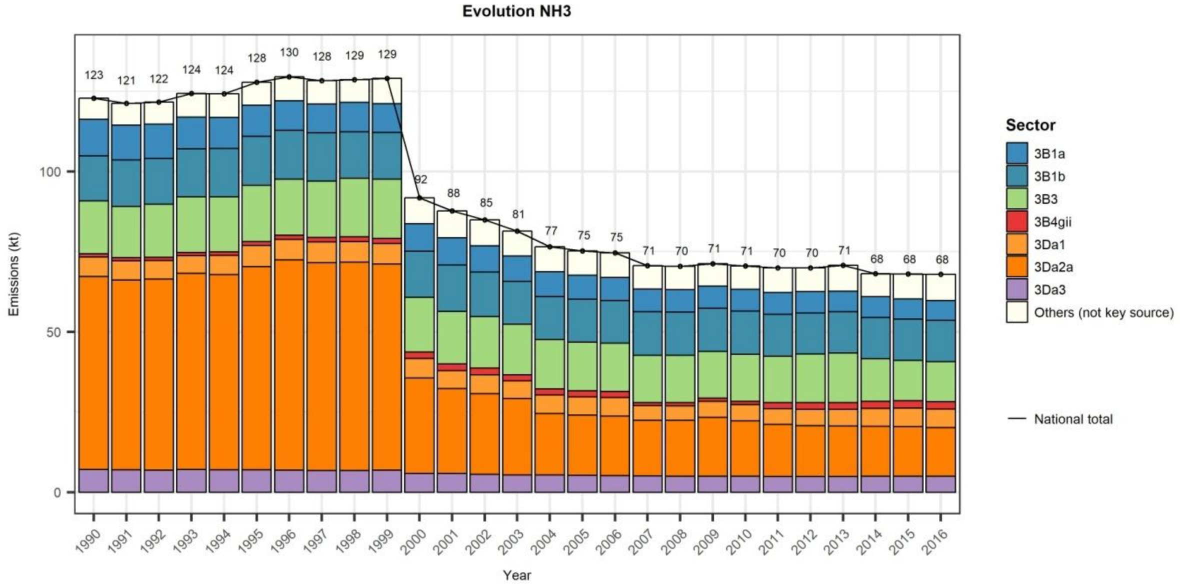


Figure 2-8 Trends in NH_3 emissions for the key sectors

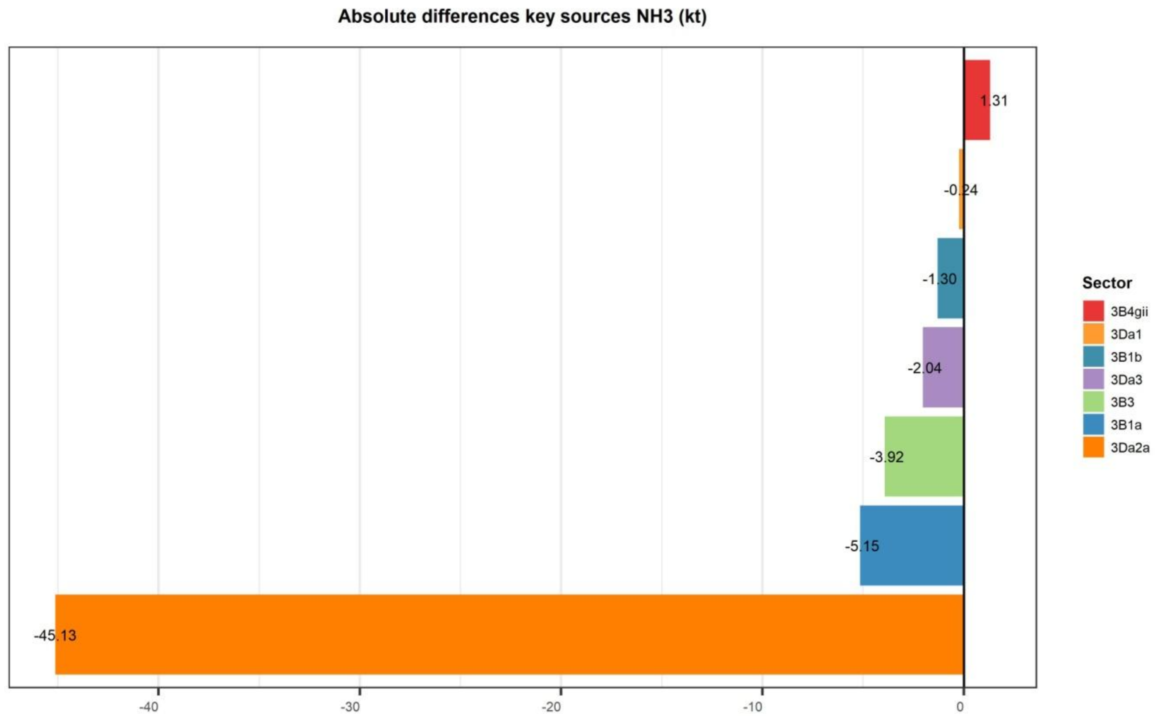


Figure 2-9 Absolute NH_3 emission differences from 1990 to 2016 for all key sectors.

2.3.5. CO

CO emissions decreased from 1389 kt in 1990 to 368 kt in 2016, a reduction of 74% (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).

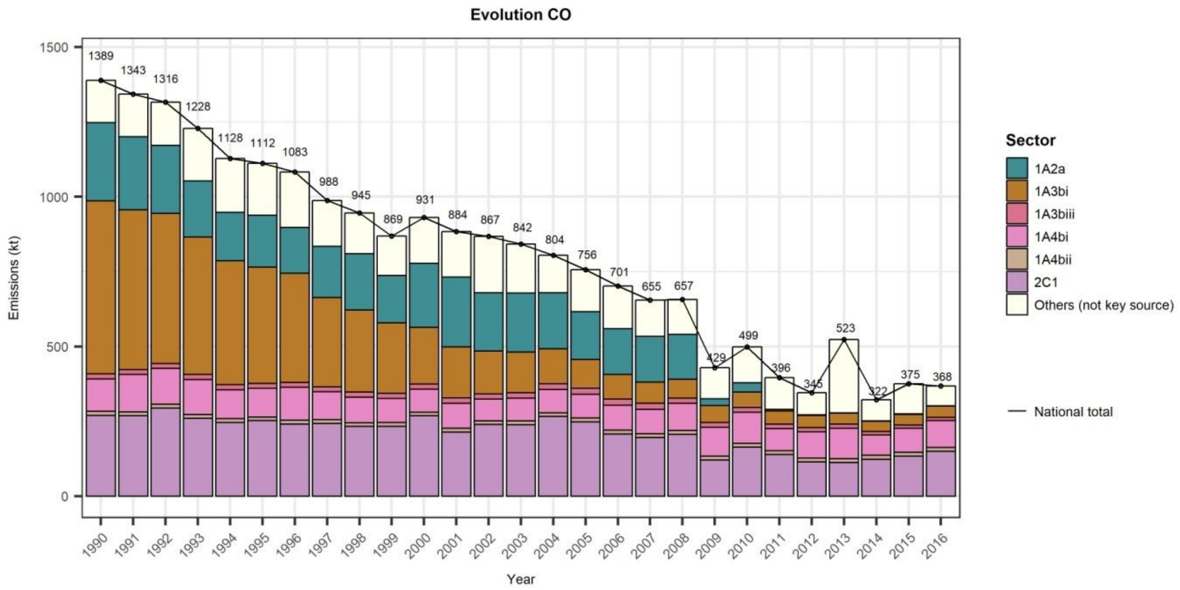


Figure 2-10 Trends in CO emissions for the key sectors

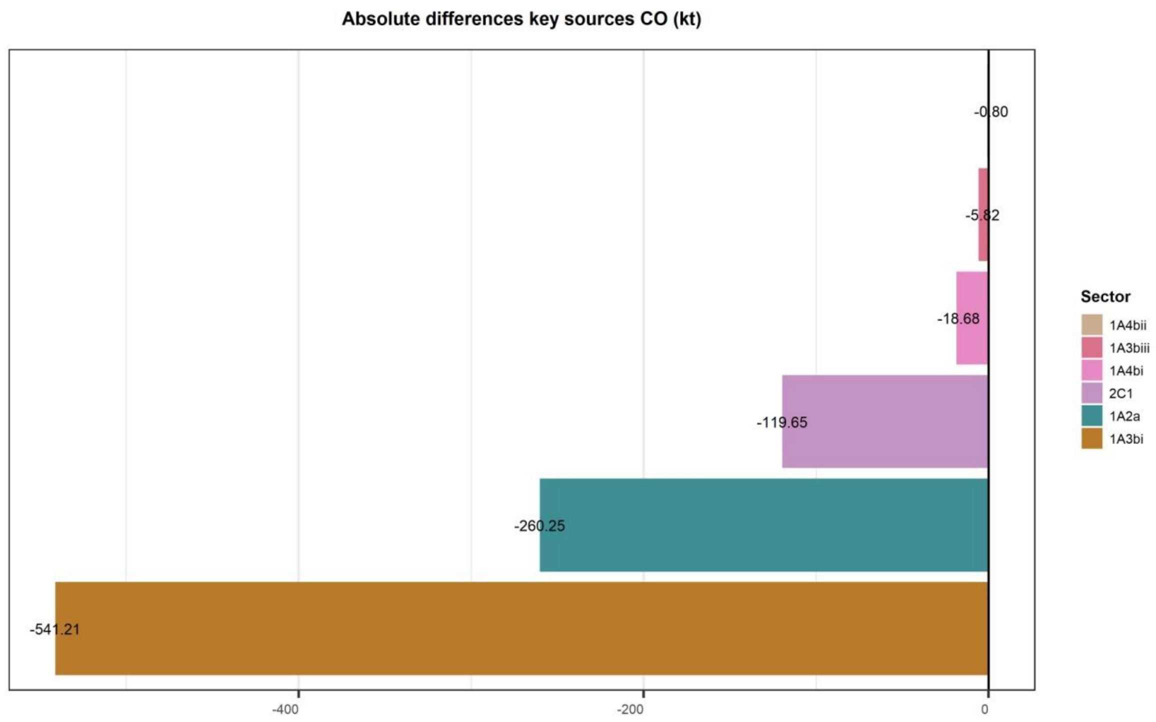


Figure 2-11 Absolute CO emission differences from 1990 to 2016 for all key sectors

2.3.6. PM10

PM10 emissions between 2000 and 2016 declined with 37%, from 55 kt to 34 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 (passenger cars and heavy duty vehicles) and the energy sector. The reduction in the transport sector is due to more stringent emission standards for diesel cars. Between 2008 and 2009 the emissions of the iron and steel production have been reduced significantly due to the closure of some iron and steel plants in Wallonia during 2008 (one coking plant, one sinter plant and one blast furnace plant). There is still one coking plant in Wallonia in 2012. The last sinter plant and the last blast furnace closed in 2011.

The emissions from the residential sector increase significantly over the last 16 years due to the increased use of wood for residential heating.

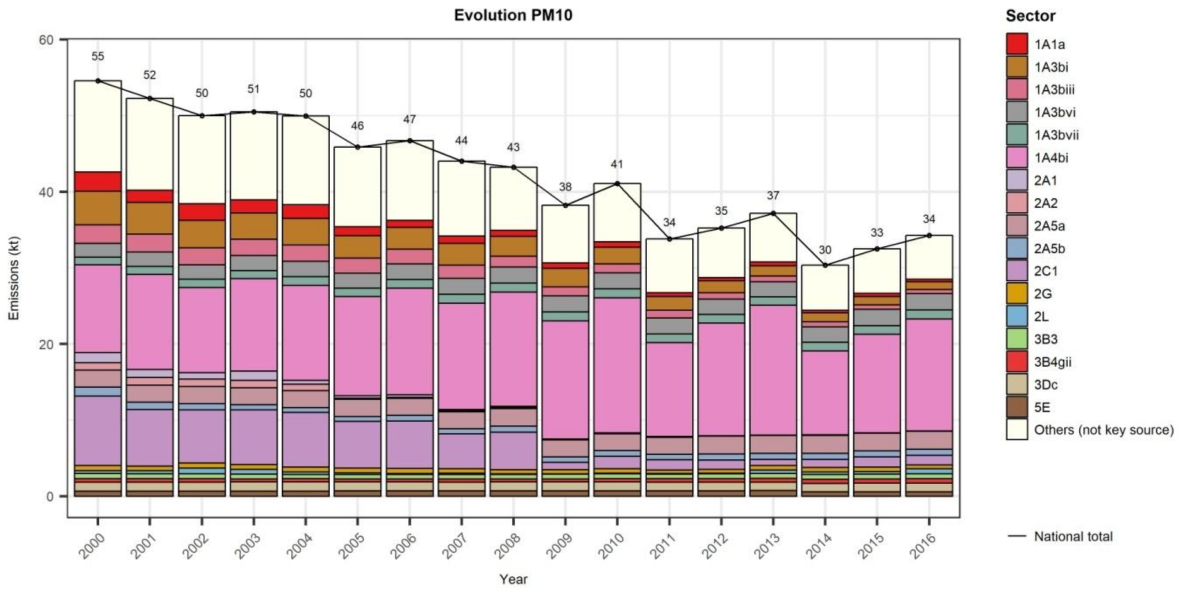


Figure 2-12 Trends in PM10 emissions for the key sectors

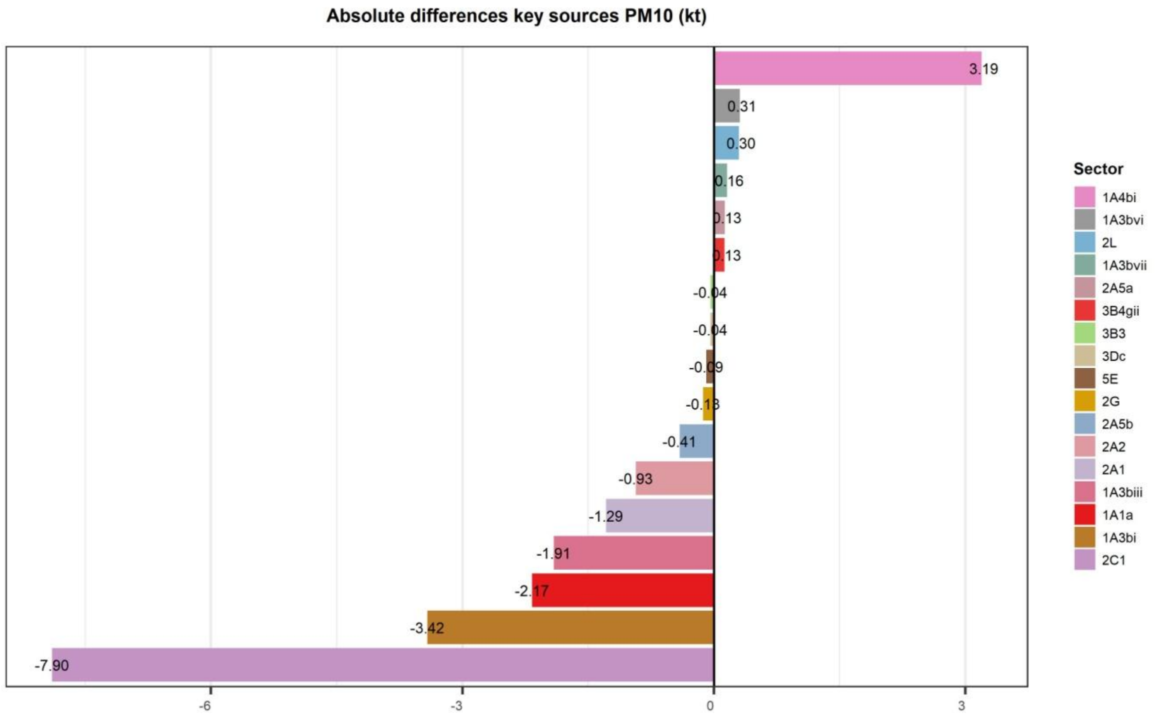


Figure 2-13 Absolute PM10 emission differences from 1990 to 2016 for all key sectors

2.3.7. Pb

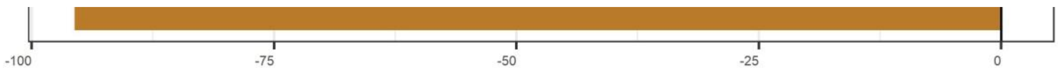


Figure 2-15). The use of unleaded petrol from 2000 on made Pb emissions originated from road transport exhaust very small. *Iron and steel production, public electricity and heat production* and *other metal production* are the other sectors with the greatest emission decreases.

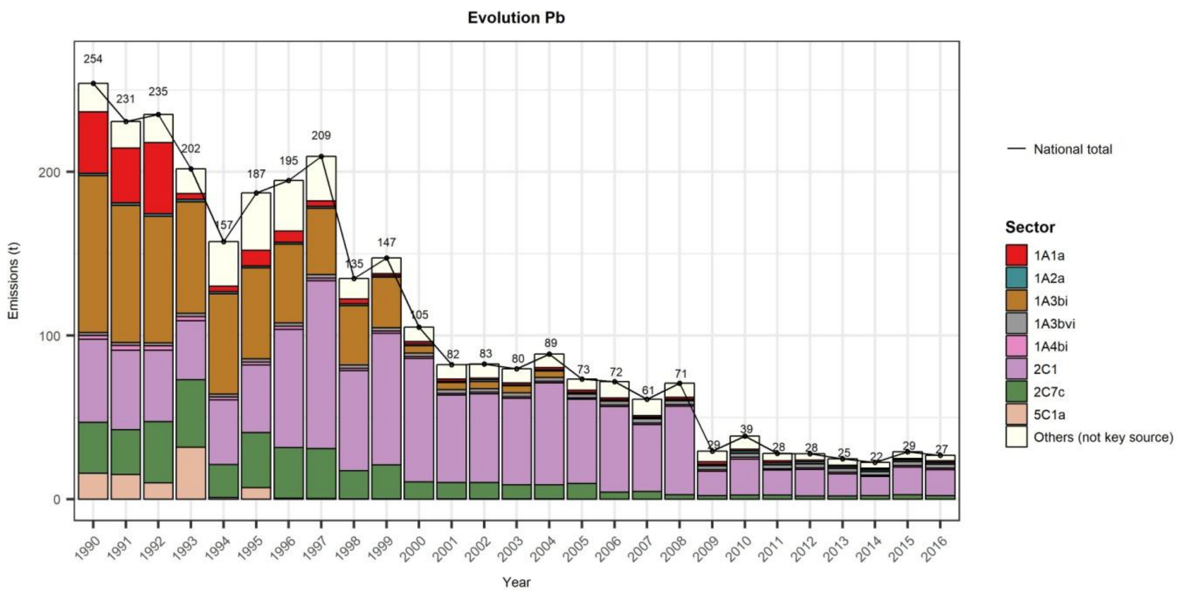


Figure 2-14 Trends in Pb emissions for the key sectors

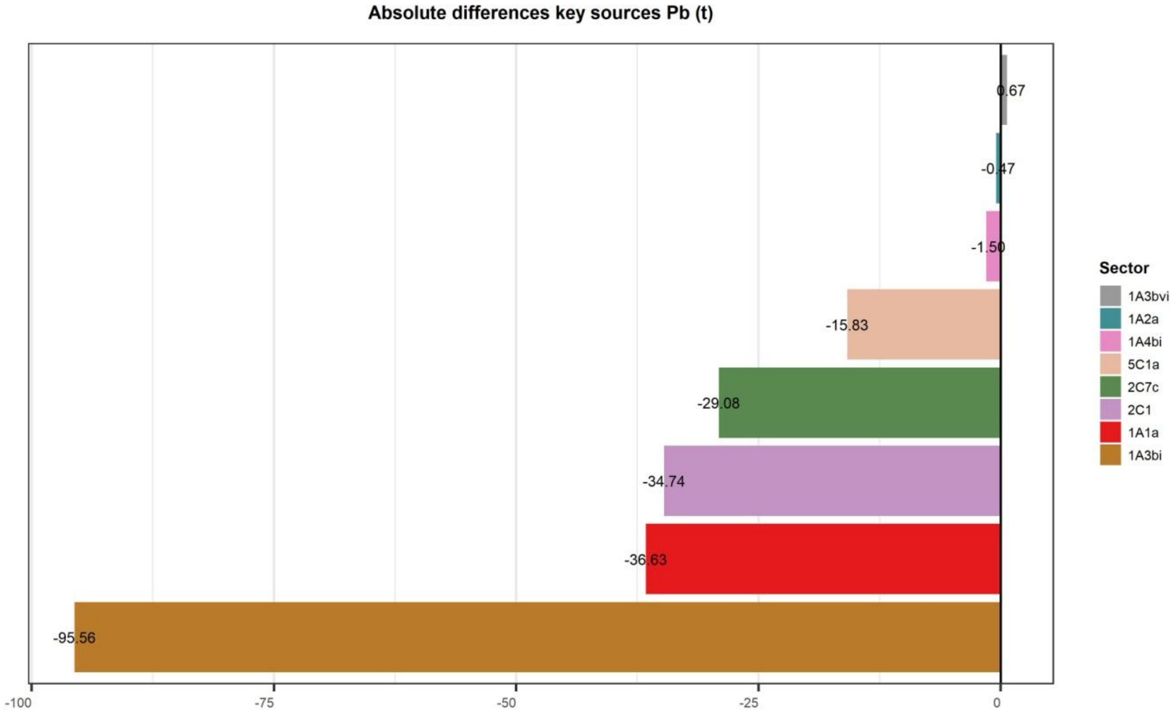


Figure 2-15 Absolute Pb emission differences from 1990 to 2016 for all key sectors

2.3.8. Dioxins and furanes

PCDD-PCDF emissions were high in the early nineties (586 g I-teq), but are greatly reduced in 2016 (32 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*.

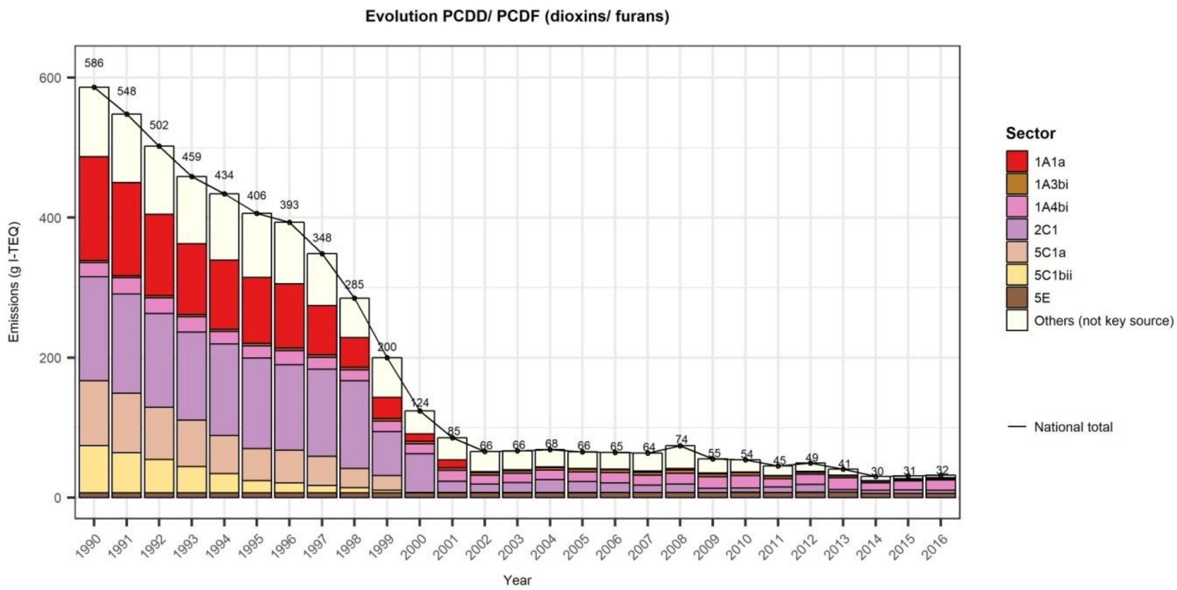


Figure 2-16 Trends in PCDD-PCDF emissions for the key sectors

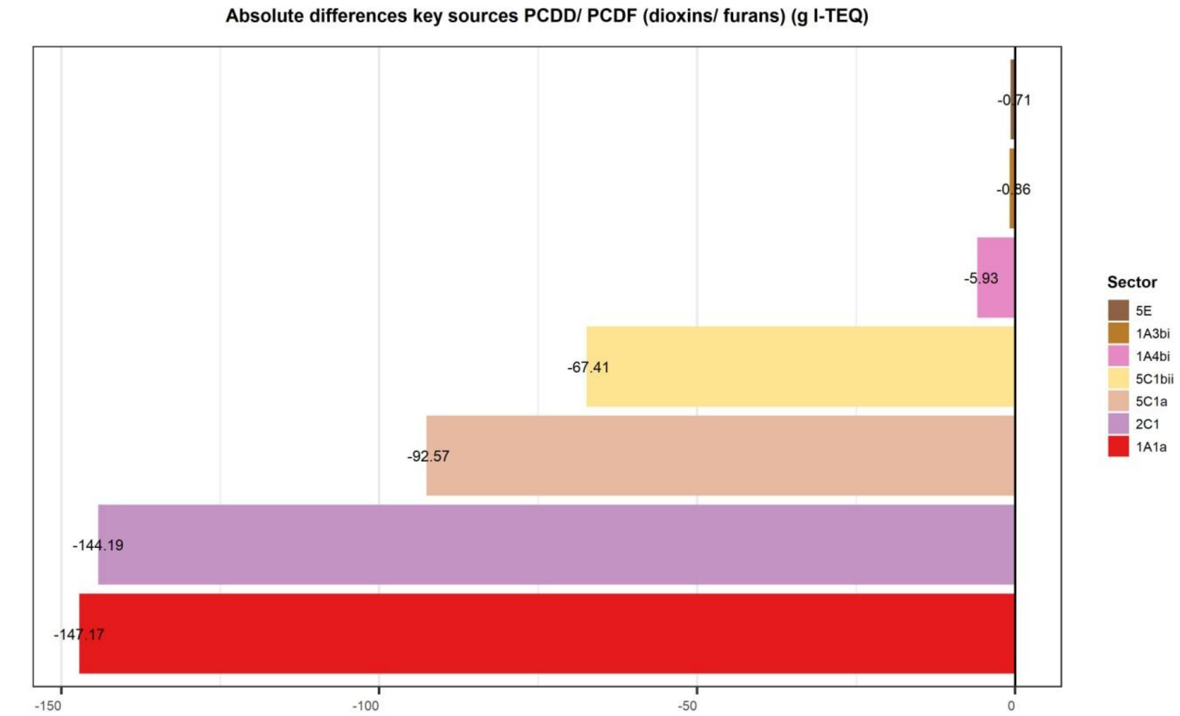


Figure 2-17 Absolute PCDD-PCDF emission differences from 1990 to 2016 for all key sectors

2.3.9. PAHs

Emissions of PAHs decreased from 55 tonnes in 1990 to 9 tonnes in 2016, a reduction of 83% (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.

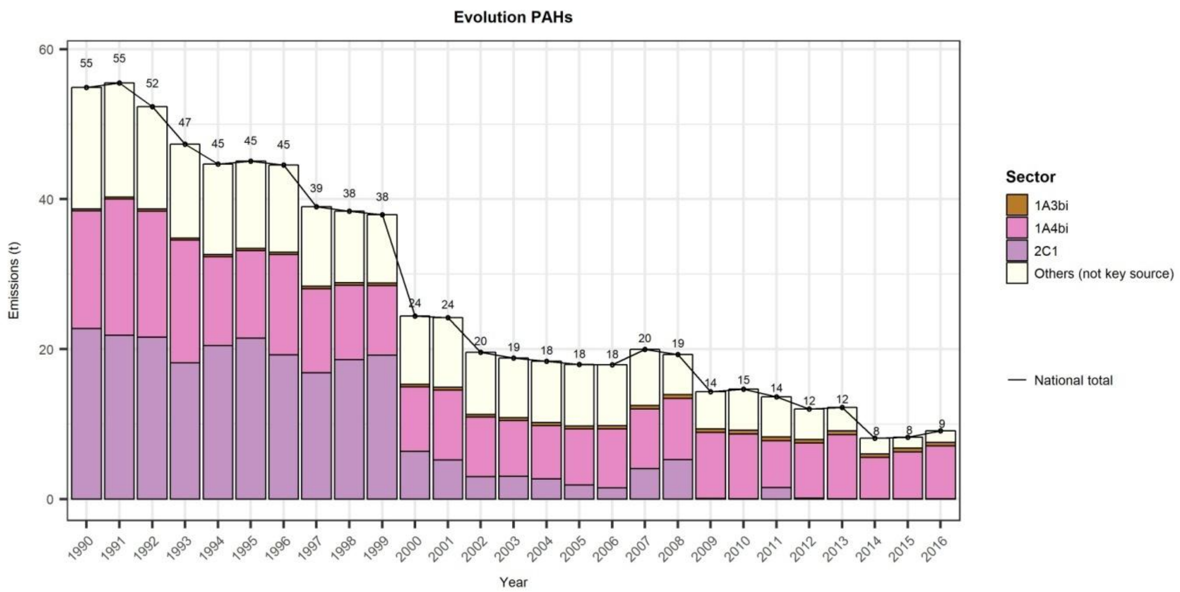


Figure 2-18 Trends in PAH emissions for the key sectors

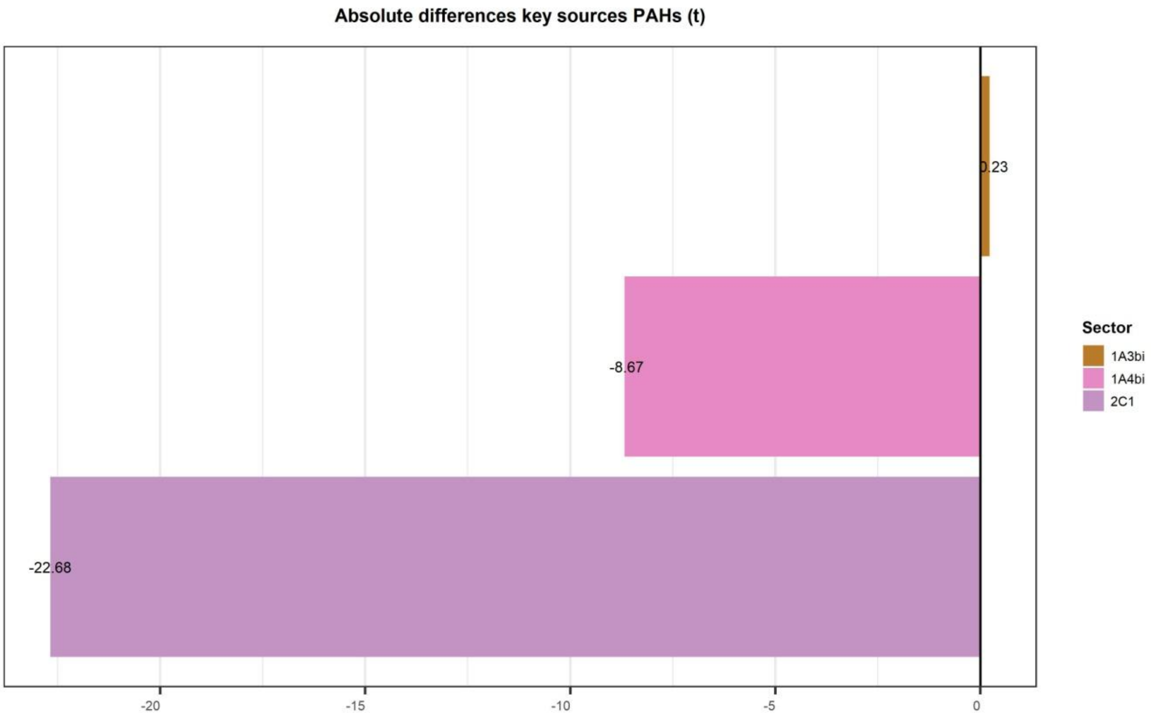


Figure 2-19 Absolute PAH emission differences from 1990 to 2016 for all key sectors

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 :

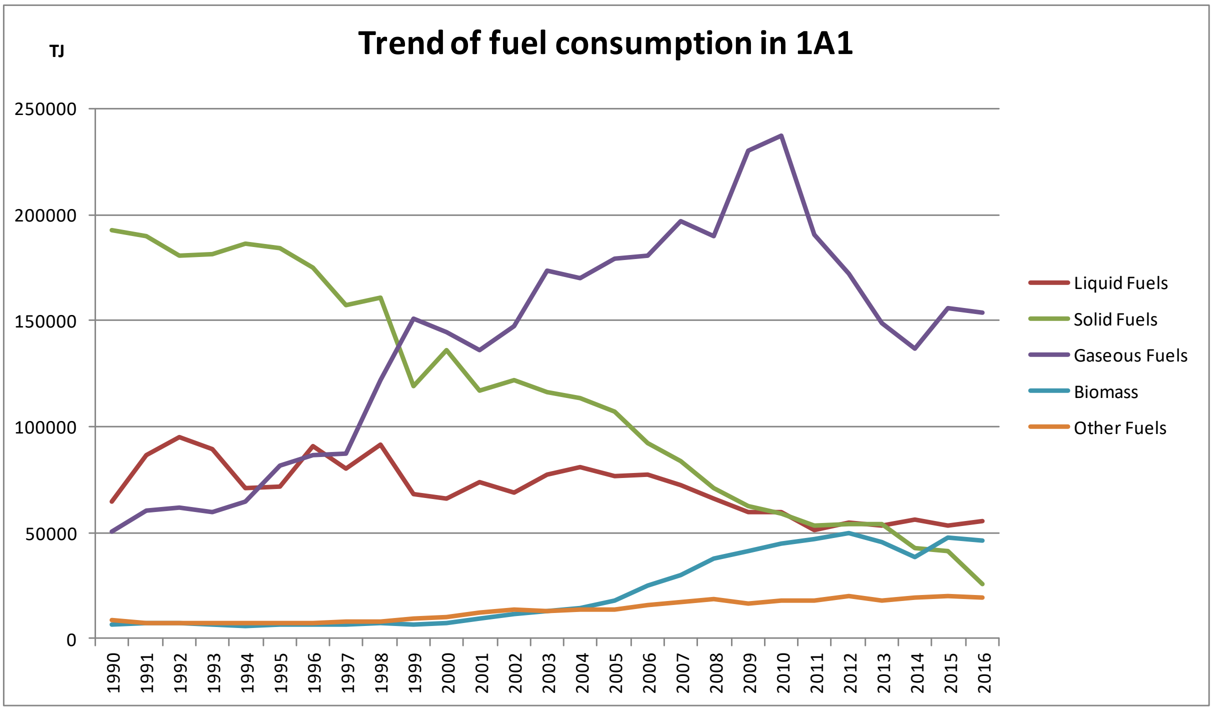


Figure 3-1 Trend of fuel consumption in the energy industries (1A1).

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).

Category 1A1a is a key category of NO_x, Cd, Hg, As, Ni, Se, Zn and HCB emissions in terms of emissions level and trend and a key category of SOx, PM2.5, PM_{10}, TSP, Pb, Cr, Cu and PCDD/F emissions in terms of emissions level or trend only.

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 2016 is presented in the following table (Table 3-1):

Table 3-1 Share to national emissions by regions for the sector 1A1a in the emission year 2016

	Flanders	Brussels	Wallonia
NOx	63.10%	2.43%	34.46%
SOx	66.96%	2.64%	30.40%
TSP	37.13%	1.34%	61.53%

Following the table 3-1, Flanders is prominent for NO_X (63%) and SO_X (67%) but this order is reversed for TSP where the Walloon region becomes prominent with 62% of the emissions. The explanation of this inversion is that in the Walloon region, the emission data are mainly based on environmental annual reports submitted by the operator. For small CHP (combined heat and power) installations < 50MWth, there are no plant specific data and 2016 EMEP/EEA Guidebook emission factors are used to calculate emissions (172 g/GJ wood for TSP - table3-7 2016 EMEP/EEA Guidebook). In Flanders, the emission data are provided by the operators and no wood is burnt in these CHP installations.

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 73 % for NOx, 40 % for SO_2 and for 14 % 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 to 2016. 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 toTable 3-17).

Table 3-2 Emission factors for the sector 1A1a Public electricity and Heat Production in the Walloon region (EMEP/EEA Guidebook 2013 – NH_3 : 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	PS	PS	2.60	39.00	0.60	0.89	0.89	0.89	0.02
Natural gas (in gas turbine)			1.6	4.8	0.60	0.2	0.2	0.2	0.005
GC			2.60	39.00	0.87	2.60	1.18	1.18	0.03
BFG			2.60	39.00	0.60	2.60	1.18	1.18	0.03

Diesel oil			0.80	16.20	0.10	6.50	3.20	0.80	0.27
Diesel oil (in gas turbine)			0.19	1.49	0.10	1.95	1.95	1.95	0.65
Fuel			2.30	15.10	0.10	35.40	25.20	19.30	1.08
Coal			1.00	8.70	0.40	PS	PS	PS	2.2%of PM2.5
Biogas (in stat.engine)	43.70	88	2.50	13	15				
Wood	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/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	mg/GJ	ng/GJ	mg/GJ	yg/GJ	ng/GJ
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 turbine)	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	0.1500		
BFG	5.40	2.60	5.30	9.00	7.50	8.40	0.30	9.20	0.10	1.90	0.1500		
Diesel oil	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 turbine)	0.002	0.0012	0.17	0.28	0.0023	0.007	0.0023	0.44	0.053				
Fuel	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 2016 – NO_X, NMVOC, SO_X,PM2.5, PM10, TSP, BC, CO, PCDD/PCDF, heavy metals, PAHs; EMEP 1996 – NH_3;
For waste : EMEP/EEA Guidebook 2016 – BC, Ni, Se, Zn, PAHs; measurements at the waste incinerator – other pollutants)

FUEL	UNIT	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC	CO	PCDD/PCDF*
Natural gas	g/GJ	89	2.6	0.28	0.6	0.89	0.89	0.89	0.022	39	0.5
Gas 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	235.39	20	65.97	9	8.93	8.93	8.93	0.29	53.09	39.22
FUEL	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAH((4)**
Natural gas	mg/GJ	0.002	0.00025	0.1	0.12	0.0008	7.6E-05	0.0005	0.0112	0.002	0.00308
Gas oil	mg/GJ	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	
Waste	mg/tonne	1109	100	66.1	79.1	91.54	245.5	142	12	1810	12.16
* ng-TEQ/GJ or ng-TEQ/tonne											

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 2016.

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 3-4). 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 3-4 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
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).

[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

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 3-5).

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

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

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

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

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

The percentages applied per power plant are given below (Table 3-6):

Table 3-6 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.

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

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

with :

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

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

- As : the ash content of the fuel, either coming from Michelangelo and provided by TDM, either submitted by external analyses, provided by Fuel Procurement.
- As_{std} : standard ash content that was used in the study of Laborelec to determine the emission rates. this default percentage should be calculated to the current ash-percentage. It amounts to 18.5%.
- $PM_{inst-av}$: the (weighted) yearly average dust emission for the set of groups for which the calculation is performed, expressed in mg/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 3-7). 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 3-7). 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 3-7). For the heavy metals this factor is put at 100% because the effect of the FGD is already taken into account by reduced dust emissions. Only heavy metals that are emitted in volatile state are even further reduced by the FGD.

Table 3-7 Factors to calculate emissions of heavy metals for the sector 1A1a Public electricity and Heat Production in the Flemish region based on fuel analyses

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

<u>Conversion of delivered to consumed solid fuels:</u>

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 3-8):

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

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

Table 3-8 Emission factors for heavy metals from fluid fuels for the sector 1A1a Public electricity and Heat Production in the Flemish region

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

<u>Emissions calculation :</u>

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

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 3-9):

- ESP : dust reduction via electrostatic dust filter (or sleeve filter)
- FGD : SO_2-reduction via FGD

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

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

Table 3-9 Emission factors for heavy metals from gaseous fuels for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel		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

<u>Emission calculations:</u>

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

The calculation of emissions of the PAHs benzo(a)pyrene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and benzo(b)fluoranthene is based on emission factors, which are given in Table 3-10.

Table 3-10 Emission factors for PAH(4) for the sector 1A1a Public electricity and Heat Production in the Flemish region

g/GJ	benzo(a) pyrene	benzo(k) fluoranthene	indeno(1,2,3-cd)pyrene	benzo(b) fluoranthene	source
coal	6,80E-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, biodust	8,00E-05	0	0	0	CORINAIR
biofuel	0	0	0	0	EPA

The calculation of emissions of dioxins and furans (PCDD/PCDF) is based on emission factors, representing the sum of PCDDs and PCDFs (Table 3-11). The emission is expressed in mg I-TEQ (International toxic equivalent). It is assumed that only FGD affects the PCDD/PCDF-emissions. A distinction should be made between normal boilers and gas turbines.

Table 3-11 Emission factors for PCDD/PCDF for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Emission factor (mg I-TEQ/TJ)	RF_{FGD}	source

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 3-12).

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

Table 3-12 Emission factors for PCBs for the sector 1A1a Public electricity and Heat Production in the Flemish region

Fuel	Emission factor (mg/TJ)	Source
Coal	0,04	ESI
Water treatment sludge	0,0456	ESI
Olive stones	0,0456	ESI
Wood dust	0,0456	ESI
Wood chips	0,0456	ESI
Wood pellets	0,0456	ESI
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 3-13, Table 3-14 and Table 3-15.

Table 3-13 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 2016 *
Gas motor	Natural gas	g/GJ	135	56	0.5	0.6	EMEP/EEA Guidebook 2016*
Gas turbine	Gas oil	g/GJ	398	1.49	46.5	0.1	EMEP/EEA Guidebook 2016*
Gas motor	Gas oil	g/GJ	942	130	46.5	0.1	EMEP/EEA Guidebook 2016*
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 3-14 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 2016)

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 3-15 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 2016)

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 3-16).

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 3-17).

Table 3-16 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 3-17 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 NO_x-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.

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 3-18):

Table 3-18 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.

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

There was a coke plant in the Brussels region until 1993. The emission factors used are those included in the EMEP/EEA guidebook 2016 update September 2016 for all the pollutants except for NH_3 which is the same as used in Wallonia (Table 3-19).

Table 3-19 Emission factors for the coke oven in Brussels in the sector 1A1c

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 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).

Following the recommendation of the review team, the notation keys of NMVOC and particulate matter are 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.

The emission factors for heavy metals are given in Table 3-20.

Table 3-20 Emission factors of heavy metals for the cokes ovens in Flanders in the sector 1A1c

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	Source
g/Mg produced coke	0.38	0,007	0,012	0,013	0.17	0.048	0,12	0.016	0.22	EMEP/EEA Guidebook 2016

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.

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. The following chart (Figure 3-2) shows the trend of the energy consumption in this sector :

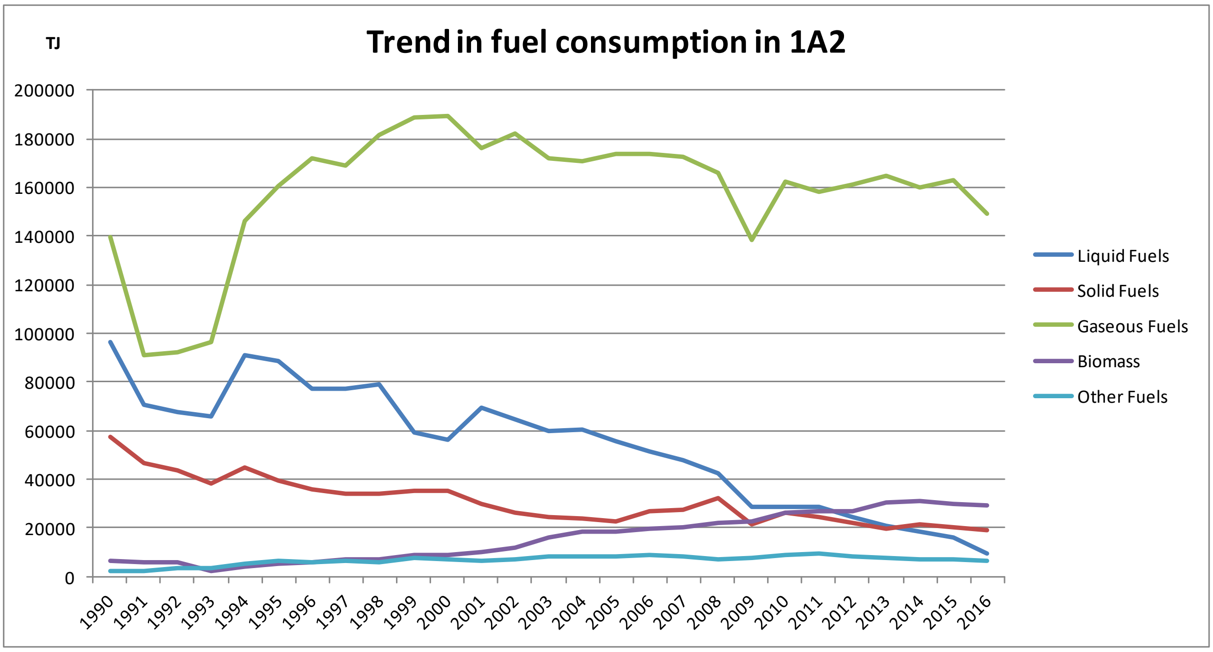


Figure 3-2 Trend of fuel consumption in the manufacturing Industries and construction.

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 3-21 and Table 3-22) give the default emission factors used in the Walloon and Brussels region. Estimated emissions in individual plants in Flanders are based on plant-specific emission factors per installation.

Table 3-21 Emission factors for the sector 1A2 Manufacturing Industries and Construction in the Walloon region (EMEP/EEA Guidebook 2016 – NO_x diesel : calculated with the maximum norm in the plants permits for diesel boilers - 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	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	47	163	25	66	20	20	20	11.2	0.1
Fuel		163	25	66	20	20	20	11.2	0.1

Coal	900	173	88	931	124	117	108	6.912	0.4
Coke	540	173	88	931	124	117	108	6.912	0.4
Wood	11	91	300	570	150	143	140	39.2	37
BFG	70	74	2.5	25	2.60	1.18	1.18	0.03	
Coke gas	70	74	2.5	25	2.60	1.18	1.18	0.03	0.87
LPG		74	2	29	0.45	0.45	0.45	0.02	0.6
Petroleum coke	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 gas	0.1	0	8E-05	8E-04	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-05	8E-04	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

Table 3-22 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	0,031	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	0,031	29	0,52
Fuel	**UNIT**	**Pb**	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**	**PAH(4)**
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	0,08	0,006	0,12	0,03	0,2	0,22	0,008	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 Cr emissions in terms of emissions level and trend and a key category of NOx, SO_2, CO, Pb, As, Ni and Zn emissions in terms of emissions level or 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.

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 3-23) the estimated emission is calculated.

Table 3-23 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	g/GJ	59	0.0000450	46
Cokes gas	g/GJ	40	0.5	58

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2016 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 3-24).

Table 3-24 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 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source Renewable fuels - solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 3-25.

Table 3-25 Emission factors of heavy metals for the sector 1A2a Iron and steel production in the Flemish region (Source: EMEP/EEA Guidebook 2016)

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 a key category of Ni in terms of emissions level.

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

Category 1A2d is a key category of As, Ni and Zn emissions in terms of emissions level and trend and a key category of Cr 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. Flanders will plan this improvement in the future.

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2016 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 3-26):

Table 3-26 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 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source cokes, coal, renewable fuels -solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source renewable fuels - solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 - gaseous	ton/PJ	0,45	100%	100%	7%
Source		EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 - gaseous	ton/PJ	0,45	100%	100%	7%
Source		EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source cokes, renewable fuels - solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 3-27.

Table 3-27 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 2016)

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	1030	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	1030	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 remainder of the emissions is calculated on the basis of the energy balance and the default emissions factors (Table 3-21).

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 3-28).

Table 3-28 Emission factors of CO, SO_x and NO_x in the non-metallic minerals 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

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2016 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 3-29).

Table 3-29 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%
Source		EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source other fuels		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 3-30 gives an overview of the emission factors that are used to calculate the emissions of the sectors included in category 1A2f.

Table 3-30 Emission factors of heavy metals for combustion in the sector of non-metallic mineral product activities for the Flemish region (Source: EMEP/EEA Guidebook 2016)

Non-metallic mineral products 1A2**f**	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

In Wallonia, all the plants which are under the IPPC directive report their annual emissions. The remainder of the emissions is calculated on the basis of the energy balance and the default emissions factors (Table 3-21).

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 2016. VOC and dust are included in the process sector. Heavy metals and dioxins emission factors are coming from the ULg study, see Table 3-31.

Table 3-31 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 Ni emissions in terms of emissions level and 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 3-32).

Table 3-32 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		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

TSP emissions are based on calculations (fuel consumed x emission factors per fuel type). Mostly emission factors of EMEP/EEA Guidebook 2016 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 3-33).

Table 3-33 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 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source renewable fuels - solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO
Source renewable fuels - solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 2016	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	TNO

Source renewable fuels - solid		standard	EMEP/EEA Guidebook 2016	EMEP/EEA Guidebook 2016	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 3-34 gives an overview of the emission factors that are used to calculate the emissions of the sectors included in category 1A2gviii.

Table 3-34 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 2016).

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 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 3-22.

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). In Wallonia, some plants (cement plant, carriers,...) report their off-road emissions which are also included in 1A2gvii.

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

3.4.1. Source category description

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

Until the 2013 submission, the 3 regions used COPERT4 methodologies in specific regional models (previous versions of COPERT4 were used in the Walloon and the Brussels Capital regions, MIMOSA

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

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:

- Each region uses a common fleet module (produced by Transport & Mobility Leuven (TML)) which provides harmonized regional fleet files as input for COPERT. The vehicle fleet is based on actual registration data for the period 2007-2016 and on a combination of fleet data and backwards extrapolations for the period 1990-2006.
- Each region uses the same module for the assignment of mobility.
- Each region uses directly COPERT4 to produce regional emissions and fuel consumptions, on a “fuel used” basis. The emission estimation methodology covers exhaust emissions of CO, NO_x, NMVOC, CH_4, CO_2, N_2O, NH_3, SO_x, exhaust PM, PAHs and POPs, dioxins and furans, PCBs, HCB, and heavy metals contained in the fuel and lubricant, and heavy metals non-exhaust. NO_x emissions are further split into NO and NO_2. PM is also divided into elemental carbon and organic carbon as a function of vehicle technology. A detailed speciation of NMVOCs is also provided. All PM mass emissions in vehicle exhaust are assumed to correspond to PM2.5. PM non exhaust emissions are calculated using the equations from the EMEP/EEA Guidebook 2016.

Emission factors used in the COPERT model can be found in the EMEP/EEA Guidebook 2016.

The 2 major determinants of COPERT modelling, fleet and mobility, are now fully harmonized across the 3 regions. However, for some parameters regional data based on specific measurements and/or modelling have been used (mainly average trip length and duration, driving modes and corresponding average speed values).

For the 2018 submission the emissions from road transport have been recalculated for the whole time series 2000-2016 using the COPERT4v11.4 software :

- By using COPERT4 v11.4, updated NO_x emission factors for PC Diesel & LDV Diesel, Euro6 and on are used
- For Brussels Region, a new dataset for veh.km urban/rural/highway is now available, from year 2000 on. Average speed on the different road types have also been recalculated accordingly
- In Flemish Region, new insights are available to determine the share of busses, coaches and heavy duty vehicles in the ‘heavy transport’ countings on roads. Mobility data were recalculated on that basis from 2013 on.
- No data on mobility were available for 2016 in Walloon Region. For 2018 submission, mobility 2016 = mobility 2015 x Walloon GDP growth (1,4 %).

For PM, a post process correction was applied to account for the retrofitted particulate filters for Euro 4 passenger cars and Euro II and Euro III urban busses.

Because the COPERT results for non-exhaust PM emissions do not allow to differentiate emissions due to road vehicle tyre and brake wear (NFR code 1.A.3.b.vi) and road abrasion (NFR code 1.A.3.b.vii), the non-exhaust PM emissions are calculated outside COPERT. Emission factors for Tier 1 level are used (Table 3-35).

Table 3-35 : Emission factors for non-exhaust particle emissions in the sector road-transport (g/veh.km) (Source: EMEP/EEA Guidebook 2016).

g/veh.km	Tyre & brake wear			Road abrasion		
Vehicle class	T_PM25	T_PM10	T_TSP	R_PM25	R_PM10	R_TSP
Heavy duty vehicles	0,0316	0,059	0,0777	0,0205	0,038	0,076
Light duty vehicles	0,0117	0,0216	0,0286	0,0041	0,0075	0,015
Mopeds & motorcycles	0,0034	0,0064	0,0083	0,0016	0,003	0,006
Passenger cars	0,0074	0,0138	0,0182	0,0041	0,0075	0,015

The consumption modelling in COPERT is entirely based on the energy content of fossil fuels. The use of air-conditioning is included.

Fuel used emissions from road transport are calculated using COPERT4v11.4 and a number of input data: fleet, annual mileages for different vehicle types, number of kilometers driven. In COPERT, emissions of SO_2 and heavy metals are calculated on fuel (used) consumption and the sulphur and heavy metal contents of the fuels.

The statistical fuel correction function in COPERT is not used in Belgium. With the statistical fuel correction function in COPERT the emissions fuel used can be recalculated to fuel sold emissions. But because the 3 Belgian Regions are each responsible for their own emission inventory in their region, and the fuel balance (fuel sold) is on a national scale, the recalculation fuel used/fuel sold is done as a post-processing on COPERT results.

Figure 3-3 shows the amount of fuel for the bottom-up calculation for fuel used (ton fuel) and the reported fuel sold (ton fuel) for road transport, for gasoline and diesel in Belgium. For gasoline, the time series shows a good agreement last 10 years, being the fuel sold amount a little higher for all years. For diesel the difference is larger and varies between the different years. Diesel passenger cars dominate the fleet in Belgium. Difference in diesel quantities can probably be explained by fueling by commuters from neighboring countries, cross-border shoppers, and maybe the main cause the international road transit traffic of freight by heavy duty vehicles.

Figure 3-3 Fuel used vs. fuel sold trend for gasoline and diesel for road transport in Belgium

Since the 2015 submission, the emissions are reported as “fuel sold”. Fuel sold emissions are calculated using a correction on the fuel used emissions, the so called ‘scaling factor’, The scaling factor is obtained by dividing for each year and given fuel the total amount of fuel sold from the federal fuel balance report by the total fuel used of the 3 regions. The difference between fuel used and fuel sold emissions depends on the share of the different fuel types in the emission totals. The same scaling factor is used for all air pollutants (exhaust). PM emissions from brake and tyre wear and from road abrasion were not adjusted for differences between fuel used and fuel sold, since these emissions are not directly related to fuel use. Table 3-36 shows the scaling factors Fuel sold/Fuel used. Figure 3-4 shows the trend of the fuels sold in the road transport sector (1A3b).

Table 3-36 Fuel sold/fuel used scaling factors (calculated)

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gasoline	1.17	1.16	1.25	1.23	1.26	1.30	1.29	1.24	1.26	1.24
Diesel	1.09	1.03	1.01	1.05	1.03	1.01	1.02	1.05	1.04	1.02

Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gasoline	1.23	1.26	1.25	1.28	1.23	1.13	1.14	1.16	1.16	1.16
Diesel	1.05	1.06	1.07	1.08	1.13	1.10	1.11	1.12	1.17	1.18

Fuel	2010	2011	2012	2013	2014	2015	2016
Gasoline	1.13	1.13	1.09	1.09	1.10	1.11	1.10
Diesel	1.16	1.14	1.11	1.09	1.10	1.14	1.14

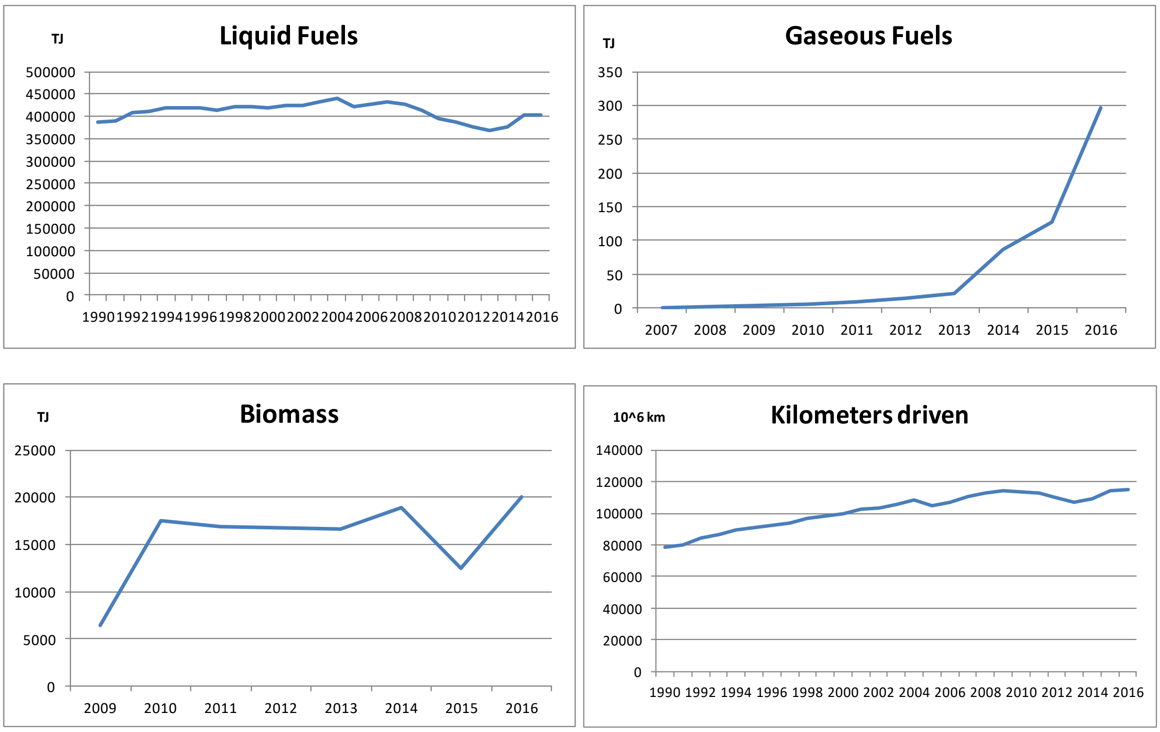


Figure 3-4 Trend of fuels sold and kilometers driven in road transport 1A3b

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, 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. In September 2017, EUROCONTROL made available new datasets with emissions for years 2005-2016 and a document with the explanation about the changes made in 2017. In the 2018 submission, this dataset is used for emissions 2016. That means their new calculation method for NMVOC and TOG (organic gas emissions, e.g. benzene) is implemented in our inventory for the year 2016 only. New datasets for 2005-2015 will be used in the 2019 submission.

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 aannam
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 + b
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 aannam
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 aannam
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.

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 2016.

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 2016, 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 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., van der Gon, H.D., Appelman, W. & Verheul, M. (2012): Emission factors for heavy metals from diesel and petrol used in European vehicles. 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 emissions in terms of emissions level and trend.

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 (**Fout! Verwijzingsbron niet gevonden.**). The NCV considered is 42,7 GJ/t)

Table 3-43 Emission factors in the railways sector (EMEP/EEA Guidebook 2016)

Fuel	**UNIT**	**NOx**	**NMVOC**	**SOx**	**NH3**	**PM2.5**	**PM10**	**TSP**	**BC (EC)**	**CO**	**PCDD/PCDF***
Gas oil	g/GJ	1219	108.2	94.4	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											

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.

3.4.2.4 Navigation

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

For navigation, fuel consumption is taken from the regional energy balances.

In Flanders, emissions from maritime navigation are calculated with the emission model EMMOSS. The emissions originating from maritime shipping starting and arriving in Belgium (including sand extraction at sea, dredging activities and tugboats) are reported in the category 1A3di(ii) (international inland waterways). The emissions coming from maritime shipping between a Flemish and a foreign harbour (including emissions originating in the Flemish harbour) are reported in the memo item 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 (Figure 3-5) is shown below

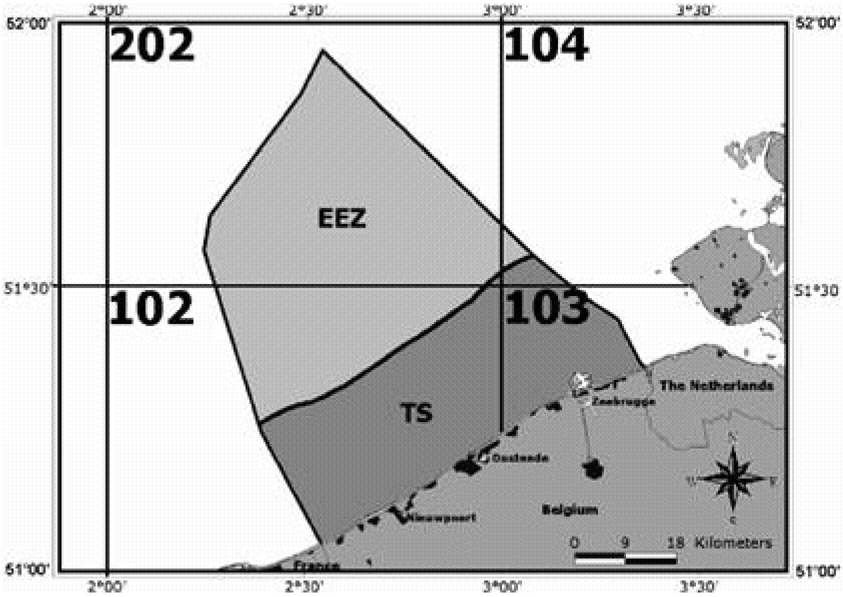


Figure 3-5 Map of the Belgian maritime areas

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

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 are emission factors of the EMEP/EEA Guidebook 2006 (Table 3-45).

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	0,0017	EMEP-EEA guidebook
Ni	0,00007	EMEP-EEA guidebook
Pb	0,01	EMEP-EEA guidebook
Zn	0,001	EMEP-EEA guidebook

The emissions from inland navigation are estimated in the Walloon and Brussels region by multiplying the sector's fuel consumption by the fuel specific emission factors. The emission factors are those described in the EMEP/EEA Guidebook 2016.

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

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	193
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.

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) (Schrooten et al., 2009) in the three regions.

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 and As emissions in terms of emissions level and trend and of Ni emissions in terms of trend.

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.

The following chart (Figure 3-6) shows the trends of the energy consumption in the commercial/institutional sector.

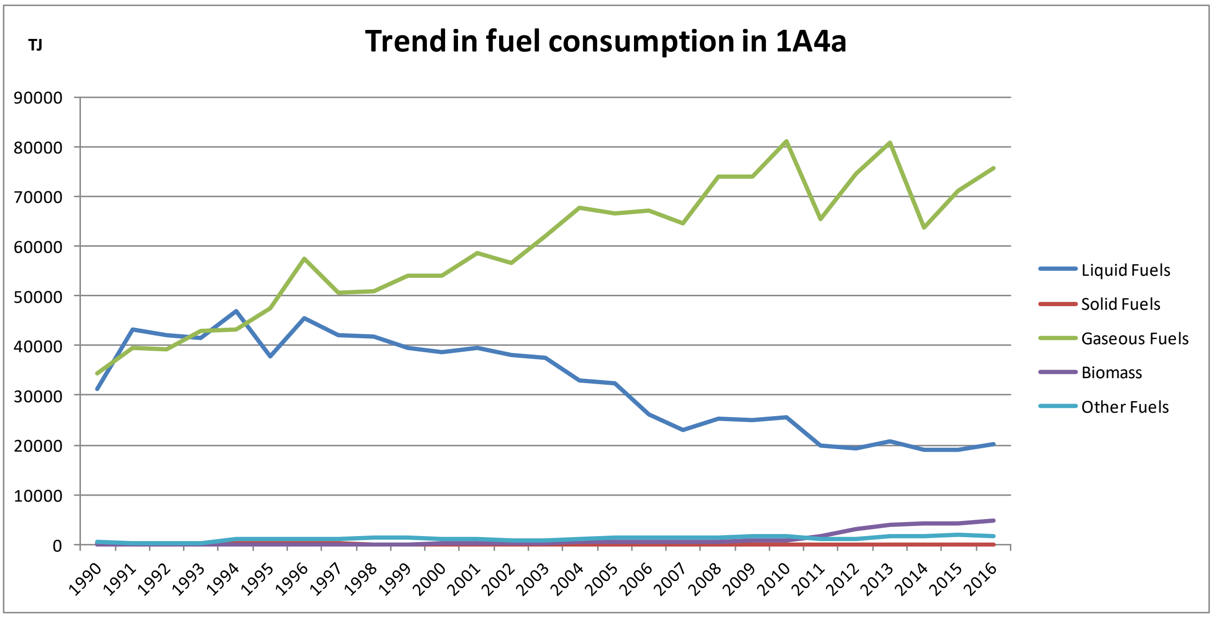


Figure 3-6 Trend of fuel consumption in the commercial/institutional sector.

In Flanders, emissions by heating systems of buildings are calculated on a collective basis. The database consists of emissions due to tertiary combustion (heating by hotels/restaurants, medical services, education, offices and administrative activities, trade, other services and combined heat-power installations (CHP)). Emissions are calculated by multiplying the energy use and emission factors. Data on energy used can be found in the Energy Balance for Flanders. A provisional energy balance is made yearly for year (x-1), whereas a final energy balance is made for year (x-2). The tertiary sector contains energy data on 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 2016.

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 2017 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 3.

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

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

Emission factors used to calculate the emissions of stationary combustion in the commercial sector in the the Walloon and Brussels regions are given below (

Table 3-47 to Table 3-48).

Table 3-47 Emission factors for the sector 1A4ai in the Walloon region (EMEP/EEA Guidebook except NO_x and dust).

	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	600	104	89	931	124	117	108	6.9	0.4
Wood	11	77.5-77.9	300	570	150	143	140	39.2	37
Diesel oil	48	42.3-43	10	66	5.0	3.9	3.0	1.7	0.1
Natural gas	0.5	36.1-40.3	0.36	24	0.45	0.45	0.45	0.02	0.6
Lamp petroleum		60	10	66	5.0	3.9	3.0	1.7	0.1
LPG		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	4	1.8	17.5	13.5	13	134	1.8	200	7.9	203	146.6	170	0.62
Wood	0.19	13	6	23	2	27	0.5	512	0.56	100	35	0.06	5
Diesel oil	0.03	0.006	0.22	0.2	0.008	0.08	0.11	29	0.12	1.4	0.02		
Natural gas	0.12	0.00025	8E-05	0.0008	5E-04	0.0015	0.011	0	0.1	0.5	0.003		
Lamp petroleum	0.03	0.006	0.22	0.2	0.008	0.08	0.11	29	0.12	1.4	0.02		
LPG	0.12	0.00025	8E-05	0.0008	5E-04	0.0015	0.011	0	0.1	0.5	0.003		

Table 3-48 Emission factors for the sector 1A4ai in the Brussels Capital Region.

Fuel	**UNIT**	**NOx**	**NMVOC**	**SOx**	**NH3**	**PM2.5**	**PM10**	**TSP**	**BC (EC)**	**CO**	**PCDD/PCDF***
Natural gas	g/GJ	343.61	23	0,67	0,6	0,78	0,78	0,78	0,031	29	0,52
Gas oil	g/GJ	41.82	12.9	23.7	0,1	20	20	20	11,2	40.3	2.6
Wood	g/GJ	91	300	11	37	140	143	150	39,2	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	2	0,6	0,4	4.2	0,6	2	0,4	2.1	36	0,0201
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 NO_x, NMVOC, SO_x, CO, $PM_{2,5}$, PM_{10}, TSP, BC, Cd, Cr, Zn, PAH and PCDD/F emissions in terms of emission level and trend and of Pb, Hg and As 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)

The following chart (Figure 3-7) shows the trends of the energy consumption in the residential sector.

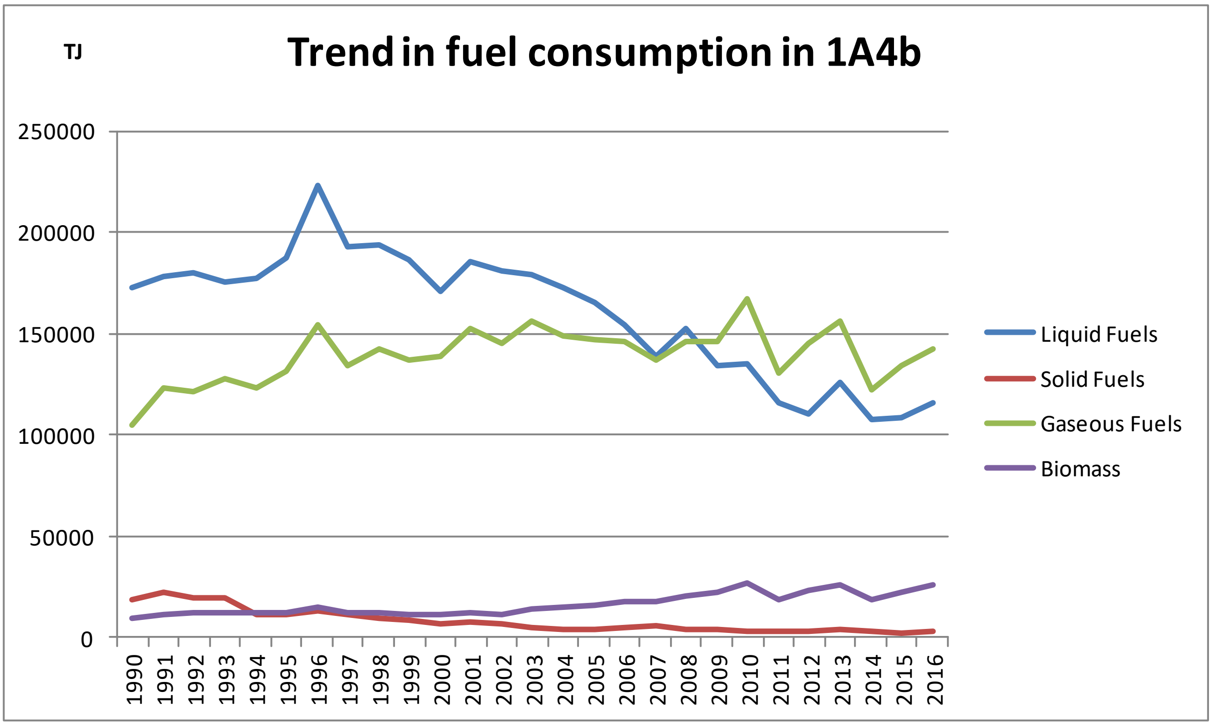


Figure 3-7 Trend of fuel consumption in the residential sector.

In Flanders, emissions by heating systems of buildings are calculated on a collective basis. The database consists of emissions due to residential combustion (heating by households). Emissions are calculated by multiplying the energy use and emission factors (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 2016. In 2017 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 3.

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

In 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 (emssion factors for 2016). 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.

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).

Table 3-49 Emission factors for the sector 1A4bi in the Walloon region for 2015 (EMEP/EEA Guidebook 2013 update June 2016 except NO_x and dust)

	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	48	42.4-43	0.69	57	1.9	1.9	1.9	0.2	0.1
Natural	0.3	30-40	1.9	26	1.2	1.2	1.2	0.1	0.6
LPG	0.3	40	1.9	26	1.2	1.2	1.2	0.1	0.6

	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	5.9	0.35		
Natural	0.12	0.0003	7.6E-	0.0008	0.00051	0.0015	0.011	0.002	0.1	1.5	0.003		
LPG	0.12	0.0003	7.6E-	0.0008	0.00051	0.0015	0.011	0.002	0.68	1.5	0.003		

Table 3-50 Emission factors for the sector 1A4bi in the Brussels Capital Region for 2015 (Source for the emission factors: ECONOTEC study 2010 for NO_x; EMEP 1996 for NH_3 and EMEP/EEA 2016 for the other pollutants). except wood, Inventory peer-audit 2018

Fuel	UNIT	NOx	NMVOC	SOx	NH3	PM2.5	PM10	TSP	BC (EC)	CO	PCDD/PCDF*
Natural gas	g/GJ	27.22	1,9	0,3	0,6	1,2	1,2	1,2	0,065	26	1,5
Gas oil	g/GJ	41.41	0,69	70	0,1	1,9	1,9	1,9	0,1615	57	5,9
Wood	g/GJ	87.23	285.45	11	37.59	228.39	234.24	246.38	22.84	2744.31	177.04
Coal	g/GJ	104,4	484	900	0,3	398	404	444	25,472	4600	800
Butane/Propane	g/GJ	40	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	0,002	0,00025	0,1	0,12	0,0008	0.000076	0,0005	0,011	0,0015	0,00308
Gas oil	mg/GJ	0,012	0,001	0,1	0	0,2	0,13	0,005	0,002	0,42	0,35
Wood	mg/GJ	27	13	0,6	0,19	23	6	2	0,5	512	183.42
Coal	mg/GJ	130	1,5	5,1	2,5	11,2	22,3	12,7	1	220	800
Butane/Propane	mg/GJ	0,002	0,00025	0,1	0,12	0,0008	0.000076	0,0005	0,011	0,0015	0,00308
* ng-TEQ/GJ											

Concerning the wood and the coal combustion in the Walloon region, no detailed information is available on individual installations, The approach used during this submission consisted in an approach between a tier 1 and a tier 2 approach. Following the Walloon energy balance, a distinction is made between the use of pellets and wood logs and also between the centralized residential heating (boilers) and the decentralized residential heating (stoves,...). Since 2000, the amount of wood and coal has been estimated for 5 types of installations. The references of the emission factors coming from the EMEP/EEA Guidebook 2016 are included in the Table 3-51.

Table 3-51 Reference to EF tables in EMEP/EEA Guidebook 2016 used in the Walloon region

Coal (stoves,..)	Coal (boilers)	Wood logs (stoves)	Wood logs (boilers)	Pellets (stoves and boilers)
Table 3-15	Table 3-16	Table 3-17	Table 3-18	Table 3-25

For the Brussels Capital Region, in the 2018 submission, new emission factors 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.

This information was combined with the Tier 2 emission factors of EMEP/EEA Guidebook 2016 in order to calculate average emission factors for Brussels as indicated in Table 3-50 allowing to include the evolution of park of equipment and its performance.

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. The following chart (Figure 3-8) shows the trends of the energy consumption in the agricultural sector.

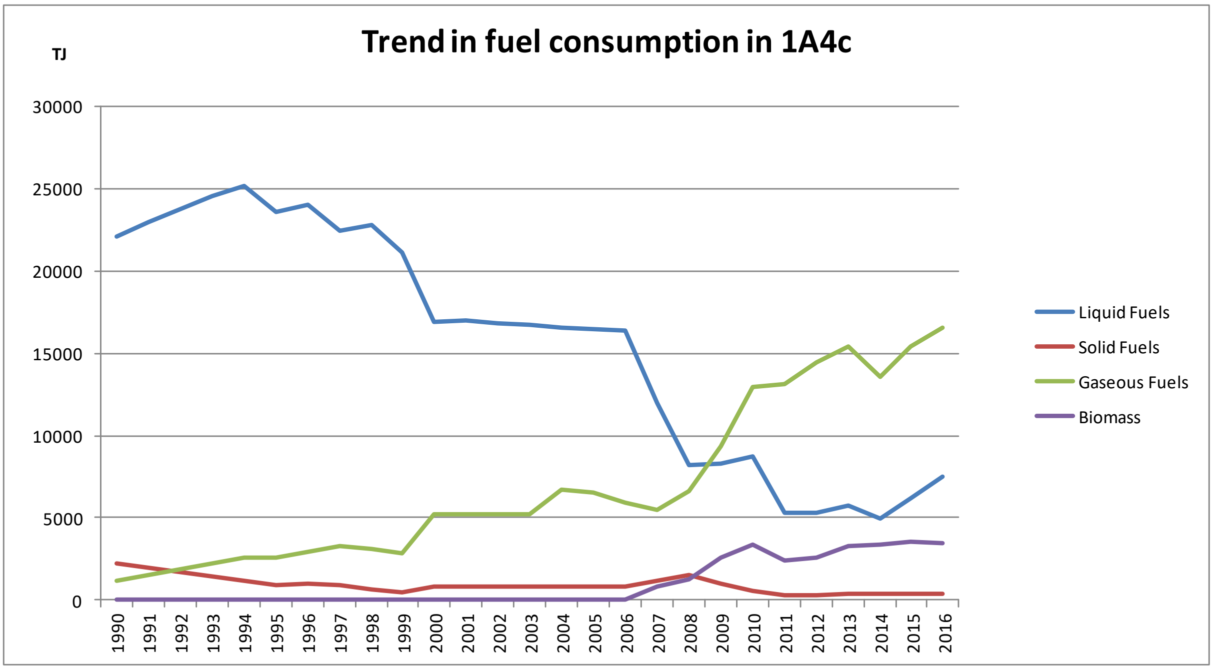


Figure 3-8 Trend of fuel consumption in the agricultural sector.

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. The activity data (energy consumption data) of the sectors 1A4ci are taken from the regional energy balances. Emission factors are region specific (NMVOC, TSP, PM10, PM2,5), derived from the S-content and regional tuning (SO_x) or originate from the EMEP/EEA Guidebook 2016,.

An overview of the emission factors used in the sector 1A4ci in the Flemish region is given in Annex 3.

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.

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

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

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

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

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 2016.

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).

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).

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) :

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	10000	mg/Mg PRODUCT

In the 2017 submission, Wallonia splitted the emissions of NEC pollutants between sectors 1A1c and 1B1b. This explains the reallocation between the 2016 and 2017 submission.

In the Brussels Capital Region the plant closed in 1993. The emission factors come from the Guidebook 2016; they are 0.8 g SO_2/t and 0.9g NO_x/t.

In Flanders no fugitive SO_2 and NO_x emissions are estimated.

3.7.2. Fugitive emissions from oil (category 1B2a)

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

Category 1B2aiv is a key category of NMVOC emissions in terms of emissions level and trend and of Cd 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. Whereas no distinction between fugitive and combustion emissions is possible, emissions of sector 1B2aiv are allocated in 1A1b.

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 timeseries 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 P., 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 methodology to calculate the emissions of NMVOC originating from the gas distribution (category 1B2biv) is completely harmonised for all the regions in Belgium since the submission in 2004. All information is reported by SYNERGRID, the federation of the grid operators of gas and electricity in

Belgium. These emissions are determined on the basis of the length of gas distribution pipelines. The lengths of the main pipelines (exclusive additional, service pipelines which are pipelines going to households) per public utility board are available. The number of additional service pipelines in Flanders is estimated at 1 888 000 for the year 2015. 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 186 500 for the year 2006 and is relatively stable for the following years (186 565 in 2010). The average length per pipeline is 3 m because of the urban environment. Depending on the material of the pipeline different emission factors are used. These emission factors are based on measurements carried out. In particular 869, 7865, 869 and 95 m^3/y/km for respectively steel, pig iron, fibre cement and synthetic material. The density of NMVOC is 1,42 kg/m^3. The NMVOC content of natural gas distributed is 8 %.

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

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

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

3.8. Recalculations and planned improvements

Recalculations

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

- The energy balance was reviewed for 2014 to integrate new approaches / data and insure consistency with the methodology applied in 2015 energy balance.
- .New emissions factors were calculated for wood combustion in sector 1A4bi to consider historic evolution and equipment performance.
- Recalculation of NMVOC emission from service stations with a Tier 2 approach.
- Recalculation of road transport emissions 2000-2015.
- Brussels Capital Region improved their Inventory System “BRAINS NG”. It aims to reduce errors and performs some automatic quality checks.

In the Walloon region, following recalculations were made:

- in 2009 and 2010, in 1A1a, the amount of wood in one wood boiler (>50 MW) was incorrect and the consumption of this plant was over-estimated in the previous submission. This led to an under-estimation of the amount of wood burnt in small installations which have a much higher $PM_{2.5}$ emission factor. These emissions were revised during this submission.
- In 1A1a, recalculations of the emissions from two incinerators (from 2008 to 2016) and for the following pollutants : NOx, TSP, SO_2, CO and NMVOC.
- recalculation of the emissions from the .aviation with the results of Eurocontrol.
- In 1A2gviii, Recalculation emissions road transport 2014-2015
- 1A3ei, calculations of all pollutants coming from the pipeline compressors.
- light revisions of the emissions from the harbour activities.
- recalculation of the VOC emissions from the service stations by using the Tier 2 methodology.

In Flanders following recalculations were made:

- Recalculation emissions road transport 2013-2015
- A new tool EISSA-B, 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 2016 were applied.
- 1A3ei: the NMVOC emission of pipeline compressors are allocated in category 1A3ei instead of 1A3eii.
- 1B2c: NMVOC emission of the venting of gas is allocated in category 1B2c instead of 1B2b.

Improvements

- For the 3 Belgian Regions: In the category 1A3b efforts will be made to prepare and customize input and tools to calculate emissions with COPERT 5. The adaptation of the ‘fleet’ model to take into account the vehicle categories of COPERT5 is the first step.
- Improvement and modification of the energy balance methodology is taking place in the Brussels Capital Region. Some changes of data are possible. A survey about consumption of wood is done in Brussels. There will be maybe changes in future energy balance.
- 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) and used on the entire time series 1990-2004.
- In the Walloon region, a study will be launched to estimate the consumption of wood, natural gas and gasoil by technology in the residential sector.
- In Flanders a study will be performed 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 will be revised in the future in order to take into account abatement technologies.

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 and 2016 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), 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, 2008-2012) compared to the other years (1994, 1997, 1999, from 2001 to 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).

In the Walloon region, the previous inventory for PAHs emissions only reported on total PAHs giving no information on the speciation of the PAHs emitted. In addition, it was not always clear from the reference material used which PAHs (6 PAHs from Borneff,..) were included in the "total". In this submission, a speciation has been performed since the year 2010 and the PAHs emission factors from studies has been recalculated since 1990 to be in line with the 4 PAHs of the POPs protocol. As the others regions have already performed this speciation in their regional inventory, this improvement allows Belgium to include the PAHs detailed inventory in the NFR tables since 2010.

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 SO_x, Hg, Se and PCB emissions in terms of emissions level and trend and a key category of NOx in terms of emission level and PM10 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.

The evolution of the activity data, the NO_x, SO_x, PM10 emissions and the implied emission factors are presented in the Table 4-1.

Table 4-1 Cement production in Wallonia.

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016
Clinker production (kt)	5292	6055	6089	5555	4740	5060	4869	4694	4831	4396	4458
IEF clinker (kg NOx/t)	2,78	2,74	2,87	2,57	2,24	2,31	2,16	1,88	1,76	1,87	1.49
NOx emissions (kt)	14,7	16,6	17,5	14,3	10,6	11,7	10,5	8,83	8,50	8,21	6.64
IEF clinker (kg SOx/t)	0,81	0,78	0,80	0,94	0,99	0,93	0,8	0,68	0,65	0,66	0.63
SOx emissions (kt)	4,3	4,7	4,9	5,2	4,7	4,7	3,9	3,2	3,2	2,9	2.79
IEF clinker (kg PM10/t)			0,20	0,06	0,02	0,02	0,0004	0,0058	0,033	0,0068	0,0062
PM10 emissions (kt)			1,2	0,33	0,1	0,1	0,02	0,027	0,16	0,03	0,03

4.2.1.2 Lime production (2A2)

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

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	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lime + dolomite lime (kt)	2640	2601	2774	2677	2586	1783	2116	2234	2091	2034	2110	2079	2009
IEF (kg PM10/t)	0,96	0,62	0,80	0,54	0,44	0,38	0,34	0,03	0.01	0.008	0.012	0.005	0.015
PM10 emissions (kt)	0,36	0,24	0,29	0,20	0,17	0,21	0,16	0,01	0.026	0.017	0.025	0.01	0.03

The evolution of the NOx 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 NOx produced has therefore decreased.

4.2.1.3 Glass production (2A3)

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 NOx 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 de decrease of the NOx emissions.

Table 4-3 Glass production and IEF in Wallonia.

	1990	1995	2000	2005	2010	2015	2016
Glass (kt)	1 503	1 574	1 587	1 644	1 560	1 461	1 209
IEF (kg NOx/t)	4.87	5.94	4.069	4.166	2.356	1.716	2.56
IEF (kg SOx/t)	7.87	2.377	3.17	3.457	2.37	0.757	0.917

In Flanders the emissions under 2A3 are mostly taken from reports from the industry. For the heavy metals after 2000 and particulate matter, process emissions of the glass production are included in the sector 2A6 (see 4.2.1.6).

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

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

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

Table 4-4 PM10 emissions in 2A5a

	PM10 (tonnes) (2000-2006)	PM10 (tonnes) (2007-2015)
Storage of mineral products	1957	1957
Quarrying	284	Plant specific emissions

Emissions (kt)	2000-2006	2010	2011	2012	2013	2014	2015	2016
2A5a Quarrying and mining of minerals other than coal	2,2398	2,1634	2,238	2,290	2,376	2.3565	2.33	1,959

4.2.1.5 Construction and demolition (2A5b)

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

The estimations of the emissions are based on the US EAP 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)

EF_{PM10} = the emission factor for this pollutant emission (kg/(m2xyear))

d = duration of construction (year)

PE = Thornthwaite precipitation-evaporation index

s = soil silt content (%)

The parameters of the equation are presented in the table below.

Table 4-4 Parameters for PM10 emission calculation in 2A5a

		d	PE	s (%)	$A_{affected}$
Houses	terraced	0.5	120	20	162.45
	semi-detached	0.5	120	20	167.55
	detached single family	0.5	120	20	248.8
Apartment buildings		0.8	120	20	585
Non residential constructions		0.8	120	20	1000

The $A_{affected}$ is calculated by using the regional footprint area (Walloon energy balance).

4.2.1.6 Other mineral products (2A6)

This source is a key category of SO_x emissions 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. In Flanders, the process emissions of the glass industry (flat and bowed glass, glass fiber, glass wool,…) of particulate matter and heavy metals after 2000 also are included in sector 2A6.

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.

The following chart (Figure 4-1) shows the trend of the ammonia production in Belgium:

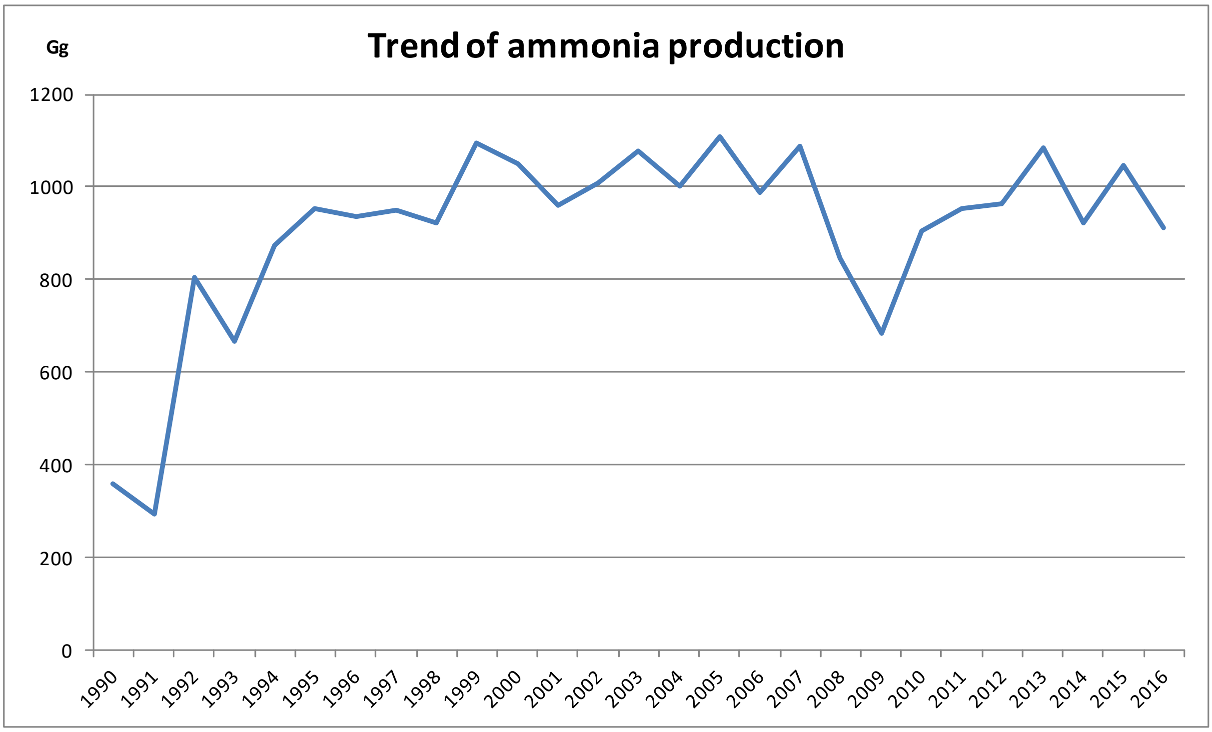


Figure 4-1 Trend of ammonia production.

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 2016 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 :

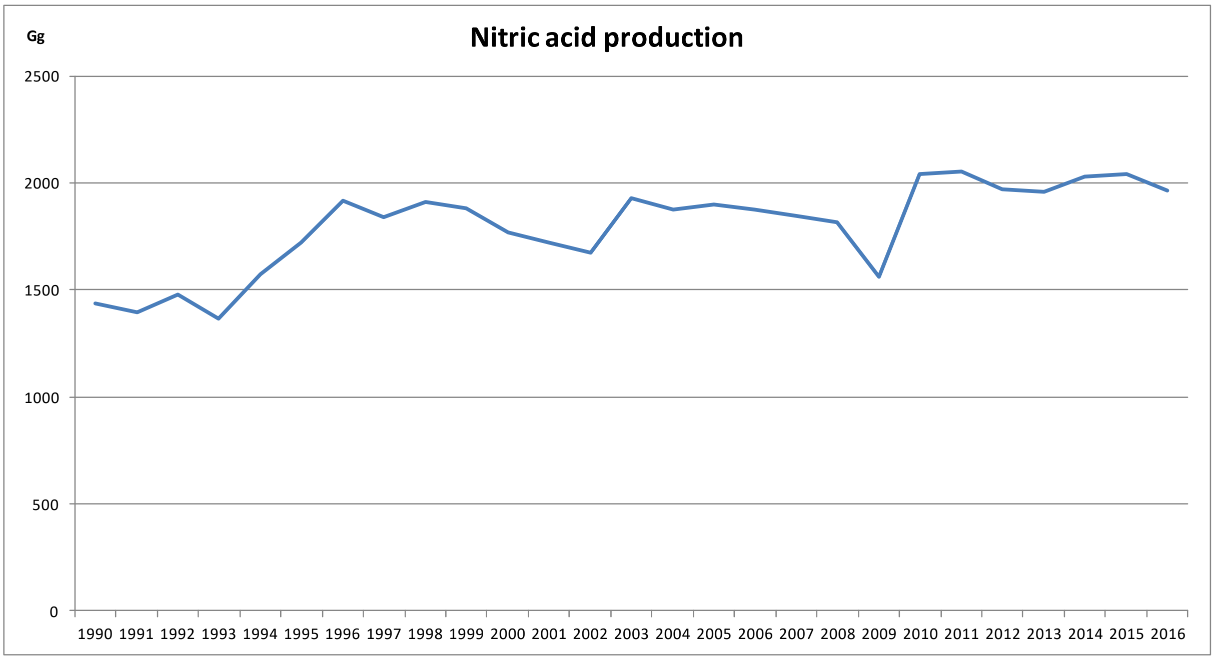


Figure 4-2 Trend of nitric acid production.

4.2.2.3 Other chemical industry (2B10a)

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

4.2.3. Metal production (category 2C)

4.2.3.1 Iron and steel production (2C1)

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

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

In Flanders, the HCB emissions are calculated based on activity data and emission factors. The activity data are reported by the industrial companies via the integrated environmental reports. The emission factors are listed in Table 4-5.

Table 4-5 Emission factors of HCB for the sector 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 in 2016.

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)):

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, the ratio is the ratio of the EMEP guidebook 2006 where the emission factor is in the same order of magnitude with the emission factor used in the Walloon inventory.

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 SO2, Nox and CO.

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 2009-2015 and 2004-2015 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.

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.

4.2.3.4 Other metal production (2C7c)

This category is a key category of SOx, Hg and As emissions in terms of emission level and trend and of Pb,Cd, Cu and Ni emissions in terms of emission level 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.

4.2.3.5 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 (category 2D3a)

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 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 4-5).

Table 4-5 Region specific emission factors based on the Arcadis study in 2010

	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
Total	1.324	1.219	1.412

According to the study, VOC-contents in household products have not been severely regulated over the past years. There is no legislation that significantly influenced the VOC-contents in cosmetics, cleaning products or other important VOC-containing household products. Evolution is therefore largely depending on activity data and minor VOC-specific changes. Bearing in mind the recent update of the emission registration methodology (and historical recalculations) in the Netherlands, the evolution for the Netherlands has been transferred to Belgium (1990-2008). A similar evolution of activity data can be assumed as it's a neighbouring country and culture and climate closely relate to each other. For the next years (2009-2016), the emission factors can be assumed to remain constant.

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 2016, 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 newly 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.

<u>Construction, building and domestic use</u>

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.

[5]SPF Economie (NACE 45.204: Carrosserie), data updated in 04/10/2017

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 rest 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. The number of workers in the metal fabrication industry is then used as allocation key to calculate the Walloon sales.

The solvent content in the paints 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.

Other Non-Industrial Application

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 and 2016.

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) In 2014,2015 and 2016, the NMVOC emissions of road marking for Belgium are 713 t (428 t for Flanders and 285 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) 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 and since 2014, 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

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. 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. 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/hab determined in 2002, combined with the evolution of the total population.

Other Industrial Cleaning (category 2D3e)

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 in terms of emission level.

Polyester Processing

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

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

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

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

In 1996, according to the fiberglass suppliers, the proportion of the different application techniques was: 42% for contact, 12% for filament winding, 35% for projection and 11% for other techniques. The styrene content in the resin depends on the process and can vary between 30 and 50%. A styrene content of 40% was assumed. For each application technique, the following styrene emissions (in % of the styrene used) were assumed: 3.2% for contact (1% in case of LSE resin), 4% for filament winding (2% for LSE resin), 8,3% for projection (3% in case of LSE resin) and 1,3% for other techniques (0,6%

for LSE resin). In 1996, the proportion of low styrene emission resin was approximately 20% but this proportion has increased since then and is estimated to 40% in 2010. It is assumed that no abatement techniques are applied.

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

Polyvinyl Chloride Processing (PVC)

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

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

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

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

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

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

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

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 CRB 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.

4.2.4.8 Printing (category 2D3h)

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

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 from 2002 to 2015.

In addition to providing the sales of solvent based glues and adhesives for different applications, the DETIC study also provided the average solvent content of the glues and adhesives for each application. According to DETIC, the solvents in the solvent based glues and adhesives represent 90% of the total solvents (in both solvent and water based glues and adhesives). On the basis of these data, the Walloon consumption of solvent in glues and adhesives has been estimated for 2002 (excluding domestic use). As the data cannot be adjusted annually, the same figure is used from 2002 to 2015.

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

Preservation of Wood (category 2D3i)

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 2016 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)

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.

For Flanders emissions due to smoking of tobacco are calculated for NO_x, NMVOC, CO, NH_3, PM2,5, PM10, TSP, BC, Cd, Cu, Ni and Zn.

In response to the NECD Review, since this submission, the three regions estimate these emissions by multiplying the regional tobacco consumption with the emission factors coming from the EMEP/EEA Guidebook 2016 (Table 3-14). The regional tobacco consumption is calculated from the Belgian tobacco consumption, taking into account the number of households and the average spending; see Table 4-6.

Table 4-6 Activity data for tobacco smoking

Type of product	Region	Activity data for 2016	Reference
cigarettes	Belgium	10176536162 cigarettes	statbel
cigars and cigarillos	Belgium	283288871 cigars and cigarillos	statbel
tobacco	Belgium	9061314158 grams	statbel

The Cu emissions due to letting off fireworks are also allocated in sector 2G. Emissions are calculated by multiplying the number of inhabitants (www.statbel.fgov.be) and an emission factor (456 mg Cu/inhabitant, Sleeuwaert et al., 2009).

Concerning dust and NMVOC emissions from fireworks (calculated according the method suggested by the review team), it is not possible to find Eurostat data (zero or confidential) or activity data from Statbel (the Federal Public Service for Economy, General Directorate for Statistics and Information on Economy). A request for data from PRODCOM was made but without response.

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 and trend.

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 below in Table 4-7.

In Wallonia and in the Brussels Capital Region, the emissions are calculated with the activity data and the emission factors given in Table 4-7.

Table 4-7 AD and EFs used in 2H2

Type of products	region	Activity data	Emission factor	Reference
Bread	Flanders	7473 g/hab.day	4500 g NMVOC/t	AD: Statbel EF: Emep guidebook 2016 Study Van Rompaey (1999)
Bread	Wallonia	125 g/hab.day	4500 g NMVOC/t	AD : Professional union of bakers and Statbel EF : Emep guidebook 2016
Beer	Flanders	74% x Belgium production	0,035 kg NMVOC/hl beer	AD : Beerparadise EF : Emep guidebook 2016
Beer	Wallonia	26 % x Belgium production	0,035 kg NMVOC/hl beer	AD : Beerparadise EF : Emep guidebook 2016
Bread/cookies	Brussels	112 g/hab.day	4500 g NMVOC/t	AD : Statbel EF : EMEP guidebook 2016
Fish smoking	Flanders	Prodcom statistics	0.080 kg TSP/ton	Study Schrooten & Van Rompaey (2002)
Meat cooking	Flanders	57.8 kg/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)

<u>The use of PCB transformers and capacitors</u>

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 4-8), the PCB-emissions can be calculated.

Table 4-8 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

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

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

4.3. Recalculations and improvements

Recalculations

For the three regions, the emissions from the smoking of tobacco (sector 2G) are calculated in the same way.

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

- 2G: NOx, CO, NH_3 and NMVOC emissions for tobacco smoking have been estimated for the whole time series

In Wallonia, the following recalculations have been performed:

- *2D3d Coating applications*:
    - Other industrial paint application: Emissions from 2010 to 2015 have been modified on the basis of new emission factors calculated for the emissions not reported annually.

- Other non-industrial paint application: Emissions from 2011 to 2013 have been modified to use the same interpolation methodology as in Flanders.

- *2D3e Degreasing:*
  - Metal degreasing: Emissions from 2010 to 2015 have been modified on the basis of new emissions factors calculated for the emissions not reported annually and to take into account the global sales of chlorinated solvent given by ESIG for 2013 and 2015.
  - Other industrial cleaning: Emissions of 2014 and 2015 have been modified to take into account the global sales of chlorinated solvent given by ESIG for 2013 and 2015.
- *2D3f Dry cleaning:*
  - Dry cleaning: Emissions of 2014 and 2015 have been modified to take into account the global sales of chlorinated solvent given by ESIG for 2013 and 2015.
- *2D3g Chemical products*:
  - Pharmaceutical products manufacturing: Emissions of 2015 have been slightly revised to reflect the actualised emissions from one plant.
- *2D3h Printing*:
  - Printing industry: Emissions from 1990 to 2015 have been slightly revised to take into account a revision in the emissions of one plant.

Improvements

In the Flemish region, the following improvements are planned:

- Revision of the NMVOC-emissions from dry cleaning for 2015 and 2016 on the basis of the survey performed by the Belgian textile federation in order to collect the solvent consumption figures.
- 2G: calculation of the whole time series of PM and NMVOC emissions from fireworks after receiving the activity data.

In Wallonia, the following improvements are planned:

- For some plants, the emission factors are not consistent throughout the time series. 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) and used on the entire time series 1990-2004.
- The emission factors for PM10 and PM2.5 are not consistent for the time series as since 2005, the lime plants have performed PM10 analyses and have made an estimation of their PM2,5 emissions. Following information's coming from these plants, the size of the dust is high and there is very little fine dust. Before 2005, the proportion between PM10 and TSP was the proportion written in the EMEP Guidebook. A recalculation is planned to harmonise the proportion TSP/PM10/PM2.5 with plant data for the entire period.
- Revision of the emissions for Wood paint application ;
- Revision of the emissions for non-chlorinated solvents for Metal degreasing, Dry cleaning and Other industrial cleaning;
- Revision of the emissions for Polyester processing, Polyvinylchloride processing, Polyurethane processing,;
- Estimation of the missing emissions (NE) for Textile finishing, Glass wool enduction, Mineral wool enduction ;
- Estimation of the Cu emissions from the fireworks;

- Revision of the emissions from key sources in order to move from Tier 1 to Tier 2 methodology when necessary.

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), urine & dung deposited by grazing animals (NFR sector 3Da3) and from manure processing (NFR sector 3Dd). 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 (swineand 3B4gii (broilers), 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 categoris 3B1b, 3B3, 3B4gi (laying hens) and 3B4gii are a key categories for PM10 or TSP in terms of emission level or trend. For NMVOC, the categories 3B1a, 3B1b, 3B3 and 3B4gii (dairy cattle, non-dairy cattle, swine and broilers resp.) are key categories in terms of emission level.

5.1.2. Description of the sector

The land used for agriculture in 2016 in Belgium extends to1354984 hectares. In 2016, the number of agricultural and horticultural businesses amounted to 36910. This number had dropped by 40% since 2000. The disappearing of small businesses being a general trend in the sector. Additionally in Flanders, this partly can be explained due to the subsidized cut down of the number of cattle. This was in 2001 and 2002 only the case for swine. In 2003 however an extension to bovine and poultry occurred. Nevertheless the land area used for agricultural purposes remained more or less the same during this period. In 2016 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 26 ha per farm in the Flemish region and 57 ha per farm in the Walloon region.

5.1.3. Climate:

With an average temperature of 10.7°C in 2016 (http://www.meteo.be/meteo/view/nl/28697360-2016.html), Belgium as a whole has a ‘cool’ climate.

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 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.

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

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

5.1.4.1 Livestock

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

Fout! Verwijzingsbron niet gevonden.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 numbers in the two regions

Livestock numbers	Flanders	Wallonia
1990-1999	STATBEL	STATBEL
2000-2012	Manure Bank (VLM)	STATBEL
2013-2016	Manure Bank (VLM)	Walloon Statistics (DGO3 – Agriculture Administration)

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. In 2017 the animal numbers were revised by the VLM for 2014-2015. 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, 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 the activity data from regional statistics (DGO3 – Direction générale opérationnelle de l'Agriculture, des Ressources naturelles et de l'Environnement). For this reason and also because of different methods of collecting data, some numbers are changing significantly for some categories. For cattle, sheep & goats, differences are under 3%. For pigs, horses and poultry, the differences are reaching respectively, 30%, 40% and 50%. For all animals (except dairy cows), Walloon statistics are always higher than those from STATBEL. However, as the cattle represent the large majority of the Walloon emissions, these differences are mitigated in terms of emissions.

5.1.4.2 N-excretion factors

For the N-excretion factors of swine and poultry in Flanders, a farmer can choose to use the standard excretion factors (no special effort to reduce N and/or P production). Or they can choose (or in some cases are obliged) to use the other systems (regressive balance, animal feed covenant, a complete fodder (input-output) balance). These data are obtained by the Manure Bank of the Flemish Land Agency. The N-excretion factors of cattle, sheep, goats, horses, mules and rabbits used in 2016 are described in https://www.vlm.be/nl/SiteCollectionDocuments/Publicaties/mestbank/bemestingsnormen_2016.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 N-excretion factors were first determined for the implementation of the CE Nitrates Directive 91/676 but were representing the nitrogen *after* deduction of the atmospheric losses, so new factors were calculated on this basis for the purposes of estimating atmospheric emissions. A check for update has been done with the latest legislation (PGDA 2014, http://www.nitrawal.be/resources/shared/telechargements/feuilletpgdaIIIv2.pdfhttp://www.nitrawal.be/resources/shared/telechargements/feuilletpgdaIIIv2.pdf) and no significant difference has been observed. So the N-excretion factors are kept unchanged.

Table 5-2 gives an overview of the livestock number and N-excretion factors (weighted average) used in both regions in 2016.

Table 5-2 Animal number and weighted average of nitrogen excretion factors for each animal category in Flanders and in Wallonia (2016).

Category	**Population**		**Weighted Average Nex (kg N/head.yr)**	
	Flanders	*Wallonia*	*Flanders*	*Wallonia*
Dairy Cattle	292341	167 045	117,65	120.5
Brood cows	162569	282 916	65.0	97.8
Other cattle	886066	766 245	42,7	47
Fattening Pigs	5704978	359 386	10,3	16.1
Swine	370246	59 028	5,8	15
Sheep	64073	58 494	8.2	6.9
Goats	44538	12 410	8.7	7.6

Category	Population		Weighted Average Nex (kg N/head.yr)	
	Flanders	*Wallonia*	*Flanders*	*Wallonia*
Horses/mules and asses	52399	22 878	48.2	75.0
Rabbits and fur animals	67337	NE	2.4	-
Laying Hens	10194480	1 832 478	0.7	0.8
Broilers	24182236	5 185 494	0,6	0.4
Other Poultry	366308	318 466	1,42	0.6

The allocation of animals to animal waste management system (AWMS) in Wallonia (see **Fout! Verwijzingsbron niet gevonden.**) 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 originate from the Department of Agriculture and Fisheries (Table 5-4).

Table 5-3 Allocation of animals to AWMS for each category in Wallonia (2016)

	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 (2016)

	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 two regions differ and are individually described below.

In Flanders, for the entire time series, the EMAV1.0-model (Foqué & Demeyer, 2009) 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 farm, using detailed input data, as animal number, stable type and N-production . These data are collected by the Flemish Land Agency. In 2017, the EMAV-model1.0 was subject to a thorough update, resulting in EMAV2.0. With EMAV2.0 it is now possible to calculate the emissions on the level of the stable and no longer on the level of the farm, giving an even more precise NH_3-estimation.

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 new stables for swine and poultry have to be constructed in an emission poor way. The licensed stables are inventoried by the manure bank of the Flemish Land Agency based on the amount 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 EMAV2.0 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. Emission factors for the different stable types of dairy cattle are given in Table 5-5 for the year 2016. For the years 1990 till 2006 the EMAV 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 2007 on, a distinction can be made. But to have a consistent time series, dairy cattle and brood cows are still reported as one category. It should be noted that in the CRF tables brood cows are reported in the category non-dairy cattle. For N_2O and CH_4 the calculation-model is based on input data on the regional level (CRF-tables) and not on the level of the stable.

Table 5-5 Overview of NH3 emission factor for dairy cattle and brood cows for each stable type in Flanders (2016)

Animal subcategory	Stable type	Emission factor (NH_3)
Dairy cattle	Lying box+cowshed	9,26
Dairy cattle	cowshed	8,11
Dairy cattle	Deep stable	9,50
Dairy cattle	Lying box	8,11
Brood cows	Lying box+cowshed	5,30
Brood cows	cowshed	5,30
Brood cows	Deep stable	5,30
Brood cows	Lying box	5,30

In Flanders, the emission factors used for dairy cows originate from the RAV (Regeling Ammoniak en veehouderij), used in the Netherlands (Dutch legislation). The Netherlands are the only neighboring 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 described emission factors are derived from a series of measurements in different stable types. Because the stable types used in Flanders are very similar to those used in the Netherlands, the emission factors are withheld in Flemish legislation as well after a thorough research from the Scientific Comité in Flanders. The emission factors are written in Flemish Legislation: 'richtlijnenboek landbouwdieren' (= guidebook for livestock). The emission factors used can be found by following link: https://www.lne.be/richtlijnenboeken-handleidingen-en-codes-van-goede-praktijk. For the revision of the EmissionModel Ammonia Flanders (EMAV2.0), it was suggested that the emission factor of 9.5kg

NH_3/cow/yr should be raised to 11kg NH_3/cow/yr, following a recent revision of the RAV (a dutch factor). But the Flemish Steering Committee of EMAV 2.0 (Flemish experts in the agricultural sector, including ILVO and Ugent) decided to retain the 9.50 factor. Also the Flemish Farmer's Union had already suggested that the Dutch situation of ration differs from the Flemish one (more concentrate feed in Flanders, more rough feed in the Netherlands). Flanders considers its approach as the best available and based on measurements and scientific reviews.

In Wallonia, the emissions are calculated using the Tier 2 methodology described in the EMEP/EEA Guidebook 2016. The methodology has allowed improving the estimations of the NH_3 emissions and the coherency with the GHG inventory. The actualisation takes also into account some new 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. This was not taken into account in the previous submissions. Furthermore, thanks to a survey realised last year, data have been collected on slurry application practices: application near the soil have increased since 2003. This lead to a decrease of the emissions of manure application.

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 buildings emissions.

The emission factor reductions used come from the UNECE publication 'Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions' (2015).

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 2016 (*Chap. 3.B Manure management*, table 3-5, p19) and the activity data from national and Walloon statistics.

In Flanders, the TSP emissions for the category 3B are also calculated by using emission factors from the EMEP/EEA Guidebook 2016. (*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 for 2007-2015. 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.

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 2016 (*Chap. 3.B Manure management,* table 3-3, p.17) and the activity data from the Flemish Land Agency (Flanders).

In Wallonia, the NO_x emissions are derived from the NH_3 calculations as described in the tier 2 methodology in the EMEP/EEA Guidebook 2016.

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) and the Tier 1 emission factors coming from the EMEP/EEA Guidebook 2016 (*Chap. 3.B Manure management,* table 3-4, p.18). For Wallonia, the EF with silage feeding were used. For Flanders, the EF without silage feeding were used. For the next submission, experts will be consulted to evaluate the share with and without silage feeding to give a better estimate of the emission factors.

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 EMAV2.0-model as described above (5.1.4.1) in which the amount and type of fertiliser used (kg N/exploitation) is multiplied by the corresponding emission coefficient. Depending of the type of mineral fertiliser, a different emission coefficient is used. The relative amount of different types of mineral fertiliser used in Belgium originates from the *International Fertilizer Industry Association (IFA).* The emission coefficients (%) for the different types of fertilizer are given in Table 5-6.

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 fertiliser 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 EMAV2.0 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 2016 (*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 use in Wallonia in 2016 is 100.89 kg N per ha.

Table 5-6 The amount (kg N) of the total synthetic fertilizer used (2016) and the emission coefficient for each fertilizer type in the Flemish Region.

	Synthetic Fertilizer use (kg N)	**Emission Coëfficiënt (%)**
Flanders	82333598	
Urea		15
Ammonium sulphate		4
Ammonium nitrate		2
Nitrogen solutions		9

5.3.1.2 NOx

In Wallonia and Flanders, NOx emissions are calculated following the Tier 1 methodology of EMEP/EEA Guidebook 2016 (Table 3-1, p 14). 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).*

5.3.1.3 Particulate matter

Until now the emissions of particulate matter for this sector are only calculated in Wallonia. For the next submission Flanders will also estimate emissions of PM2.5, PM10 and TSP.

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

5.3.2.1 NH_3

In Wallonia, manure application to land counts for a little less than 25% of the NH_3 agricultural emissions in 2016. NH_3 emissions from manure application are calculated following the Tier 2 methodology of the EMEP/EEA Guidebook 2016. Thanks to new information coming from a Walloon survey on the application of slurry, data have been updated concerning the practices and the use of precise equipment (injectors). 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.

In Flanders, as described under 5.2.1, NH_3 emissions from the application of manure to soils are calculated using the EMAV2.0 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.

There is a strong reduction from NH_3 emissions in Flanders from 1990 to 2016. 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 witch reduced the period in which manure can be spread and foresees for the first time in the emission poor application of manure on land. 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 emissionsThe EMAV2.0 model takes (on the level of the farm) into account the maximum amount of N that can be applied on land corresponding to the croptype 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.

5.3.2.2 NOx

In Wallonia and Flanders, NOx emissions are calculated following the Tier 1 methodology of EMEP Guidebook 2016 (Table 3-1 p 14).

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.

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

Emissions from grazing are following the trends of the livestock evolution.

In both regions, the ammonia emission from grazing is estimated, taking into account the number of days in pasture, the nitrogen excreted by each animal category, and the EEA emission factor of 8% in Flanders and the emission factors of the Table 3.9 of the 2016 EMEP Guidebook in Wallonia. In Table 5-7 an overview is given of the different factors used in both regions and for the different grazing animal categories.

Table 5-7 The days in pasture (%/yr), nitrogen excreted on pasture (ton) and the emission factor used for each grazing category in 2016.

	Days in pasture (% of year)	Nitrogen excreted on pasture (ton)	Emission factor (%)
Flanders			
bovine	± 50	26885	8
Sheep	80	415	8
Horses	50	1233	8
Wallonia			
Non dairy cattle	50	30858	6
Dairy cattle	56	8826	10
Sheep & goats	50	185	9
Horses	50	860	35

5.3.5. Farm-level agricultural operations (category 3Dc)

Following the NEC review and the EMEP/EEA Guidebook 2016 (table 3-1), the PM emissions in Wallonia were reallocated from 3Da1 to 3Dc. Also Flanders reallocated the NH3 emissions from farm-level storage from 3B to 3Dc in this submission.

5.3.6. Manure processing (category 3Dd)

5.3.6.1 NH_3

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. 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 2016 account for less than 3% of the total NH_3-emission in Flanders. The emissions for manure processing are calculated using the same model as used for the calculation of ammonia emission from livestock and synthetic fertilizer: the EMAV2.0 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.

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 , with exception of 2014, till 2016. 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%).

5.3.7. Cultivated crops (category 3De)

5.3.7.1 NMVOC

NMVOC emissions are calculated following the Tier 1 Methodology of 2016 EMEP Guidebook (Table 3-3 p 18). The activity data are the number of ha of cropped area (national statistics).

5.3.8. 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: 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.

5.4. Recalculations and improvements

<u>Recalculations</u>

In Wallonia, all the NH_3 emissions has been improved by using the Tier 2 methodology of the EMEP/EEA Guidebook 2016. This lead to larger emissions (33kt in place of 23kt in 1990) but it takes now into account some reduction efforts not taken into account before and so, the emissions are much more decreasing in the last years.

In Flanders, following recalculations were made:

- NO_x:, for category 3B (manure management) Tier1 emission factors from the EMEP/EEA Guidebook 2016 are used instead of the emission factors of the 2013 EMEP Guidebook. This results in an increase of the emissions for the entire time series.
- NO_x:, for category 3Da1, an update occurred of the amount of inorganic fertilizer applied to soils for the entire time series. This results in a minor change of emissions for the entire time series.
- NO_x and NMVOC: the animal number in 2014 and 2015 was updated, resulting in a minor change of emissions in category 3Da2a and category 3B,
- NH_3: an actualisation of the EmissionModelAmmoniaFlanders (EMAV) leads to new NH_3-emissions for the entire time series for the categories 3B and 3D.

Improvements

In Wallonia, it is planned to follow the EMEP/EEA Guidebook 2016 for all the emissions. For this submission, the focus was on the NH_3. The other pollutants are the focus of the next submission.

It will be evaluated in both regions which emission factors are the best to be used for NMVOC emissions from manure management in the different animal categories: with or without silage feeding.

Chapter 6. **Waste (NFR sector 5)**

Waste sector emissions are classified into 5 categories as described in Table 6-1. Main emissions of the 5 waste categories in Belgium.

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, dioxins & furans, PAH(4), HCB
Wastewater handling (5D)	NH_3
Other (5E): car and house fires	NMVOC, NO_x, SO_2, PM2.5, PM10, TSP, heavy metals

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 2009 EMEP/EEA Guidebook. The volume of landfill gas resulted from the IPCC model used for GHG inventory and from the recovery data of the sites managers. The methodology is the one described in the 2006 IPCC Guidelines. The emission factor used for NMVOC is 5.65 g NMVOC/m³ landfill gas, coming from the 2009 EMEP/EEA Guidebook. In the 2013 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/m³ landfill gas, which corresponds to the 1.56 kg/Mg waste (2013 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 2016 in Flanders and following the Tier 3 methodology of the EMEP/EEA Guidebook 2016 in Wallonia.

6.2. Biological treatment of waste (category 5B)

NH_3 emissions from compost production, allocated in category 5B1 are estimated in Wallonia and in the Brussels Capital Region using regional activity data combined with a default emission factor of 0,24 kg NH_3/ton compost (EMEP/EEA Guidebook 2013). These emissions are not yet estimated in Flanders.

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 Pb, Cd, Hg, Cr, Ni, Zn and PCDD/F in terms of emission trends. Category 5C1b is key category for PCDD/PCDF and HCB emissions in terms of emission trend or both level and trend.

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_x, 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. For HCB, one plant performs stack measurement and the emissions of other plants are based on an emission factor from AKVB 1996 (2 mg/ton of incinerated waste). The ranges of implied emission factors in 2016 are presented in Table 6-2 for each pollutant and compared to the emission factors of the EMEP Guidebook 2016.

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, SO2, 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 to 2016. Wallonia will prevent under-estimated reporting from operators in the future.

Table 6-2 Implied emission factors in 2016 in Wallonia compared to EMEP Guidebook 2016

Pollutant	Unit	EMEP 2016	EF range in 2016
NOx (as NO_2)	g/ton	1071	400-700
NMVOC	g/ton	5.9	3-20
SOx (as SO_2)	g/ton	87	70-190
NH_3	g/ton	3	1-29

$PM_{2.5}$	g/ton	3	3-5
PM_{10}	g/ton	3	3-5
TSP	g/ton	3	3-5
BC	g/ton	0.105	0.12-0.17
CO	g/ton	41	20-320
Pb	mg/ton	58.0	5-115
Cd	mg/ton	4.6	3-70
Hg	mg/ton	18.8	1-35
As	mg/ton	6.2	5-70
Cr	mg/ton	16.4	10-220
Cu	mg/ton	13.7	30-155
Ni	mg/ton	21.6	15-80
Se	mg/ton	11.7	7-79
Zn	mg/ton	24.5	20-1830
PCDD/ PCDF	ng/ton	52.5	9-150
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	0.2-2
PCBs	µg/ton	0.0034	0-395

The only hospital waste incinerator has closed since 2005. 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 5C, when waste is incinerated without energy recovery because of occasional problems in the energy recovery systems. In 2010, this represents 2% of the incinerated waste. In 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. In 2014 and 2015, the incinerated waste without energy recovery represents 2% of the incinerated waste. In 2016, it represents 4%.

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 report real emissions. The companies are urged to report the actual emissions in future. A correction of the historical data is also requested from the companies that take into account the confidence interval, but the correction of these emissions is not yet completed.

All (intermunicipal) waste incineration plants produce electricity since 2006. 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 6-3).

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 6-4).

Table 6-3 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 6-4 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 2006. 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).

In the Brussels Capital Region, the last waste incinerator without recuperation of energy has closed in 1998.

6.3.2. Emissions by cremation

For Flanders: the activity data is 41657 cremations in 2016 (derived from the yearly statistics of crematoria [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 Wallonia: for dioxins, the emission factor from the Netherlands of 4µg TEQ/corpse, reported in EMEP (Emission Inventory Guidebook December 2006 B991-9) is applied. A specific emission factor is used for Hg emissions. This emission factor is equal to 2 g/corpse and is coming from measurements and analysis made in a Walloon crematorium.

Emissions from the other pollutants are estimated using the emission factors of the EMEP/EEA guidebook 2013. The number of corpses is coming from the national Belgian statistics available on the website of STATBEL.

For the Brussels Capital Region, the emission factor for dioxins is 27 ng TEQ/cremation as stated in the EMEP/EEA 2016 guidebook. The number of cremations comes also from national statistics available on the website of STATBEL, for 2016, it was 5283.

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 and PAH's. These emissions are allocated in sector 5C2. 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://www.lne.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). The emission factor of TSP is taken from a study performed by VITO under the authority of AMINAL/Aminabel (Wevers, 2002). Emission factors for PM10 and PM2,5 are taken from TNO (2001). Emissions of EC are calculated as a fraction of PM2.5 (Table 6-5).

In Wallonia, these emissions are not estimated.

Table 6-5 Emission factors of TSP, PM10, PM2.5 and EC for the open combustion of waste in the Flemish region

unit	TSP	% PM10 of TSP	% PM2,5 of TSP	% EC of PM2.5
Kg/ton	8,30	75%	75%	35%

[6] http://statbel.fgov.be/fr/statistiques/chiffres/population/autres/cremations/

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. 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 the next submission a methodology will be developed to calculate the NMVOC-emissions of wastewater handling. The emissions are in all cases below the threshold of significance (based on preliminary calculations).

6.5. *Other (5E)*

This source is a key category of PM2.5 and PM10 in terms of emission level and of PCDD/F in terms of emission level and trend.

6.5.1. Car and house fires

This source is a key category of PCDD/F in terms of emission level.

Emissions originating from car and house fires are estimated for PM2.5, PM10, TSPand PCDD/F. For heavy metals only emissions originating from house fires are estimated. The same methodology is used for the three regions in Belgium.

During this submission a new methodology was developed to estimate the emissions for the entire time series (1990-2016).
For the years 2012, 2013 and 2014 the number of fires are obtained from the Belgian fire brigade (www.civieleveiligheid.be). For the other years (also for 2015 and 2016) the number of fires is calculated based on total population. For the next submission, the number of fires will be obtained from the Belgian fire brigade for the year 2015 and subsequent years. 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 6-6 Split between detached and undetached house fires

region	Detached houses	Undetached houses
Flemish region	42%	58%
Walloon region	39%	61%
Brussels Capital region	4%	96%

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 2016 for car fires, detached house fires, undetached house fires, apartment building fires and industrial building fires respectively.

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.

During the 2017 NECD review, a revised estimate concerning NH3 emissions from sludge spreading was made in Wallonia. These revised estimates were included in this submission.

6.6. Recalculations and improvements

<u>Recalculations</u>

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

- 5A Solid waste disposal on land: emissions of NMVOC have been recalculated from 2009 on the basis of the Tier 1 emission factor given in the EMEP Guidebook 2009. In this way the same emission factor is used for Flanders and Wallonia.

- 5C2 open combustion of waste: emissions have been recalculated from 2011. The amount of waste incinerated decreases. In Flanders only under strict conditions combustion in open barrels is allowed.

- 5E: emissions of PM2.5, PM10, TSP, heavy metals and PCDD/F have been calculated for the whole time series on the basis of the Tier 2 emission factors given in de EMEP Guidebook 2016 for source category 5E car and house fires. This is a technical correction for PM2.5 as a result of the NECD review 2017.

In Wallonia, the following recalculations were performed:

- 5C1a Municipal waste incineration: The emissions of NOx, TSP, SO_2, CO and NMVOC have been adjusted to add the confidence interval from 2008 to 2015.

In the Brussels Capital region, following improvements have been done:

- Sector 5D1 : new data from the FAO have been used between 2000 and 2013. The protein content is also updated and is constant between 2013 and 2016. It is equal to the protein content of 2013. For the year 2016, this content is taken account the leap year.
- Sector 5E : the emissions from this sector has been calculated

<u>Improvements</u>

In the Flemish region, the following improvements are planned:

- 5C Waste incineration: for the next submission the real emissions of waste incineration plants will be included in the inventory instead of emissions corrected by the confidence interval.

- 5D Wastewater handling: for the next submission a methodology will be developed to calculate the NMVOC-emissions of wastewater handling. The emissions are in all cases below the threshold of significance.

- 5E Car and house fires: for the next submission, for the year 2015 and subsequent years the number of fires will be obtained from the Belgian fire brigade.

In the Brussels Capital Region:

5E : As the Flemish region, the data from the Belgian fire brigade will be integrated in this sector calculation for the next submission .

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 ($ng/m^2/s$)	Monoterpenes ($ng/m^2/s$)	Other VOC ($ng/m^2/s$)
Broadleaf trees			
Beech	8.89	57.78	192.78
Oak/American oak	5333.33	17.78	192.78
Poplar	5333.33	0.00	192.78
Other	5333.33	17.78	242.22
Mixed broadleaf			
Beech	20.56	152.22	285.28
Oak	5298.61	112.50	285.28
Poplar	5298.61	95.00	285.28
Other	5298.61	112.50	317.50
Mixed conifers			
Larch	1349.44	91.11	197.22
Scots pine	2492.22	168.06	305.56
Black pine	2492.22	321.67	605.56
Spruce	4658.33	302.78	572.78
Douglas	3349.44	225.83	572.78
Other (default)	2492.22	321.67	258.89
Conifers			
Larch	8.33	125.00	192.78
Scots pine	19.44	291.67	359.72
Black pine	19.44	583.33	359.72
Spruce	388.89	583.33	770.83
Douglas	27.78	416.67	770.83
Other	19.44	583.33	287.78
Grassland	0.00	11.11	23.33

The leaf density of a tree species expresses the amount of dry matter (g) of a tree in terms of the ground area, taken by this species. The leaf density can vary significantly in the course of the seasons. Since several factors can influence the leaf density, the calculations are made with average leaf densities (already taken in account in table 9.1).

Since the leaf temperature and the light intensity are the most important factors that influence VOC emissions, a correction factor (specified for isoprene and terpene emissions) is taken from literature.

Wallonia

<u>Methodology</u>

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

Recalculations

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

- The energy balance was reviewed for 2014 to integrate new approaches / data and insure consistency with the methodology applied in 2015 energy balance.
- .New emissions factors were calculated for wood combustion in sector 1A4bi to consider historic evolution and equipment performance.
- Recalculation of NMVOC emission from service stations with a Tier 2 approach.
- Recalculation of road transport emissions 2000-2015.
- Brussels Capital Region improved their Inventory System “BRAINS NG”. It aims to reduce errors and performs some automatic quality checks.

In the Walloon region, following recalculations were made:

- in 2009 and 2010, in 1A1a, the amount of wood in one wood boiler (>50 MW) was incorrect and the consumption of this plant was over-estimated in the previous submission. This led to an under-estimation of the amount of wood burnt in small installations which have a much higher $PM_{2.5}$ emission factor. These emissions were revised during this submission.
- In 1A1a, recalculations of the emissions from two incinerators (from 2008 to 2016) and for the following pollutants : NOx, TSP, SO_2, CO and NMVOC.
- recalculation of the emissions from the .aviation with the results of Eurocontrol.
- In 1A2gviii, Recalculation emissions road transport 2014-2015
- 1A3ei, calculations of all pollutants coming from the pipeline compressors.
- light revisions of the emissions from the harbour activities.
- recalculation of the VOC emissions from the service stations by using the Tier 2 methodology.

In Flanders following recalculations were made:

- Recalculation emissions road transport 2013-2015
- A new tool EISSA-B, 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 2016 were applied.
- 1A3ei: the NMVOC emission of pipeline compressors are allocated in category 1A3ei instead of 1A3eii.
- 1B2c: NMVOC emission of the venting of gas is allocated in category 1B2c instead of 1B2b.

Improvements

- For the 3 Belgian Regions: In the category 1A3b efforts will be made to prepare and customize input and tools to calculate emissions with COPERT 5. The adaptation of the ‘fleet’ model to take into account the vehicle categories of COPERT5 is the first step.
- Improvement and modification of the energy balance methodology is taking place in the Brussels Capital Region. Some changes of data are possible. A survey about consumption of wood is done in Brussels. There will be maybe changes in future energy balance.
- 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) and used on the entire time series 1990-2004.

- In the Walloon region, a study will be launched to estimate the consumption of wood, natural gas and gasoil by technology in the residential sector.
- In Flanders a study will be performed 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 will be revised in the future in order to take into account abatement technologies.

8.2. Recalculations and improvements in the sector of industrial processes and products use

Recalculations

For the three regions, the emissions from the smoking of tobacco (sector 2G) are calculated in the same way.

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

- 2G: NOx, CO, NH_3 and NMVOC emissions for tobacco smoking have been estimated for the whole time series

In Wallonia, the following recalculations have been performed:

- *2D3d Coating applications*:
    - Other industrial paint application: Emissions from 2010 to 2015 have been modified on the basis of new emission factors calculated for the emissions not reported annually.
    - Other non-industrial paint application: Emissions from 2011 to 2013 have been modified to use the same interpolation methodology as in Flanders.
- *2D3e Degreasing:*
    - Metal degreasing: Emissions from 2010 to 2015 have been modified on the basis of new emissions factors calculated for the emissions not reported annually and to take into account the global sales of chlorinated solvent given by ESIG for 2013 and 2015.
    - Other industrial cleaning: Emissions of 2014 and 2015 have been modified to take into account the global sales of chlorinated solvent given by ESIG for 2013 and 2015.
- *2D3f Dry cleaning:*
    - Dry cleaning: Emissions of 2014 and 2015 have been modified to take into account the global sales of chlorinated solvent given by ESIG for 2013 and 2015.
- *2D3g Chemical products*:
    - Pharmaceutical products manufacturing: Emissions of 2015 have been slightly revised to reflect the actualised emissions from one plant.
- *2D3h Printing*:
    - Printing industry: Emissions from 1990 to 2015 have been slightly revised to take into account a revision in the emissions of one plant.

Improvements

In the Flemish region, the following improvements are planned:

- Revision of the NMVOC-emissions from dry cleaning for 2015 and 2016 on the basis of the survey performed by the Belgian textile federation in order to collect the solvent consumption figures.
- 2G: calculation of the whole time series of PM and NMVOC emissions from fireworks after receiving the activity data.

In Wallonia, the following improvements are planned:

- For some plants, the emission factors are not consistent throughout the time series. 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) and used on the entire time series 1990-2004.
- The emission factors for PM10 and PM2.5 are not consistent for the time series as since 2005, the lime plants have performed PM10 analyses and have made an estimation of their PM2,5 emissions. Following information's coming from these plants, the size of the dust is high and there is very little fine dust. Before 2005, the proportion between PM10 and TSP was the proportion written in the EMEP Guidebook. A recalculation is planned to harmonise the proportion TSP/PM10/PM2.5 with plant data for the entire period.
- Revision of the emissions for Wood paint application ;
- Revision of the emissions for non-chlorinated solvents for Metal degreasing, Dry cleaning and Other industrial cleaning;
- Revision of the emissions for Polyester processing, Polyvinylchloride processing, Polyurethane processing,;
- Estimation of the missing emissions (NE) for Textile finishing, Glass wool enduction, Mineral wool enduction ;
- Estimation of the Cu emissions from the fireworks;
- Revision of the emissions from key sources in order to move from Tier 1 to Tier 2 methodology when necessary.

8.3. Recalculations and improvements in the agricultural sector

Recalculations

In Wallonia, all the NH_3 emissions has been improved by using the Tier 2 methodology of the EMEP/EEA Guidebook 2016. This lead to larger emissions (33kt in place of 23kt in 1990) but it takes now into account some reduction efforts not taken into account before and so, the emissions are much more decreasing in the last years.

In Flanders, following recalculations were made:

- NO_x:, for category 3B (manure management) Tier1 emission factors from the EMEP/EEA Guidebook 2016 are used instead of the emission factors of the 2013 EMEP Guidebook. This results in an increase of the emissions for the entire time series.
- NO_x:, for category 3Da1, an update occurred of the amount of inorganic fertilizer applied to soils for the entire time series. This results in a minor change of emissions for the entire time series.
- NO_x and NMVOC: the animal number in 2014 and 2015 was updated, resulting in a minor change of emissions in category 3Da2a and category 3B,
- NH_3: an actualisation of the EmissionModelAmmoniaFlanders (EMAV) leads to new NH_3-emissions for the entire time series for the categories 3B and 3D.

Improvements

In Wallonia, it is planned to follow the EMEP/EEA Guidebook 2016 for all the emissions. For this submission, the focus was on the NH_3. The other pollutants are the focus of the next submission.

It will be evaluated in both regions which emission factors are the best to be used for NMVOC emissions from manure management in the different animal categories: with or without silage feeding.

8.4. Recalculations and improvements in the waste sector

Recalculations

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

- 5A Solid waste disposal on land: emissions of NMVOC have been recalculated from 2009 on the basis of the Tier 1 emission factor given in the EMEP Guidebook 2009. In this way the same emission factor is used for Flanders and Wallonia.

- 5C2 open combustion of waste: emissions have been recalculated from 2011. The amount of waste incinerated decreases. In Flanders only under strict conditions combustion in open barrels is allowed.

- 5E: emissions of PM2.5, PM10, TSP, heavy metals and PCDD/F have been calculated for the whole time series on the basis of the Tier 2 emission factors given in de EMEP Guidebook 2016 for source category 5E car and house fires. This is a technical correction for PM2.5 as a result of the NECD review 2017.

In Wallonia, the following recalculations were performed:

- 5C1a Municipal waste incineration: The emissions of NOx, TSP, SO_2, CO and NMVOC have been adjusted to add the confidence interval from 2008 to 2015.

In the Brussels Capital region, following improvements have been done:

- Sector 5D1 : new data from the FAO have been used between 2000 and 2013. The protein content is also updated and is constant between 2013 and 2016. It is equal to the protein content of 2013. For the year 2016, this content is taken account the leap year.
- Sector 5E : the emissions from this sector has been calculated

Improvements

In the Flemish region, the following improvements are planned:

- 5C Waste incineration: for the next submission the real emissions of waste incineration plants will be included in the inventory instead of emissions corrected by the confidence interval.

- 5D Wastewater handling: for the next submission a methodology will be developed to calculate the NMVOC-emissions of wastewater handling. The emissions are in all cases below the threshold of significance.
- 5E Car and house fires: for the next submission, for the year 2015 and subsequent years the number of fires will be obtained from the Belgian fire brigade.

In the Brussels Capital Region:

5E : As the Flemish region, the data from the Belgian fire brigade will be integrated in this sector calculation for the next submission .

Chapter 9. **Projections**

Projections are reported for 2020, 2025, 2030 'With measures' on 15 March 2017. No update was made in 2018.

Belgian emission projections are the sum of the regional projections for stationary and mobile sources

9.1. Mobile sources

9.1.1. Flanders

For the transport sector, different emission models have been used, depending on the transport mode:

- Road traffic: FASTRACE, model based on COPERT IV (VITO).
- Sea shipping, inland shipping and rail traffic: EMMOSS-model (TML).
- Off-road: OFFREM-model (ILVO and VITO).
- Air traffic: own estimations.

The evolution of mobility is based on growth rates provided by the federal Belgian plan bureau:

Growth rate compared to 2012	2020	2030
Passenger traffic	+4%	+14%
Light duty traffic	+18%	+44%
Heavy duty traffic	+14%	+34%
Busses and Coaches	+8%	+17%
Two wheelers	+13%	+30%

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 traffic (Euro standards), such as regulations 692/2008/EC and 595/2009/EC have been taken into account.

Emissions have been calculated using the COPERT IV model. Only the NOx-emission factor for Euro 6 diesel cars has been changed, taking into account the so called conformity factor (CF): a CF of 2,1 from September 2019 on and a CF of 1,5 from January 2021 on (for all new vehicles).

The basis of the sea shipping model in EMMOSS are ship movements (the number of so called callings) per port, type of boat and length class. For the projections, a yearly growth rate per type of good has been established based on the strategic plans for the ports. 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:

% 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. 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. The table below shows the expected evolution of the share of energy use for the three inland vessel types in the period 2015 – 2030.

%	2010	2015	2020	2025	2030
No emission standards	53.3	22.4	7.3	2.0	0.5
CCR I	35.6	30.9	15.1	5.2	1.5
CCR II – EU fase III	11.1	46.7	77.6	92.7	97.9
Total	100	100	100	100	100

The emission factors in EMMOSS are taken from the study 'Methoden om Nederlandse scheepvaartemissies te schatten' (Netherlands, Denier & Hulskotte, 2010). These are based on real emissions.

For rail traffic, only emissions from diesel trains, for transport of both passengers and goods, have been taken into account. The growth rate used for calculating projections is:

% growth	2020 compared to 2010	2025 compared to 2010	2030 compared to 2010
goods	+44%	+67%	+92%
passengers	+17%	+29%	+43%

The yearly growth rate is applied to the reported tonkilometers for rail traffic in 2013. The distribution diesel/electrical is kept constant (for goods: 76% of bruto-tonkm electrical between 2005 and 2030).

For other off road sectors emissions are calculated with the OFFREM model. This covers ten categories: off-road machines and off-road vehicles in agriculture, forestry, households, greening, industry, construction, ports, airports, multimodal terminals for handling and defense (military).

For air traffic, only the emissions of landing and take off (LTO) are taken into account. Growth rates are taken from projections published by Eurocontrol in 'Challenges of Growth 2013, Task 4, European Air Traffic in 2035' (Global growth scenario);

IRF Movements (000s)	2010	2020	2025	2030	% 2020 compared to 2010	% 2025 compared to 2010	% 2030 compared to 2010
A: Global Growth	9.493	12.485	14.139	15.749	131.52	148.94	165.90

9.1.2. Walloon region:

The Walloon projections for road transport (1A3b) are established on the principle of :

"emission = mobility (vkm) x emission factor (t/km)"

where:

- The projections of the overall mobility are calculated using the principle of mobility demand (projections of the Federal Plan Bureau (FPB/BFP))
- The projections of the vehicle fleet are calculated using survival curves based on the historic inventory data.
- The emission factors are calculated from the historic inventory data (year 2014)

- Emission factors for new technologies are established assuming improvements expressed in % with regards to existing technologies.

Conventional vehicles remain the main technologies operating up to 2030.

Regarding Offroad transport (1A3a,c,d and e, 1A2gvii, 1A4aii, bii, cii and ciii, 1A5b), it has been assumed that emissions will remain stable over the projection period.

9.1.3. Brussels Capital Region:

The model distinguishes between road, railways and waterways transport. The projections horizon is 2030.

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 *(9)* and INRETS study *(10)*), and recalibrated to the actual situation in the Brussels Region using emission inventories and outputs from a detailed traffic model (MUSTI).

Pollutants emissions calculations with COPERT have been processed using the same software version and hypotheses as for the UNFCCC 2015 GHG inventory preparation. Fuels consumption are detailed for gasoline, diesel, LPG and CNG. In Belgium, biofuels are mixed with gasoline and diesel in public fuel tank stations (blends). The CO_2 emissions from the biogenic part of fuels (bioethanol or biodiesel) are calculated in post-treatment, on the basis of the composition of blends, which may vary from year to year.

For railways, the evolution of liquid fuel (gasoil) consumption is derived from the evolution of freight transport demand (11). Pollutants emissions are calculated by combining fuel consumptions with emission factors from IPCC 2006 Guidelines for national emission inventories[7]. Passengers transport (trains, metro and tramways) is driven by electricity; the transport supply (and the corresponding electricity consumption) increases then by 70% between 2012 and 2025, together with the expected finalization of the express regional network (RER, French acronym).

For inland navigation, the evolution of liquid fuel (gasoil) consumption is derived from a reference scenario of transport demand for Belgium (11). The 2014 value (starting point of the projections) comes from the regional energy balance. Pollutants emissions are calculated by combining fuel consumptions with emission factors from IPCC 2006 Guidelines for national emission inventories[8].

For off-road transport, the OFFREM model is used at regional scale by the 3 Regions in Belgium.

9.2. Stationary sources

9.2.1. Flanders: Flemish energy and greenhouse gas simulation model

A new Flemish simulation model has been developed in 2014 to construct short term projections for Flanders. 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) that covers most of the relevant emission sectors (energy sector, industry, waste, agriculture, residential and commercial buildings).

[7] http://www.ipcc-nggip.iges.or.jp/public/2006gl/

[8] http://www.ipcc-nggip.iges.or.jp/public/2006gl/

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);
- a representation of the structure of the residential heating (type and age) and of residences (idem for the heating of tertiary buildings).
- Share of the emissions, per sector, that comes from processes (and thus is not related to fuel consumption).
- For the agricultural emissions (dust, greenhouse gasses and ammonia emissions coming from stables and from manure), the starting point is the number of animals (detailed per animal category and per type of stable) and the amount of manure that is spread out.

For the residential sector, projections are driven by assumptions on degree days in the future, the share of new residences and the lifetime of existing installations. Policies on energy efficiency and on ecodesign are taken into account.

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 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).

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). For the residential sector, the emission factors take into account the use of different types of boilers and stoves.

For the agricultural sector, the predicted number of animals is multiplied with animal specific emission factors (both for the greenhouse gasses as for ammonia and dust). These emission factors are lower for the new low emission stables. Also the amount of manure that is spread out is multiplied with specific emission factors. At the time of reporting, final results were not yet available, so projections are likely to change soon.

9.2.2. Walloon region

SO_2 and NOx

For Wallonia, projections of SO_2 and NOx emissions from stationary sources (combustion and processes) up to 2030 are similar to those reported in the previous issue. They have been established using the EPM model developed by ECONOTEC. This model is also a techno-economic bottom-up simulation model.

Projections are established on the basis of energy projections, in combination with the consideration of several abatement measures taken or in project in the Walloon industry, concerning the relevant air pollutants.

The energy projections are those reported in 2017 under Article 14(1) of Regulation No 525/2013 in the framework of the so-called "with measures scenario", ie a reference situation considering the impact of existing and implemented measures aiming at the reduction of greenhouse gases.

NMVOC

Projections of NMVOC emissions have been established on the basis of the following assumptions:

- Energy sectors (1A1, 1A2, 1A4, 1A5): As the combustion in the residential sector is the main contributor to the NMVOC emissions, the NMVOC emissions in 2030 have been calculated on the basis of energy consumption projection established using the EPM model developed by ECONOTEC for the residential sector. The same approach has been used for the Commercial sector. The other emissions have been considered identical to 2014 (most recent historic year used for the projections).

- Industrial processes (2A1, 2A2, 2B10a, 2C1, 2C7c, 2H1, 2H2): The complete shutdown of all blast furnaces has been taken into account. The emissions of the food and beverage sector have been assumed to follow the evolution of population between 2014 and 2030. The other emissions have been considered identical to 2014.

- Solvent and other product use (2D, 2G): 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 2013 and 2030. For other sectors, the emissions have been considered identical to 2014.

NH3

The evolution of NH3 emissions follows the same evolution as the activity data when it is possible or is kept constant.

PM 2.5

As for NOx and SOx, projections of PM2.5 emissions from stationary sources (combustion and processes) up to 2030 have been established using the EPM model developed by ECONOTEC.

Projections are established on the basis of energy projections, in combination with the consideration of several abatement measures taken or in project in the Walloon industry, concerning the relevant air pollutants.

And for 1A4 (Other sectors), the main contributor to the PM2.5 emissions, the methodology is the same as this one used for NMCOV. For this sector, the PM2.5 emissions in 2030 have been calculated on the basis of the EPM fuel consumption projection.

Agriculture

The projections for agricultural emissions (NH_3, NOx, NMVOC, PM2.5) are calculated with the same methodology described in chapter 5. The equations, the parameters and the emissions factors are the same. The activity data (heads of animals, crop areas and fertiliser use) are mainly estimated from the historic trends.

Waste

Concerning the projections of emissions from waste sector (NOx, NMVOC, PM2.5, BC, SO_2 & NH_3), the hypothesis followed is conservative and the emissions from the last submission are kept constant.

9.2.3. The Brussels Capital region

The Brussels Institute for Environmental Management has developed its own projection model for energy demand and atmospheric emissions from stationary sources (residential, tertiary, industry and heat and electricity sector). The horizon of the projections is 2030.

As bottom-up type model, changes in consumption of the several energy carriers used in the Brussels-Capital Region (natural gas, light oil, propane/butane, coal, electricity, wood, solar and heat pump) and their associated emissions (CO2, CH4, N2O, NOx, CO, NMVOC, SOx, NH3, PM) are determined by the evolution of parameters that define the consumption of each sector.

For example, the residential sector is defined by the following main parameters:

- population and average household size (those 2 parameters define the net requirement for new dwellings)
- climate (expressed in degree-days, this parameter is of great importance for the Brussels-Capital Region, as it reflects the need for heating of buildings which represents about 70% of regional GHG direct emissions)
- renovation rate, improvement of energy efficiency expected in case of renovation and new constructions. This improvement depends on the typology of building stock composed of 140 type-dwellings : apartment or house, 5 age range of the building concerned, the 7 energy carrier used for heating, and the installed heating system (central or decentralized.

The model has been calibrated for each sector with the regional annual energy balances from 2000 to 2013. The modelled energy consumptions have then been converted into atmospheric emissions through emission factors, the ones used to establish the emission inventories.

The model also takes into account the GHG direct emissions that are not related to energy consumption: i.e. the fugitive methane emissions of natural gas delivery, the use of N2O for anaesthesia and aerosols, the emissions from the decomposition of organic matter (composting plant, water purification plant). Emissions for sector solvent use, dry cleaning and domestic coating application is based on the population evolution; the other sectors concerning solvents use are considered constant during the projected period (2015 – 2030).

This model is a dynamic one. It allows new future available data to be integrated (for instance future energy balances) as well as new assumptions reflecting new studies and new phenomena (in the fields of regulation, technological change, through awareness campaigns, incentives …)

Chapter 10. **Gridded Data and LPS**

10.1. Introduction

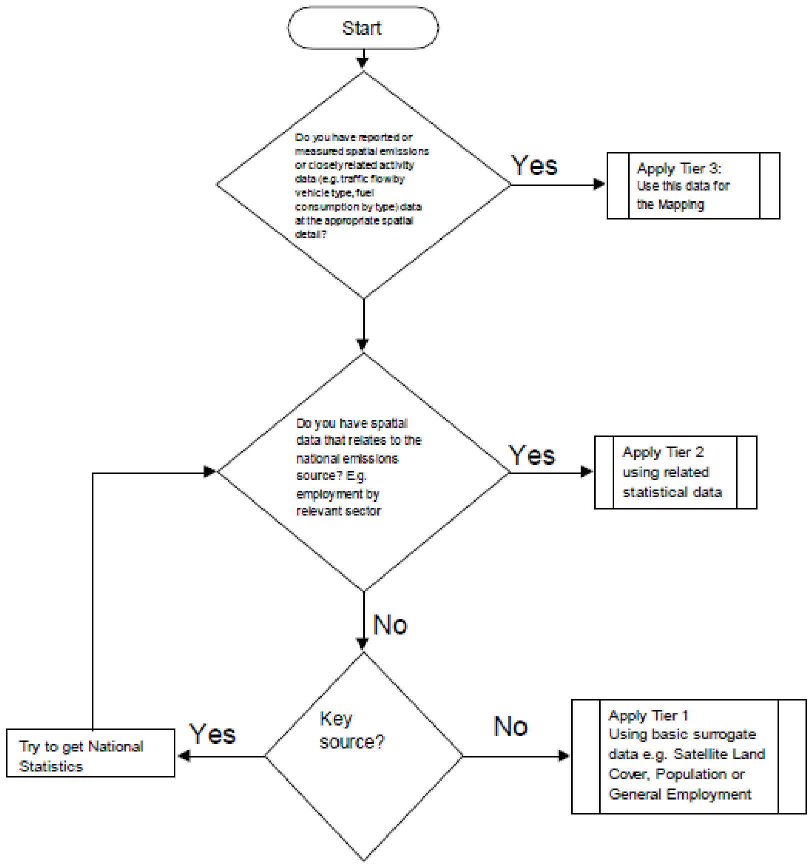
According to the Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125) and the revised NEC Directive (2016/2284/EC), Belgium is required to report four-yearly its gridded emissions and emissions from LPS for the year x-2, starting in 2017.

By the 1st of May 2017, Belgium submitted LPS emission data of 2015 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 2015 were reported in the aggregated NFR sectors (GNFR) for NOx, NMVOC, SOx, NH3, 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 lon-lat in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84.

The methodology for spatialisation of emissions is based on the guidelines provided in the EMEP/EEA Guidebook 2016. Following the decision tree from the guidebook (Figure 10-1) 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 spatialisation such as population or surface (Tier 1).

Figure 3-2 General decision tree for emissions mapping



Source: EMEP/EEA Guidebook 2016. Part A Chapter 7.Spatial mapping of emissions

Figure 10-1 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.

A new regroupment of NFR-14 sectors is used for the gridded data compared to the previous submission in 2012. The GNFR sectors accounting for the national totals are summarised in Figure 10-2.

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 10-2. GNFR sectors to be reported in 2017

Source: http://www.tfeip-secretariat.org/assets/Meetings/Presentations/Ghent-2014/1NewEMEPgrid.pdf

Next sections describe each GNFR sector, the NFR-14 sectors included, the methodology applied for the spatialisation 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 as mention in Table 10-1.

Table 10-1. NFR-14 sectors included in GNFR A

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
A_PublicPower	1A1a	Public electricity and heat production

In Brussels Capital Region, the spatialisation of the emissions uses as base information, on the one hand the localisation of the municipal waste incinerator and turbojets, on the other hand the addition of installed power of CHP in each municipality. For the incinerator and the turbojets, the emissions are allocated to the specific point while for the CHP the emissions are split proportionally to the installed power. The final result is the sum of the emissions per cell in the grid.

In Wallonia, the spatialisation of the emissions is based on the localisation of point sources. 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 spatialized by the Geogremis tool (Janssen & Colles, 2004).

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 activites of NFR sector 2A to 2L (Table 10-2) excluding the solvents use.

Table 10-2. NFR-14 sectors included in GNFR B

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
B_Industry	1A1b	Petroleum refining
B_Industry	1A1c	Manufacture of solid fuels and other energy industries
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel
B_Industry	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals
B_Industry	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals
B_Industry	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals
B_Industry	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)
B_Industry	2A1	Cement production
B_Industry	2A2	Lime production
B_Industry	2A3	Glass production
B_Industry	2A5a	Quarrying and mining of minerals other than coal
B_Industry	2A5b	Construction and demolition
B_Industry	2A5c	Storage, handling and transport of mineral products
B_Industry	2A6	Other mineral products (please specify in the IIR)
B_Industry	2B1	Ammonia production
B_Industry	2B2	Nitric acid production
B_Industry	2B6	Titanium dioxide production
B_Industry	2B10a	Chemical industry: Other (please specify in the IIR)
B_Industry	2B10b	Storage, handling and transport of chemical products (please specify in the IIR)
B_Industry	2C1	Iron and steel production
B_Industry	2C2	Ferroalloys production
B_Industry	2C3	Aluminium production
B_Industry	2C4	Magnesium production
B_Industry	2C5	Lead production
B_Industry	2C6	Zinc production

B_Industry	2C7a	Copper production
B_Industry	2C7b	Nickel production
B_Industry	2C7c	Other metal production (please specify in the IIR)
B_Industry	2C7d	Storage, handling and transport of metal products (please specify in the IIR)
B_Industry	2D3c	Asphalt roofing
B_Industry	2D3b	Road paving with asphalt
B_Industry	2H1	Pulp and paper industry
B_Industry	2H2	Food and beverages industry
B_Industry	2H3	Other industrial processes (please specify in the IIR)
B_Industry	2I	Wood processing
B_Industry	2J	Production of POPs
B_Industry	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)
B_Industry	2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)

The GNFR B sector in Brussels Capital region has only two sectors to be spatialized: 1A2gviii and 2H2. Emissions are spatialized using the environment permit database to identify industrial establishments in the region. Most of industrial activity in Brussels is small sized, thus the split of emissions consideres the density of points in the grid as a reference.

In Wallonia, the emissions are spatialized by using the energy balances by municipality. For each municipality, detailed emissions and energy consumptions from the E-PRTR point sources are known as well as for ETS plants, their locations and their energy consumptions and also for beer production plants, the locations and the emissions. The aggregated site specific energy consumption is substracted from the energy balance of the municipality and the residual energy consumption is used to calculate the emissions and are mapped by using industrial economic zone as surrogate. The emissions from the production of bread (2H1), 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, all emissions (except NMVOC, POP's, 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) are spatialized by shapefiles per sector (distribution per km^2, per industrial zones or per municipality).
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 an allocation pattern. Emissions of particulate matter and heavy metals are allocated as a point source (facilities with emissions above the threshold) or by shapefiles per sector (industrial zones, patterns of chemical facilities, pattern of iron and steel sector,…)(Decoene, 2012).
The locations of the point sources or the emissions that are spatialized otherwise are 'translated' to the right EMEP grid by means of a datawarehouse.

10.2.3. GNFR C : Other stationary combustion

The sector GNFR C includes the emissions from the combustion on the commercial, the residential, agriculture and military sectors as detailed in Table 10-3.

Table 10-3. NFR-14 sectors included in GNFR C

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary
C_OtherStationaryComb	1A4bi	Residential: Stationary
C_OtherStationaryComb	1A4ci	Agriculture/Forestry/Fishing: Stationary
C_OtherStationaryComb	1A5a	Other stationary (including military)

In Brussels Capital Region, there are emissions for sectors 1A4ai and 1A4bi. The spatialisation 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 split is based on the population.

In Wallonia, the emissions are spatialized by using the energy balances by municipality. The distribution of emissions is made on the ETS plants locations and on the commercial and institutional surface by municipality (1A4Ai), on the basis of the population (1A4bi) and on the basis of the agricultural plot (1A4ci).

In Flanders, the emissions (except PAHs) of the commercial/institutional sector (1A4ai), the residential sector (1A4bi) and the agricultural sector (1A4ci) are spatialized by the Geogremis tool. Emissions of PAHs are allocated by the EISSA tool by an allocation pattern.
The locations of the emissions that are spatialized by the allocation pattern are 'translated' to the right 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 NFR sectors included are detailed in Table 10-4.

Table 10-4. NFR-14 sectors included in GNFR D

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
D_Fugitive	1B2ai	Fugitive emissions oil: Exploration, production, transport
D_Fugitive	1B2aiv	Fugitive emissions oil: Refining / storage
D_Fugitive	1B2av	Distribution of oil products
D_Fugitive	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)
D_Fugitive	1B2c	Venting and flaring (oil, gas, combined oil and gas)
D_Fugitive	1B2d	Other fugitive emissions from energy production

Brussels Capital Region reports emissions for the distribution of oil products and it is based on the placement of Brussels harbour and also on the proportion or the surface of the region on the grid since there is no more precise data concerning this sector.

In Wallonia, the localizations of the petroleum stocks are known. The 'PICC' data (Mapping project in the Walloon region) are used to localise petroleum stations. Concerning the gas transportation, the emissions are disagragated 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 POP's) 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. The locations of the point sources or the emissions that are spatialized otherwise are 'translated' to the right EMEP grid by means of a datawarehouse.

10.2.5. GNFR E : Solvents

The sector GNRF E includes the use of solvent products as described in Table 10-5.

Table 10-5. NFR-14 sectors included in GNFR E

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
E_Solvents	2D3a	Domestic solvent use including fungicides
E_Solvents	2D3d	Coating applications
E_Solvents	2D3e	Degreasing
E_Solvents	2D3f	Dry cleaning
E_Solvents	2D3g	Chemical products
E_Solvents	2D3h	Printing
E_Solvents	2D3i	Other solvent use (please specify in the IIR)
E_Solvents	2G	Other product use (please specify in the IIR)

Due to the variety of activities included in this sector, the Brussels Capital Region emissions were spatialized per NFR sector in order to use the best available information. Sectors 2D3a and 2D3f use the population data for the split of emissions in the cells. This is coherent with the inventory were population is the main driver for these sectors. Sector 2D3d is spatialized with 2 datasets. Domestic coating uses population data while industrial coating uses the location of establishements on the basis of Environmental permit database; the split of emissions consideres the density of points as a reference. Moreover, emissions from the establishements submitted to the obligation of reporting the NMVOC emissions under the VOC solvents Emissions Directive are allocated directly to their location. Sector 2D3e emissions are spatialized using the information of NMVOC balance under VOC solvents emissions Directive. Finally, sector 2D3h uses the same methodology as in industrial coating, companies that submit NMVOC balace are located in the grid and the small companies emissions are distributed according to the density of pints in the grid. The final result is the sum of emissions in each cell of the grid.

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 located on the basis of the population data.

In Flanders, all emissions (except NMVOC and POP's) 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. Emissions of particulate matter (smoking of tobacco) and heavy metal emissions (due to firework) are spatialized with a shape file based on the population pattern.
By spreading the emission data rounding errors occur for some pollutants/sectors. This error is relatively big for dioxine emissions (spreading of small numbers and a limitation of the number of decimals by the datawarehouse, which increases the error, e.g. the emissions by smoking of tobacco differ significantly in absolute value between the time series (February 2017) and the gridded data (0.00007 vs. 0.0006 g-teq).
The locations of the point sources or the emissions that are spatialized otherwise are 'translated' to the right EMEP grid by means of a datawarehouse.

10.2.6. GNFR F : Road transport

Road transport emissions reported under GNFR F include NFR sectors described in Table 10-6.

Table 10-6. NFR-14 sectors included in GNFR F

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
F_RoadTransport	1A3bi	Road transport: Passenger cars
F_RoadTransport	1A3bii	Road transport: Light duty vehicles
F_RoadTransport	1A3biii	Road transport: Heavy duty vehicles and buses
F_RoadTransport	1A3biv	Road transport: Mopeds & motorcycles
F_RoadTransport	1A3bv	Road transport: Gasoline evaporation
F_RoadTransport	1A3bvi	Road transport: Automobile tyre and brake wear
F_RoadTransport	1A3bvii	Road transport: Automobile road abrasion

Brussels Capital Region uses a combination of road shapefiles 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 the lengths of road sections for the 3 driving modes (highway, rural/suburban and urban) in each cell of the grid. For each driving mode, the total emissions at the regional level are affected to a given cell proportionally to the cumulated length of the road sections in the cell compared to the whole Region. Finally, the emissions from the 3 driving modes are summed for each cell.

The methodology in Wallonia is the same as in the Brussels Capital Region.

In Flanders, also COPERT is used to generate gridded data of the road transport sector. The emissions are allocated over road segments. At the borders of Flanders, the fraction of the road 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 total gridded data of the road transport sector and the total of the NFR-codes 1A3b reported for the time series (February 2017).

10.2.7. GNFR G : Shipping

The GNFR G sector includes international inland waterways and national navigation (Table 10-7).

Table 10-7. NFR-14 sectors included in GNFR G

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
G_Shipping	1A3di(ii)	International inland waterways
G_Shipping	1A3dii	National navigation (shipping)

Brussels Capital Region only reports emissions from sector 1A3dii. Emissions are distributed according to the length of the canal among the cells. The canal is the only navigable waterway in the region.

In Wallonia, the emissions for inland waterway transport are divided into navigable rivers.

For the Flemish Region, the spatialized emissions of the sector G_Shipping are calculated with the EMMOSS model (see also § 3.4.2.4). 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) occurs. Due to different runs with the EMMOSS model that have to be done to calculate the emissions that are reported for the time series (February 2017) on the one hand and the gridded emissions on the other hand, slight differences between the gridded data and the data reported for the NFR-codes 1A3dii can occur.

10.2.8. GNFR H : Aviation

The GNFR H sector includes sectors described in Table 10-8.

Table 10-8. NFR-14 sectors included in GNFR H

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
H_Aviation	1A3ai(i)	International aviation LTO (civil)
H_Aviation	1A3aii(i)	Domestic aviation LTO (civil)

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 distributed on the grid (two commercial airports and four tourism airports).

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. The distribution pattern is taken from Decoene (2012).
For PM2.5, PM10 and BC only LTO emissions are reported for the gridded data. When the whole time series was reported (February 2017) no distinction was made between LTO and cruise emissions for these pollutants. This results in a difference between the emissions reported for the time series and the emissions reported for the gridded data.

10.2.9. GNFR I : Off road

Sector GNFR I includes the NFR sectors described in Table 10-9.

Table 10-9. NFR-14 sectors included in GNFR **I**

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
I_Offroad	1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)
I_Offroad	1A3c	Railways
I_Offroad	1A3ei	Pipeline transport
I_Offroad	1A3eii	Other (please specify in the IIR)
I_Offroad	1A4aii	Commercial/institutional: Mobile
I_Offroad	1A4bii	Residential: Household and gardening (mobile)
I_Offroad	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
I_Offroad	1A4ciii	Agriculture/Forestry/Fishing: National fishing
I_Offroad	1A5b	Other, Mobile (including military, land based and recreational boats)

The offroad sector includes a variety of sectors industry, agriculture, residential, railways and pipelines transport.

The spatialisation of the offroad sector in Brussels Capital Region is done by NFR sector. The emissions for 1A2gvii and 1A3eii follows the same methodology as sector 1A2gviii (Chapter **Fout! Verwijzingsbron niet gevonden.**.). The sector 1A4bii is distributed using as population as the reference. Emissions from sector 1A4cii are allocated to the cells where agriculture and forest activities take place in the region. The distribution of emissions from 1A5b uses the proportion of the surface in the grid. Finally, emissions from sector 1A3c are distributed using the length of the rail network per cell.

In Wallonia, the sector 1A2gviii is distributed by using offroad emissions from industrial point sources. Emissions from sector 1A3c are distributed using railway sections on which the oil-fueled trains run. The gridding of the sector 1A3e is based on point sources emissions (gas compression plants, harbours and air ports). The sector 1A4bii is distributed using habitat areas and the sector 1A4cii is distributed using the data of the agricultural plot and the Sector Plan covering forests and parks.

In Flanders, most off-road emissions (1A2gvii, 1A3eii, 1A4bii, 1A4cii, part of 1A5b) are calculated with the OFFREM model. To allocate the emissions spatially different shapefiles are used according to the sector (Decoene, 2012).

To spread the railways emissions (1A3c) a shapefile of the railways is used. The emissions are allocated over railway segments. 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 and the emissions reported in the NFR-codes 1A3c for the time series (February 2017).

Emissions reported in the sector 1A3ei are point sources.

Emissions of military aviation (also reported in 1A5b) are calculated with the EMMOL model. The allocation pattern is taken from Decoene (2012).

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.

The locations of the point sources or the emissions that are spatialized otherwise are 'translated' to the right EMEP grid by means of a datawarehouse.

10.2.10. GNFR J : Waste

Sector GNFR J considers the NFR sectors detailed in Table 10-10. The emissions from municipal incinerators with energy recovery are included in sector GNFR A.

Table 10-10. NFR-14 sectors included in GNFR J

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
J_Waste	5A	Biological treatment of waste - Solid waste disposal on land
J_Waste	5B1	Biological treatment of waste - Composting
J_Waste	5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities
J_Waste	5C1a	Municipal waste incineration
J_Waste	5C1bi	Industrial waste incineration
J_Waste	5C1bii	Hazardous waste incineration
J_Waste	5C1biii	Clinical waste incineration
J_Waste	5C1biv	Sewage sludge incineration
J_Waste	5C1bv	Cremation
J_Waste	5C1bvi	Other waste incineration (please specify in the IIR)
J_Waste	5C2	Open burning of waste
J_Waste	5D1	Domestic wastewater handling
J_Waste	5D2	Industrial wastewater handling
J_Waste	5D3	Other wastewater handling
J_Waste	5E	Other waste (please specify in IIR)

Brussels Capital Region reports emissions from composting and cremation. There is one establishement for each activity and the emissions are allocated to the grid cell where the installation is located.

In Wallonia, the spatialisation of the emissions is based on the localisation of point sources (E-PRTR plants).

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 (most 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.
The emissions due to Open burning of waste 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 of domestic waste water handling are spread according to a pattern of residents who are not connected to the sewage network (personal communication, Flemish Environment Agency, Team Unlocking Sewer Database).
The locations of the point sources or the emissions that are spatialized otherwise are 'translated' to the right EMEP grid by means of a datawarehouse.

10.2.11. GNFR K : Agriculture - Livestock

Sector GNFR K considers the NFR sectors detailed in Table 10-11.

Table 10-11. NFR-14 sectors included in GNFR K

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
K_AgriLivestock	3B1a	Manure management - Dairy cattle
K_AgriLivestock	3B1b	Manure management - Non-dairy cattle
K_AgriLivestock	3B2	Manure management - Sheep
K_AgriLivestock	3B3	Manure management - Swine
K_AgriLivestock	3B4d	Manure management - Goats
K_AgriLivestock	3B4e	Manure management - Horses
K_AgriLivestock	3B4f	Manure management - Mules and asses
K_AgriLivestock	3B4gi	Manure mangement - Laying hens
K_AgriLivestock	3B4gii	Manure mangement - Broilers
K_AgriLivestock	3B4giii	Manure mangement - Turkeys
K_AgriLivestock	3B4giv	Manure management - Other poultry
K_AgriLivestock	3B4h	Manure management - Other animals (please specify in IIR)

In Wallonia, emissions of NH_3, NOx, NMVOC and PM coming from the livestock (NFR sector 4B) have been spatially distributed firstly across the municipalities, thanks to national and regional statistics giving the number of heads by municipalities. However, these numbers are not available for every year. So we used the latest information available (2015 for cattle, poultry, swine, 2012 for ovines and goats and 2010 for horses) and these repartitions were used with the 2015 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 occurs only on crop and pasture).

In Flanders the ammonia emissions of manure management are calculated with the EMAV model (see also IIR Chapter 5). The emissions of the GNFR-sector K_AgriLivestock (NH_3, NO (reported as NOx) and NMVOS) are spread according to a pattern of animals per community. This pattern takes into account the manure management system, animal number and category at each farm, further aggregated per community.

10.2.12. GNFR L : Agriculture Other

Sector GNFR K considers the NFR sectors detailed in Table 10-12.

Table 10-12. NFR-14 sectors included in GNFR L

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
L_AgriOther	3Da1	Inorganic N-fertilizers (includes also urea application)
L_AgriOther	3Da2a	Animal manure applied to soils
L_AgriOther	3Da2b	Sewage sludge applied to soils
L_AgriOther	3Da3	Urine and dung deposited by grazing animals
L_AgriOther	3Da4	Crop residues applied to soils
L_AgriOther	3Db	Indirect emissions from managed soils
L_AgriOther	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
L_AgriOther	3Dd	Off-farm storage, handling and transport of bulk agricultural products
L_AgriOther	3De	Cultivated crops
L_AgriOther	3Df	Use of pesticides
L_AgriOther	3I	Agriculture other (please specify in the IIR)

In Wallonia, emissions of NH_3, NOx, NMVOC and PM coming from the agricultural soils (NFR sector 4D) have been distributed following the same approach as emissions of livestock. The 2015 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 accross the crop and pasture areas.

In Flanders the emissions of the sector 3D are calculated with the EMAV model (see also IIR Chapter 5). The emissions of the GNFR-sector L_AgriOther are spread according to a pattern of animal number, the available cropland/grassland and crop type per community. The pattern also takes into account the amount of organic fertiliser used in each agricultural zone.

10.2.13. GNFR M : Other

Table 10-13. NFR-14 sectors included in GNFR M

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
M_Other	6A	Other (included in national total for entire territory) (please specify in IIR)

Emissions for the GNFR sector M Other were not estimated.

10.2.14. GNFR N : Natural

Table 10-14. NFR-14 sectors included in GNFR N

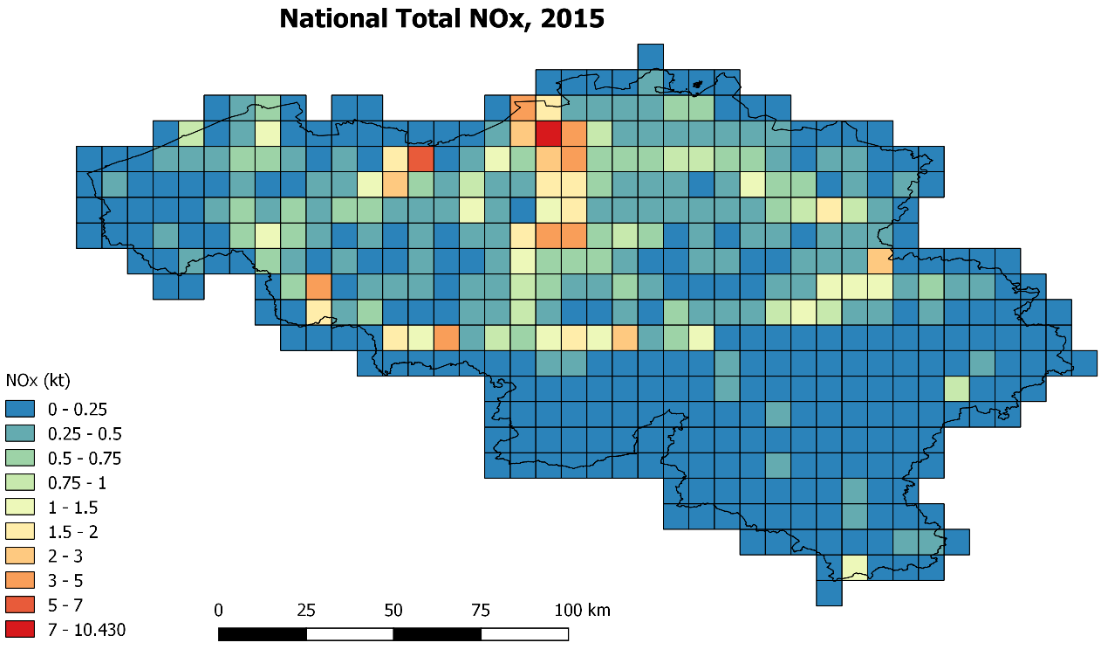
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
N_NATUREL	11C	Other natural emissions (please specify in IIR)

In Wallonia, this sector is distributed using the Sector Plan covering forests.

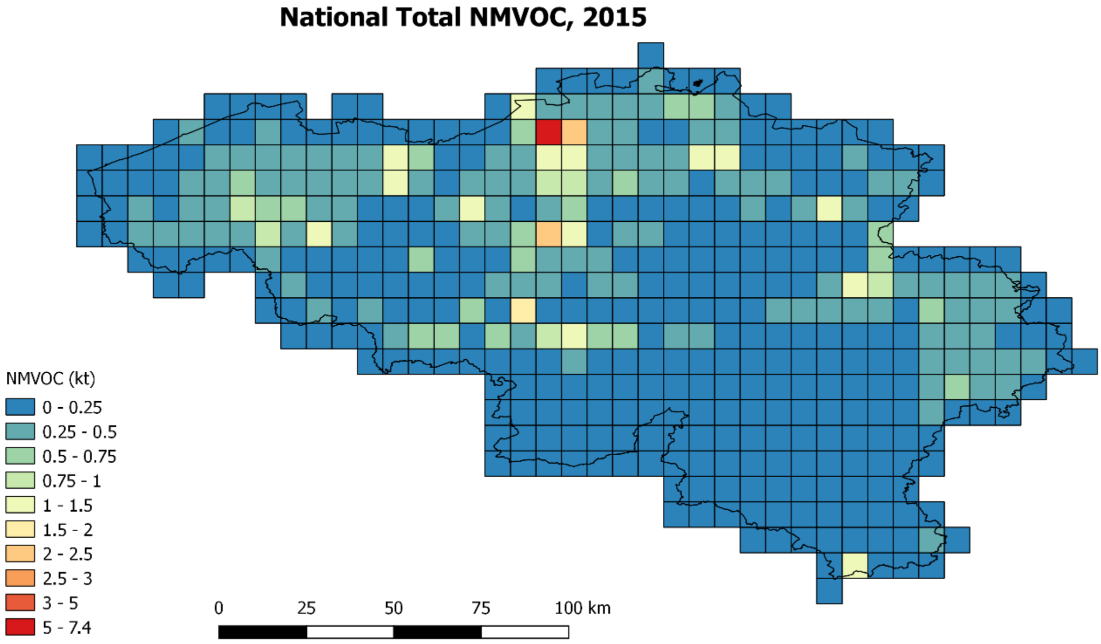
In Flanders, the emissions of this sector are distributed based on the available cropland/grassland and forest areas in Flanders.

10.3. 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.

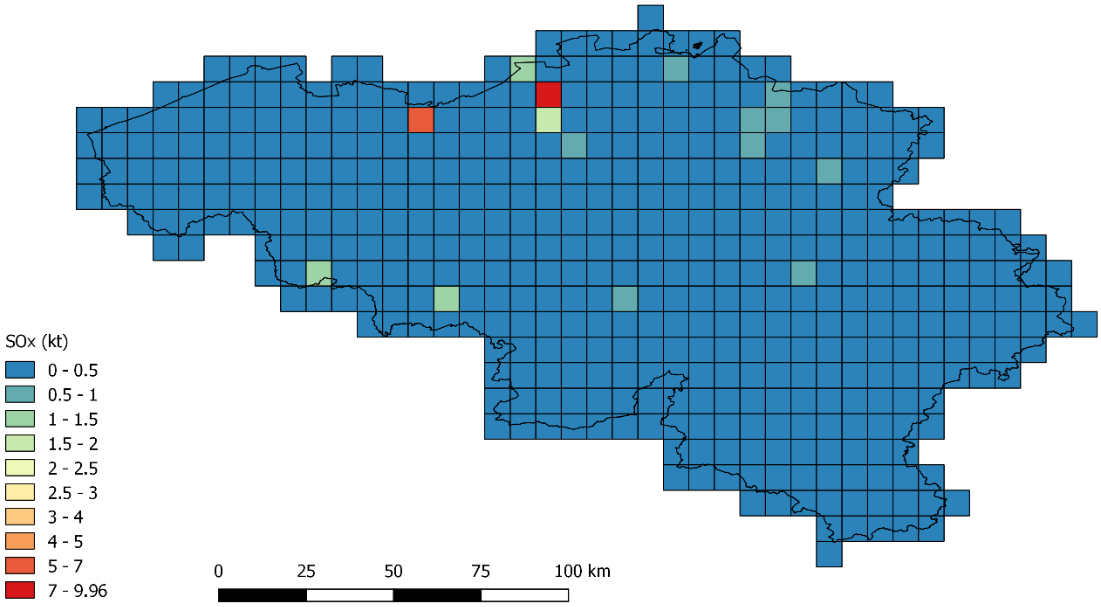


National Total NOx, 2015
NOx (kt)
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 5
5 - 7
7 - 10.430
0
25
50
75
100 km

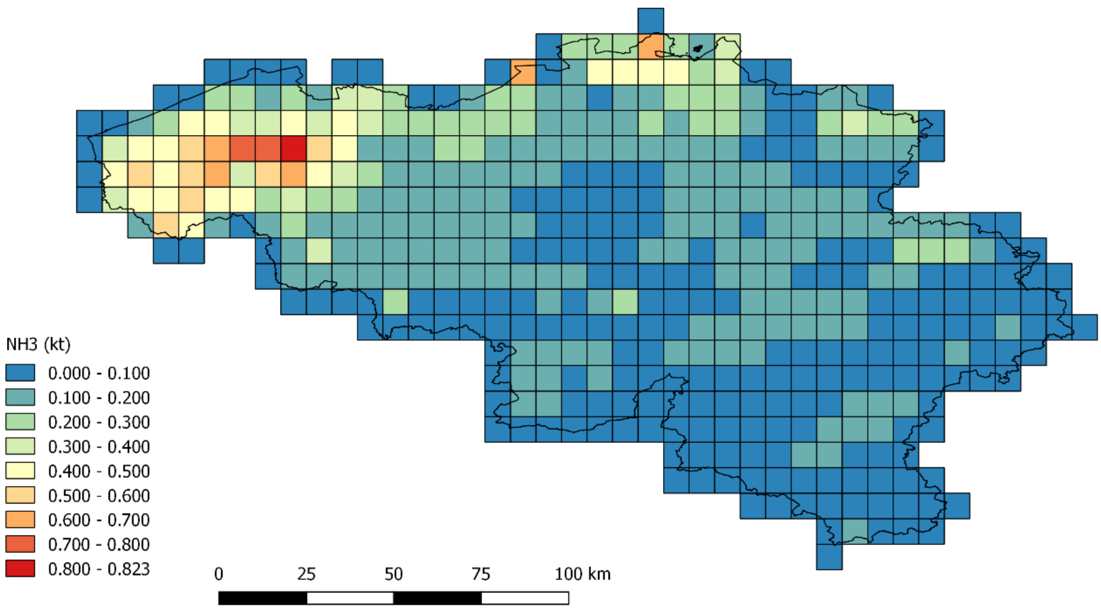


National Total NMVOC, 2015
NMVOC (kt)
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7.4
0
25
50
75
100 km

National Total SOx, 2015



National Total NH3, 2015



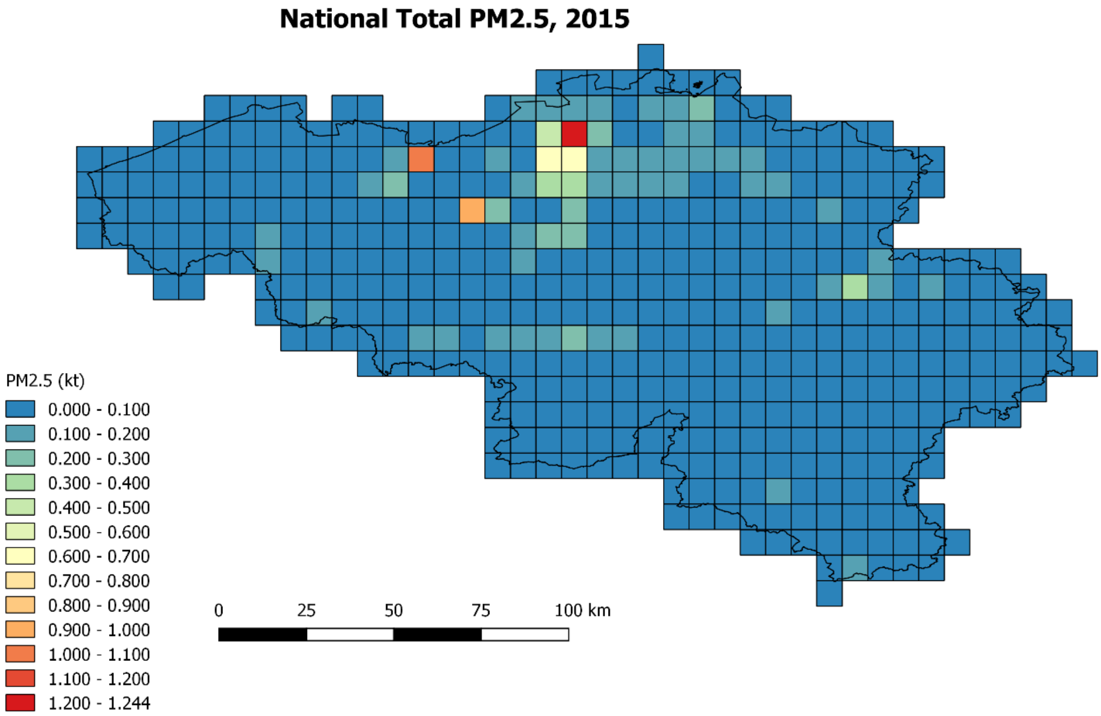


Figure 10-3: Gridded national total emissions for NOx, NMVOC, SOx, NH3 and PM2.5 in 2015.

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 2015 according to this definition, including information on stack height class.

Belgium reported emissions for 2015 from 308 facilities, of which 225 in Flanders, 2 in the Brussels Capital Region and 81 in Wallonia. Most facilities are from the industrial or agricultural sectors.

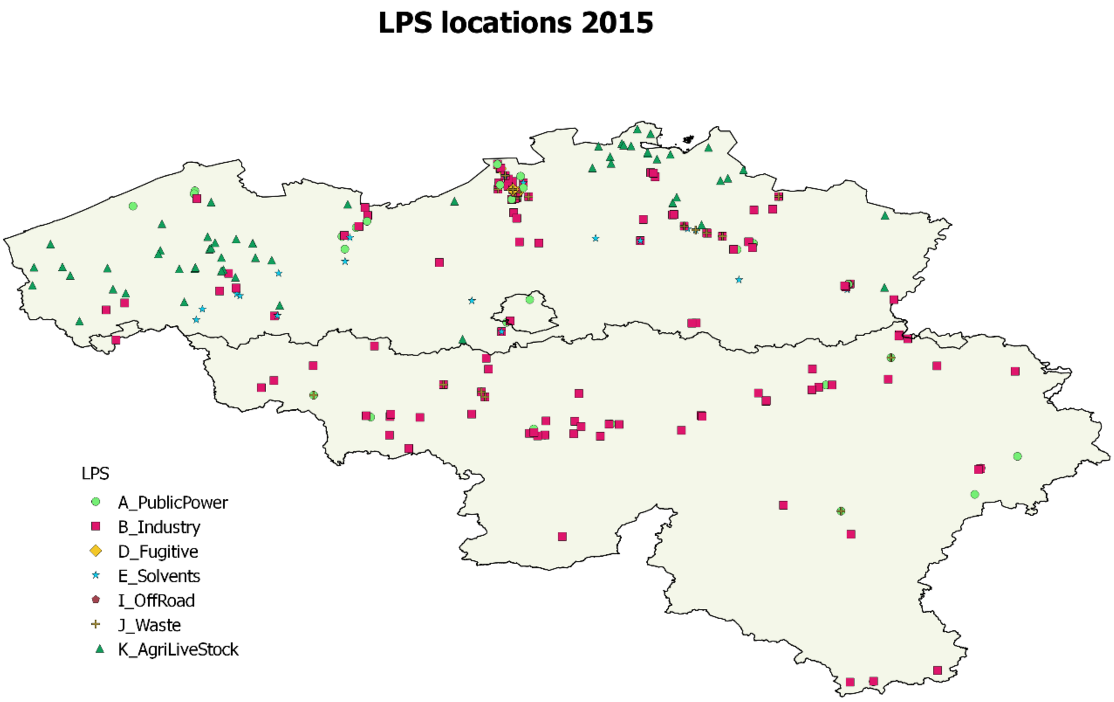


Figure 10-4: Location of LPS in 2015

Chapter 11. **Adjustments**

For more detailed information on the calculation of the adjustments, approved under CLRTAP in 2015, please refer to the 'adjustment report 2015' and Appendix B, submitted together with the 2015 IIR. For submission in the framework of the revised NECD (2016/2284/EU), the numbers in the original report have been actualised, see 'adjustment report 2017' and Annex VII, submitted together with the 2017 IIR (NECD reporting on CDR). In this chapter, only conclusions are included, up to date with the emissions reported on 15 February 2018. Reasons for recalculations between the original approved adjustments and the current adjustments are given in the document ApprovedAdj_BE_2018.

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 reduce its emissions of NO_x, SO_2, NMVOC and NH_3 to the agreed national emission ceilings by 2010 and to respect these ceilings from 2010 onwards.

Table 11-1 summarizes the emission totals, based on **fuel used** for compliance under the NECD and the Gothenborg Protocol emission ceilings. Belgium exceeds its national emissions ceiling for NOx by 30% in 2010 against the NECD and by 27% against the Gothenborg Protocol ceiling. The estimates for 2016 give an exceedance of 3% and 1% against NECD en Gothenborg respectively. For NMVOC, the NEC emission ceiling was exceeded in 2010, but the Gothenborg ceiling was met. Since 2011, NMVOC emissions are below both emission ceilings. The NEC and Gothenborg emission ceilings for the other pollutants were met in 2010 or earlier.

Table 11-1: National non-adjusted total emissions (fuel used) and national emission ceilings.

National Total (fuel used)	NOx (kt)	NMVOC (kt)	SOx (kt)	NH3 (kt)
2010	229.42	140.42	60.15	70.42
2011	214.44	128.50	52.84	69.78
2012	204.70	125.73	47.22	69.83
2013	203.56	123.00	44.13	70.65
2014	192.89	115.85	41.27	68.07
2015	189.87	113.60	41.43	67.97
2016	182.00	113.47	42.32	67.84
NEC Emission ceiling 2010	**176**	**139**	**99**	**74**
% above NEC ceiling in 2016	3%	-18%	-57%	-8%
Gothenborg Emission ceiling 2010	**181**	**144**	**106**	**74**
% above Gothenborg ceiling in 2016	1%	-21%	-60%	-8%

The non-compliance for NOx emissions up to 2016, as well as for NMVOC emissions in 2010 (NEC) are due to changes in the emission inventory, not foreseen at the time the emission ceilings were set. These changes include the partial failure of certain EURO vehicle emission standards, especially for diesel vehicles, as well as the inclusion of new source categories.

In accordance with Directive 2016/2284/EU, Article 5(1) and Annex IV, Part 4 (NECD), and based on EB decision 2012/4 allowing the provisional application of article 3, paragraph 11 quinquies of the amended Gothenborg Protocol (CLRTAP), Belgium applies for making use of the adjustment procedure as described in EB Decision 2012/3 and according the Guidance in the consolidated version of the adapted EB Decision 2012/12 and additional Guidances for its emission inventory for NOx for 2010 to 2016 and NMVOC for 2010 in order to prove its compliance with the 2010 NECD ceilings.

For **NOx**, the adjustment application to the emission inventory is the result of two (aggregated) adjustments, both of them in accordance with one of the circumstances as described in Annex IV, Part 4 (NECD) and EB Decision 2012/3, article 6 (CLRTAP):

1. **Road transport (1A3bi-iv)**: Significant change in emission factors (NECD - Annex IV, Part4.1.d.(ii) and LRTAP - Decision 2012/3, article 6(b))
2. **Agriculture (3B, 3Da1 and 3Da2a)**: new source categories (NECD - Annex IV, Part 4.1.d.(i) and LRTAP - Decision 2012/3, article 6(a))

For **NMVOC**, the adjustment application to the emission inventory is due to the inclusion of the emissions from agricultural soils and manure management, two source categories that were not taken into account at the time the emission ceilings were set, and therefore in accordance with circumstance (i) in Annex IV, Part4.1.d (NECD) and with circumstance a) in EB Decision 2012/3 (CLRTAP):

Agriculture (3B and 3De): new source categories (NECD - Annex IV, Part 4.1.d(i) and LRTAP - Decision 2012/3, article 6(a)).

Table 11-2 summarizes the individual adjustments as well as the adjusted national total emissions. For compliance purposes, Belgium is allowed to use national total emissions based on **fuel used**[9]. **With application of the adjustments, Belgium is in compliance with its NEC emission ceilings from 2010 on for all NEC pollutants. A fortiori, the Gothenborg Protocol emission ceilings are met.**

Table 11-2: Total Emissions and adjustments for NOx and NMVOC.

NOx	2010	2011	2012	2013	2014	2015	2016	NEC 2010	Gothenborg 2010
National Total (fuel used)	229.42	214.44	204.70	203.56	192.89	189.87	182.00	176	181
Adjustment Road transport (1A3bi-iv)	-48.23	-48.16	-47.87	-49.11	-47.78	-45.15	-43.01		
Adjustment Agriculture - Manure management (3B)	-0.83	-0.81	-0.81	-0.82	-0.83	-0.83	-0.83		
Adjustment Agriculture - Inorganic N-fertilizers (3Da1)	-5.95	-5.73	-5.70	-5.97	-6.06	-6.14	-6.22		
Adjustment Agriculture -Animal manure applied to soils (3Da2a)	-6.92	-6.64	-6.43	-6.37	-6.34	-6.26	-6.26		
Adjusted national total for compliance	167.49	153.10	143.88	141.29	131.89	131.49	125.68		

[9] ECE/EB.AIR/125. Guidelines for Reporting Emissions and Projections Data under the Convention on Longe-range Transboundary Air Pollution, Chapter V, A.23.

NMVOC	2010	2011	2012	2013	2014	2015	2016	NEC Emission ceiling 2010	Gothenborg emission ceiling 2010
National Total (fuel used)	140.42	128.50	125.73	123.00	115.85	113.60	113.47	139	144
Adjustment Agriculture - Manure management (3B)	-28.24	NR	NR	NR	NR	NR	NR		
Adjustment Agriculture - Cultivated crops (3De)	-1.22	NR	NR	NR	NR	NR	**NR**		
Adjusted national total for compliance	110.96	NR	NR	NR	NR	NR	**NR**		

Based on the emission factors used in COPERT IV v11.3, compliance with the NECD 2010 ceiling without adjustments and based on fuels used emissions is foreseen for 2017. For the Göteborg Protocol, under the same conditions, compliance was foreseen in 2016.

References

Arcadis (2010). NMVOC emissions through domestic solvent use and the use of paints in the Brussels Capital Region.

Bartelink, H.H. (1997). Allometric relationships for biomass and leaf area of beech (Fagus sylvatica L) . Annales des Sciences Forestières, 54 pp 39-50.

Bauwens, S. (2010). Inventaire sur l'affectation des terres et du changement d'affectation des terres et la foresterie (LULUCF) de la Belgique, Rapport intermédiaire 2 février 2010 Gemboux Agro Biotech.

Bauwens, S. (2011). Inventaire sur l'affectation des terres et du changement d'affectation des terres et la foresterie (LULUCF) de la Belgique, Rapport final Mai 2011Gemboux Agro Biotech.

Bauwens, S. (2011). Optimalisatie emissie-inventaris lucht : sector landgebruik en verandering in landgebruik, Final Report, December 2011. Gembloux Agro Biotech.

Beerparadise. URL via www.beerparadise.be

Belkacem, S., Nys, C. & Gelhaye, D. (1992). Effets d'une fertilisation et d'un amendement sur l'immobilisation d'éléments dans la biomasse d'un peuplement adulte d'épicéa commun (Picea abies L Karst). Annales des Sciences Forestières, 49, pp 235-252.

Bogaert, S., Devoldere, K., Van Hyfte, A., Van Biervliet, K. & Le Roy D. (2004). Evaluatie van het reductiepotentieel voor diverse polluentemissies naar het compartiment lucht in een aantal homogene subsectoren van de chemische industrie in Vlaanderen, deel III. Aminal – Aminabel. 442p.

Bonneau (1995). La fertilisation en forêt.

Campens, V. & Lauwers, L. (2002). Kunstmestgebruik en gewasproductie als determinanten van de nutriëntenemissie, uitgevoerd door de VMM en CLE.

Corsi, R.L., Torres, V.M., Carter, G., Dombrowski, K., Dondelle, M., Fredenberg, S., Takahama, S. & Taylor, T. (2000). Non-point source ammonia emissions in Texas: a first estimate. Prepared fo the Texas Natural Resources Conservation Commission. August 2000.

Curran, R.J. (2006). Method for estimating particulate emissions from aircraft brakes and tyres. Study performed by QinetiQ Ltd. Under the authority of the Department for Transport (confidential document).

Decoene, K. (2012). Handleiding nieuwe methode geografische spreiding PM10, PM2.5 en EC. Methodologie uitgewerkt in opdracht van VMM, Emissie-inventaris lucht, 121 p.

D'Haene, V., Van Hyfte, A. & Van Langenhove, H. (2002). Emissies van vluchtige organische stoffen in Vlaanderen: verfijning van de inventarisatie en van het relationeel verband met troposferische ozon. Universiteit Gent, Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen, Vakgroep Organische Chemie. Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij, onderzoeksopdracht nr. VMM.AMO.2000, 346 p.

D'Haene, V., Van Hyfte, A. & Van Langenhove, H. (2002). Emissies van vluchtige organische stoffen in Vlaanderen: verfijning van de inventarisatie en van het relationeel verband met troposferische ozon. Study performed by Ghent University under the authority of the Flemish Environment Agency, VMM.AMO.2000, 346 p.

De Roo, K., Philips, G. & Van Durme, J. (2009). Optimalisatie emissie-inventaris vluchtige organische stoffen van sectoren 'coating, 'droogkuis' en 'reinigen en ontvetten'. Studie uitgevoerd door de

Universiteit Gent in samenwerking met PRG Odournet in opdracht van de VMM. Ref. G08/VMM/11, 133p.

Denier van der Gon, H. & Hulskotte, J. (2010). Methodologies for estimating shipping emissions in the Netherlands; a documentation of currently used emission factors and related activity data. Study conducted under the auspices of the Netherlands Research Program on Particulate Matter (BOP), 56 p. URL: http://www.rivm.nl/bibliotheek/rapporten/500099012.pdf

DNV, CCI, TNO (2014). Uncertainty analysis of emission inventories of NEC/LRTAP air pollutants. Final report, 115p.

Duvigneaud, P., Denaeyer, S. & Kestemont, P. (1977). Productivité primaire de forêts belges de types variés. Productivité biologique en Belgique, Travaux de la section belge du Programme Biologique International. Editions Duculot, Paris-Gembloux.

ECE/EB.AIR/125 (2013). Guidelines for Estimating and Reporting Emission Data under CLRTAP. Available via http://www.ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf

Econotec (1997), Inventaire 1996 des émissions atmosphériques en région wallonne-Groupe 2, 5 et 6 de la nomenclature Snap.

Econotec (2010). Study on dust : analyse prévisionnelle des émissions de poussières en région wallonne à l'horizon 2010, juillet 2010.

EMEP / EEA. (2016). *Air pollutant emission inventory guidebook 2016.*

EPA (1996), AP42-Hot mix asphalt plant.

European Environment Agency (2013). Emep/EEA air pollutant emission inventory guidebook – 2013.

EXcoser : Quantification des émissions d'HAP dans l'environnement en Belgique - Rapport final, Excoser SA pour la DGRNE, 30/5/95.

Essen (1997), Identification of relevant industrial sources of dioxins and furans in Europe.

Foqué D. & Demeyer P. (2009). Optimalisering en actualisering van de emissie-inventaris ammoniak landbouw. Instituut voor Landbouw- en Visserijonderzoek. Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij. Mededeling ILVO nr 69, 147 p.

FPS Health. Brochure 'CCIM – één unieke stem op de internationale milieuscène'. Available via URL http://www.health.belgium.be/eportal/Environment/Inspectionandenvironmentalrigh/international/CCPIE/index.htm?fodnlang=nl

Gloaguen, J.-C. & Touffet, J. (1982). Production de litière dans une chênaie–hêtraie atlantique. Relations avec les caractères climatiques. Revue Forestière française, XXXIV, pp108-118.

Guns, A. (1990). Effets à moyen terme d'un apport de fertilisants sur une jeune plantation d'épicéa commun (Picea abies L Karst). Travail de fin d'études. Section interfacultaire d'agronomie, Université Libre de Bruxelles.

Hewitt C.N., Street, R.A. & Scholefield P.A. (1997). Isoprene and monoterpene-emitting species survey 1997. http://www.es.lans.ac.uk/es/people/pg/pas/download.html

Janssen, L. & Colles, A. (2004) Geografische spreiding van het brandstofverbruik in Vlaanderen voor de huishoudens, de tertiaire sector en de land- en tuinbouwsector. VITO-rapport 2004/IMS/R/110 april 2004.

Klein,J., Hoen, A., Hulskotte,J., Van Duynhoven, N., Smit,R., Hensema, A. & Broeckhuizen, O. (2006). Methoden voor de berekening van de emissies door mobiele bronnen in Nederland.

Van Mierlo, J., Boureima, F., Messagie, M., Sergeant, N., Govaerts, L., Denys, T., Michiels, H., Vernaillen, S., Schrooten, L., Beckx, C., Macharis, C., Turcksin, L., Bernardini, A., Hecq, W., Klopfert, F., Englert, M., De Caevel, B. & De Vos, M. (2009). CLEAN VEHICLE RESEARCH: LCA AND POLICY MEASURES 'CLEVER' - Final Report. Brussels : Belgian Science Policy 2009 – 119 p. (Research Programme Science for a Sustainable Development).

Lodewijks, P., Van Rompaey, H. & Sleeuwaert, F. (2003). VOS-emissies naar de lucht bij de productie en het industrieel gebruik van coatings, inkt en lijm in Vlaanderen. Studie uitgevoerd door de VITO in opdracht van AMINAL ref. nr. 2003/IMS/R155, 359 p.

Lodewijks, P., Polders, C. & Van Rompaey, H. (2005). Evaluatie van de inschatting van NMVOS emissies door verbrandingsprocessen in Vlaanderen. Study performed by VITO under the authority of Aminal, 2005/IMS/R/323, 132 p.

Luchetta, L., Simon, V. & Torres, L. (2000). Emission des principaux composés organiques volatils biogéniques en France. Pollution Atmosphérique, n° 167.

Mathot *et al*. (2011) *Filière de gestion des effluents d'élevages bovins : Impact environnemental de la production et du stockage.* UCL, CRAw

Meulepas P. & Vercaemst P. (1999). *Beste Beschikbare Technieken voor de benzinetankstations*, VITO, 1999/PPE/P/103, 233pg

MNZ (1995), Quantification des emissions d'hydrocarbures aromatiques polycycliques (HAP) dans l'environnement en Belgique.

Neirynck, J., Maddelein, D., de Keersmaeker, L., Lust, N. & Muys, B. (1998). Biomass and nutrient cycling of a highly productive Corsican pine stand on former heathland in northern Belgium. Annales des Sciences Forestières, 55, pp 389-405.

NIR (2016). Belgium's greenhouse gas inventory (1990-2014). Available via http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/9492.php

NIS (2010). Belgium's National Inventory System for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, paragraph 1, of the Kyoto Protocol, 45 p.

OVAM (2008). Tarieven en capaciteiten voor storten en verbranden - Actualisatie tot 2006, evolutie en prognose. D/2007/5024/79. 69 p.

Parcom (1992), Emission factors manual.

Polders, C., Hooyberghs, E., Vanassche, S. & Huybrechts, D. (2011). Beste Beschikbare Technieken (BBT) voor de houtverwerkende nijverheid. Gent, Academia Press, xiv + 635 p.

Polders, C., Wevers, M. & Van Rompaey, H. (2003*).* Haalbaarheidsonderzoek en aanzet tot de opmaak van een emissie-inventaris van dioxines. Studie uitgevoerd door de VITO in opdracht van VMM, ref. 2003/IMS/R/006, 107 p.

Ponette, Q. & Ranger, J. (2000). Biomasses et minéralomasses aériennes de cinq peuplements de douglas du réseau Rénécofor : quantification et implications sylvicoles. Revue Forestière française, LII-2, pp115-133.

Pulles, T., van der Gon, H.D., Appelman, W. & Verheul, M. (2012): Emission factors for heavy metals from diesel and petrol used in European vehicles.

Ranger, J., Cuirin, G., Bouchon, J., Colin, M., Gelhaye, D. & Mohamed Ahamed, D. (1992). Biomasse et minéralomasse d'une plantation d'épicéa commun (Picea abies L Karst) de forte production dans les Vosges. Annales des Sciences Forestières, 43, pp 651-668.

Ranger, J., Marques, R., Colin-Belgrand, M., Flammang, N. & Gelhaye, D. (1996). La dynamique d'incorporation d'éléments nutritifs dans un peuplement de douglas. Conséquences pour la gestion sylvicole. Revue Forestière française, XLVIII-3, pp217-230.

Renders, N., Duerinck, J., Altdorfer, F. & Baillot, Y. (2010). Potentiële emissiereducties van de verwarmingssector tegen 2030. Study performed by VITO and Econotec under the authority of the Federal Public Service Health, food chain safety and environment, 2010/TEM/R, 256 p.

Schrooten, L. & Van Rompaey, H. (2002). Ontwikkeling van een methodologie voor een emissie-inventaris van PM10 en PM2,5 en opstellen van een emissie-inventaris voor 1995 en 2000. Study performed by VITO under the authority of VMM, 2002/IMS/R/200, 246 p.

Schrooten, L., Jespers, K., Baetens, K., Van Esch, L. Gijsbers, M., Van Linden, V. & Demeyer, P. (2009). OFFREM. Model voor emissies door niet voor de weg bestemde mobiele machines. Study performed by ILVO and VITO under the authority of Environment, Nature and Energy Department of the Flemish Government (2009/TEM/R). 133 p.

Schrooten, L., Van Rompaey, H., Berghmans, P., Vanderreydt, I. & Bleux, N. (2002). Deel A: Emissie-inventaris fijn stof Vlaanderen voor 1995 en 2000. Deel B: Monitoring fijn stof emissies voor industriële bronnen. Study performed by VITO under the authority of VMM. 2002/IMS/R/200.

Sleeuwaert, F., Polders C.& Van Rompaey, H. (2006). Optimalisatie en actualisatie van de emissie-inventaris fijn stof in het kader van internationale ontwikkelingen. Study performed by VITO under the authority of VMM, 2006/IMS/R/391, 140 p.

Sleeuwaert F., Van Esch L. & Engelen G. (2012). Ontwikkelen en optimalisatie van een emissie-inventaris Persistente Organische Polluenten (POP's). Study performed by VITO in cooperation with TNO (Coenen P., Visschedijk A., Van der Gon H. & Hulskotte J.) under the authority of VMM. 2012/MRG/R/389, 163 p.

Sleeuwaert, F., Van Esch, L., Jespers, K., Van Rompaey H. & Engelen, G. (2010). Actualisering en optimalisering van de inschatting van de verbrandingsemissies door de collectief geregistreerde bedrijven. Study performed by VITO under the authority of VMM, 2010/MRG/R/352, 88 p.

Sleeuwaert, F., Van Rompaey, H., Visschedijk, A., Coenen, P. & Ten Broeke, H. (2009). Ontwikkelen van een methodologie voor een emissie-inventaris zware metalen en opstellen van een emissie-inventaris voor 2000 en 2005. Study performed by VITO in cooperation with TNO under the authority of VMM. 2009/MRG/R/207, 126 p.

Teller, A. (1983). Biomasse, productivité et évaluation des déchets dans un peuplement d'épicéa à Strainchamps (Ardennes) Travail de fin d'études. Section interfacultaire d'agronomie, Université Libre de Bruxelles.

ULG (1998). Inventaire des émissions atmosphériques en Région Wallonne pour 1996, Université de Liège, juillet 1998.

Van Hyfte, A. & Van Langenhove, H. (2000). Emissies van vluchtige organische stoffen in Vlaanderen: verfijning van de inventarisatie en van het relationeel verband met troposferische ozonvorming. Programma Beleidsgericht Onderzoek 1997, project PB097/29/160, 190 p.

Van Ransbeeck, N. (2013). Particulate matter, ammonia and greenhouse gases in pig fattening facilities: measuring strategies, indoor concentrations and emissions. Universiteit Gent, 165 p.

Van Rompaey, H., De Fré, R., De Spiegeleer, E., Polders, C., Vanderstraeten, P. & Wevers, M. (2001). Emissies van dioxins en PAK's door gebouwenverwarming met vaste brandstoffen. Study performed by VITO under the authority of AMINAL. 2001/IMS/R/059, 208 p.

Van Rompaey, H. & Wuyts, H. (1999). Collectieve registratie van industriële emissies. Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij, project 1999/PPE/R/153, 55 p.

Vanherle, K, Van Zeebroeck, B. & Hulskotte, J. (2007). Emissiemodel voor spoorverkeer en scheepvaart in Vlaanderen: EMMOSS. Study performed by Transport and Mobility Leuven (TML) under the authority of VMM. 100 p. URL: http://www.tmleuven.be/project/emmoss/index.htm

Vanherle, K, Vanhove, F., Spitaels, K, Carlier, K. (2010). Actualisering en verfijning van het emissiemodel voor spoorverkeer en scheepvaart in Vlaanderen (EMMOSS). 85 p.

Wevers, M. (2002). Meetcampagnes dioxines en PAK's: emissies door open vuren, open tonnetjes, kachels en allesbranders en analyses van roetstalen uit schouwen. Study performed by VITO under the authority of AMINAL/Aminabel.