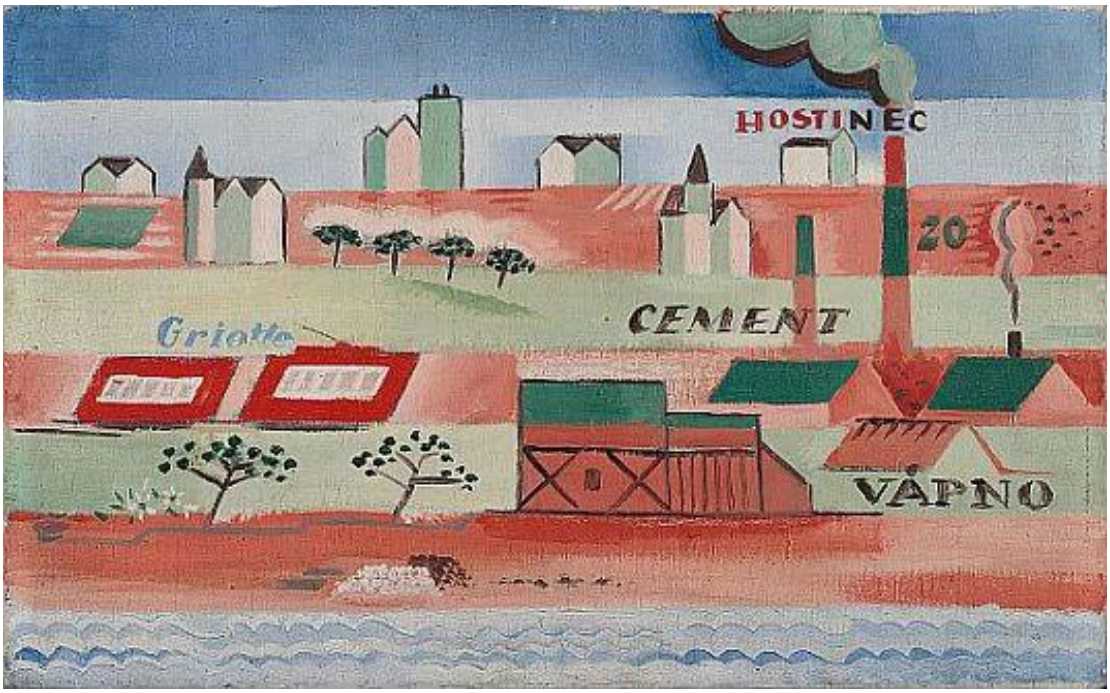
CZECH INFORMATIVE INVENTORY REPORT 2017



CZECH HYDROMETEOROLOGICAL INSTITUTE

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Submission under the UNECE Convention on Long-range Transboundary Air Pollution and the National Emission Ceilings Directive (NECD 2016/2284/EU)

Ilona Dvořáková, Václav Dvořan, Helena Hnilicová, Pavel Machálek, Miloslav Modlík (ČHMÚ)
Martin Dědina (VUZT), Hana Geiplová.(SVUOM), Vladimír Neužil (KONEKO), Leoš Pelikán (CDV)

Picture: Josef Čapek, Na obvodu města, 1920 (On the Perimeter of the Town)

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EXECUTIVE SUMMARY

The Czech Republic acceded to The Convention on Long-range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UNECE/CLRTAP) and has been a member of the EU since 2004. From these facts it is clear obligation to report annual emission data. The report includes description of determination of the emissions.

The annual comparison of emissions of main pollutants in 2014 and 2015 shows a significant effect of a colder heating period in 2015 and thus higher anticipated fuel consumption in households. Moreover there was remarkable impact of emission reduction, mainly at large combustion and technology sources as a result of fulfilment the requirements in Directive 2010/75/EU on industrial emissions. While REZZO 1 emissions decreased comparing to 2014 (SO_2 even at 6.7%), model-calculated emissions from household heating show an increase on average by 7%. The reduction in REZZO 1 emissions was achieved by implementation of National air pollution control programme, e.g. for iron and steel production in the Moravian-Silesian Region. There was also a drop in emissions from mobile sources (about 2%).

The sector of residential heating (NFR 1A4bi) still contributes significantly to air pollution, specifically PM_{10} emissions by 36,4 %, $PM_{2.5}$ emissions by 54,5 %, carbon monoxide by 49,8 % and benzo[a]pyrene by 97,3 %. The decisive share of the public sector energy (NFR 1A1a) prevailed in emissions of Sulphur dioxide 61,2 %, arsenic 24,7 %, nickel 39,3 % and cadmium 20,0 %. Emissions of lead were 40,1 % in the sector of iron and steel (NFR 1A2a and 2C1). The road freight transport sector over 3.5 tonnes (NFR 1A3biii), passenger car (NFR 1A3bi) and off-road vehicles and other machinery in agriculture and forestry (NFR 1A4cii) created 39,6 % of nitrogen oxide emissions. The most significant sources of emissions of volatile organic compounds are found in the sector of use and application of organic solvents (NFR 2D) with share 50,6 %. The main source of ammonia emissions is livestock sector (NFR 3B), whose share of total emissions accounted for 70.0%.

Figure 0-1, Figure 0-2, Figure 0-3, Figure 0-4 show the emissions in the years 2000 – 2015

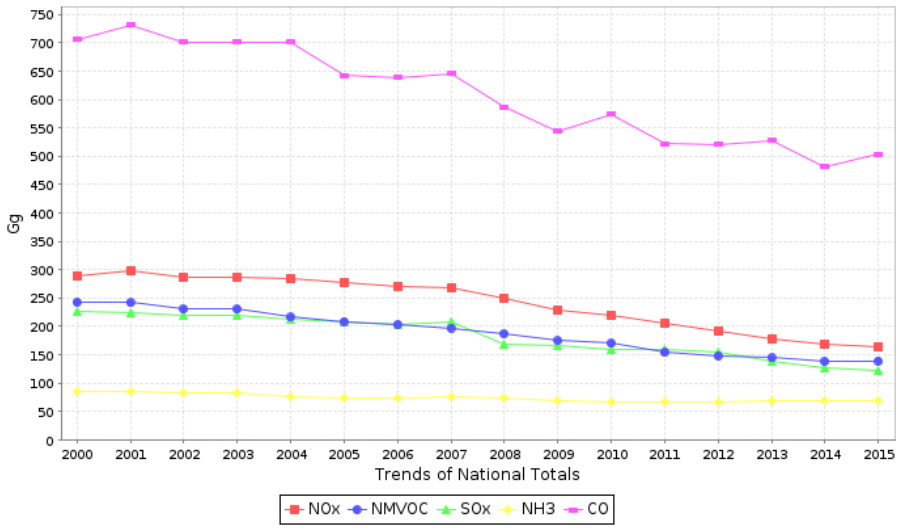

Figure 0-1 Trends of national totals of main pollutants

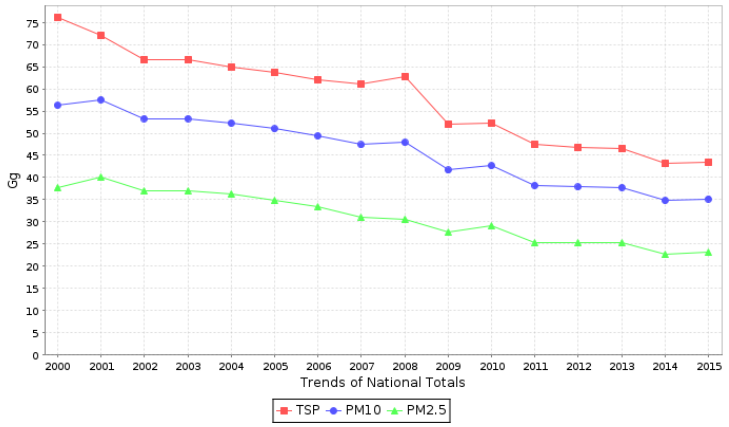

Figure 0-2 Trends of national totals of particulate matter

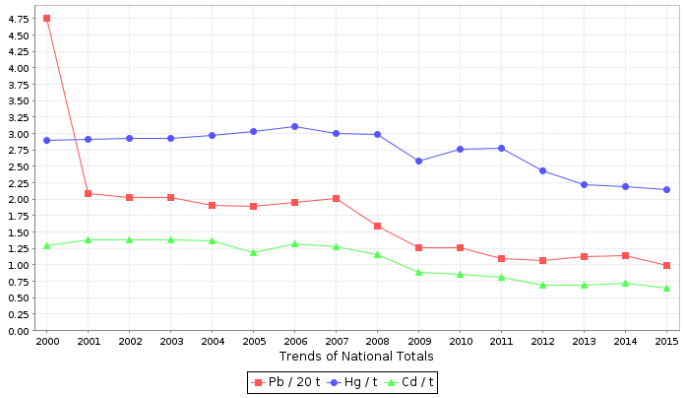

Figure 0-3 Trends of national totals of heavy metals

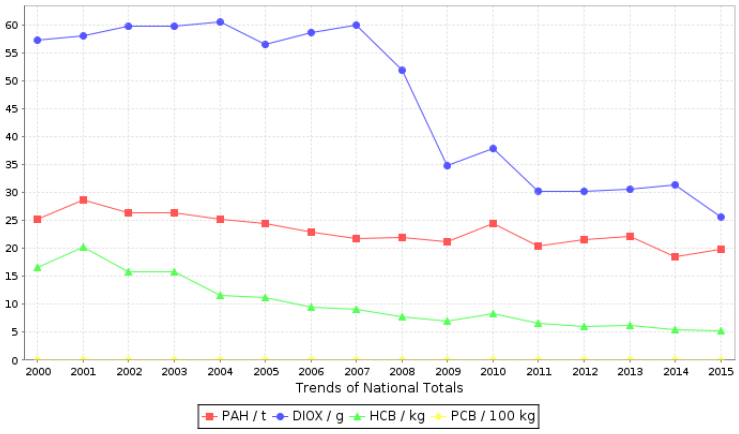

Figure 0-4 Trends of national totals of POPs

1 INTRODUCTION

1.1 National Inventory Background

The Convention on Long-range Transboundary Air Pollution was negotiated in 1979 and belongs to the important instruments of prevention of the long-range transfer of air pollution. The Convention has a framework character: the contractual reduction of air pollution is realized through protocols adopted to the Convention. So far, 8 protocols have been adopted. The Czech Republic acceded to the Convention on 1 January 1993 and is a party to all 8 protocols.

- *Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe. It was agreed in 1984, came into force on 28 January 1988 and to this date has 42 Contracting Parties.*
- *Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent. It was agreed in 1985, came into force on 2 Septenber1988 and to this date has 24 Contracting Parties.*
- *Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes. It was agreed in Sofia in 1988, entered into force on 14 February 1991 and has 33 Contracting Parties.*
- *Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes). It adopted in 1991, entered into force on 29 September 1997 and has 23 Contracting Parties.*
- *Protocol on Further Reduction of Sulphur Emissions. It was agreed in Aarhus, in 1994, came into force on August 5, 1998 and to this date has 42 Contracting Parties.*
- *Protocol on Heavy Metals. It was adopted in 1998, entered into force on 29 December 2003 and has 29 Contracting Parties. In the framework of the protocol have been developed methods of modelling the transfer of heavy metals (cadmium, lead and mercury) over long distances and storing it in the soil, water, sediments of rivers and seas etc.*
- *Protocol on Persistent Organic Pollutants (POPs)). Adopted in 1998, entered into force on 23 December 2003 and has 29 Contracting Parties.*
- *Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. It was adopted Nov. 30, 1999, entered into force on 17 May 2005 and has 25 Contracting Parties.*

The current CLRTAP development strategy is focusing, above all, on increase in ratifications and on the revision of the last 3 protocols, i. e. the revision of the Protocol on Heavy Metals, Protocol on Persistent Organic Pollutants and Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. An important task is also the strengthening of the implementation of the Protocols and of the emission reporting by the Parties, including its control.

According to the Guidelines for Estimating and Reporting Emission Data, each party must report the annual national emission data of pollutants in the NFR source category and shall submit an informative inventory report on the latest version of the templates to the Convention Secretariat.

1.2 Institutional arrangements

Czech emission inventory is performed in accordance with the national legislation for the prevention of air polluting and reduction of air pollution from 2012. There are Act 201/2012 Coll., on the air protection (Air Protection Act), and Regulation 415 /2012

Coll., on the permitted level of pollution and its ascertainment and on the implementation of some further provisions of the Act on the protection of air.

The information is stored in the Register of Emissions and Stationary Sources (REZZO), which is maintained by the Ministry of the Environment of the Czech Republic. This emission database, which is used for archiving and presenting data on stationary and mobile sources of air pollution, is, pursuant to the valid legislation (Section 7 of Air Protection Act), is part of the Air quality information system (ISKO) operated by Czech Hydrometeorological Institute (CHMI). Air pollution sources are divided to the individually monitored sources and sources monitored as area sources.

Since 2013, in connection with the change in categorization of sources pursuant to Annex 2 to the Air Protection Act, REZZO sources are newly circumscribed (Table 1-1).

Table 1-1 The categorization of pollution sources

Type of source				
Category	REZZO 1	REZZO 2	REZZO 3	REZZO 4
	Stationary plants for combustion of fuels with a nominal heat input power 0.3 MW and higher, waste incinerators and other specified sources (technological combustion processes, industrial production etc.)	Stationary plants for combustion of fuels with a nominal heat input power up to 5 MW inclusive, combusting liquid or gas fuels and service stations and facilities for transporting and storing petrol fuel	combustion of fuels with a total thermal input lower 0.3 MW, non-specified technological processes (domestic solvent use, building, agricultural activities)	Road, railway, water and air transport of persons and freight, tyre and brake wear, road abrasion and evaporation from fuel systems of vehicles using petrol, non-road vehicles and machines used in maintenance of green spaces in parks and forests etc.
Origin of emissions	Reported emission data	Calculated emissions from reported activity data (consumption and calorific capacity of fuels, gasoline distribution) and emission factors	Calculated emissions from activity data obtained e.g. from the Census, production and energy statistical surveys and emission factors	Calculated emissions from activity data obtained e.g. from road traffic census, the register of vehicles etc. and emission factors
Method of monitoring	Individually monitored sources – reported emissions	Individually monitored sources – emissions calculated from the reported data and emission factor	Sources monitored collectively	Sources monitored collectively

1.3 Inventory preparation process

The Czech Hydrometeorological Institute (CHMI), under the supervision of the Ministry of the Environment, is designated as the coordinating and managing organization responsible for the compilation of the national inventory and reporting its results.

Sectoral inventories are prepared by sectoral experts from sector-solving institutions, which are coordinated and reviewed by CHMI:

Transport Research Centre (CDV), Brno, is responsible for compilation of the inventory in sector 1 Energy, Road and non-road Transport.

Research Institute of Agricultural Technology (VUZT), Prague, is responsible for compilation of the inventory in sector 3, Agricultural and sector 1A4cii non-road Agricultural and Forestry mobile sources.

National Research Institute for the Protection of Materials, Ltd. (SVÚOM), Prague, is responsible for compilation of the inventory in sector 2D Solvent Use

Economic indicators show overall trend of economic growth. GDP indicator against 2014 rose by 4.5 %. The total fuel consumption for power generation and heat production also grew partly due to colder weather conditions during heating season, but also due to slight increase of fossil fuels power generation (by approx. 2 %). The industrial production also showed an increase, for example cement and lime production, chemical production whereas steel and iron production dropped down moderately.

The trend of main pollutants, TSP and CO emissions is showed in Figure 2-2. The level of air pollution in 2015 changed in comparison with the year 2014 as follows: VOC, NH_3, PM, BC increased on average by 1 % and TSP 1,7 %. CO rose by 4.5 %, whereas NOx and SO_2 decreased by 3 %. The trend of heavy metals and POPs is strongly dependent on trends in individual categories. While emissions with core source of residential heating show an increase (PAHs mainly) as well as heavy metals for automobile tyre and break wear. Metallurgy, mainly production of sintering product shows a significant decrease of PM emissions (more than 25 %) and related decrease of heavy metals and POPs emissions.

1.4 Methods and data sources

The emission inventory of air pollution sources in the Czech Republic, prepared for the purposes of international reporting, is based on a combined methodology. In addition to the reporting of primary emission data from operators of sources, other operating information is also used to estimate emissions in certain sectors (fuel consumption, production, etc.). A significant part of emissions is also estimated on the basis of statistically monitored and reported information and available emission factors.

1.4.1 Emissions from individually monitored sources - stationary sources

Pursuant to the Air Protection Act, Section 17 (Obligations of an operator of a stationary source), paragraph 3, the operators of stationary sources listed in Annex 2 to this Act are obliged to keep operational records on constant and fluctuating information on the stationary source describing said source and its operation, as well as information on inputs and outputs from said source, and disclose data each year summarizing the operational records by means of the integrated system for notification obligations (ISPOP). Reporting through this system has been mandatory from 2010. The data from ISPOP are then submitted to the REZZO 1 and REZZO 2 database. Requirements of summary operating records are stated in Annex 11 to Regulation 415/2012 Coll.

Operators are obliged to provide emission data on pollutants escaping into the air from the stationary source per reported calendar year for which the operator of the stationary source, according to Section 6(1) of the Act has the stated obligation to determine emissions. The emission limit values are set in Annexes 2–8 (specific) and 9 (general) to Regulation 415/2012 Coll. Furthermore, specific emission limits and methods, conditions and frequency of ascertaining the pollution levels can be set for any pollutant in operating permit issued by regional authorities. The manner and frequency of measuring or calculating pollution levels and the scope, manner and conditions for recording, verification, evaluation and storage of results of the ascertainment of pollution are set in Regulation 415/2012 Coll. Part Two (Ascertainment of the Level Of Pollution and Evaluation of the Fulfilment of Emission Limits). Itis preferred if emissions of specific pollutants are reported by the operators of their sources, as this is the Tier 3 approach.

Emission of the pollutants, for which operators are not required to ascertain pollution levels, are calculated for each source in the emission database on the basis of reported activity data and emission factors (Tier 2). Emission factors for stationary combustion sources are divided according to the type of fire place and nominal thermal output. As activity data, fuel consumption expressed in

t.year^{-1}, thousand.m^{-3}.year^{-1}, or the calorific capacity of fuel in GJ.year^{-1} is used. For other sources emission factors are related to the amount of their product in tonnes.

To determine emissions of PM_{10} and $PM_{2.5}$, emission factors expressed as percentage of PM fraction in total emissions of solid pollutants (TSP) are used. If a source is equipped with technology for reducing emissions, the share of particles depends on the separation principle of this technology. In cases of combustion sources without any technology for reducing emissions, the shares of particles are determined according to the type of fuel. For other sources, the TSP origin is a crucial factor (Hnilicová; 2013).

The monitored or based on the activity data calculated emissions of individually monitored sources are used namely for following main categories – 1A1, 1A2, 1A4 (except for 1A4bi), 1B (except for 1B1a and 1B2av), 2A (except for 2A5b), 2B (except for 2B1), 2C, 2H, 2I, 2L and 5 (except for 5A), furthermore for category 1A3ei and partly also for category 2D3c (Asphalt Roofing). There are two exceptions in emissions of heavy metals and POPs that are in some categories taken over as reported and in some other categories calculated, based on activity data or other statistical data about production facilities in some products categories (for details see chapters 3 and 4). This category includes emission of coal sorting and drying mainly in sorting plants producing coal for household consumption, coke plants and wood coal production emissions. Emissions from coal sorting plants are usually based on one-time measurement of suction devices. Wood coal production emissions are being measured while putting the facility in the operation and for annual reporting specific production emissions are being used.

Besides the above mentioned categories, the REZZO register also contains emissions of solvent using sources (categories 2D3d to 2D3i). There are more than 3600 sources (painting and degreasing plants, printing plants etc.) that produce more than 9 Gg of VOC emissions. These data are not used directly but considering high number of non-monitored facilities and the area character of emissions in protective and decorative coating, these are used for more precise estimates of total VOC emissions for each 2D category (see chapter 4.7).

The sources in category 5A are being monitored in a similar way. The permits of sources underlying a permission mostly include the obligation to ascertain the TSP emissions. These sources are currently not being used for emission inventory that is in category 5A being carried out according to Tier 1 methodology (see chapter 6.2.2).

1.4.2 Emissions from collectively monitored sources

The stationary air pollution sources monitored collectively are registered in REZZO 3. They include emission from local household heating, fugitive TSP emissions from construction and agricultural activity, ammonia emissions from the breeding of farm animals, the application of mineral nitrogenous fertilizers and VOC emissions from the use of organic solvents.

With the exception of emission from household heating, other groups of sources are calculated solely using data obtained within the national statistical monitoring. Potential year-to-year changes are usually related to development of the relevant indicators. By contrast, year-to-year changes of the amount of emissions from local household heating depend primarily on the character of heating season, which is expressed by the number of degree-days, and on the changes of the composition of combustion units. The calculation of emissions from local household heating is based mainly on the results of the population and housing census (SLDB). The calculation of activity data for the period1990–1999 was carried out according to methodology of 1997 (Machálek, Machart; 1997) and for the period 2000–2015 according to methodology of 2007 (Machálek, Machart; 2007).

Data on mobile sources registered in REZZO 4 are monitored collectively, too. This category of sources includes emissions from road, railway, water and air transport, non-road vehicles (machines used in agriculture, forestry and building industry, military vehicles etc.). The database includes also emissions from tyre and brake, road abrasion and evaporation calculated from data on transport

performance. Since 1996 the emission balance from mobile sources had been complied by Transport Research Centre (CDV) based on data on the sale of fuels submitted by Czech Association of Petroleum Industry and Trade (ČAPPO), since 2000 on the data from CSO, and own emission factors(Dufek; 2006). Set of the own EF is not complete, therefore for the remaining pollutants was complemented from EIG. Set Emission data on mobile sources in agriculture and forestry are processed by Research Institute of Agricultural Engineering (VÚZT). The consistent time series of emissions from traffic are available since 2000.

Emissions of area monitored sources are being represented in main category 1A3 with the exception of categories 1A3ei and 3B. These furthermore include other categories of mobile sources (1A2gvii, 1A4aii, 1A4bii and 1A4cii), coal mining (1B1a), distribution of fuel (1B2av), construction and demolition (2A5b) and solid waste disposal on land.

All emission factors used in Czech emission inventory are listed in individual sectors.

Emissions of area monitored sources are being represented in main category 1A3 with the exception of categories 1A3ei and 3B. These furthermore include other categories of mobile sources (1A2gvii, 1A4aii, 1A4bii and 1A4cii), coal mining (1B1a), distribution of fuel (1B2av), construction and demolition (2A5b) and solid waste disposal on land.

1.4.3 Inventory preparation timetable

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Annual Reporting of Operators				Emission database ISKO & Basic data checks																				
Data of Czech Armed Forces																								
Agricultural Data - VÚZT																								
Reported Data Checks and Processing - CHMI																								
Industrial Processes - Solvents											Data for solvents available in October													
Public Electricity Sector - CZSO											Publication of energetic bilance on 15.11. (AEEA)													
Agricultural Data - CZSO																								
Transport Data - CDV																								
Waste Sector Data													Waste data available in January											
Finalization of Emission Inventory																								
Submission to CLRTAP																								
International Review UNECE															International review									

The collection of individually monitored sources is related to the deadline set by law for reporting of summary operating evidence (SPE) 31st March. Approximately by the end of April there are the first data in XML format available in central storage ISPOP. During May the announcements are being checked and in June correction notifications are being send in case of unfilled or incorrect data. Complete download of the announced data including additional or correction reports is being done in September. Some further additional announcements and corrections are possible for further processing at the beginning of December. The total amount of operating sites may vary and in the period 2000–2010 it used to oscillate at approx. 22 000, currently 17.000. Some sources or group of sources are being announced as a sum (for example cascade of gas boilers) and with emissions or fuel consumptions are being represented by approx. 40–55 000 records a year.

The processing of this data set in the period of December and January includes mainly the check of the correctness of the NFR sector and the appropriate composition of emissions. Should unexpected emissions be reported for certain category, the emissions are being shifted to the appropriate category (for example NOx and CO at an operating site for VOC abatement at a source using solvents

are being shifted to category 1A2 or 1A4). The processing result are the sums of emissions for categories including individually monitored sources.

For the processing of emissions of area monitored sources of most categories, routine methodology procedures, collection of timely corresponding activity data or publication by official authorities like Czech Statistical Office (CZSO), Ministry of Industry and Trade (MIT – fuel data, production facilities data, livestock and other socioeconomic indicators) and CHMI (number of degree-days) are being used. The collection and processing of these data take place in the period May–December. Emission calculations for each category take place in January.

The final stage of the data processing that takes place at the beginning of February is the emission take over by sector specialists (transport, agriculture, solvent use) and filling the reporting template in. The analysis of the new data is being performed simultaneously compared to previous year. During February and at the beginning of March the IIR texts are being finalized and translated in English.

1.5 Key Categories

The sources that add up to at least 80 % of the national total emission are defined as being a key source for each pollutant. Table 1-2 provides an overview of the key sources for selected pollutants monitored under the CLRTAP in the current inventory.

Sector NFR 1A4bi Residential: Stationary was among the most significant sources of emissions in the Czech Republic in 2015. This sector was a key source of the largest number of pollutants (19 out of 26 pollutants monitored) and predominantly contributed to the national total of $PM_{2.5}$, PM_{10}, TSP, BC, CO, As and PAH. Sector NFR 1A1a Public electricity and heat production was a key source for 15 out of 26 pollutants monitored. The contribution of this sector to total emissions was the largest in the cases of NO_x, SO_x, Hg, Cr, Ni, Se and HCB. The production of iron and steel, which is comprised in sectors NFR 1A2a and 2C1 represented a key source of CO, persistent organic pollutants and heavy metals. The contribution of these sectors to the national total was the largest in the emissions of Cd, PCDD/PCDF and PCBs.

Table 1-2 Key NFR Sources of Air Quality Pollutants in the Czech Republic in 2015

Component	Key categories (Sorted from high to low from left to right)											Total (%)
SOx	1A1a	1A4bi	1A2c									81,3
	61,20%	13,70%	6,50%									
NOx	1A1a	1A4cii	1A3biii	1A3bi	1A2f	1A4bi	1A4ai					82,9
	30,90%	18,30%	13,80%	7,50%	4,80%	4,40%	3,10%					
NH_3	3Da1	3B1b	3B1a	3B3								83,1
	26,50%	24,50%	18,20%	14,00%								
NMVOC	2D3d	1A4bi	2D3g	2D3a	1A3bv	1B1a	2D3e	2D3i	1A3biii			81,6
	21,40%	18,20%	7,80%	7,40%	5,90%	5,50%	5,50%	5,40%	4,50%			
CO	1A4bi	1A2a	1A3bi	2C1								83,3
	49,80%	17,60%	8,70%	7,20%								

Component	Key categories (Sorted from high to low from left to right)											Total (%)
TSP	1A4bi	3Dc	1B1a	1A1a	2A5a	1A3bvi	1A3bvii	3B3	1A4cii	1A3biii	3B4gii	80,7
	32,00%	10,30%	9,50%	6,30%	4,00%	3,80%	3,40%	3,30%	3,20%	2,60%	2,40%	
PM_{10}	1A4bi	3Dc	1A1a	1B1a	1A4cii	1A3bvi	2A5a	1A3biii	3B4gii	3B4gi		80,4
	36,40%	12,70%	6,50%	5,50%	3,90%	3,60%	3,30%	3,30%	2,90%	2,20%		
$PM_{2.5}$	1A4bi	1A1a	1A4cii	1A3biii	1A3bi	1A3bvi	2A5a					81,3
	54,50%	7,10%	6,00%	5,00%	3,20%	2,90%	2,70%					
Pb	1A3bvi	1A2a	2C1	1A1a								82,8
	35,10%	20,20%	19,90%	7,60%								
Hg	1A1a	1A2a	2C1	5C1bv	1A2f	1A1c						82,4
	48,70%	9,20%	8,30%	6,60%	5,90%	3,70%						
Cd	2C1	1A1a	1A2a	1A4bi	2C3	1A3bi	1A3bvi	1A4ai				82,9
	22,00%	20,00%	14,70%	6,60%	5,80%	5,00%	4,90%	3,90%				
DIOX	1A2a	2C1	1A4bi									87,1
	65,50%	13,10%	8,60%									
PAH	1A4bi											95,7
	95,70%											
HCB	1A1a	1A4bi										85,1
	57,50%	27,60%										

1.6 QA/QC and Verification methods

Quality Control (QC) *is a system of routine technical activities used to measure and control the quality of the inventory as it is being developed.*

Quality Assurance (QA) *activities include a planned system of review procedures conducted by personnel not directly*

The process of air pollutant emission inventory is a part of the Air Quality System and Management in the Czech Republic. According § 7 of the Air Quality Act 201/2012 coll. the Czech Ministry of Environment (CME) on basis of collected data performs the emission inventory comprising the total amount of air pollutants that had been emitted in the atmosphere in the previous year and emission projections consisting of air pollutant emission estimates for coming years. Czech Hydrometeorological Institute had been authorized to monitor the air quality in the Czech Republic. The process of emission inventory is legally bound with activities of other air quality and integrated prevention control bodies (Czech Environmental Inspectorate and regional authorities).

1.6.1 QA procedures

The emission inventory in the Czech Republic is based on emission database REZZO a complex system for storage and data presentation of stationary and mobile sources. According the requirements of the ISO 9001:2015 norm, the emission database is being operated according operating manual that sets rules for emission inventory, the taking over rules, checking, verification and

storage of emission and other data handed over by sources operators and cooperating subjects as well as scope and way of emission calculations including provision of data and information of emission data agenda. The methodology of air pollutants emission estimates for each source category, incl. verification of emission factors used undergo peer review process and are being updated in legal acts, methodology guidelines of CME or technical publications.

The system of data collection and the content of emission database is defined by law. The data acquisition of individually monitored sources used to take place in form of mainly printed reports until 2009. Since 2010, the data collection is electronic via ISPOP system (Integrovaný systém plnění ohlašovacích povinností - Integrated System for Fulfilment of Reporting Duties). Implementation of this system had accelerated the reporting process, reduced formal errors and lowered the labour-intensity. ISPOP is interconnected with other registers and electronic systems of state administration and enables unique territorial sources identification. The system performs automatic processing of standardized electronic documentation representing the individual reports and makes storage of all already processed reports. To ensure the quality of reported data, regular training courses for source operators under participation of CHMI take place.

Software for data sampling, checking and evaluation in emission database that is regularly updated is being used to ensure the transparency, consistency, comparability, completeness and correctness of the emission data. Emission inventory of several sectors is being done in close cooperation with sub-suppliers. They also participate on the emission inventory of the greenhouse gases according UN Framework Convention on Climate Change (UNFCCC) the activity of whose is regularly checked by revision procedures. The statistical data availability for emission inventories is covered by long-range data exchange contract between CZSO and CHMI.

1.6.2 QC procedures

Data of emission inventory in the Czech Republic are also being used for air quality modelling and for this reason the requirements of correctness and exactness are high. Checking mechanism are an integral part of the emission inventory processing that apply on several levels as data acquisition, recording of the emission database, processing and evaluation.

The data acquisition form of individually monitored sources has checking mechanism set that during insertion of data point out unusual value range or other formal error. The completeness of filled in form is being checked and after sending the data, further sophisticated checks get activated that can prevent an invalid reporting. Other set of control mechanism is being set during recording the data in the emission database and its processing. To analyse and solve errors, Administrator of checking e-mails application had been implemented that runs several tests of reported data. In case an error has been identified, the application sends an email to the source operator that draws the attention of the source operation to the error and asks him to have the data corrected. Corrections done are also being checked and in case of need control body is being asked to put it right.

During the data processing and reporting preparation also includes comparison of activity data with fuel consumption, statistics of CZSO (industrial production, agriculture, civil engineering) and data of industrial producer federations. As a check of reported emission of individual sources, data of national air pollution register kept for fulfilment of requirements of Regulation of the European Parliament and European Council EC/166/2006 also being used.

1.7 General uncertainty evaluation

In the process of emission inventories in the CR there are mainly used the data provided by the operators of stationary sources of air pollution, the statistical data of the Czech Statistical Office (data on fuel consumption, number of vehicles, number of livestock and

area of cultivated land), or from the Population and housing census (information on household heating), using emission factors and other sources of data.

From the above overview it is clear that the emission data, from which the inventory has been compiled, are of varying quality. Emissions of individual point sources set on the basis of measurements are determined with less uncertainty than the emissions calculated on the basis of statistical data. The uncertainty of the sum of emissions from point sources is below 5 % (e.g. emissions from large combustion sources), the uncertainty of emission data based on a model (e.g. emissions from household heating and exhaust emissions from transport) ranges between 25–30 %, and the uncertainty of emissions set by statistical data and predefined emission factors is estimated according to the methodology of the EMEP/EEA air pollutant emission inventory guidebook from 50 up to 200 % (in this way the emissions from the use of solvents, animal production and non-combustion emissions from transport are estimated).

1.8 General Assessment of Completeness

1.8.1 Sources Not Estimated (NE)

*Label: "**NE**" (not estimated) for existing emissions by sources of compounds that have not been estimated. Where "NE" is used in an inventory the Party should indicate why emissions could not be estimated;*

NFR Code	Pollutants	Reason for not estimated
1A1b	NH_3	EF is not available
1A2b	NH_3	EF is not available
1A2d	NH_3	EF is not available
1A2e	NH_3	EF is not available
1A2gvii	Pb, PCDD/ PCDF	EFs are not available
1A2gviii	NH_3	EF is not available
1A3ai(i)	NH_3, Pb, PCDD/ PCDF, PAHs, PCBs	EFs are not available
1A3aii(i)	NH_3, PCDD/ PCDF, PCBs	EFs are not available
1A3bi	PCDD/ PCDF, HCB, PCBs	Will be calculated after COPERT implementation
1A3biii	Pb, HCB	Will be calculated after COPERT implementation
1A3biv	Pb, HCB, PCBs	Will be calculated after COPERT implementation
1A3bvi	Hg, PCDD/ PCDF, InP, HCB, PCBs	Will be calculated after COPERT implementation
1A3bvii	Hg, Cd, Hg, As, Se, PCDD/ PCDF, PAHs, HCB, PCBs	Will be calculated after COPERT implementation
1A3c	Pb, PCDD/ PCDF, PCBs	Will be calculated after COPERT implementation

NFR Code	Pollutants	Reason for not estimated
1A3dii	HCB, PCBs	Will be calculated after COPERT implementation
1A3ei	NH_3	EF is not available
1A4ai	NH_3	EF is not available
1A4aii	PCDD/ PCDF, HCB	EFs are not available
1A4bi	NH_3	EF is not available
1A4bii	PCDD/ PCDF, HCB	EFs are not available
1A4ci	NH_3	EF is not available
1A4cii	PCDD/ PCDF, HCB, PCBs	EFs are not available
1A5b	Pb, HCB, PCBs	
1B1a	BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	EFs are not available
1B1b	BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF	EFs are not available
1B1c	SOx, NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF	ADs are not available
1B2aiv	NH_3, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs	ADs are not available
1B2c	NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
2A1	NOx, NH_3, NMVOC, SOx, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
2A2	NMVOC, SOx, BC, CO, Pb, Cd, Hg	EFs are not available
2A3	NMVOC, NH_3, BC, PCDD/PCDF, PAHs, HCB	EFs are not available
2A5c	$PM_{2.5}$, PM_{10}, TSP	EFs are not available
2A6	Pb, Cd, Hg, As, Cr, CU, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB	EFs are not available
2B2	BC	EFs are not available
2B6	NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
2B10a	All	ADs are not available
2B10b	$PM_{2.5}$, PM_{10}, TSP	EFs are not available
2C1	NH_3, BC, HCB	EFs are not available
2C2	NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, HCB, PCBs	EFs are not available
2C3	NH_3, BC, Cr, Ni, Se, HCB	EFs are not available
2C4	NH_3, BC, Cr, Cu, Ni, Se, HCB	EFs are not available
2C5	NH_3, BC, HCB	EFs are not available
2C6	NH_3, BC, Pb, Cd, Hg, As, Cu, Ni, Se, PCDD/PCDF, PAHs HCB, PCBs	
2C7a	NH_3, Cr, Ni, Se, HCB	EFs are not available
2C7c	BC, PAHs, HCB, PCBs	EFs are not available

NFR Code	Pollutants	Reason for not estimated
2C7d	All	EFs are not available
2D3b	NOx, SOx, NH_3, BC, CO, PCDD/PCDF, HCB	EFs are not available
2D3c	BC, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB	EFs are not available
2D3g	NOx, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
2G	all	AD are not available
2H1	PAHs, HCB	EFs are not available
2H2	BC	Will be calculated
2H3	all	AD are not available
2I	NOx, SOx, NH_3, BC, CO, PCBs	EFs are not available
3B1a	NOx, NMVOC	Will be calculated later
3B1b	NOx, NMVOC	Will be calculated later
3B2	NOx, NMVOC	Will be calculated later
3B3	NOx, NMVOC	Will be calculated later
3B4d	NOx, NMVOC	Will be calculated later
3B4e	NOx, NMVOC	Will be calculated later
3B4gi	NOx, NMVOC	Will be calculated later
3B4gii	NOx, NMVOC	Will be calculated later
3B4giii	NOx, NMVOC	Will be calculated later
3B4giv	NOx, NMVOC	Will be calculated later
3B4h	NOx, NMVOC	Will be calculated later
3Da1	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Da2a	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Da2b	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Da2c	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Da3	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Da4	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later

NFR Code	Pollutants	Reason for not estimated
3Db	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Dc	NOx, NMVOC	Will be calculated later
3Dd	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3De	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3Df	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3F	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
3I	NOx, NMVOC, $PM_{2.5}$, PM_{10}, TSP	Will be calculated later
5A	NH_3, CO, Hg	Will be calculated later
5B1	NOx, SOx, TSP, BC, CO	EFs are not available
5B2	BC, Pb, Hg, Cd, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
5C1biii	NH_3	EF is not available
5C1bv	NH_3	EF is not available
5C2	All	AD are not available
5D1	Ni, Se, Zn	EFs are not available
5D2	BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	
5D3	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	AD are not available
5E	NOx, NMVOC, NH_3, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	AD are not available
6A	All	AD are not available

1.8.2 Sources Included Elsewhere (IE)

*Label: "**IE**" (included elsewhere) for emissions by sources of compounds that are estimated but included elsewhere in the inventory instead of in the expected source category.*

NFR sectors	Longname	
1A3bii	Road transport: Light duty vehicles	(g) included in 1A3bi

NFR sectors	Longname	
1A5a	Other stationary (including military)	(h) included in 1A4ai
5C1bii	Hazardous waste incineration	(f) included in 5C1bi, 5C1biii
3Da2a	Animal manure applied to soils	(i) included in 3B1a, 3B1b, 3B2, 3B3, 3B4a, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h
3Da3	Urine and dung deposited by grazing animals	(i) included in 3B1a, 3B1b, 3B2, 3B3, 3B4a, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	(i) included in 3B1a, 3B1b, 3B2, 3B3, 3B4a, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h
3Dd	Off-farm storage, handling and transport of bulk agricultural products	(i) included in 3B1a, 3B1b, 3B2, 3B3, 3B4a, 3B4d, 3B4e, 3B4f, 3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h
1A5b	Other, Mobile (including military, land based and recreational boats)	(j) included in 1A4cii, only to 2002
5D2	Industrial wastewater handling	(k) included in 5D1

2 EXPLANATION OF KEY TRENDS

2.1 The development of emissions

The development of air pollution is closely connected with economic and socio-political situation and with the development of knowledge in the field of environment. The trend of emission development in the period 1990–2015 can be generally characterized by the reduction of emissions from point stationary sources of REZZO 1 and REZZO 2 categories (point sources) due to the implementation of the air quality control system, implementing a number of tools at various levels (normative, economic, information etc.). The impacts of these tools was most evident in late 90s of the last century, i.e. in the period when the emission limit values implemented by the new legislation came into force. The significant decrease in emission production resulted e.g. in the reduction of long-range transport of pollutants from the most significant sources. However, there remain the problems in the field of maintaining the air quality parameters, and therefore attention has been focused recently also on the sources of REZZO 3(area sources) and REZZO 4(mobile sources) categories; for their regulation the effective measures have not been implemented yet.

2.1.1 The trend in the development of emissions in the period 1990–2001

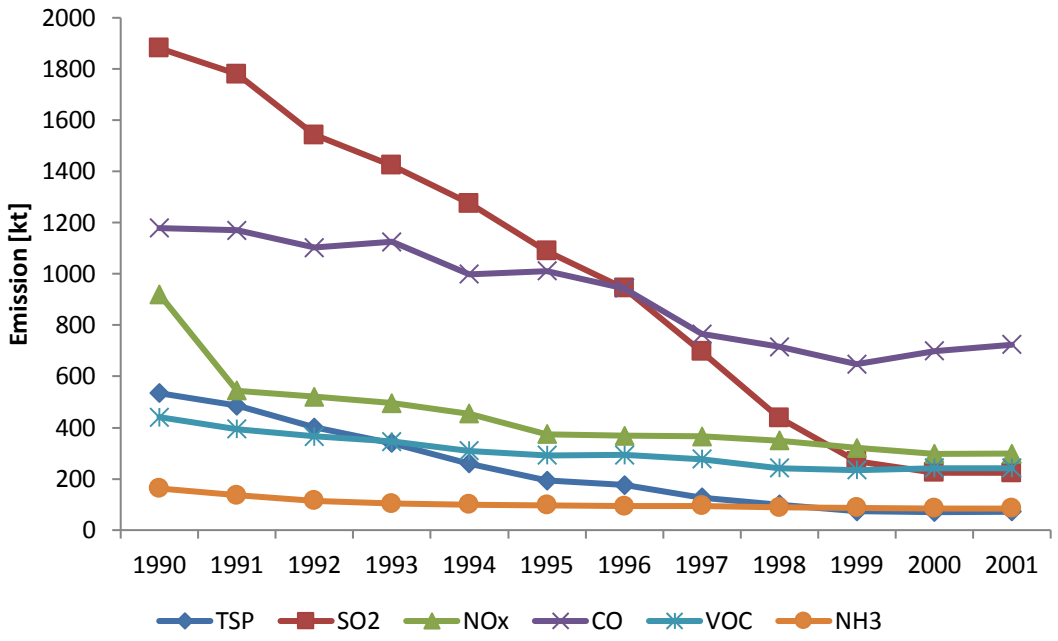

Figure 2-1 The trend in the development of emissions in the period 1990–2001

In 1991 Act No. 309/1991 Coll. on air protection came into force supplemented by the Act No. 389/1991 Coll. on air protection authorities of the state and air pollution charges,, which for the first time in the CR history, implemented the emission limit values effective from the year 1998. This schedule was arranged to help prepare the sources for the new operating conditions. The national economy was restructured, the sources were modernized, and many of them closed or reduced their operation. These changes were reflected e.g. in the sector of iron and steel production where in 1992–1994 a significant decrease of production occurred. For instance the termination of pig iron production in the Vítkovice ironworks in 1998 contributed to the improvement of ambient air

quality directly in the city centre. In the sector of electricity and heat production old boilers have been closed or modernized, or new low-emission fluid boilers installed since 1991. In the period 1996–1998 the coal burning power stations were desulphurized. The combustion sources with lower heat consumption (heating plants/boiler houses) gradually replaced the solid and liquid fossil fuels by natural gas. The number of pollutants for which fees was charged increased and the fee rates for emission release rose. These measures resulted in the decrease of emissions of all pollutants of REZZO 1 and REZZO 2 categories.

In the sector of local household heating the greatest decrease of emissions was recorded in 1993–1997 due to the gasification and government subsidies for electricity heating. The consumption of solid fossil fuels in the year 2001 was by 60 % lower in comparison with the year 1990.

The total level of air pollution in 2001 decreases as compared with the year 1990 in TSP by 85 %, in SO_2 by 88 %, in NOx by 68 %, in CO by 37 %, in VOC by 47 % and in NH_3 by 43 % (Figure 2-1).

2.1.2 The trend in the development of emissions in the period 2002–2015

New legislation, reflecting a number of European directives, came into force in 2002. Act No. 86/2002 Coll. on air protection was adopted, which together with Act No. 76/2002 Coll. on the integrated prevention and limitation of pollution created the basic framework for the solution of air pollution problems. The Czech Republic committed itself to meeting the national emission ceilings for emissions of SO_2, NOx, VOC and NH_3 pursuant to Directive No. 2001/81/EC as from 2010. A more significant decrease of emissions from sources belonging to the REZZO 1 category resulted from the fulfilment of the National programme to reduce emissions from existing extra-large combustion sources (Government Order No. 372/2007 Coll.), which implemented the emission ceilings for TSP, SO_2 and NOx set for individual sources of LCP3 since 2008. The reduction of emissions from industrial processes was influenced by the decline of a number of branches of production after the year 2007 caused by the economic crisis (Figure 2-2)

The favourable trend of decreasing consumption of solid fossil fuels in the sector of local household heating did not continue after 2001, mainly due to growing prices of natural gas and electricity. In the period 2002–2007, the consumption of coal decreased, as it was replaced by increasingly popular firewood. These changes caused a reduction of TSP and SO_2 emissions. Since 2009, funded by government subsidies within the Green Savings Programme, thermal insulation was installed on buildings, and unfriendly heating was replaced by low-emission sources. So far, however, the effect of these measures on the total emission balance of this sector has been marginal.

In 2012 the new act on air protection came into force, implementing stricter emission limit values for combustion sources pursuant to the Directive 2010/75/EU on industrial emissions. Some new emission limit values come into force step by step, in order the operators of the sources could prepare for their fulfilment. Thus, by 2016 it can be expected that the decreasing trend of emissions from the specified stationary sources will continue. The new act is focused on emission reduction from the sector of local household heating and it implements the minimum values of emission parameters for the combustion sources with total nominal heat consumption of up to 300 kW when putting them on the market from 2014 and 2018. In this group of sources, starting from the year 2022, it will be possible to operate only the boilers complying with the 3rd emission class, which should result in the shutdown of the old types of boilers and their replacement by modern devices.

The level of air pollution in 2015 decreased in comparison with the year 2001 as follows: TSP by 39 %, SO_2 by 45 %, NOx by 45 %, CO by 31,0 %, VOC by 42,0 % and NH_3 emissions by 18,0 % (Figure 2-2).

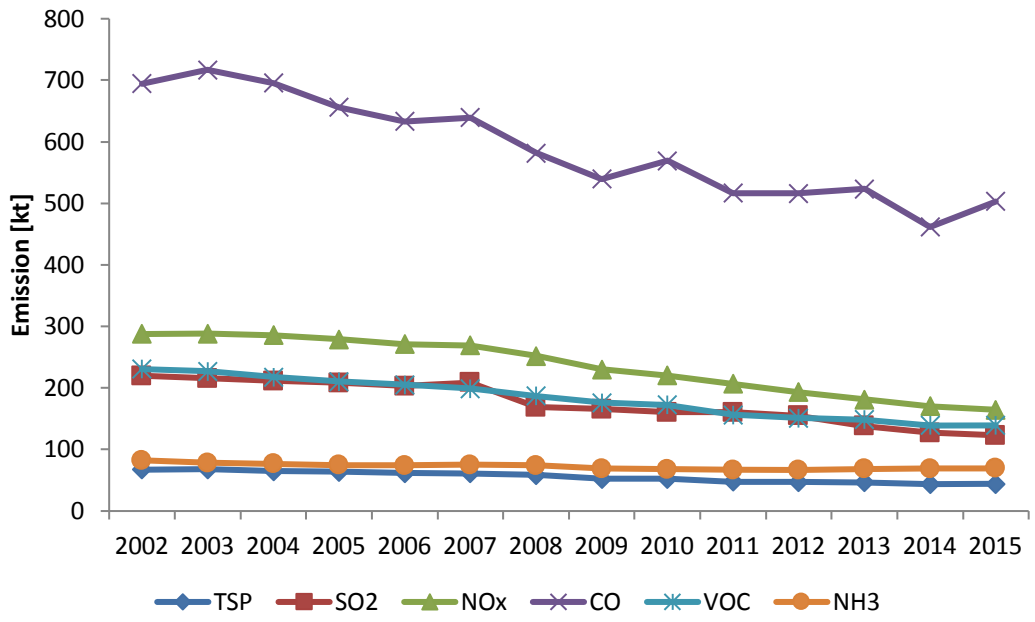

Figure 2-2 The trend in the development of emissions in the period 2002–2015

2.1.3 Last year's development

Economic indicators show overall trend of economic growth. GDP indicator against 2014 rose by 4.3 %. The total fuel consumption for power generation and heat production also grew partly due to colder weather conditions during heating season, but also due to slight increase of fossil fuels power generation (by approx. 2 %). The industrial production also showed an increase, for example cement and lime production, chemical production whereas steel and iron production dropped down moderately.

The trend of main pollutants, TSP and CO emissions is showed in Figure 2-2. The level of air pollution in 2015 changed in comparison with the year 2014 as follows: VOC, NH_3, TSP, PM and BC increased on average by 1 %. CO rose by 4.5 %, whereas NO_x and SO_2 decreased by 3 %. The trend of heavy metals and POPs is strongly dependent on trends in individual categories. While emissions with core source of residential heating show an increase (PAHs mainly) as well as heavy metals for automobile tyre and break wear. Metallurgy, mainly production of sintering product shows a significant decrease of PM emissions (more than 25 %) and related decrease of heavy metals and POPs emissions.

3 ENERGY (NFR SECTOR 1)

3.1 Overview

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

The emission data from this sector are based on operator-reported emissions or on calculations.

Specific emission limit values for stationary combustion plants are stated in Annex 2 to Regulation 415/2012 Coll. They are set for SO_2, NOx, TSP and CO and depend on rated thermal input and type of fuel used (Tier 3). The PM_{10} and $PM_{2.5}$ emissions are determined on base of information on abatement equipment and type of fuel.

Operators of certain sources are also obliged to measure some of the other pollutants in accordance with legislation (Annex 4 to Act. 201/2012 Coll.)

Furthermore, limits for a number of the other pollutants are set in operating permits of individual sources. Emissions of obligatorily monitored pollutants unavailable for a concrete source in a certain year are calculated using the emissions reported in the nearest year and activity data (own emission factors). Emissions of pollutants that are not reported are calculated from activity data (total annual amount of energy input in TJ) and emission factor in mg/GJ. The total annual amount of energy input is calculated from fuel consumption and net calorific values; they are also reported by operators in summary operating records. Czech emission factors are predominantly based on either own measurements, and partly taken from the EMEP/EEA Air pollutant Emission Inventory Guidebook (Tier 2).

3.2 1A1 Energy industries

In the Table 3-1 is link between NFR category and classification pursuant Czech legislation.

Table 3-1 NFR categories and Czech classification for sector 1A1 Energy industries

NFR code	Longname	Classification pursuant Annex 2 to Act 201/2012 Coll.
1A1a	Public electricity and heat production	1.1. Fuel combustion in boilers with a total nominal heat consumption above 5 MW
1A1b	Petroleum refining	6.24. Oil refining, production, and processing of petrochemical products
1A1c	Manufacture of solid fuels and other energy industries	3.4. Coal heat treatment (briquetting plant, low-temperature carbonization, drying)

3.2.1 1A1a Public electricity and heat production

3.2.1.1 Source characteristic

The category 1A1a is represented by combustion plants for producing public electricity and heat with total rated thermal input equal to or greater than 50 MW (according to aggregation rules pursuant to article 29 of the Directive 2010/75/EU on Industrial Emissions – IED), regardless the type of the used fuel. These sources are classified according to IED as Large Combustion Plants – LCP. Sources for district heating with rated thermal input from 0.3 MW and less 50 MW are included in category 1A4ai (Commercial/institutional: Stationary) and 1A4ci (Agriculture/Forestry/Fishing: Stationary).

This sector is characterized by a relatively small number of plans (70 in 2015).

The fuel base consists mainly of solid fuels, which are burned primarily in dry-bottom boilers and fluidized bed boilers. Solid fuels are mostly represented by pulverized brown coal (72.5 %) and pulverized hard coal (10 %), followed by various types of biomass (wood, herbal biomass). In addition to solid-fuel boilers in this category, oil-fired boiler and gas-fired boilers, burning mainly natural gas, are represented. Natural gas and fuel oils are also used as stabilizing fuels in solid-fuel boilers.

3.2.1.2 Methodology for Public electricity and heat production (NFR 1A1a)

The specific emission limit values for these plants are stated in Annex 2 to Regulation 415/2012 Sb. (see paragraph 3.1). Additionally, operators of these plants are obliged to provide one-time emission measurements for pollutants stated in Annex 4 to Act. 201/2012 Coll. There are following pollutants: Cd, Hg, Pb, As, PCDD/PCDF, PCBs, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, benzo(k)fluoranthene. Their emission limit values can be set in operating permits of individual sources, in the case of all LCP sources it is an integrated permit pursuant to Act 76/2002 Coll., on the integrated prevention.

Emissions of pollutants that are not reported are calculated from activity data (total annual amount of energy input in TJ) and emission factor in mg/GJ (see paragraph 3.1). The methodology is the same for all stationary sources in categories 1A2, 1A4ai and 1A4ci.

3.2.1.3 The development of emissions from category 1A1a

Table 3-2 Development of emissions of selected pollutant from category 1A1a in the period 2000–2015

Year	SO_2 (kt/year)	NO_x (kt/year)	TSP (kt/year)
2000	137,71	95,68	4,25
2001	134,35	98,50	5,23
2002	133,19	96,75	4,90
2003	131,02	93,49	4,45
2004	126,40	94,86	4,68
2005	127,76	90,95	4,45
2006	126,32	91,60	4,24
2007	129,67	96,28	4,31
2008	107,09	84,17	3,30
2009	104,87	79,94	3,14
2010	103,72	80,61	3,45
2011	101,80	75,02	3,60
2012	94,44	67,38	3,41
2013	86,13	58,37	3,18

Year	SO_2 (kt/year)	NO_x (kt/year)	TSP (kt/year)
2014	80,66	54,49	2,95
2015	75,32	50,78	2,75

These are the pollutants included in the international reporting procedure, i.e. SO_2, NO_x and TSP. It is apparent that all reported substances exhibited marked decrease of emissions as compared with the year 2000; the largest difference has been achieved in emissions NO_x and SO_2 (47 and 45 %, respectively). In the case of TSP is decrease 35 %. The marked decrease occurred mainly between the years 2007 and 2008, when the obligation to meet the plan on the reduction of emission from the existing LCP sources within the National Emission Reduction Program pursuant to § 54, Art. 7 of the Act 86/2002 Coll. arose.

A further marked decrease has been ensured by the European legislation. Starting from the year 2016 the plants are obliged to meet the emission limit values pursuant to Annex V of IED, which makes the previous limit values set by the Directive 2001/80/EC and depending on the rated thermal input and the fuel type stricter. The plants thus may apply some of the transition plans pursuant to the Articles 32–35 of IED.

Many sources within the National Emission Reduction Programme have undergone reconstructions, shutdowns and changes of boilers. Moreover, more efficient desulphurization equipment has been installed, and changes of the fuel base have taken place. For instance, in September 2012 the comprehensive renewal of three reactor units of the power plant Prunéřov II belonging to the ČEZ group was reflected already in the emission balance for the year 2014. Emission decrease of all pollutants in the period 2014–2015 was 7 %.

3.2.1.4 QA/QC for category 1A1a

QA/QC for category 1A1a is the same as in case of other stationary point sources (see 1.6.1).

In addition to these general controls take place further validation mechanisms under international reporting performed annually since the reporting period 2003 pursuant to valid European legislation. Among other items it includes contain information about the annual emissions of SO_2, NOx and TSP and activity data (heat supplied).

Data are being submitted via the system EIONET (European Environment Information and Observation Network), where are subjected to further checks. Since 2013, data are inserted via web form with implemented control mechanism making attention specifically to the need to fill out required items and desired numeric formats.

Before making the completed form accessible to the public, automatic validation checking possible errors preventing from submission is to be activated. Additionally, warning about possible errors that cannot prevent the submission also takes place but the inserted data are to be checked.

Following checks take place:

- *basic data completeness*
- *unequivocal naming of plants*

- *consistency of plant ID and name over time*
- *location check (coordinates)*
- *E-PRTR ID (in case threshold values are exceeded and the source has an obligation to report to the EPRTR registry)*
- *rated thermal input value*
- *plausibility of fuel input*
- *share in overall reported emissions*
- *SO_2, NOx and TSP emission outlier test:*
- *significant difference in reported and expected SO_2, NOx and TSP emissions,*
- *consistency with emission trend at national level*

Since 2016, integration of LCP data under the IED into E-PRTR takes place. Estimated completion date of the project is May of 2018.

3.2.2 1A1b Petroleum refining

3.2.2.1 Processes included

Reported under this category are consumptions of fuel consumed solely by energy-producing and technological facilities within plants that can actually be regarded as refineries. In the Czech Republic, this applies only to the following companies:

- *Česká rafinérská*
- *Rafinérie Litvínov*
- *PARAMO, a.s. – HS Pardubice*
- *PARAMO, a.s. – HS Kolín*

The process of refining crude oil involves the following production steps:

- *production of heat for captive use – only if these sources are not part of category 1A1a*
- *crude oil preheating*
- *atmospheric and vacuum distillation*
- *cleavage of crude oil and other products*
- *oxidation of asphalts*
- *regeneration of catalysts*

The national legislature does not define the categories of sources of pollution from crude oil processing in a way that would allow direct conversion between the categories of the national system and NFR sectors. Sources with a contactless combustion process with a power input above 0.3 MW, typically technological heaters in crude oil processing, are grouped together with basic combustion sources as well as, for example, furnaces for producing electricity and heat. In the national legislature, the division of technological sources operated within refineries is rather general and only comprises the following categories:

6.24. Oil refinery, production, and processing of petrochemical products

6.25. Storage of petrochemical products and other volatile liquid organic matter with a volume above 1,000 m3 or storage tanks with annual filling volume 10,000 m3 and handling (not designated for car fuel)
6.13. Production of Sulphur (Claus process)
7.17. Regeneration and activation of catalysts for catalytic fission in a fluid layer
10.1. Terminals for storing petrol fuel

For the years 2000–2015, the national registry REZZO contains more than 550 records assigned to category 1A1b, of which more than 470 records have been reported for combustion sources. Further sources, such as oxidation of asphalt, are categorized as technological heating with direct contact (code 3.1. combustion processes with contact), but are part of processes registered under category 6.24. Waste water cleaning stations are operated as auxiliary sources.

Of the listed categories, the category Petroleum refining – NFR 1A1b only comprises emissions from combustion sources such as furnaces for producing process steam or refinery furnaces with indirect heating (atmospheric furnaces, hydrogenation chambers, cleavage units, etc.).

Other sources mentioned above are assigned to the following categories:

- *1B2aiv Fugitive emissions oil: Refining / storage*
- *1B2c Venting and flaring (oil, gas, combined oil and gas)*
- *2B10a Chemical industry: Other (please specify in the IIR) – this category only includes emissions of NH_3 from cooling circuits – the assignment will be changed*

All reported emissions under category 1A1b for year 2000–2015 are taken solely from data reported in Summary operational records, and no further calculations are made. The completeness and correctness of the reported emissions are verified by the Czech Environmental Inspectorate. The extent of ascertained and reported emissions is not, with the exception of category 7.17., explicitly laid out by any implementing regulation, but by the requirements of individual integrated permits pursuant to Act 76/2002 Coll., following up on Directive 2010/75/EU.

Due to the changes in integrated permits of refinery a petrochemical facilities in Litvínov, the obligation to monitor and calculate emissions of combustion flares have been modified since 2014. According to the agreement with the source operator to keep consistence in the reporting of SO_2 and NOx emissions in category 1B2aiv will be calculated considering the average Sulphur content in the waste gas and its burnt amount. First calculations will be provided with the reporting in 2018.

3.2.2.2 Contribution to total emissions

Since the 1990s Czech refineries underwent rapid development due to increasing production capacities as well as the need to meet ever more restrictive requirements of environmental legislature. The development of crude oil consumption is presented in the chart below (Figure 3-1).

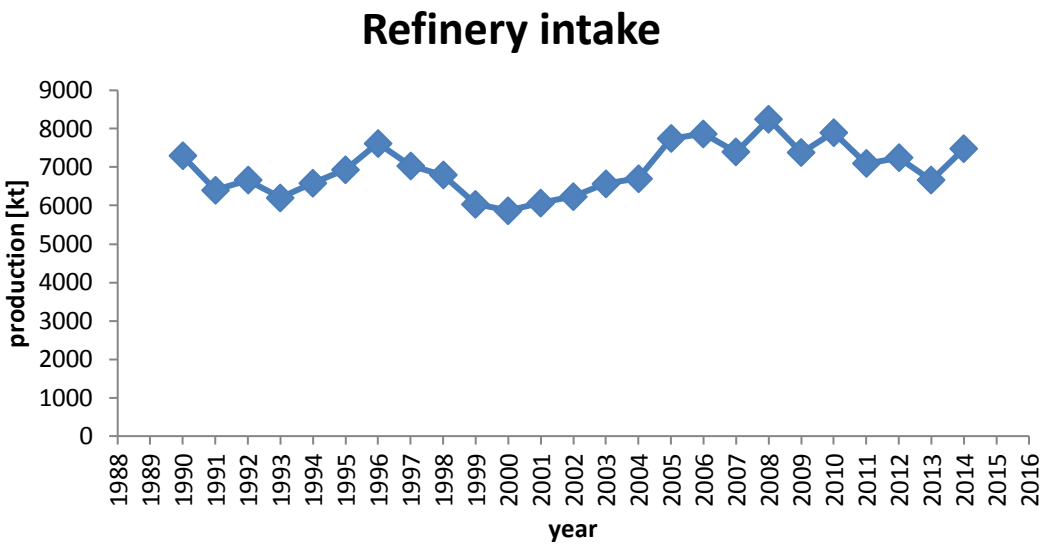

Figure 3-1 The development of crude oil consumption

Crude oil refining is pivotal to the economy of the Czech Republic, not only due to the production volumes reached, but also to its wider significance (ensuring energy safety and the close connection with the third most important manufacturing sector: the chemical industry).

Considering the conditions set by the national legislature and integrated permits, the main pollutants reported are NOx and SO_2, followed by TSP, CO and VOC.

3.2.1 1A1c Manufacture of solid fuels and other energy industries

The chapter will supplied later.

3.3 1A2: Manufacturing Industries and Construction

Distribution of the combustion sources into categories 1A2A to 1a2g viii is done according to the NACE classification of the source operator. Combustion sources for heat production or power generation are being categorized according NACE classification in metal industry (NACE 24), chemical industry (NACE 20 a 21), paper production (NACE 17 and 18) and food production (NACE 10, 11 and 12). Row material production and processing sites (NACE 07, 08, 09, 23, 41 and 42) are collected in NFR 1A2f and other activities in processing industry (for instance 13 – 16, 22, 25 – 33) in NFR 1A2gviii. These are than in a specific way divided among NFR categories of sources where processing combustion – processing heating etc. take place. In the Table 3-4 is link between NFR category and classification pursuant Czech legislation (technological sources with combustion of fuel only).

Table 3-3 NFR categories and Czech classification for sector 1A2 Manufacturing Industries and Construction

NFR code	Longname	Classification pursuant Annex 2 to Act 201/2012 Coll.
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	4.1.2. Sintering belt agglomeration
		4.1.4. Palletization operations (crushing, drying, palletization)
		4.2.3. Air heaters
		4.4. Rolling mills under heat and cold, including heating furnaces and furnaces for heat processing with a projected output of over 10 t of processed steel per hour
		4.5. Forges - heating furnaces and furnaces for heat processing with a projected thermal output of over 5 MW
		4.6. Production of castings from ferrous metals (iron alloys - Fusion in electrical arc furnace, Cupola furnaces, Fusion in rotating drum oil and gas furnaces)
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	4.7. Ore dressing for nonferrous metals
		4.10. Smelting and casting of nonferrous metals and alloys thereof
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	6. Chemical industry – process furnaces
		6.5. Production and processing of other synthetic polymers and production of composites, with the exception of composites specified elsewhere
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	7.10. Production of paper and cardboard which does not fall under 7.9.
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	7.2. Treatment and processing facilities for the purpose of production food products from plant raw materials with a projected capacity of 75 tons of finished products per day and over
		7.3. Treatment and processing facilities for the purpose of production food products from animal raw materials with a projected capacity of 50 tons of finished products per day and over
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	5.1.2. Production of cement clinkers in rotary furnaces
		5.1.3. Other technological equipment for cement production
		5.1.4. Lime production in rotary furnaces
		5.1.5. Lime production in shaft furnaces and other furnaces
		5.1.6. Furnaces for processing desulphurization products
		5.1.7. Treatment and refinement of fire-resistant clays and china clays in rotary furnaces
		5.3. Production of glass, fibre, glass products, enamel, and sintered glass for glazing and glass for jewellery processing

NFR code	Longname	Classification pursuant Annex 2 to Act 201/2012 Coll.
		5.4. Production of composite glass fibres with the use of organic binders
		5.5. Glass processing and refinement (polishing, painting, crushing, smelting of semi-finished product or shards, production of jewellery and other articles) with a projected capacity exceeding 5 tons of processed glass raw materials per year
		5.7. Processing of magnesite and production of basic fire-resistant materials, silica, etc.
		5.8. Smelting of mineral materials in dome furnaces
		5.9. Production of composite glass fibres with the use of organic binders
		5.10. Production of ceramic products by means of firing, in particular roofing tiles, bricks, fire-resistant blocks, facing tiles, ceramic wares or porcelain
		5.14. Packaging plants for bituminous mixtures and asphalt mixing plants, recycling of asphalt surfaces
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	Unspecified in Annex 2 to Act 201/2012 Coll.
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	3.1. Combustion units of direct process heaters (with contact) not specified elsewhere with a nominal heat consumption over 5 MW (another then 1A2a – 1A2f)
		3.2. Defrosters with direct heating
		4.12.
		7.7. Industrial wood processing, with the exception of the products specified in item 7.8, with an annual material consumption of over 150 m3, inclusive
		7.8. Production of chipboard, wood filaments, and OSB boards

3.3.1 Source characteristic

This sector includes emissions from stationary combustion in manufacturing industries and construction, e.g. metallurgy of ferrous and non-ferrous metals, chemical industry, pulp and paper industry, food industry (especially sugar factories), cement and lime production. Sector 1A2 is represented by some LCP, too. Combustion plants with total rated thermal input equal to or greater than 50 MW are included in categories 1A2a, 1A2c, 1A2d and 1A2e. Emissions from industrial processes without combustion are included in NFR category 2 (Industrial processes).

3.3.2 Methodology for Manufacturing Industries and Construction (NFR 1A2)

The methodology for category 1A2 except mobile sources belonging to the sector 1A2gvii is the same as in the case of sector 1A1a (see #1A1 Energy industries). A summary of emission factors of HMs and POPs for stationary sources in category 1A depending on nominal thermal output, type of fire place and fuel is presented in Table and Table 0-2.

3.3.3 The development of emissions from category 1A2

Amount of emissions from industrial combustion included in category 1A2 primarily depends on production in individual sectors. Trends for production in period 2000–2015 are shown graphically in the chapter 4 Industrial Processes (NFR sector 2). The reduction of production was influenced by the decline of a number of branches after the year 2007 caused by economic crisis.

3.4 NFR 1A4: Small Stationary Combustion and Non-road mobile sources & machinery

Combustion sources for heat production or power generation are being categorized according NACE classification in mainly in NFR 1A4ci – agriculture (NACE 01–03), NFR 1A4ai – district heating (NACE 35) and tertiary sector (self-employment, offices, public health, education etc.). In a specific way are then divided among NFR categories of sources where processing combustion – processing heating (paint shops), drying of agricultural products etc. take place.

In the Table 3-4 is link between NFR category and classification pursuant Czech legislation.

Table 3-4 NFR categories and Czech classification for sector 1A4 Small Stationary Combustion and Non-road mobile sources & machinery

NFR code	Longname	Classification pursuant Annex 2 to Act 201/2012 Coll.
1A4ai	Commercial/institutional: Stationary	1.1. Fuel combustion in boilers - non industrial combustion (selected by NACE)
		1.2. – 1.4. Another fuel combustion (engines, turbines, etc.)
1A4aii	Commercial/institutional: Mobile	Unspecified in Annex 2 to Act 201/2012 Coll.
1A4bi	Residential: Stationary	Unspecified in Annex 2 to Act 201/2012 Coll.
1A4bii	Residential: Household and gardening (mobile)	Unspecified in Annex 2 to Act 201/2012 Coll.
1A4ci	Agriculture/Forestry/Fishing: Stationary	1.1. Fuel combustion in boilers - combustion in agricultural (selected by NACE)
		1.2. – 1.4. Another fuel combustion (engines, turbines, etc.)
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Unspecified in Annex 2 to Act. 201/2012 Coll.

3.4.1 Source characteristic

This chapter is concerned by emission data from stationary sources with total nominal heat consumption from 0.3 MW to 50 MW inclusive. These sources are divided by NACE code to two categories: Commercial/institutional (1A4ai) and Agriculture/Forestry/Fishing (1A4ci).

Residential sources in category 1A4bi belong among collectively monitored sources and they are described in chapter 3.5 (1A4bi Small-scale combustion – Residential). Methodology for mobile sources is specified in chapter 3.6 (Mobile sources).

3.4.2 Methodology for Small Stationary Combustion (NFR 1A4ai and 1A4ci)

The methodology for categories 1A4ai and 1A4ci is the same as in the case of sector 1A1a (see #1A1 Energy industries).

A summary of emission factors of HMs and POPs for stationary sources in category 1A depending on nominal thermal output, type of fire place and fuel is presented below in Table 0-1 and Table 0-2 in Annex.

3.5 1A4bi Small-scale combustion – Residential

NFR sector 1A4bi includes emissions from small combustion sources with nominal thermal input smaller than 300 kW which are used for domestic heating. The term "domestic" covers only permanently occupied apartments.

3.5.1 Methodology

The method of estimating fuel consumption is based on calculating the average annual heat consumption and particular type of fuel for the average apartment. Information about the structure of apartments by predominant heating method and floor area size are derived from the results of people and household censuses from year 1991, 2001 and 2011. Number of apartments and their heating method is updated annually according to the data of the new apartments and documents from fuels and energy distributors. Quality characteristics of solid fuels (caloric value, content of ash, sulphur, carbon) are also updated annually. Year changes of fuel consumption are determined mainly the character of the heating season, which is expressed by the number of degree days (Figure 3-2). The calculation is performed at the level of individual municipalities.

Annual heat requirement for domestic heating:

$$Q_{a,i} = 0{,}0036 \cdot q_m \cdot P_i \cdot \frac{D_{21,i}}{D_{21N,i}}$$

Q_a – annual heat requirement per apartment in municipality i [GJ]

q_m – specific heat requirement [kWh.m-2.year-1] (q_m = 150 kWh.m^{-2}.year^{-1} for family homes and q_m = 130 kWh.m^{-2}.year^{-1} for apartment and other buildings)

P_i – average total apartment area in municipality i [m^2]

$D_{21,i}$ – day-degrees in municipality i and temperature of the indoor air 21°C [D.K]

$D_{21N,i}$ – 30-year mean in municipality I [D.K]

The number of days-degrees is using the formula:

$$D_{21} = d(21 - T_s)$$

D_{21} – day-degrees [D.K]

d – number of heating days when T_S < 13°C

T_S – average outside temperature of heating days [°C]

21 – average inside temperature [°C]

*The dependence of the number of day-degrees on the elevation was derived as a linear regression of the day-degrees over the heating period and the elevation of the meteorological stations. The D_{21} value for each municipality was calculated from the equation for the regression straight line (**Figure 3-3**).*

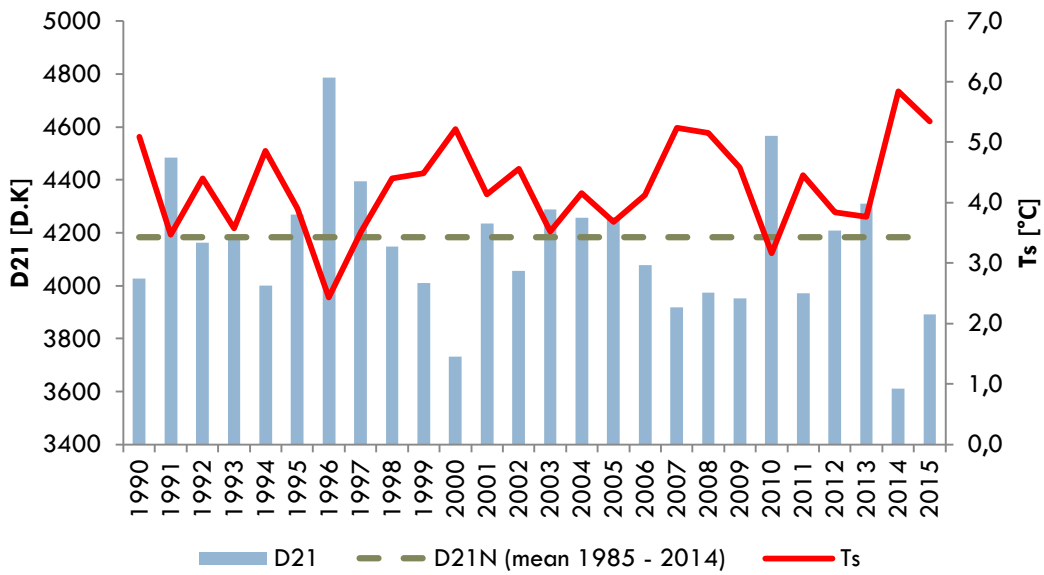

Figure 3-2 Course of D21 and TS in period 1990–2015

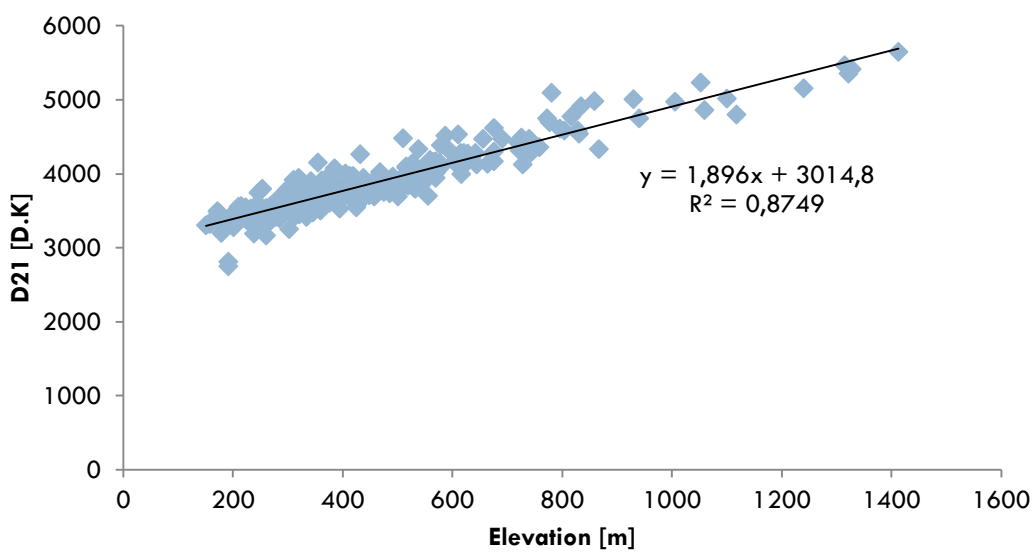

Figure 3-3 D21 depending on elevation of station in 2015

The average annual consumption of fuel f per flat $M_{pal,f,i}$ is determined based on the annual requirement for heat per apartment Q_a in the given municipality, the average calorific value of the fuel Q_f and the operational efficiency of the incinerating facility η_f using the following formula:

$$M_{pal,f,i} = \frac{Q_{a,i}}{Q_f \cdot \eta_f}$$

$M_{pal,f,I}$ – average annual fuel consumption per apartment [t, thousand.m^3]
Q_f – average heating value of fuel f [MJ.kg^{-1}, MJ.m^{-1}]
η_f – average operational efficiency of the heating unit and fuel f [-]

The average operational efficiency depends on the representation of individual types of incineration facilities in households, and its values are updated annually.

The annual consumption of fuel f in municipality i is determined according to the following relation:

$$M^R_{pal,f,i} = N_{f,i} \cdot M_{pal,f,i} \cdot K_{P,f}$$

$M^R_{pal,f,i}$ – annual consumption of fuel f in municipality i [t, thousand.m^3.year^{-1}]
$N_{f,i}$ – number of apartments in municipality i heated by fuel f
$K_{P,f}$ – fractions of the individual kinds of fuels f in regional level (It is determined only for coal)

The average heating value Q_i of coal fuels and K_P are derived from yearly survey of fuel producers.

The model includes the following types of fuels (see Figure 3-4):

- *Coal (Brown Coal, Hard Coal, Coke)*
- *Biomass (Q_f = 14,6 MJ.kg^{-1})*
- *Natural Gas (Q_f = 34,06 MJ.m^{-3}, S = 0,0002 g.m^{-3})*
- *LPG (Q_f = 46 MJ.kg^{-1}, S = 0,2 g.kg^{-1})*
- *Liquid fuels (Q_f = 42,3 MJ.kg^{-1}, S = 0,1 % weight)*

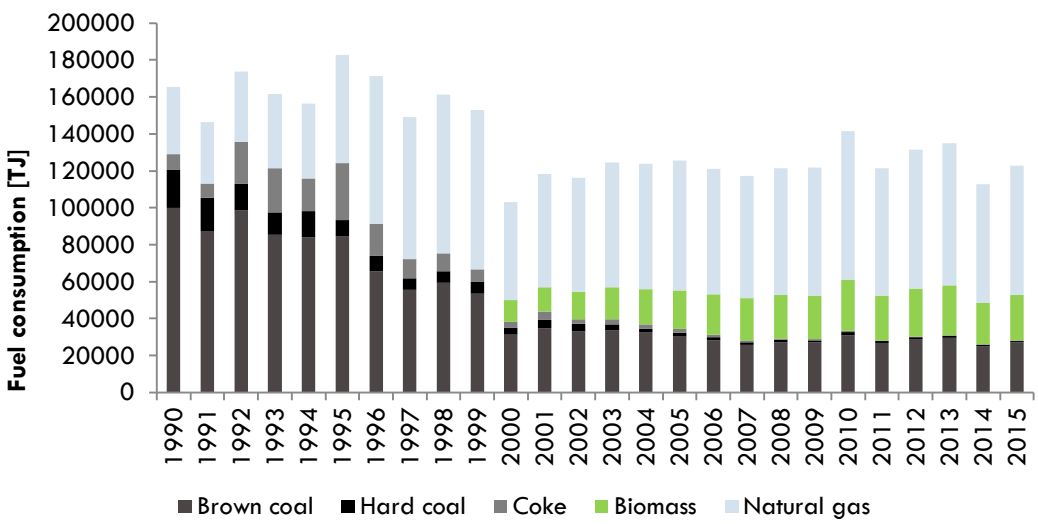

Figure 3-4 Trends of fuel consumption in residential sector in 1990-2015

3.5.2 Emission factors

Emission factors for the combustion of solid fuels are derived from results of measurements carried out by the VEC VŠB in the whole range of monitored pollutants, and their values are updated annually according to developments in the representation of individual types of incineration facilities in households. Emission factors for other types of fuels were taken from the Air Pollutant Emission Inventory Guidebook–2016 and methodological guidelines of the Ministry of the

According to the results of statistical analysis, 620 000 solid-fuel boilers were in operation in the Czech Republic in 2010. Of these 35,9 % were over-fire boilers, 49,5 % were under-fire boilers, 11,6 % were gasification boilers, and 3 % were automatic boilers. The VEC, based on emission measurements, created a relatively extensive database of specific emissions of pollutants for different types of combustion facilities and for different fuels. The method of weighted averaging was chosen as the method for calculating emission factors from experimental data. The "weight" in this case is the proportion of a given fuel burned in combustion facilities of a given construction.

Values of emission factors for coal in the period 2000–2015 (see Table 3-7 and Table 3-8) were gradually decreasing because the proportion of coal burnt in over-fire boilers was decreasing and because the amount of coal burned in automatic boilers was increasing. An exception is emission factors for NO_X whose value was gradually growing because higher specific emissions of this pollutant have been measured in the exhausts of more modern boilers. Values of emission factors for biomass (see Table 3-9) were increasing in the cases of all pollutants because the share of biomass combusted in over-fire boilers was growing.

Table 3-5 Emission factors for Brown Coal

Pollutant	Unit	1990	1995	2000	2005	2010	2015
NOx	$kg.t^{-1}$	1,84	1,84	1,84	1,85	1,87	1,88
TOC	$kg.t^{-1}$	10,47	10,47	10,47	9,50	7,55	7,02
SO_2	$kg.t^{-1}$	13,6*Sp					
BC	% $PM_{2.5}$	6,4	6,4	6,4	6,4	6,4	6,4
$PM_{2.5}$	% TSP	89,6	89,6	89,6	89,6	89,6	89,6
PM_{10}	% TSP	91	91	91	91	91	91
TSP	$kg.t^{-1}$	9,58	9,58	9,58	9,02	7,90	7,60
CO	$kg.t^{-1}$	89,6	89,6	89,6	88,4	85,8	85,1
Pb	$mg.t^{-1}$	446	446	446	455	473	478
Cd	$mg.t^{-1}$	9,3	9,3	9,3	9,5	9,7	9,8
Hg	$mg.t^{-1}$	13,6	13,6	13,6	12,5	10,4	9,8
As	$mg.t^{-1}$	173	173	173	175	180	181
Cr	$mg.t^{-1}$	448	448	448	405	321	298
Cu	$mg.t^{-1}$	123	123	123	123	123	123
Ni	$mg.t^{-1}$	81,6	81,6	81,6	80,6	78,6	78,1
Se	$mg.t^{-1}$	40,3	40,3	40,3	40,5	41,0	41,2
Zn	$mg.t^{-1}$	1479	1479	1479	1509	1567	1583

PCDD/F	mg.t^{-1}	0,000526	0,000526	0,000526	0,000502	0,000452	0,000439
B(a)P	mg.t^{-1}	4220	4220	4220	4039	3676	3577
B(b)F	mg.t^{-1}	1648	1648	1648	1562	1391	1344
B(k)F	mg.t^{-1}	1769	1769	1769	1699	1560	1522
I(1,2,3-cd)P	mg.t^{-1}	1685	1685	1685	1607	1450	1408
HCB	mg.t^{-1}	0,02	0,02	0,02	0,02	0,02	0,02
PCBs	mg.t^{-1}	0,03	0,03	0,03	0,03	0,03	0,03

Sp – sulphur content in a raw sample of solid fuels (% weight)

Table 3-6 Emission factors for Hard Coal

Pollutant	Unit	1990	1995	2000	2005	2010	2015
NOx	kg.t^{-1}	4,50	4,50	4,50	4,51	4,55	4,56
TOC	kg.t^{-1}	21,45	21,45	21,45	21,50	21,61	21,64
SO_2	kg.t^{-1}	13,6*Sp					
BC	% $PM_{2.5}$	6,4	6,4	6,4	6,4	6,4	6,4
$PM_{2.5}$	% TSP	89,6	89,6	89,6	89,6	89,6	89,6
PM_{10}	% TSP	91	91	91	91	91	91
TSP	kg.t^{-1}	8,09	8,09	8,09	8,02	7,88	7,84
CO	kg.t^{-1}	114,3	114,3	114,3	112,9	109,9	109,1
Pb	mg.t^{-1}	541	541	541	531	510	505
Cd	mg.t^{-1}	5,5	5,5	5,5	5,4	5,2	5,2
Hg	mg.t^{-1}	23,4	23,4	23,4	23,2	22,9	22,7
As	mg.t^{-1}	57	57	57	52	44	42
Cr	mg.t^{-1}	261	261	261	250	228	223
Cu	mg.t^{-1}	101	101	101	99	94	93
Ni	mg.t^{-1}	59,5	59,5	59,5	56,4	50,2	48,5
Se	mg.t^{-1}	206,6	206,6	206,6	203,8	198,3	196,8
Zn	mg.t^{-1}	614	614	614	575	499	478
PCDD/F	mg.t^{-1}	0,009191	0,009191	0,009191	0,009756	0,010891	0,011209
B(a)P	mg.t^{-1}	7416	7416	7416	7333	7165	7118
B(b)F	mg.t^{-1}	4989	4989	4989	4970	4932	4921
B(k)F	mg.t^{-1}	3215	3215	3215	3183	3120	3102
I(1,2,3-cd)P	mg.t^{-1}	4483	4483	4483	4404	4247	4203
HCB	mg.t^{-1}	46,22	46,22	46,22	44,76	41,83	41,04
PCBs	mg.t^{-1}	0,12	0,12	0,12	0,12	0,13	0,13

Sp – sulphur content in a raw sample of solid fuels (% weight)

Table 3-7 Emission factors for Biomass

Pollutant	Unit	1990	1995	2000	2005	2010	2015
NOx	$kg.t^{-1}$	1,01	1,01	1,01	1,01	1,02	1,02
TOC	$kg.t^{-1}$	9,39	9,39	9,39	8,93	8,58	8,52
SO_2	$kg.t^{-1}$	-	-	-	-	-	-
BC	% $PM_{2.5}$	10	10	10	10	10	10
$PM_{2.5}$	% TSP	92,5	92,5	92,5	92,5	92,5	92,5
PM_{10}	% TSP	95	95	95	95	95	95
TSP	$kg.t^{-1}$	1,54	1,54	1,54	1,57	1,58	1,58
CO	$kg.t^{-1}$	71,1	71,1	71,1	72,2	73,0	73,1
Pb	$mg.t^{-1}$	139	139	139	129	121	120
Cd	$mg.t^{-1}$	16,1	16,1	16,1	16,4	16,5	16,5
Hg	$mg.t^{-1}$	2,1	2,1	2,1	2,4	2,6	2,6
As	$mg.t^{-1}$	27	27	27	33	38	38
Cr	$mg.t^{-1}$	348	348	348	393	428	433
Cu	$mg.t^{-1}$	107	107	107	117	124	126
Ni	$mg.t^{-1}$	58,6	58,6	58,6	61,0	62,9	63,1
Se	$mg.t^{-1}$	19,4	19,4	19,4	22,3	24,5	24,8
Zn	$mg.t^{-1}$	523	523	523	566	599	604
PCDD/F	$mg.t^{-1}$	0,000387	0,000387	0,000387	0,000531	0,000641	0,000657
B(a)P	$mg.t^{-1}$	1353	1353	1353	1403	1442	1447
B(b)F	$mg.t^{-1}$	937	937	937	1001	1050	1057
B(k)F	$mg.t^{-1}$	581	581	581	610	632	635
I(1,2,3-cd)P	$mg.t^{-1}$	932	932	932	964	988	991
HCB	$mg.t^{-1}$	0,07	0,07	0,07	0,08	0,08	0,08
PCBs	$mg.t^{-1}$	0,05	0,05	0,05	0,05	0,04	0,04

Table 3-8 Emission factors for Liquid fuels and Natural Gas

		Liquid fuels	LPG	Natural Gas
NOx	$kg.t^{-1}$; $thous.m^{-3}$	2	1,8	1,3
TOC	$kg.t^{-1}$; $thous.m^{-3}$	0,34	0,09	0,064
SO_2	$kg.t^{-1}$; $thous.m^{-3}$	20*S	0,02*S	2*S
BC	%$PM_{2.5}$	8,5	8,5	5,35

$PM_{2.5}$	%TSP	100	100	100
PM_{10}	%TSP	100	100	100
TSP	$kg.t^{-1}$; $thous.m^{-3}$	2,13	0,45	0,02
CO	$kg.t^{-1}$; $thous.m^{-3}$	0,59	0,46	0,32
Pb	$mg.t^{-1}$; $thous.m^{-3}$	0,5076	-	0,05109
Cd	$mg.t^{-1}$; $thous.m^{-3}$	0,0423	-	0,008515
Hg	$mg.t^{-1}$; $thous.m^{-3}$	5,076	-	23,1608
As	$mg.t^{-1}$; $thous.m^{-3}$	0,0846	-	4,0872
Cr	$mg.t^{-1}$; $thous.m^{-3}$	8,46	-	0,0258856
Cu	$mg.t^{-1}$; $thous.m^{-3}$	5,499	-	0,00258856
Ni	$mg.t^{-1}$; $thous.m^{-3}$	0,2115	-	0,0173706
Se	$mg.t^{-1}$; $thous.m^{-3}$	0,0846	-	0,37466
Zn	$mg.t^{-1}$; $thous.m^{-3}$	17,766	-	0,05109
PCDD/F	$mg.t^{-1}$; $thous.m^{-3}$	0,00024957	-	0,00005109
B(a)P	$mg.t^{-1}$; $thous.m^{-3}$	3,384	-	0,0190736
B(b)F	$mg.t^{-1}$; $thous.m^{-3}$	1,692	-	0,0286104
B(k)F	$mg.t^{-1}$; $thous.m^{-3}$	2,961	-	0,0286104
I(1,2,3-cd)P	$mg.t^{-1}$; $thous.m^{-3}$	6,768	-	0,0286104
HCB	$mg.t^{-1}$; $thous.m^{-3}$	-	-	-
PCBs	$mg.t^{-1}$; $thous.m^{-3}$	-	-	-

S – sulfur content in a raw sample of liquid fuels (% weight), LPG (g/kg), gaseous fuels (mg.m-3)

3.5.3 Explanation of trends

Emissions from local household heating are related to the trend in the consumption of solid fuels. The positive trend of decreasing consumption of solid fuels that started in the 1990s did not continue after the year 2000. The main reason was growing prices of natural gas and electricity. The overall consumption of solid fuels in the period 2000–2015 changed solely depending on the course of temperatures during heating seasons. In the period under consideration, the year 2010 was the most outstanding because it was characterized by the lowest average temperature over heating season days of 3.2 °C and an average length of the heating season of 247 days. Conversely, the least pronounced heating season was that of the year 2000 with an average temperature over heating season days of 5.2 °C and an average length of 220 days. In the period 2002–2007, the consumption of coal decreases because it is being replaced by ever more popular firewood. These changes cause the emission of most pollutants to decrease, especially PM_{10}, $PM_{2.5}$ and PAH particles. The contribution of the local household heating sector to the overall emissions of these pollutants nevertheless still remains dominant. In 2015 the sector of local household heating contributed to the total emissions of PM_{10} by 36,4 %, of $PM_{2.5}$ by 54,5 % and of benzo[a]pyrene by 97,3 %.

3.6 Mobile Sources

This chapter was prepared by CDV and VUZT. Criteria of sorting means of transport are a type of transport, fuel used and the emission standard that a particular vehicle must meet (in road transport). Categories of vehicles are not as detailed for a non-road transport and mobile sources. Activity data for all sectors and main emission factors are displayed below (National EF in abbreviation noted as "CS").

Table 3-9 Fuel consumption by all modes of transport

Year	Aviation		Road Transport						Railways	Navigation
	Aviation gasoline	Jet kerosene	Gasoline	Diesel oil	LPG	CNG	Biodiesel	Bioethanol	Diesel oil	Diesel oil
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
2000	3	192	1 845	1 741	62	2	70	0	104	5
2001	2	205	1 888	1 968	63	2	52	0	97	8
2002	3	177	1 908	2 133	64	5	73	0	94	4
2003	3	238	2 084	2 525	65	5	70	0	92	4
2004	3	306	2 077	2 772	68	3	36	0	91	6
2005	2	318	2 039	3 228	70	3	3	0	92	5
2006	2	326	1 994	3 369	72	3	20	2	96	6
2007	2	342	2 081	3 558	77	4	34	0	95	5
2008	2	362	2 001	3 561	80	5	85	54	105	4
2009	2	331	1 936	3 445	74	6	154	91	95	5
2010	2	310	1 755	3 301	77	7	196	90	92	4
2011	1	307	1 684	3 318	78	8	271	94	90	3
2012	2	286	1 569	3 356	86	10	248	87	87	5
2013	2	276	1 474	3 406	89	15	253	83	85	2
2014	2	283	1 455	3 570	98	21	284	102	86	3
2015	3	287	1 465	3 799	98	31	264	98	83	4

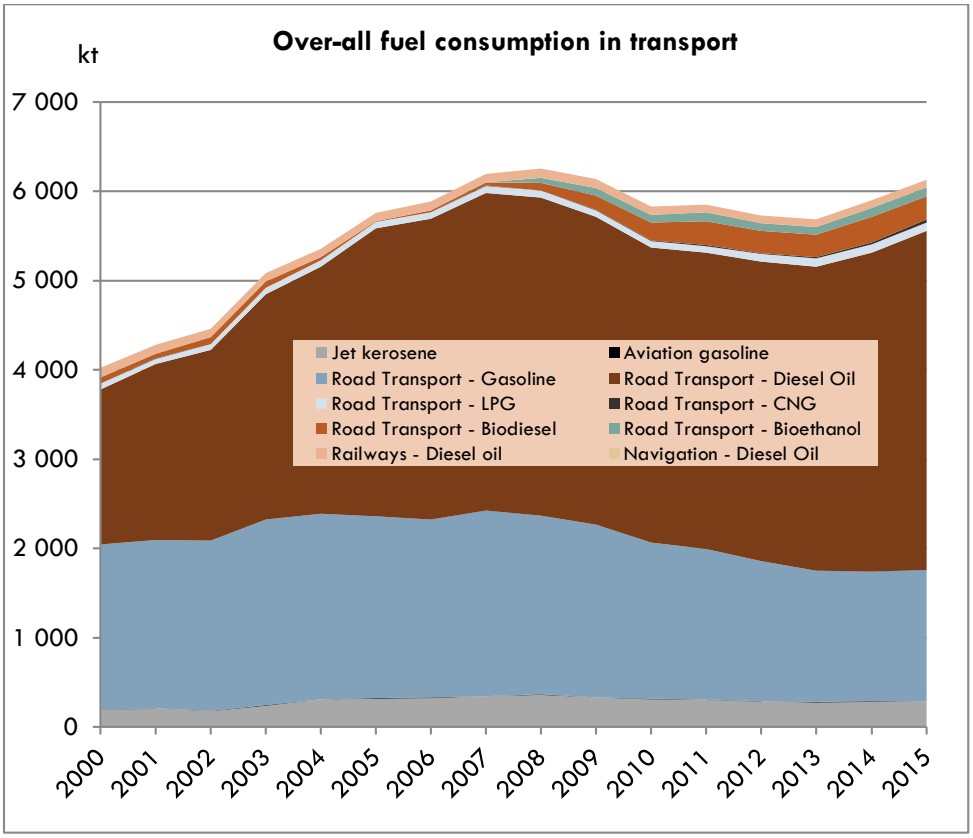

Figure 3-5 Annual fuel consumption by all modes of transport

3.6.1 1.A.3.a Civil aviation

Burning processes in air transport are very different from those in land and water transport. This is caused by its operation in a wider range of atmospheric conditions (namely by substantial changes in atmospheric pressure, air temperature and humidity). These variables are changing vertically with an altitude and horizontally with air masses. In the category 1.A.3.a emissions of both national (domestic) and international civil aviation are reported with respect to distinctive flight phases: the LTO (Landing/Take-off: 0-3,000 feet) and the Cruise (above 3,000 feet). Emissions from military aircraft are not included in this category but are reported under 1.A.5.b Military: Mobile Combustion.

3.6.1.1 Method

The estimate of aircraft emissions has been carried out on the basis of overall fuel consumption in aviation. It is very important to separate domestic and international flights. CZSO provides fuel consumption for these two categories separately. Next step is to define a ratio between fuel consumption during LTO and Cruise phases of flights (see Table 3-10). Emissions are estimated by multiplying the consumption of jet kerosene and aviation gasoline by the ratio of consumption of a flight phase and by emission factors (EF).

Table 3-10 Ratio of fuel usage between LTO and Cruise flight mode

Fuel	Flight mode	Ratio
Jet Kerosene	LTO	0.15
	CRUISE	0.85
Aviation gasoline	LTO	0.1
	CRUISE	0.9

3.6.1.2 Activity data

Activity data are gained from CZSO and are divided between LTO and Cruise flight mode according to ratio which is stated in the Table 3-15. The total consumption of Jet Kerosene in the Czech Republic is divided into five categories (Civil Aviation, International Aviation, Army, Industry and Commercial and Public Services). The Jet Kerosene consumption as well as relevant emissions from categories Army, Industry, Commercial and Public Services is not reported in NFR tables in Transport sector 1A3, but in sectors 1A5b, 1A2f and 1A4a respectively. Other two categories (Civil Aviation and International Aviation) are divided on the basis of expert judgement in the whole time period if main criteria are passengers transport (only small amount of domestic lines among Czech main airports) and transport of goods (MoT, 2000; MoT, 2006; MoT, 2011; MoT, 2014). The regular domestic flights using Jet Kerosene are, in comparison with international flights, represented in the Czech Republic by a very small percentage.

Table 3-11 Jet kerosene consumption according to flight mode in 2000–2015

Jet kerosene consumption	Domestic Flights LTO kt	International Flights LTO kt	Domestic Flights Cruise kt	International Flights Cruise kt
2000	0.5	191.5	28.7	162.8
2001	0.6	204.4	30.7	173.7
2002	0.5	176.5	26.5	150.0
2003	0.6	237.4	35.6	201.8
2004	0.8	305.2	45.8	259.4
2005	0.9	317.1	47.6	269.5
2006	1.1	324.9	48.7	276.2
2007	1.1	340.9	51.1	289.8
2008	0.7	361.3	54.2	307.1
2009	1.0	330.0	49.5	280.5
2010	0.8	309.2	46.4	262.8
2011	0.5	306.5	46.0	260.5
2012	0.4	285.6	42.8	242.8
2013	0.5	275.5	41.3	234.2
2014	0.3	282.7	42.4	240.3

Jet kerosene consumption	Domestic Flights LTO kt	International Flights LTO kt	Domestic Flights Cruise kt	International Flights Cruise kt
2015	0.3	286.7	43.0	243.7

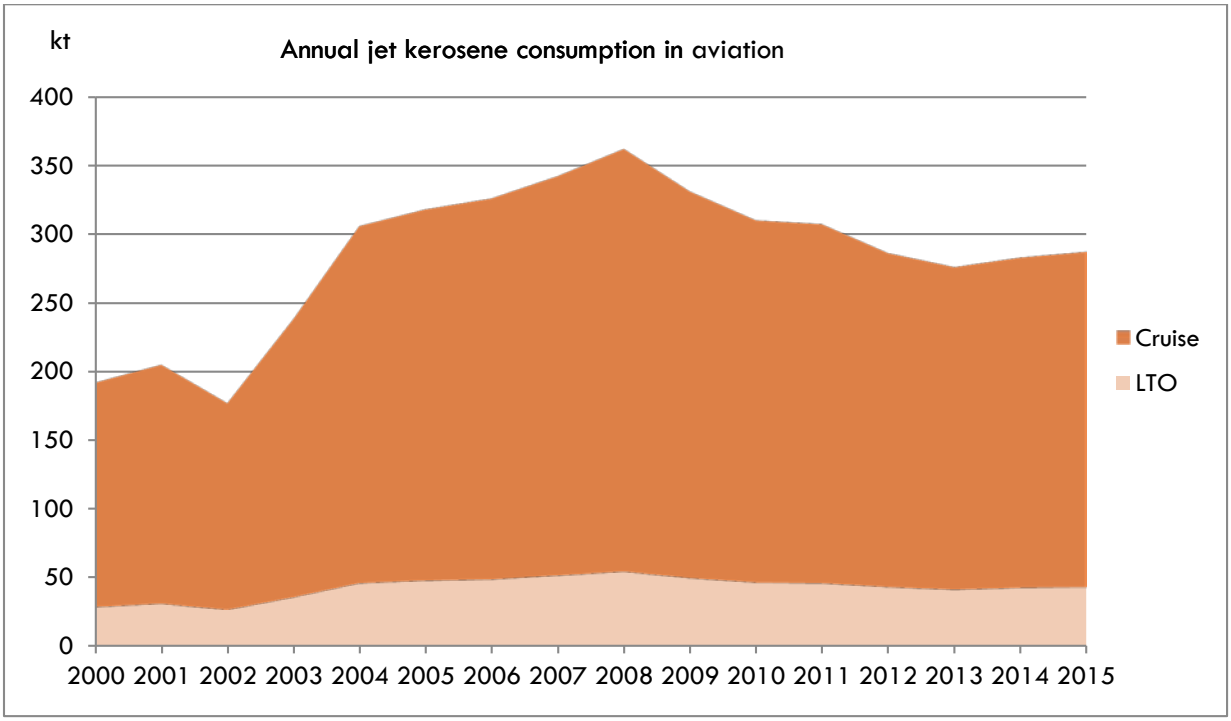

Figure 3-6 Annual jet kerosene consumption in aviation in 2000–2015

3.6.1.3 Emission factors

The emission factors are derived from the internal database of the Transport Research Centre, which contains the default emission factors taken from EIG database (Tier 1), and also those that have country-specific character (see Table 3-16 and Table 3-17). Emission factors are mostly country specific. Tier 1 EFs were taken from other modes of transport (jet kerosene – road diesel oil, aviation gasoline - road gasoline) according EIG 2016. PCDD/F and PCBs are not reported from Civil Aviation. Total emissions from each sector are combination of emission factor, ratio of LTO and Cruise on a total fuel consumption and activity data.

Table 3-12 Method of emission factors

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	TSP	BC	CO
1 A 3 a i (i) International aviation (LTO)	CS	CS	CS	CS	CS	CS	CS

1 A 3 a ii (i) Civil aviation (Domestic, LTO)	CS	CS	CS	CS	CS	CS	CS
1 A 3 a i (ii) International aviation (Cruise)	CS	CS	CS	CS	CS	CS	CS
1 A 3 a ii (ii) Civil aviation (Domestic, Cruise)	CS	CS	CS	CS	CS	CS	CS

Table 3-13 EF method

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1 A 3 a i (i) International aviation (LTO)	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
1 A 3 a i (ii) International aviation (Cruise)	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
1 A 3 a ii (ii) Civil aviation (Domestic, Cruise)	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1

Table 3-14 Method of emission factors

	PCDD/ PCDF (dioxines/ furanes)	PAHs				PCBs
		benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	
1 A 3 a i (i) International aviation (LTO)	NR	CS	CS	CS	CS	NR
1 A 3 a ii (i) Civil aviation (Domestic, LTO)	NR	CS	CS	CS	CS	NR
1 A 3 a i (ii) International aviation (Cruise)	NR	CS	CS	CS	CS	NR
1 A 3 a ii (ii) Civil aviation (Domestic, Cruise)	NR	CS	CS	CS	CS	NR

Table 3-15 Emission factors used in the current year

	Emission factor $g.kg^{-1}$							
	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	TSP	BC	CO	Pb
Jet kerosene LTO	12.5	1.59	0.2	0	0.09	0.0135	2.7	0.0
Jet kerosene Cruise	12.5	1.59	0.2	0	0.09	0.0432	2.2	0.0
Aviation Gasoline LTO and Cruise	21.87	26.01	0.02	0	0	0	126.4	0.5

Table 3-16 Emission factors used in the current year

	Emission factor ug.kg^{-1}							
	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Jet kerosene LTO and Cruise	8.7	5.3	0.1	30.0	21.2	8.8	0.1	1738.0
Aviation Gasoline LTO and Cruise	10.8	8.7	0.3	16.0	42.0	13.0	0.2	2163.0

Table 3-17 Emission factors used in the current year

	PCDD/ PCDF (dioxines/ furanes)	PAHs				PCBs
		benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene	
Jet kerosene LTO and Cruise	NR	0.0	0.0	0.0	0.0	NR
Aviation Gasoline LTO and Cruise	NR	10.7	15.0	8.7	10.7	NR

3.6.1.4 Uncertainties

Uncertainty in civil aviation was calculated according to EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainty given here has been evaluated for all of time series (2000–2015) and both flight stages. Total combined uncertainty of national emissions within civil aviation is ±31.59 %. Uncertainty in activity data is up to 4 %. Uncertainty in EFs ranges from 50 to 200 %. Especially heavy metals, NH_3 and PAHs have less reliable EFs.

3.6.2 1.A.3.b Road Transport

Under this category emissions from motor road traffic are reported in the Czech Republic. It includes all traffic on public roads except agricultural and forestry transports and military transports which are reported in separate categories. Estimations are made for these vehicle categories: passenger cars (PCs), light duty vehicles (LDVs), heavy duty vehicles (HDVs), buses and motorcycles (MCs). For calculation purposes, the vehicle categories were broken down by a type of fuel and EURO norms.

Since 2000, emissions of NO_x, NMVOC and SO_2 from road transports have decreased sharply due to use of catalytic-converters and engine improvements (a result of a continual tightening of emissions laws) and a higher quality of fuels. For buses and heavy duty vehicles (over 3.5 t of a total permissible vehicle weight), maximum permissible levels of hydrocarbon (HC, incl. NMVOC) emissions were lowered especially sharply because of the introduction of the EURO3 standard in 2000. See 1.A.3.b i and ii (Passenger Cars and Light Duty Vehicles).

3.6.2.1 Method

The data necessary for calculations of a fuel distribution are provided by the Ministry of Transport in transport yearbooks and traffic surveys (Traffic census) and by the CDV´s research activities. Some sources of a road transport are monitored separately. Primarily data about CNG vehicles, which have been experiencing a boom in recent years, are collected from two public website sources. The

first source of information is Czech source administrated by Czech Gas Association and the second one is Natural & bio Gas Vehicle Association Europe. The most important source of information for distribution a dynamic structure (emission standards) of vehicle fleet on roads in the Czech Republic are particularly CDV´s research activities, a lot of traffic surveys, every five years traffic census and also aggregate outcomes of studies prepared for The Road and Motorway Directorate of the Czech Republic.

The appropriate distribution is necessary for assigning of a relevant emission factor. Sector 1A3b Road Transportation is split into five subsectors:

- *1.A.3.b i* *Passenger Cars*
- *1.A.3.b ii* *Light Duty Vehicles*
- *1.A.3.b iii* *Heavy Duty Vehicles*
- *1.A.3.b iv* *Mopeds & Motorcycles*
- *1.A.3.b v* *Gasoline Evaporation*
- *1.A.3.b vi* *Automobile tyre and brake wear*
- *1.A.3.b vii* *Automobile road abrasion*

Emission estimates of subsector 1A3b ii Light Duty Vehicles are included in the subsector 1A3b i Passenger Cars, because the differentiation between these two subsectors is not available owing to inappropriate structure of activity data provided by The Czech Statistical Office (CzSO). Next issue is that in some years a lot of passenger cars are registered in The Central Vehicle Register as light duty vehicles because of fixed separation between passenger cabin and trunk space according to Czech legislation.

3.6.2.2 Activity data

Activity data of a road transport (see Table 3-22) are based on the official energy balance of the Czech Republic prepared by the CzSO. The most important feature is an annual sale of fuels expressed as units of weight since emission factor´s values are expressed in g.kg^{-1} in the CDV database. The parameters necessary for distribution of this amount of fuels are a transport mode, a fuel type, weight of vehicle and the occurrence of equipment with more or less effective catalytic system.

Table 3-18 Fuel consumption within road transport in the Czech Republic

Year	Gasoline kt	Diesel oil kt	LPG kt	CNG kt	Biodiesel kt	Bioethanol kt
2000	1 845	1 741	62	2	70	0
2001	1 888	1 968	63	2	52	0
2002	1 908	2 133	64	5	73	0
2003	2 084	2 525	65	5	70	0
2004	2 077	2 772	68	3	36	0
2005	2 039	3 228	70	3	3	0
2006	1 994	3369	72	3	20	2
2007	2 081	3 558	77	4	34	0
2008	2 001	3 561	80	5	85	54
2009	1 936	3 445	74	6	154	91
2010	1 755	3 301	77	7	196	90

Year	Gasoline kt	Diesel oil kt	LPG kt	CNG kt	Biodiesel kt	Bioethanol kt
2011	1 684	3 318	78	8	271	94
2012	1 569	3 356	86	10	248	87
2013	1 474	3 406	89	15	253	83
2014	1 455	3 570	98	21	284	102
2015	1 465	3 799	98	31	264	98

3.6.2.3 Emission factors

The emission factors are derived from an internal database of the Transport Research Centre which contains the default emission factors taken from EIG databases and also those that have country-specific character. The country-specific emission factors are represented by measured values of particular road vehicles. These values include pollutants as carbon monoxide (CO), nitrogen oxides (NO_X), non-methane volatile organic compound (NMVOC), sulphur oxides (SO_X), ammonia (NH_3), total suspended particles (TSP) and their fractions (PM_{10} and $PM_{2.5}$) and lead (Pb). All emission factors for current year are placed in each category chapters.

3.6.2.4 Emissions

Emission downwards trends of NOx, NMVOC, and CO depend on different EURO regulations which came into force and on ongoing technical development (engines, catalysts etc.). SO_2 shows the strong dependence on an increasing quality of fuels (sulfur content) bringing significant downward trend which is slightly influenced by increases in fuel consumption. The ammonia emissions chart varies significantly. There should occur a decrease from the year 2000 because of introducing better technologies into catalytic converters in gasoline driven cars and the ongoing shift from gasoline to diesel cars result in decreasing emissions in the following years. However the chart shows slightly increasing trend. Emission factors for cars Euro 3 and higher are unfortunately based on old methodology made for old catalytic converters. Together with rising total fuel consumption and rising share of cars with higher Euro standard is emission trend distorted. The discrepancy will be solved in next submissions by actualizing of methodology. Share of TSP emission from fuel combustion is decreasing because of technical development. In break, tyre and road abrasion technical development is not so progressive and emission production is most dependent on vehicles activity. This caused that from 2010 emissions of TSP from tyre, break and road abrasion is higher than from fuel combustion.

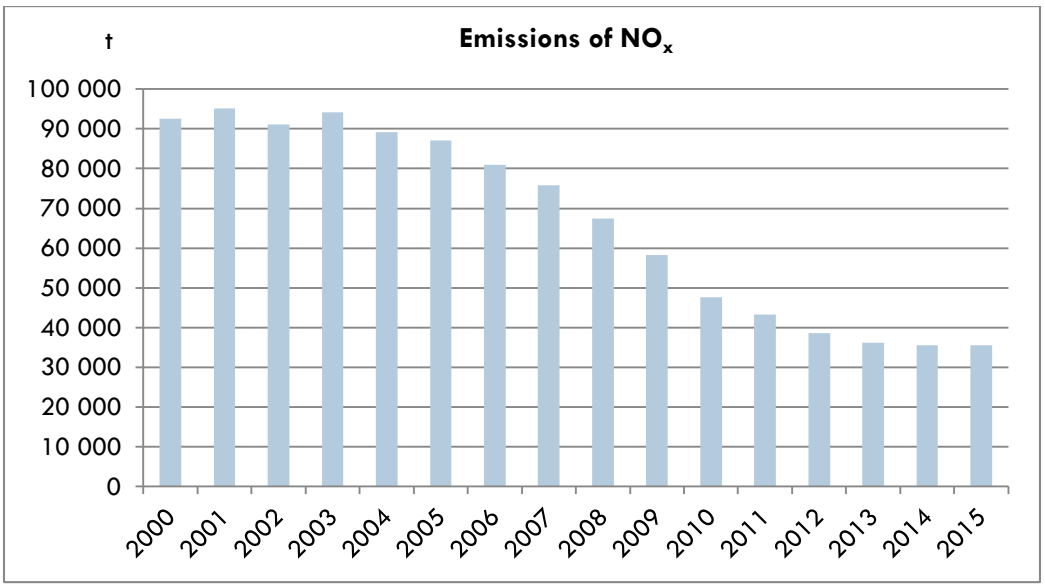

Figure 3-7 Emissions from road transport in 2000–2015

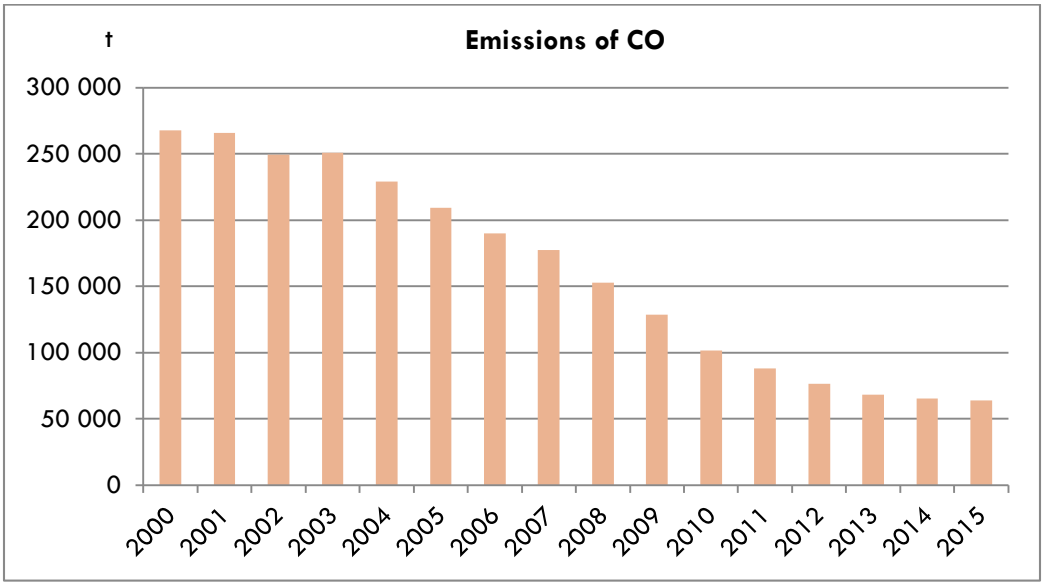

Figure 3-8 Emissions from road transport in 2000–2015

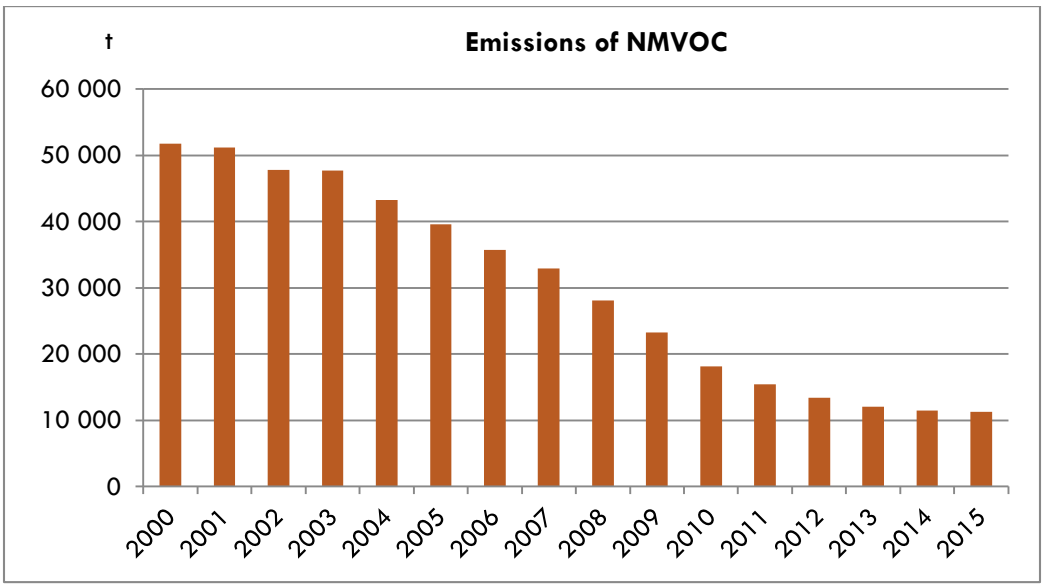

Figure 3-9 Emissions from road transport in 2000–2015

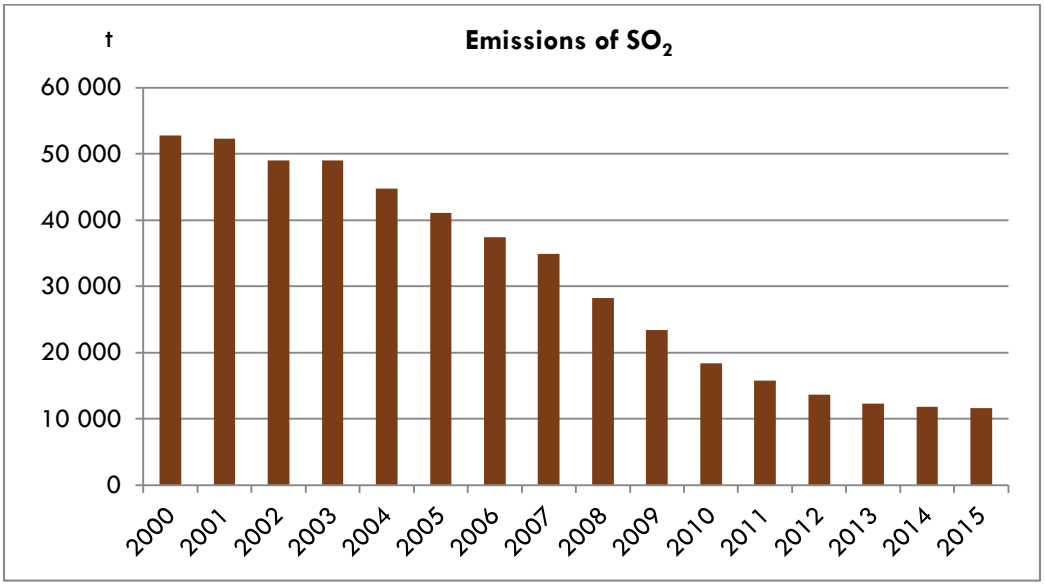

Figure 3-10 Emissions from road transport in 2000–2015

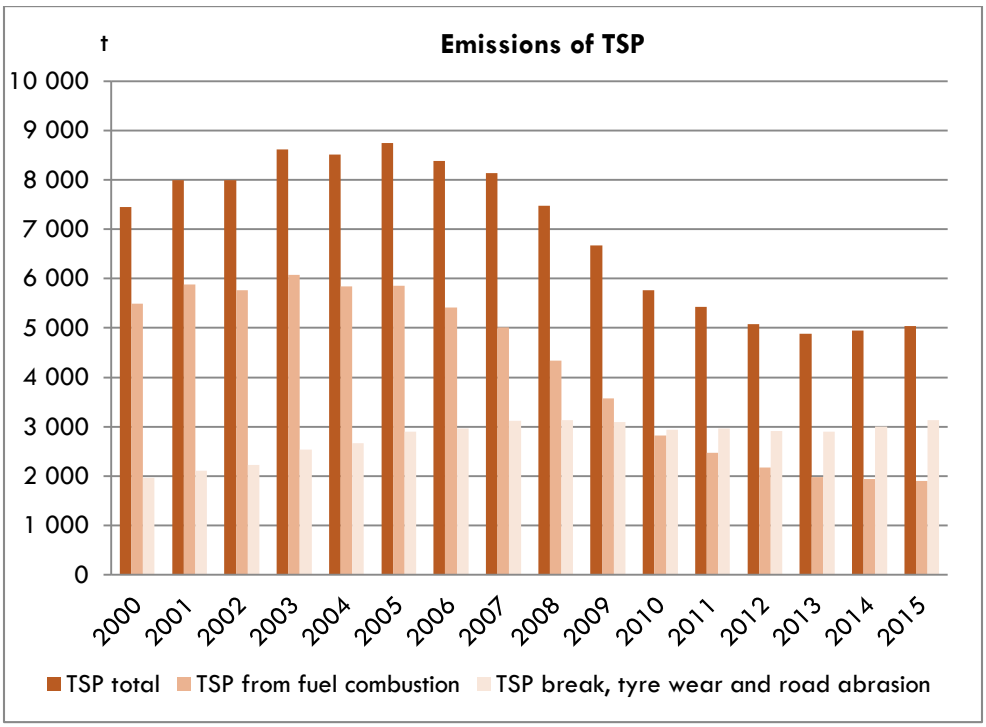

Figure 3-11 Emissions from road transport in 2000–2015

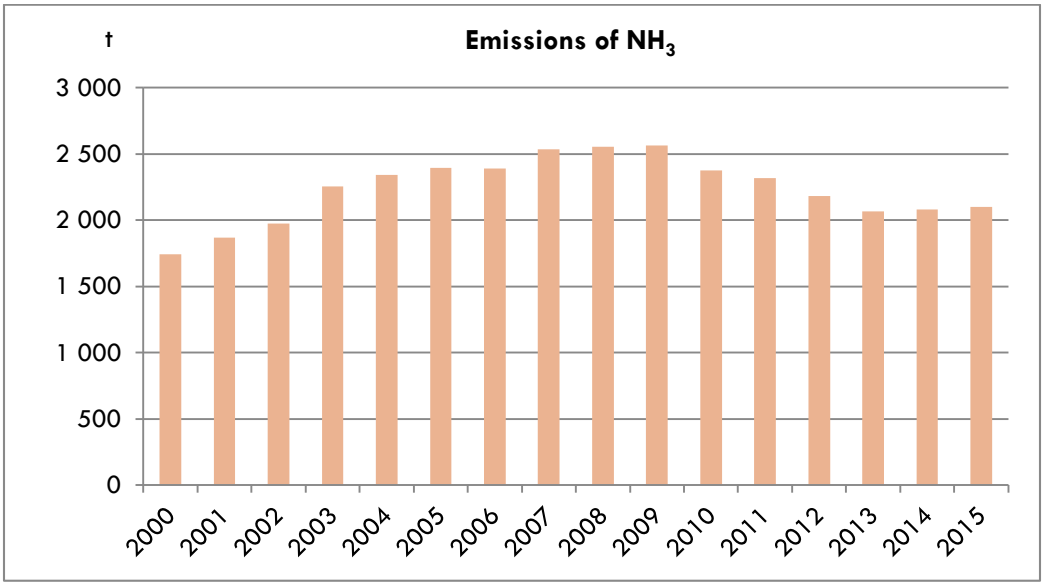

Figure 3-12 Emissions from road transport in 2000–2015

3.6.2.5 Uncertainties

Uncertainty in road transport was calculated according to EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainty given here has been evaluated for all of time series (2000–2015) and reported categories. Total combined uncertainty of national emissions from road transport is ± 27.48 % and from tyre - break wear and road abrasion is ± 36.49 %. Uncertainty in activity data is up to 3 % for road transport and for tyre - break wear and road abrasion up to 5 %. Uncertainties in EFs in both categories range from 50 up to 200 %. Especially heavy metals, NH_3 and PAHs have less reliable EFs.

3.6.2.6 1.A.3.b i Passenger Cars and Light Duty Vehicles

- *passenger and light duty gasoline vehicles conventional,*
- *passenger and light duty gasoline vehicles with EURO 1-6 limits,*
- *passenger and light duty diesel vehicles conventional,*
- *passenger and light duty diesel vehicles with EURO 1-6 limits,*
- *passenger cars and light duty vehicles using LPG, CNG and biofuels (separately),*

3.6.2.6.1 Activity data

General rising trend of fuel consumption by PCs and LDVs is in line with general trend in whole Europe. In 2007, the economic crisis started in the Czech Republic and influenced overall fuel consumption. (*Figure 3-13*). The decrease of a fuel consumption stopped in 2013 with a renewal of economic growth and the fuel consumption started to increase again. The most significant was a decrease in gasoline consumption. Diesel oil consumption wasn´t so much influenced. In 2015, the overall fuel consumption reached the same level as had been usual in years before crisis. From 2008, biofuels started to be used in higher share in the Czech Republic. Till then, there was not almost used bioethanol here, and biodiesel only in a very small share. In 2015 we can see slight decrease in use of biofuels. The reason was an increase of taxes for blends with high percentage of biodiesel in 2015. Next reason was gasoline and diesel oil price which significantly decreased in 2015 and customers rather used cheaper gasoline and diesel oil than blends with high percentage of biofuels. CNG started to be used from 2002 in the Czech Republic but rise in use of this fuel dates back to 2008. There was a significant increase of CNG share till 2012.

Table 3-19 Fuel consumption by PCs and LDVs

Year	Gasoline kt	Diesel oil kt	LPG kt	CNG kt	Biodiesel kt	Bioethanol kt
2000	1 835	439	62	0	8	0
2001	1 877	516	63	0	6	0
2002	1 897	592	64	0	9	0
2003	2 071	735	65	1	8	0
2004	2 064	835	68	1	4	0
2005	2 026	1 017	70	1	0	0
2006	1 981	1 114	72	1	2	2
2007	2 067	1 231	77	2	4	0
2008	1 987	1 287	80	2	31	54
2009	1 922	1 293	74	3	58	90

Year	Gasoline kt	Diesel oil kt	LPG kt	CNG kt	Biodiesel kt	Bioethanol kt
2010	1 742	1 280	77	4	76	89
2011	1 671	1 325	78	5	108	93
2012	1 557	1 383	86	6	102	86
2013	1 462	1 431	89	11	106	82
2014	1 443	1 532	98	15	122	101
2015	1 453	1 666	98	21	116	97

Table 3-20 Ratio of PCs – non catalytic system and catalytic system

Year	uncontrolled	medium controlled
2000	68%	32%
2001	63%	37%
2002	59%	41%
2003	53%	47%
2004	48%	52%
2005	44%	56%
2006	39%	61%
2007	34%	66%
2008	29%	71%
2009	24%	76%
2010	21%	79%
2011	18%	82%
2012	16%	84%
2013	15%	85%
2014	13%	87%
2015	12%	88%

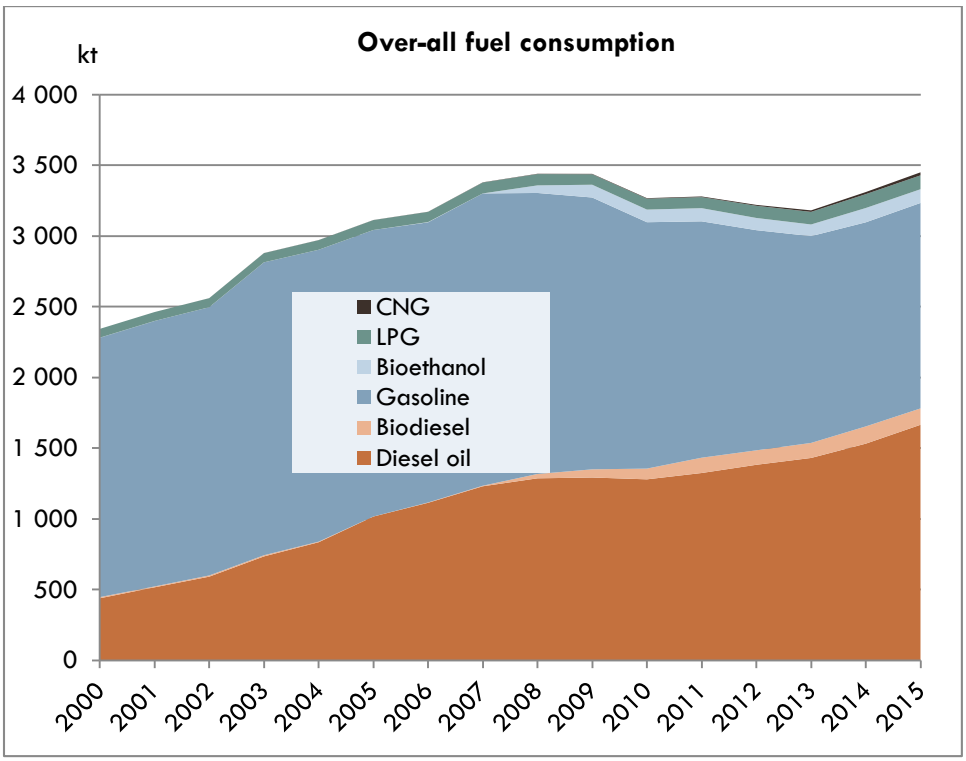

Figure 3-13 Fuel consumption by PCs and LDVs in 2000–2015

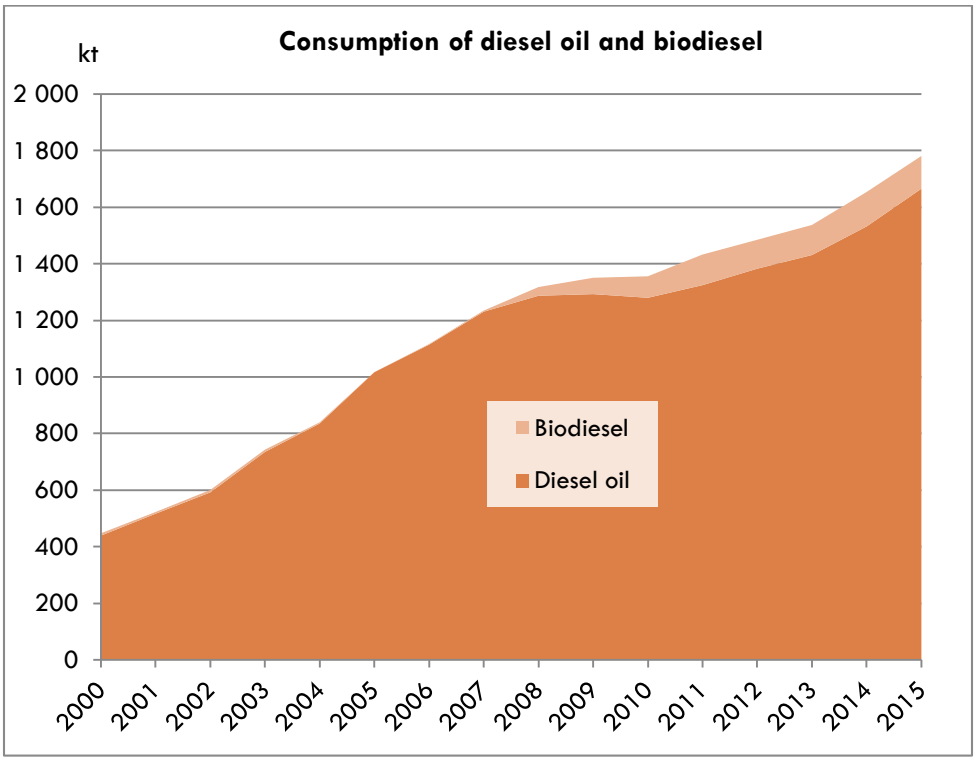

Figure 3-14 Fuel consumption by PCs and LDVs in 2000–2015

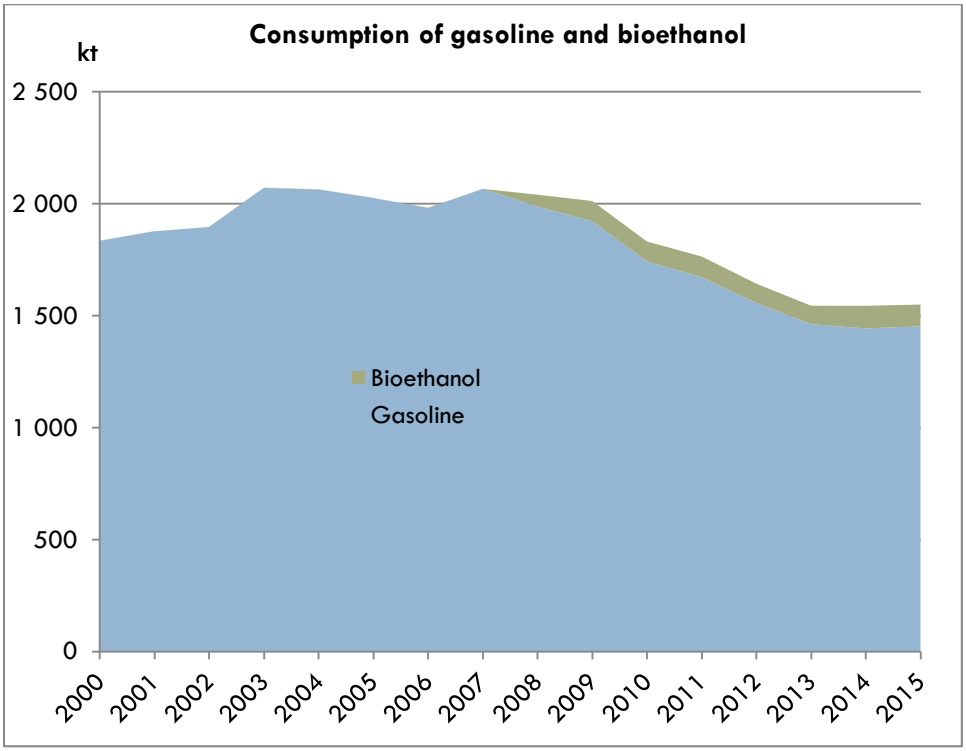

Figure 3-15 Fuel consumption by PCs and LDVs in 2000–2015

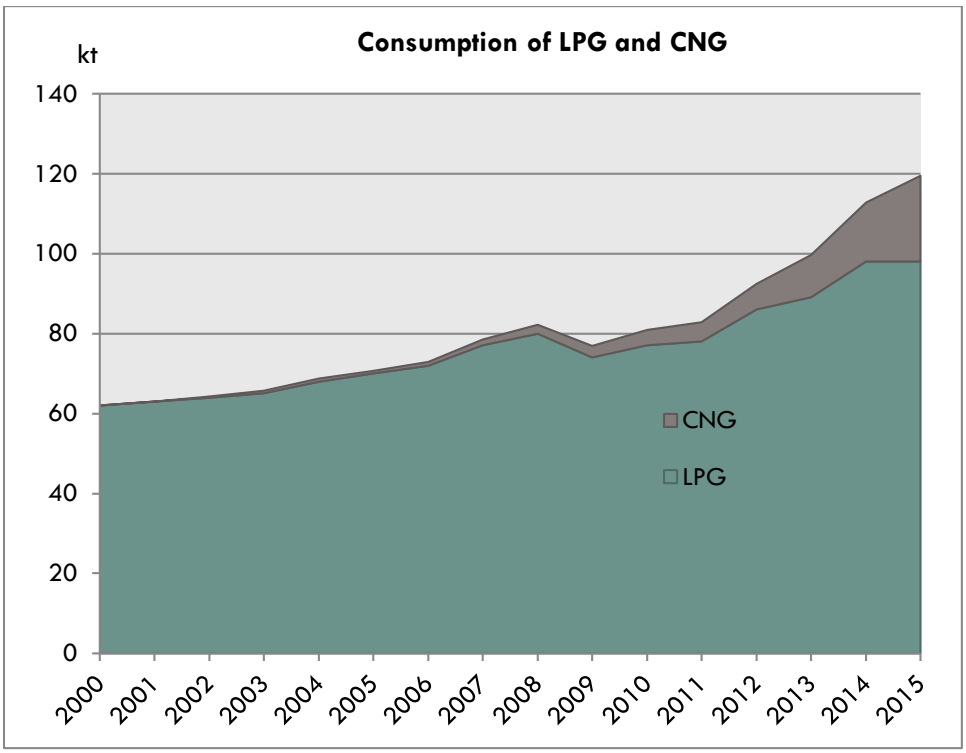

Figure 3-16 Fuel consumption by PCs and LDVs in 2000–2015

3.6.2.6.2 Emission factors

Table 3-21 EF method for PCs and LDVs

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
PCs and LDVs	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**
	CS	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*
	PCDD/ PCDF (dioxines/ furanes)	**PAHs**				**PCBs**			
		benzo(a) pyrene	**benzo(b) fluoranthene**	**benzo(k) fluoranthene**	**Indeno (1,2,3-cd) pyrene**				
	Tier 2	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 2*			

Table 3-22 EF for PCs and LDVs for main pollutants in g.kg^{-1} in the current year

Fuel type	European emission standard	CO	NOx	NMVOC	SOx	Pb	TSP	NH_3
Gasoline	**PRE-EURO**	167,2	45,1	39,2	0,02	0,0005	0,03	0,029
Gasoline	**EURO I and EURO II**	49,1	3,2	4,8	0,02	0,0005	0,03	1,333
Gasoline	**EURO III and higher**	18,2	1,1	1,3	0,02	0,0005	0,02	1,333
Bioethanol	**PRE-EURO and higher**	1,9	12,3	1,1	0,02	0,0005	0,62	0,000
Diesel Oil	**PRE-EURO**	9,0	18,2	2,3	0,02	0,0000	6,24	0,016
Diesel Oil	**EURO I and EURO II**	5,5	8,5	1,1	0,02	0,0000	1,84	0,016
Diesel Oil	**EURO III and higher**	2,4	3,5	0,6	0,02	0,0000	0,28	0,016
LPG	**PRE-EURO and higher**	27,0	5,0	1,1	0,1	0,0000	0,00	0,021
CNG	**PRE-EURO and higher**	27,0	1,0	1,1	0,00	0,0000	0,00	0,000
Biodiesel	**PRE-EURO and higher**	1,9	12,3	1,1	0,02	0,0005	0,62	0,000

Table 3-23 EF for PCs and LDVs for other pollutants in the current year

Pollutant		PCs+LDVs **Gasoline**	PCs+LDVs **Diesel Oil**
Cd	ug.kg^{-1} of fuel	10,8	8,7
Cr	ug.kg^{-1} of fuel	16	30
Cu	ug.kg^{-1} of fuel	42,0	21,2
Ni	ug.kg^{-1} of fuel	13,0	8,8
Se	ug.kg^{-1} of fuel	0,2	0,1
Zn	ug.kg^{-1} of fuel	2163	1738
As	ug.kg^{-1} of fuel	0,3	0,1
Hg	ug.kg^{-1} of fuel	8,7	5,3
PCDD	pg I-Teq.kg^{-1} fuel	49,9	231,4
PCDF	pg I-Teq.kg^{-1} fuel	75,2	344,7
PCBs	ug.kg^{-1} of fuel	25,2	115,3
B(a)P	ug.kg^{-1} of fuel	5.5	21.4
B(b)F	ug.kg^{-1} of fuel	7.9	22.4
B(k)F	ug.kg^{-1} of fuel	3.9	11.8
ID(1,2,3-cd)P	ug.kg^{-1} of fuel	8,9	21,2

3.6.2.6.3 Emissions

SO_2 emissions show a strong dependence on the increasing quality of fuels (sulphur content) producing the cascaded downward trend, only slightly influenced by increase in fuel consumption. In emissions of TSP we can see rising trend till 2007, then decrease till 2013 followed by a slight increase. This variability is caused by a changing share of emissions from fuel combustion together with tyre, break and road abrasion (TBRa). Especially better technology in diesel particulate filters caused significant decrease of emissions from fuel combustion, but emissions from TBRa are dependent on activity, so their trend is generally increasing.

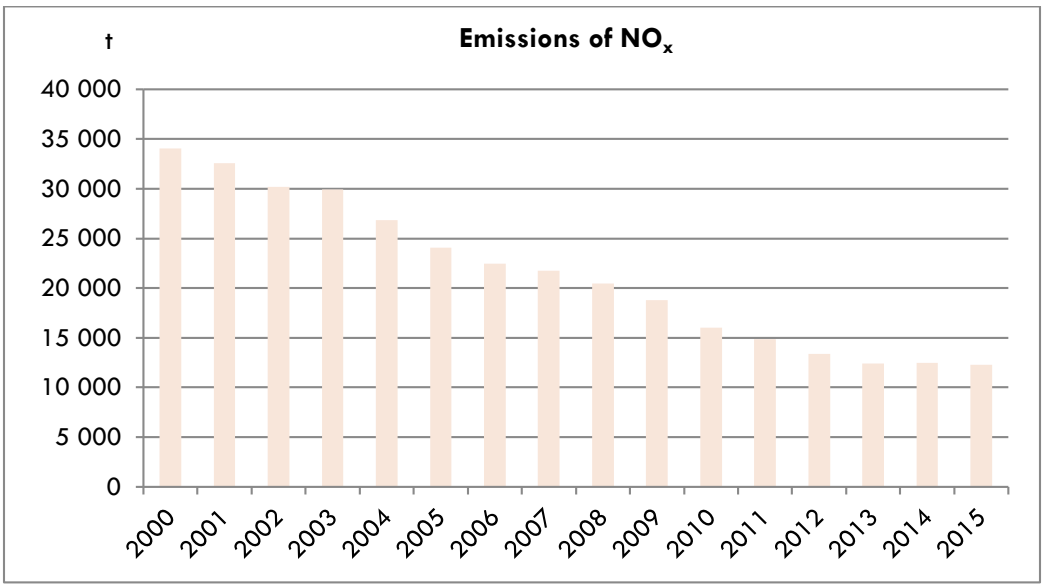

Figure 3-17 Emissions by PCs and LDVs in 2000–2015

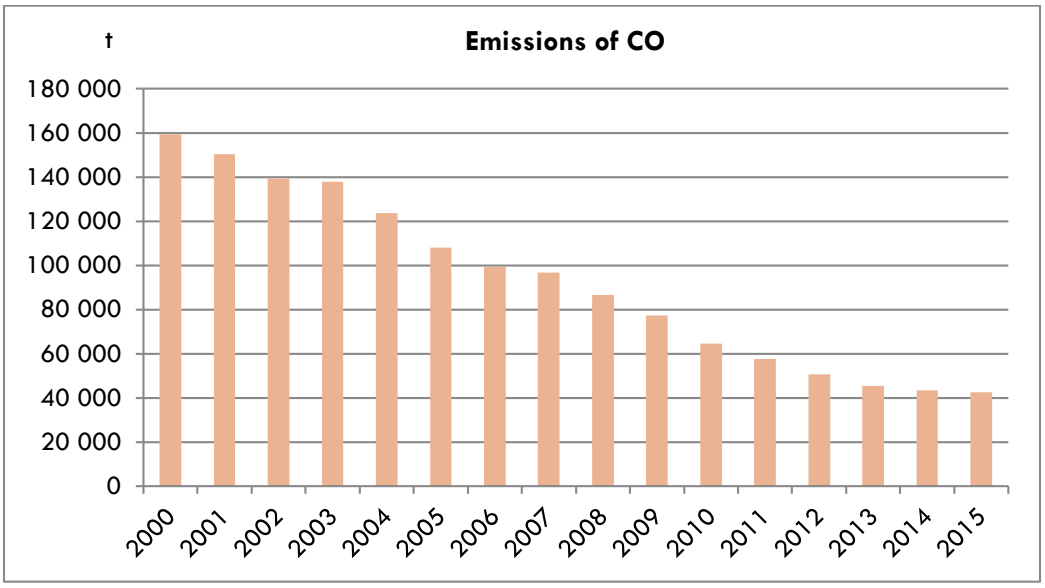

Figure 3-18 Emissions by PCs and LDVs in 2000–2015

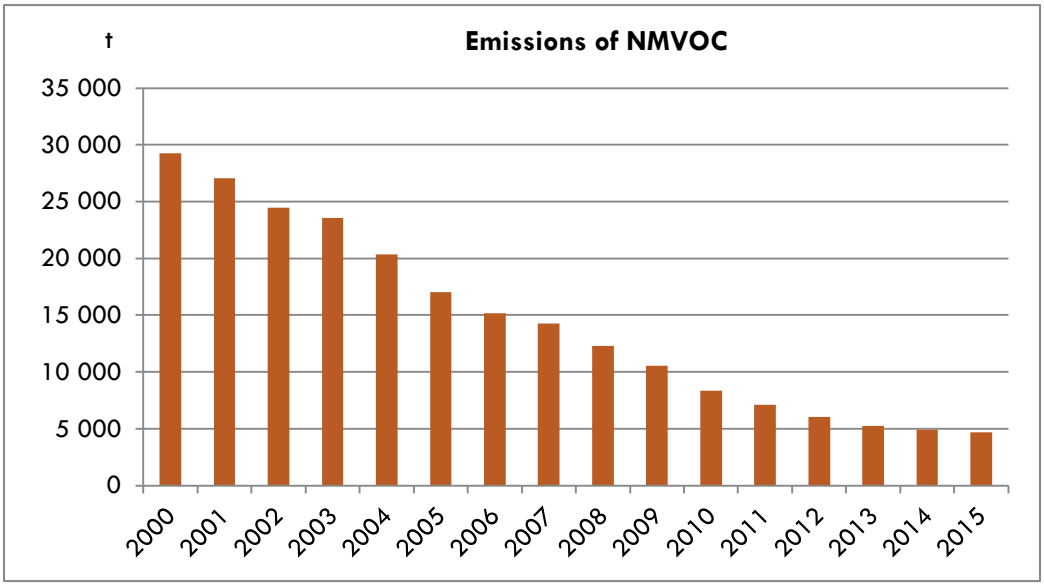

Figure 3-19 Emissions by PCs and LDVs in 2000–2015

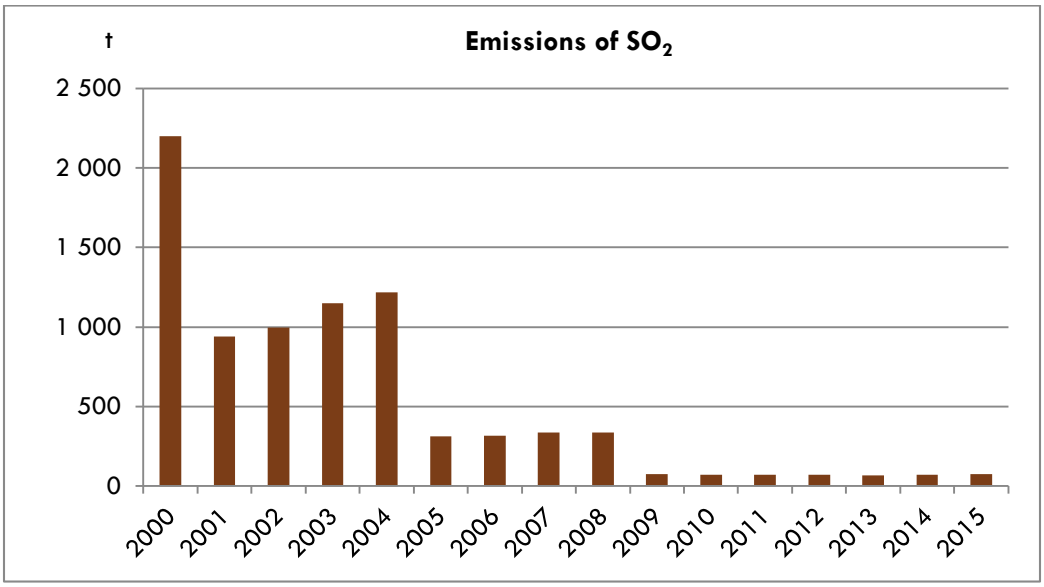

Figure 3-20 Emissions by PCs and LDVs in 2000–2015

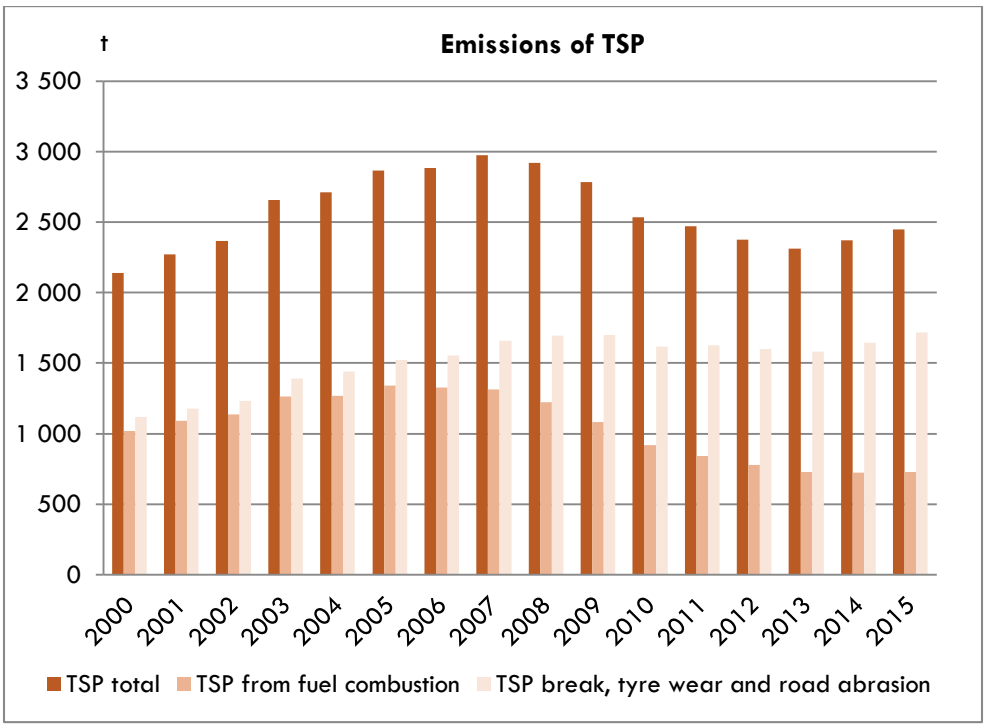

Figure 3-21 Emissions by PCs and LDVs in 2000–2015

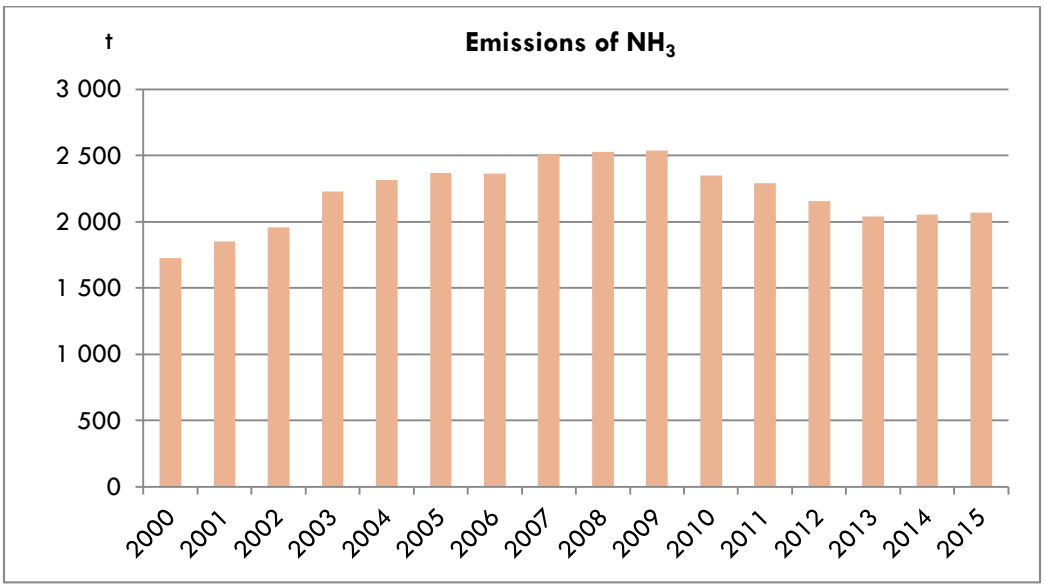

Figure 3-22 Emissions by PCs and LDVs in 2000–2015

3.6.2.7 1.A.3.b iii Heavy Duty Vehicles

- *heavy duty diesel vehicles (including buses), conventional,*
- *heavy duty diesel vehicles (including buses) with EURO I-VI limits, heavy duty vehicles (including buses) using CNG and biofuels (separately).*

3.6.2.7.1 Activity data

Fuel consumptions of HDVs and buses show the same trends as that of PCs and all of them are caused by the same reasons. Fuel consumptions of CNG buses shows small peak in 2002 and 2003. The reason of decrease of CNG consumption in 2004 was introducing of CNG consumption tax. The steep increase of CNG consumption from 2012 is caused by subsidies from public resources for using CNG buses especially in public transport.

Table 3-24 Fuel consumption by HDVs and buses

Year	HDVs			Busses		
	Diesel oil kt	CNG kt	Biodiesel kt	Diesel oil kt	CNG kt	Biodiesel kt
2000	956.0	0.0	41.2	346.1	2.0	20.6
2001	1065.7	0.0	30.6	385.9	2.0	15.3
2002	1131.5	0.0	42.9	409.7	4.8	21.5
2003	1314.2	0.0	41.2	475.8	4.3	20.6
2004	1421.9	0.0	21.2	514.8	2.3	10.6
2005	1623.4	0.0	1.8	587.8	2.2	0.9
2006	1655.7	0.0	11.8	599.5	2.1	5.9
2007	1708.5	0.1	20.0	618.6	2.4	10.0
2008	1669.4	0.1	39.8	604.4	2.7	14.4
2009	1580.0	0.1	70.6	572.1	2.9	25.6
2010	1483.8	0.3	88.1	537.2	2.9	31.9
2011	1463.4	0.3	119.5	529.9	3.0	43.3
2012	1448.6	0.3	107.1	524.5	3.2	38.8
2013	1449.9	0.4	107.7	525.0	3.9	39.0
2014	1496.1	0.6	119.0	541.7	5.6	43.1
2015	1566.3	0.9	108.8	567.1	8.6	39.4

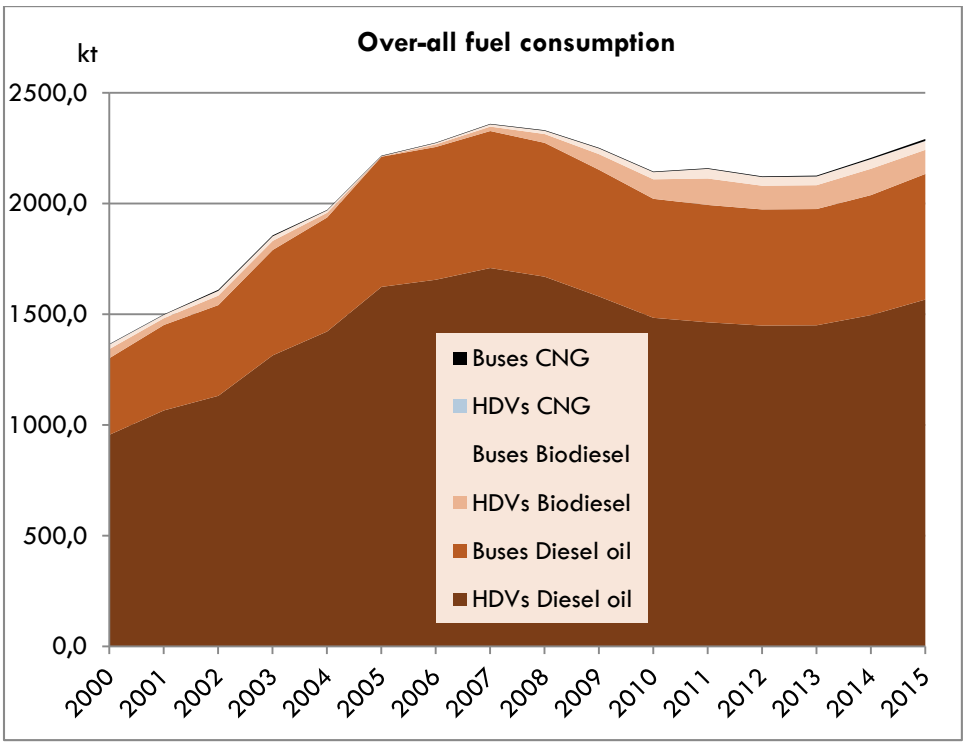

Figure 3-23 Fuel consumption by HDVs and Buses LDVs in 2000–2015

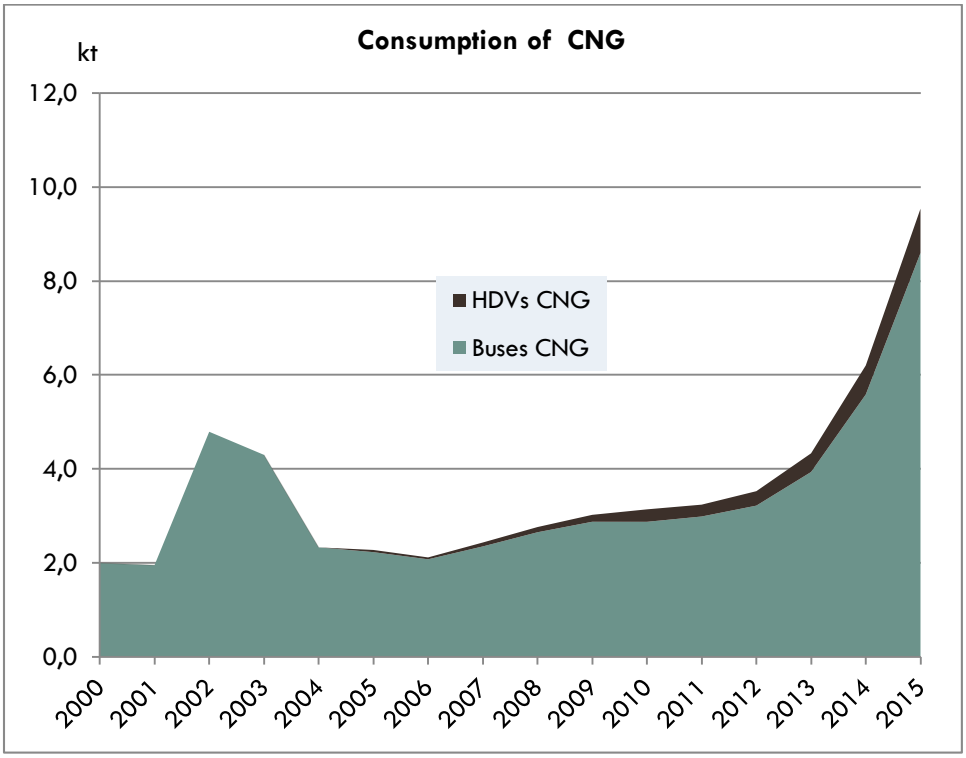

Figure 3-24 Fuel consumption by HDVs and Buses LDVs in 2000–2015

3.6.2.7.2 Emission factors

Emissions of heavy metals, PAHs, PCDD and PCDF from HDVs and buses are estimated according to diesel oil emission factors (see Table 3-31). There is no data to make estimations of EFs from other fuels in the Czech Republic up to the present. In the next submission this will be improved by introducing COPERT 5.

Table 3-25 EF method for HDVs and buses

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
HDVs and Buses	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**
	CS	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*
	PCDD/ PCDF (dioxines/ furanes)	**PAHs**				**PCBs**			
		benzo(a) pyrene	**benzo(b) fluoranthene**	**benzo(k) fluoranthene**	**Indeno (1,2,3-cd) pyrene**				
	Tier 2	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 2*			

Table 3-26 EF for HDVs and buses for main pollutants in $g.kg^{-1}$ in the current year

Fuel type	*European emission standard*	*CO*	*NOx*	*NMVOC*	*SOx*	*Pb*	*TSP*	*NH_3*
Diesel oil	***PRE-EURO***	*221,2*	*93,4*	*41,1*	*0,02*	*0,00*	*6,21*	*0,012*
Diesel oil	***HDV EURO I and EURO II***	*19,3*	*18,5*	*8,1*	*0,02*	*0,00*	*1,36*	*0,012*
Diesel oil	***HDV EURO III and higher***	*7,3*	*8,1*	*2,7*	*0,02*	*0,00*	*0,41*	*0,012*
CNG	***HDV PRE-EURO and higher***	*6,7*	*1,0*	*26,4*	*0,00*	*0,00*	*0*	*0,000*
Biodiesel	***HDV PRE-EURO and higher***	*15,8*	*12,3*	*3,8*	*0,02*	*0,00*	*1,05*	*0,010*
Diesel oil	***BUS EURO II and older***	*39,3*	*35,4*	*6,5*	*0,02*	*0,00*	*3,77*	*0,012*
Diesel oil	***BUS EURO III and higher***	*6,0*	*11,3*	*1,9*	*0,02*	*0,00*	*0,28*	*0,012*
CNG	***BUS PRE-EURO and higher***	*6,7*	*1,0*	*3,8*	*0,02*	*0,00*	*0*	*0,000*
Biodiesel	***BUS PRE-EURO and higher***	*15,8*	*12,3*	*3,8*	*0,02*	*0,00*	*1,05*	*0,010*

Table 3-27 EF for HDVs and buses for other pollutants in the current year

Pollutant		*HDV and Bus* ***All***
Cd	*$ug.kg^{-1}$ of fuel*	*8,7*

Pollutant		HDV and Bus **All**
Cr	ug.kg^{-1} of fuel	30
Cu	ug.kg^{-1} of fuel	21,2
Ni	ug.kg^{-1} of fuel	8,8
Se	ug.kg^{-1} of fuel	0,1
Zn	ug.kg^{-1} of fuel	1738
As	ug.kg^{-1} of fuel	0,1
Hg	ug.kg^{-1} of fuel	5,3
PCDD	pg I-Teq.kg^{-1}fuel	45,8
PCDF	pg I-Teq.kg^{-1}fuel	69,7
PCBs	ug.kg^{-1} of fuel	22,9
B(a)P	ug.kg^{-1} of fuel	5,1
B(b)F	ug.kg^{-1} of fuel	30,8
B(k)F	ug.kg^{-1} of fuel	34,4
ID(1,2,3-cd)P	ug.kg^{-1} of fuel	7,9

3.6.2.7.3 Emissions

All pollutants show decreasing trend with less significant declines in last years. There is a slightly different situation for SO_2 and NH_3 emissions (see the explanation of this in chapters above). TSP trend between emissions from fuel combustion and from abrasion of tyre, break and road is similar as described in previous categories of road transport.

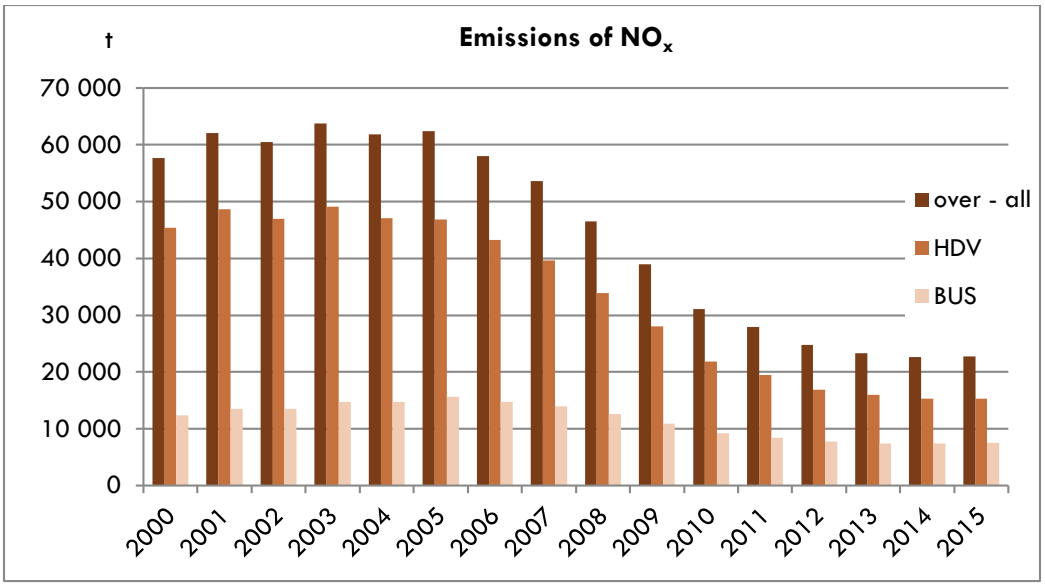

Figure 3-25 Emissions from HDVs and buses in 2000–2015

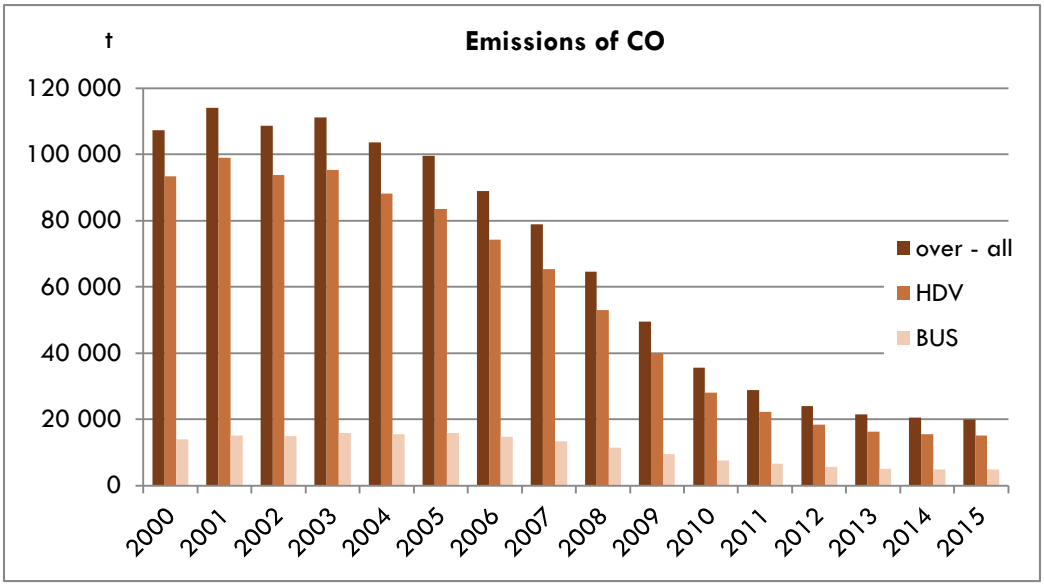

Figure 3-26 Emissions from HDVs and buses in 2000–2015

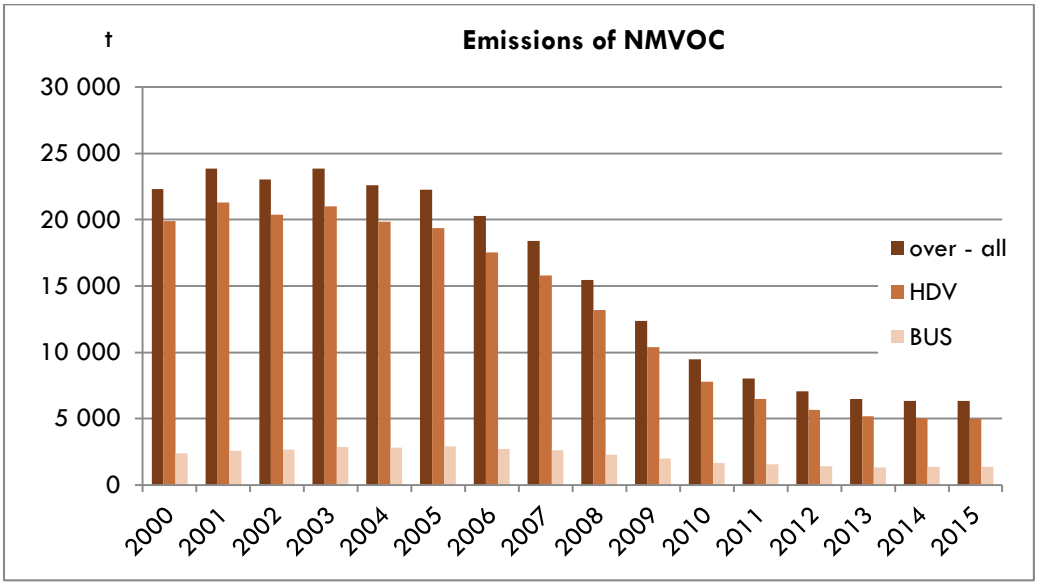

Figure 3-27 Emissions from HDVs and buses in 2000–2015

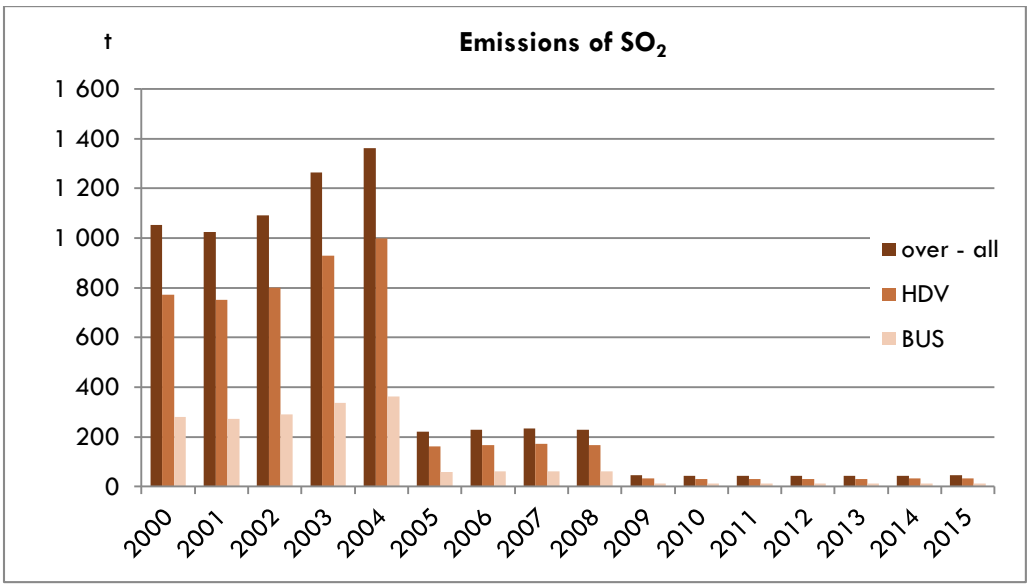

Figure 3-28 Emissions from HDVs and buses in 2000–2015

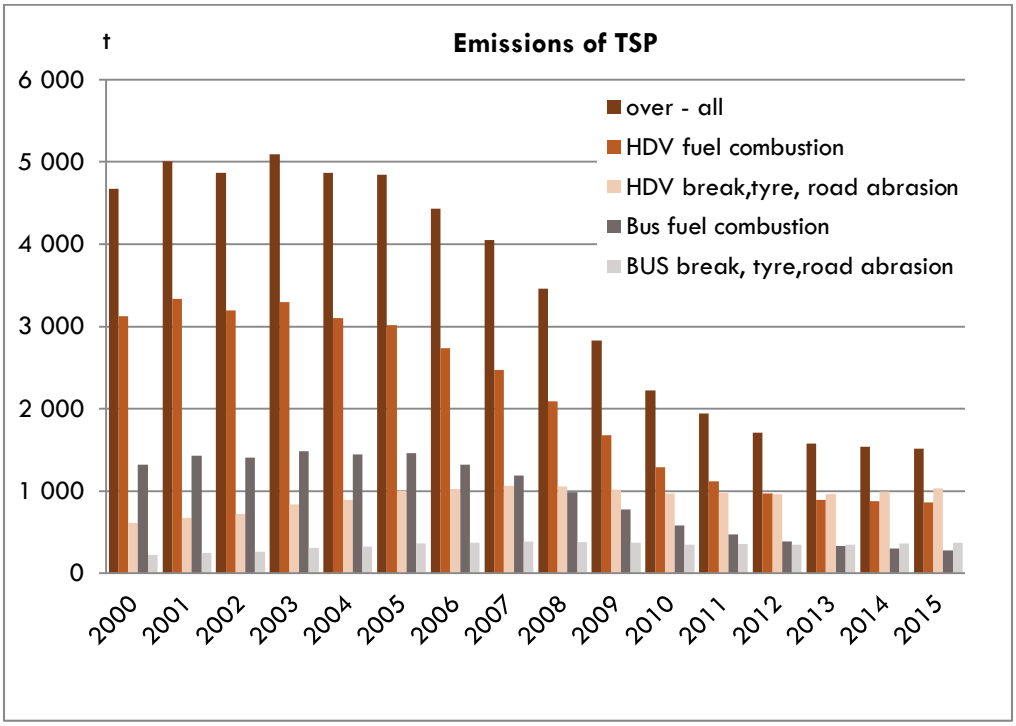

Figure 3-29 Emissions from HDVs and buses in 2000–2015

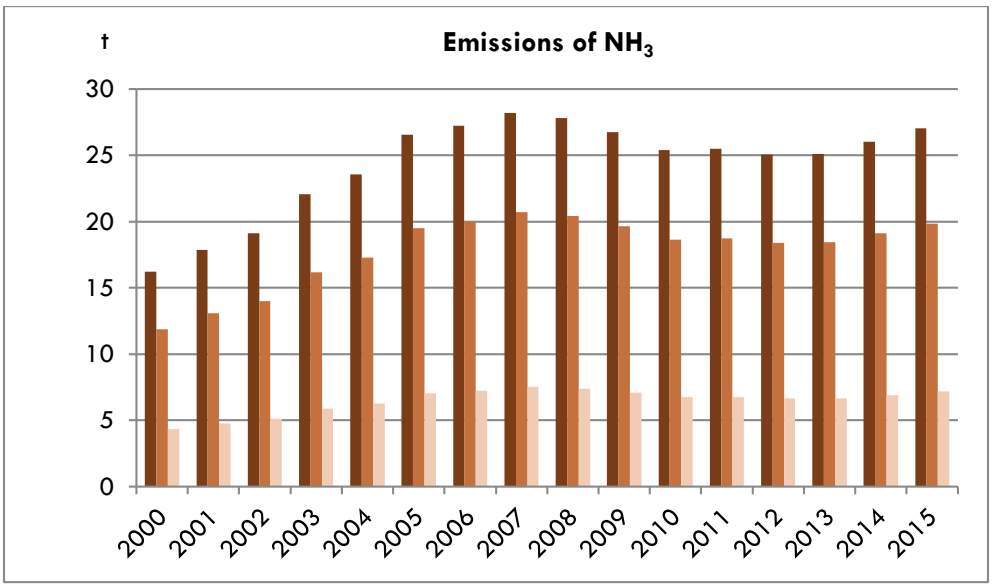

Figure 3-30 Emissions from HDVs and buses in 2000–2015

3.6.2.8 1.A.3.b iv Mopeds and Motorcycles

3.6.2.8.1 Activity data

The following table and charts provide an overview of annual amounts of gasoline fuels consumed by motorized two-wheelers in the Czech Republic.

Table 3-28 Fuel consumption of two-wheelers

Year	Gasoline	Bioethanol
	kt	kt
2000	10.4	0.0
2001	10.9	0.0
2002	11.4	0.0
2003	12.9	0.0
2004	13.3	0.0
2005	13.3	0.0
2006	13.3	0.0
2007	14.3	0.0
2008	14.1	0.4

2009	14.0	0.7
2010	13.0	0.7
2011	12.8	0.7
2012	12.3	0.7
2013	11.8	0.7
2014	11.9	0.8
2015	12.3	0.8

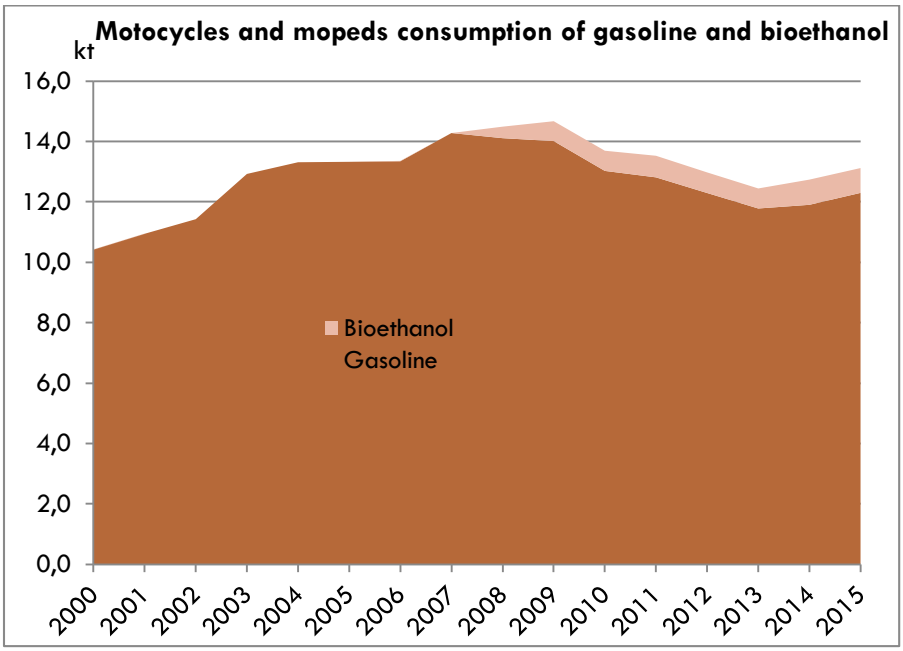

Figure 3-31 Fuel consumption of two - wheelers in 2000–2015

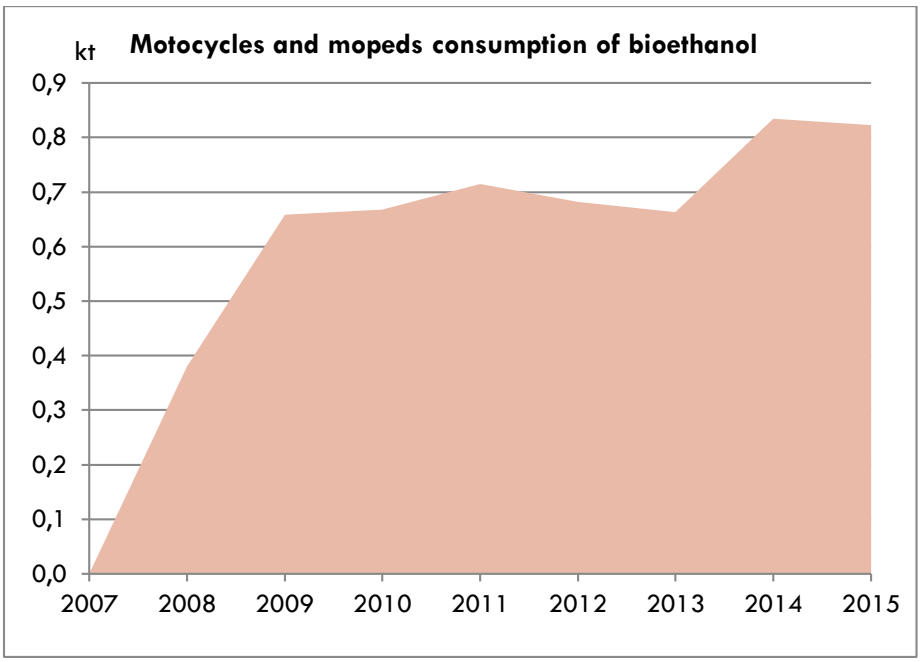

Figure 3-32 Fuel consumption of two - wheelers in 2000–2015

3.6.2.8.2 Emission factors

Table 3-29 EF method of two - wheelers

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Two wheelers	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*	*CS*
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**
	CS	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*
	PCDD/ PCDF (dioxines/ furanes)	**PAHs**				**PCBs**			
		benzo(a) pyrene	**benzo(b) fluoranthene**	**benzo(k) fluoranthene**	**Indeno (1,2,3-cd) pyrene**				
	Tier 2	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 2*			

Table 3-30 EF of two-wheelers for main pollutants in $g.kg^{-1}$ of fuel in the current year

Fuel type	*European emission standard*	*CO*	*NOx*	*NMVOC*	*SOx*	*Pb*	*TSP*	*NH_3*
Gasoline	***PRE-EURO and higher***	*59,7*	*36,9*	*22,4*	*0,01*	*0,0005*	*2,20*	*0,070*

Table 3-31 EF of two-wheelers used for other pollutants in the current year

Pollutant		Gasoline
Cd	ug.kg^{-1} of fuel	10,8
Cr	ug.kg^{-1} of fuel	16
Cu	ug.kg^{-1} of fuel	42,0
Ni	ug.kg^{-1} of fuel	13,0
Se	ug.kg^{-1} of fuel	0,2
Zn	ug.kg^{-1} of fuel	2163
As	ug.kg^{-1} of fuel	0,3
Hg	ug.kg^{-1} of fuel	8,7
PCDD	pg I-Teq.kg^{-1}fuel	211,4
PCDF	pg I-Teq.kg^{-1}fuel	240,5
PCBs	ug.kg^{-1} of fuel	230,4
B(a)P	ug.kg^{-1} of fuel	8,4
B(b)F	ug.kg^{-1} of fuel	9,4
B(k)F	ug.kg^{-1} of fuel	6,8
ID(1,2,3-cd)P	ug.kg^{-1} of fuel	10.2

3.6.2.8.3 Emissions

Emissions from two – wheelers follow fuel consumption trend. SO_2 emissions are significantly influenced by a quality of fuel. TSP emissions show different trend compared to other road transport categories. TSP emissions from fuel combustion are much higher compared with those of tyre, break and road abrasion. This is caused by different degree of technological development of engines in proportion to other categories.

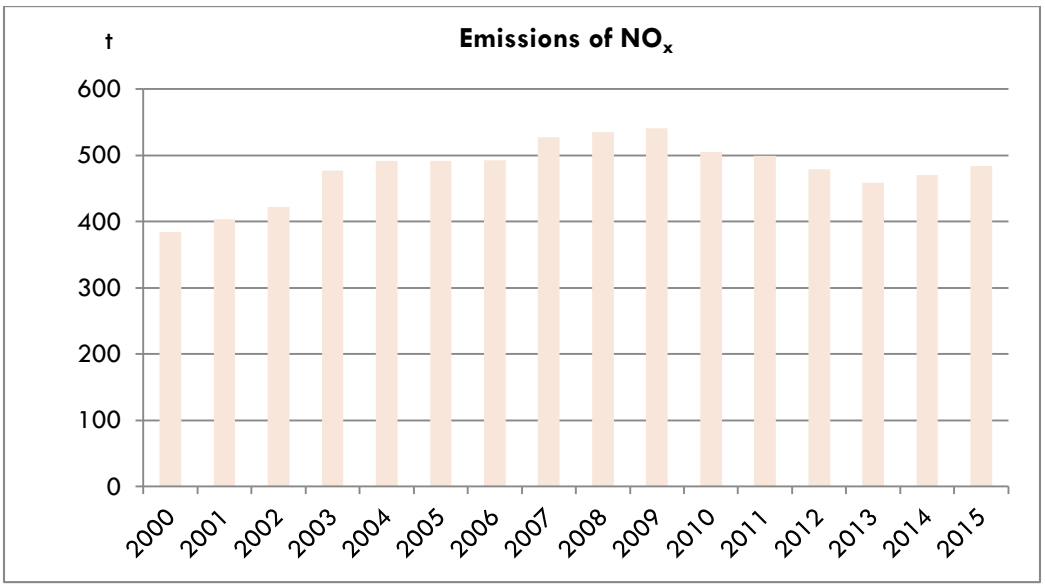

Figure 3-33 Emissions from two - wheelers in 2000–2015

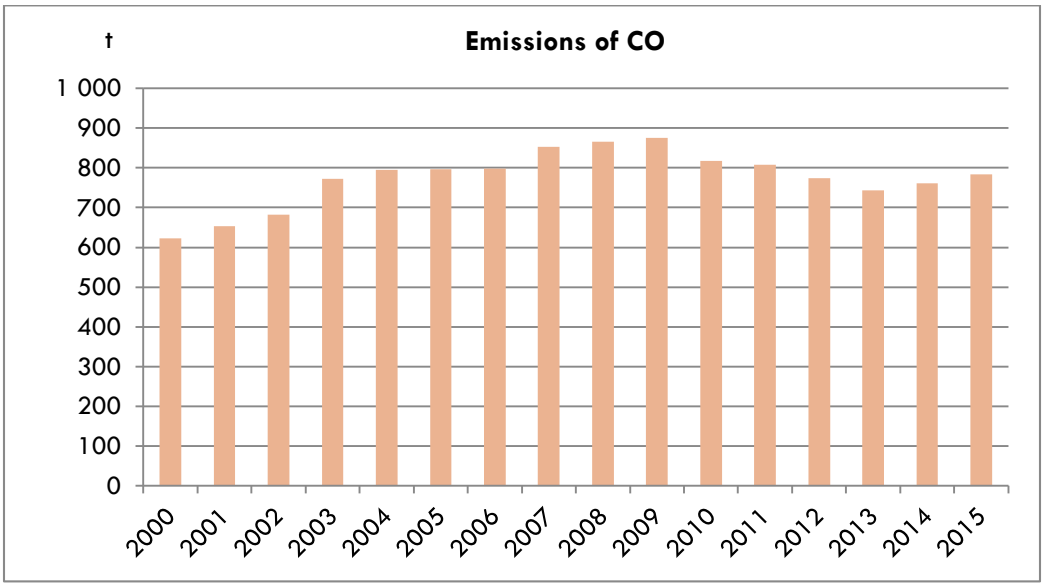

Figure 3-34 Emissions from two - wheelers in 2000–2015

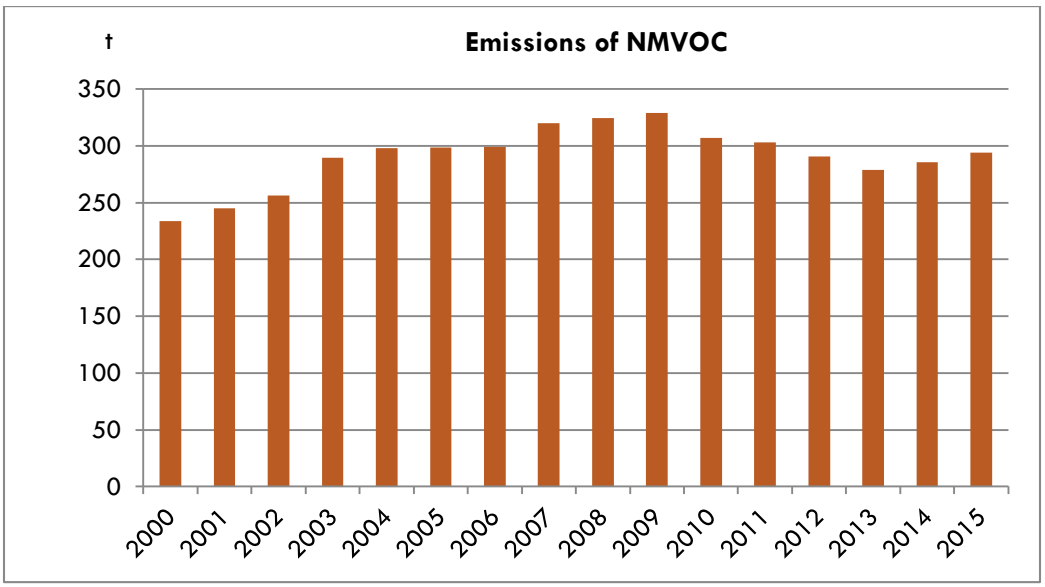

Figure 3-35 Emissions from two - wheelers in 2000–2015

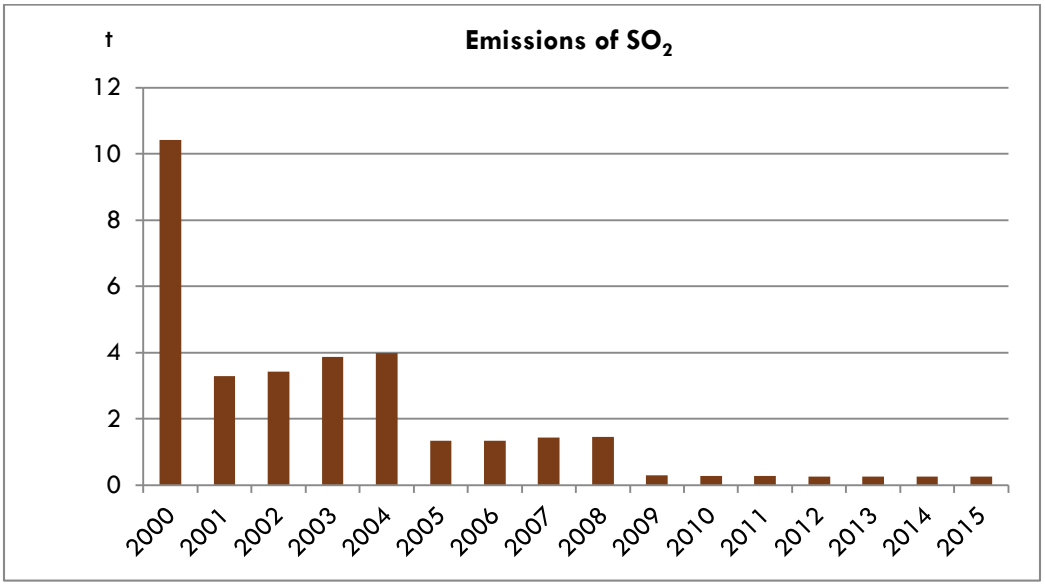

Figure 3-36 Emissions from two-wheelers in 2000–2015

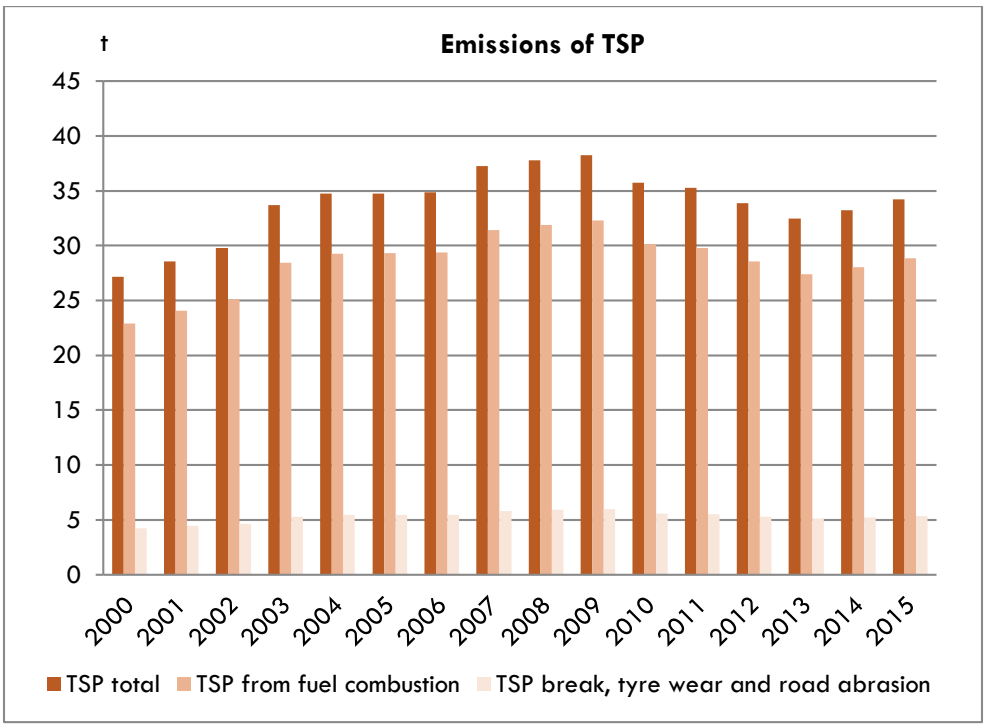

Figure 3-37 Emissions from two-wheelers in 2000–2015

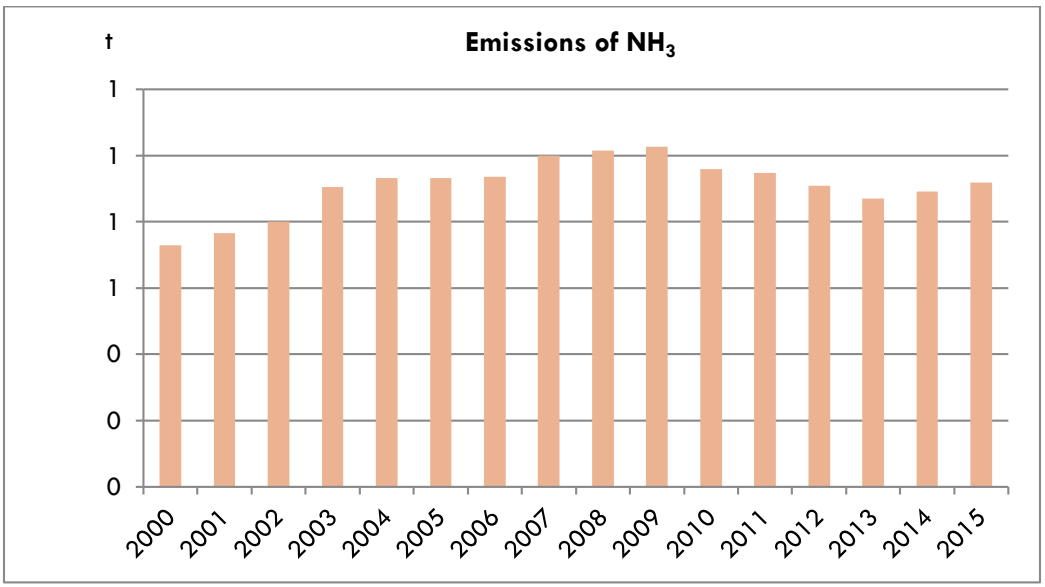

Figure 3-38 Emissions from two-wheelers in 2000–2015

3.6.2.9 1.A.3.b vi Automobile tyre and brake wear and 1.A.3.b vii Automobile road abrasion

3.6.2.9.1 Method

Calculations of emissions from automobile tyre, break and road abrasion are made on basis of consumptions of these two fuels: gasoline + bioethanol and diesel oil + biodiesel. Other fuels account only for a very small share of activity data and therefore they are not considered in estimates regarding these emissions.

3.6.2.9.2 Activity data

Table 3-32 Fuel consumption according to modes of transport

Year	Two wheelers	PCs + LDVs gasoline	PCs + LDVs diesel oil	HDVs + Bus diesel oil	Total consumption
	kt	kt	kt	kt	kt
2000	10.4	1834.6	438.9	1302.1	3586.0
2001	10.9	1877.1	516.5	1451.5	3856.0
2002	11.4	1896.6	591.8	1541.2	4041.0
2003	12.9	2071.1	734.9	1790.1	4609.0
2004	13.3	2063.7	835.2	1936.8	4849.0
2005	13.3	2025.7	1016.9	2211.1	5267.0
2006	13.3	1980.7	1114.1	2255.2	5363.3
2007	14.3	2066.7	1230.8	2327.2	5639.0
2008	14.1	1986.9	1287.1	2273.9	5562.0
2009	14.0	1922.0	1292.9	2152.1	5381.0
2010	13.0	1742.0	1279.9	2021.1	5056.0
2011	12.8	1671.2	1324.7	1993.3	5002.0
2012	12.3	1556.7	1382.8	1973.2	4925.0
2013	11.8	1462.2	1431.1	1974.9	4880.0
2014	11.9	1443.1	1532.3	2037.7	5025.0
2015	12.3	1452.7	1665.6	2133.4	5264.0

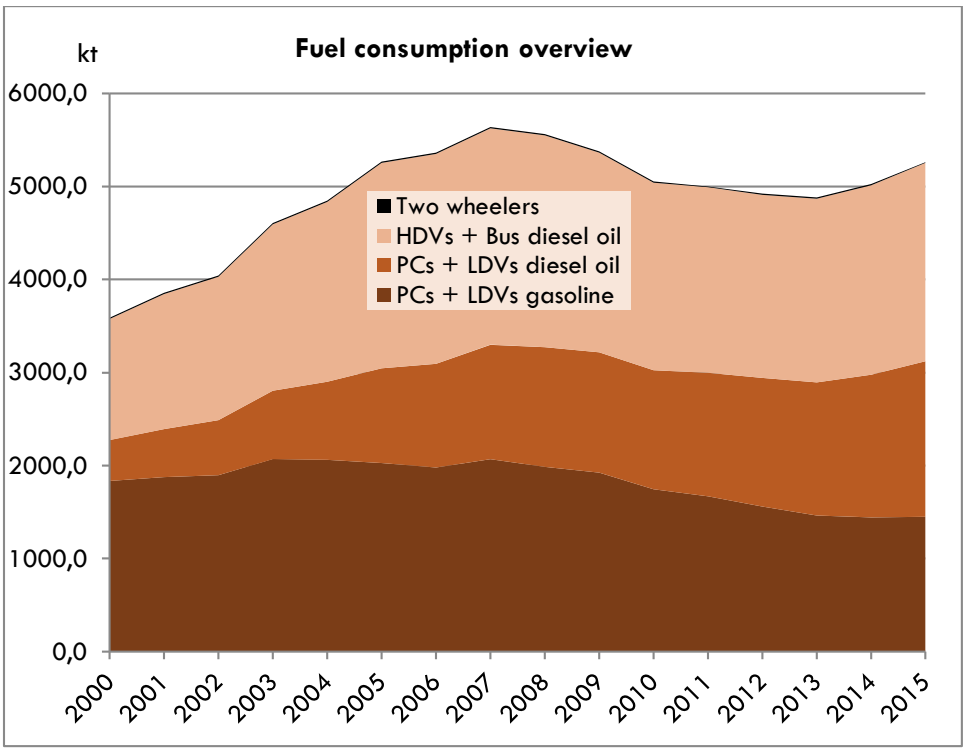

Figure 3-39 Overview of fuel consumption by modes of transport in 2000–2015

3.6.2.9.3 Emission factors

Calculations of emissions from automotive tyre, break wear and road abrasion of PM and PAHs are made according to the EIG - Tier 2 in units of g.km^{-1}. Tier 2 EFs were converted to g.kg^{-1} via the average Tier 1 fuel consumption (g.km^{-1}) from EIG. These emissions are based on fuel consumption. Heavy metals from automobile tyre and break wear are derived on basis of emission factors published in the EIG 2016 in units (ug.km^{-1}). There are no emission factors of road abrasion stated in the EIG 2016. This is the reason why they were converted to ug.kg^{-1} of fuel and calculated on basis of Denmark emission factors (Winther and Slentø 2010) and based on mileage derived from official OECD data. EFs are in g.km^{-1}. BC is estimated on basis of share of PM (EIG, Tier 1).

Table 3-33 EF method used for automobile tyre, break wear and road abrasion

Pollutant	Method of Efs		
	Tyre	Break	Road
PM 2.5	Tier 2	Tier 2	Tier 2
PM 10	Tier 2	Tier 2	Tier 2
TSP	Tier 2	Tier 2	Tier 2
BC (Tyre+Break)	Tier 1	Tier 1	NR
B(a)P	Tier 2	Tier 2	NR
B(b)F	Tier 2	Tier 2	NR
B(k)F	Tier 2	Tier 2	NR
I(1,2,3-cd)P	Tier 2	Tier 2	NR

Pollutant	Method of Efs		
	Tyre	Break	Road
Pb	Tier 2	Tier 2	Tier 2
Cd	Tier 2	Tier 2	NR
Hg	NR	NR	NR
As	Tier 2	Tier 2	NR
Cr	Tier 2	Tier 2	Tier 2
Cu	Tier 2	Tier 2	Tier 2
Ni	Tier 2	Tier 2	Tier 2
Se	Tier 2	Tier 2	NR
Zn	Tier 2	Tier 2	Tier 2

Table 3-34 EFs used for automobile tyre, break wear and road abrasion regarding main pollutants in $g.kg^{-1}$ in the current year

Automotive Tyre					
Pollutant	Unit	Gasoline*		Diesel Oil*	
		Two - wheelers	PCs + LDVs	PCs + LDVs	HDVs + Buses
PM 2.5	$g.kg^{-1}$	0.055	0.064	0.078	0.069
PM 10	$g.kg^{-1}$	0.079	0.092	0.112	0.098
TSP	$g.kg^{-1}$	0.131	0.153	0.187	0.164
BC (Tyre+Break)	% PM	0.11	0.12	0.57	0.53
B(a)P	$ug.kg^{-1}$	0.513	0.596	0.728	0.639
B(b)F	$ug.kg^{-1}$	0.000	0.000	0.000	0.000
B(k)F	$ug.kg^{-1}$	0.000	0.000	0.000	0.000
I(1,2,3-cd)P	$ug.kg^{-1}$	0.000	0.000	0.000	0.000
Automotive Break wear					
PM 2.5	$g.kg^{-1}$	0.041	0.042	0.051	0.053
PM 10	$g.kg^{-1}$	0.104	0.105	0.128	0.134
TSP	$g.kg^{-1}$	0.106	0.107	0.130	0.136
B(a)P	$ug.kg^{-1}$	0.078	0.079	0.096	0.101
B(b)F	$ug.kg^{-1}$	0.044	0.045	0.055	0.057
B(k)F	$ug.kg^{-1}$	0.066	0.066	0.081	0.085
I(1,2,3-cd)P	$ug.kg^{-1}$	0.000	0.000	0.000	0.000
Automotive Road abrasion					
PM 2.5	$g.kg^{-1}$	0.046	0.058	0.063	0.086
PM 10	$g.kg^{-1}$	0.086	0.107	0.117	0.158

Automotive Tyre					
TSP	g.kg-1	0.171	0.214	0.234	0.317
*Difference between Gasoline and Diesel Oil emission factor in PC+LDT category is caused by different PC/LDT ratio within every fuel category.					

Table 3-35 EFs used for automobile tyre, break wear and road abrasion regarding other pollutants in current year

Automotive Tyre						
Pollutant	Unit	Two - wheelers	PCs	LDVs	HDVs	Buses
Pb	ug.kg-1	23.1	26.9	32.8	28.8	28.8
Cd	ug.kg-1	0.6	0.7	0.9	0.8	0.8
Hg	ug.kg-1	N/A	N/A	N/A	N/A	N/A
As	ug.kg-1	0.5	0.6	0.7	0.6	0.6
Cr	ug.kg-1	3.1	3.6	4.4	3.9	3.9
Cu	ug.kg-1	22.9	26.6	32.5	28.5	28.5
Ni	ug.kg-1	3.9	4.6	5.6	4.9	4.9
Se	ug.kg-1	2.6	3.1	3.7	3.3	3.3
Zn	ug.kg-1	977.0	1136.3	1386.9	1218.0	1218.0
Automotive Break wear						
Pb	ug.kg-1	641.9	650.6	791.3	828.5	828.5
Cd	ug.kg-1	2.4	2.4	2.9	3.1	3.1
Hg	ug.kg-1	N/A	N/A	N/A	N/A	N/A
As	ug.kg-1	7.1	7.2	8.8	9.2	9.2
Cr	ug.kg-1	244.3	247.6	301.2	315.3	315.3
Cu	ug.kg-1	5403.3	5476.3	6660.5	6974.2	6974.2
Ni	ug.kg-1	34.6	35.0	42.6	44.6	44.6
Se	ug.kg-1	2.1	2.1	2.6	2.7	2.7
Zn	ug.kg-1	917.2	929.6	1130.6	1183.8	1183.8
Automotive Road abrasion						
Pb	ug.kg-1	8.6	10.0	10.9	15.0	16.0
Cd	ug.kg-1	N/A	N/A	N/A	N/A	N/A
Hg	ug.kg-1	N/A	N/A	N/A	N/A	N/A
As	ug.kg-1	N/A	N/A	N/A	N/A	N/A
Cr	ug.kg-1	2.9	4.3	4.7	6.3	6.3
Cu	ug.kg-1	2.9	1.4	1.6	3.3	3.3
Ni	ug.kg-1	2.9	2.9	3.1	5.0	5.0
Se	ug.kg-1	N/A	N/A	N/A	N/A	N/A
Zn	ug.kg-1	14.3	15.7	17.2	23.8	24.8

3.6.2.9.4 Emissions

All reported emissions from tyre, brake wear and road abrasion are connected directly to activity data.

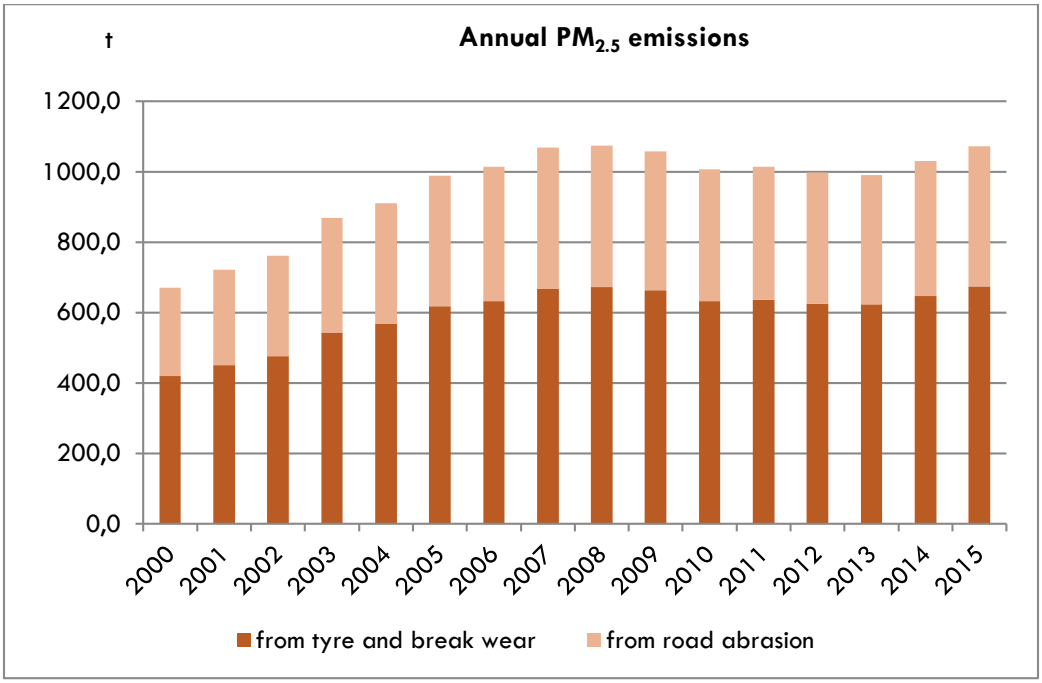

Figure 3-40 Emissions from automotive tyre, brake wear and road abrasion in 2000–2015

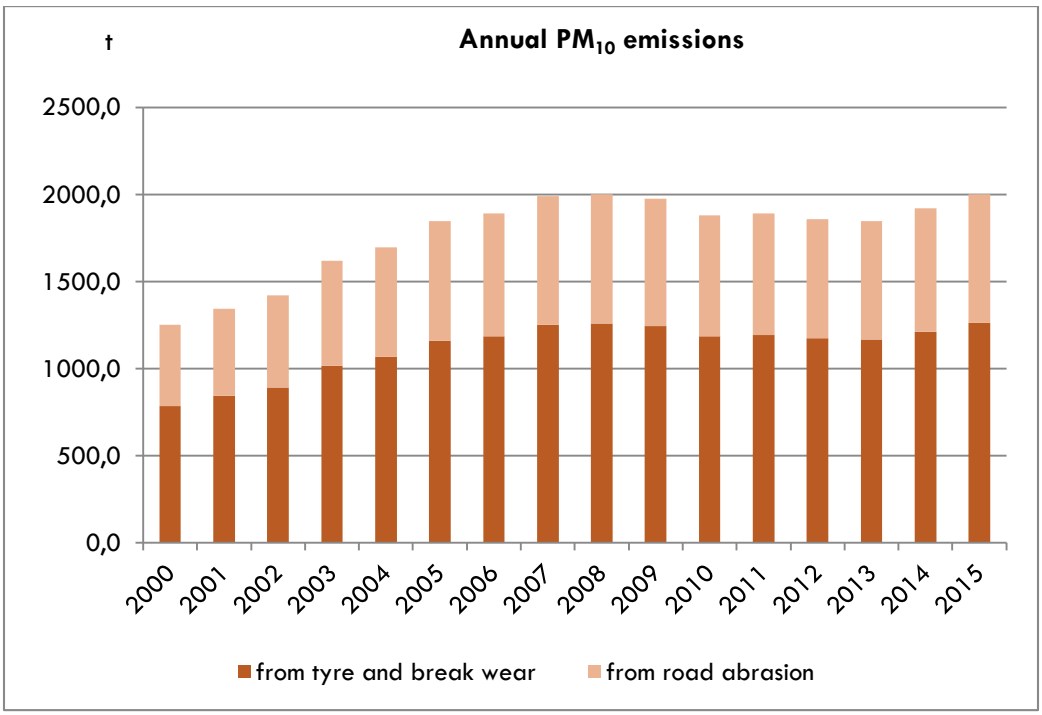

Figure 3-41 Emissions by automotive tyre, brake wear and road abrasion in 2000–2015

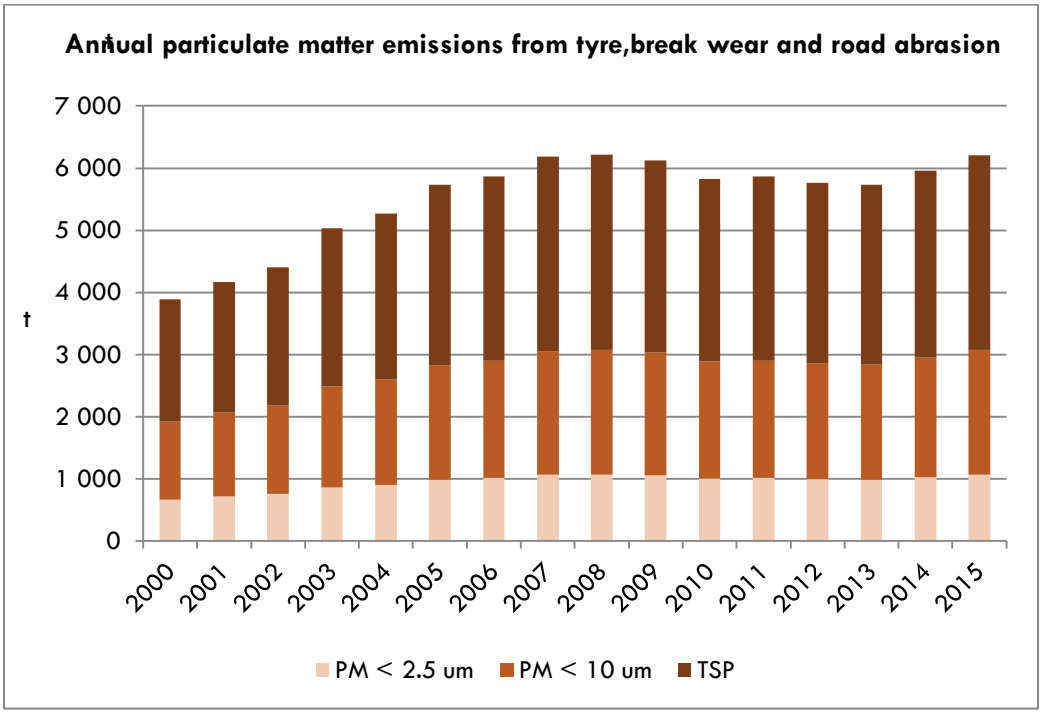

Figure 3-42 Emissions from automotive tyre, brake wear and road abrasion in 2000–2015

3.6.2.10 1.A.3.b.v Gasoline evaporation

VOC emissions in the category 1.A.3.b.v of road transport took also into consideration gasoline evaporation and were estimated by the model COPERT. To estimate these emissions, statistical data regarding the number of passenger vehicles and vehicles with or without integrated catalytic converters were used. See shares of individual categories in the period 2000–2015 in the table.

3.6.3 1.A.3.c Railways

3.6.3.1 Method

The Czech railway sector is undergoing a long-term modernization process. The aim is to make electricity the main energy source for rail transports. Use of electricity, instead of diesel fuel, to power locomotives has been continually increasing and electricity now provides 86 % of all railway traffic volumes. Energy consumption share of locomotives powered by electricity is 54 %. Railways' power stations for generation of traction current are allocated to the stationary component of the energy sector (1.A.1.a) and are not included in further text. In energy inputs used by trains, diesel fuel is the only energy source that plays a significant role apart from electric power.

3.6.3.2 Activity data

Regular railway operation use only diesel oil. Coal is used solely within historical rides and the percentage of its consumption is negligible. In general, fuel consumption by railways has a slight decreasing trend from 2000. The only exception is the period 2006–2008. After this, the increase stopped because of economic crisis and replacement of diesel powered locomotives by electric ones.

Table 3-36 Fuel consumption by railways

Year		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Diesel Oil consumption	kt	104	97	94	92	91	92	96	95	105	95	92	90	87	85	86	83

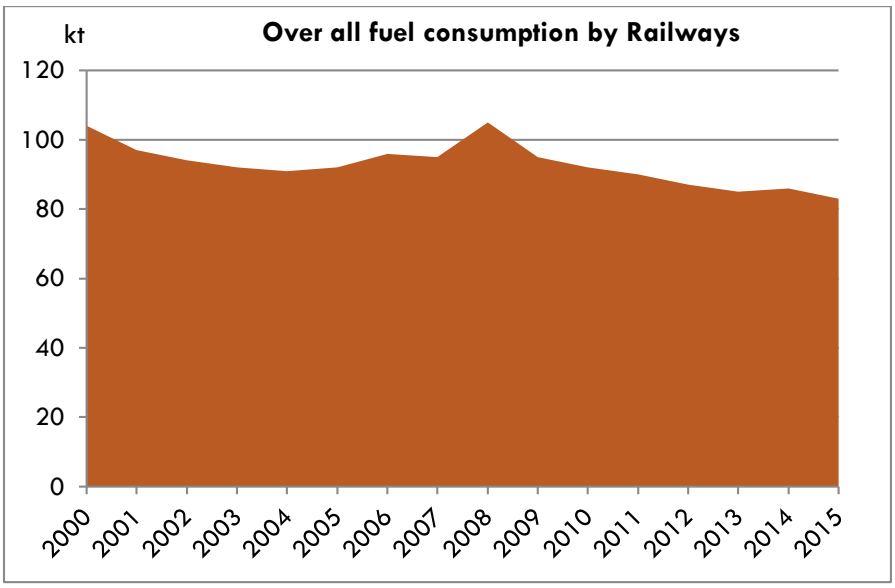

Figure 3-43 Overview of fuel consumption by railways in 2000–2015

3.6.3.3 Emission factors

Emission factors for benzo(k)fluoranten and Indeno(1,2,3cd)pyrenare are not stated in a corresponding EIG. According recommendation from the EIG, HDVs Tier 1 EFs are used for railway.

Table 3-37 EF method used for railways

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
PCs and LDVs	CS	CS	CS	CS	CS	CS	CS	CS	CS
	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
	PCDD/ PCDF (dioxines/ furanes)	PAHs				PCBs			
		benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene				
	NR	Tier 1	Tier 1	Tier 1	Tier 1	NR			

Table 3-38 EFs used for railways regarding main pollutants in $g.kg^{-1}$ in the current year

Fuel type	CO	NOx	NMVOC	SOx	Pb	TSP	NH_3
Diesel Oil	19,7	33,9	4,7	0,02	0,00	2,6	0,012

Table 3-39 EFs used for railways regarding other pollutants in the current year

Pollutant		Diesel Oil
Cd	ug.kg^{-1} of fuel	8,7
Cr	ug.kg^{-1} of fuel	30
Cu	ug.kg^{-1} of fuel	21,2
Ni	ug.kg^{-1} of fuel	8,8
Se	ug.kg^{-1} of fuel	0,1
Zn	ug.kg^{-1} of fuel	1738
As	ug.kg^{-1} of fuel	0,1
Hg	ug.kg^{-1} of fuel	5,3
B(a)P	ug.kg^{-1} of fuel	30
B(b)F	ug.kg^{-1} of fuel	50
B(k)F	ug.kg^{-1} of fuel	37,2
ID(1,2,3-cd)P	ug.kg^{-1} of fuel	8,6

3.6.3.4 Emissions

Emissions from railways are strongly dependent on fuel consumption. The only exception are SO_2 emissions strongly dependent on increasing quality of fuel. Thank to lowered content of sulphur, there is observed a cascaded downward trend here which is only slightly influenced by increases in fuel consumption. Regarding heavy metals, the specific emission trends reflect the trend of diesel oil consumption, because at present, emission factors are applied only for diesel oil.

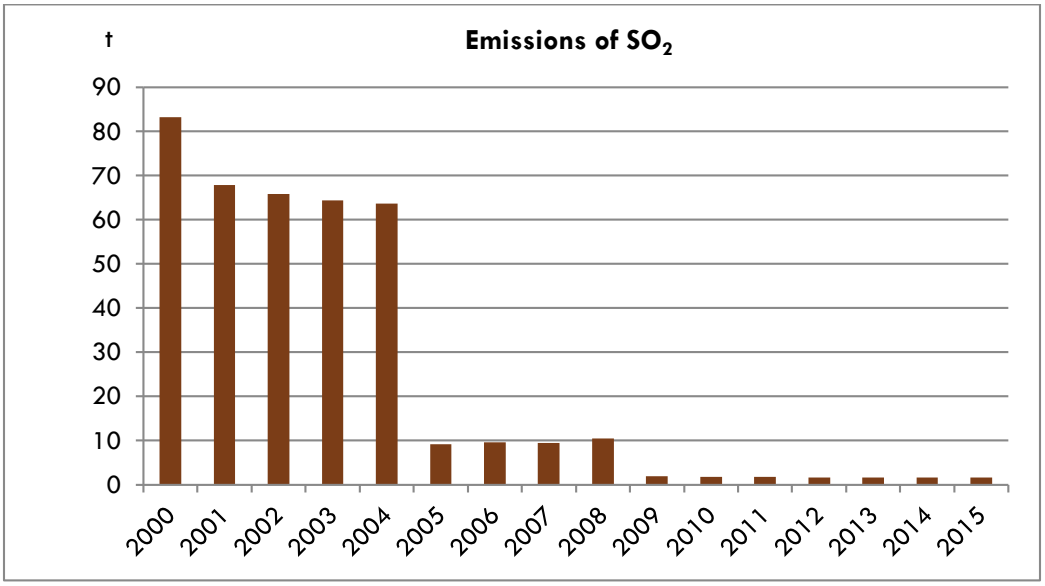

Figure 3-44 Emissions by railways in 2000–2015

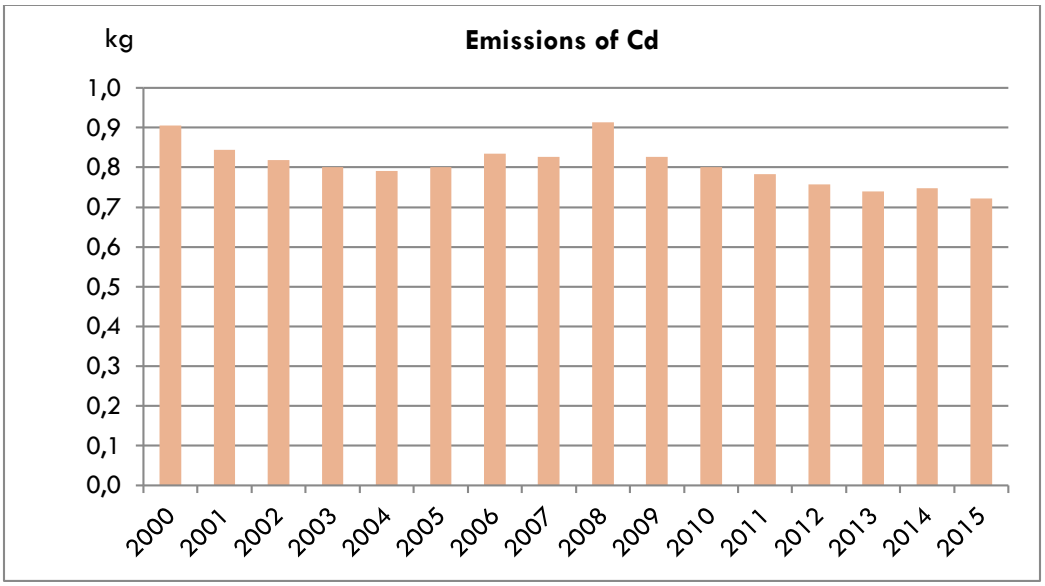

Figure 3-45 Emissions by railways in 2000–2015

3.6.3.5 Uncertainties

Uncertainties for railways were calculated according to the EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainties given here have been evaluated for all of time series (2000–2015) and for all reported categories. The total combine uncertainty of national emissions from railways is ± 33.49 %. Uncertainty in activity data is up to 5 % and in EFs ranges from 50 up to 200 %. Especially heavy metals, NH_3 and PAHs have less reliable EFs.

3.6.4 1.A.3.d Navigation

3.6.4.1 Method

Primary data on fuels available via the CZSO or other statistics do not allow a differentiation into national and international inland navigation on inland waterways in the Czech Republic. Therefore, for the time being, all activity data are allocated to NFR 1.A.3.d ii - National Navigation (Shipping) and to the sub-sector of 1.A.3.d ii (b) - National inland navigation.

3.6.4.2 Activity data

Fuel consumption by national navigation is very low (see Table 3-44). The CZSO provides only data regarding diesel oil consumption within recreational fleet, which basically represent most of fuel consumption by national navigation in the Czech Republic. The Czech merchant fleet doesn´t exist.

Table 3-40 Fuel consumption by inland navigation

Year		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fuel consumption	kt	5	8	4	4	6	5	6	5	4	5	4	3	5	2	3	4

3.6.4.3 Emission factors

Emission factors used for heavy metals and PAHs are not stated in the EIG. HDVs Tier 1 EFs are used for inland navigation. EFs are only applied to diesel oil owing to lack of data.

Table 3-41 EF method used for inland navigation

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
PCs and LDVs	CS	CS	CS	CS	CS	CS	CS	CS	CS
	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
	PCDD/PCDF(dioxines/ furanes)	PAHs				PCBs			
		benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene				
	NR	Tier 1	Tier 1	Tier 1	Tier 1	NR			

Table 3-42 EF used for inland navigation regarding main pollutants in $g.kg^{-1}$ in the current year

Fuel type	CO	NOx	NMVOC	SOx	Pb	TSP	NH_3
Diesel Oil	19,7	33,9	4,7	0,02	0,00	2,6	0,012

Table 3-43 EF used for inland navigation regarding other pollutants in the current year

Pollutant		Diesel Oil
Cd	ug.kg-1 of fuel	8,7
Cr	ug.kg-1 of fuel	30
Cu	ug.kg-1 of fuel	21,2
Ni	ug.kg-1 of fuel	8,8
Se	ug.kg-1 of fuel	0,1
Zn	ug.kg-1 of fuel	1738
As	ug.kg-1 of fuel	0,1

Hg	*ug.kg-1 of fuel*	*5,3*
B(a)P	*ug.kg-1 of fuel*	*30*
B(b)F	*ug.kg-1 of fuel*	*50*
B(k)F	*ug.kg-1 of fuel*	*37,2*
ID(1,2,3-cd)P	*ug.kg-1 of fuel*	*8,6*

3.6.4.4 Emissions

Emissions from national inland navigation are strongly dependent on fuel consumption. The only exceptions are SO_2 emissions strongly dependent on increasing quality of fuel. Thank to lowered content of sulphur, there is observed a cascaded downward trend here which is only slightly influenced by increases in fuel consumption. Regarding heavy metals, the specific emission trends reflect the trend of diesel oil consumption, because emission factors are applied only for diesel oil at present.

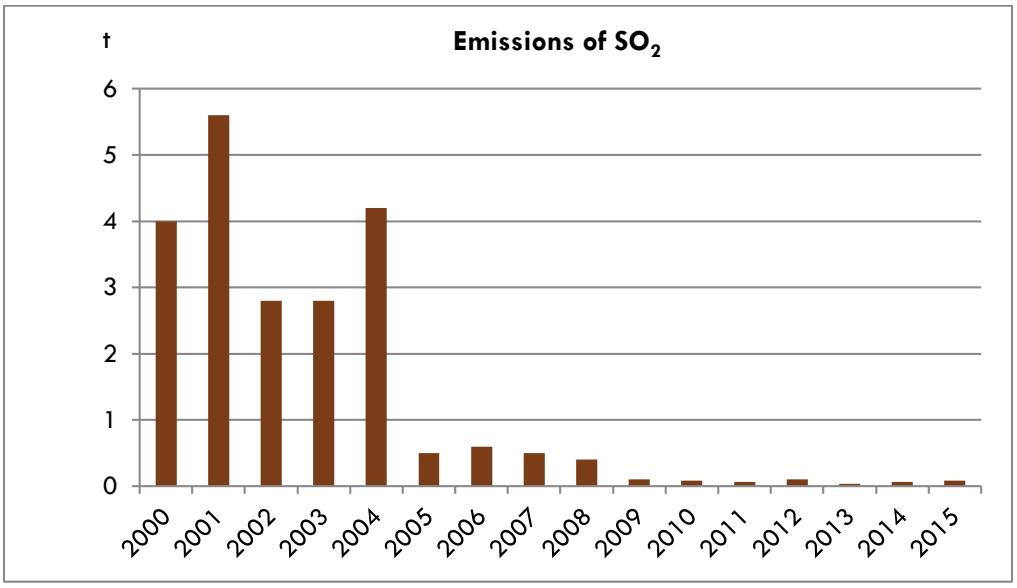

Figure 3-46 Emissions by national inland navigation in 2000–2015

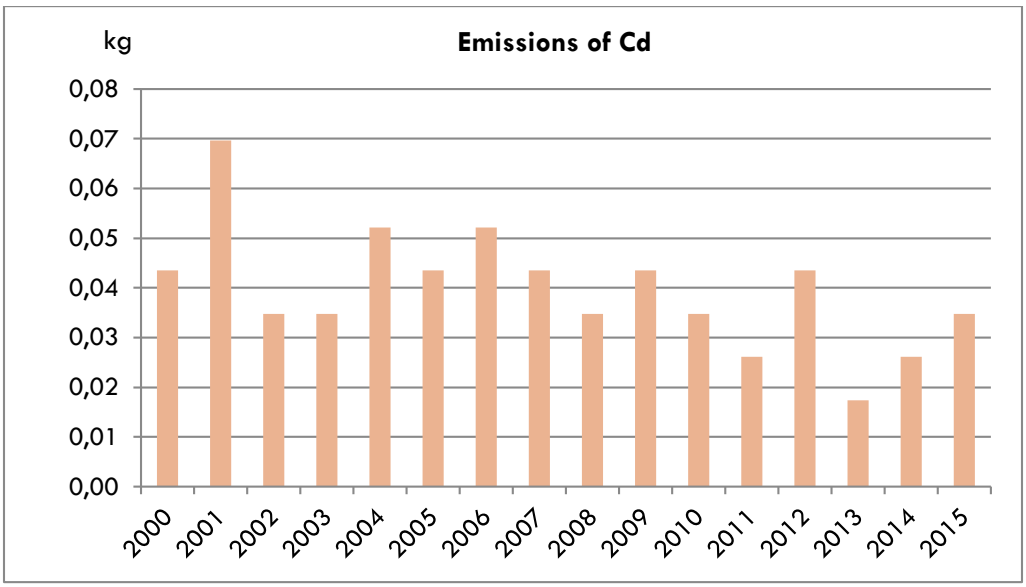

Figure 3-47 Emissions by national inland navigation in 2000–2015

3.6.4.5 Uncertainties

Uncertainty related to inland national navigation was calculated according to the EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainty given here has been evaluated for all of time series (2000–2015) and all reported categories. The total combine uncertainty of national emissions from national inland navigation is ± 34.43 % Uncertainty in activity data is to 5 % and in EFs it is from 50 to 200 %. Especially heavy metals, NH_3 and PAHs has less reliable EFs.

3.6.5 1.A.2.f ii Fuel Combustion Activities in Industries and Construction

3.6.5.1 Method

In this category are reported fuel combustion emissions of non - road mobile machinery in the construction and other industries e.g. excavators, caterpillars, loaders.

3.6.5.2 Activity data

Table 3-44 Fuel consumption by non - road mobile machinery in construction and industries

1 A 2 f ii	Year															
Diesel Oil kt	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	49.0	44.0	36.0	45.0	52.0	50.0	47.0	50.0	52.0	48.0	46.0	47.0	43.0	41.0	43.0	42.0

3.6.5.3 Emission factors

Emission factors are mainly used from the EIG. The exception are SO_x emissions based on country specific contents of pollutants in fuels.

Table 3-45 EF method used for non - road mobile machinery in the construction and other industries

Millitary Combustion	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	Tier 2	*Tier 2*	*CS*	*Tier 2*	*Tier 2*	*Tier 2*	*Tier 2*	*Tier 2*	*Tier 2*
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**
	CS	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*
	PCDD/ PCDF (dioxines/ furanes)	**PAHs**				**PCBs**			
		benzo(a) pyrene	**benzo(b) fluoranthene**	**benzo(k) fluoranthene**	**Indeno (1,2,3-cd) pyrene**				
	NR	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*NR*			

Table 3-46 EF used for non - road mobile machinery in the construction and other industries regarding main pollutants in $g.kg^{-1}$ in the current year

Sector	Fuel type	CO	NOx	NMVOC	SOx	Pb	TSP	NH_3
1 A 2 f ii	**Diesel Oil**	6.360	9.860	0.607	0.020	0.000	0.098	0.008

Table 3-47 EF used for non - road mobile machinery in the construction and other industries regarding other pollutants in the current year

Pollutant		1 A 2 f ii
		Diesel Oil
Cd	$ug.kg^{-1}$	10
Cr	$ug.kg^{-1}$	50
Cu	$ug.kg^{-1}$	1700
Ni	$ug.kg^{-1}$	70
Se	$ug.kg^{-1}$	10
Zn	$ug.kg^{-1}$	1000
As	$ug.kg^{-1}$	0.1
Hg	$ug.kg^{-1}$	5.3
B(a)P	$ug.kg^{-1}$	30
B(b)F	$ug.kg^{-1}$	50
B(k)F	$ug.kg^{-1}$	34.4
ID(1,2,3-cd)P	$ug.kg^{-1}$	21.2

3.6.5.4 Emissions

Emission trends of heavy metals from non-road mobile machinery in the construction and other industries are influenced mainly by a consumption of fuel and its quality. Emission trends of main pollutants are influenced by rising standards for small combustion mobile machinery. Also concerning SO_x emissions, the trend is influenced by variable quality of fuels (see figures below).

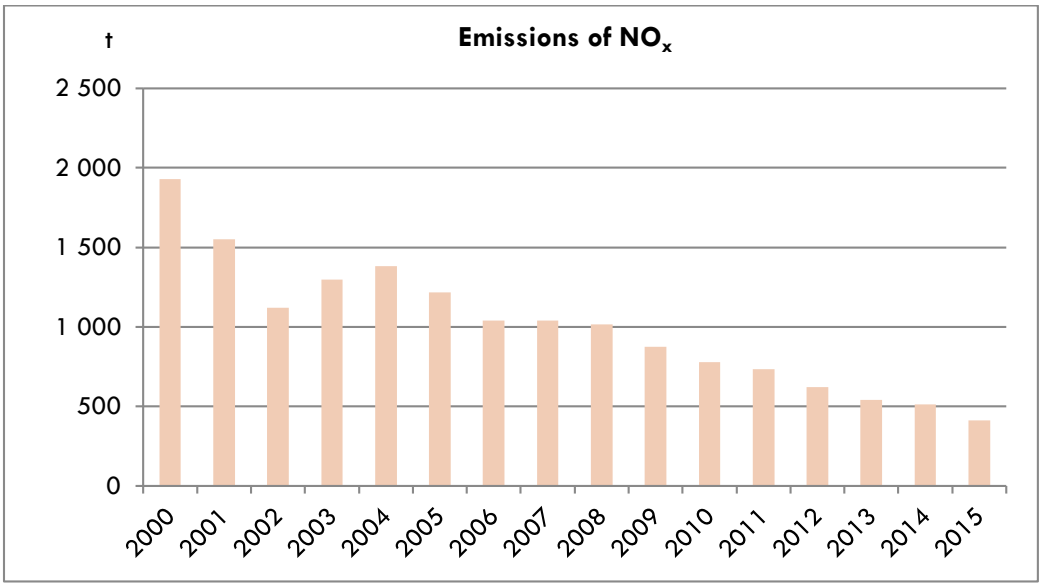

Figure 3-48 Emissions by non - road mobile machinery in the construction and other industries in 2000–2015

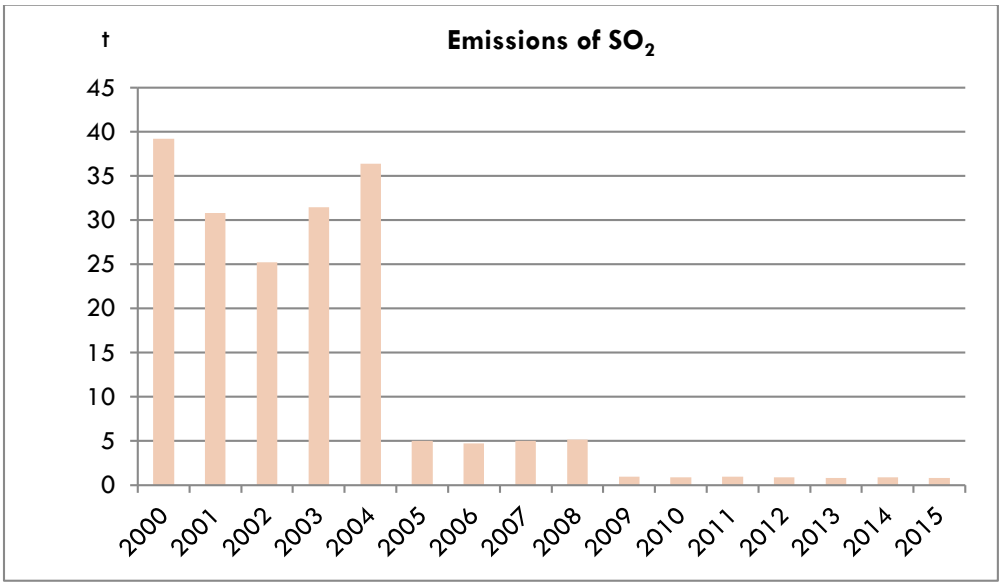

Figure 3-49 Emissions by non - road mobile machinery in the construction and other industries in 2000–2015

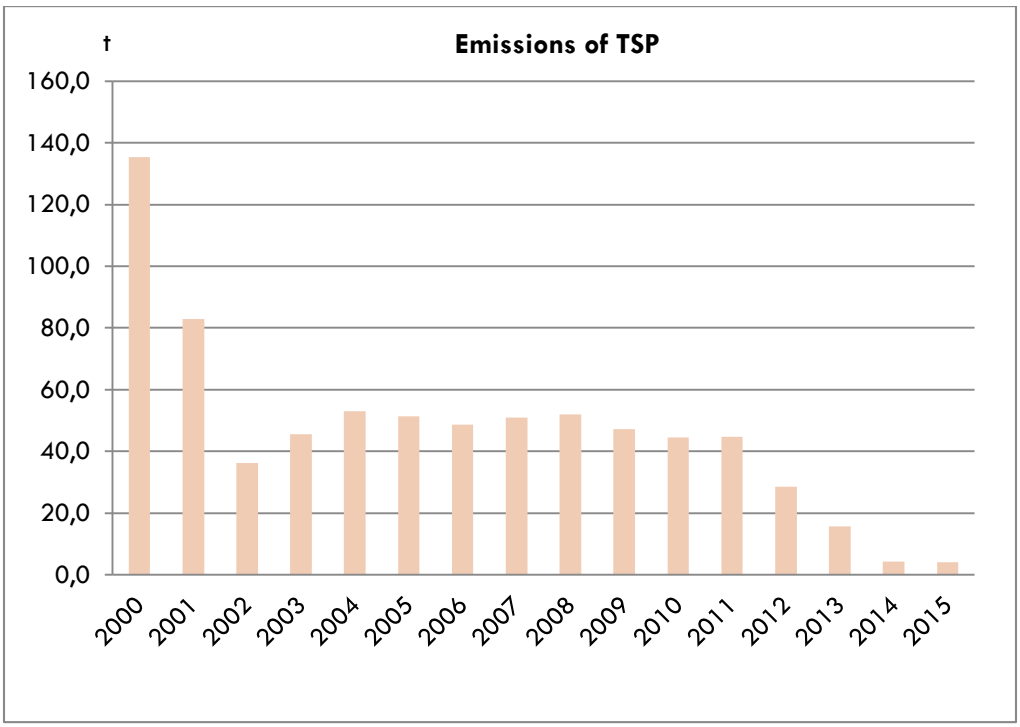

Figure 3-50 Emissions by non - road mobile machinery in the construction and other industries in 2000–2015

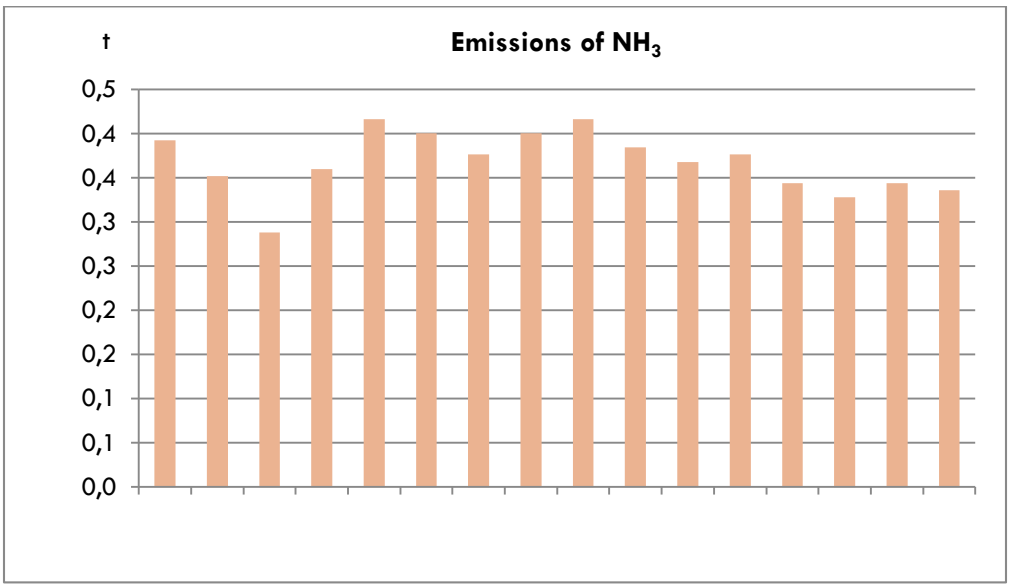

Figure 3-51 Emissions by non-road mobile machinery in the construction and other industries in 2000–2015

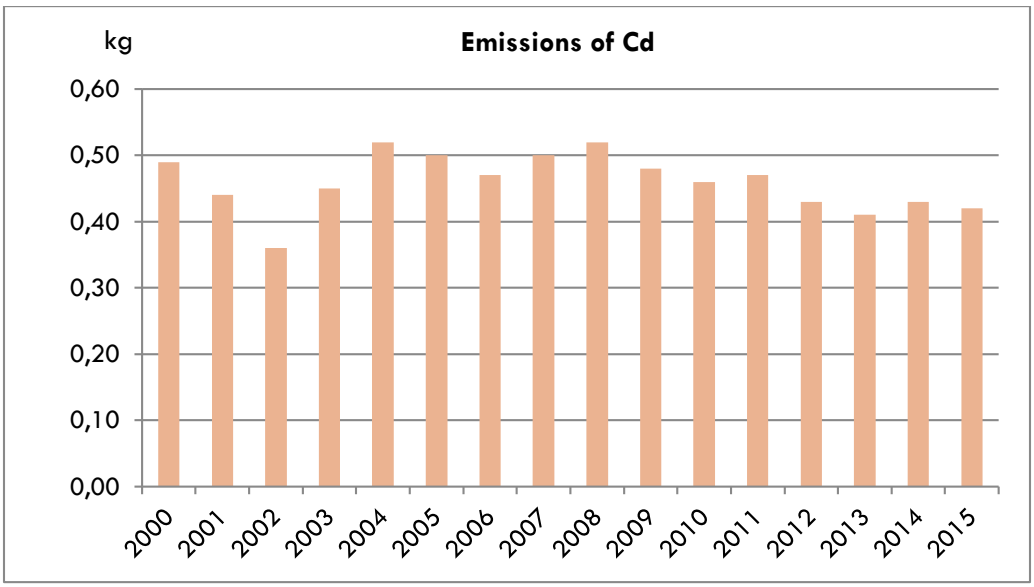

Figure 3-52 Emissions by non - road mobile machinery in the construction and other industries in 2000–2015

3.6.5.5 Uncertainties

Uncertainty for a non - road mobile machinery in the construction and other industries was calculated according to the EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainties given here have been evaluated for all of time series (2000 – 2015) and all reported categories. The total combine uncertainty of national emissions from non - road mobile machinery is ± 41.19 %. Uncertainty in activity data is up to 5 % and in EFs it is from 50 up to 150 %. Less reliable EFs have especially heavy metals, NH_3 and PAHs.

3.6.6 1.A.4 Small mobile Combustion

- *1.A.4.a ii* *Commercial / Institutional: Mobile*
- *1.A.4.b ii* *Residential: Household and Gardening: Mobile*
- *1.A.4.c ii* *Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery*

3.6.6.1 Method

Mobile sources reported under NFR 1.A.4 (Small combustion) *represent versatile equipment and means of transport like diesel non-road machinery (e.g. forklifters), airplanes fueled by jet kerosene and aviation gasoline (1.A.4.a ii), gasoline-driven lawn mowers used for gardening (1.A.4.b ii), tractors, harvesters, chain saws, gasoline off-road vehicles and other machinery used in agriculture and forestry (1.A.4.c ii).*

3.6.6.2 Activity data

Estimates of emissions regarding mobile small combustion are used in category 1.A.4.a ii diesel oil and jet kerosene. In 1.A.4.c ii, there is consumed diesel oil and gasoline there and in the 1.A.4.b ii only gasoline (see Table 3-52). These categories cover the major part of fuel consumption of small combustion, others are negligible. There are no other AD regarding of other fuels potentially used in the Czech Republic.

Table 3-48 Fuel consumption by small mobile combustion

Year	1 A 4 a ii		1 A 4 b ii	1 A 4 c ii	
	Diesel Oil	Jet kerosene	Gasoline	Diesel oil	Gasoline
	kt	kt	kt	kt	kt
2000	4.0	N/A	3.0	371.0	10.0
2001	4.0	N/A	3.0	364.0	10.0
2002	5.0	18.0	4.0	330.0	10.0
2003	4.0	13.0	4.0	314.0	8.0
2004	4.0	16.0	4.0	326.0	8.0
2005	5.0	17.0	5.0	321.0	8.0
2006	5.0	13.0	5.0	310.0	8.0
2007	5.0	19.0	6.0	308.0	8.0
2008	6.0	19.0	6.0	321.0	7.0
2009	4.0	21.0	6.0	317.0	6.0
2010	3.0	15.0	6.0	313.0	6.0
2011	5.0	14.0	6.0	316.0	6.0
2012	5.0	12.0	6.0	319.0	6.0
2013	5.0	13.0	6.0	319.0	6.0
2014	5.0	14.0	6.0	319.0	6.0
2015	5.0	13.0	6.0	316.0	6.0

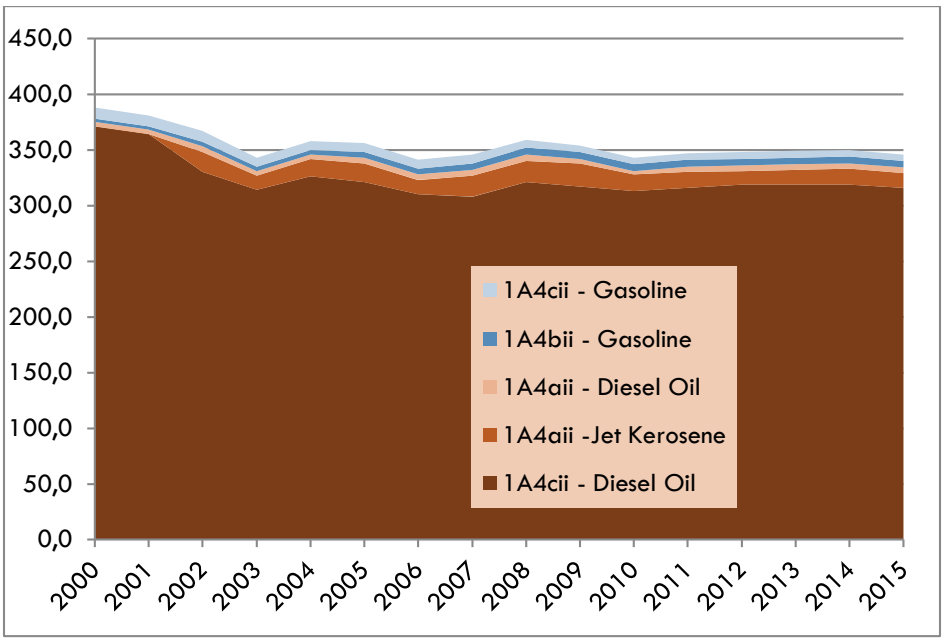

Figure 3-53 Fuel consumption by small mobile combustion

3.6.6.3 Emission factors

Emission factors (excepting diesel agriculture and forest machines) are mainly used from the EIG 2016. Exceptions are emissions of SO_x, Pb. Those are country specific and based on content of pollutants in fuels. Jet kerosene EFs for calculation of PAHs is considered the same as for diesel oil (jet kerosene EFs are not in the EIG). Emission factors of diesel agriculture and forest machines are based on emission measurements done in past years for each type of vehicle for various performance parameters.

Table 3-49 EF method used for small mobile combustion

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Millitary Combustion	*Tier 2*	*Tier 2*	*CS*	*Tier 2*	*Tier 2*	*Tier 2*	*Tier 2*	*Tier 2*	*Tier 2*
	Pb	**Cd**	**Hg**	**As**	**Cr**	**Cu**	**Ni**	**Se**	**Zn**
	CS	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*
	PCDD/ PCDF (dioxines/ furanes)	**PAHs**				**PCBs**			
		benzo(a) pyrene	**benzo(b) fluoranthene**	**benzo(k) fluoranthene**	**Indeno (1,2,3-cd) pyrene**				
	NR	*Tier 1*	*Tier 1*	*Tier 1*	*Tier 1*	*NR*			

Table 3-50 EF used for small mobile combustion regarding main pollutants in g.kg^{-1} in the current year

Sector	Fuel type	CO	NOx	NMVOC	SOx	Pb	TSP	NH_3
1 A 4 a ii	Diesel Oil	6.360	9.860	0.607	0.020	0.0000	0.098	0.008
	Jet Kerosene	6.074	7.772	0.541	0.20	0.0000	0.099	0.008
1 A 4 b ii	Gasoline	740.613	4.125	63.070	0.020	0.0004	2.229	0.004
1 A 4 c ii	Gasoline	740.613	4.125	63.070	0.020	0.0004	2.229	0.004

Table 3-51 EF used for small mobile combustion regarding other pollutants in the current year

EFFICIENCY	CO	NMVOC	NO	TSP
	g/kWh	g/kWh	g/kWh	g/kWh
Tractor below 20 kW	6.0	0.40	10.5	0.50
Tractor 21 - 39 kW	6.0	0.40	10.2	0.45
Tractor 40 - 60 kW	4.5	0.35	10.0	0.43
Tractor 61 -99 kW	3.2	0.30	9.5	0.40
Tractor over 100 kW	3.2	0.30	9.0	0.36
Harvester below 120 kW	3.2	0.30	9.0	0.36
Harvester over 120 kW	3.2	0.30	9.0	0.36
Sugar beet harvester over 120 kW	3.2	0.30	9.0	0.36
Lorry (below 5 t) below 90 kW	3.4	0.30	9.0	0.36
Lorry (over 5 t) over 90 kW	3.2	0.30	9.0	0.36

The Czech national emission factors for agricultural sources were set based on evaluation of real measurements between years 2000–2002.

3.6.6.4 Emissions

Emission trends regarding heavy metals are mainly influenced by fuel consumption and fuel quality. Emission trends of main pollutants are influenced by rising standards for non-road mobile machinery. The SO_x emission trend is influenced by changing fuel quality, too. There is also the influence of the different trend of changing fuel quality between diesel oil, gasoline and jet kerosene (see figures 3-54 to 3-58 Emissions from non-road mobile machinery). This is noticeable in SO_x emission estimates mainly between the years 2000 and 2001 (ratio between1.A.4.c ii – gasoline and other categories). Trends of main pollutants for the non-road mobile machinery in Agriculture and Forestry depend on fuel consumption (see Figure 3-59).

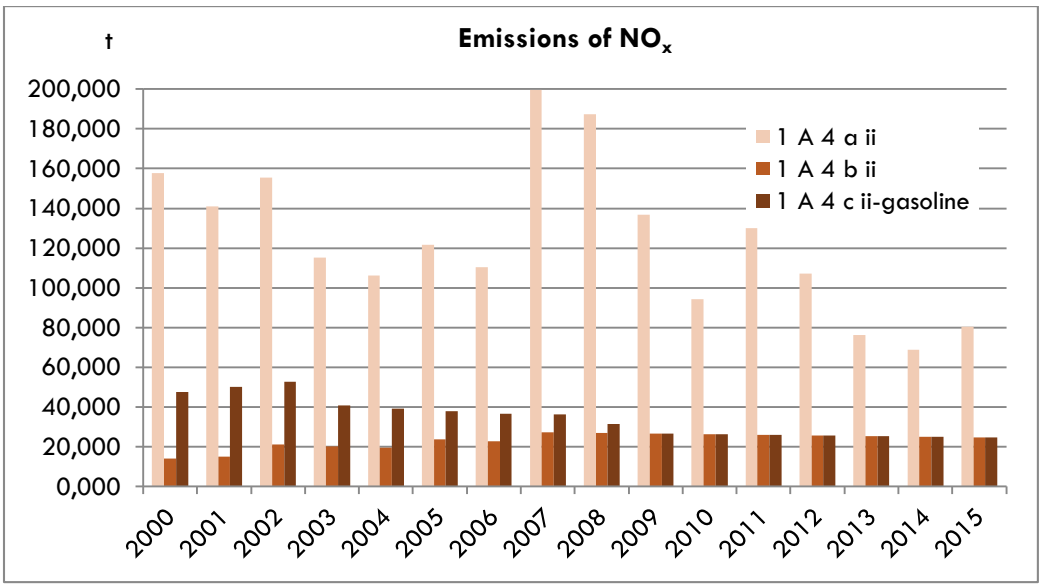

Figure 3-54 Emissions from small mobile combustion in 2000–2015

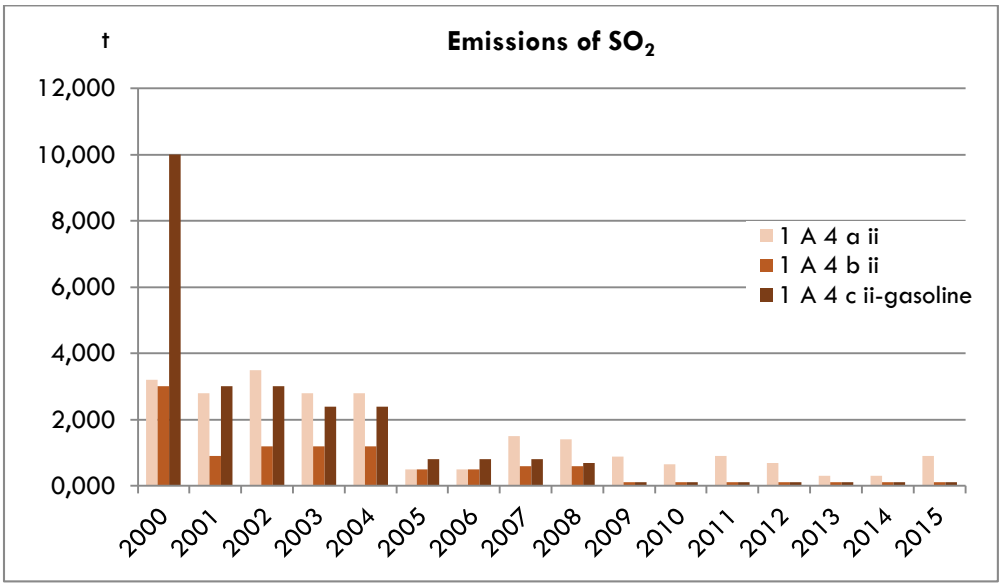

Figure 3-55 Emissions from small mobile combustion in 2000–2015

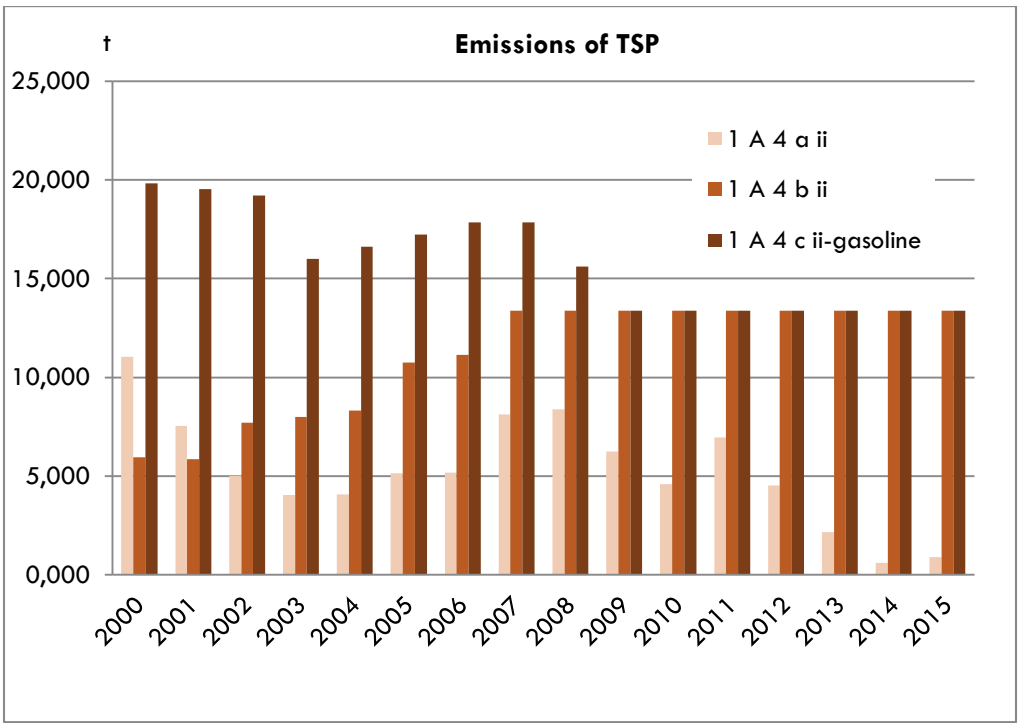

Figure 3-56 Emissions from small mobile combustion in 2000–2015

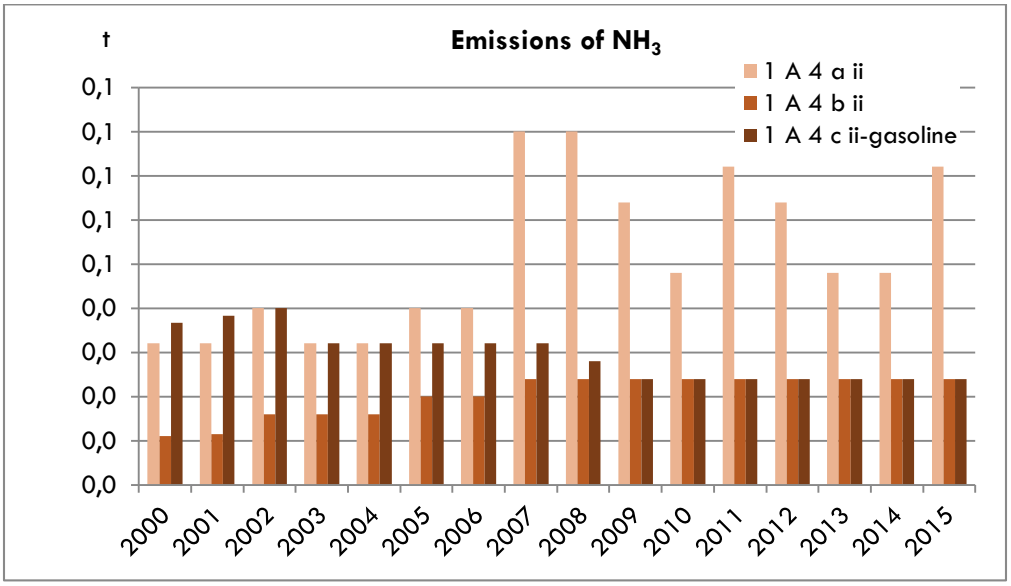

Figure 3-57 Emissions from small mobile combustion in 2000–2015

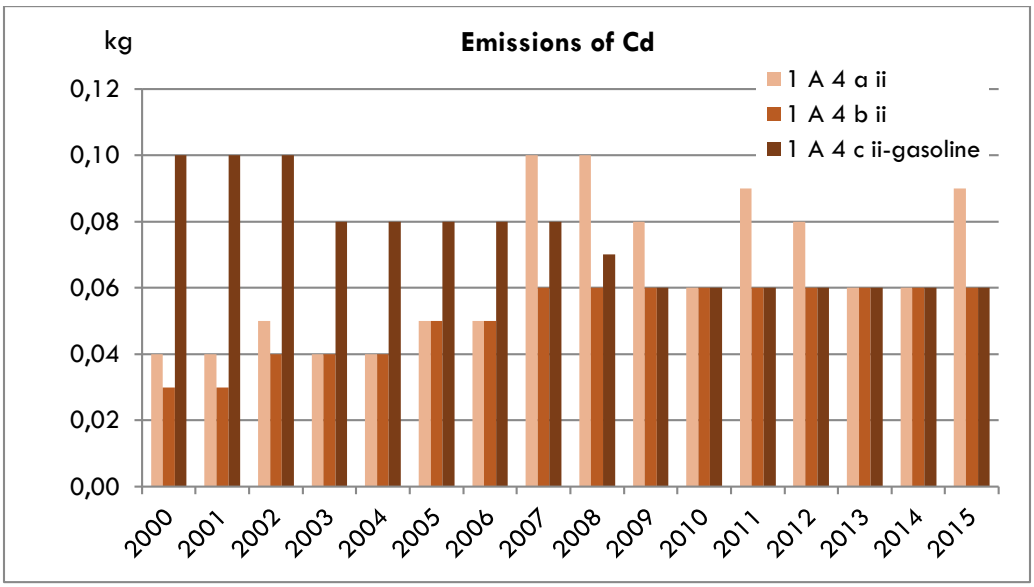

Figure 3-58 Emissions from small mobile combustion in 2000–2015

3.6.6.5 Uncertainties

Emission factors for non-road mobile machinery in Agriculture and Foresrty have not been updated since 2002 and therefore could be rather uncertain. However these factors mirror a real used agricultural machinery state of the art. Uncertainties used for other non-road mobile machinery were calculated according to the EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainties given here have been evaluated for all of time series (2000 – 2015) and all reported categories. The total combine uncertainty of national emissions from small mobile combustion is ± 34.68 % Uncertainty in activity data is to 5 % and in EFs it is from 50 to 200 %. Especially heavy metals, NH_3 and PAHs has less reliable EFs.

3.6.7 1.A.5.b Other, Mobile (Military)

3.6.7.1 Method

Basically, all military ground transport fueled by diesel oil (1.A.5.b i) and military aviation fueled by jet kerosene (1.A.5.b ii) is included in this category. There is no Military Navigation (1.A.5.b iii) in the Czech Republic, so this is not reported.

3.6.7.2 Activity data

Activity data used for Czech Military are available from the year 2002 and are gathered by the CZSO. The peak of fuel consumption was in 2009. Afterwards the trend of fuel consumption is almost decreasing – started by economic crisis (see Table 3-56).

Table 3-52 Fuel consumption by small mobile combustion

Category	Year															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.A.5.b i Diesel Oil (kt)	N/A	N/A	9	7	7	6	7	7	9	9	9	9	9	8	8	10
1.A.5.b ii Jet Kerosene (kt)	N/A	N/A	18	13	16	17	13	19	19	21	15	14	12	13	14	13

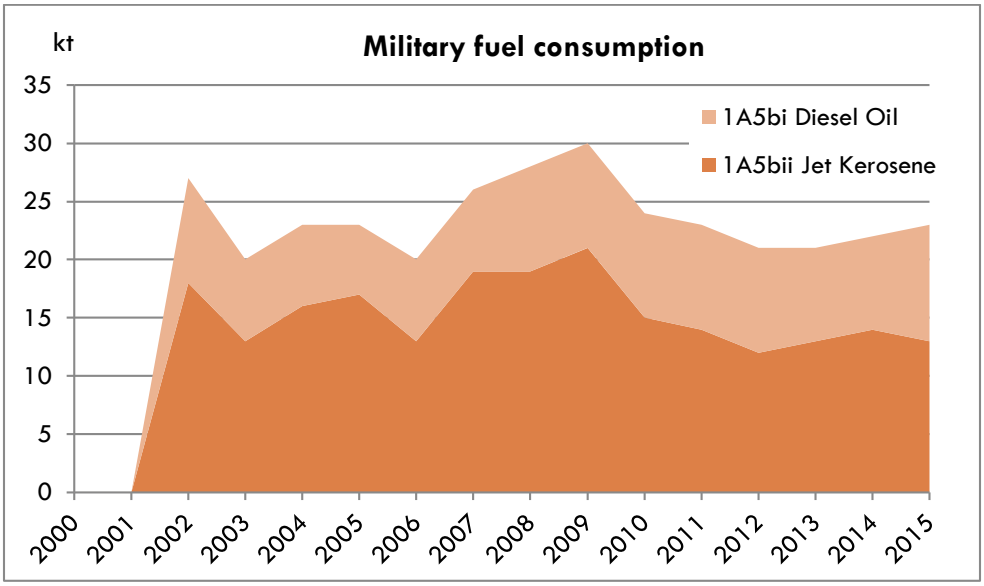

Figure 3-59 Fuel consumption by small mobile combustion

3.6.7.3 Emission factors

Emission factors for jet kerosene combustion for military purposes which are not CS were used from the EIG 2016. They are the same as for diesel oil, because EFs for jet kerosene is not sated in EIG 2016.

Table 3-53 EF method for military combustion

	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Millitary Combustion	Tier 2	Tier 2	CS	Tier 2	Tier 2	Tier 2	Tier 2	Tier 2	Tier 2
	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	CS	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1
	PCDD/ PCDF (dioxines/ furanes)	PAHs				PCBs			
		benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno (1,2,3-cd) pyrene				
	NR	Tier 1	Tier 1	Tier 1	Tier 1	NR			

Table 3-54 EF for military combustion for main pollutants in g/kg in current

Sector	Fuel type	CO	NOx	NMVOC	SOx	Pb	TSP	NH_3
1.A.5.b i	**Diesel Oil**	6.074	7.772	0.541	0.020	0.000	0.099	0.008
1.A.5.b i i	**Jet Kerosene**	6.074	7.772	0.541	0.200	0.000	0.099	0.008

Table 3-55 EF for military combustion for other pollutants in current year

Pollutant		1.A.5.b i	1.A.5.b i i
		Diesel Oil	**Jet Kerosene**
Cd	ug/kg fuel	10	10
Cr	ug/kg fuel	50	50
Cu	ug/kg fuel	1700	1700
Ni	ug/kg fuel	70	70
Se	ug/kg fuel	10	10
Zn	ug/kg fuel	1000	1000
As	ug/kg fuel	0.1	0.1
Hg	ug/kg fuel	5.3	5.3
B(a)P	ug/kg fuel	30	30
B(b)F	ug/kg fuel	50	50
B(k)F	ug/kg fuel	34.4	34.4
ID(1,2,3-cd)P	ug/kg fuel	21.2	21.2

3.6.7.4 Emissions

Fuel consumption is provided by CzSO from the year 2002. Emissions for all pollutants are calculated by Tier 2 EFs (see Table 3-57, Table 3-58, Table 3-59) taken from EIG are influenced by rising technological standards and fuel consumption. SO_x emissions from diesel oil are influenced mostly by changing SO_2 content in fuel. Jet kerosene SO_x emission estimates are influenced mainly by fuel consumption.

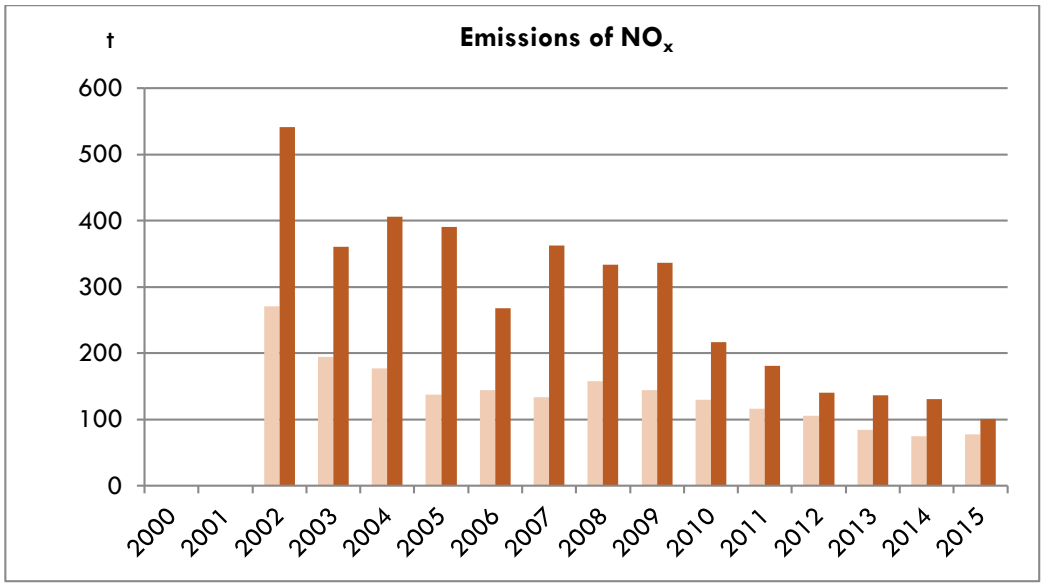

Figure 3-60 Emissions by military combustion in 2000–2015

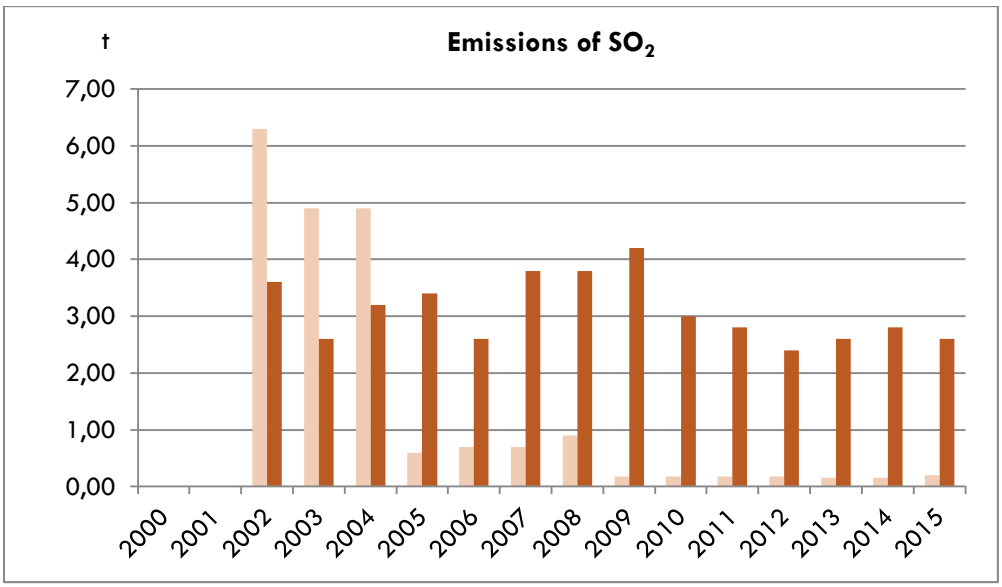

Figure 3-61 Emissions by military combustion in 2000–2015

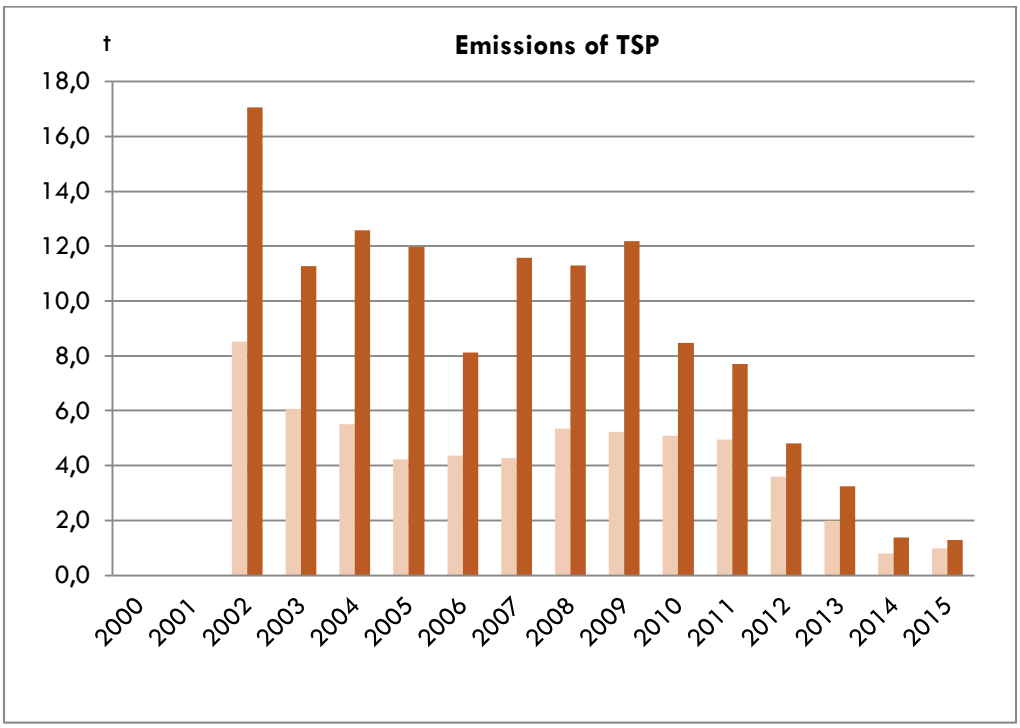

Figure 3-62 Emissions by military combustion in 2000–2015

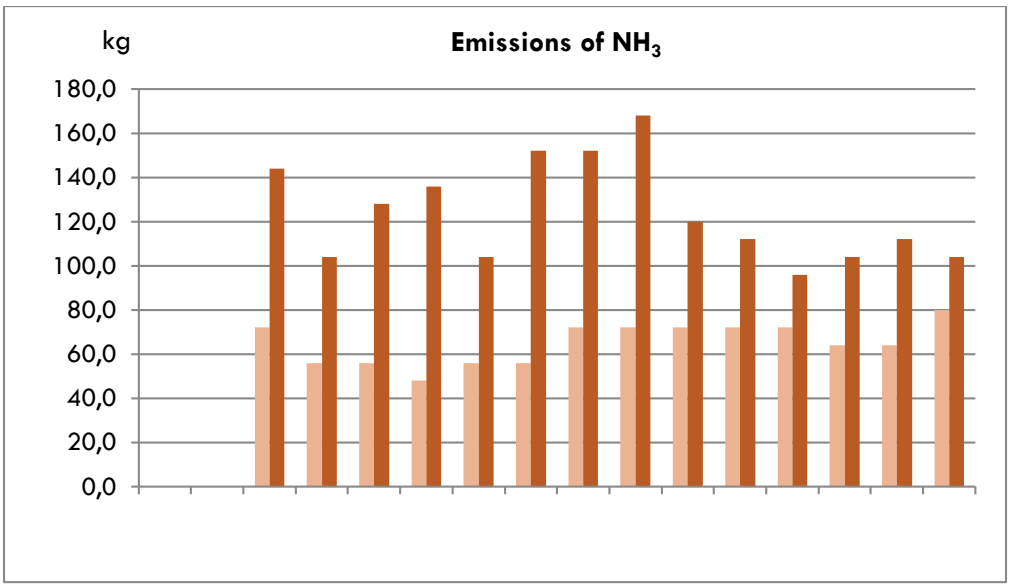

Figure 3-63 Emissions by military combustion in 2000–2015

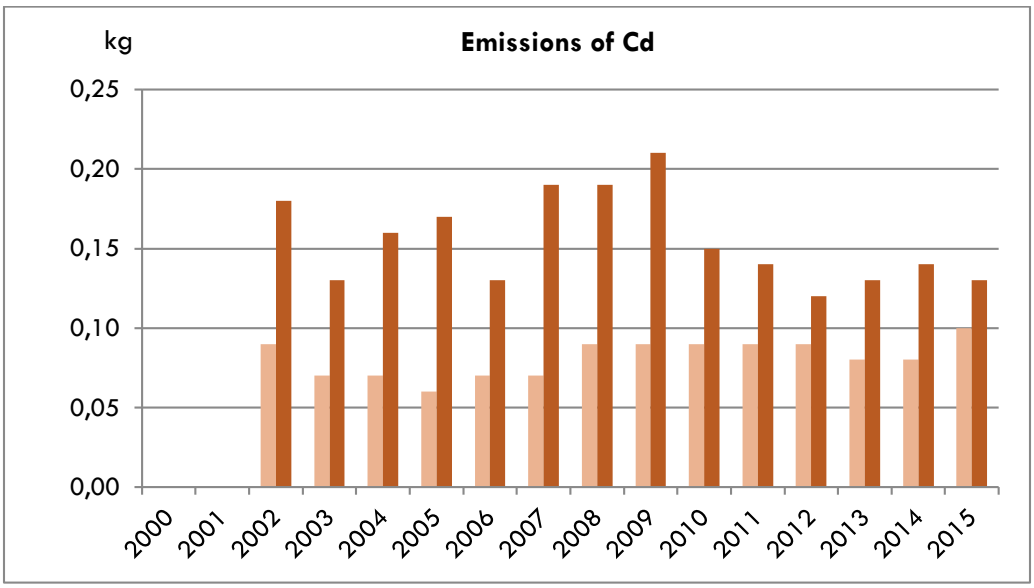

Figure 3-64 Emissions by military combustion in 2000–2015

3.6.7.5 Uncertainties

Uncertainty for military combustion was calculated according EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainty given here has been evaluated for all-time series (2000–2015) and reported categories. Total combine uncertainty of national emissions from military combustion is ± 41.65 % Uncertainty in activity data is to 5 % and in EFs it is from 50 to 200 %. Especially heavy metals, NH_3 and PAHs has less reliable EFs.

3.6.8 QA/QC and verification

QC carried out in Transport Research Centre (CDV) is based on routine and consistent checks to ensure data integrity, correctness, completeness and identifying and addresings errors. Documentation and archivation of all QC activities is carried out. QC activities include methods such as accuracy checks on data acquisition and calculations, and the use of approved standardized procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. QC activities also include technical reviews of categories, activity data, emission factors, other estimation parameters, and methods. QA and verification is guaranteed in CDV by comparing activity data with world and European databases and third person checks.

Inventory compiler is responsible for coordinating the institutional and procedural arrangements for inventory activities. It is data collection from CzSO, deciding of usage of emissions factors (CS or according EIG) and estimation of emissions from mobile sources. The uncertainty assessment is carried out by inventory compiler too. The last step is documentation and archiving of data. Inventory compiler designes responsibilities for Implementing QA/QC procedures between persons not directly involved in compilation of inventory and other organizations.

A QA/QC plan is a fundamental element of a QA/QC and verification system. The plan of QA/QC procedures in CDV is based on the inner quality control procedure system, which is harmonised with the QA/QC system of Czech Hydrometeorological Institute (CHMI). Since the transport sector belongs to the energy sector, there has been a close co-operation of CDV and CHMI in the field of energy and fuel consumption data as well as specific energy data used (in MJ/ kg fuel). The CHMI in close co-operation with CzSO ensures that Transport research centre works with the most updated data about total energy and specific energy consumed.

3.6.8.1 QA/QC activities

QC Activities:

- *Checking criteria for the selection of activity data, emission factors, and other estimation parameters are documented.*
- *Checking that emissions and removals are calculated correctly.*
- *Checking that parameters and units are correctly recorded and that appropriate conversion factors are used.*
- *Checking the integrity of database files.*
- *Checking for consistency in data between categories.*
- *Checking that the movement of inventory data among processing steps is correct.*
- *Checking that uncertainties in emissions and removals are estimated and calculated correctly.*
- *Checking time series consistency.*

QA Activities:

- *Check completeness (confirm that estimates are reported for all categories, all years, all subcategories and confirm that entire category of mobile sources is being covered).*
- *Trend checks (checking value of implied emission factors and unusual, unexplained trends noticed for activity data or other parameters across the time series)*
- *Checking of internal documentation and archiving.*

3.6.8.2 Responsibilities in CDV

The sectoral guarantor of QA/QC procedures for mobile sources:

- *is responsible for the sectoral QA/QC plan and the compliance of all QA/QC procedures,*
- *provides plan for the QC procedure and is responsible for its implementation.*

Inventory compiler of inventory from mobile sources:

- *performs the emission calculations from transport in emission model,*
- *provides for data import in the NFR table,*
- *is responsible for the storing of documents,*
- *carries out auto-control and control of data consistency,*
- *performs the uncertainty calculation,*
- *introducing improvements.*

Third person check (Transport yearbook of Czech Republic compiler)

- *detailed control of timeliness, completeness, consistency, comparability and transparency.*

The sectoral guarantor of QA/QC procedures for Agricultural and Forestry non-road mobile sources:

- *Martin Dedina (Research Institute of Agricultural Technology)*

3.6.8.3 QA/QC procedure in CDV

During every submission inventory compiler recieves first preliminary activity data from CzSO in the beginning of summer and makes first calculations which are compared with previous years regarding to a trend in data from last years. If there is some discrepancies activity data are consulted with CzSO and inaccuracies are corrected. During autumn CzSO provides final activity data. Than final calculations are made. The QC is made by inventory compiler, than by person responsible for compilation of Transport yearbook in CDV and The sectoral guarantor of QA/QC. Every error is described, documented and saved. Next quality control is made by expert in CHMI. Last step of QC are European reviews. The QA is made on activity data by comparing it with databases like Eurostat and IEA. Main discrepancies are consulted with CzSO and explained during reviews Emission estimates are prepared for submission until 5 February and send to inventory coordinator. During second half of March Stage 1 review questions are processed. In May and June Stage 2 review questions are processed.

3.6.8.4 Recalculations and improvements

3.6.8.4.1 Recalculations

- *For non – road mobile sources, former and now outdated, country specific EFs were changed according to the EIG 2016 (main pollutants Tier 2 and PAHs Tier 1 methodology).*

- *Automotive tyre and brake wear abrasion and Automotive road abrasion EFs (g.km^{-1}) were changed for particulate matter according to the EIG 2016 Tier 2 method and transferred to EFs (g.kg^{-1}) via Tier 1 average fuel consumption per km stated in the EIG. Automobile tyre and brake wear EFs used for heavy metals are derived on basis of the EIG 2016 emission factors in ug.km^{-1}. Emission factors for automobile road abrasion are not stated in the EIG 2016. This is the reason why they were recalculated to ug.kg^{-1} of fuel on basis of Denmark emission factors (Winther and Slentø 2010) which appear to be the most adequate to the conditions in the Czech Republic. Automobile tyre, break wear and road abrasion of PAHs are calculated according to the EIG - Tier 2 (g.km^{-1}). Tier 2 EFs were recalculated to g.kg^{-1}. BC was estimated by Tier 1 share on PM.*
- *EFs of PAHs from fuel combustion within road transport, railways and navigation were changed according to the Tier 1 EFs from the EIG 2016.*
- *EF of Pb from fuel combustion was changed. Originally, EF was equal to the content of Pb in fuels. Now it is equal to 0,75 of Pb content in fuels, as it is stated in the EIG 2016.*

3.6.8.4.1.1 Improvements

- *Estimates of emissions of PCDD/F and PCB from road transport were newly added. Estimated by Tier 2 EFs from the EIG 2016 and filled for all of time series 1990–2015.*
- *Estimates of emissions of BC from aviation, national navigation and road transport were added. Tier 1 method of fraction BC on PM according to the EIG 2016 was chosen. Emission estimates of BC for non - road sources (Tier 1) were added and filled for all of time series 1990–2015.*

3.6.8.4.2 Estimates of emissions of main pollutants from non-road mobile machinery in Agriculture and Forestry have not been updated since 2002 and therefore could be rather uncertain. Calculation emissions for 1990–1999

Due to new activity data for the period 1990–1999 obtained from the CzSO the calculation of emission estimates of all pollutants was made in this period.

3.6.8.4.3 Method

There were specific conditions in road transport before 2000 in the Czech Republic. After the year 1989 the market with all types of vehicles and active car fleet were slowly approximated to the conditions in countries of "Western" Europe. To define correct AD of subsectors was complicated task due to lack of information before 2000. The CzSO was able to do the research on AD and to provide data to the CDV which afterwards made the research on some EFs for all pollutants.

Up to the present day, there were only SO_2, NOx, NH_3, NMVOC, and CO emission estimates for Road transport reported in the period 1990–1999. In the new calculation dataset for the period 1990–1999 were actualized some EFs, especially for LPG and CNG vehicles in sector Road transport – fuel combustion. Calculations of all pollutants which are reported in the year 2015 and missing in older submissions for 1990–1999 were subsequently made.

3.6.8.4.4 Activity Data

In this chapter are stated AD obtained from the CzSO, see tables below.

Table 3-56 AD used for Road Transportation, Railways and Domestic navigation

Fuel type	Unit	1 990	1 991	1 992	1 993	1 994	1 995	1 996	1 997	1 998	1 999
Aviation Gasoline	kt	45	12	12	7	6	4	4	2	1	2
Jet Kerosene	kt	169	139	161	134	168	180	137	159	188	177
Road Gasoline	kt	1 161	1 085	1 412	1 348	1 568	1 637	1 843	1 826	1 801	1 910
Road Diesel oil	kt	2 115	1 901	1 717	1 671	1 734	1 422	1 285	1 267	1 677	1 629
LPG	kt	0	0	0	4	8	12	12	25	55	64
CNG	kt	0	0	0	0	1	2	2	2	2	2
Road Biodiesel	kt	0	0	3	6	11	18	25	38	41	51
Road Bioethanol	kt	0	0	0	0	0	0	0	0	0	0
Railways Diesel oil	kt	244	199	186	151	146	158	130	121	113	105
Navigation Diesel oil	kt	17	17	17	16	16	16	16	14	55	64

Table 3-57 AD used for Non road mobile sources

Code	Unit	1 990	1 991	1 992	1 993	1 994	1 995	1 996	1 997	1 998	1 999
1.A.2.f.ii mobile	kt	47	35	49	45	53	54	52	48	47	45
1.A.4.a.ii mobile	kt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	4
1.A.4.b.ii. Mobile	kt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	3
1.A.4.c.ii.	kt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15	12	11
1.A.5.b. mobile	kt	14	14	14	14	14	14	14	14	14	13

3.6.8.4.5 Emission Factors

New EFs were derived on basis of national research studies (country specific EFs) and Emission inventory Guidebooks. Part of EFs was derived from the EIG 2016 especially for non-road sources (according to EFs for different stages).

3.6.8.4.5.1 1.A.3.a Aviation

In subsectors of International and Civil aviation were used constant emission factors for all of time series and all pollutants. These EFs corresponds with those for the year 2015 (see EFs tables in IIR chapter dedicated to Aviation). Main pollutants (SO_2, NOx, NH_3, NMVOC), TSP, BC, CO, Pb and PAHs EFs are CS (based on average airplane fleet of airlines which operated in the Czech Republic). Other heavy metals are used according to the Tier 1 methodology from the EIG 2016 for road gasoline and road diesel, because there are no values in the EIG 2016 for Aviation and any research in the Czech Republic haven´t been done yet.

3.6.8.4.5.2 1.A.3.b Road transportation

3.6.8.4.5.2.1 Fuel combustion

EFs in Road transportation (fuel combustion) subsector are changing according to changes in dynamic car fleet composition according to Euro standards and type of fuel. Euro standards are aggregated to 3 categories: Pre – Euro, Euro 1 and 2, Euro 3 and higher. Final emission factors for every subcategory (PCs, LDVs, HDVs) is variable according to the share on fuel consumption of particular Euro standards vehicle. Main pollutants, PM, BC, CO, Pb emission factors are CS (based on Dufek et al. 2006 and Dufek et al. 2008). In old submissions were reported only emissions of NOx, NMVOC, NH_3, SO_2 and CO from road transport fuel combustion. Most of these EFs remain the same as in old submissions, but some of them – especially for LPG and CNG were changed, because in national studies (Dufek et al. 2006 and Dufek et al. 2008) weren´t sufficient data and information. EFs of SO_2 are dependent on sulfur content in fuel and remained unchanged.

There was lack of sufficient information about EFs of NO_x for LPG and CNG vehicles in Czech methodologies. New EFs for NO_x were taken from "Czech methodology for calculating emissions from road transport" called the MEFA 13 (Šebor et al. 2010).

Table 3-58 Changes of EFs of NO_x in selected years

Subsector	Fuel type	Emission factor g.kg^{-1}					
		1990 old	1990 new	difference	1999 old	1999 new	difference
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	5.00	25.90	20.90	5.00	7.09	2.09
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	1.00	9.58	8.58	1.00	1.86	0.86
1.A.3.b.iii HDVs and Buses	CNG	1.00	9.58	8.58	1.00	1.86	0.86

*There was lack of sufficient information about **NMVOC** EFs for LPG and CNG vehicles in Czech methodologies. New values in 1990 respond to the maximum NMVOC Tier 1 value stated in the EIG 2016 for LPG passenger cars (same value due to lack of information were used for CNG PCs and CNG HDVs and Buses). From 1990 values of EFs decrease with linear trend towards values in 2000, which are verified in Czech methodologies.*

Table 3-59 Changes in NMVOC EFs in selected years

Subsector	Fuel type	Emission factor g.kg^{-1}					
		1990 old	1990 new	difference	1999 old	1999 new	difference
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	26.40	25.66	-0.74	26.40	13.37	-13.04
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	26.40	25.66	-0.74	26.40	13.37	-13.04
1.A.3.b.iii HDVs and Buses	CNG	26.40	25.66	-0.74	26.40	13.37	-13.04

*There was lack of sufficient information about **NH_3** EFs for gasoline PCs, Diesel PCs and HDVs, LPG and CNG vehicles in Czech methodologies. New values for gasoline and diesel PCs and LDVs in 1990 respond to the mean Tier 1 value stated in the the EIG 2016. New values for diesel HDVs in 1990 respond to the maximum Tier 1 value stated in EIG 2016. There were no EFs for LPG and CNG vehicles in the period 1990–1999 stated in Czech methodologies. New LPG EFs values in 1990 respond to the maximum Tier 1 value stated in EIG 2016 for LPG passenger cars (same value due to lack of information were used for CNG PCs and CNG HDVs and Buses). From 1990 values of EFs decrease with linear trend towards values in 2000, which are verified in Czech methodologies.*

Table 3-60 Changes in NH_3 EFs for selected years

Subsector	Fuel type	Emission factor g.kg^{-1}					
		1990 old	1990 new	difference	1999 old	1999 new	difference
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Gasoline	0.029	1.106	1.077	0.823	1.106	0.283
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Diesel Oil	0.016	0.082	0.066	0.016	0.071	0.055
1.A.3.b.iii HDVs	Diesel Oil	0.012	0.018	0.006	0.012	0.015	0.003
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	0	0.108	0.108	0	0.030	0.030
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	0	0.108	0.108	0	0.030	0.030
1.A.3.b.iii HDVs and Buses	CNG	0	0.108	0.108	0	0.030	0.030

*Situation with **CO** EFs is similar to previous cases. New EFs for LPG and CNG PCs were taken from "Czech methodology for calculating emissions from road transport" called MEFA 13 (Šebor et al. 2010). New values for CNG HDVs and buses in 1990 respond to the maximum Tier 1 value stated in EIG 2016. From 1990 values of EFs decrease with linear trend towards values in 2000, which are verified in Czech methodologies.*

Table 3-61 Changes of EFs of CO in selected years

Subsector	Fuel type	Emission factor g.kg^{-1}					
		1990 old	1990 new	difference	1999 old	1999 new	difference
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	35.00	107.83	72.83	35.00	42.28	7.28
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	35.00	107.83	72.83	35.00	42.28	7.28
1.A.3.b.iii HDVs and Buses	CNG	7.50	15.00	7.50	7.50	8.25	0.75

In the tables below are displayed final values of emission factors in selected years, regarding main pollutants from Road transport – fuel combustion sectors, which are most significant producers of air pollution from transport.

Table 3-62 NO_x emission factors

Subsector	Fuel type	Emission factor g.kg^{-1}			
		1990	2000	2005	2015
1..A3.b.iv Motorcycles	Gasoline	36.89	36.89	36.89	36.89
1.A.3.b.i PCs, 1.A.3.b.iii LDVs		45.09	7.86	7.86	1.95
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Diesel Oil	18.24	11.10	7.87	4.68
1.A.3.b.iii HDVs		93.39	47.27	28.83	10.93
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	25.90	5.00	5.00	5.00
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	9.58	1.00	1.00	1.00
1.A.3.b.iii HDVsand Buses		9.58	1.00	1.00	1.00

Table 3-63 NMVOC emission factors

Subsector	Fuel type	Emission factor g.kg^{-1}			
		1990	2000	2005	2015
1..A3.b.iv Motorcycles	Gasoline	22.40	22.40	22.40	22.40
1.A.3.b.i PCs, 1.A.3.b.iii LDVs		39.21	15.18	7.70	2.25
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Diesel Oil	2.32	1.43	1.03	0.62
1.A.3.b.iii HDVs		41.09	20.79	11.93	3.11
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	25.66	12.00	5.17	1.07
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	25.66	12.00	5.17	1.07
1.A.3.b.iii HDVsand Buses		25.66	12.00	5.17	1.07

Table 3-64 SO_2 emission factors

Subsector	Fuel type	Emission factor g.kg^{-1}			
		1990	2000	2005	2015
1..A3.b.iv Motorcycles	Gasoline	1.00	1.00	0.10	0.02
1.A.3.b.i PCs, 1.A.3.b.iii LDVs		1.00	1.00	0.10	0.02
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Diesel Oil	3.00	0.80	0.10	0.02
1.A.3.b.iii HDVs		3.00	0.80	0.10	0.02
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	0.00	0.00	0.00	0.00
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	0.00	0.00	0.00	0.00

1.A.3.b.iii HDVsand Buses		*0.00*	*0.00*	*0.00*	*0.00*

Table 3-65 TSP emission factors

Subsector	Fuel type	Emission g.kg^{-1}			
		1990	2000	2005	2015
1..A3.b.iv Motorcycles	Gasoline	*2.20*	*2.20*	*2.20*	*2.20*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs		*0.35*	*0.03*	*0.03*	*0.03*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Diesel Oil	*4.76*	*2.19*	*1.27*	*0.39*
1.A.3.b.iii HDVs		*6.21*	*3.22*	*1.86*	*0.48*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	*0.331*	*0.319*	*0.315*	*0.313*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	*0.331*	*0.319*	*0.315*	*0.313*
1.A.3.b.iii HDVsand Buses		*0.331*	*0.319*	*0.315*	*0.313*

Table 3-66 NH_3 emission factors

Subsector	Fuel type	Emission factor g.kg^{-1}			
		1990	2000	2005	2015
1..A3.b.iv Motorcycles	Gasoline	*0.07*	*0.07*	*0.07*	*0.07*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs		*1.11*	*0.94*	*1.16*	*1.32*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	Diesel Oil	*0.08*	*0.07*	*0.05*	*0.02*
1.A.3.b.iii HDVs		*0.02*	*0.01*	*0.01*	*0.01*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	LPG	*0.11*	*0.02*	*0.02*	*0.02*
1.A.3.b.i PCs, 1.A.3.b.iii LDVs	CNG	*0.11*	*0.02*	*0.02*	*0.02*
1.A.3.b.iii HDVsand Buses		*0.11*	*0.02*	*0.02*	*0.02*

Heavy metals *are derived from the EIG 2016 Tier 1 and are constant for all of time series (see tables for current years in IRR chapter Road transport). PAHs are derived from EIG 2016 (Tier 1). For 1990 was taken maximum value of interval given in EIG 2016 and there is linear decreasing trend towards the year 2000. For years 2000 – 2015 EFs are with no trend and corresponding to mean value of interval given in EIG 2016.*

EFs for ***TSP*** *were taken from "Czech methodology for calculating emissions from road transport" called the MEFA 13 (Šebor et al. 2010). EFs have downward trend according to introduction of new standards* ***.BC*** *EFs are calculated according to the Tier 1 share on TSP EFs.*

*EFs for **PAHs** are taken from EIG 2016 (Tier 1) and are constant for all of time series. EFs for **PCDD/F and PCBs** from the EIG 2016 Tier 2 (g/km) and recalculated to g/kg (method is described in chapter of IIR dedicated to road transportation – fuel combustion sectors).*

3.6.8.4.5.2.2 Tyre, break and road abrasion

***EFs of PM, BC, PAHs** and **heavy metals** from tyre, break wear and road abrasion are constant for all of time series. They were calculated according to the Tier 2 EIG 2016 and are described in chapter "Automobile Tyre and Brake Wear and 1.A.3.b vii Automotive road abrasion".*

3.6.8.4.5.3 1.A.3.c Railways

EFs of main pollutants (SO_2, NOx, NH_3, NMVOC), TSP, BC, CO and Pb are CS (based on average locomotive fleet operated in the Czech Republic). EFs are constant for all of time series because lack of data from 1990. The exception is NO_x and PM where we were able to find some reasonable values in old EIGs and make the linear trend between 1990–2000 (from 2000 are used recent constant values described in IIR chapter dedicated to Railways). Other heavy metals and PAHs EFs are according Tier 1 methodology from EIG 2016, because there are no country specific data. All EFs are stated in tables in IIR chapter dedicated to Railways.

3.6.8.4.5.4 1.A.3.d.ii Domestic water-borne Navigation

Main pollutants EFs (SO_2, NOx, NH_3, NMVOC), TSP, BC, CO and Pb are CS (based on average ship fleet operated in Czech Republic). EFs are constant for whole time series because lack of data from 1990. The exception is NO_x, NMVOC and PM where we were able to find some reasonable values in old EIGs and make the linear trend between 1990–2000 (from 2000 are used recent constant values described in IIR chapter dedicated to navigation). Other heavy metals and PAHs EFs are according Tier 1 methodology from EIG 2016, because there are no country specific data. All EFs are stated in tables in IIR chapter dedicated to Navigation.

3.6.8.4.5.5 1.A.4. Non road mobile machinery

EFs for SO_2 and Pb are CS dependent on Pb and S content in fuels. Other main pollutants (NOx, NH_3, NMVOC), PM, CO and BC were taken from EIG 2016 according Tier 2 and stages for non road mobile machinery. Heavy metals have Tier 1 EFs from EIG 2016 and are constant in who time series (values are described in IIR chapter dedicated to non road mobile machinery). For B(a)P and B(b)F EFs values were taken from EIG 2016 for non road mobile sources. B(k)F and ID(,2,3-cd)P were taken from EIG 2016 road transport chapter (diesel, gasoline), because EFs for non road sources are not stated in EIG. PAHs EFs are constant for whole time series (values are described in IIR chapter dedicated to non road machinery).

3.6.8.4.6 Emissions

In the figures below you can see emissions trends for main pollutants and TSP from Road transport – fuel combustion (most significant producers of air pollution from Transport) between the years 1990–2015. Emissions of all main pollutants are decreasing continuously. Decrease in SO_2 emissions shows strong dependence on increasing fuel qualities (sulfur content) leads to a cascaded downward trend, influenced only slightly by increases in fuel consumption. Exception are NH_3 emissions which are influenced by

variable road gasoline consumption. NH_3 is produced mainly by gasoline passenger cars. Increase of emissions 1990–1999 is caused by increasing gasoline consumption (1161 kt in 1990 to 1910 kt in 1999). In 2000 there is a decrease of gasoline consumption followed by increase 2001–2008 (3561 kt). There is decrease of gasoline consumption again from 2009 to 2014 (1455 kt). In 2015 gasoline consumption increased by 10 kt. Next factor is (according Durbin et al. 2015) decreasing sulfur content in fuel, which cause increase of the NH_3 emissions.

Figure 3-65 Emissions of NO_x from fuel combustion

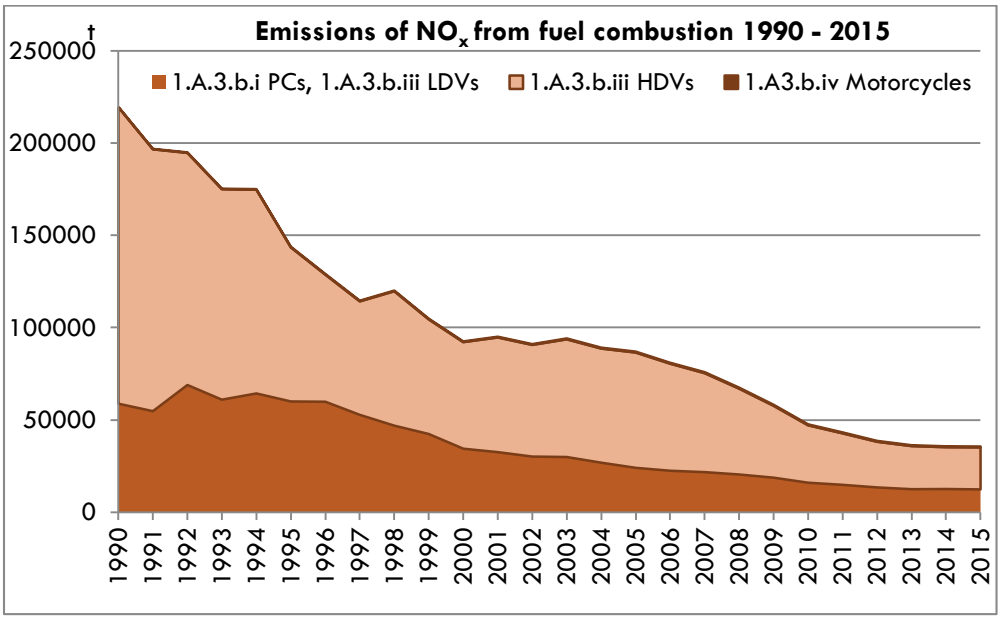

Figure 3-66 Emissions of NO_x from fuel combustion

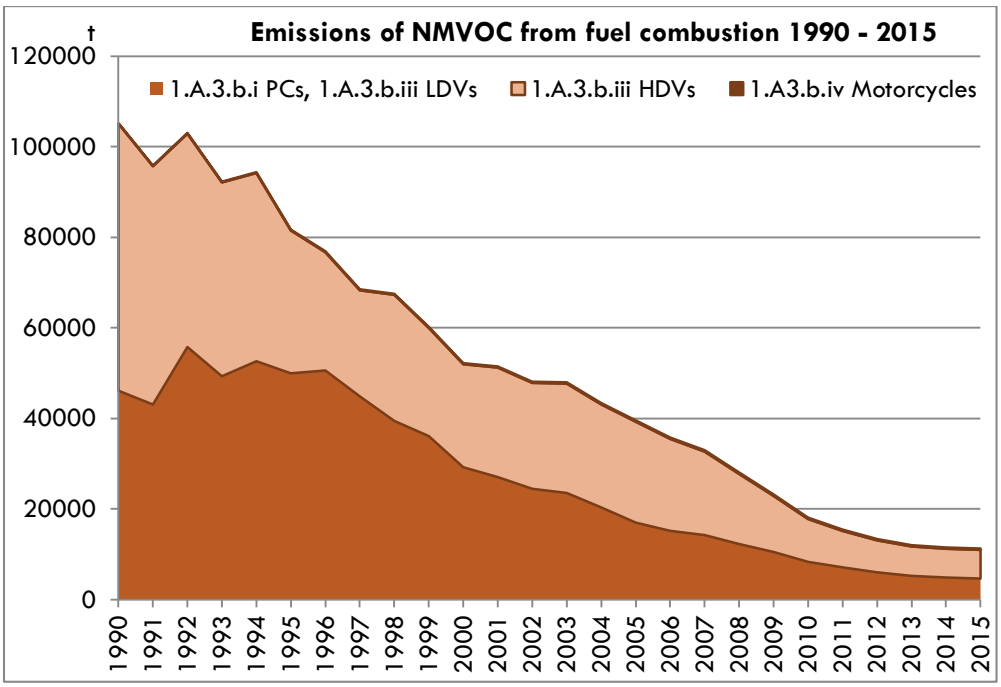

Figure 3-67 Emissions of NMVOC from fuel combustion

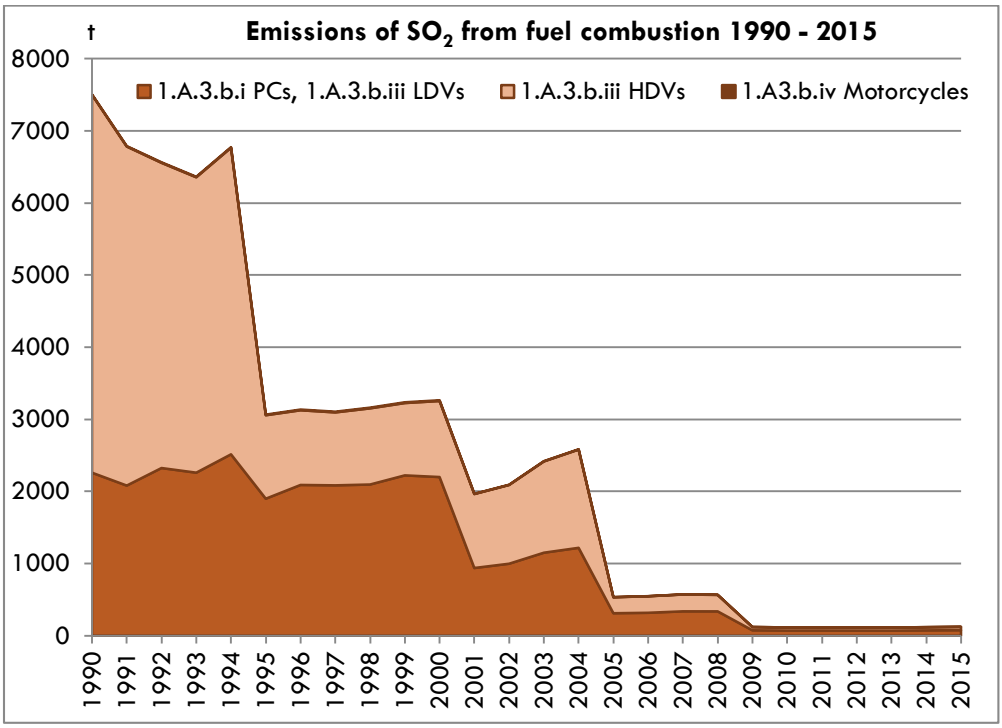

Figure 3-68 Emissions of SO_2 from fuel combustion

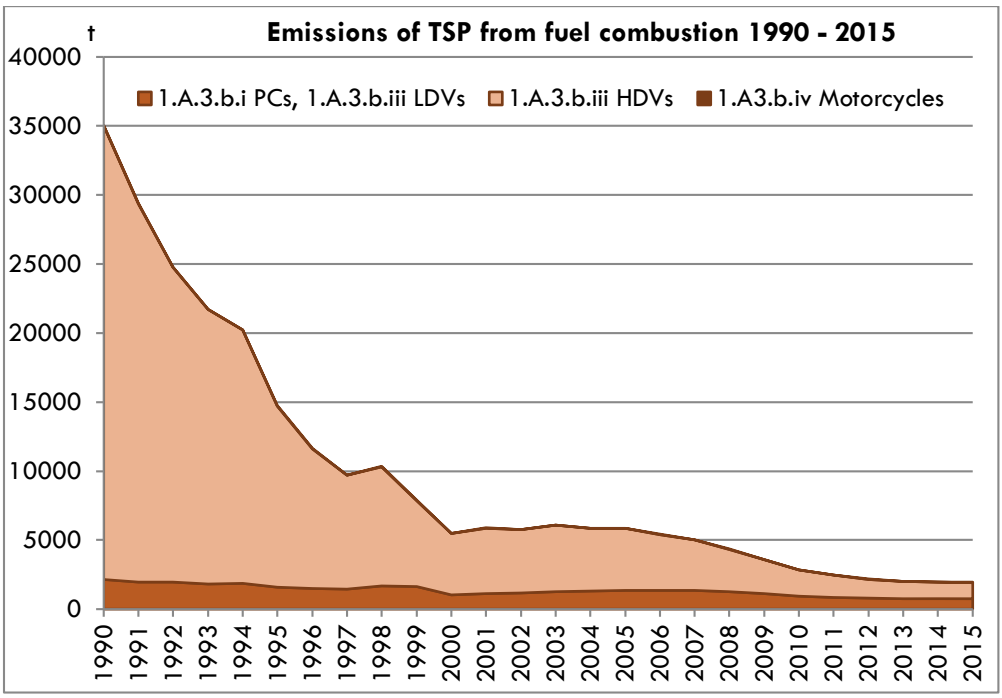

Figure 3-69 Emissions of TSP from fuel combustion

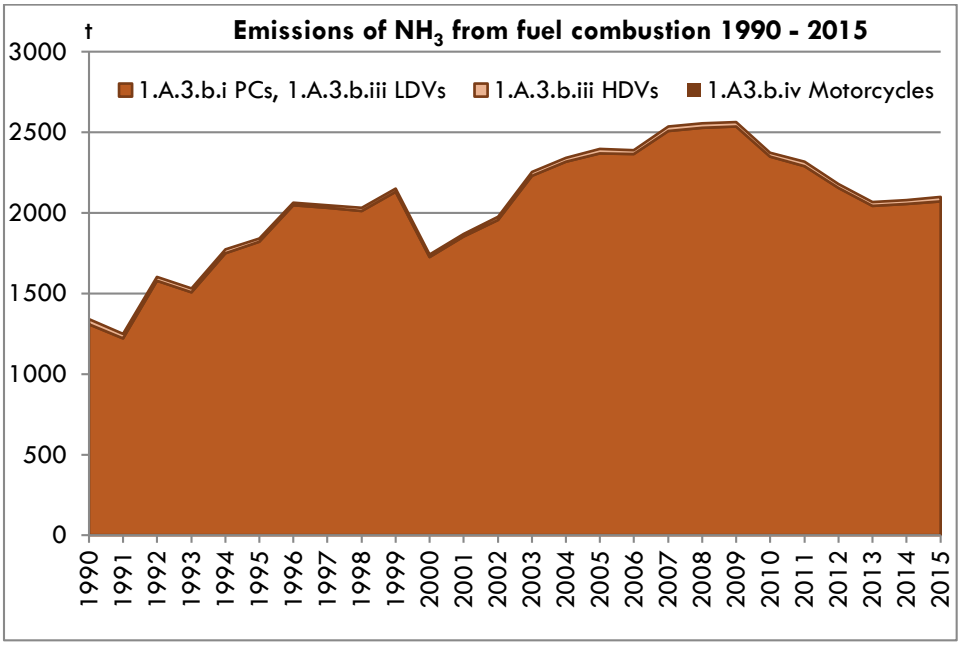

Figure 3-70 Emissions of NH_3 from fuel combustion

3.6.8.5 Source-specific planned improvements

The planned improvements are related mainly to performance of projects to measure other country-specific emission factors in key categories of road transportation. The greatest emphasis will be placed on refinement of methodologies for each category of transport. Next planned improvement is to introduce COPERT 5 for estimating emissions and creating very detailed and accurate car fleet composition methodology based on information database compiled from regular technical control of vehicles which is obligatory for all cars in operation.

For the Agricultural and Forestry non-road mobile sources is planned to calculate a certain share of emission based on emission factors set down by Stage I – Stage III for newer tractors, which are obligated to fulfil these emission parameters.

3.7 NFR 1B1 Fugitive emissions from solid fuels

The source category Solid fuels (1.B.1) consists of three sub-source categories – the source category Coal mining (1.B.1.a), the source category Coal transformation (1.B.1.b) and the source category Other (1.B.1.c).

3.7.1 1B1a Fugitive emissions from solid fuels: Coal mining and handling

This chapter deals with fugitive emissions from coal mining and handling. In the Emission inventory guidebook are listed EF for NMVOC and particulates, but currently does not address the emission of Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, BC.

In the Czech Republic is mined bituminous and lignite coal. Lignite is mined mainly in open cast mining, bituminous coal in underground mining. Emission factors for quantifying particulate emissions are taken from EIG. EFs for NMVOC are adapted to the conditions in the Czech coal mines. EFs depend on geological conditions, the composition and amount of firedamp.

Annual amount extracted coal is shown in Figure 3-71

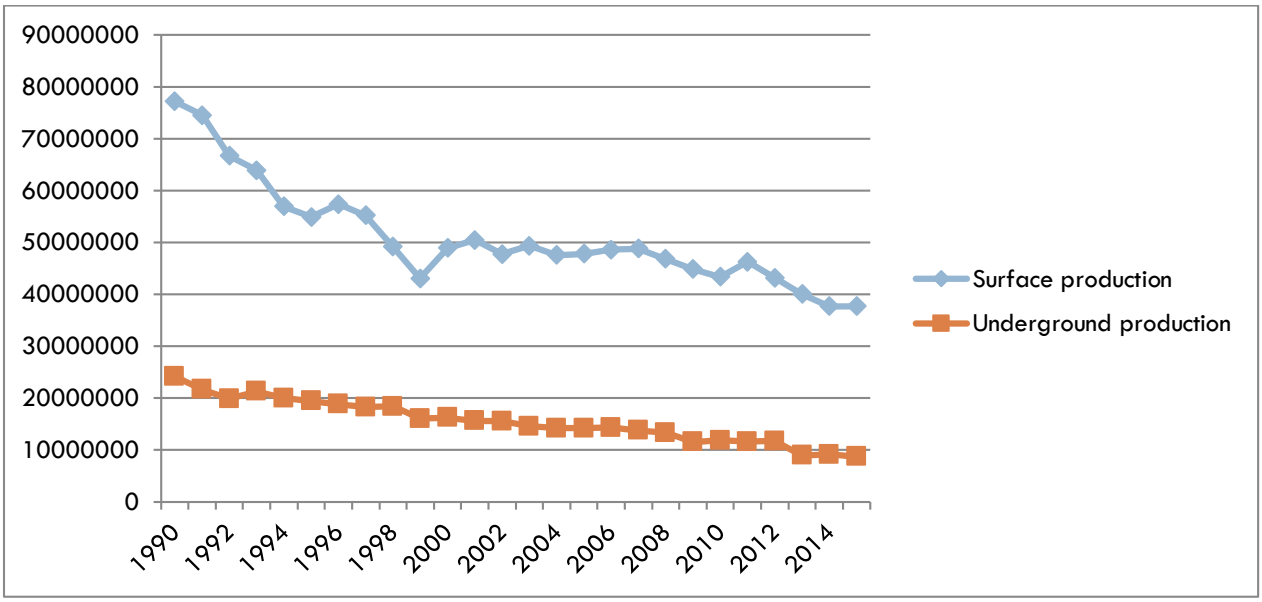

Figure 3-71 The amount of coal extracted 1990–2015

3.7.2 1B1b Solid fuel transformation

In the period 1990–2015, six coking plants were in operation in the Czech Republic, of which three were operated within steelworks. As a consequence of restructuralization of the national economy and the introduction of emission limits in the 1990s these works underwent modernization whereas others decreased or stopped their production. In 1997 production was stopped at the ČSA coking plant, and one year later it also ceased at the coking plant of the Vítkovické železárny steelworks. Coke production decreased further in 2010 when production ended at the Jan Šverma coking plant. Currently there are three operational coke plants with nine coke oven batteries (Table 3-70).

Table 3-67 Summary of coking batteries and their parameters in the year 2015

Coke oven plants	Battery	Count of chambers	Capacity	Type of charging
ArcelorMittal Ostrava a.s.-závod 10-Koksovna	KB1	72	378000 t/year	stamp charging system
ArcelorMittal Ostrava a.s.-závod 10-Koksovna	KB2	72	378000 t/year	stamp charging system
ArcelorMittal Ostrava a.s.-závod 10-Koksovna	VKB 11	60	775000 t/year	top charging systems
OKK Koksovny, a.s. - Koksovna Svoboda	KB 7	50	204000 t/year	stamp charging system
OKK Koksovny, a.s. - Koksovna Svoboda	KB 8	54	214000 t/year	stamp charging system
OKK Koksovny, a.s. - Koksovna Svoboda	KB 9	50	204000 t/year	stamp charging system
OKK Koksovny, a.s. - Koksovna Svoboda	KB 10	56	218000 t/year	stamp charging system
TŘINECKÉ ŽELEZÁRNY, a.s. - Koksochemická výroba	KB 11	72	371400 t/year	stamp charging system
TŘINECKÉ ŽELEZÁRNY, a.s. - Koksochemická výroba	KB 12	72	350000 t/year	stamp charging system

Coke production in the years 2000–2008 was around 3,3 million tonnes. After 2008 it decreased to 2,2 million tonnes due to the economic crisis and limitations of the operation of some coking batteries (Figure 3-72).

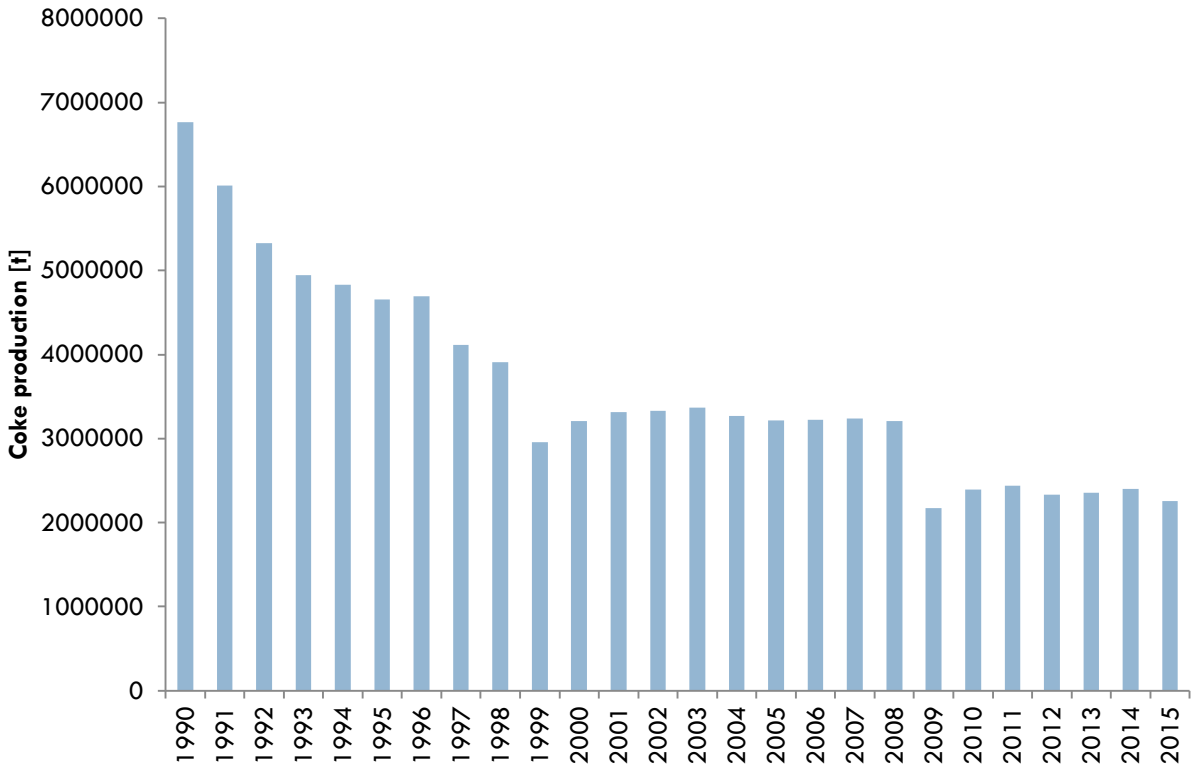

Figure 3-72 Coke production in 1990-2015

From the perspective of emissions inventorying, the process of coke production is divided into six sectors (Table 3-72). These are individually monitored sources listed in Annex 2 to the Law. Emissions from these sources are ascertained by measurements. One exception is the process of coke production, during which fugitive emissions escape due to leakages of coking batteries.

Table 3-68 Mapping of NFR 1A1c and 1B1b source categories to Annex 2 source categories

NFR	Coke production - coking batteries	TSP	SO_X	NO_X	PAH	H_2S	CO	VOC	NH_3	HCN	C_6H_6
1A1c	3.5.1. Coking battery heater	M	M	M			M	M			
1B1b	3.5.2. Coal charge preparation	M						M			
1B1b	3.5.3. Coking	C	C	C	C	C	C	C	C	C	C
1B1b	3.5.4. Coke extrusion	M			M						
1B1b	3.5.5. Coke classification	M									
1B1b	3.5.6. Coke cooling	M									

M – measurement
C – calculation

Individual coking plants differ from each other and do not necessarily include all sources. The preparation of coal charge usually entails storage of coal, grinding of coal, mixing of coal or the processing of tar. For the heating of coking batteries, technical grade coking gas, blast furnace gas or mixed gas is usually used. Besides emissions from leaking coking batteries, the coking process also produces emissions from the extraction, transport and cleaning of crude coking gas and from the processing of chemical products.

Emissions from the coke production process are ascertained according to a unified methodology of quantifying emissions from coking plants[1]. The methodology is based on measuring emissions and visual observation of emissions being released. Measurements are made for one coking chamber of each coking battery during entire coking cycles. The measurements are repeated once every five years. Visual assessment is carried out at least 250 times a year. If a smoke plume smaller than 2 m is detected, the emissions are assumed to be 20-fold higher than measured values of emission flux. If a smoke plume larger than 2 m is observed, the emissions are assumed to be 200-fold the values of the emission flux from a tight source.

The annual amount of emissions from the coking process can be calculated using the following formula:

$$ET(ko)_i = \sum EF(kd)_i \cdot A \cdot 10^{-6}$$

- *$ET(ko)_i$ – annual emission rate of pollutant „i" from the coking of coal charge in one coking battery [t.year^{-1}]*
- *$EF(kd)_i$ emission factor of pollutant „i" for a sub-source during the technological process of coking over the duration of one cycle in one coking chamber [g.cycle^{-1}]*
- *A – overall number of cycles per year for one coking battery [cycle.year^{-1}]*

The following applies to coking batteries with stamp charging operation:

$$EF(kd)_i = EF_i \cdot k_{1-5} \cdot \left(k_0 \cdot \frac{Pt_{1-5}}{Pp_{1-5}} + k_{20} \cdot \frac{Pn_{1-5}}{Pp_{1-5}} + k_{200} \cdot \frac{Ps_{1-5}}{Pp_{1-5}}\right)$$

The following applies to coking batteries with top charging operation:

$$EF(kd)_i = EF_i \cdot k_{1-6} \cdot \left(k_0 \cdot \frac{Pt_{1-6}}{Pp_{1-6}} + k_{20} \cdot \frac{Pn_{1-6}}{Pp_{1-6}} + k_{200} \cdot \frac{Ps_{1-6}}{Pp_{1-6}}\right)$$

- *EF_i – emission factor of pollutant „i" over the duration of one cycle for one coking chamber; it is ascertained by measuring leakages from furnace doors [g.cycle^{-1}]*
- *Pp – number of units in operation; arithmetic mean of the number of sub-sources of emissions in operation per year calculated based on all observations made*
- *Pt – number of tight units; arithmetic mean of the number of tight sub-sources per year calculated based on all observations made; Pt = Pp – Pn – Ps*
- *Pn – number of leaking units; arithmetic mean of the number of leaking sub-sources per year calculated based on all observations made*
- *Ps – number of unadjusted units; arithmetic mean of the number of unadjusted sub-sources per year calculated based on all observations made*
- *k_0, k_{20}, k_{200} – correction coefficients for source tightness (Table 3-75)*
- *k_{1-5} – contribution coefficients for coking batteries with stamp charging operation*
- *k_{1-6} – contribution coefficients for coking batteries with stamp charging operation*

[1] Surý, A., Čech, L., 2011. Jednotný metodický postup vyčíslování emisí z koksoven České republiky. HUTNÍ PROJEKT Frýdek-Místek.

Emission rates from sub-units are quantified by estimation based on the proportionality to measured values of emissions from furnace doors of the corresponding coking battery (Table 3-73 and Table 3-74).

Table 3-69 Proportionality between sub-sources during the coking process – stamp charging operation

Source	Proportional contribution [%]	k_{1-5}
doors on the machine side	35	0,35
doors on the coke side	35	0,35
connecting (suction) openings	15	0,15
shafts	5	0,05
other emission sources	10	0,1

Table 3-70 Proportionality between sub-sources involved in the coking process – with top charging operation

Source	Proportional contribution [%]	k_{1-6}
doors on the machine side	25	0,25
doors on the coke side	25	0,25
comparison doors	10	0,1
shafts	10	0,1
filling openings	20	0,2
other emission sources	10	0,1

Table 3-71 Correction for operational state assessed visually for the determined percentage of tight, leaking and unadjusted sources

$k_0 = 1$	tight sources (no smoke plume detected by visual observation)
$k_{20} = 20$	leaking sources (smoke plume smaller than 2 m detected by visual observation)
$k_{200} = 200$	unadjusted sources (smoke plume larger than 2 m detected by visual observation)

Until 2008, in accordance with the legislature current at the time (Decree 356/2002 Coll.), PAH emissions were measured as the sum of ten congeners:

- *fluoranthene*
- *pyrene*
- *benzo(a)anthracene*
- *chrysene*
- *benzo(b)fluoranthene*
- *benzo(k)fluoranthene*
- *benzo(a)pyrene*
- *dibenzo(a,h)anthracene*

- *benzo(g,h,i)perylene*
- *indeno(1,2,3-cd)pyrene*

Since 2009 PAH emissions are measured as the sum of four congeners: benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene. For the purpose of estimating emissions of individual congeners, their contributions to the total sum of PAH were obtained by analysing protocols from one-off measurements (Table 3-76).

Table 3-72 Contributions of individual congeners to the total sum of PAH

Process	benzo(a)pyrene		benzo(b)fluorantene		benzo(k)fluorantene		indeno(1,2,3-cd)pyrene	
	% 10PAH	% 4PAH	% 10PAH	% 4PAH	% 10PAH	% 4PAH	% 10PAH	% 4PAH
Coking	5	25	7	41	4	20	2	14
Coke extrusion	5	23	7	42	4	21	2	14

3.7.3 1B1c Other fugitive emissions from solid fuels

This category includes emission of coal sorting and drying mainly in sorting plants producing coal for household consumption, coke plants and wood coal production emissions. Emission for coal sorting plants are usually based on one-time measurement of suction devices. Wood coal production emissions are being measured while putting the facility in the operation and for annual reporting specific production emissions are being used.

3.8 NFR 1B2 Fugitive emissions from oil fuels – Refining, storage and distribution

The chapter will supplied later.

4 INDUSTRIAL PROCESSES (NFR SECTOR 2)

In the inventorying system of the Czech Republic, emissions from industrial processes not listed in Annex 2 to Act No. 201/2012 Coll. are monitored. Emissions from these sources are ascertained by source operators themselves, who carry out authorized measurements or in exceptional cases by computations using emission factors. Inventorying of emissions from processes not listed in Annex 2 is done according to methodologies contained in EIG 2013. In cases of processes involving solvent use, emissions are determined based on a material balance based on statistics of production and imports, data from the largest producers and users, etc. A number of industrial processes belong to key categories.

The following chapters describe the method of assigning sources listed in Annex 2 to NFR sectors. Unless stated differently, emissions of all reported substances were ascertained by source operators themselves (Tier 3 approach).

4.1 NFR 2A Mineral products

Industrial processing of mineral raw materials represent a broad group of activities that incorporate significant sources of emissions. Fuel combustion emissions by raw materials processing are included in NFR sector 1A2f, processing emissions are divided among sectors NFR 2A1 – 2A6. NFR sector 2A5a Mining of raw materials (coal excluded) belonged in 2015 to key sources of $PM_{2.5}$ (5,3 %), PM_{10} (6,5 %) and TSP (7,7 %) emissions. NFR sector 2A3 – glass production belonged to key categories As (15,1 %) and Ni (10,0 %). Activity data of the most important production facilities are based on REZZO database in cooperation with CZSO, SVV and SVC (Figure 4-1)

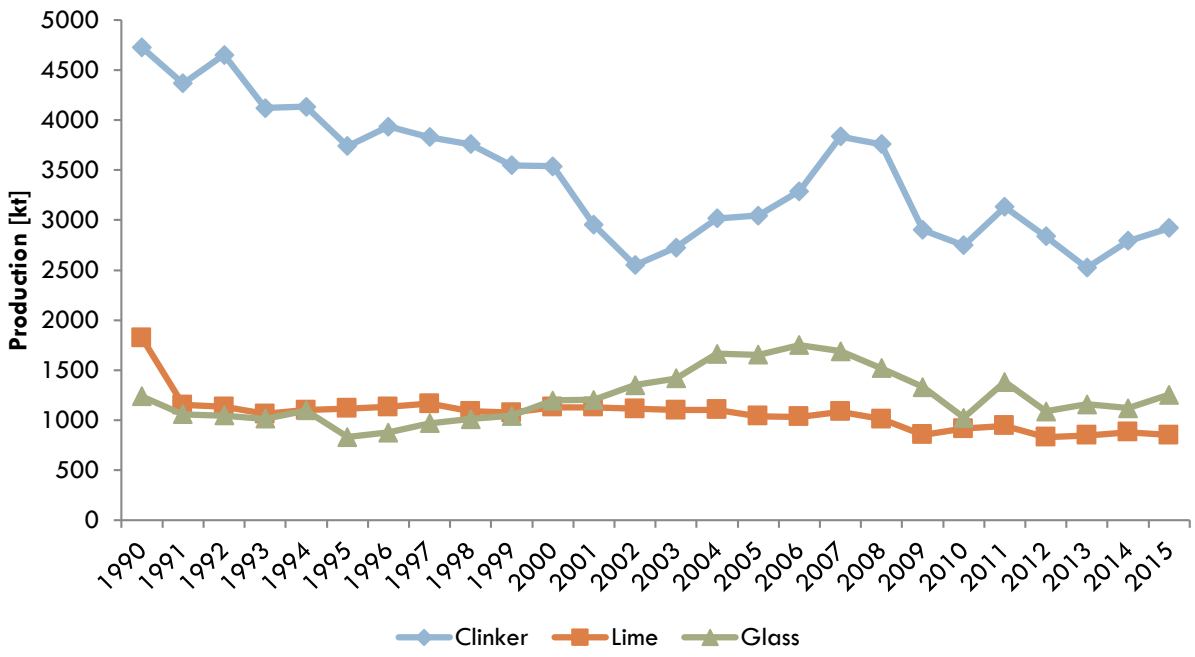

Figure 4-1 Trend of clinker, lime and glass production in 1990–2015

4.1.1 Production of cement clinker, lime, treatment of fire-resistant clays and desulfurization products

In the period 2000–2003 six factories producing cement and six factories producing lime operated in the Czech Republic. Since 2004 their number in both fields dropped to five. All cement factories produced cement clinker in rotary furnaces using a dry process with preheating. The largest emissions from the production of cement occur during clinker production in rotary furnaces, which use ground coal as fuel, and fuel oils or natural gas, meat-and-bone products, waste oils, pretreated wastes, alternative fuels and sludge. Emissions from these sources are comprised under sector NFR 1A2f. Emissions produced during the handling of raw materials and products are reported under sector NFR 2A1. Emissions from the mining of raw materials for the production of cement belong to sector NFR 2A5a. Emissions by handling the raw material or product are based on one-time measurements in prescribed intervals. Emissions of TSP, NOx, SO_2, CO, NH_3, HF and HCl for clinker production in rotary kilns are being measured continuously. Emissions of Cd, Tl, Hg, Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V and PCDD/F are being ascertained by one-time measurement twice a year. Emissions of PCB and PAH, that have prescribed measurement interval once a three years, are being estimated on the basis of national emission factors and amount of clinker production (Table 4-1). For other substances emission factors from the EIG 2016-Tier 2 [1] approach had been used.

Table 4-1 Production of cement clinker in rotary kilns – emission factors

PCBs	BaP	BbF	BkF	InP	Total_PaH
$\mu g.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$
3,355	0,004	0,003	0,004	0,003	0,014

Lime is produced in rotary or shaft furnaces. The fuels used are natural gas, fuel oils, ground coal or coke. To a lesser extent, meat-and-bone products, waste oils and alternative fuels are used as fuel supplements. Emissions from the production of lime are comprised under sector NFR 1A2f, emissions of raw material handling in NFR sector 2A5a and emissions of other sources in NFR sector 2A2. Emissions of sources in the category raw material or product handling are being ascertained by one-time measurement in prescribed intervals. Shall by lime burning in shaft furnaces natural gas, fuel oil, coal or coke be used, emissions of TSP, SO_2, NOx and CO are being ascertained by one-time measurement once a year. Should as additional fuel various waste oils be used, there are furthermore once a three years emissions of heavy metals, PCDD/F, HF and HCl measured. In case of rotary kilns lime production using beside standard fuel a waste co-combustion, the conditions for emissions ascertainment are similar to cement clinker production. Emission factors for heavy metals and POPs by lime production hadn´t been set yet, therefore emission inventory only includes reported emissions of sources operators.

Other emission sources belonging to the sector of mineral products are represented by furnaces for processing desulfurization products (flue gas desulfurization gypsum) and rotary furnaces for baking chamotte and kaolin. Emissions from these sources, being ascertained by one-time measurement in prescribed intervals, are comprised under sector NFR 1A2f.

Table 4-2 Mapping of NFR 2A1 and 2A2 source categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Production of cement clinkers, lime, treatment of fire-resistant clays, and desulphurization products	
2A1; 2A2	5.1.1. Handling raw materials and products, including storage and shipping
1A2f	5.1.2. Production of cement clinkers in rotary furnaces

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Production of cement clinkers, lime, treatment of fire-resistant clays, and desulphurization products	
1A2f; 2A1*	5.1.3. Other technological equipment for cement production
1A2f	5.1.4. Lime production in rotary furnaces
1A2f	5.1.5. Lime production in shaft furnaces and other furnaces
1A2f	5.1.6. Furnaces for processing desulphurization products
1A2f	5.1.7. Treatment and refinement of fire-resistant clays and china clays in rotary furnaces
***processes without fuel**	

4.1.2 Production of glass including glass fibres

The production of glass is an energy-intensive high-temperature activity producing emissions caused by oxidation of combustion air and vaporization of compounds contained in raw materials present in molten glass mixtures. In the Czech Republic in 2015 there were 64 operational glass works that melt glass. Of the total amount of glass produced, 41,4 % was drawn sheet glass, 33,6 % was container glass, 10,4 % was glass fibres and 14,6 % was utility, lighting and other glass. The Czech glass and costume jewellery industry uses two energy sources – natural gas and electric energy. Electricity dominates in the field of processing, and natural gas dominates in the field of melting. Electricity is, however, widely used also for melting, which is a certain speciality of the Czech Republic. Emissions TSP, SOx, NOx, CO, VOC a NH_3 from processes involved in melting and from combustion during the processing and refinement of glass, being ascertained by one-time or continuous measurement, were assigned to sector NFR 1A2f. Emissions from the preparation of molten glass mixtures and other processes were comprised under sector NFR 2A3.

Table 4-3 Mapping of NFR 2A3 source categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Production of glass including glass fibres	
1A2f; 2A3*	5.3. Production of glass, fibre, glass products, enamel, and sintered glass for glazing and glass for jewellery processing
1A2f	5.4. Production of composite glass fibres with the use of organic binders
1A2f; 2A3**	5.5. Glass processing and refinement (polishing, painting, crushing, smelting of semi-finished product or shards, production of jewellery and other articles) with a projected capacity exceeding 5 tons of processed glass raw materials per year
2A3	5.6. Chemical glass polishing
***heavy metals and POPs emissions**	
****processes without fuel**	

n all glass work melting furnaces of projected melting capacity higher than 150 t/year are being ascertained by one-time measurement with interval once a year for emissions of Pb, Sb, Mn, V, Sn, Cu, Co, Ni, Cr, As, Cd, Se, HF and HCl. Emissions of heavy metals depend on the sort of the molten glass material, the composition of which vary among individual glassworks based on the input material, melting substances and pigments. For that reason, measured values of individual glassworks are being preferred for emission inventory. For assessment of heavy metals emissions by glass melting furnaces with projected capacity lower than 150 t/year emission factors according EIG 2016-Tier 1 [9] had been used. Emissions of heavy metals for glass melting furnaces are comprised in NFR sector 2A3.

4.1.3 Smelting of mineral materials, including mineral fibres production

The group of sources belonging to the Mineral products category also comprises the production of heat-resistant ceramics and the production of special insulating building materials. Cupola furnaces are being used for smelting of mineral materials that are sources of TSP, SO_2, NOx, CO, HF and HCL emissions. These processes are being followed-up by production of composite mineral fibres using organic binders that emit TSP, NOx, VOC, NH_3, phenol and formaldehyde. Emissions of these pollutants are being ascertained by continuous measurement or by one-time measurement in prescribed intervals. For the estimate emissions of heavy metals and POPs, emission factors hadn´t been determined yet. The assignment of these sources to NFR sectors is presented in Table 4-4.

Table 4-4 Mapping of NFR 2A6 source categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Smelting of mineral materials, including mineral fibre production	
1A2f; 2A6*	5.7. Processing of magnesite and production of basic fire-resistant materials, silica, etc.
1A2f	5.8. Smelting of mineral materials in cupola furnaces
1A2f; 2A6*	5.9. Production of composite glass fibres with the use of organic binders
***processes without fuel**	

4.1.4 Production of ceramic products

Emissions from the production of ceramics belong to article 5.10. Production of ceramic products by means of firing, in particular roofing tiles, bricks, fire-resistant blocks, facing tiles, ceramic wares or porcelain in Annex 2 to No. 201/2012 Coll. were comprised under sector NFR 1A2f. Emissions from the preparation and mixing of materials were comprised under sector NFR 2A6.

4.1.5 Production of construction materials, mining and processing of stones, minerals and fuels of surface mines

The determination of emissions in surface mines of fuels is described in chapter 3.7.1. Emissions from quarrying and mining of minerals other than coal depend on the processes that take place in the quarry. When ascertaining TSP emissions, operators uniformly use national emission factors (Table 4-6) listed in the methodological guidelines of the Ministry of the Environment [2]. Among other emission sources in this branch (Table 4-5) there belong preparation of construction materials and concrete. Emission of these sources are being monitored based on one-time measurements.

Table 4-5 *Mapping of NFR 2A5a source categories to Annex 2 source categories*

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Production of construction materials, mining and processing of stones, minerals, and fuels from strip mines	
2A5a	5.11. Quarrying and stone processing, refined stone production, mining, treatment, and processing of gravel (natural and artificial) with a projected output of over 25 m3/day
1A2f; 2A5a*	5.12. Preparation of construction materials and concrete, recycling lines for construction materials with a projected output of over 25 m3/day

1B1a; 2A5a**	5.13. Strip mines for fuel, ore, mineral raw materials and processing thereof, primarily the mining, drilling, dredging, separation, milling, and transportation with a projected output of over 25 m3/day
1A2f	5.14. Packaging plants for bituminous mixtures and asphalt mixing plants, recycling of asphalt surfaces
***processes without fuel** ****strip mines of fuel**	

Table 4-6 Quarrying and mining of minerals other than coal – emission factors

Technology process - devices	EF TSP in $g.t^{-1}$ processed stone					
	Dry material			Wet material[1)] (1,5 - 4% weight)		
	Uncontrolled[2)]	Cyclone, misting systems[3)]	Fabric filter[4)]	Uncontrolled[2)]	Cyclone, misting systems[3)]	Fabric filter[4)]
Drilling	10	10	0,4	10	10	0,3
Loading and unloading of stone	0,2	0,2	0,2	0,1	0,1	0,1
Line for stone treatment						
1) Primary crushing (PC)	150	34	4	10	4	2,5
2) Primary screening	140	13	3	8	3	2
3) Conveyor Transfer Points behind PC	100	10	3	5	3	2
4) Secondary crushing	222	97	8	13	5	5
5) Secondary and another screening	210	35	4	12	4	2,5
6) Conveyor Transfer Points behind another crushing	150	15	3	8	3	2
7) Tertiary and another crushing	930	205	15	56	28	10
Notes:						
1) When determining emission factors depending on humidity, humidity is determined by drying the material at 105 °C.						
2) Quarry without any separation, without covering of technologies and transport routes.						
3) Quarry equipped with cyclones or misting systems (or a different equivalent device) with covered technologies.						
4) Quarry with covered technologies equipped with fabric or other equivalent filters.						

In 2015 there were 102 registered hot mix plants. Gaseous and liquid fuels, exceptionally dust coal are used for heating and drying of mixtures. The amount of hot mixtures production in hot mix plants is a part of REZZO database (Figure 4-2). Emissions of TSP, SO_2, NOx and CO are being determined on the basis of one-time measurements in regular intervals.

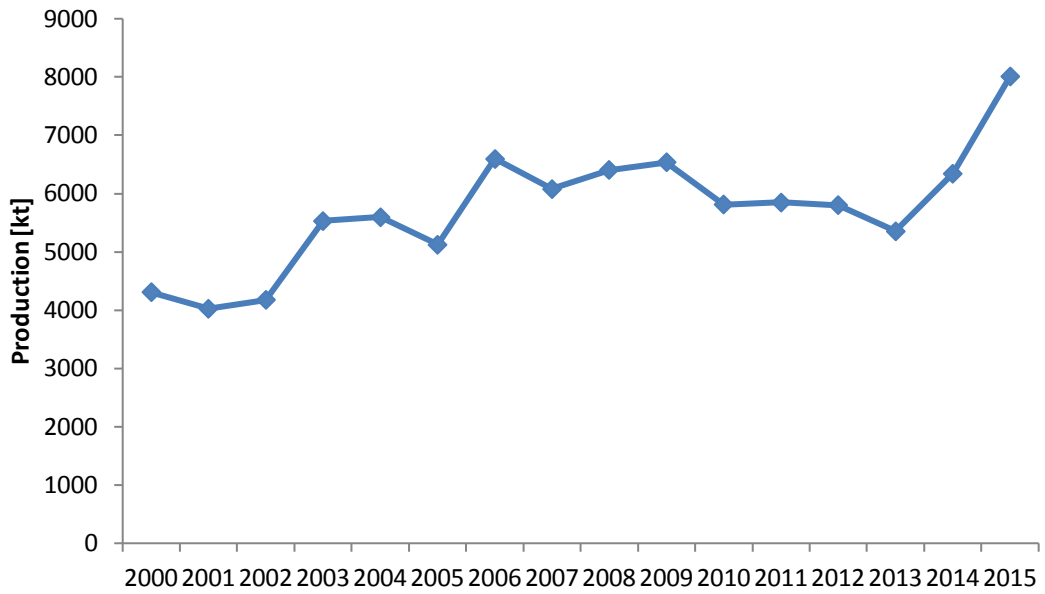

Figure 4-2 Trend of asphalt mixes production in 2000-2015

The production of asphalt mixes causes emissions of PAH. Emission estimates of these substances are being carried out using national emission factors derived from measurements taken from several sources (Table 4-7).

Table 4-7 PAH emission factors for asphalt mixes production

B(a)P	B(b)F	B(k)F	I(d)P	PAH	Unit
0,016333	0,0455	0,0225	0,0205	0,104833	mg.t-1 mixes

4.1.6 Construction and demolition

Sector NFR 2A5b comprises fugitive emissions TSP, PM_{10} and $PM_{2.5}$ from the construction of residential and non-residential buildings (e.g. hotels, shopping centers, schools, etc.). The emission inventory does not comprise emissions from the construction of transport infrastructure and industrial objects. The statistics do not provide information about demolitions.

The activity information used is the floor area of buildings approved for use in the given year (Figure 4-3). In the Czech Republic these data are processed by the Czech Statistical Office, which maintains a database of floor areas of residential buildings going back to 1997 and of non-residential buildings since 2005. For this reason, emissions from sector NFR 2A5b are reported only since 2005.

To calculate the emissions, emission factors from the CEPMEIP database were used (Table 4-8).

Table 4-8 Emission factors for building construction

Poll.	Residential buildings	Non-residential buildings	Unit
TSP	0,21515	0,12268	$kg.m^{-2}$
PM_{10}	0,10757	0,06134	$kg.m^{-2}$
$PM_{2.5}$	0,01075	0,00613	$kg.m^{-2}$

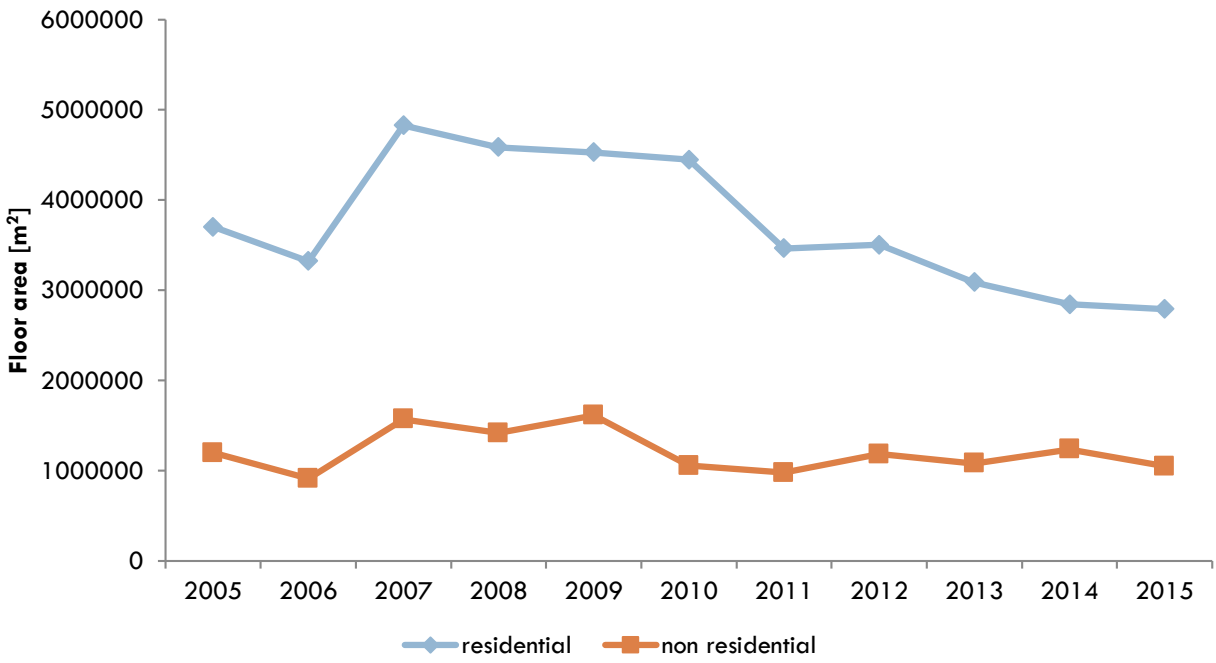

Figure 4-3 Trend of building floor area in 2005-2015

4.2 NFR 2B Chemical industry

The chemical industry represents one of the largest industrial branches in the Czech Republic with production of a wide range of organic and inorganic substances. Emissions of combustion processes in this sector are being reported in NFR sector 1A2c. Process emissions for named sorts of production include NFR sectors 2B1–2B7. Process emissions for production and processing of other inorganic substances, the whole production and processing of organic substances are included in NFR sector 2B10a (Table 4-9). Activity data of main productions are based on REZZO database and CZSO data (Figure 4-4). NFR sectors 2B do not belong to key categories. Emissions of these sources are being determined on the basis of one-time measurements of the sources operators in prescribed intervals. There is one exception – emissions for ammonia production, estimated with EIG 2016-Tier 1 emission factors [11].

An important component of the chemical industry is refineries, which ensure the basic processing of crude oil and the production of petrochemical products. Emissions from the production of sulfur from crude oil (the Claus process) are reported under sector NFR 1B2aiv. The Claus process is also used in the production of sulfur during tar processing and in the processing of benzol in coking plants. Emissions from these processes are comprised under sector NFR 2B10a.

Chlorine production by amalgam electrolysis is a source of Hg emissions. Emissions of other heavy metals take place for example by production of phosphoric acid by thermic method, in production of accumulator fillings or agents for galvanic plating and metallurgy. Emissions of PCDD/F are being monitored in production of dichlorinethane and vinyl chloride. Emissions of PAH occur in production and processing of tar.

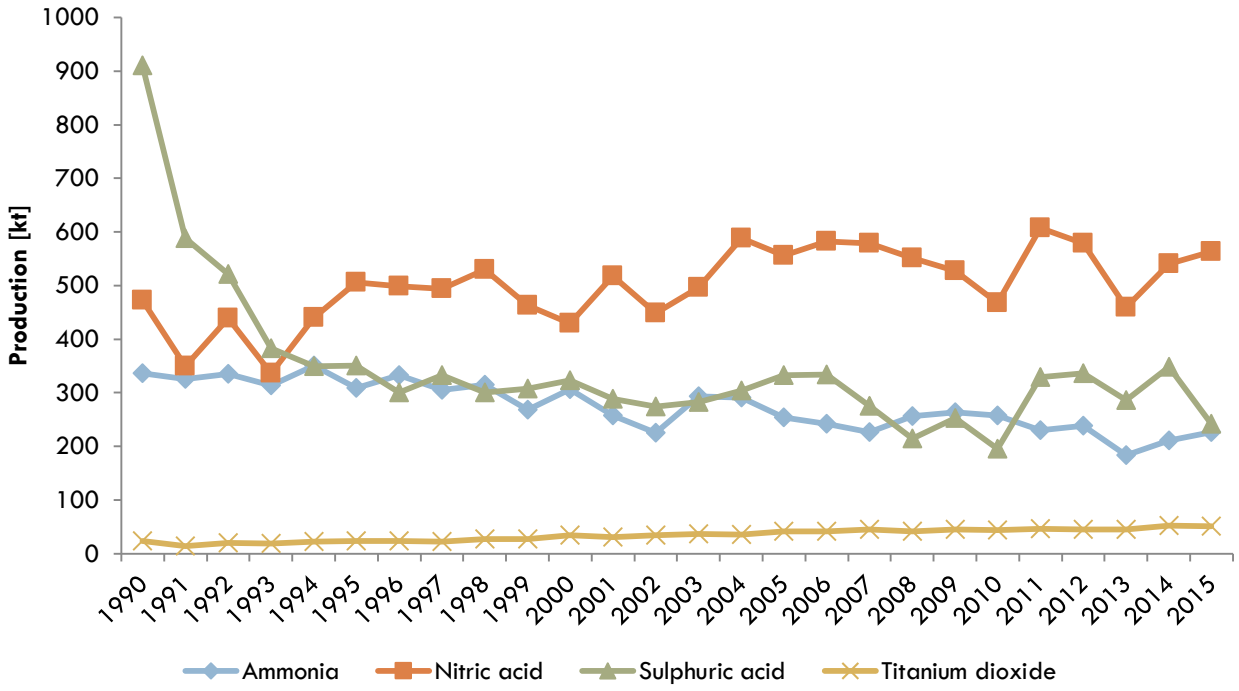

Figure 4-4 Trend of ammonia, sulfur acid and nitric acid production in 1990–2015

Table 4-9 Mapping of NFR 2B source categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll. Production and processing of organic substances and products containing them
2B10a	6.1. Production of 1.2 dichlorethane and vinyl chlorides
2B10a	6.2. Production of epichlorhydrine (1-chlorine-2.3-epoypropane) and allyl chloride (1-chlorine-2-propene)
2B10a	6.3. Production of polymers on the basis of polyacrylonitrile
2B10a	6.4. Production of 1.2 dichlorethane and vinyl chlorides
2B10a	6.5. Production and processing of other synthetic polymers and production of composites, with the exception of composites specified elsewhere
2B10a	6.6. Production and processing of viscose substances

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Production and processing of organic substances and products containing them	
2B10a	6.7. Production of auxiliary preparations for rubber production
2B10a	6.8. Tar processing
2B10a	6.9. Production of expanding polystyrene
2B10a	6.10. Acetylene production using the wet method
Production of inorganic substances	
2B10a	6.11. Chlorine production
2B10a	6.12. Hydrochloric acid production
1B2aiv; 2B10a	6.13. Sulfur production (Claus process)
2B10a	6.14. Liquid sulfur dioxide production
2B10a	6.15. Sulfuric acid production
2B1	6.16. Ammonia production
2B2	6.17. Production of nitric acid and salts thereof
2B10a	6.18. Fertilizer production
2B10a	6.19. Production of basic agents to protect plants and biocide production
2B10a	6.20. Production of explosives
2B10a	6.21. Sulfate process in titanic oxide production
2B10a	6.22. Chloride process in titanic oxide production
2B10a	6.23. Production of other pigments

4.3 NFR 2C Metal production

This sector includes primary metal production, metal processing, foundries and surface treatment of metals, plastics and non-metal objects. Metal production, namely iron and steel production belong long-time to most significant emission sources in the Czech Republic. NFR sectors 1A2a and 2C1 were among the key sources of CO, heavy metals (Pb, Cd, Hg, Cr, Ni, Zn), PCDD/F and PCBs. NFR sector 2C3 delivered high portion of Cd emissions and NFR sector 2C5 was a key source of As. Activity data were collected on the REZZO database and sectoral statistics HŽ a.s. (Figure 4-5).

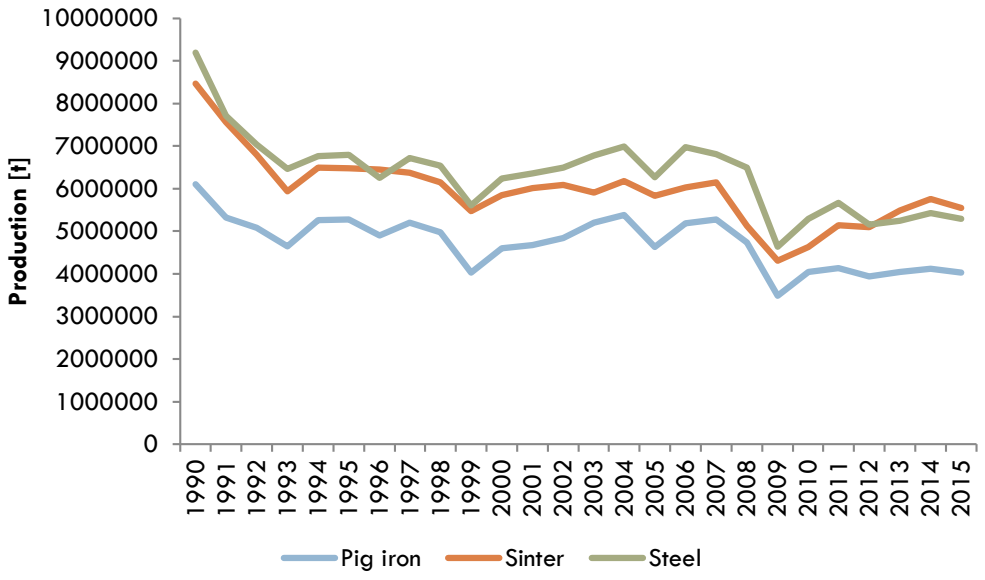

Figure 4-5 Trend of pig iron, steel and sinter production in 1990–2015

4.3.1 Iron production

In the Czech Republic there were three works with integrated metals production in 1990-2015 (VÍTKOVICE, a.s., ArcelorMittal Ostrava, a.s., TŘINECKÉ ŽELEZÁRNY, a.s.), which comprises the production of coke, processing of iron ore, the production of agglomerate, production of pig iron in blast furnaces and production of steel. Due to the fact that the production facility of VÍTKOVICE, a.s. was close to housing estate and high abatement technology costs, the production ended in 1998. Other factories are starting with the production of steel in electric arc furnaces.

Iron ore, coke and other raw materials are being sintered on the sintering belts in agglomerate that is part of material input into blast furnaces. The palletization process is not being used in Czech Republic. Emissions from charge preparation (coke and lime milling) and manipulation with the agglomerate (removals, de-dusting of cooling belts) and its processing are being set by one-time measurement in prescribed intervals. Emissions of TSP, SO_2, NOx and CO from sintering belts are being measured continuously. One-time measurements of heavy metals emissions (Sn, Cr, Mn, Cu, Pb, V, Zn, Hg) and PCDD/F took place in 2001-2013 once a year, emissions of Cd, As, PCB and PAH once a three years. Changes in integrated source permits with gradual improvement (Table 4-11) of the sources lead in 2013 in annual one-time emission only of Hg and PCDD/F once a five years. On the basis of results of one-time measurements, emission factors for Pb, Cd, Hg, As, Cr, Cu, Zn, PCDD/F, PAH and PCBs that are being used emission inventory of sintering belts according UN CLRTAP (Table 4-11, Table 4-12). Emission factors for Ni, Se, HCB had been taken from EIG 2016-Tier 2 (Table 3.7) [12]

Table 4-10 Mapping of NFR 2C1 source categories to Annex 2 source categories (iron and steel)

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Calcination or sintering of metal ore, including sulfide ores	
2C1	4.1.1. Charge preparation

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
1A2a	4.1.2. Sintering belt agglomeration
2C1	4.1.3. Manipulation via sintering such as cooling, crushing, grinding, separation
1A2a; 2C1*	4.1.4. Palletization operations (crushing, drying, palletization)
Iron production	
2C1	4.2.1. Transport and handling of blast-furnace charge
2C1	4.2.2. Casting (blast furnace)
1A2a	4.2.3. Air heaters
Steel production	
2C1	4.3.1. Transportation and handling of charge or product
2C1	4.3.2. Hearth furnace with oxygen intensification
2C1	4.3.3. Oxygen converter
2C1	4.3.4. Electric arc furnaces
2C1	4.3.5. Slag furnaces
2C1	4.3.6. Electrical induction furnaces with projected output of over 2.5 t/hour
Ferrous metal processing in rolling mills and forges	
1A2a; 2C1*	4.4. Rolling mills under heat and cold, including heating furnaces and furnaces for heat processing
1A2a; 2C1*	4.5. Forges - heating furnaces and furnaces for heat processing
*processes without fuel	

Table 4-11 Sintering belts of agglomeration and abatement equipment overview

IDFPROV	Plant name	Source	Sintering belt	1990	1996	1998	2009	2011	2015
714220271	ArcelorMittal Ostrava a.s.-závod 12-Vysoké pece	101	Sintering belt A	MC	ESP	ESP	ESP	BF	BF
714220271	ArcelorMittal Ostrava a.s.-závod 12-Vysoké pece	102	Sintering belt B	MC	ESP	ESP	ESP	BF	BF
714220271	ArcelorMittal Ostrava a.s.-závod 12-Vysoké pece	103	Sintering belt C	MC	ESP	ESP	ESP	BF	BF
714220271	ArcelorMittal Ostrava a.s.-závod 12-Vysoké pece	104	Sintering belt 4	ESP	ESP	ESP	ESP	ESP	ESP
714220271	ArcelorMittal Ostrava a.s.-závod 12-Vysoké pece	105	Sintering belt 5	ESP	ESP	ESP	ESP	ESP	ESP
770890561	TŘINECKÉ ŽELEZÁRNY,a.s. - Výroba surového železa	101	Sintering belt č. 1	ESP	ESP	ESP	BF	BF	BF
770890561	TŘINECKÉ ŽELEZÁRNY,a.s. - Výroba surového železa	102	Sintering belt č. 2	ESP	ESP	ESP	BF	BF	BF
770890561	TŘINECKÉ ŽELEZÁRNY,a.s. - Výroba surového železa	104	Sintering belt č. 3	ESP	ESP	ESP	ESP	ESP	BF
770890561	TŘINECKÉ ŽELEZÁRNY,a.s. - Výroba surového železa	105	Sintering belt č. 4	ESP	ESP	ESP	ESP	ESP	BF
714070111	VITKOVICE A.S.- VYSOKE PECE	105	Sintering belt č. 1	MC	MC	-	-	-	-
714070111	VITKOVICE A.S.- VYSOKE PECE	105	Sintering belt č. 2	MC	MC	-	-	-	-
714070111	VITKOVICE A.S.- VYSOKE PECE	105	Sintering belt č. 3	MC	MC	-	-	-	-
714070111	VITKOVICE A.S.- VYSOKE PECE	105	Sintering belt č. 4	MC	MC	-	-	-	-

MC - multicyclone

ESP - electrostatic separator

BF - bag filter

Table 4-12 Sintering belt agglomeration - heavy metals emission

Abatement	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$
Dry ESP	2137,674	47,179	34,652	14,518	146,178	749,279	0,250	20,000	2595,790

Bag filter	61,946	3,052	34,652	1,499	56,146	93,062	0,250	20,000	451,987

Sintering belt agglomeration – POPs emission factors

Abatement	PCDD/F	BaP	BbF	BkF	InP	4PAH	HCB	PCB
	µg TEQ.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	µg.t^{-1}
Dry ESP	7,304	2,333	23,544	6,945	7,992	40,814	0,030	113,223
Bag filter	1,048	0,012	0,108	0,026	0,012	0,158	0,030	47,780

Iron ore in the form of agglomerate, coke and other inputs are being transported into blast furnaces where they melt during complicated processes and change in pig iron. Bell-less charging systems are being used for material input, isolated by blast furnace gas before opening so that the blast furnace atmosphere leak in the input chamber and environment consequently. There are emissions of TSP while transport and handling the input material and emission of CO originated from the blast furnace gas containing CO. The integrated permit contains emission factors of CO for each blast furnace to assess the emissions that may vary with applied abatement technique (TSP 17-22 g.t^{-1} of pig iron, CO 750 g.t^{-1} of pig iron). Preheated air flows into blast furnace through the air heaters burning blast furnace gas, coke or natural gas. These sources are being equipped with continuous CO monitoring. Emission monitoring of NOx and SO_2 is being assessed during one-time measurement once a year. Emissions by pig iron casting in casting halls are being suck away and cleaned in bag filters. Emission monitoring of TSP, SO_2, NOx and CO is based on one-time measurement once a year. The integrated permits until 2013 used to oblige these sources to measure emissions of Pb, Cd, Hg, As, Zn and PCDD/F once a three years. This obligation of heavy metals monitoring for casting halls de-dusting was cancelled in 2013 and interval for PCDD/F measurement had been extended to once a five years. For emission inventory of heavy metals and POPs during pig iron casting emission factors based on the measurement results had been set (Table 4-13).

Table 4-13 Casting (blast furnace) – emission factors

Abatement	Pb	Cd	Hg	As	Zn	PCDD/F	BaP	BbF	BkF	InP	4PAH
	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	µg TEQ.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}
Dry ESP	52,001	5,998	47,999	4,498	1729,997	0,010	0,087	0,534	0,246	0,113	0,980
Bag filter	11,105	1,285	0,662	1,504	79,663	0,010	0,029	0,177	0,082	0,038	0,325

4.3.2 Steel production

In 2015 94 % of the steel in the Czech Republic were produced in oxygen convertors and tandem furnaces (Figure 4-6). Tandem furnaces (hearth furnace with oxygen intensification) and oxygen convertors represent casting aggregates that serve to liquid steel production by oxygen technology process. During oxidation, carbon mainly in gaseous form is being removed. The main inputs are the steel and cast iron scrap, pig iron and metallic – deoxidation and non-metallic – cindering ingredients. Emissions of TSP, SO_2, NOx in tandem furnaces and oxygen convertors are being measured once a year. CO emissions in tandem furnaces are being estimated by emission factor of 7043 g.t-1 of produced steel while CO emissions of oxygen convertors are being balance estimated based on operating measurement. For emission inventory Pb, Cd, Hg, As, PCDD/F, PAH, and PCB are being based on national

emission factors (Table 4-14, Table 4-15). Emissions of other pollutants reported under UN CLRTAP are being estimated based on emission factors according EIG 2016-Tier 2 (Table 3.16 – Tandem ovens; Table 3.17 – Oxygen convertors) [12]

Table 4-14 Tandem furnaces – emission factors

Pb	Cd	Hg	As	PCDDF	BaP	BbF	BkF	InP	4PAH	PCB
mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	µg I-TEQ.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	µg.t^{-1}
854,149	34,387	24,540	5,982	1,433	0,030	0,176	0,071	0,035	0,311	30,000

Table 4-15 Oxygen converters – emission factors

Pb	Cd	Hg	As	PCDDF	BaP	BbF	BkF	InP	4PAH	PCB
mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	µg I-TEQ.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	mg.t^{-1}	µg.t^{-1}
549,75	9,459	7,652	1,942	0,082	0,471	5,839	1,976	0,246	8,532	30,000

For special steels production electric arc furnaces are being used. The main input there are the steel and cast iron scrap, alloy and cindering ingredients. The own melting takes place in heat reaction among the arc burning between electrodes and solid scrap. In some cases, furnaces may be intensified by oxygen. Emissions of TSP, NOx and CO for electric arc furnaces are being monitored by one-time measurement once a year. National emission factors for PCDD/F had been set 0,144 µg I-TEQ.t^{-1} and for emissions of PCB 2,2 µg.t^{-1}. Emissions of other pollutants according UN CLRTAP are being based on EIG 2016-Tier 2 emission factors (Table 3.19) [12].

Siemens-Martin furnaces used to be operated in the Czech Republic until 2001. The resulting emissions depend namely on the sort of the input (pig iron or metal scrap), the sort of the fuel used and production intensification by oxygen. One-time measurement of TSP, SO_2, NOx and CO emissions for this type of furnaces used to take place once a year. For inventory of other pollutants required by UN CLRTAP emission factors according EIG 2016-Tier 2 (Table 3.13) [12]. The emission factor for Pb according EIG 2016 300 g. t^{-1} of steel was adapted to more real value 30 g. t^{-1} of steel.

Emission resulting from the transport and handling the input material or product, are being determined by one-time measurement in prescribed intervals. Significant portion of TSP emission is being emitted inside the steel production halls. The amount of these fugitive emissions is being estimated by prescribed balance methods for each steelwork and are reported under NFR 2C1.

In slag furnaces the liquid steel from casting aggregate is being processed to reach the desired chemical composition (removal of undesired rests and ingredients of the melting process) and reduction of gaseous particles content. Emissions of TSP, SO_2, NOx and CO from slag furnaces are being assessed by one-time measurement once a year. Emission inventory of other pollutants according UN CLRTAP is not being performed, because steel production of slag furnaces is not being reported by sectoral statistics.

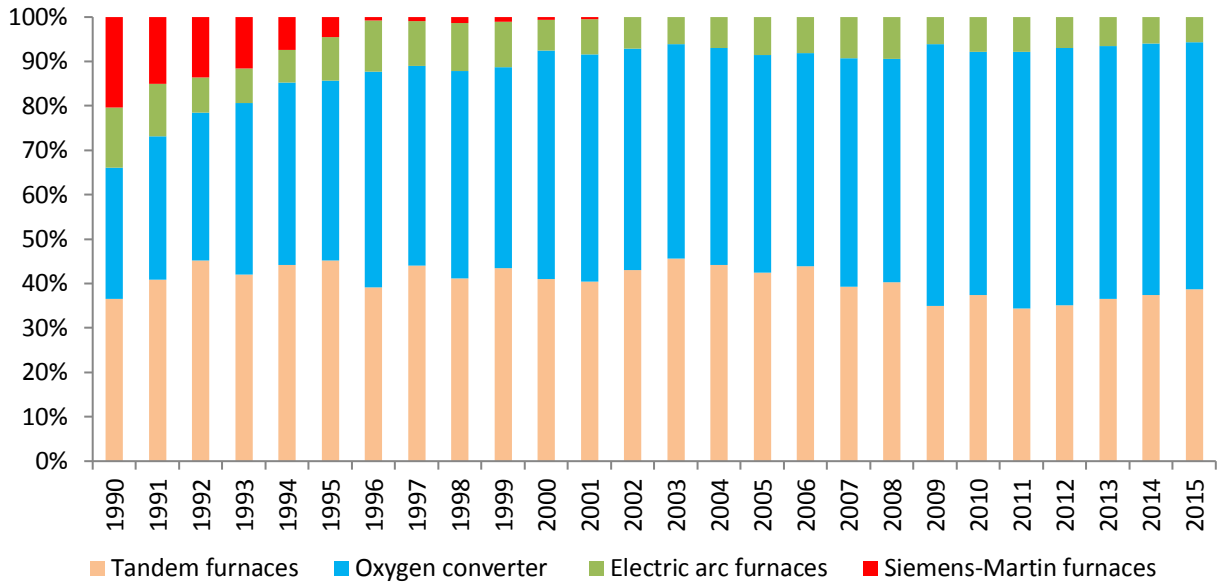

Figure 4-6 Crude steel production by process in 1990–2015

4.3.3 Ferrous metal processing

Emissions from metal processing in rolling mills and forges are being closely linked to heating furnaces that are being monitored by one-time measurement in prescribed intervals.

4.3.4 Ferrous metal foundries

The iron and steel production is being followed by foundry branch focused to production cast iron castings of different types and steel castings. For metal melting, different types of furnaces – mainly electric induction furnaces, electric arc furnaces and cupola furnaces are being used. The transport and handling the input material includes several processes that may vary for each foundry (for example production of models, storage and handling the material, forms and cores preparation, surface treatment of the castings). Emissions in this sector are being assessed by one-time measurement in prescribed intervals. National emission factors have only been set for emission inventory of heavy metals and POPs for cupola ovens (Table 4-16).

Table 4-16 Cupola furnaces – emission factors

Pb	Cd	Hg	As	PCDD/F	BaP	BbF	BkF	InP	4PAH	PCBs
$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g\ TEQ.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g.t^{-1}$
149,8	5	7	12	0,481	0,502	2,668	1,207	0,176	4,553	1023,024

Table 4-17 Mapping of NFR 2C1 source categories to Annex 2 source categories (foundries)

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Ferrous metal foundries (iron alloys)	
2C1	4.6.1. Transportation and handling of charge or product
1A2a; 2C1*	4.6.2. Annealing and drying furnaces
2C1	4.6.3. Smelting in electrical arc furnace
2C1	4.6.4. Smelting in electrical induction furnace
1A2a	4.6.5. Cupola furnaces
1A2a	4.6.6. Smelting in other furnaces – liquid fuels
1A2a	4.6.7. Smelting in other furnaces – gas fuels

4.3.5 Metallurgy of nonferrous metals

In the Czech Republic non-ferrous metals are made only by recasting secondary raw materials. This is how copper, lead, magnesium, aluminium and zinc is produced. The amount of lead and aluminium produced increases every year. Besides these sources, there is a large number of foundries of non-ferrous metals, especially aluminium. An overview of sources and their assignment to NFR sectors is presented in Table 4-18. Emission inventory in this sector is being performed on the basis of one-time measurements in prescribed intervals.

Table 4-18 Mapping of NFR 2C3-2C7c sources categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Metallurgy of nonferrous metals	
1A2b; 2C7c*	4.7. Ore dressing for nonferrous metals
Production or smelting of nonferrous metals, casting alloys, remelting products, refining, and casting production	
2C3-2C7c	4.8.1. Transportation and handling of charge or product
2C3-2C7c	4.8.2. Furnace aggregates for the production of nonferrous metals
2C3	4.9. Electrolytic aluminium production
2C3-2C7c	4.10. Smelting and casting of nonferrous metals and alloys thereof
2C7c	4.11. Aluminium processing with rolling mill

*processes without fuel

4.3.6 Surface treatment of metals and plastics

Mechanical pretreatment of surfaces produces emissions of TSP, which are a mixture of abrasives and particles of the underlying material. This group of sources includes finishing and polishing, abrasive blasting and deburring or tumbling. Emissions from these sources were comprised under sector NFR 2L (Table 4-19). Some processes of degreasing use solvents, and emissions from them are reported under sector NFR 2D3e. These surface modifications are usually followed by the main process (copper and copper alloy plating, nickel electroplating, chromium plating, zinc and zinc alloy plating, etc.), which tends emit heavy metals and other pollutants. These emissions were assigned to sector NFR 2C7c. The only exception there is the hot zinc coating reported under NFR 2C6. Emission inventory in the sector of surface treatment is based on one-time measurements within prescribed intervals. Activity data are not being reported in statistics.

Table 4-19 Mapping of NFR 2C7c sources categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Surface treatment of metals and plastics and other non-metallic objects and processing thereof	
2L**; 2C7c	4.12. Surface treatment of metals and plastics and other non-metallic objects and processing
2C7c	4.13. Metal machining (grinding mills and machining shops) and plastics with a total electrical consumption of over 100 kW
2C7c	4.14. Welding of metallic materials with a total electrical consumption equal to or greater than 1000 kVA
2C7c	4.15. Spraying of protective coatings made of molten metals with a projected output of less than or equal to 1 t of coated steel per hour
2C7c	4.16. Spraying of protective coatings made of molten metals with a projected output of greater 1 t of coated steel per hour
2C7c	4.17. Hot zinc coating

**processes without fuel*

***processes without plating bath*

4.4 NFR 2D3b Road paving with asphalt

This paragraph contains information about emission estimate based on the Guidebook 2016 recommendations. Basically there are two sources of volatile organic compounds (VOCs) in the sector 2.D.3.b Road paving with asphalt: cutback asphalt and emulsified asphalt. The combustion emissions of gaseous and liquid fuels in hot mix plants are collected separately under sector NFR 1.A2.f and VOCs content in hot mix plants asphalt is considered to be zero.

The content of VOCs by mass is considerably higher in cutback asphalt and was assessed 23.5 % by mass. On the other hand the total amount of cutback asphalt used in the Czech Republic does not exceed 1 Gg. There was a significant decrease in the use of cutback asphalt since 1990s.

Emulsified asphalt prevails as cold asphalt technology in the Czech Republic, but due to a very low content of mainly paraffin emulsifier (0.5 % by mass), the total VOCs emission is almost comparable with cutback asphalt. The total emission of VOCs is the sum of both.

The trend of VOCs emissions in sector 2D3b Road paving with asphalt is significantly decree-sing in late 1990s with a minimum in 2001 and relatively strong oscillation at approximately 0.5 Gg since 2007 onwards.

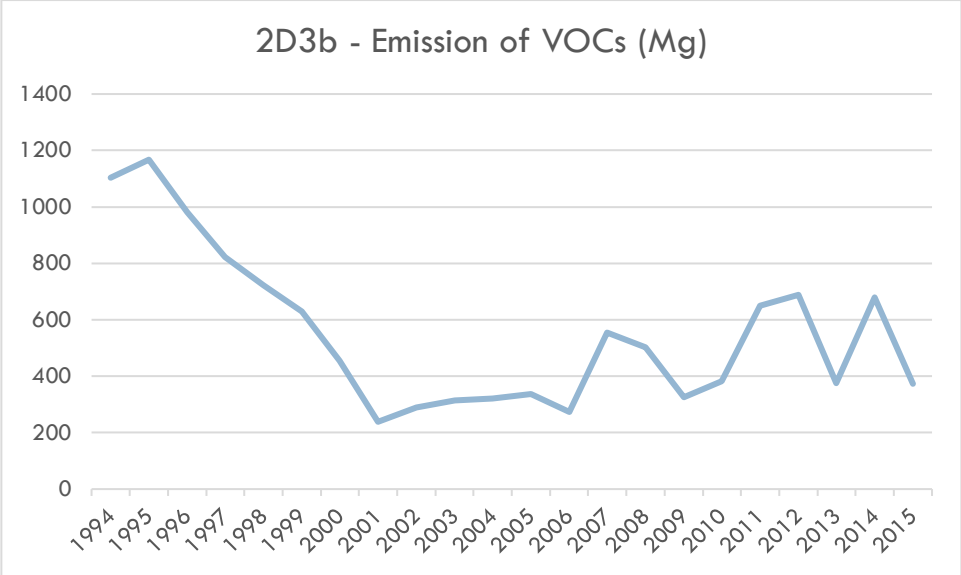

Figure 4-7 Road paving VOC emissions in 1994 - 2015

Table 4-20 Road paving VOC emissions in 1994 - 2015

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NA	NA	NA	NA	1104,1	1167,4	979,9	821,6	722,1	629,7
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
454	238,5	290,2	313,3	320	336,46	274,35	554,66	503,4	324,55
2010	**2011**	**2012**	**2013**	**2014**	**2015**				
381,52	649,52	688,29	375,33	679,9	373,6				

4.5 NFR 2D3c Asphalt roofing

This sector covers the emissions by production of asphalt roofing materials. The total amount of production and use of asphalt roofing materials in Czech Republic in 2015 was 50 Gg. So the emission estimate of NMVOC based on Tier 1 Guidebook 2016 value 120g/Mg is 6 Mg, which is 45% of emission in 2000 since there was approximately 5 % annual decrease of the market between 2000 and 2015.

4.6 NFR 2H-L Food processing, woodworking, and other industries

Out of the group of sources assigned to food processing, woodworking and other industry categories, the most important from the perspective of air pollution is the production of wood pulp and paper from virgin pulp. In the Czech Republic there are two factories

for the production of pulp. The sulfate pulping process and the sulfite pulping process are used. The most emissions originate during chemical recovery in recovery boilers and causticising, including lime regeneration. Emissions from these sources are reported under sector NFR 1A2d; other emission sources involved in the production of wood pulp and paper from virgin pulp are comprised under sector NFR 2H1 (see .Figure 4-6).

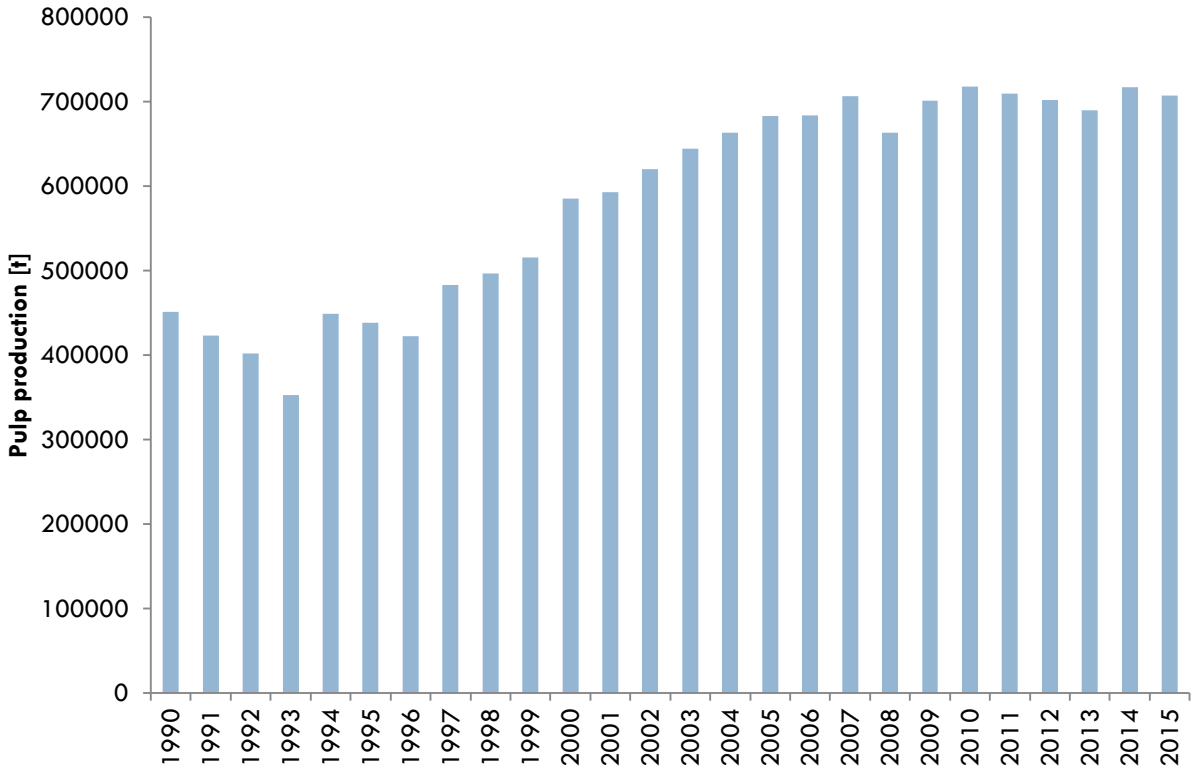

Figure 4-8 Trend of pulp production in 1990 - 2015

A significant amount of emissions originates from the production of chipboard, wood filaments and oriented strand boards. Emissions from the process of drying wood particles and fibres are comprised under sector NFR 1A2gviii, and emissions from other processes involved in the processing of wood belong to sector NFR 2I.

Table 4-21 Mapping of NFR 2H-L sources categories to Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll. Food processing, woodworking, and other industries
2H2	7.1. Slaughterhouses with a slaughter capacity of over 50 tons per day
2H2	7.2. Treatment and processing facilities for the purpose of production food products from plant raw materials with a projected capacity of 75 tons of finished products per day and over
2H2	7.3. Treatment and processing facilities for the purpose of production food products from animal raw materials with a projected capacity of 50 tons of finished products per day and over
2H2	7.4. Facilities for milk treatment and processing, in which the quantity of milk obtained is greater than 200 tons per day (on the average per year)
2H2	7.5. Coffee roasting plants with a projected output of over 1 ton/day
2H2	7.6. Smokehouses with a projected output for processing over 1 000 kg of products per day

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
Food processing, woodworking, and other industries	
1A2gviii; 2I*	7.7. Industrial wood processing, with the exception of the products specified in item 7.8, with an annual material consumption of over 150 m3, inclusive
1A2gviii; 2I*	7.8. Production of chipboard, wood filaments, and OSB
1A2d; 2H1*	7.9. Production of wood pulp and paper from virgin pulp
2H1	7.10. Production of paper and cardboard which does not fall under 7.9.
2L	7.11. Preliminary treatments (operation such as washing, bleaching, mercerization) or coloring of fibres or textiles; technology lines
2L	7.12. Tanning of leathers and furs; technology lines
2I	7.13. Wood coal production
2L	7.14. Facilities for the production of carbon (high-temperature coal carbonization) or electrographite by means of burning or graphitization and processing of carboniferous materials
2L	7.16. Veterinary decontamination facilities
*processes without fuel	

4.7 2.D. (except 2.D.3.b and 2.D.3.c) SOLVENT AND OTHER PRODUCT USE

4.7.1 Overview of the sector

4.7.1.1 Description

This chapter describes emissions from solvents and other product use. The use of solvents and products containing solvents results in emissions of non-methane volatile organic compounds (NMVOC) when emitted into the atmosphere.

The main activities generating air pollutant emissions in the solvent and other product use sector in Czech Republic are paint applications, degreasing and dry cleaning, use of chemical products and other product use such as for example printing and domestic solvent use as presented in Figure 4-7. NMVOC emissions are generated in the production and use of paints, in pharmaceutical, plastic, leather and textile manufacturing, in printing, timber preservation, manufacturing of fibreglass, household and cleaning agents with solvent use and the extraction of fats and oils.

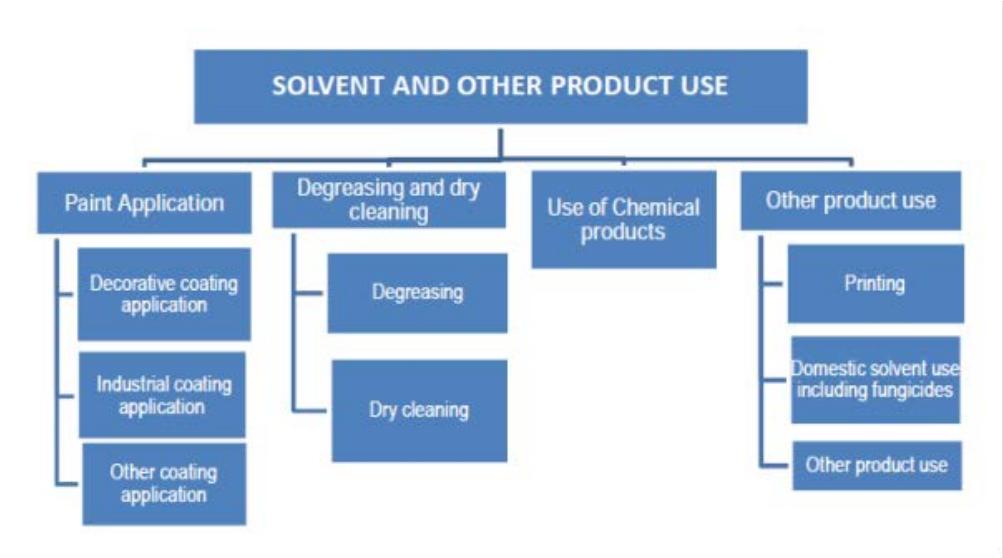

Figure 4-9 Solvent use diagram

In 2013–2014, at that time the Czech Hydrometeorological Institute (CHMI) outsourced an expert opinion of the estimation of NMVOC emissions from diffuse sources, including NMVOC emissions from solvent and other product use. The most common method of estimating NMVOC emissions is calculation by the using emissions factors. The emissions are estimated on the basis of production or activity level of the source from which an emission level is calculated using existing emission factors. The main database of emission factors is the EMEP/EEA air pollutant emission inventory guidebook (2013).

Source category description

Air pollutants under NFR 2.D. except 2.D.3.b and 2.D.3.c in the Czech Republic inventory are presented in Table 4-14

Table 4-22 Activities and emissions reported from the solvent and other product use sector

NFR	Source	Description	Emissions reported
Paint application			
2.D.3.d	1. Decorative coating application	Includes emissions from paint application in construction and buildings and domestic use.	NMVOC
	2. Industrial coating application	Includes emissions from paint application in car repairing and manufacturing of automobiles, coil coating, boat building, wood coating and other industrial paint application.	NMVOC
	3. Other coating application	Emissions in this sector include branch of production car parts, containers, tins and barrels, aircrafts, coating of plastics etc. This sector includes painting in site (bridges, buildings).	NMVOC
Degreasing and dry cleaning			

NFR	Source	Description	Emissions reported
Paint application			
2.D.3.e	Degreasing	Includes emissions from degreasing, electronic components manufacturing and other industrial cleaning.	NMVOC
2.D.3.f	Dry cleaning	Includes emissions from dry cleaning.	NMVOC
Chemical products			
2.D.3.g	Chemical products	Includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other use of solvents.	NMVOC
Other product use			
2.D.3.h	Printing	Solvents emissions from printing industry.	NMVOC
2.D.3.a	Domestic solvent use including fungicides	NMVOC emissions from the use of personal care, adhesive and sealant and household cleaning products	NMVOC
2.D.3.i	Other product use	Includes emissions from oil extraction, application of glues and adhesives, preservation of wood, Glass and Mineral Wool production, use of tobacco and other solvent use.	NMVOC

4.7.1.2 Quantitative overview of NMVOCs

In 2013, the solvent and other product use sector was the largest pollution source of NMVOC emissions in Czech and it accounted for over 47% of total NMVOC emissions. The largest share was for decorative coating application at 42.2%, with the others being chemical products 15.3%, domestic solvent use at 14.9%, , degreasing 10.7% and other solvent use 10.7% (Figure 4-8).

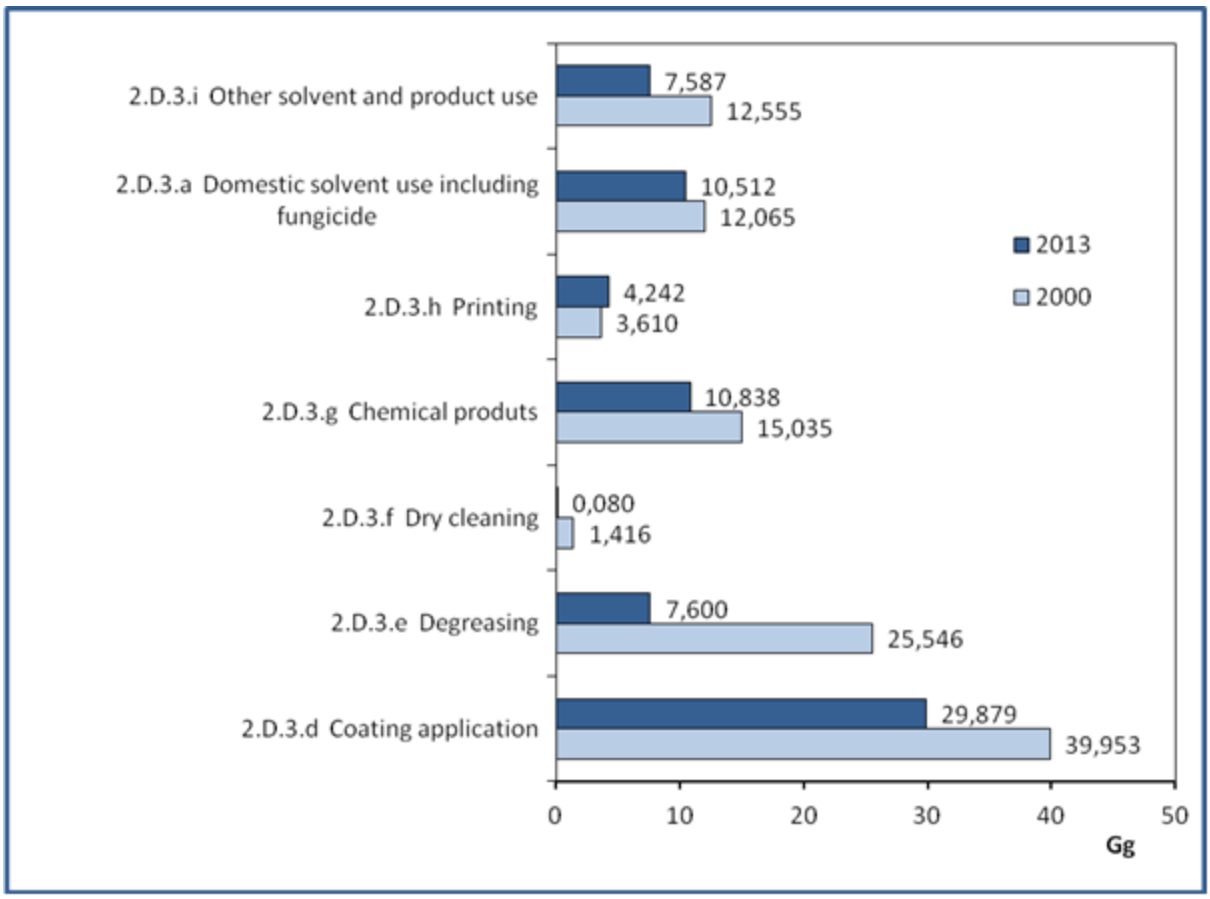

Figure 4-10 NMVOC emissions from Solvent and other production use sector in 2000 and 2013

There has been a decrease in trends of the NMVOC emissions from solvent and other product use in recent years. Since 1990 NMVOC emissions have decreased in the NFR 2D Solvent use sector by 31% (Figure 4-9). The trend in emissions is determined, in order of importance, by categories 2.D.3.d (Paint Application) and 2.D.3.i (Other Product Use). Two main categories where the decreasing of NMVOC emissions has occurred in recent years include paint application (2.D.3.d) and other product use (2.D.3.i). The fluctuation of NMVOC emissions in the period 2000–2013 has mostly occurred due to the economic depression and progress of the country.

NMVOC emissions in this sector decreased by 38,2 % between 1990 and 2013 (Table 4-15), due to decreasing solvent use in restructuring of industry, as well as due to positive impact of the enforced laws and regulations in Czech Republic. One of this positive impact was limitation of emission of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products in order to combat acidification and ground-level ozone as well as the adaptation to technical progress of Annex III to Directive 2004/42/EC of the European Parliament and of the Council on the limitation of emissions of volatile organic compounds

The air protection measures were annexed by low No.35 at the 1967 yet. The next lows about protection of the environment are coming later and they are continuously developed. The systems of new regulations were accepted in the year 2002. These systems of new regulations were devoted to degreasing VOC emissions very strictly. This system unification the Czech and EU low, too. Other regulations come after later and implemented European Solvent Ordinance. Limitation of emission of volatile organic compounds

due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products in order to combat acidification and ground-level ozone as well as the adaptation to technical progress of Annex III to Directive 2004/42/EC of the European Parliament and of the Council on the limitation of emissions of volatile organic compounds.

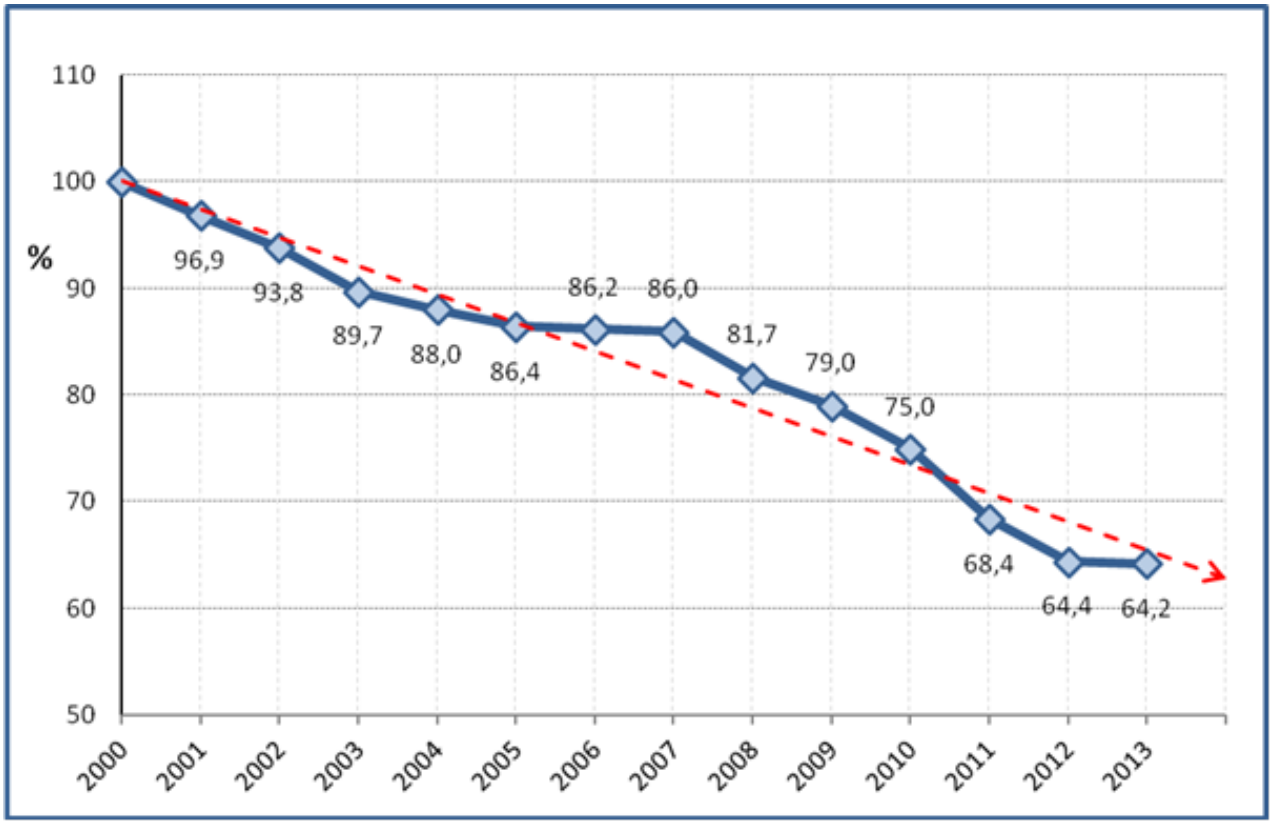

Figure 4-11 NMVOC emissions from the solvent and other product use sector in the period 2000–2013

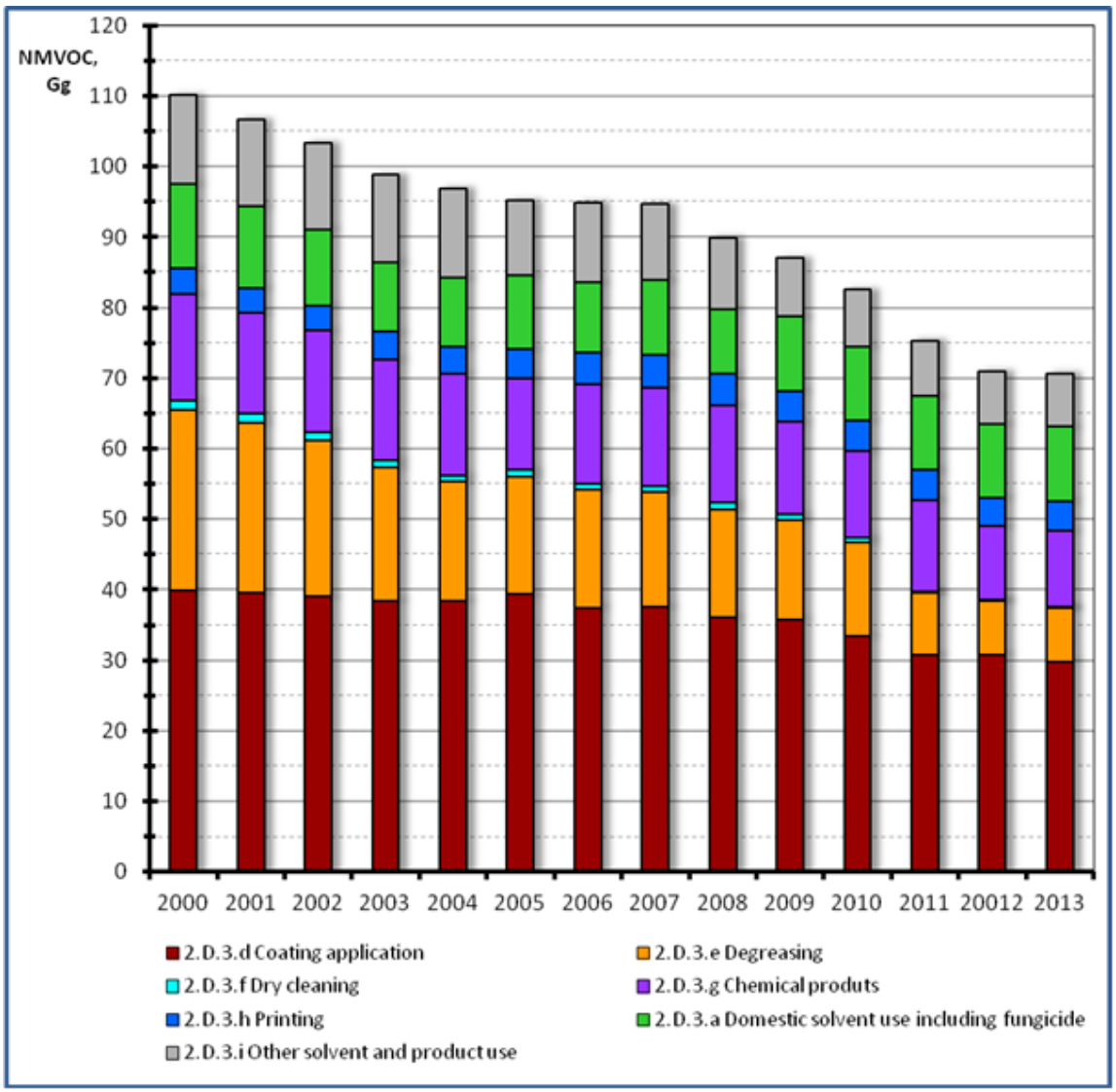

Figure 4-12 NMVOC emissions from the solvent and other product use sector in the period 2000–2013 (main sectors)

Table 4-23 NMVOC emissions in the period 1990–2014 reported under NFR 2.D. (Gg)*

Sector	Total	2.D.3.a	2.D.3.d	2.D.3.e	2.D.3.f	2.D.3.g	2.D.3.h	2.D.3.i
1990	185,00	NA	NA	NA	NA	NA	NA	NA
1991	151,00	NA	NA	NA	NA	NA	NA	NA
1992	154,40	NA	NA	NA	NA	NA	NA	NA
1993	135,30	NA	NA	NA	NA	NA	NA	NA
1994	161,10	10,62	57,89	37,23	1,2	6,40	0,37	17,39
1995	124,60	12,76	50,25	37,14	1,5	6,56	1,90	15,83
1996	118,40	12,76	47,18	34,05	1,5	6,28	2,12	14,51

Sector	Total	2.D.3.a	2.D.3.d	2.D.3.e	2.D.3.f	2.D.3.g	2.D.3.h	2.D.3.i
1997	117,80	12,71	44,09	33,95	1,48	6,26	2,15	17,192
1998	116,42	12,66	43,38	33,80	1,46	6,15	2,08	16,88
1999	118,40	12,76	47,18	34,05	1,5	6,28	2,12	14,51
2000	110,18	12,07	39,95	25,55	1,42	15,04	3,61	12,56
2001	106,73	11,66	39,60	24,09	1,27	14,36	3,51	12,24
2002	103,40	10,93	39,10	22,04	1,25	14,35	3,51	12,22
2003	98,87	9,92	38,53	18,91	0,95	14,34	3,86	12,38
2004	96,98	9,73	38,53	16,85	0,90	14,36	3,90	12,71
2005	95,23	10,43	39,38	16,76	0,85	13,00	4,20	10,62
2006	94,95	9,87	37,50	16,71	0,84	14,10	4,56	11,39
2007	94,71	10,60	37,67	16,18	0,84	14,05	4,64	10,72
2008	89,98	9,23	36,15	15,32	0,86	13,93	4,36	10,14
2009	87,07	10,51	35,87	13,98	0,85	13,11	4,45	8,31
2010	82,58	10,52	33,52	13,19	0,73	12,26	4,35	8,02
2011	75,38	10,50	30,85	8,79	0,10	13,03	4,24	7,88
2012	70,98	10,51	30,87	7,59	0,10	10,50	4,01	7,39
2013	70,74	10,51	29,88	7,60	0,08	10,84	4,24	7,59
2014	69,86	10,30	30,18	7,45	0,06	10,62	3,82	7,44

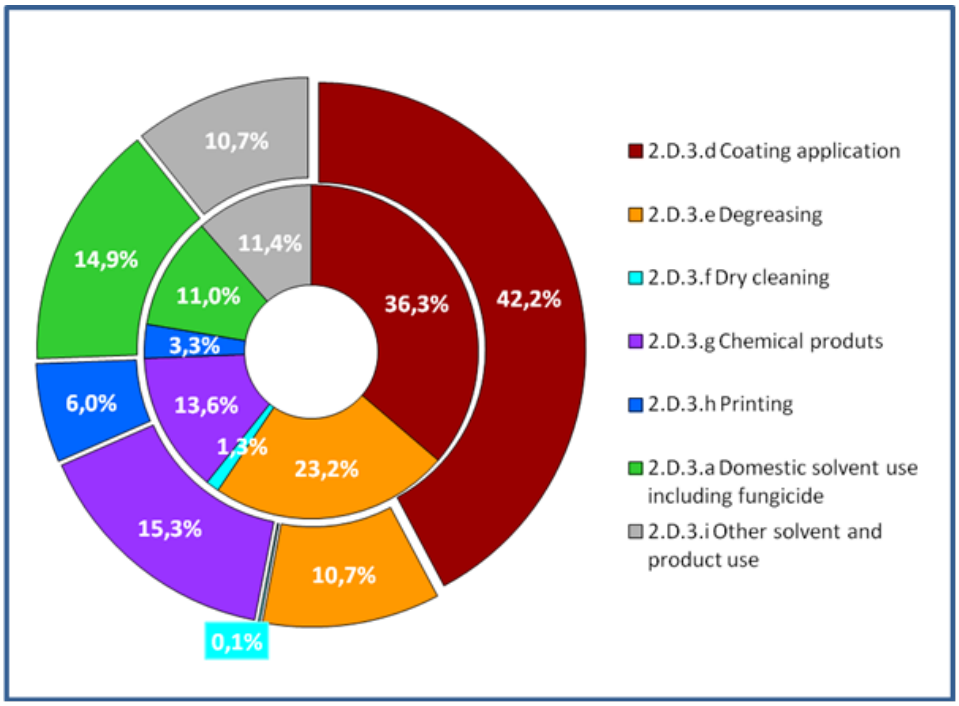

Figure 4-13 The share of NMVOC emissions in 2000 and 2013 by NFR 2D subcategory codes

Severe measurements were implemented for the reduction VOC emission in areas such as painting and printing as well as in the chemical product. The primary measures have more significant influence. These measures are mainly substitution of certain solvents, technological change from solvent emitting processes to low or non-solvent emitting processes, reduction of the solvent content by changing the composition of solvent containing products, reduction of fugitive emissions and installation of new equipment and facilities, which replace the old and absolute facilities.

Secondary measures have important influence in reduction of VOC emission too. These measures are mainly good technological practise in solvent management, compilation of solvent balance, preparation and performance of solvent reduction plan, waste gas purification (where it is suitable recycled solvents).

4.7.2 Methods

The calculation of NMVOC emissions from solvent and other product use are based on several data sources and methods. Emissions from point sources are gathered from the web-based air emissions data system for point sources (ISPOP) and the emissions for diffuse sources are calculated from the data received from Czech Statistical Office using international emission factors and expert opinions. The statistic statement of Customs Administration of the Czech Republic is significant source of date and information.

Emissions from the application of paints produced by companies which are members of the Association of Paint Manufacturers of the Czech Republic, are estimated by expert, which compiles national statistics on the annual sales of paint products of its members. The paint sales and product statistics are divided into decorative (DIY/architectural) and industrial sectors. For these two sectors, the statistics are further divided into subgroups of several types of products and various types of surfaces to be painted, such as "waterborne decorative indoor paints" or "solvent borne decorative indoor paints". For each of these subgroups average NMVOC content and an average density has been estimated by the expert.

Information sources for the NMVOC inventory by different sub-categories are presented in theTable 4-24together with emission sources.

Table 4-24 Information sources for the NMVOC inventory under NFR 2.D.

NFR 2014	Product group	SNAP	Activity where used	Reference, information sources
2.D.3.d	Coating application	060101	Manufacture of automobiles	Reported by operators, Automotive Industry Association, Verification by expert calculation
		060102	Car repairing	Expert estimate; reported by operators
		060103	Construction and buildings	Czech Statistical Office; expert estimate
		060104	Domestic use	Czech Statistical Office; expert estimate
		060105	Coil coating	Reported by operators; Verification by expert calculation
		060106	Boat building	This section is minimal in CZ and it is included in 060108
		060107	Wood coating	Reported by operators, expert estimate
		060108	Other industrial paint application	Reported by operators, expert estimate, verification by expert calculation

NFR 2014	Product group	SNAP	Activity where used	Reference, information sources
		060109	Other non-industrial paint application	Reported by operators, expert estimate
2.D.3.e	Degreasing	060201	Metal degreasing	Reported by operators, expert estimate
		060203	Electronic components manufacturing	Reported by operators, expert estimate
		060204	Other industrial cleaning	Reported by operators expert estimate
2.D.3.f	Dry cleaning	060202	Dry cleaning	Czech Statistical Office, reported by operators
2.D.3.g	Chemical products	060301	Polyester processing	Reported by operators, expert estimate
		060302	Polyvinylchloride processing	Reported by operators, expert estimate
		060303	Polyurethane processing	Reported by operators, expert estimate
		060304	Polystyrene foam processing	Reported by operators, expert estimate
		060305	Rubber processing	Reported by operators, expert estimate
		060306	Pharmaceutical products manufacturing	Reported by operators, expert estimate
		060307	Paints manufacturing	Reported by operators, expert estimate
		060308	Inks manufacturing	Reported by operators, expert estimate
		060309	Glues manufacturing	Not included
		060310	Asphalt blowing	Reported by operators, expert estimate
		060311	Adhesive, magnetic tapes, films and photographs manufacturing	Reported by operators, expert estimate
		060312	Textile finishing	Reported by operators, expert estimate
		060313	Leather tanning	Reported by operators, expert estimate
		060314	Other	Reported by operators, expert estimate
2.D.3.h	Printing	060403	Printing industry	Czech Statistical Office; reported by operators, expert estimate, verification by expert calculation
2.D.3.a	Domestic solvent use including fungicides	060408	Domestic solvent use (other than paint application)	Czech Statistical Office, expert estimate,
		060411	Domestic use of pharmaceutical products	
2.D.3.i;	Other solvent and product use	060401	Glass wool enduction	Czech Statistical Office, expert estimate
		060402	Mineral wool enduction	Czech Statistical Office, expert estimate
2.G		060403	Printing	Czech Statistical Office, reported by operators, expert estimate
		060404	Fat, edible and non-edible oil extraction	Czech Statistical Office; reported by operators, expert estimate, verification by expert calculation
		060405	Application of glues and adhesives	Czech Statistical Office; reported by operators, expert estimate,
		060406	Preservation of wood	Czech Statistical Office; reported by operators, expert estimate,
		060407	Under seal treatment and conservation of vehicles	expert estimate
		060409	Vehicles dewaxing	Not included (emissions are negligible)
		060602*	Use of tobacco	Czech Statistical Office

** not included in inventory*

Emissions that are other than NMVOC are taken from the REZZO database (reported by operators). The facilities that are obliged to have an air pollution permit (for small facilities) or IPPC permit submit their annual emissions and activity data into REZZO database by point sources.

The air pollution permit is required for facilities where annual projected capacity consumption of solvent are 0.6 tonnes or more in accordance with Czech Act (see Regulation 415/2012 Coll., ANNEX 11-EN.DOC, Annex 5).

The data that is collected in the annual air emissions report for the solvent use are:

- *Activity or technological process by NACE code (Czech Republic classification of economic activities) and SNAP codes where the reported chemical has been used,*
- *Classification of facilities, nomenclature of section,*
- *The annual consumption of solvent or solvent containing preparation in tonnes per year;*
- *Emissions of pollutants by the used solvent or solvent containing preparation – NMVOC emissions in tonnes per year;*
- *The number of a source of pollution on a plan or map of the facility.*

4.7.3 4.6.3. Source category explanations

4.7.3.1 Coating Application (NFR 2.D.3.d)

Source category description

The use of paint is a major source of NMVOC emissions. The use of paints is generally not considered relevant for emissions of particulate matter, heavy metals and POPs.

The paints in this section contain organic solvent, which must be removed by evaporation after application on the surface. Some part of evaporated organic solvent captured and recovered to next processing or they are destroyed. Some part are emitted into the atmosphere. Some organic solvent may be added to coatings before application and will also be emitted. Further solvent that is used for cleaning coating equipment is also emitted.

The amount of organic solvent in paints is different. Traditional solvent borne paints contain approximately 50% organic solvents and 50% solids. In addition, more solvent may be added to further dilute the paint before application. High solids and water borne paints both contain less organic solvent, typically less than 30%, while powder coatings and solvent free liquid coatings contain no solvent at all.

Due to the wide range of paint applications and the even larger number of paint formulations that are available, there must be considerable scope for uncertainty in emission factors. Due to developments in paint formulation, the emission factors may only be valid for a short period. Therefore, improved emission factors are especially required for controlled processes.

Another aspect is the variation of paint types. This requires good activity data, which may not be present, particularly with the increasing use of alternatives to high solvent paints.

Decorative coating application (2.D.3.d)

This section refers to two sub-categories of paint application:

- *Paint application: construction and buildings (SNAP activity 060103)*

This category refers to the use of paints for architectural application by construction enterprises and professional painters.

- *Coating application: domestic use (SNAP activity 060104)*

This category refers to the use of paints for architectural or furniture applications by private consumers. It is good practice not to include other domestic solvent use. However, it is sometimes difficult to distinguish between solvents used for thinning paints and solvents used for cleaning.

Industrial coating application (2.D.3.d)

This section describes the following sub-categories of paint application:

1)	manufacture of automobiles	(SNAP activity 060101);
2)	car repairing	(SNAP activity 060102);
3)	coil coating	(SNAP activity 060105);
4)	boat building	(SNAP activity 060106);
5)	wood	(SNAP activity 060107);
6)	other industrial paint application	(SNAP activity 060108).

Most of the plants included in this sub-category are legally obliged to do report about consumption of solvents and VOC emission.

Other coating application (2.D.3.d)

This category refers to the use of high performance protective and/or anti corrosive paints applied to structural steel, concrete and other substrates together with any other non-industrial coatings which are not covered by any of the other SNAP codes described in the "Paint application" section. The sector includes coatings applied on site by brush, rolling or spraying. They are repairing bridges, columns and similar structures as well as road marking, non-decorative floor paints etc.

All emissions are fugitive in this section.

Table 4-25 Activities concern the Solvent use and other product use in sector Paint application

NFR´09	Source	description	SNAP activities
3A1	Decorative coating	Non industry paint application in construction and building, domestic use	060103 060104
3A2	Industrial coating	In this section are calculated production parts for automotive industry, busses, tractors, production of cans, barrels, military technic, spare parts, coating of plastic, etc.	060101 060102 060105 060106 060107 060108
3A3	Other coating application	Emission from this sector is allocated to 3A1 and 3A2. At this time are not relevant data to separate from other section	060109

4.7.3.2 Methodological issues

Inventorying of NM VOC emission sector was made in project VaV 520/3/97 "Establishment and performing of the National program of decreasing emission of NM VOC". During solving of this project was turned to using NM VOC. One of the results was detailed inventory in the CORINAIR structure and verification earlier emission inventory. The activity data was achieved from a lot of sources. Primarily all accessible data from Czech Statistical Office was used. Association of Paint Manufacturers of the Czech Republic is very important source of information about production and consumption of all paints type. Association of Paint Manufacturers CR associates manufacturers, research institutes, distributors of paints and raw materials for their production and currently, total production of paints member producers 70 % of the total production of paints in the Czech Republic in terms of value. The data of import of the paints and inks was achieved from the Customs Administration of the Czech Republic. Additionally the detailed investigation was made directly at many producers and at many facilities with large consumption of NM VOC product.

Unification Czech and EU legislation, mainly The Solvents Emissions Directive (1999/13/EC) was reached by Act No.86/2002 Co. on the Protection of Air and the Amendment of Certain Other Acts (the Air Protection Act) and subsequent five Government Order (No. 350 to 354/2002 Co.) and four Decree of the Ministry of the Environment (No. 355 to 358/2002 Co.).

Emissions from the industrial coating application sector have been significantly reduced by not only by introduction of the European Solvents Directive (1999/13/EC). In Czech Republic was monitoring emission a long time before 2002, when was implement Solvents Directive (1999/13/EC). The big influence were rebuilding the old technology.

Emissions from the industrial coating application sector have been significantly reduced by not only by introduction of the European Solvents Directive (1999/13/EC). In Czech Republic was monitoring emission a long time before 2002, when was implement Solvents Directive (1999/13/EC). The big influence were rebuilding the old technologies and using new equipment. Reduce of emission of NM VOC were achieve by replace of paints and other materials by new type of these, with low content of VOC. The numbers of power paint shops are significantly grown in the last years. NM VOC emission is nearly zero from these technologies.

Activity data

In 1994–1997 was made very detailed inventory study. A lot of companies were visited and ere obtained information about technologies and emissions. Activity data were obtained

The quantity of paints and lacquers used in total in Czech Republic is estimated according to the import and export data (CN codes 3208, 3209 and 3210) and production data (total amount of paints and lacquers) from Statistics Czech Republic. The amounts of paints (produced, exported and imported) are obtained in the Association of Paint Manufacturers of the Czech Republic, too.

The majority of paints are used by point sources (companies with permission) and most of the remaining paint is used for decorative coating application. Also, some of the paint is used for car repairing.

Significant quantity of emission VOC is emitted from production of motor vehicles. Emission from this sector is very exact based on the number of production, emission limit from valid legislative in Czech Republic. Verification of this activity data are from REZZO report.

Activity data were obtained from:

- *Czech Statistical Office, production of relevant sectors,*
- *The Customs Administration of the Czech Republic,*
- *Regional authority report (production, new development of plants, reports from environment field, etc.)*
- *Information and data from REZZO*
- *Annual reports of individual producers, specific association,*
- *Inventory from earlier years, specific works of experts, like continuously observations of the capital constructions, progress in new technics, exercise and work in the field of BREF and BAT and there implementation in factories,*
- *Other information from accessible public data, consultation, etc.*

Verification of show data

In some sectors were emission calculated from activity data obtain mainly from Czech Statistical Office, from association reports or from The Customs Administration of the Czech Republic. Concrete calculation is shown below (in particular SNAP). Some SNAP was calculating on the base on EMEP/EEA emission inventory Guidebook methodology and compared with calculation from activity data. Usually the Tier 2 was used. Very good conformity was obtained from this comparison. This conformity was in range of 5 to 10 %, see separate SNAP.

4.7.3.3 Inventory – calculation particular SNAP category

SNAP 060101 Manufacture of automobiles

In Czech Republic was produced 1 128 473 cars. The emission are calculated using emission factor 35 g/m² .This EF was valid in time building all producers (Škoda auto, TPCA and Hyundai). Automotive areas are from BREF and from expert's knowledge.

Table 4-26 Type of automobiles

Type of car	Area (m²)	Production	emission (t/year)
Small	60	185 124	388,8
Middle	80	303 460	849,7
Big	90	639 889	2 016
Total emission			**3 254,5**

Data verification using EF from Guidebook

EF = 8 kg VOC/car,
All emission = 9 028 t
Abatement, average value 60 %; all emission after abatement 3 611 t/year

Difference between shown and calculated value using TIER 2 end abatements efficient is 10%. This difference is minimal and it can be caused by higher efficiency end of pipe for VOC elimination, because plants are relatively new and all of them used BAT.

SNAP 060102 Car repairing

There is no statistical information regarding the amount of paint used for car repairing. Therefore, expert opinion was based on the number of accidents and other technical knowledgies. From these data are calculated consumption and emission NM VOC. Data are collected from Czech Statistical Office, Automotive Industry Association, etc. In Czech Republic are most then 251 repairing paint shops with consumption VOC higher 500 kg VOC. A lot of smaller car repair shops are exists without obligation makes report about VOC consumption.

Inventory calculation is based on technical expert estimate

In Czech Republic passengers car are registered 4 787 849 in2013. Accident rate may be 10%. Area for repairing estimated about 5 m2, consumption painting including thinner 2,25 kg. Emission VOC is 681,2t. This emission is 20 % increased for imprecision technical estimate. Total emission is 851,2 t.

Data verification using EF from Guidebook

Total consumption paints 1 075 500 kg (technical estimate)
EF from guidebook 720 g/kg Paint
Total emission 851,8

SNAP 060105 Coil coating

Coil coating is technology with significant progress, but emission is small and in this sector is used successfully abatement technology (thermal incineration) with height efficiency. In additional in CZ is only one producer. Inventory is very exact.

Verification

Total consumption paints	*1 075 500 kg*	*(technical estimate)*
EF from Guidebook	*720 g/kg Paint*	
Total emission	*851,8*	

Calculation

Production	*6 389 535 m² Al sheet*
	13 945 312 m² Fe sheet
EF from Guidebook	*90 g/m²*
Total emission	*1830 t VOC*

New incinerator VOC emission is in plant. When efficiency is 99 % in this case, the total emission is 18,3 t VOC. In consideration on the opportunity produced thickness sheet, shown VOC emission is 15 t/year.

Using TIER 3 from Guidebook
REZZO emission are 15 t/year, the same like calculated

SNAP 060104 Domestic use

The paints use for decorative coating application, mainly SNAP 060104 was calculated on the base of statistic data and small survey.

Calculation

Inhabitants in CZ	*10 512 419 person*
Used EF from Guidebook	*EF 0,522 g/person*
Emission is	*5 487 t*

Verification

Czech Republic are	*4 375 000 household*
Consumption paints	*2,2 to 3,0 kg (from survey)*
VOC Content assumption	*40 %*
Emission is	*5 250 t*

Difference between these values is less than 5 %. This is good sameness of both method of calculation.

SNAP 060108 Other industrial paint applications

This category refers to all industrial applies paints for metal, plastic, paper, leather and glass substrates which are not covered by any of the other categories described here. These categories include agriculture, construction and earthmoving equipment. Aircraft, cans and drums, caravan, freight containers, machine tools, military vehicles, motor vehicles components, office equipment, etc.

VOC emissions in this sector have great part production related to car component. The car parts for domestic and export produce higher than 300 producer with higher than 140 000 employment.

Abatement in part of this sector is implementing only by using paint with low content of VOC or using water based paints. A lot of products have electrophoretic coats with minimum content VOC. In this sector a lot of producer use abatement of VOC emission. End of pipe (emission abatement) may be used only in production where they are technically and economically possible. Most of producers have line production or production of large series.

Powder coatings, mainly for small producers or for interior construction have been used. This technology emitted no VOC but the preparation of surface must be very quality. The equipment of painting shop required big investment and working costs. This technology may be used only for stable and perspective program.

4.7.3.4 Source-specific QA/QC and verification

Normal statistical quality checking related to the assessment of magnitude and trends has been carried out. Calculated emissions and emission data from the REZZO database have been compared to the previous years in order to detect calculation errors, errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures have been studied. The data reported and entered into the REZZO database by operators is firstly checked by specialists.

General verification data

Production solvent based paint in CZ	77 366 t
Assumption VOC content	30%
Total consumption of solvent based paint	(production) – (export) + (import) = 139 046 t
VOC emission	41 714 t VOC
Production water based paint in CZ	83 121 t
Total consumption of water based paint	(production) – (export) + (import) = 84 519 t
Assumption VOC content	4%
VOC emission	3 381 t VOC
Emission from production of paints	1 605 t
Total VOC emission	46 700 t
VOC emission shown in inventory	43 895 t

(SNAP 060100, 060307, 060308, 060309, 060403, 060405)

Conclusion: Difference between VOC emission calculated from global statistic data and shown data in inventory is only 6%, which is very good conformity.

4.7.4 Degreasing and dry cleaning (NFR 3.B)

4.7.4.1 Source category description

Degreasing (NFR 2.D.3.e)

The metalworking industries are the major users of solvent degreasing. Solvent degreasing is also used in industries such as printing and in the production of chemicals, plastics, rubber, textiles, glass, paper, and electric power. Also, repair stations for transportation vehicles use solvent cleaning on occasion.

Information on industrial activities falling under NFR 3B Degreasing and dry cleaning is shown in Table 4-19.

Table 4-27 Activities reported from the Solvent and other production use

Sector (NFR´09 and NFR´14)		Source	Description
3B1	2.D.3.e	Degreasing	Metal degreasing, other industrial cleaning, electronic components manufacturing
3B2	2.D.3.f	Dry cleaning	Any process to remove contamination from furs, leather, textiles or other object made of fibres using organic solvents

Metal degreasing by using organic solvents takes place in either open top or closed tanks. The open top tanks, however, have been phased out in the European Union due to the Solvents Emissions Directive 1999/13/EC. Only small facilities, which use no more than 1 tonnes kg of solvent per year, are still permitted to use open top tanks. Closed tanks offer much better opportunities for the recycling of solvents.

A lot of companies made cold cleaning by spraying, brushing, flushing and immersion. Emission occurs by waste solvent evaporation, solvent carry out, solvent bath evaporation, spray evaporation and agitation.

Dry cleaning (NFR 2.D.3.f)

Dry Cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres, using organic solvents.

Emissions arise from evaporative losses of solvent, primarily from the final drying of the clothes, known as deodorization. Emissions may also arise from the disposal of wastes from the process.

The most widespread solvent used in dry cleaning, accounting for about 90% of total consumption, is perchlorethylene (PER). The most significant pollutants from dry cleaning are NMVOCs, including chlorinated solvents. Heavy metal and POP emissions are unlikely to be significant.

4.7.4.2 Methodological issues

SNAP 060201 Degreasing (metal) + 060204 (other cleaning)

Activity data

For calculation was used number of workshops for Czech statistical Office and data form REZZO

Emission shown in REZZO (large source)		*849 t*
Estimated emission		
number of middle source are 2650 (consumption to 500 kg)	*emission 1 325 t*	
number of small source are 30 000 (consumption to 100 kg)	*emission 3 000 t*	
total VOC emission		*5 173 t*

This VOC emission is fugitive. Increasing VOC emission may be realized only by using new modern technologies like degreasing with aqua alkaline means, or application solvent with high boiled temperature.

The captures of VOC emission are made in large company and they are recorded in REZZO. Described technology is used particularly by small manufactures and services.

SNAP 060203 Production of electronic components

VOC emissions are created mainly by degreasing and by application of non-solder mask. Non-solder mask contain epoxy and acrylate resin with 50%content of VOC (methoxypropylacetate). Facility with 5 to 15 t/year consumption falls up limitation VOC.

Activity data

Activity data are from REZZO – emission is 162 t.

4.7.4.2.1 SNAP 060202 Dry Cleaning

The most significant pollutants from dry cleaning are NMVOC, including chlorinated solvents. Heavy metal and persistent organic (POP) emissions are unlikely to be significant. Most of the solvent is recycled, but some is lost to the environment. This needs to be replaced and it can be assumed that the quantity of solvent, which is used for replacement, is equivalent to the quantity emitted plus the quantity taken away with the sludge.

The most significant pollutants from dry cleaning are NMVOC, including chlorinated solvents. Heavy metal and persistent organic (POP) emissions are unlikely to be significant. In Czech Republic, closed-circuit equipment are mainly used for dry cleaning

The stabilized rate is expected in this sector or only with small difference. The Association of laundries and dry cleaners are working in this sector. It is based in 1993 and now has 120 members.

Activity data
Tier 3 are used.
VOC emission show in inventory is value from REZZO. REZZO register 166 source with total consumption of 85,9 t solvents and emission 80 t. The part of solvent is eliminated like waste.

4.7.5 Chemical Products Manufacturing and Processing (2.D.3.g)

Source category description

This chapter covers emissions from the use of chemical products. These include many activities such as paints, inks, glues and adhesives manufacturing, polyurethane and polystyrene foam processing, tyre production, fat, edible and non-edible oil extraction and more.

Sector NFR 3C (2.D.3.g) include 14 categories. In some sectors are presented significantly uncertainly of registration and production of emission. The increasing of emission will be to arrive in this technological sector only by significant changes in production like new equipment, construction new facilities installation of end of pipe etc.

By 2012, NMVOC emissions from the NFR 2.D.3.g sector is 14,2% of the total NM VOC emission.

4.7.5.1 Methodological issues

This sector includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other chemical products manufacturing or processing activities under SNAP 060314. All emission estimates from the NFR 2.D.3.g sector are based on emission data reported by operators in the REZZO database and from Czech Statistical Office.

The following equation for calculations emission is applied:
ENMVOC = ARproduction x EFNMVOC

Where:

ENMVOC = the emission of NM VOC
ARproduction = the activity value
EFNMVOC = the emission factor for NMVOC

SNAP 060301 Polyester processing

Emission NMVOC from production of composite material is shown In this sector composite material is produced from liquid polyester resin with content of styrene and with projected capacity higher than 0,6 t/year.

TIER 3 was used. VOC emission was increased of 30% connected with number facilities with consumption smaller than 0,6 t/year.

Number of facilities	*63*
Total shown consumption solvents	*1 788,3 t*
Total shown emission VOC	*183,2 t*
Emission increase of 30%	*238 t*

4.7.6 Other

4.7.6.1 Source category description

This sector includes activities like printing (2.D.3.h), domestic solvent use (other than paint application) (2.D.3.a) and other product use (2.D.3.i) such as the application of glues and adhesives, preservation of wood, underseal treatment and conservation of vehicles, and use of tobacco.

SNAP 060403 Printing (NFR 2.D.3.h)

Printing involves the use of inks, which may contain a proportion of organic solvents. These inks may then be subsequently diluted before use. Different inks have different proportions of organic solvents and require dilution to different extents. Printing can also require the use of cleaning solvents and organic dampeners. Ink solvents, diluents, cleaners and dampeners may all make a significant contribution to emissions from industrial printing and involve the application of inks using presses.

In the EMEP/EEA Guidebook, the following printing categories are identified:

- *Heat set offset printing*
- *Publication packaging*
- *Rotogravure & Flexography*

The emissions of NMVOCs from printing have been significantly reduced following the introduction of the Solvents Emissions Directive 1999/13/EC in March 1999. Larger facilities are now required to control their emissions in such a way that the emission limit value in the residual gas does not exceed a maximum concentration. The threshold is 15 ton/year for heat set offset and flexography/rotogravure in packaging and 25 ton/year for publication gravure.

Activity data

REZZO show 309 facilities with consumption 7165 t solvent. These facilities are large, with abatement of emissions.

The Czech Statistical Office register 7105 producer in branch of printing activities. Number of facilities in printing branch is in Table 4-20.

Table 4-28 Number of facilities in printing branch (CZ-NACE 18 code)

CZ-NACE	2007	2008	2009	2010	2011	2012	2013
18.1	8908	8242	8238	8206	7977	7840	7105
18.2	610	690	711	748	780	890	1080
18	9518	8932	8949	8954	8757	8730	8185

REZZO activity data

	emission	solvent consumption
Heat set offset printing	457,8 t	1043,9 t
Publication packaging	1,9 t	2,1 t
Rotogravure & Flexography	1134,2 t	6093,7 t
Other technology	13,0 t	27,0 t
Total	1606,9 t	7 166,7 t

Assumption REZZO registers only part of facilities and emission must be higher. Emission is only 50% (estimated value).
Total estimated emission 3 583 t

4.7.6.1.1 SNAP 060408 Domestic solvent use (2.D.3.a)

Emissions occur due to the evaporation of NMVOCs contained in the products during their use. For most products, all of the NMVOC will be emitted to the atmosphere.

This emission is included in this inventory in NFR code 2.D.3.a. SNAP codes 060408 and 06411 are summarized in one code.

4.7.6.2 Other product use (NFR 2.D.3.i)

SNAP 060404 Fat, edible and non-edible oil extraction

This activity includes solvent extraction of edible oils from oilseeds and the drying of leftover seeds before resale as animal feed.

If the oil content of the seed is high the majority of the oil is pressed out mechanically. Where the oil content is lower or the remaining oil is to be taken from material that has already been pressed, solvent extraction is used.

Hexane has become a preferred solvent for extraction. In extracting oil from seeds, the cleaned and prepared seeds are washed several times in warm solvent. The remaining seed residue is treated with steam to capture the solvent and oil that remain in it.

The oil is separated from the oil-enriched wash solvent and from the steamed-out solvent. The solvent is recovered and re-used. The oil is further refined.

SNAP 060406 Preservation of wood

This activity encompasses industrial processes impregnation of timber in organic solvent based preservatives, creosote or water based preservatives. Wood impregnation may be carried out only at large plants, where control of emissions may be practical. The application of preservative is via vaccum or dipping processes in special equipment. In Czech Republic are only two plants in this section. Both plants show emission in REZZO.

This section is not intended to cover the surface coating of timber with paints, varnishes or lacquer.

SNAP 060405 Industrial application of adhesives

Sectors using adhesives are very diverse as well as production processes and application techniques.

Relevant sectors are the production of adhesive tapes, composite foils, the transportation sector (passenger cars, commercial vehicles, mobile homes, rail vehicles and aircrafts), the manufacture of shoes and leather goods, and the wood material and furniture industry (EGTEI, 2003).

SNAP 060409 Vehicles dewaxing

Dewaxing operations do not have been carried out at least the last ten years. If required, paint protection is provided by using follies. Waxing is only used in very rare cases, such as special deliveries by sea transport from long distances (e.g. USA, Japan).

In the period from 1991 to 2005, dewaxing was carried out in rare cases, too. It is very difficult to obtain relevant data. Most of the dewaxing operations of imported cars, when was carry out, was made in treatment centre of special automotive shop.

According to the gathered information, NMVOC emissions from this source are considered to be approximately zero and historical emissions are considered negligible.

4.7.7 Quantitative or qualitative assessment of uncertainties

The calculations of NMVOC emissions from solvent use were done in several steps. As a first step, the quantity of solvents used and the solvent emissions were calculated. To determine the quantity of solvents used in the Czech Republic in the various applications, a bottom-up and a top-down approach were combined. One study (Neuzil et al. 2014; Machalek et al. 2015) described emission estimates based on the bottom-up approach. Emissions of volatile organic compounds from individually monitored sources included in the REZZO 1 database are calculated by a procedure which is directly set out by the Czech legislature (Directive 415/2012 Coll., Annex 5) for the protection of air quality, where it was adopted from the COUNCIL DIRECTIVE 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, Annex III. The calculation entails the ascertainment of emissions usually released in a controlled manner and the calculation of fugitive emissions entering the atmosphere in an uncontrolled way. The resulting total combined uncertainty concerning the ascertainment of fugitive emissions, using the formula presented above, amounts to 13 %. It must be stated that all the calculations made tend to give results that are closer to the lower bound of the given range and that the real uncertainty can actually be somewhat higher. It, however, follows from the nature and the principle of the method of calculating fugitive emissions of VOC that this ascertainment is based on the balance method, which generally provides relatively accurate results. It can therefore be assumed that the total uncertainty should not exceed the threshold of 15 %, provided that the input data correspond to reality.

The basic approach to emission inventories, which is the top-down balance method, utilizes results derived from emissions reported to the REZZO database, especially to ascertain the rate of capture and destruction of VOC contained in the products used. If a product containing VOC is used in an installation without an end technology for reducing output concentrations of VOC or for their complete or partial regeneration, the full amount of VOC gets released into the atmosphere. The uncertainty associated with ascertaining emissions from these sources is related solely to the accuracy of the activity data used and, of course, also with the proportion of VOC contained in them. The uncertainty concerning emissions derived from statistical data and predefined emission factors based on the consumption of VOC in products is estimated, according to the methodology of the EMEP/EEA air pollutant emission inventory guidebook, to range from 50 to 200 %.

5 AGRICULTURE (NFR SECTOR 3)

5.1 Overview of sector

The agricultural sector consists of the following categories:

- *Manure management;*
- *Crop production and agricultural soils*
- *Field burning of agricultural residues;*
- *Other.*

In the Czech Republic field burning is prohibited by law on the air protection. Emissions of the greenhouse gases nitrous oxide (N_2O) and methane (CH_4) are being reported on in the National Inventory Report (NIR). This Informative Inventory Report (IIR) focuses on ammonia (NH_3) and particulate matter (PM). The agricultural sector is responsible for more than 85% of NH_3 emissions in the Czech Republic. Emissions from the animal excrements represent more than 80 % share in total ammonia emission while the fertilizers application contributes by less than 20 % of share.

5.2 Key sources

In the Czech Republic cattle (NFR code 3B1a and 3B1b) are the biggest key source of NH_3, followed by swine (NFR code 3B3) and poultry (NFR code 3B4gi and 3B4gii).

5.3 Trends

NH_3 emissions have decreased rapidly between 1990 and 2014 as the result of animal population significant reduction, especially in case of dairy cattle breeding. While milk productions per head have increased, animal numbers showed a decreasing trend. In case of pig production amount of rearing pigs and sows also decreased rapidly in last 5- 6 years as a result of crises on the pig market. It is expected a slight increase of pig production in the Czech Republic.

Another reason for NH_3 emissions abatement was implementation of the EU legislation and international obligations. The Czech Republic ratified the Gothenburg protocol in 1999. Since that year a serious and major attention has been paid to the implementation of ammonia abatement techniques in the Czech agriculture, to meet the requirements of the Annex IX of Gothenburg protocol. Within the years 2000 – 2002 a new legislation on air protection was established and developed. This effort was completed by laying down of the Decree 86/2002 on the air protection. Implementing regulation no 353/2002 of the Law on the air protection includes some principles of the Annex IX, which is focused on agricultural sources. In the same year 2002 by adopting the Law No. 76/ 2002 concerning Integrated Prevention Pollution and Control EC Directive 96/61 was implemented in the Czech legal system. Both regulations were prepared in parallel, but in harmony with principles of Gothenburg protocol.

The Czech agriculture is characterized by a high amount of extra-large enterprises with intensive poultry, pigs or cattle breeding. Four hundred and twenty two enterprises come under the IPPC directive. Integrated prevention pollution and control Directive 96/61/EC like the Annex IX of the Protocol deals with an extra-large installation for more than 2 000 places for rearing pigs over 30 kilo or 750 sows or 40 000 places for poultry. Approximately of 89% of lying hens, 86% of chicken broilers, 32% of rearing pigs and 32% of sows are hold in installations covered by IPPC Directive.

On these farms only Best Available Techniques (BAT) can be operated and every operator of these farms (installations) has to obtain an integrated permission of operation. The integrated permission granted by the local authority contains some environmental conditions, which have to be fulfilled. Improvement in diets as a one of BAT leading to lower N excretions per animal has also contributed significantly to ammonia emission abatement. All categories of pigs, sows and poultry kept on farm under IPPC use phase-feedstuff containing amino acids as lysin, methionin, threonin, and tryptophan.

5.4 Manure management

5.4.1 Source category description

This source comprises emissions from animal housing, manure storage and its application to the soil. Within the category manure management, the following subcategories are distinguished:

- *3B1a - Dairy cattle*
- *3B1b - Non-dairy cattle*
- *3B2 - Sheep3*
- *B3 - Swine*
- *3B4a - Buffalo*
- *3B4d - Goats*
- *3B4e - Horses*
- *3B4f - Mules and asses*
- *3B4gi - Laying hens*
- *3B4gii - Broilers*
- *3B4giii - Turkeys*
- *3B4giv - Other poultry*
- *3B4h - Other animals*

Animals in the category 3B4a and 3B4f are not kept as livestock in the Czech Republic it means these subcategories are not estimated. Under category 4B4h Other livestock, emission from rabbits are calculated.

5.4.2 Key sources

Cattle (3B1a and 3B1b) are the largest contributors to NH_3 emissions, approximately at 60 % of the national total. Swine (3B3) and poultry are also key sources of emissions that contribute for 20 % of the total and 10 %, respectively.

5.4.3 Overview of emission shares and trends

Table 5-1 presents an overview of ammonia emissions of originating from this category. According to the Czech legislation focused on management with fertilizers all slurry independently on farm size has to be incorporated within 24 hours after application.

Table 5-1 Ammonia emissions from manure management

Year	Gg
2000	67350
2001	67240
2002	64390
2003	62470
2004	59290
2005	57490
2006	56520
2007	57110
2008	54920
2009	50890
2010	49530
2011	47830
2012	47120
2013	48190
2014	48410

Between 2000 and 2014 NH_3 ammonia emissions have reduced by 28 %. The mentioned ammonia abatement was mainly the result of changes in animal population and adoption of ammonia abatement measures presented in Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources. In recent years a slight increase of animal population especially rearing pigs is seen.

5.4.4 Activity data and emission factors

For national estimation of ammonia emissions from animal husbandry in the Czech Republic the Tier 2 approach is used according to the 3.B Manure management EMEP/EEA emission inventory guidebook 2013 update July 2014. Each category of animals is multiplied by the country specific emission factors. Number of animals is taken from annual agricultural census coming from the official statistics (The Czech Statistical Office). In the Table 5-2 animal population in the period 1990 – 2014 is shown.

Table 5-2 Animal population in the period 1990–2014 (heads)

	1990	1991	1992	1993	1994	1995	1996
Cattle	3 506 222	3 359 976	2 949 574	2 511 737	2 161 438	2 029 827	1 988 810
Pigs	4 789 898	4 569 304	4 609 149	4 598 821	4 070 898	3 866 568	4 016 246
Poultry	31 981 100	33 278 468	30 756 308	28 219 580	24 974 149	26 688 376	27 875 356

	1997	1998	1999	2000	2001	2002	2003
Cattle	1 865 902	1 700 789	1 657 337	1 573 530	1 582 285	1 520 136	1 473 828
Pigs	4 079 590	4 012 943	4 000 720	3 687 967	3 469 802	3 440 925	3 362 801
Poultry	27 572 714	29 035 455	30 222 187	30 784 432	28 864 561	29 946 846	26 873 408

	2004	2005	2006	2007	2008	2009	2010
Cattle	1 428 329	1 397 308	1 373 645	1 391 393	1 401 607	1 363 213	1 349 286
Pigs	3 126 539	2 876 834	2 840 375	2 830 415	2 432 984	1 971 417	1 909 232

Poultry	25 493 559	25 372 333	25 736 003	24 592 085	27 316 866	26 490 848	24 838 435

	2011	**2012**	**2013**	**2014**			
Cattle	1 343 686	1 353 685	1 352 822	1 373 560			
Pigs	1 749 092	1 578 827	1 586 627	1 617 061			
Poultry	21 250 147	20 691 308	23 265 358	21 463 815			

Current national emission factors used for calculation of ammonia emission originating from key animal categories are result of new legislation preparation in the Czech Republic. In the 2013 implementary regulation no 377/2013 on manure storage and its utilization was finished. For preparation of this regulation a large database of data dealing with nutrient quantity presented in manure was used. This database is based on real manure analyses caring out in hundreds of cattle, pigs and poultry farms since 2005. On selected farms following data were collected:

Type of animal housing

- *,Numbers of individual animal category and their housing according to feeding days in monitored period*
- *Average weigh of individual animal category housed in relevant housing system*
- *Results of manure analyses of monitored farms*

Result of these analyses was a comparison of nitrogen production in different types of housing systems. Nitrogen losses in excrement and urine produced by selected categories of livestock were quantified. Total nitrogen content in excrement and urine before their application on the field was found. Nitrogen losses which part of them is formed by ammonia were quantified. For key animal livestock categories these nitrogen losses were set as national emission factors taking into account influence of housing systems and manure storage technology. These ammonia emission factors reflect a real situation of nitrogen balance in livestock housing systems and manure storage as a result of ammonia emission abatement technology utilization in the livestock breeding in the Czech Republic.

The used country specific emission factors for key category of animals used in the Czech Republic for calculation of national ammonia emission balance since 2014 are introduced in Table 5-3.

Ammonia emission factor for key animal category

Table 5-3 Ammonia emission factor for key animal category

animal category	**national emission factors ($kgNH_3.ks^{-1}.rok^{-1}$)**		
	housing + manure storage	manure application	total
cattle less than 1 year (calf) - solid	5,4	6	11,4
cattle 1-2 years (bulls) - solid	6,7	6	12,7
cattle 1-2 years (heifers) - solid	6,7	6	12,7
cattle over 2 years (bulls) - solid	9,7	6	15,7
cattle over 2 years (heifers) - solid	9,7	6	15,7
cattle over 2 years (dairy cows) - solid	27,7	12	39,7
cattle over 2 years (dairy cows) - liquid	12,6	12	24,6
cattle over 2 years (other categories) - solid	31,7	1,8	33,5

piglets - solid	1	2,5	3,5
sows - solid	3,1	4,8	7,9
sows - liquid	4,1	4,8	8,9
farrowing sows - solid	8,6	8	16,6
farrowing sows - liquid	7,4	8	15,4
rearing pigs - solid	3,1	3	6,1
rearing pigs - liquid	4,1	3	7,1
chicken	0,16	0,1	0,26
laying hens - solid	0,22	0,1	0,32
laying hens - liquid	0,16	0,1	0,26
rabbits			0,97

5.4.5 Methodological issues

Emissions of NH_3 from stables and storage, as well as NH_3 during manure application were calculated using Tier 2 approach according to the 3.B Manure management EMEP/EEA emission inventory guidebook 2013 update July 2014. Total nitrogen in manure was assessed and integrated into the Czech implementary regulation no 377/2013 on manure storage and its utilisation.

5.4.6 Uncertainties and time-series consistency

There was insufficient data available to assess the uncertainty of the calculations. The same calculation system have been used for the whole series.

5.4.7 QA/QC and verification

This source category is covered in under general QA/QC procedures.

5.4.8 Recalculations

Annual national ammonia emission balances were calculated according to different emission factors until 2013. These obsolete emission factors were based on ammonia emission measurements carried out within 1998 – 2002. These ammonia emission factors did not take ammonia abatement options into account. For this reason they were substituted by new above mentioned national ammonia emission factors since 2014. Recalculation of all ammonia emission balance since 2000 was executed.

5.4.9 Planned improvements

NOx emissions from manure application is planned to calculate according to Tier 1 approach since 2015.

5.5 Crop production and agricultural soils

There are four main sources of emissions from crop production and agricultural soils:

- *fertiliser application (NH_3)*
- *soil microbial processes (NO)*

- *crop processes (NH_3 and NMVOCs)*
- *soil cultivation and crop harvesting (PM)*

Sector NFR 3Dc comprises fugitive emissions of PM_{10} and $PM_{2.5}$ produced by agriculture during soil cultivation, harvesting of crops, and their subsequent cleaning and drying. It can be assumed that emissions produced during field operations are composed mainly of inorganic soil particles, during harvesting mainly of organic plant remains, and in some cases of spores of moulds etc. Emissions depend on the type of crop, the type of soil, the method of soil cultivation used, and on the climatic conditions before and during farming operations.

5.5.1 Methodology

5.5.1.1 Nitrogen fertilizer application

Ammonia emissions from synthetic N fertilizer application (3.D.a.1) were calculated according to the methodology and emission factors used for the GAINS model (see IR-04-048, IIASA, Laxenburg). Emission factors for urea (0.182 kg/ kg fertilizer-N) and other N-fertilizers (0.04 kg/ kg fertilizer-N) are based on average values from scientific researches. The activity data on N-fertilizer application are provided by the Czech Statistical Office and are based on the fertilizer consumption in the Czech Republic. The share of urea (cca. 20%) was estimated by the Ministry of Agriculture

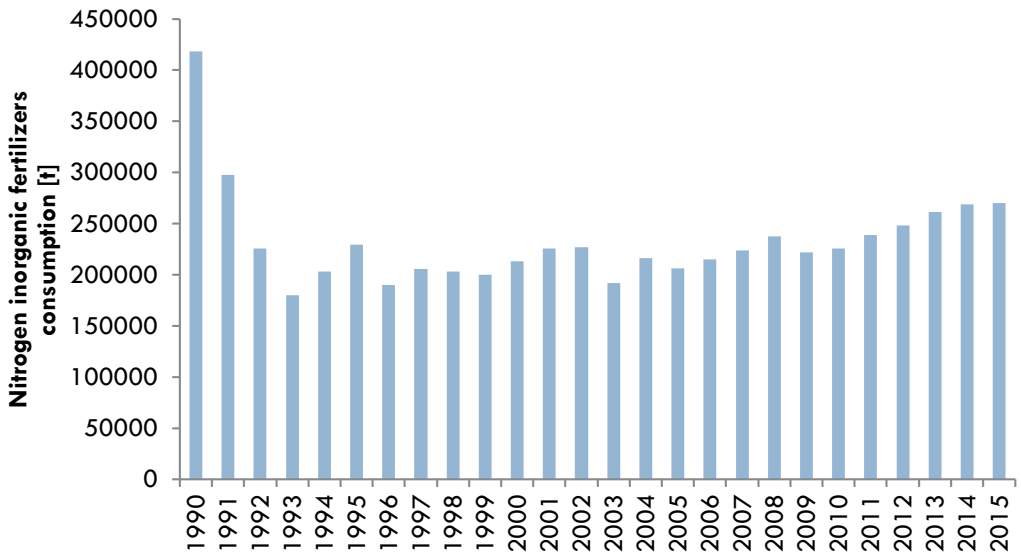

Figure 5-1 Trend of annual use of nitrogen inorganic fertilizers in 1990-2015 [t]

5.5.1.2 Soil cultivation and crop harvesting (PM)

According to the Tier 2 metohdology Technologically specific approach, emissions of PM_{10} and $PM_{2.5}$ are calculated as the product of cropped areas of individual crops and emission factors pertaining to individual field operations emitting dust particles, expressed by the formula:

$$E_{PM} = \sum_{i=1}^{I} \sum_{n=0}^{N_{i_k}} EF_{PM_i_k} \cdot A_i \cdot n$$

with the following variables:

- *EPM – emissions of PM_{10} or $PM_{2.5}$ from the ith crop in $kg.a^{-1}$*
- *I – number of crops grown*
- *Ai – annual cropped area of the ith crop in ha*
- *Ni_k – number of times the kth operation is performed on the ith crop, in a^{-1}*
- *EFPM_i_k – EF for the kth operation of the ith crop, in $kg.ha^{-1}$*

5.5.1.2.1 Activity data

Cropped areas of individual crops at the level of administrative regions were obtained from the annual report of the Czech Statistical Office (Figure 5-2). The focus was on areas of monitored cereals, i.e. wheat, rye, barley and oats, which are grown on approximately 50–60% of arable land. The area taken up by cereal crops was subtracted from the total area of arable land, which gave the area of arable land on which root crops, vegetables, oilseeds, fodder plants, etc. are grown.

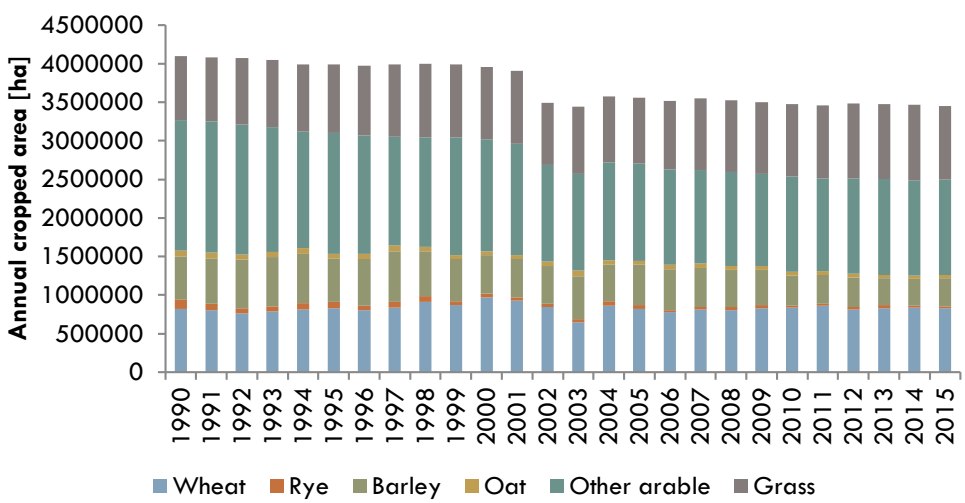

Figure 5-2 Trend of annual cropped area in 1990-2015 [ha]

5.5.1.2.2 Emission factors

Emission factors for PM_{10} and $PM_{2.5}$ were adopted from EIG2013 for the region with humid climatic conditions. To take into account the effects of the conventional and the minimization approach to growing cereals, and to obtain a more precise calculation of PM emissions from the agricultural operation Soil cultivation, the area taken up by cereal crops in each region was divided into thirds. For one-third of the area of cereals farmed using the minimization approach, the emission factor for soil cultivation was factored in twice; for the remaining area it was factored in four times, as was the case for areas classified as other arable land. In the case of permanent grasslands, the emission factor for the operation Harvesting was factored in twice (Table 5-4). Total emission of PM_{10} or $PM_{2.5}$ for a given region is determined by the sum of individual emissions of PM for individual operations and individual crops.

Table 5-4 Frequency of farming operations during the course of the year for individual types of crops

Crop	Soil cultivation		Harvesting	Cleaning	Drying
	Conventional	Minimization			
Wheat	4	2	1	1	1
Rye	4	2	1	1	1
Barley	4	2	1	1	1
Oat	4	2	1	1	1
Other arable	4	-	-	-	-
Grass	1	-	2	0	0

6 WASTE (NFR SECTOR 5)

6.1 Overview

Table 6-1 NFR categories and Czech classification for sector 5 Waste

NFR code	Longname	Classification pursuant Annex 2 to Act 201/2012 Coll.
5A	Biological treatment of waste - Solid waste disposal on land	2.2. Dumps which accept more than 10 t of waste per day or have a total capacity of over 25 000 t
5B1	Biological treatment of waste - Composting	2.3. Composting facilities and biological waste treatment facilities with a projected capacity equal to or greater than 10 tons per fill or greater than 150 tons of processed waste per year
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	3.7. Biogas production
5C1a	Municipal waste incineration	2.1. Thermal waste processing in incinerators
5C1bi	Industrial waste incineration	2.1. Thermal waste processing in incinerators
5C1bii	Hazardous waste incineration	2.1. Thermal waste processing in incinerators
5C1biii	Clinical waste incineration	2.1. Thermal waste processing in incinerators
5C1biv	Sewage sludge incineration	2.1. Thermal waste processing in incinerators
5C1bv	Cremation	7.15. Crematoriums
5C1bvi	Other waste incineration (please specify in the IIR)	Unspecified in Annex 2 to Act 201/2012 Coll.
5C2	Open burning of waste	Unspecified in Annex 2 to Act 201/2012 Coll.
5D1	Domestic wastewater handling	2.7. Wastewater treatment plants with a projected capacity per 10 000+ equivalent residents
5D2	Industrial wastewater handling	2.6. Wastewater treatment plants; facilities intended for the operation of technologies producing wastewater which cannot be assigned to equivalent residents at a quantity greater than 50 m^3/day
5D3	Other wastewater handling	Unspecified in Annex 2 to Act. 201/2012 Coll.
5E	Other waste (please specify in IIR)	2.4. Biodegradation and solidification facilities
		2.5. Sanitation facilities (elimination of oil and chlorinated hydrocarbons from contaminated soil) with a projected oil output of greater than 1 t of volatile organic compounds, inclusive

6.2 NFR 5A Biological treatment of waste – Solid waste disposal on land

6.2.1 Source characteristic

This category describes emissions from municipal solid waste disposal in landfills. These sources are only a minor source of air pollutant emissions.

6.2.2 Methodology for Solid waste disposal on land (NFR sector 5A)

In the inventory system of the Czech Republic are monitored about facilities for the landfilling of solid municipal waste listed in Annex 2 to Act 201/2012 Coll. (2.2. Dumps which accept more than 10 t of waste per day or have a total capacity of over 25 000 t).Emissions from these facilities are not registered by the REZZO database. Only for some facilities are reported emissions from flaring for emergency combustion of collected landfill gas.

Czech national legislation does not specify emission limit values or technical conditions of operation for this category. Emission factors for NMVOC, TSP, PM_{10} and $PM_{2.5}$ were taken from the EMEP/EEA Air pollutant Emission Inventory Guidebook (Tier 1 approach). Due to the technology used, emission factors were considered at their lowest level. Most landfill gas in the Czech Republic gets extracted and burned. There are no estimates available on the emission factors for the other pollutants. Summary of used emission factors is presented below in Table 6-2.

Activity data (amount of landfill waste) were taken from the Waste Management Information System (ISOH). This is a country-wide database information system containing data about the production and management of wastes as well as information about facilities for their treatment and removal. From 2002 until 2006 the ISOH database was operated for the Ministry of the Environment by the T. G. Masaryk Water Research Institute (VÚV), one of whose parts was the Centre for Waste Management (CeHO). Since 2007 the operator of the ISOH database is the Czech Environmental Information Agency (CENIA). This database can be queried by year, area, treatment method and waste catalogue number.

Table 6-2 Used emission factors for category 5A

Pollutant	Unit	Value
NMVOC	kg/t	0,5
TSP	g/t	0,006
PM_{10}	g/t	0,003
$PM_{2.5}$	g/t	0,0004

6.2.3 The development of emissions from category 5A

Table 6-3. presents the amounts and proportions of deposited and incinerated solid municipal waste in the monitored time frame. The proportion of landfilled waste is notably high although in the last years it has been decreasing slightly in favour of incineration excepting years 2014-2015 (see also chapter 6.5.3 – 5C1a). Emissions from deposited waste change depending on its amount.

Table 6-3 Comparison of the amount and share of deposited and incinerated municipal waste

Year	Amount of deposited waste (kt/year)	Amount of incinerated waste (kt/year)	Total waste (kt/year)	Share of incinerated waste	Share of deposited waste
2000	2 803	343	3 146	10,9 %	89,1 %
2001	2 826	368	3 194	11,5 %	88,5 %
2002	2 920	414	3 333	12,4 %	87,6 %
2003	2 952	406	3 357	12,1 %	87,9 %
2004	3 000	410	3 410	12,0 %	88,0 %
2005	3 070	387	3 457	11,2 %	88,8 %
2006	3 221	393	3 614	10,9 %	89,1 %
2007	3 314	391	3 704	10,5 %	89,5 %
2008	3 424	377	3 801	9,9 %	90,1 %
2009	3 406	360	3 766	9,6 %	90,4 %
2010	3 185	486	3 671	13,2 %	86,8 %
2011	2 981	613	3 594	17,1 %	82,9 %
2012	2 786	634	3 420	18,5 %	81,5 %
2013	2 543	638	3 181	20,0 %	80,0 %
2014	2 786	643	3 428	18,7 %	81,3 %
2015	3 172	632	3 804	16,6 %	83,4 %

6.3 NFR 5B1: Biological treatment of waste – Composting

6.3.1 Source characteristic

Composting is a biological method of utilising biowaste which under controlled conditions transforms biowaste into compost through aerobic processes and microbial activity. This process does not produce any emissions of monitored pollutants, only malodorous compounds.

Pursuant to Annex 8 to the Regulation No 415 /2012 Coll., point 1.1. (Composting plants and equipment for biological modification of waste with projected capacity greater or equal to 10 tonnes per one batch or greater than 150 tonnes of the processed waste per year) for these plants isn't set any emission limit, only technical conditions of operation:

a) Feeding bunkers have closed construction with the chamber for vehicles, for open halls, and during unloading of collecting vehicles with waste; gases must be exhausted and collected into facilities for cleaning waste gases.

b) Condensed vapours and water produced during the composting process (maturing of composts) may be used for construction of open and not covered composting plants for watering of compost only in cases that they will not increase the dust load of the surrounding environment.

c) Waste gases from maturing of composts in closed halls of composting plants are collected into facilities for cleaning of waste gases.

6.4 NFR 5B2: Biological treatment of waste –Anaerobic digestion at biogas facilities

6.4.1 Source characteristic

In a biogas station, single-step fermentation (decomposition) transforms organic compounds into biogas. Anaerobic fermentation is a biological process decomposing organic matter which takes place without the presence of air. It naturally occurs in nature, e.g. in bogs, on the bottoms of lakes or in waste dumps. During this process, a mixed culture of microorganisms gradually decomposes organic matter.

Due to the hermetisation the biogas plant are not expected any releases of air emissions. The small amounts of emissions of NO_x, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO indicated in this category come from emergency flares burning the excessive biogas.

Czech national legislation does not specify emission limit values or technical conditions of operation for this category.

6.4.2 Methodology for Anaerobic digestion at biogas facilities (NFR sector 5B2)

Emissions of NO_x, NMVOC, SO_2, NH_3 and TSP are reported in the Summary operation records. The PM_{10} and $PM_{2.5}$ emissions are determined on base of type of technology.

6.5 NFR 5C1a–5C1biv: Waste incineration

6.5.1 Source characteristic

In these categories are included all installations for thermal treatment of waste (municipal, industrial, clinical, sewage sludge). The category 5C1bii (Hazardous waste incineration) is not considered separately; incineration of hazardous waste is included in categories 5C1bi and 5C1biii. Category 5C1biv is at present represented by a single facility for incineration of waste sludge, which was out of operation in years 2014–2015, therefore symbol "NO" was used.

Most of facilities use heat generated by waste incineration. For smaller incinerators are most common heating of own objects (hospitals, factories etc.) and warming of water. The larger facilities supply heat to the public networks, alternatively work on the principle of cogeneration cycle, which provides heat and electricity production.

The database of installations for thermal treatment of waste in the Czech Republic (Register of waste incinerators and co-incinerators) has been maintained since 2002 in accordance with legal requirements. Information from this register is made available to the public on the website of the Czech Hydrometeorological Institute. CHMI makes the following information accessible to the public:

Monthly updated review of waste incineration and co-incineration facilities

(http://portal.chmi.cz/files/portal/docs/uoco/oez/emise/spalovny/index.html)

Information for this review are obtained from periodic report of the Czech Environmental Inspectorate. The following information is monitored: change of operator or source name, technological modifications, changes in the composition of waste, source shutdown or start of operation. These reports also provide information about the performed measurements and compliance with emission limits. Some summary information (especially amount of incinerated waste) are obtained from summary operating records. They are made public in the form of synoptic tables which contain following data: identification data (region, name of operator, name of facility, identification number (IČ), identification number of the operating unit (IČP), address of operator, address of facility, contact of processor of summary operating records) and operating data (putting into operation, capacity in tonnes per year, amount of waste incinerated in last three years in tonnes per year, emission limit values compliance and appropriate comments about operating changes, performed measurements etc.).

Yearly updated geographical navigator
(http://portal.chmi.cz/files/portal/docs/uoco/web_generator/incinerators/index_CZ.html)

The graphic navigator presents overall annual information about facilities for the incineration and co-incineration of waste, which are obtained from summary operating records. These are the following: identification number (IČ), name of the facility, address of the operator, address of the facility, putting into operation, types of waste incinerated, nominal capacity, amount of waste incinerated in tonnes per year, number and brief description of incineration lines, enumeration of equipment for reducing emissions, annual emissions of all pollutants reported.

Evidence of permits for waste incineration and co-incineration
(http://portal.chmi.cz/files/portal/docs/uoco/oez/emise/spalovny/evidence/index.html)

This website is updated based on information of regional authorities, which have been issuing permits since 1. 1. 2003.
The types of permits are the following:
Permits according to § 17 paragraph 1 and 2 of Act 86/2002 Coll. – permits issued until 1. 9. 2012.
Permits according to § 11 paragraph 2 d) of Act 201/2012 Coll. – permits issued from 1. 9. 2012.
Integrated permits according to § 13 paragraph 3 of Act 76/2002 Coll. – for plants meeting certain criteria(primarily capacity constraints) within the categorization according to Annex 1 to Act 76/2002 Coll.

Data from Register of waste incinerators are utilized in emission inventory. Co-incineration plants which are in the Czech Republic only cement kilns cannot be included into emission inventory because the largest share of emissions does not come from waste incineration, but from the production of cement clinker. Amount of waste incinerated in in rotary furnaces for production of cement clinkers is included in activity data of category 1A2f as other fuels.

The emission inventory shows that the share of emissions of all pollutants in the total number is very low. Therefore, thermal treatment of waste has great potential, both economic and environmental.

6.5.2 Methodology for Waste incineration (NFR sectors 5C1a–5C1biv)

Methodology for particular reported categories is the same. Pursuant to Annex 2 to the Air Protection Act, waste incineration plants are ranked among specified stationary sources and they are registered within the REZZO 1 category. The emission inventory preparation in periods 2000–2015 and 1990–1999 was different and is therefore described for each period separately.

6.5.2.1 Methodology for period 2000–2015

For the purpose of emission inventory, the majority of data on pollutants is obtained from the Summary operation records (Tier 3). The respective pollutants are listed in Annex 4 to the Regulation No 415 /2012 Coll., which sets specific emission limit values pursuant to Annex VI to the Directive 2010/75/EU, on industrial emissions. The following substances are reported in the Summary operation records: NO_x, VOC, SO_2, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni and PCDD/F. Emissions of obligatory pollutants, that were for concrete source not available in some year, are calculated using the emissions reported in the nearest year and activity data (specific manufacturing emission). The remaining pollutants which are included in the emission inventory and not reported are calculated using emission factors and activity data, i. e. the amount of waste incinerated in tonnes per year. Czech emission factors for waste incineration are predominantly based on either own measurements (POPs), partly they were taken from the EMEP/EEA Air pollutant Emission Inventory Guidebook, version 2016 (Zn, Se). PM_{10} and $PM_{2.5}$ emissions are determined based on information about abatement equipment. BC emissions amount to 3.5 % of $PM_{2.5}$ in all categories.

A summary of used emission factors of heavy metals and POPs not reported for categories 5C1a–5C1biv is presented below in Table 6-4.

Table 6-4 Emission factors of heavy metals and POPs not reported used for categories 5C1a–5C1biv

NFR sector	Zn (mg/t)	Se (mg/t)	benzo(a) pyrene (mg/t)	benzo(b) fluoranthene (mg/t)	benzo(k) fluoranthene (mg/t)	Indeno (1,2,3-cd) pyrene (mg/t)	HCB (mg/t)
5C1a	24,5	11,7	0,7	3,15	3,15	0,10666	0,15
5C1bi	21000	150	0,6923	3,03845	3,03845	0,10666	0,139
5C1biii	21000	150	0,6923	3,03845	3,03845	0,10666	0,04559
5C1biv	21000	150	0,6923	3,03845	3,03845	0,10666	0,139

6.5.2.2 Methodology for period 1990–1999

Fundamental for the inventorying were also the data of summary operational records (SPE). According to the legislation of that time the emission limits were set until 1998 for the first time (see chapter 2.1). The reporting pollutants therefore were not available in full range.

The initial data were available emissions and activity data (the amount of waste incinerated) in 1990–2001. This period was chosen due to the new legislation valid since 2002 (Act 86/2002 Sb.). For each waste incinerator, emission consistency of each pollutant for full time series was performed and unreal values were calculated using activity data. Based on this data emission factors were calculated for all pollutants of summary operating database. Emission factors gained were grouped by NFR categories. Zero, distant and implausible values were eliminated and from the remaining the average values were calculated. These emission factors were compared to EMEP/EEA Air Pollutant Emission Inventory Guidebook and found comparable order of magnitude. Based on these values there were calculated all missing emissions of all reported air pollutants. The remaining pollutants which are included in the emission inventory and not reported (Zn, Se, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PM_{10}, $PM_{2.5}$ and BC) are calculated according to the methodology used for the period 2000–2015.

Specific emission factors set for purposes of emission inventory for the categories 5C1a–5C1biv in 1990-1999 are presented below in tables 6-5 and 6-6.

Table 6-5 Emission factors of basic pollutants for categories 5C1a–5C1biv in 1990–1999

NFR sector	TSP (kg/t)	SO_2 (kg/t)	NOx (kg/t)	CO (kg/t)	TOC (kg/t)
5C1a	2,413	1,579	2,403	3,572	1,077
5C1bi	3,824	3,736	6,064	5,507	0,949
5C1biii	3,969	4,632	5,760	4,004	1,650
5C1biv	0,396	2,722	4,662	5,772	8,693

Table 6-6 Emission factors of reported heavy metals and PCDD/F for categories 5C1a–5C1biv in 1990–1999

NFR sector	Pb (mg/t)	Cd (mg/t)	Hg (mg/t)	As (mg/t)	Cr (mg/t)	Cu (mg/t)	Ni (mg/t)	PCDD/F (mg/t)
5C1a	529	94	104	273	57	178	201	0,001
5C1bi	18 993	639	1 602	3 911	5 284	3 834	1 031	0,030
5C1biii	11 838	3 264	3 520	4 856	1 092	4 967	1 633	0,033
5C1biv	18 993	639	1 602	3 911	5 284	3 834	1 031	0,030

6.5.3 The development of emissions from category 5C1a

According to the chapter 2-1 there were presented data divided in periods 1990–2001 and 2002–2015. There is presented emission development of TSP, SO_2, NOx, CO and VOC. These are substances referred to as basic within the emission database; they are part of the emission balance published on the website of the CHMI. The emission balance also published emissions of ammonia, which is usually not being reported with the exclusion of selective reduction of NOx. In this case, specific emission limit is being applied to control ammonia emission.

Further you can see the emission development of heavy metals and POPs reported as part of general operational auditing in the same periods. Emissions of substances calculated using emission factors which are not included in the table because they change solely depending on the amount of waste incinerated, which is presented together with emissions of main air pollutants.

6.5.3.1 The development of emissions from category 5C1a in the period 2002–2015

Table 6-7 Development of emissions of basic pollutants from municipal waste incinerators in the years 2002–2015

Year	Amount of incinerated waste (kt/year)	TSP (kt/year)	SO_2 (kt/year)	NO_x (k/year)	CO (kt/year)	VOC (kt/year)
2002	414	0,009	0,025	0,470	0,039	0,003
2003	406	0,010	0,020	0,477	0,038	0,007
2004	410	0,008	0,011	0,440	0,047	0,004
2005	387	0,007	0,013	0,372	0,047	0,002

Year	Amount of incinerated waste (kt/year)	TSP (kt/year)	SO_2 (kt/year)	NO_x (k/year)	CO (kt/year)	VOC (kt/year)
2006	393	0,005	0,010	0,317	0,034	0,002
2007	391	0,004	0,010	0,315	0,033	0,002
2008	377	0,003	0,011	0,305	0,028	0,001
2009	360	0,002	0,013	0,277	0,031	0,001
2010	486	0,003	0,017	0,371	0,044	0,002
2011	613	0,004	0,031	0,449	0,053	0,004
2012	634	0,005	0,040	0,487	0,058	0,003
2013	638	0,005	0,040	0,489	0,047	0,003
2014	643	0,001	0,036	0,499	0,048	0,003
2015	632	0,001	0,035	0,499	0,037	0,003

Table 6-8 Development of emissions of heavy metals and POPs from municipal waste incinerators in the years 2002–2015

Year	Pb (t/year)	Cd (t/year)	Hg (t/year)	As (t/year)	Cr (t/year)	Cu (t/year)	Ni (t/year)	PCDF (g I-TEQ/year)
2002	0,235	0,023	0,091	0,210	0,028	0,355	0,292	0,231
2003	0,060	0,011	0,031	0,007	0,088	0,365	0,332	0,146
2004	0,016	0,006	0,013	0,005	0,022	0,094	0,059	0,153
2005	0,011	0,002	0,009	0,005	0,033	0,020	0,018	0,125
2006	0,019	0,002	0,041	0,002	0,016	0,033	0,016	0,140
2007	0,026	0,003	0,042	0,005	0,055	0,030	0,013	0,093
2008	0,023	0,003	0,024	0,004	0,009	0,009	0,007	0,047
2009	0,021	0,003	0,024	0,006	0,013	0,045	0,026	0,040
2010	0,017	0,002	0,024	0,002	0,020	0,025	0,016	0,024
2011	0,020	0,002	0,014	0,003	0,018	0,029	0,020	0,040
2012	0,040	0,003	0,013	0,002	0,040	0,140	0,041	0,039
2013	0,026	0,002	0,024	0,002	0,023	0,029	0,109	0,086
2014	0,026	0,002	0,006	0,003	0,026	0,137	0,040	0,044
2015	0,020	0,002	0,009	0,004	0,013	0,014	0,030	0,079

The above presented data show high consistency of all pollutants for the period monitored and mainly depend on the amount of waste incinerated.

There are currently three facilities for energetic utilisation of waste in the Czech Republic: Pražské služby, a.s. – Factory 14, Facility for energetic utilisation of waste Malešice, SAKO Brno, a.s. - Division 3 ZEVO and TERMIZO a.s. – Incinerator of municipal waste Liberec, which were operated throughout the monitored timeframe; the overall number of their combustion lines was 7. All the facilities reach a high degree of energetic efficiency; efficiency values and the formula used for their calculation are presented in Supplement 12 to Act 185/2001 Coll. on waste (60% or 65% depending on the operation permit issue date). This case concerns the utilisation of wastes in ways listed under code R1 in Supplement No. č. 3 to the same Act. Such facilities should not be referred to as incinerators, but facilities for energetic utilisation of waste.

It is also clear from Table 6-7 that the amount of incinerated waste has significantly increased in the last years excepting 2015. The reason is increasing preference for incineration to landfilling. From the economic perspective, the use of waste for generating heat is highly beneficial because it leads to savings of fossil fuels. Next there is the ecological perspective. On aspect is the reduction of the volume of waste deposited in landfills. Energetic utilisation of municipal waste reduces its volume by about 90 % and its weight by about 70 %. But most importantly, emission limits for incinerators are very low compared to emission limits for other facilities for

the production of heat or electricity, comparable only to limits imposed for sources burning natural gas. Incineration of waste therefore significantly reduces the amount of pollutants exhausted into the atmosphere. For instance, in the facility SAKO Brno, a. s., an extensive reconstruction took place in the years 2009–2010, which also increased the capacity to incinerate waste. Besides existing facilities, new projects are currently being prepared. In the summer of 2016 new facility was put into operation: Plzeňská teplárenská, a.s. – Facility for energetic utilisation of waste Chotíkov.

6.5.3.2 The development of emissions from category 5C1a in the period 1990–2001

Table 6-9 Development of emissions of basic pollutants from municipal waste incinerators in the years 1990–2001

Year	Amount of incinerated waste (kt/year)	TSP (kt/year)	SO_2 (kt/year)	NOx (k/year t)	CO (kt/year)	VOC (kt/year)
1990	60	0,082	0,080	0,189	0,061	0,030
1991	58	0,079	0,077	0,176	0,058	0,029
1992	80	0,111	0,115	0,243	0,090	0,042
1993	110	0,159	0,147	0,329	0,124	0,058
1994	145	0,059	0,180	0,438	0,147	0,073
1995	164	0,012	0,020	0,262	0,199	0,004
1996	171	0,033	0,019	0,422	0,017	0,002
1997	174	0,001	0,024	0,184	0,050	0,001
1998	245	0,011	0,039	0,502	0,353	0,137
1999	326	0,004	0,027	0,381	0,029	0,193
2000	343	0,003	0,011	0,361	0,029	0,003
2001	368	0,007	0,040	0,376	0,049	0,004

Table 6-10 Development of emissions of heavy metals and POPs from municipal waste incinerators in the years 1990–2001

Year	Pb (t/year)	Cd (t/year)	Hg (t/year)	As (t/year)	Cr (t/year)	Cu (t/year)	Ni (t/year)	PCDF (g I-TEQ/year)
1990	0,032	0,006	0,006	0,016	0,003	0,011	0,012	0,060
1991	0,031	0,005	0,006	0,016	0,003	0,010	0,012	0,058
1992	0,042	0,008	0,008	0,022	0,005	0,014	0,016	0,080
1993	0,058	0,010	0,011	0,030	0,006	0,020	0,022	0,110
1994	0,077	0,014	0,015	0,040	0,008	0,026	0,029	0,145
1995	0,087	0,015	0,017	0,045	0,009	0,029	0,033	0,164
1996	0,090	0,016	0,018	0,047	0,010	0,030	0,034	0,171
1997	0,092	0,016	0,018	0,048	0,010	0,031	0,035	0,174
1998	0,129	0,023	0,025	0,067	0,014	0,044	0,049	0,245
1999	0,197	0,029	0,034	0,101	0,019	0,058	0,066	0,326
2000	0,201	0,021	0,080	0,158	0,022	0,317	0,258	0,124
2001	0,092	0,027	0,009	0,188	0,014	0,263	0,219	0,133

The presented data make evident that are there significant extremes in comparison to the later time period. This can mainly be explained by the varying amounts of sources and waste composition. Several smaller sources were operated for example in laundries, dry cleaner's and residential heating. Moreover, the obligation to have a permit for waste incineration, which sets emission limits and

operating conditions, including requirements for measurement and equipment to reduce emissions entered into force only after the legislation in 2002.

6.5.4 The development of emissions from categories 5C1bi–5C1biv

As in the case of category 5C1a, presented data were divided into periods 1990–2001 a 2002–2015.

6.5.4.1 The development of emissions from categories 5C1bi–5C1biv in the period 2002–2015

Table 6-11shows the emission development of basic pollutants in the period 2002–2015, Table 6-12 shows the emission development of heavy metals and POPs reported as part of SPE in the same period.

Table 6-11 includes also information about number of incineration lines and amount of incinerated waste. It is obvious that a relatively large decrease of the number of facilities occurred between the years 2003 and 2005. This was caused by the fact that many of these facilities would not be able to meet demanding emission limits and operational requirements without undergoing extensive reconstruction. Their operation was therefore terminated. On the other hand, numerous facilities underwent modifications leading to a lowering of emissions.

Table 6-11 Development of emissions of basic pollutants from other waste incinerators in the years 2002–2015

Year	Number of incinerating lines	Amount of incinerated waste (kt/year)	TSP (kt/year)	SO_2 (kt/year)	NO_x (kt/year)	CO (kt/year)	VOC (kt/year)
2002	59	60	0,008	0,026	0,126	0,015	0,003
2003	48	87	0,007	0,028	0,151	0,015	0,003
2004	41	66	0,005	0,018	0,118	0,013	0,002
2005	34	63	0,003	0,014	0,109	0,008	0,001
2006	32	71	0,002	0,012	0,107	0,013	0,001
2007	35	72	0,002	0,008	0,096	0,011	0,002
2008	33	74	0,002	0,010	0,102	0,011	0,002
2009	32	72	0,002	0,009	0,088	0,008	0,002
2010	32	77	0,002	0,011	0,085	0,008	0,001
2011	32	84	0,002	0,009	0,092	0,009	0,001
2012	33	83	0,001	0,007	0,095	0,009	0,001
2013	32	82	0,002	0,007	0,106	0,008	0,001
2014	29	89	0,002	0,006	0,096	0,009	0,001
2015	27	81	0,001	0,007	0,096	0,010	0,001

Table 6-12 Development of emissions of heavy metals and POPs from other waste incinerators in the years 2002–2015

Year	Pb (t/year)	Cd (t/year)	Hg (t/year)	As (t/year)	Cr (t/year)	Cu (t/year)	Ni (t/year)	PCDF (g I-TEQ/year)
2002	0,205	0,018	0,058	0,034	0,087	0,102	0,066	1,494
2003	0,202	0,025	0,036	0,028	0,020	0,133	0,051	0,792
2004	0,081	0,015	0,014	0,010	0,017	0,081	0,024	0,506

2005	0,031	0,010	0,013	0,005	0,033	0,049	0,056	0,130
2006	0,036	0,003	0,025	0,007	0,020	0,058	0,026	0,503
2007	0,024	0,004	0,015	0,006	0,021	0,041	0,033	0,063
2008	0,027	0,005	0,021	0,006	0,018	0,042	0,031	0,021
2009	0,020	0,005	0,014	0,005	0,010	0,040	0,032	0,019
2010	0,023	0,002	0,014	0,004	0,012	0,018	0,017	0,032
2011	0,032	0,002	0,024	0,008	0,012	0,016	0,026	0,108
2012	0,033	0,002	0,014	0,006	0,018	0,011	0,013	0,319
2013	0,021	0,002	0,012	0,003	0,028	0,018	0,009	0,076
2014	0,034	0,002	0,020	0,005	0,019	0,017	0,015	0,030
2015	0,030	0,001	0,012	0,004	0,016	0,032	0,008	0,037

6.5.4.2 The development of emissions from categories 5C1bi–5C1biv in the period 1990–2001

Table 6-13 Development of emissions of basic pollutants from other waste incinerators in the years 1990–2001

Year	Number of incinerating lines	Amount of incinerated waste (kt/year)	TSP (kt/year)	SO_2 (kt/year)	NOx (kt/year)	CO (kt/year)	VOC (kt/year)
1990	34	35	0,155	0,338	0,232	0,272	0,037
1991	63	54	0,148	0,378	0,202	0,360	0,058
1992	140	63	0,242	0,419	0,247	0,399	0,067
1993	155	52	0,221	0,351	0,351	0,733	0,061
1994	137	81	0,146	0,367	0,228	0,402	0,059
1995	122	66	0,082	0,219	0,328	0,307	0,022
1996	109	67	0,070	0,088	0,227	0,181	0,018
1997	92	64	0,059	0,084	0,246	0,166	0,011
1998	79	63	0,041	0,086	0,176	0,281	0,008
1999	65	61	0,022	0,070	0,146	0,037	0,007
2000	52	80	0,006	0,032	0,064	0,009	0,004
2001	59	53	0,007	0,014	0,084	0,008	0,002

Table 6-14 Development of emissions of heavy metals and POPs from other waste incinerators in the years 1990–2001

Year	Pb (t/year)	Cd (t/year)	Hg (t/year)	As (t/year)	Cr (t/year)	Cu (t/year)	Ni (t/year)	PCDF (g I-TEQ/year)
1990	0,654	0,027	0,060	0,139	0,178	0,137	0,037	1,060
1991	0,993	0,048	0,096	0,216	0,265	0,213	0,059	1,639
1992	1,217	0,067	0,122	0,254	0,295	0,251	0,070	1,911
1993	0,923	0,057	0,104	0,212	0,237	0,209	0,059	1,586
1994	1,439	0,092	0,164	0,333	0,367	0,330	0,093	2,490
1995	0,832	0,071	0,110	0,190	0,206	0,191	0,117	2,026
1996	0,889	0,058	0,084	0,158	0,189	0,169	0,061	2,043
1997	0,735	0,064	0,083	0,185	0,180	0,180	0,052	1,943
1998	0,681	0,057	0,086	0,181	0,265	0,249	0,051	1,917
1999	0,743	0,050	0,077	0,171	0,210	0,155	0,057	1,859

Year	Pb (t/year)	Cd (t/year)	Hg (t/year)	As (t/year)	Cr (t/year)	Cu (t/year)	Ni (t/year)	PCDF (g I-TEQ/year)
2000	0,234	0,013	0,030	0,081	0,131	0,143	0,081	2,254
2001	0,742	0,011	0,017	0,049	0,062	0,120	0,061	0,863

The Table 6-13 makes evident that number of the facilities was very variable, most of them were in 1992–1996. Most of hospitals had their own incinerator as well as more facilities were operated in factories in various branches (food processing, metallurgy, chemical industry etc.). Also the composition waste varied same as in category 5C1.

6.5.5 Recalculations in NFR sector 5C1a–5C1biv

The whole time series 1990-2015 were supplemented by emissions of BC, Zn and Se. Emission factors were adopted from EMEP/EEA Air Pollutant Emission Inventory Guidebook, version 2016 (see table 6-4). Specifically, they were filled in Zn emission for category 5C1a and emissions of Se and BC for all categories. Emission factor for Se was not available for category 5C1biii, assumption that it is identical with the emission factor for category 5C1bi was used. Other activity data for heat supplied to other fuels co-burned (mostly natural gas, a lesser extent also liquid fuels).

6.6 Cremation (NFR sector 5C1bv)

6.6.1 Source characteristic

This sector mainly covers the atmospheric emissions from the incineration of human bodies, organs and remains in crematorium. Incineration of animal carcasses is also considered here.

Furnaces for incinerating animal remains are usually installed in large animal farming facilities or crematoria for pets. There are currently about 30 facilities in operation in the country.

There are two main types of crematoria: crematoria powered by gas or oil and crematoria powered by electricity. Liquid fuels are used almost nowhere in the Czech Republic. Most cremation furnaces in use are powered by natural gas and have been made by TABO-CS Ltd. The exhausts produced during cremation in the main chamber are drawn through side mixing chambers with inlets of secondary air into final combustion chambers. Secondary and tertiary air facilitates an effective final combustion process which eliminates pollutants in line with requirements for environmental protection.

6.6.2 Methodology for Cremation (NFR sector 5C1bv)

Reported emissions in sector 5C1bv (Cremation) are as point sources being registered within REZZO database. Until 2012 they had been part of REZZO 2 category, since 2013 they have been included within REZZO 1 in connection with the change of categorization (see chapter 1.2.).

Emission limits for cremation are set by Annex 8 to the Regulation No 415 /2012 of Coll., Point 6.13. Crematoria. They are set for TSP, NOx, CO and VOC. The same emission limits are also applicable to facilities incinerating exclusively animal remains including parts of them.

Emissions of these pollutants are reported in the Summary operation records, as well as SO_2, whose emission limits are specified in the permits of individual sources (Tier 3). Because emissions in category REZZO 2 are available since 1995, for the purpose of additional calculation of earlier years there had been calculated emission factors for the above specified pollutants that had then been calculated additionally on the basis of activity data. An overview of emission factors is being presented in the following Table 6-15.

Table 6-15 Emission factors for basic pollutants in category 5C1v for period 1990–1994

Pollutant	Value	Unit
TSP	0,031	kg/body
SO_2	0,022	kg/body
NOx	0,321	kg/body
CO	0,059	kg/body
VOC	0,006	kg/body

The PM_{10} and $PM_{2.5}$ emissions are determined on base of type of technology and fuel used.

Emissions of heavy metals and POPs from the incineration of human bodies are calculated using emission factors and activity data. This concerns the following substances: Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, HCB and PCBs . The emission factors were adopted from the EMEP / EEA Air pollutant Emission Inventory Guidebook version 2016 (Tier 1).

A summary of emission factors used for category 5C1bv is presented below in Table 6-16

Table 6-16 Emission factors of heavy metals and POPs used for category 5C1bv

Pollutant	Value	Unit
Pb	30,03	mg/body
Cd	5,03	mg/body
Hg	1490	mg/body
As	13,61	mg/body
Cr	13,56	mg/body
Cu	12,43	mg/body
Ni	17,33	mg/body

Pollutant	Value	Unit
Se	19,78	mg/body
Zn	160,12	mg/body
PCDD/F	0,027	µg/body
Benzo(a)pyrene	13,2	µg/body
Benzo(b)fluoranthene	7,21	µg/body
Benzo(k)fluoranthene	6,44	µg/body
Indeno(1,2,3-cd)pyrene	6,99	µg/body
HCB	0,15	mg/body
PCBs	0,41	mg/body

Numbers of cremations in the given year were used as activity data. Shares of cremations in the total number of funerals in the entire reporting period have been obtained from study of The Institute of Sociology of the Czech Academy of Sciences[2] *and are presented below in Table 6-17. It is apparent that this share has stabilized at about 85 % since 2005. The number of deaths was taken from the website of the Czech Statistical Office. Incineration of animal tissues was not included in the balance of heavy metals, which also applies to activity data.*

Table 6-17 Shares of cremations in the total number of funerals

Year	Share of cremations (%)
1920	0,37
1925	2,09
1930	3,32
1935	4,04
1940	5,01
1945	8,11
1950	11,60
1955	19,63
1960	24,26
1966	45,54
1970	39,00
1975	45,00
1980	64,40
1986	53,54
1990	55,22
1995	72,50

[2] http://www.soc.cas.cz/publikace/v-zaru-lasky-se-zivot-zapocal-v-zaru-ohne-se-konci-ctyri-pohledy-na-vyvoj-kremacniho-hnuti

Year	Share of cremations (%)
2000	75,94
2005	84,66
2008	84,72

6.6.3 The development of emissions from category 5C1bv

The contribution of emissions from the incineration of human bodies and carcasses to the total national emissions is thought to be relatively insignificant excepting Hg.

The emissions of all polluting substances depend exclusively on the number of cremations and are comparable throughout the monitored time frame.

As is apparent from Table 6-17, share of cremations has increased rapidly in monitored period, it has stabilized since 2005. Moreover, cremations of pets were started only in 2003.

6.6.4 Recalculations in NFR sector 5C1v

As promised in last year, recalculation of heavy metals and POPs emissions based on own emission factors had been made. The recalculation was performed upon study "Emission factors setting and air pollution contribution of stationary source for the purpose of subsidy application of Operation programme the Environment (OPE)" performed by the company Technické služby ochrany ovzduší Praha, a.s.. (Technical services for air protection Prague, a. s.) [13]. As part of the improvement of the emission inventorying, own emission factors were determined by combining knowledge from measurements and background research into international sources. The proposed emission factors comply with those of EMEP/EEA Air Pollution Emission Inventory Guidebook, version 2016 (see Table 6-16).

In addition to emission factors updated activity data (shares of cremation) were used. Recalculation took place for the whole-time series 1990–2015. Another activity data was added: heat supplied with the fuel, natural gas mostly (see chapter 6.6.1).

6.7 Other waste incineration (NFR sector 5C1bvi)

There are no such facilities in the Czech Republic. This category includes e .g. small waste oil burners used in motor garages; whose operation was terminated.

6.8 Open burning of waste (NFR sector 5C2)

This category includes e .g. open burning of crop residues, wood, leaves, straw or plastics.There are no such facilities in the Czech Republic.

6.9 Wastewater handling (NFR sector 5D1–5D3)

6.9.1 Source characteristic

Waste water treatment plants are in insignificant source for air pollutants. The small amount of emissions of NO_x, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP a CO originates from flaring (Tier 3).

For waste water treatment plants (both domestic and industrial), only technical condition of operation is set in Annex 8 to the Regulation No 415 /2012 Coll., points 1.4. and 1.5. This technical condition is the same for both categories and reads as follows:

For the purpose of reducing emissions of polluting materials with disturbing odour, the use of measures for reducing emissions of these matters, e.g. performing exhaustion of waste gases into the facility for reducing emissions, covering of pits and conveyers, closing of objects, and regular removal of sediments of organic nature from equipment for pre-treatment of waste water.

6.9.2 Methodology for Wastewater handling (NFR sector 5D1–5D3)

Emissions of NO_x, NMVOC, SO_2, NH_3 and TSP are reported in the Summary operation records. The PM_{10} and $PM_{2.5}$ emissions are determined on base of type of technology.

6.10 Other waste (NFR sector 5E)

6.10.1 Source characteristic

This sector includes biodegradation and solidification facilities and sanitation facilities. All the facilities listed reduce the danger that waste poses to the environment.

6.10.1.1 Biodegradation and solidification facilities

Biodegradation is a process of breaking down oil and organic pollution from contaminated wastes. It takes advantage of natural bacterial strains which perform natural decomposition of contaminants.

Solidification is a technological process of waste treatment involving their stabilisation by suitable additives which reduce the possibility that dangerous elements and compounds might get eluted from the matrix of the waste.

For biodegradation and solidification facilities, only technical condition of operation is set in Annex 8 to the Regulation No 415 /2012 Coll., point 1.2.:

In the case of processing materials which can produce emissions of polluting materials with disturbing odour, technical-organisational measures must be ensured for the reducing these materials, e.g. covering biodegradation areas and collection of waste gases into facilities for the cleaning of waste gases.

In open landfills, it is possible to reduce emissions of solid pollutants into the atmosphere, for example, by situating them in leeward positions or by watering and misting.

6.10.1.2 Sanitation facilities

These facilities are used to elimination of oil and chlorinated hydrocarbons from contaminated soil. They are mainly used for the clean-up of old ecological burdens.

Annex 8 to the Regulation No 415 /2012 Coll., point 1.3. sets NMVOC emission limit value for elimination of oil and chlorinated hydrocarbons from contaminated soil) with a projected output of greater than 1 t of volatile organic compounds, inclusive, operated ex situ.

6.10.2 Methodology for Other waste (NFR sector 5E)

In this category, only small amount of emissions NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP a CO is emitted.

Emissions of NO_x, NMVOC, NH_3 and TSP are reported in the Summary operation records (Tier 3). The PM_{10} and $PM_{2.5}$ emissions are determined on base of type of technology.

7 OTHER AND NATURAL EMISSION

Chapter will be supplied later.

8 RECALCULATIONS AND IMPROVEMENTS

The first updated set of data for period 2000–2013 in NFR format 2014 was reported in 2015. Based on further analysis of the input data and recommendations in ERT report (Stage 3 in August 2015) several corrections of reported data were performed including particularly:

- Removal of some errors and duplicities in primary REZZO data.
- Corrections of NFR code allocations for individually monitored REZZO sources.
- Provision of heavy metals emissions for break wear and tear for the period 2000-2013.
- New summations for each NFR category.
- Submission of NMVOC emission for Road paving with asphalt (2D3b) and Asphalt roofing (2D3c).

9 PROJECTIONS

The preparation of projections for the period 2020–2030 requires partial expert assessments of future emissions and activity data for some significant source categories, as for example transport, agriculture or solvent use. Projection for public electricity was computed with modelling software Message and input data of large combustion sources. Projections for some sectors have fully been completed and a detailed description of preparation that will be used for completion of several chapters in IIR in following period, is available. For further sectors such texts will probably be available in submission of IIR 2018.

9.1 Energy

9.1.1 Stationary Combustion

Chapter will be supplied later.

9.1.2 Mobile combustion

The basic approach was to obtain the time series of activity data (vehicle fleet, fuels consumptions, annual numbers of new and scrapped vehicles, transport volumes and performances, etc …) and then to analyse possible future development in the field of transport demand, vehicle fleet, modal split and the development and introduction of new vehicle technologies, more responsible to the protection of air quality and environment.

From the analysis of input data, the future time series of emission productions were calculated. In addition, the analysis of efficiency of individual policies and measures was made. The possible emission reduction was the output of this analysis. These reductions were subtracted from total future emission mass, depending of the type of scenarios: with existing measures (WM) and with additional measures (WAM).

The emission reductions were calculated mainly for the greenhouse gases and that is why individual emission reductions are not described in this report. But some measures, for example new vehicles with purer emission standards, and demand – influencing measures (investment to railway and combined transport infrastructure, road toll, and others) influence harmful emission production as well.

The prediction of future transport performances and has the three steps: first is the prediction of the total transport, which is based on the prediction of GDP and possibly demographical prediction. Second step is the prediction of shares of individual transport modes (road transportation, civil aviation, railways and water transportation). Third step is the prediction of individual transport modes in a more detailed way. In road transport it means, that the relevant calculations are done separately for vehicles categories, types and technologies.

The measures efficiency and its impacts on emissions reductions were done for greenhouse gases emissions, not for basic pollutants. But some of the measures influence transport demand and consequently harmful pollutants emissions as well. The main measure, which determine the development in air polluting emissions from transport, are the new, purer emissions standards of CO, NOx, VOC a PM for new vehicles. Other measures with a positive effect of air polluting emissions decrease, are: support of alternative vehicle propulsions, mobility management, support of environmentally friendly transport modes, road charging and parking policy. Some of these measures are on urban and regional level, but with a strong influence to the production of national emissions.

9.2 Industrial Processes and Product Use

9.2.1 Fugitive emissions from fuels

For the projecting of emission in 1B sector was used method of calculating individual amount of emissions from appropriate activity data and emission factors. It was chosen such activity data, where the prognosis of their development is available at least until 2030. The emission factors were taken from EMEP methodology or calculated from known activity data and the reported emissions in the same period.

9.2.2 Non-Energy Products from Fuels and Solvent Use

For the projecting of emission in 2D sector was used method of calculating individual amount of emissions from appropriate activity data and emission factors. It was chosen such activity data, where the prognosis of their development is available at least until 2030. That was very difficult in this sub - sector, so substitute data was used in some cases. The emission factors were taken from EMEP methodology or calculated from known activity data and the reported emissions in the same period.

9.3 Agriculture

For national estimation of ammonia emissions from animal husbandry in the Czech Republic the Tier 2 approach is used according to the 3B Manure management EMEP/EEA emission inventory guidebook 2013 update July 2015. Estimation of the future animal population data is taken from study (Dedina, 2013, updated in 2017). Based on a long-term development of meat and milk

consumption in the Czech Republic, there is not a presupposition for a rapid growth of animal population in future ten years. There also is not expected an animal population increase as a result of rapid growth of meat and milk export. Due to a low self-sufficiency in pork production (apr. 46 % in 2015) in the Czech Republic, there is possible to expect an increase of rearing pigs population by apr. 10 % from 970 thousand of heads (2015) to apr. 1 100 thousand of heads within future ten years.

The national emission factors used for calculation of ammonia emissions originating from key animal categories in the Czech Republic are divided into three parts – emission factors for animal housing, emission factors for manure storage and emission factors for manure application. The original national emission factors set down in 2002, which did not included ammonia abatement measures yet, were revised and updated in 2013 as a result of a new legislation preparation focused on manure storage and its utilization on the field in vulnerable zones according to Nitrate Directive. For preparation of this regulation a large database of data dealing with nutrient quantity presented in manure was used.

These ammonia emission factors reflect a real situation of nitrogen balance in livestock housing systems and manure storage as a result of ammonia emission abatement measures utilization in the livestock breeding in the Czech Republic. These abatement measures have covered especially BAT utilization in stables for pigs and poultry rearing, feeding measures and low emissions storage of slurry and manure. Currently, the following best available techniques/ ammonia abatement measures for housing of livestock are applied in the Czech Republic:

a. *Most of pigs and sows are bred on partly slated floor with reduce pit (ammonia reduction 15 -20 %), on partly slated floor with vacuum system (ammonia reduction 25 %) and partly slated floor with scraper (ammonia reduction 40 %).*
b. *Majority of laying hens are kept in enriched cage systems with ventilated belts, removal of manure two times per week (ammonia reduction 30 - 40 %).*
c. *All chickens produce for meat are kept in ventilated and insulated halls on dry litter without leakages drinking systems (ammonia reduction not estimated).*
d. *Cattle is housed in cubicle housing system (reference system).*

For storage of slurry and manure, most often there are applied systems as "tight" lid, roof or tent structure or formation of natural crust on the slurry surface (ammonia reduction 80 % resp. 40 %).

Since 2000 until 2015 NH_3 ammonia emissions have been reduced by 27 %. The mentioned ammonia abatement was mainly the result of changes in animal population and adoption of above mentioned ammonia abatement measures presented in Guidance Document for Preventing and Abating Ammonia Emissions from Agricultural Sources and Best Available Techniques Reference Document for Intensive Poultry and Pigs Breeding. Recently, a slight increase of animal population, especially rearing pigs, is observed and expected.

Increase of animal population, which could affect a production of ammonia emissions, will be compensated by additional abatement measures. There is in the Czech Republic a subsidy program focused on ammonia abatement techniques implementation into the Czech agricultural practice that has been utilized since 2012. The farmers have mainly utilized the subsidy program for acquisition of machinery for low emission application of slurry and manure as slurry applicators and ploughs. Effects of this ammonia abatement measures will be incorporated into the national inventory in the future. .

For future (after 2020) is also planned implementation of abatement measure focused on the obligation for incorporation of solid manure into soil within 24 hours after application on soil instead of a current practice. According to current Czech legislation solid manure has to be incorporated within 48 hours after application on field surface.

Ammonia emissions from synthetic N fertilizer application are calculated according to the methodology and emission factors used for the GAINS model (see IR-04-048, IIASA, Laxenburg). The activity data on N-fertilizer application are provided by the Czech Statistical Office and are based on the fertilizer consumption in the Czech Republic. The long-term share of urea on total mineral fertilizers consumption expressed as a ten years average is on the level of 18-21%. Emission factors for urea (0.182 kg/ kg fertilizer-N) and other N-fertilizers (0.04 kg/ kg fertilizer-N) are based on average values from scientific researches of the IIASA.

Conclusion

Currently, the NH_3 emissions coming from the stables livestock moving at about 49.09 kt in 2015. Due to increase of animal population the ammonia emissions would grow at level app. 56 kt in 2030. This trend of emissions (WM scenario) already includes the reducing technologies introduced until 2015. According to scenario with additional measures mentioned above the increase of ammonia would by at level of app. 52 kt in 2030.

The ammonia emissions from application of mineral nitrogen fertilizers and urea to agricultural managed soils equal to 18.5 kt in 2015. By 2030, it is expected decrease of share of urea utilization and its substitution by urea treated by urease inhibitors (ammonia abatement 70 %). In 2030, the emissions slightly fall at the level, of 16.2 kt.

9.4 Waste

Waste sector (IPCC guidelines sector no. 5) in the Czech Republic can be separated in to 4 distinctive source categories. First, so far dominant category is 5A, emissions from solid waste disposal sites. This category is source limited range of air pollutants, namely NMVOC, TSP, PM_{10} and $PM_{2.5}$. Second source category is a category 5B - biological treatment of waste. This source category consists mainly from composting and up to small degree to anaerobic digestion of waste. Composting is producing small amount of ammonia and carbon monoxide. Anaerobic digestion does not produce significant emissions, because main emission flow - emissions from usage of biogas produced in anaerobic digestion is not part of this source category as it should be accounted in in 1A – Energy or in 2B Fugitive emissions, depending which kind of pollutant is in question. Third source category is 5C -waste incineration. This category should be also accounted in energy sector should waste incineration produce useable energy, in 5C only hazardous and industrial waste incineration is accounted. This category consists from wide ray of pollutants such as NOx, NMVOC, SOx, $PM_{2.5}$ and BC. Last category is 5D - waste water treatment. This category includes both public and private waste water treatment plants as well as industrial counterparts and it is source of CO, NH_3 and NMVOC.

Main activity data about futures activities comes from WMP of the Czech Republic. Key assumptions in WMP are following: "The developed forecasts of municipal waste (MW) production imply that municipal waste production between 2013 and 2024 will decline slightly." "It can be seen that on the basis of these assumptions, due to the diversion of materially recoverable components of material municipal waste (MMW), in the years 2013-2024 a decrease in landfilling occurs, compensated by a significant increase in material recovery of MW, by the development of composting and anaerobic digestion, and last but not least, by energy recovery.

Main methodological approach to the emissions estimation in all categories can be described as an equation where emission factor is multiplied by activity data (Emission=AD x EF). Should there be a difference, it is specifically noted at source category. Main source of emission factors is EMEP/EEA emission inventory guidebook for year 2016 (EMEP,2016).

ABBREVIATIONS

AD	**Activity Data**
CDV	**Transport Research Centre**
CEI	**Czech Environmental Inspectorate**
CME	**Czech Ministry of the Environment**
CS	**Country Specific**
CZSO	**Czech Statistical Office**
EFs	**Emission Factors**
EIG	**Emission Inventory Guidebook**
CHMI	**Czech Hydrometeorological Institute**
NR	**Not Reported**
SVUOM	**National Research Institute for the Protection of Materials**
VUZT	**Research Institute of Agricultural Technology**
REZZO	**Register of Emissions and Stationary Sources**
MSW	**Municipal Solid Waste**
SWDS	**Solid Waste Disposal Sites**

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APPENDIX

Table 0-1 SUMMARY OF HMS EMISSION FACTORS FOR BOILERS IN CATEGORY 1A1, 1A2, 1A4AI, 1A4CI

Type of fire place	Fuel type	Thermal capacity MW	Pb mg.GJ^{-1}	Cd mg.GJ^{-1}	Hg mg.GJ^{-1}	As mg.GJ^{-1}	Cr mg.GJ^{-1}	Cu mg.GJ^{-1}	Ni mg.GJ^{-1}	Se mg.GJ^{-1}	Zn mg.GJ^{-1}
Fixed bed boiler	Brown Coal	<5	59,471	1,294	2,382	60,967	38,383	69,545	62,104	5,192	30,756
		5 - 50	6,67	0,495	1,924	2,102	9,1	1	27,67	45	8,8
		50 - 100	6,67	0,495	1,924	2,102	9,1	1	27,67	45	8,8
		>100	6,67	0,495	1,924	2,102	9,1	1	27,67	45	8,8
Fixed bed boiler	Hard Coal	<5	13,687	2,456	9,051	9,402	15	10	10	2	150
		5 - 50	2,656	0,823	1,744	0,243	4,5	7,8	4,9	23	19
		50 - 100	2,656	0,823	1,744	0,243	4,5	7,8	4,9	23	19
		>100	2,656	0,823	1,744	0,243	4,5	7,8	4,9	23	19
Fixed bed boiler	Biomass	<5	27	13	0,56	0,19	23	6	2	0,5	512
		5 - 50	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		50 - 100	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		>100	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
Pulverized coal-fired boilers	Brown Coal	<5	1,699	0,119	2,532	0,788	9,1	1	9,7	45	8,8
		5 - 50	1,699	0,119	2,532	0,788	9,1	1	9,7	45	8,8
		50 - 100	1,699	0,119	2,532	0,788	9,1	1	9,7	45	8,8
		>100	4,156	0,322	2,965	0,774	9,1	1	3,599	45	8,8
Pulverized coal-fired boilers	Hard Coal	<5	0,752	0,056	0,51	0,131	4,5	7,8	3,399	23	19
		5 - 50	0,752	0,056	0,51	0,131	4,5	7,8	3,399	23	19
		50 - 100	0,752	0,056	0,51	0,131	4,5	7,8	3,399	23	19
		>100	2,615	0,26	0,696	0,322	4,5	7,8	4,537	23	19
Pulverized coal-fired boilers	Biomass	<5	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		5 - 50	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		50 - 100	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		>100	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
Fluidized bed boiler	Brown Coal	<5	2,037	0,282	1,5	0,922	9,1	1	4,803	45	8,8

Type of fire place	Fuel type	Thermal capacity MW	Pb mg.GJ^{-1}	Cd mg.GJ^{-1}	Hg mg.GJ^{-1}	As mg.GJ^{-1}	Cr mg.GJ^{-1}	Cu mg.GJ^{-1}	Ni mg.GJ^{-1}	Se mg.GJ^{-1}	Zn mg.GJ^{-1}
Fluidized bed boiler		5 - 50	2,037	0,282	1,5	0,922	9,1	1	4,803	45	8,8
		50 - 100	2,037	0,282	1,5	0,922	9,1	1	4,803	45	8,8
		>100	2,037	0,282	1,5	0,922	9,1	1	4,803	45	8,8
	Hard Coal	<5	0,752	0,056	0,51	0,131	4,5	9	3,399	23	90
		5 - 50	0,752	0,056	0,51	0,131	4,5	9	3,399	23	90
		50 - 100	0,752	0,056	0,51	0,131	4,5	9	3,399	23	90
		>100	0,752	0,056	0,51	0,131	4,5	9	3,399	23	90
Fluidized bed boiler	Biomass	<5	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		5 - 50	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		50 - 100	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
		>100	1,606	0,169	1,268	0,871	0,027	0,106	0,085	0,211	1,991
All type of boilers	Liquid fuels	<5	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
		5 - 50	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
		50 - 100	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
		>100	4,56	1,2	0,341	3,98	2,55	5,31	255	2,06	87,8
All type of boilers	Gaseous fuels	<5	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,0112	0,0015
		5 - 50	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,0112	0,0015
		50 - 100	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,0112	0,0015
		>100	0,0015	0,00025	0,1	0,12	0,00076	0,000076	0,00051	0,0112	0,0015

Table 0-2 SUMMARY OF POPS EMISSION FACTORS FOR BOILERS IN CATEGORY 1A1, 1A2, 1A4ai, 1A4ci

Type of fire place	Fuel type	Thermal capacity MW	PCBs µg.GJ-1	PCDD_F ng.GJ-1	BaP µg.GJ-1	BbF µg.GJ-1	BkF µg.GJ-1	InP µg.GJ-1	Total_PaH µg.GJ-1	HCB µg.GJ-1
Fixed bed boiler	Brown Coal	<5	5,059052	4,986	320,061	518,482	518,482	400,322	1757,347	6,7
		5 - 50	0,757254	7,68	3,147	7,973	4,047	4,203	19,37	6,7
		50 - 100	0,757254	7,68	3,147	7,973	4,047	4,203	19,37	6,7
		>100	0,757254	7,68	3,147	7,973	4,047	4,203	19,37	6,7
Fixed bed boiler	Hard Coal	<5	8,072845	14,657	10,975	18,54	10,966	5,956	46,437	6,7
		5 - 50	0,31797	2,299	1,453	3,539	1,608	1,712	8,312	6,7
		50 - 100	0,31797	2,299	1,453	3,539	1,608	1,712	8,312	6,7
		>100	0,31797	2,299	1,453	3,539	1,608	1,712	8,312	6,7
Fixed bed boiler	Biomass	<5	0,007	100	10000	16000	5000	4000	35000	5
		5 - 50	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		50 - 100	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		>100	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
Pulverized coal-fired boilers	Brown Coal	<5	1,066271	5,616	1,546	2,385	1,674	1,856	7,461	6,7
		5 - 50	1,066271	5,616	1,546	2,385	1,674	1,856	7,461	6,7
		50 - 100	1,066271	5,616	1,546	2,385	1,674	1,856	7,461	6,7
		>100	0,547035	1,914	4,897	6,35	4,977	5,691	21,915	6,7
Pulverized coal-fired boilers	Hard Coal	<5	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
		5 - 50	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
		50 - 100	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
		>100	1,221309	0,979	1,769	3,429	2,152	1,664	9,014	6,7
Pulverized coal-fired boilers	Biomass	<5	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		5 - 50	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5

Type of fire place	Fuel type	Thermal capacity MW	PCBs µg.GJ-1	PCDD_F ng.GJ-1	BaP µg.GJ-1	BbF µg.GJ-1	BkF µg.GJ-1	InP µg.GJ-1	Total_PaH µg.GJ-1	HCB µg.GJ-1
Fluidized bed boiler		50 - 100	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		>100	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
	Brown Coal	<5	1,448563	2,778	5,148	7,621	5,321	5,559	23,649	6,7
		5 - 50	1,448563	2,778	5,148	7,621	5,321	5,559	23,649	6,7
		50 - 100	1,448563	2,778	5,148	7,621	5,321	5,559	23,649	6,7
		>100	1,448563	2,778	5,148	7,621	5,321	5,559	23,649	6,7
Fluidized bed boiler	Hard Coal	<5	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
		5 - 50	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
		50 - 100	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
		>100	0,28985	2,134	2,793	5,707	3,188	2,81	14,498	6,7
Fluidized bed boiler	Biomass	<5	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		5 - 50	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		50 - 100	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
		>100	2,232742	11,348	46,462	144,329	67,897	33,073	291,761	5
All type of boilers	Liquid fuels	<5	3,333657	2,5	3,678	12,673	3,968	6,484	26,803	-
		5 - 50	3,333657	2,5	3,678	12,673	3,968	6,484	26,803	-
		50 - 100	3,333657	2,5	3,678	12,673	3,968	6,484	26,803	-
		>100	3,333657	2,5	3,678	12,673	3,968	6,484	26,803	-
All type of boilers	Gaseous fuels	<5	-	0,5	0,56	0,84	0,84	0,84	3,08	0,00308
		5 - 50	-	0,5	0,56	0,84	0,84	0,84	3,08	0,00308
		50 - 100	-	0,5	0,56	0,84	0,84	0,84	3,08	0,00308
		>100	-	0,5	0,56	0,84	0,84	0,84	3,08	0,00308

REQUIREMENTS OF SUMMARY OPERATING RECORDS

General instructions for filling of forms for the summary operating records:
1. The combustion stationary sources mentioned in Annex 2 to the Act under Code 1.1 with the total nominal heat input power up to 5 MW inclusive, combusting liquid or gas fuel reporting data mentioned in Point 1.1. and in Point 1.2. in Items 15. and 17. in the manner stated by the data standard according to another legal regulation 3). The other data mentioned in Points 1.2., 1.4. and 1.5. are not reported.
2. Stationary sources mentioned in Annex 2 to the Act under Code 10.2 report data mentioned in Point 1.1. and in Point 1.3. in Item 12 in the manner stated by data standard according to the other legal regulation6). The other data mentioned in Points 1.3., 1.4., and 1.5. are not reported.

1.1. Identification of the operator and the operating unit

1. Data about the operator	
Identification number (IČ)[1]:	
Name of the operator (business name or name and surname):	
Address (street, registration number/orientation number):	
Address (village, town – town part):	
Post code:	
2. Date about the operating unit	
Identification number of the operating unit (IČP)[2]:	
Territorial technical unit (ÚTJ)[3]:	
Name of operating unit :	
Address (street, registration number/orientation number):	
Address (village, town – town part):	
Post code:	
Summary operating records for the year:	

Explanations to the table:

1) Identification number (IČ), is assigned. Natural persons without ID number (IČ) fill in the date of birth.

3

Act No 25/2008 Coll., on an integrated register of pollution and an integrated system for the fulfilment of obligations to notify in the area of the environment, as amended.

2) *Identification number of the operating unit (IČP) – indication of the operating unit in which one or more stationary sources are operated. IČP is assigned through the integrated system of the fulfilment of reporting obligations in the area of the environment*

3) *The territorial technical unit means a unit which is specified a cadastral territory or its part. Names and ÚTJ codes are part of METIS, maintained by the ČSÚ, which is a guarantor for the maintenance of the list of codes of territorial technical units.*

1.2. Summary operating records of combustion stationary sources and waste incineration plants.

1	Sequence number of the stationary source		
2	Classification of the stationary source according to the Act		
3	Date of issue of permit for operation		
4	Name of the stationary source		
5	Efficiency (%)		
6	Nominal thermal output (MWt)		
7	Installed electrical output (MWe)		
8	nominal thermal input power (MWt)		
9	Projected capacity of the waste incineration plant (t/year)		
10	Type of fire place		
11	Operating hours (h/year)		
12	Use of the capacity (%)		
13	Total production of heat (GJ/year)		
14	Total volume of delivered heat (%)		
15	Type of fuel or waste		
16	Calorific capacity of the fuel (kJ/kg, kJ/m^3)		
17	Consumption of fuel or waste (t/year, thousand m^3/year)*		
18	Emission of pollutants (t/year)		

Explanations and instructions for filling in the data according to the number of the line:

1 *sequence number of stationary source within the operating unit, assigned ISPOP; In the case of a combustion source or combustion stationary sources with heat input power up to 1 MW inclusive, combustion gas fuel, the data mentioned below is filled in summary.*

2 *Classification of the stationary source according to category of activity according to Annex 2 of the Act.*

3 *Indication if the date of the issue of the permit for operation or another similar permit issued according to former legal regulations for the given stationary source.*

4 *indication of the name of the stationary source according to operating rules or permit for the operation or technical documentation.*

5 *Heat efficiency of the stationary source.*

6 *Nominal heat output of the combustion stationary source according to technical documentation of the combustion stationary source.*

7 *Installed electrical output according to technical documentation of the stationary source of pollution.*

8 *Nominal heat combustion stationary source according to the technical documentation of the combustion stationary source.*

9 *Projected capacity of the incineration plant for wastes according to the technical documentation.*

10 Type of fire place (e.g. grid, fluid, gas burners, etc.) according to the list of codes mentioned in the Bulletin of the Ministry of the Environment.

11 Total number of operating hours during which the stationary source was operated in the reporting year.

12 Number of operated hours of the stationary source per year after recalculation for the level of the use of the installed capacity.

13 Total volume of the produced utility heat.

14 Total quantity of heat delivered to the public network of distance heating in the form of steam or hot water expressed as the percentage (%) of the total volume of the produced utility heat (percentage of the value mentioned in line No 13). This value is filled in only for combustion stationary sources with total nominal input power which is equal to or higher than 50 MWt.

15 Type(s) of combusted fuel (according to the list of codes published in the Bulletin of the Ministry of Environment), for waste incineration plants or for combustion stationary sources of thermally processed waste together with the fuel is also indicated as an independent item — waste (without detailed specification).

16 Value of the annual average calorific capacity of the fuel according to data from the supplier of the fuel.

17 Total consumption of the fuel used by the combustion stationary source in the reported year; in the case that waste is thermally processed, the total volume of the processed wastes is indicated for the value corresponding to the item of waste.

18 Total volume of emissions of pollutants (according to the list of codes published in the Bulletin of the Ministry of Environment escaping into the air from the stationary source per reported calendar year for which the operator of the stationary source, according to Section 6(1) of the Act has the stated obligation to determine emissions.

1.3. Summary operating records of other stationary sources

1	Sequence number of the stationary source		
2	Classification of the stationary source according to the Act		
3	Indication of sector		
4	Name of the stationary source		
5	Type of combusted fuel or waste		
6	Calorific capacity of the fuel (kJ/kg, kJ/m3)		
7	Consumption of the combusted fuel and waste (t/year, thousand m3/year)		
8	Consumption of VOC (t/year)	according to Section 20(a)	
9		according to Section 20(b)	
10		according to section 20(c)	
11	Type of product		
12	Volume of product (t/year)*		
13	Emission of pollutants (t/year)		

Explanations and instructions for filling in the data according to the number of the line:

1 Sequence number of another stationary source within the operating unit, assigned ISPOP.
In the case of another stationary source for which this option is mentioned in the list of codes published in the Bulletin of the Ministry of the Environment, it is possible to combine the data mentioned below.

2 Code of the stationary source according to Annex 2 to the Act. .

3 *Indication of the sector in accordance with nomenclature for reporting (according to the list of codes published in the Bulletin of the Ministry of the Environment).*

4 *Name of the stationary source according to the operating order or permit for operation or technical documentation (according to the list of codes published in the Bulletin of the Ministry of the Environment).*

5 *Type(s) of combusted fuel (according to the list of codes published in the Bulletin of the Ministry of Environment); in the case that waste or wastes are thermally processed; it is mentioned as an independent waste (without detailed specification).*

6 *Value of annual average calorific capacity of the fuel according to the data of the supplier of the fuel.*

7 *Total consumption of fuel used by the stationary source in the reported calendar year; in the case that waste or wastes are thermally processed, the total volume of combusted wastes is stated for the value corresponding to the item.*

8 *Consumption of volatile organic matter according to the categories of the volatile organic matter used according to Section 20(a), (b), and (c) of this Regulation.*

9 *Type of product for selected technologies (according to the list of codes published in the Ministry of the Environment Bulletin).*

10 *Volume of product in units published in the Ministry of the Environment Bulletin.*

11 *Total volume of emissions of pollutants (according to the list of codes published in the Bulletin of the Ministry of Environment) escaping into the air from the stationary source per reported calendar year for which the operator of the stationary source, according to Section 6(1) of the Act has the stated obligation to determine emissions.*

1.4. Data about discharge ducts

1	sequence number of the discharge duct (chimney)		
2	sequence number of each individual stationary source terminated to the chimney (discharge duct)		
3	Height of the chimney (discharge duct) (m)		
4	Cross-section at the crown of the chimney, cross-section of the discharge duct (m^2)		
5	Geographical coordinates of the foot of the chimney or the discharge duct	N	
6		E	
7	Average speed of gases in (m/s)		
8	Average temperature of gases (°C)		
9	Time regime of escape of emissions		
10	Operating hours of the chimney / year		
11	Type of technology for reducing emissions		
12	Efficiency of technology for reducing emissions		
13	Emission of pollutants (t/year)		

Explanations and instructions for filling in the data according to the number of the line:

1 *Sequence number of chimney/discharge duct within the operating unit.*

2 *Sequence number of each individual stationary source mentioned in Item 1 of Points 1.2. and 1.3.*

3 *Construction height of the chimney or exceeding the duct (chimney) above the surrounding terrain.*

4 *Area of cross section of the chimney (inside area at the crown of the chimney), cross section areas of the chimney.*

5,6 *Geographical width and length of the location of the chimney/duct mentioned in the coordination system WGS 84 (World Geodetic System) commonly used by GPS devices.*

7 *Ascertained or professionally estimated average speed of the mass of air at the mouth of the chimney/duct.*

8 *Ascertained or professionally estimated average temperature of the mass of air at the mouth of the chimney/duct.*

9 *Time regime characterising daily, weekly, and annual period in which there is escape of substantial pollutants from chimneys/ducts according to the diagram published in the Ministry of the Environment Bulletin (1 = pollutants have escaped within the stated time period; 0 = small volume of pollutants has escaped or has not escaped at all within the stated period).*

10 *Operating time of the chimney/duct (time during which there is drying of pollutants from some of the terminated stationary sources into the chimney/duct/cooling tower).*

11 *Indication of each technology for reduction of emissions of each pollutant (according to the list of codes published in the Ministry of the Environment Bulletin); in the case of solid pollutants, indication of the type of the last level of the separation equipment in which there is reduction of the volume of solid pollutants.*

12 *The efficiency of each technology for reducing emission expressed in % decrease of concentration of the pollutant entering into the technology for reducing emission.*

13 *The total volume of emissions of pollutants (according to the list of codes published in the Ministry of the Environment) escaped into the air per reported calendar year through the stated chimney/discharge duct/cooling tower for which the operator of the stationary source has the obligation to determine emissions according to Section 6(1) of the Act. In the case that there is escape/discharging of all emissions from stationary sources only through one chimney/discharge duct, this value is not filled in.*

1.5. Data about measurement of emissions

1	Sequence number of the stationary source/sources		
2	Indication of place of measurement of emissions		
3	Date of measurement		
4	Emissions of pollutants	specific emission limit	
5		unit of specific limit	
6		concentration by weight	
7		unit of weight of the concentration	
8		mass flow [kg/h]	
9		specific manufacturing emission	
10		unit of specific manufacturing emission	

Explanations and instructions for filling in the data according to the number of the line:

1 *Sequence number of each individual stationary source mentioned in Item 1 of Points 1.2. and 1.3.*

2 *Indication of the place of measurement of emissions according to the operating order or permit for the operation or technical documentation.*

3 *Date of the last valid authorised measurement of emissions; it is not filled in the case that the determination of emissions is performed in a continuous manner.*

4 *Indication of specific emission limit for individual pollutants (according to the list of codes published in the Ministry of the Environment Bulletin) stated in the permit for the operation and if in the permit for operation the emission limit is not stated, then the emission limit for the given stationary source according to this Regulation.*

5 *Unit of the specific emission limit /according to the list of codes published in the Ministry of the Environment Bulletin).*

6 *Concentration by weight of emissions of pollutants recalculated for the conditions stated for the emission limit of the stationary source in the legal regulation in* $mg.m^{-3}$*, or in other units mentioned in Line 7; in the case of continuous measurement the value is calculated as the arithmetic average of all valid daily values per calendar year.*

7 *Unit of the weight concentration in which the emission limit is stated.*

8 Ratio of the weight of emissions of individual pollutants per hour.

9 Ratio of the weight of emissions of pollutants and related values which is stated for the emission limit of the stationary source in the legal regulation.

10 Unit of the specific emission limit (according to the list of codes published in the Ministry of the Environment Bulletin).