2018

CZECH INFORMATIVE INVENTORY REPORT 2018

Submission under the UNECE Convention on Long-range Transboundary Air Pollution

31/08/2018

Czech Hydrometeorological Institute

Subtitle: Emission inventories from the base year of the protocols to year 2016

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Year of publication: 2018

Editing completed: 21/09/2018

Abstract: This document informs about the method of compiling emission inventories in the Czech Republic

Front page picture: Josef Lada, Autumn

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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. These facts make is the obligation to report annual emission data. The report includes description of determination of the emissions.

In 2015 there was the Stage III in depth review of our emission inventory and IIR document. Based on the recommendations there had been done significant improvements in reported emissions and presented report. The improvements are being implemented successively with full implementation in 2019 reporting.

SIGNIFICANT CHANGES PRESENTED IN IIR 2018 – EXTRAORDINARY SUBMISSION

The IIR 2018 EXTRAORDINARY SUBMISSION presents results of emission inventory 1990 - 2016, including recalculations recommanded in STAGE 3 Reviw (r. 2015), EMRT Review 2017 and 2018. For Road transport model COPERT V was introduced by Transport Research Center in 2018 and for Non-Road transport (1A4cii) the tractor fleet composition was throughly revised. As a result, new emission data sets are available for the Czech Republic.

EMISSION TRENDS IN THE CZECH REPUBLIC

Considering the above mentioned emission recalucalions, updated emission trends are presented for the whole period 1990 – 2016. Long-term emission trends in the Czech Republic as well as last annual changes show at almost all pollutants a permanently descending trend. The annual comparison of emissions of main pollutants in 2015 and 2016 shows significant effect of a colder heating period in 2016 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/EC on industrial emissions. While REZZO 1 emissions decreased compared to 2015 (SO_2 even -11%), model-calculated emissions from household heating show an increase. The reduction in REZZO 1 emissions was achieved by implementation of Industrial Emissions Directive. There was also a small increase in fuel consumption and emissions from mobile sources (about 3%).

SHARE OF CATEGORIES IN THE CZECH REPUBLIC

The sector of residential heating (NFR 1A4bi) still contributes significantly to air pollution, specifically PM_{10} emissions by 57.2 %, $PM_{2.5}$ emissions by 73.2 %, carbon monoxide by 66.3 % and benzo[a]pyrene by 98.1 %. The decisive share of the public sector energy (NFR 1A1a) prevailed in emissions of Sulphur dioxide 50.7 % and mercury 39.4%. 32.1 % of emission of lead was emitted by the sector 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 40.2 % of nitrogen oxide emissions. The most significant sources of emissions of volatile organic compounds are found in the sector 1A4bi with share 46.8 %. The main source of ammonia emissions is livestock sector (NFR 3B), whose share of total emissions is 85.1%.

Below please find the brief show the main emissions in the years 1990 – 2016.

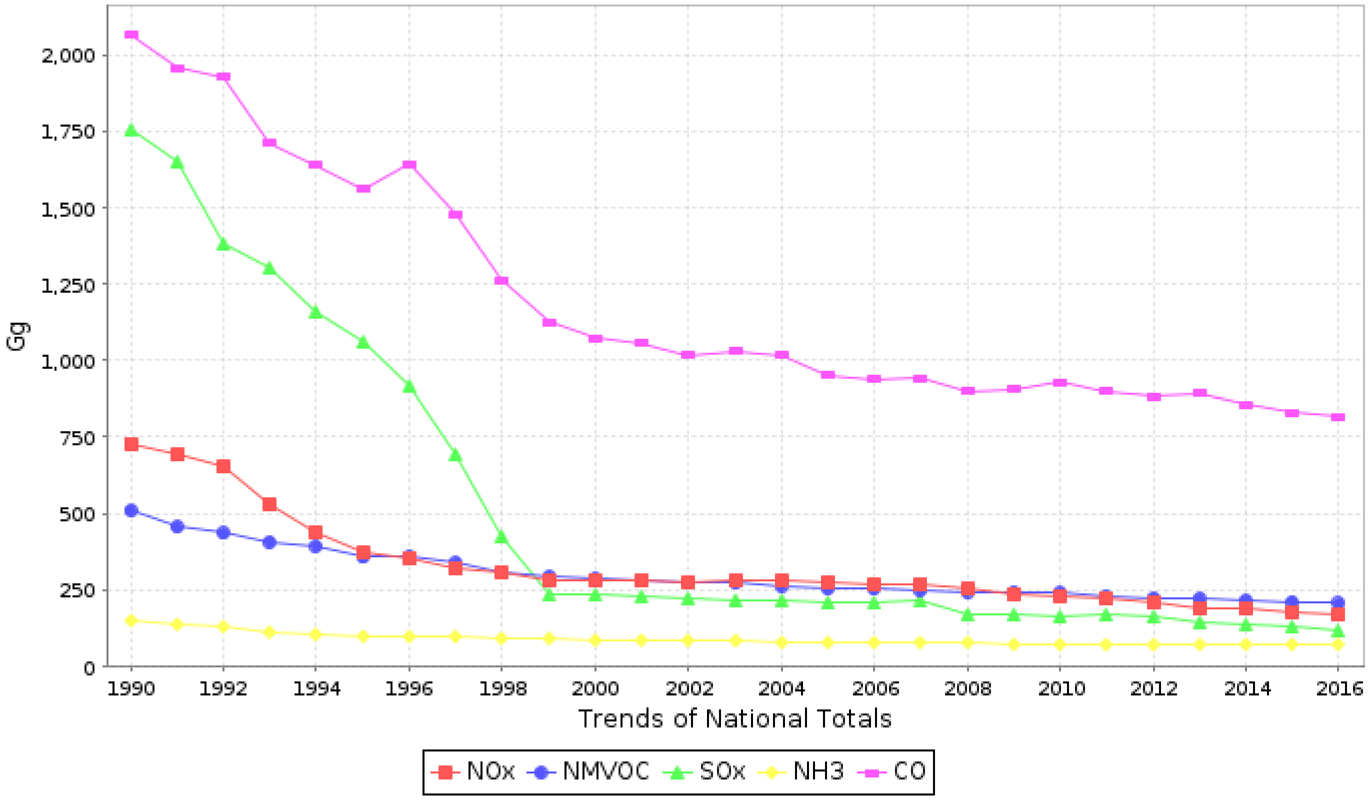

FIGURE 0-1 UPDATED TRENDS OF MAIN POLLUTANTS

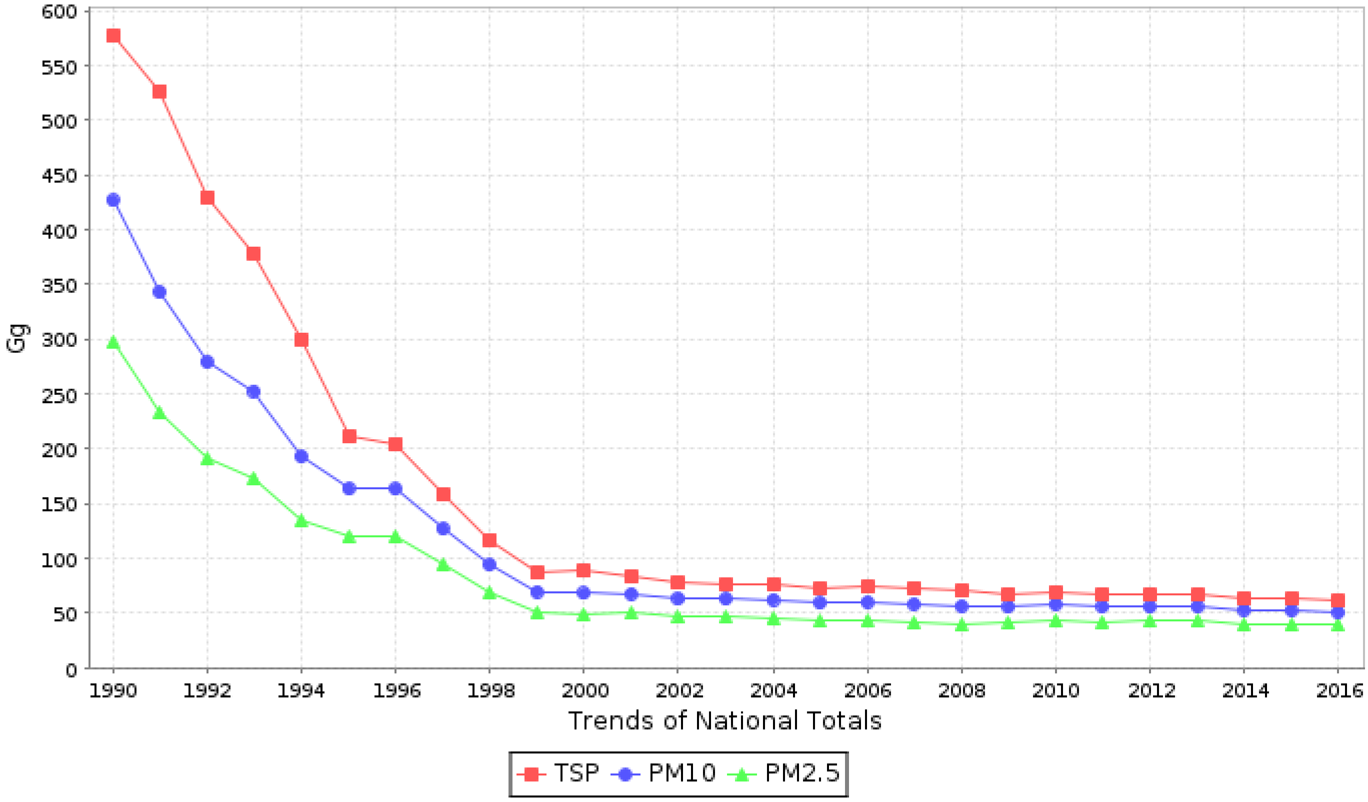

FIGURE 0-2 TRENDS OF PARTICULAR MATTER EMISSIONS

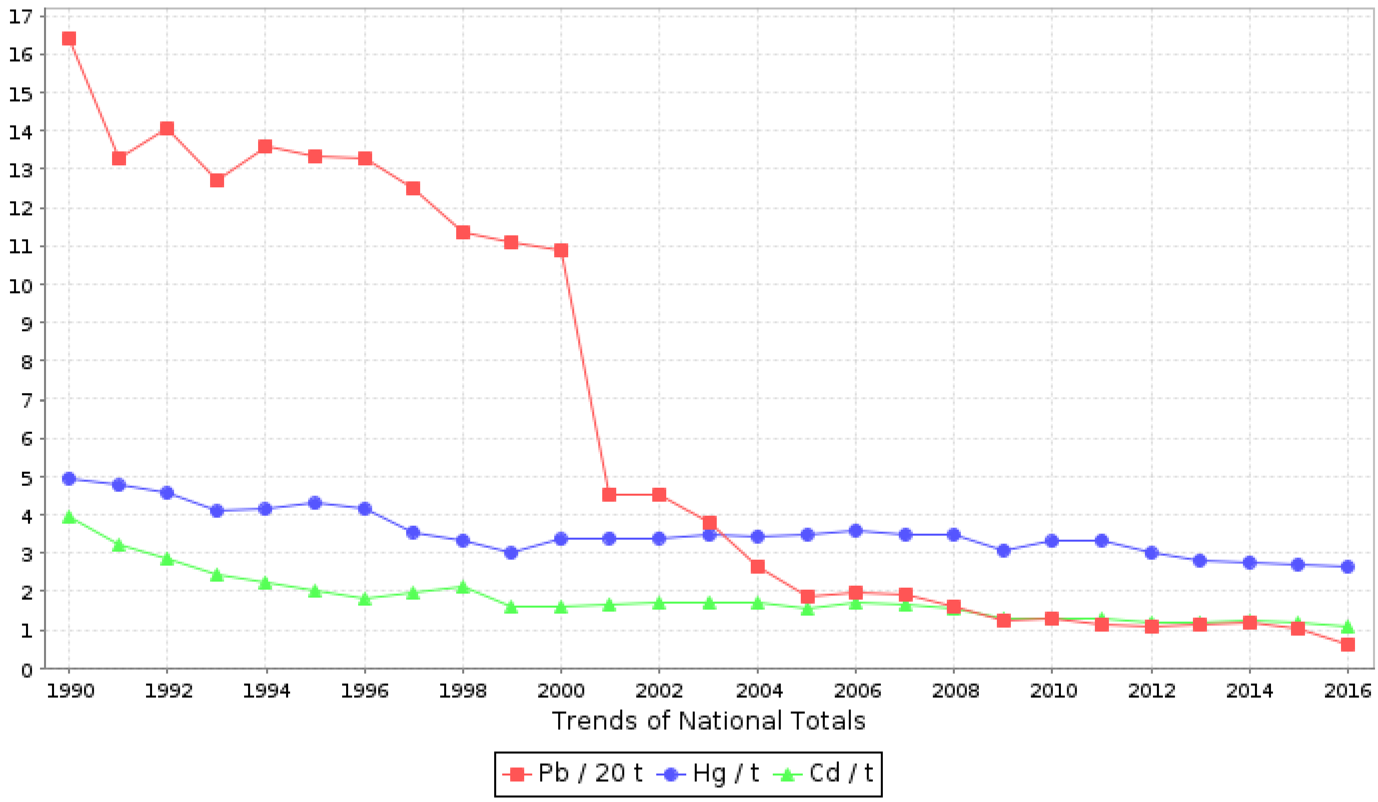

FIGURE 0-3 TRENDS OF HEAVY METALS

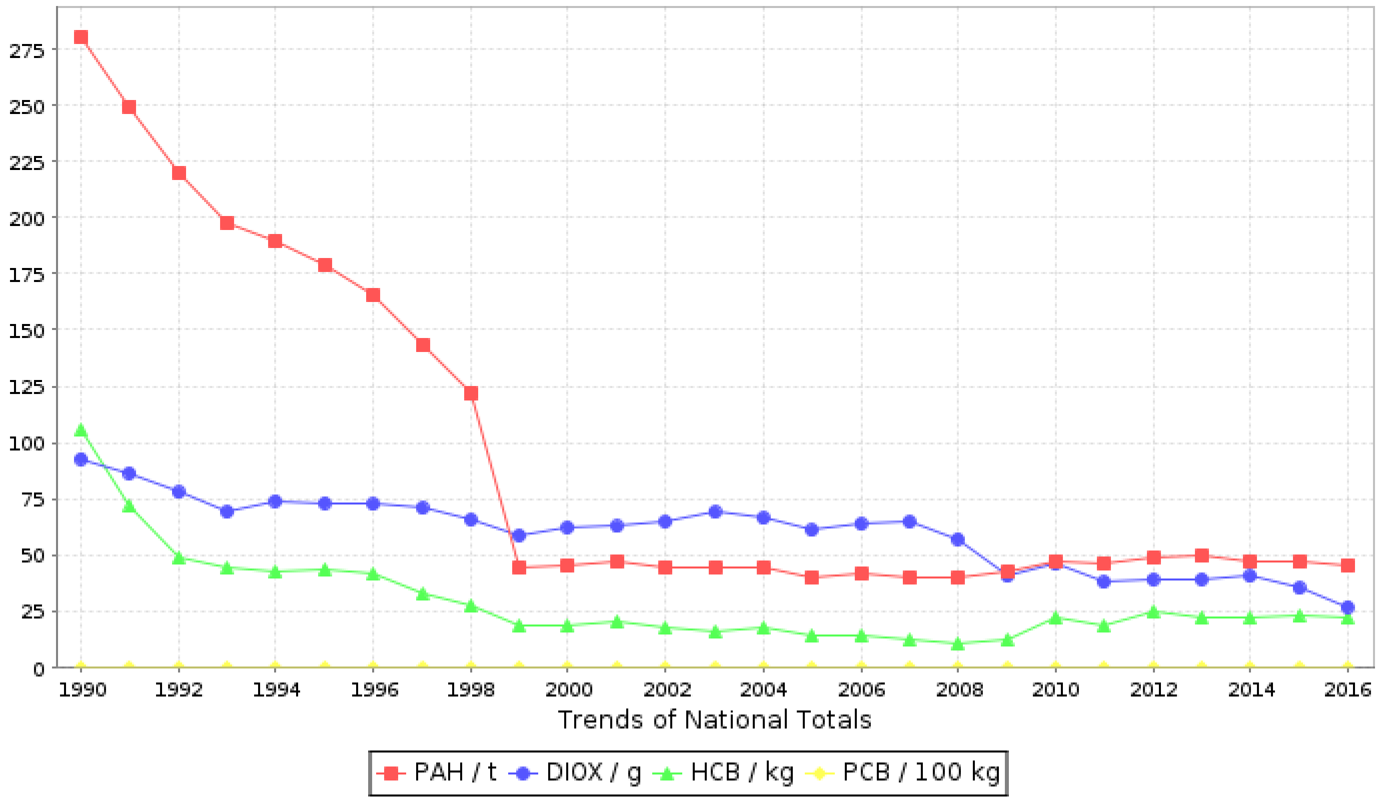

FIGURE 0-4 TRENDS OF POPS EMISSIONS

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

The date of the last edit of the chapter: 9/21/2018

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 evapora-tion from fuel systems of vehicles using petrol, non-road vehicles and machines used in mainte-nance 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

This classification corresponds to the way of emission inventory compilation. Individually monitored sources REZZO 1 and REZZO 2 are mainly represented in categories 1A (except for mobile sources and 1A4bi), 1B (except for 1B1a and 1B2av), furthermore in most of categories 2A (except for 2A5b), 2B (except for 2B1) and 2C (all). Data reported for sector Solvent use are only being used for VOC emission estimate. The whole inventory for sector 2D (except for 2D3b) is being performed by model calculation. Emissions from waste combustion and cremations (5C1) are also being monitored individually.

In other sectors the emissions are being ascertained by calculation using emission factors and activity data. This concerns residential heating (1A4bi), all categories of mobile sources 1A3 (except for gas transport 1A3ei), category 2A5b, agricultural machinery (sector 3) and some sources in sector 5.

1.3 INVENTORY PREPARATION PROCESS

The date of the last edit of the chapter: 9/21/2018

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 and 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. (SVUOM), Prague, is responsible for compilation of the inventory in sector 2D Solvent Use

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1.4 METHODS AND DATA SOURCES

The date of the last edit of the chapter: 9/21/2018

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.

For extraordinary 2018 resubmission there were done these methodology changes:

- Recalculation (1990 – 2016) of emissions in categories 1A3bi Passanger cars, 1A3bii Light duty vehicles (formerly reported as IE), 1A3biii Heavy duty vehicles and buses, 1A3biv Motocycles and mopeds as well as 1A3bv Gasoline evaporation and 1A3bvi Automobile tyre and brake wear by Transport Research Center (CDV) using COPERT 5 model (see Chapter 3.4.2.).
- Recalculation (1990 – 2016) of emissions from non-road mobile machinery (agriculture and forestry) in sector 1A4cii.

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 of the stationary source describing named source and its operation, as well as information on inputs and outputs from named 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 since 2010. The ISPOP data 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 emitted 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). It is 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 tons.

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 abatement technology, the share of particles depends on the separation principle of this technology. In cases of combustion sources without any abatement, 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).

1.4.1.1 EMISSION FACTORS USED

As stated above, emission of the most important point sources are being reported in Summary Operational Evidence (Souhrnná provozní eveidence – SPE). However part of emissions are being calculated using national emission factors. Namely there are included NMVOC combustion emissions (boilers, piston engines and other sources). Furthermore there are being calculated particle emissions of PM2.5 and PM10 as portion of TSP reported emissions. There is similar situation concerning emissions of heavy metals and POPs. For further information see following chapters.

1.4.1.2 ACTIVITY DATA USED

Activity data of individually monitored sources are usually gained from reported data of Summary Operational Evidence (SPE). This concerns fuel consumption of various fuels and their calorific values recalculated to heat content in fuel (NFR 1A1, 1A2 a 1A4). Activity data presented in categories 2A, 2B, 2C, 2H and partly 2D are being taken over from statistic data. Very problematic is the correct estimation of relevant activity data for sources using organic solvents. The completion here is assumed for reporting in coming years. Activity data for NFR 5 are partly being taken over from reported data (waste combustion) and statistic data.

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 2000–2016 according to methodology of 2007 (Machálek, Machart; 2007).

Data of 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 CZSO, and own emission factors (Dufek; 2006). Sets of emission data on mobile sources in agriculture and forestry are processed by Research Institute of Agricultural Engineering (VÚZT). The consistent time series of emissions in traffic sector for the whole period 1990 onwards were reported for the first time on 15th February 2018. For road transport emissions model COPERT V was introduced by Transport Research Center during spring 2018. For non-road transport (1A4cii) the tractor and non road machinery fleet composition as well as related emissions were throughly revised. As a result, new emission data sets are available for the Czech Republic in this extrardinary submission 2018.

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. Some area sources are partilally included in category 2D Use of solvents.

1.4.2.1 EMISSION FACTORS USED

Emissions of collectively monitored sources are being calculated using emission factors. In last period there had been implemented Emission Inventory Guidebook emission factors for calculation of most of key sources. In some cases, national emission factors based on emission measurements of large group of sources (namely in category 1A4bi) are being preferred. For NMVOC emission estimate in category Solvent use, Emission Inventory Guidebook emission factors (use in households) as well as national specific emission factors, based on long-term reported data about solvent used, applied abatement techniques and reported emission data, are being used.

1.4.2.2 ACTIVITY DATA USED

Emissions of collectively monitored sources are being calculated using activity data prevailing of public accessible web pages of Czech Statistical Office (CZSO) (metal production and raw materials, agricultural production data etc.). Some data are being prepared by CZSO officers for use in emission inventory (fuels sold) or other statistical data are being used (customs statistics for emission estimate in solvent use). More detail information is provided in following chapters.

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 balance on 15.11. (IEA)													
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 sent 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 there 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), Ministry of Agriculture (livestock and other 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.

Sector NFR 1A4bi Residential: Stationary was among the most significant sources of emissions in the Czech Republic in 2016. This sector was a key source of the largest number of pollutants 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 9 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 and Se. 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 2016

Component	Key categories Sorted from high to low from left to right)							Total %)
SOx	1A1a	1A4bi	1A2c	1A2a	1A1c			82.6
	(50.7%)	(18.3%)	(5.1%)	(4.4%)	(4.1%)			
NOx	1A1a	1A3bi	1A3biii	1A4cii	1A4bi	1A3bii	1A2f	1A4ai	83.6
	(26.6%)	(15.2%)	(11.0%)	(8.0%)	(7.7%)	(6.0%)	(4.7%)	(4.3%)	
NH3	3Da1	3Da2a	3B1b	3B1a	3B3				85.1
	(27.9%)	(22.6%)	(16.7%)	(11.3%)	(6.6%)				
NMVOC	1A4bi	2D3d	2D3g	2D3a	2D3i	2D3e	1B1a		82.2
	(46.8%)	(14.7%)	(5.2%)	(5.0%)	(3.6%)	(3.6%)	(3.3%)		
CO	1A4bi	1A2a	1A3bi						85.6
	(66.3%)	(12.1%)	(7.2%)						
TSP	1A4bi	3Dc	1B1a	1A1a	1A3bvi	1A3bvii	2A5a	3B3	81.3
	(51.7%)	(7.3%)	(6.6%)	(3.8%)	(3.6%)	(2.9%)	(2.9%)	(2.5%)	
PM10	1A4bi	3Dc	1A1a	1B1a	1A3bvi	1A4cii	2A5a		81.3
	(57.2%)	(8.7%)	(3.8%)	(3.7%)	(3.3%)	(2.4%)	(2.2%)		
PM2.5	1A4bi	1A3bvii	1A1a						80.3
	(73.2%)	(3.5%)	(3.5%)						
Pb	2C1	1A3bvi	1A1a	1A4bi	1A3bi				80.1
	(32.1%)	(18.7%)	(12.0%)	(12.0%)	(5.4%)				
Hg	1A1a	1A4bi	1A2a	5C1bv	1A2f				81.0
	(39.4%)	(24.0%)	(8.0%)	(5.2%)	(4.4%)				
Cd	1A4bi	2C1	1A1a	1A3bi					80.7
	(52.9%)	(13.2%)	(11.0%)	(3.6%)					

Component	Key categories Sorted from high to low from left to right)				Total %)
DIOX	1A4bi	1A2a	5E	2C1	84.0
	(31.6%)	(23.6%)	(14.5%)	(14.3%)	
PAH	1A4bi				98.1
	(98.1%)				
HCB	1A4bi				82.6
	(82.6%)				

1.6 QA/QC AND VERIFICATION METHODS

The date of the last edit of the chapter: 9/21/2018

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 involved in preparation of emission inventory.

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 QC PROCEDURES

The basic principle of emission inventory processing in the Czech Republic consists of dual system including processing of reported data of individual facilities (emissions or activity data enabling emissions calculations) and emission calculations based on national statistics. Despite the fact of significant differences between these approaches, quality control procedures are similar to large extent. They are based on thorough methodology preparation of each annual inventory including processing time schedules, sector splits to individual editors, consideration of new requirements or results performed revisions a fulfilment of quality control (QC) plan. The real control procedures include e.g. data completeness checks (mainly for individually monitored sources), consistent approach for necessary specialists´ estimates and thorough documentation of all emission inventory input data as well as procedures of final results processing. These results of quality control checks and procedures are being documented.

New approach having been applied since 2018 reflecting Stage 3 recommendations and EMRT review includes changes in choice of methodology for sectoral emission inventory where full completeness of individually collected data is not secured and still activity data precise enough are available enabling calculation of emissions relevant for the whole sector. These results replace individually reported data, originally chosen for emission inventory compilation by calculation using national statistics data and emission factors recommended by EIG. Key sector with emission inventory solely based on individually reported emission data will in following periods undergo detail review and there will be in case of modification of data selection for emission inventory processing.

During data selection necessary for emission inventory processing, up-to-dateness and completeness is being checked. National statistics authority data are being verified for up to date data. In the same way the ISPOP system for reporting individual emission data used for emission inventory is regularly being checked.

The procedure of individual data processing includes data import of each reporting into national emission database EDA, including a LOG entity drawing attention to reporting that due to some errors could not have been taken over for further processing in emission inventory. Such reporting need to be corrected by the source operator, sent again and consequently imported into national database EDA. The list of imported facilities is being compared with the list of reporting by ISPOP operator. Random checks of data transfer correctness into EDA database are being performed.

All individually received data are being checked using internal tests for completeness of reported emission and their correctness is being ascertained, especially non-exceeding of the upper threshold of expected emission. In a similar way the completeness and correctness of reported activity data used for emission calculations of fuels and products is being checked. Check results are being sent to source operator and the correctness of corrections is being supervised. In case of need supervision authority (environmental inspectorate) is being contact to supervise the correcting procedure of the source operator.

The whole processing of reported emissions and activity data is being performed by automatic procedures, set up in national database EDA. These procedures are regularly being checked and updated. Nevertheless the classification of national categories does not usually enable unique sector allocation of each reported emission and that´s why the final processing of the emissions sets takes place in MS Excel. Manual correction of automatic allocation to NFR sector is being documented and in final set including more than 50 thousand items for each year there is being performed summary of individually reported or calculated emissions for individual sectors.

The processing of collectively monitored sources takes place in some sectors (transport, agriculture and 1A4bi sector) using advanced tools of MS Excel or simple table calculations with activity data, emission factors and resulting emissions. All tables are being checked for calculation completeness and logical correctness. In case of any errors the correction takes place before finalizing of the reporting or in form of a resubmission.

The conversion of emission data, either reported or calculated, is being done directly in MS Excel application. Via linking of files there is the chance to eliminate errors while filling in files for reporting, however there appeared several errors in previous reporting periods. These were caused by incorrect positioning of emission data in certain rows that were while further processing hidden, not checked or wrongly linked to the file with summary annual data with incorrect reporting period. To eliminate these events test version of interlinked files with easy data for better check was prepared. This test version was in following processing locked for adjustment of linking formulas.

For emission inventory informative report (IIR) single tables are being created that incorporate summary or concrete values of emission reporting. Considering large scale of the document there can not be performed correct values setting in all tables and charts. For future periods there is being prepared a more perfect format of IIR directly using NFR emission tables.

The reproduction of individual calculations and data transfers is being secured by storing primary files with activity data and emission factors as well as files with intermediate or final calculations. In case of need a text record of calculations done is being performed.

For simultaneous working of sector solvers or air pollutants there is the documentation concerning sectors solved by main contributor (ČHMÚ) including partial and final files archived on shared disc, regularly backed up and archived after end of reporting period. Similar procedures of data storage take place at external solvers.

1.6.2 QA PROCEDURES

Review procedures on national level have not been established yet. Emission inventory team uses recommendations and results of international reviews.

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. The use of “NE” symbol in 1990-1999 data will be explained in updated version of this documents.

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, Cd, 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	Will be calculated after COPERT implementation
1A3biii	Pb, Cd, PCDD/ PCDF, HCB	Will be calculated after COPERT implementation
1A3biv	Pb, Cd, PCDD/ PCDF, HCB	Will be calculated after COPERT implementation
1A3bvi	Hg, PCDD/ PCDF, InP, HCB, PCBs	Will be calculated after COPERT implementation
1A3bvii	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
1A3dii	Pb, Cd, PCDD/ PCDF, HCB, PCBs	Will be calculated after COPERT implementation
1A3ei	NH_3	EF is not available
1A4ai	NH_3	EF is not available
1A4aii	Pb, Cd, PCDD/ PCDF, HCB	Will be calculated after COPERT implementation
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	PCDD/ PCDF, HCB, PCBs	EFs are not available
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	ADs are not available
1B1c	SOx, NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF	ADs are not available
1B2aiv	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs	ADs are not available
1B2b	NMVOC, SOx, PCDD/F	Will be calculated
1B2c	NH_3, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs	ADs are not available
2A1	NOx, NH_3, NMVOC, SOx, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB	EFs are not available
2A2	NOx, 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	ADs are not available

NFR Code	Pollutants	Reason for not estimated
2A6	BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB	ADs and EFs are not available
2B6	BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
2B10a	BC, Pb, Cd, Cu, Se, Zn, HCB, PCB	ADs are not available
2B10b	All	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	EFs are not available
2C3	NH_3, BC, Cr, Ni, Se, PAHs	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, Cr, Cu, Ni, Se, PCDD/PCDF, PAHs HCB, PCBs	ADs are not available
2C7a	NH_3, BC, Cr, Ni, Se, HCB	EFs are not available
2C7c	SOx, BC, Hg, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
2D3b	NOx, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO, PCDD/PCDF, PAHs, HCB	EFs are not available
2D3c	Nox, BC, CO, 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
2D3h	$PM_{2.5}$	EFs are not available
2G	All	AD are not available
2H1	NOx, SOx, NH_3, BC, CO, PAHs, HCB	EFs are not available
2H2	BC	Will be calculated
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, PM2.5, PM10, TSP	EFs are not available
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
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, NMVOC, SOx, $PM_{2.5}$, PM_{10}, TSP, BC, CO	EFs are not available
5B2	NOx, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Hg, Cd, Cr, Zn, PCDD/PCDF, PAHs, HCB, PCBs	EFs are not available
5C1biii	NH_3	EF is not available
5C1bv	BC	EF is not available
5D1	NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	EFs are not available
5D2	NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	
5D3	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, SOx, NH_3, BC, CO, Ni, Se, Zn, PAHs, HCB, PCBs	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	
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
5C1bii	Hazardous waste incineration	(f) included in 5C1bi, 5C1biii

2 EXPLANATION OF KEY TRENDS

2.1 EMISSIONS OF POLLUTANTS REGULATED IN THE AMENDED GOTHENBURG PROTOCOL

The development of air pollution is closely linked 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 1990–2016 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 systems, implementing 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 problems in the field of reaching 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.

2.1.1 NITROGEN OXIDES (NO_X)

The emission of nitrogen oxides of 728.8 kt in 1990 dropped significantly mainly due to decrease of economic activity in heavy industry and shut down of obsolete facilities and technologies. The total emission of nitrogen oxides in 2005 amounted 276.5 kt (-62 % compared to 1990). The further decline was relatively slight to 168.4 kt in 2016. The total emission o nitrogen oxides decreased year-on-year by more than 5.0 % (177.9 kt in 2015). Further development is very sensitive to economic activity and investment in abatement in industry and transport. The highest share of emission is being covered by sector 1A1a (26.6 %), 1A3bi (15.2 %), 1A3biii (11.0 %) and 1A4cii (8.0 %).

2.1.2 SULPHUR DIOXIDE (SO_2)

The total sulphur dioxide emission of 1,756.1 kt in 1990 was the second highest in emission inventory. Due to shut down of old power plants, primary measurements (shift to low sulphur content fuels) and intensive secondary measures (combustion adaptation and desulphurization) in power generation the total emission was reduced to 208.4 kt in 2005 (-88.1 %) and slowly declined due to further improvements to 115.1 kt in 2016. The achievements in SO2 abatement in 1990-1999 and later belong to the most significant all around the world. The year-on-year emission of sulphur dioxide lowered by -11 % (129.3 kt in 2015). The most emission is being contributed by sector 1A1a (50.7 %) and 1A4bi (18.3 %).

2.1.3 AMMONIA (NH_3)

Emission of ammonia in 1990 was 149.3 kt and declined in 2005 to 77.1 kt (-48.4 %) and remained little lower with 71.7 kt in 2016. On year-on-year basis there was slight decrease of the total ammonia emission by (72 kt in 2015). The further development depends on the strategy for animal production, swine mainly. Main contributing sectors to the final emission are in agriculture 3Da1 (27.9 %), 3Da2a (22.6 %), 3B1b (16.7 %), 3B1a (11.3 %) and 3B3 (6.6 %), which make 85.1 % as sum.

2.1.4 NMVOC

The NMVOC emission in 1990 was 509.9 kt and lowered to 252.3 kt in 2005 (-50,5 %). In general the reduction trend remained and the total emission in 2016 amounted 205.9 kt. The total emission of NMVOC decreased by 2.6 % in 2016 compared to 2015 (211.4 kt). There are two sectors with the highest share of total emission: 1A4bi (46.8 %) and 2D3d (14.7 %).

2.1.5 TOTAL SUSPENDED PARTICLES (TSP)

The TSP emission of 581.5 kt in 1990 lowered due to shut down of old power plants, primary measurements (combustion adaptation) and intensive secondary measures (new electrostatic precipitators and scrubber desulphurization units) in power generation. The total emission was reduced to 73.1 kt in 2005 (-87.4 %) and slowly decreased due to further improvements to 61.0 kt in 2016. The achievements in TSP abatement belong to the second most significant in Czech emission inventory considering the percentage ratio. The year-on-year emission of TSP declined by -2.9 % (62.8 kt in 2015). The most contributing sector is 1A4bi (51.7 %), other sectors are below 10 %.

2.1.6 PARTICULATE MATTER ($PM_{2.5}$)

The PM2,5 emission in 1990 amounted 298 kt. It dropped to 43 kt in 2005 (-85.6 %) and was 38.8 kt in 2016, which is -87 % compared to 1990. The year-on-year change 2015-2016 was -3.2 % (40.1 kt in 2015). The highest share of total emission comes from sector 1A4bi (73.2 %).

2.1.7 BLACK CARBON (BC)

The total BC emission in 1990 was 19 kt. It decreased to 4.4 kt in 2016, which is -76.8 % compared to 1990. The BC emission in 2016 4.43 kt was -3.7 % lower than in 2015 (4.6 kt).

2.1.8 THE TREND IN THE DEVELOPMENT OF EMISSIONS IN THE PERIOD 1990–2001

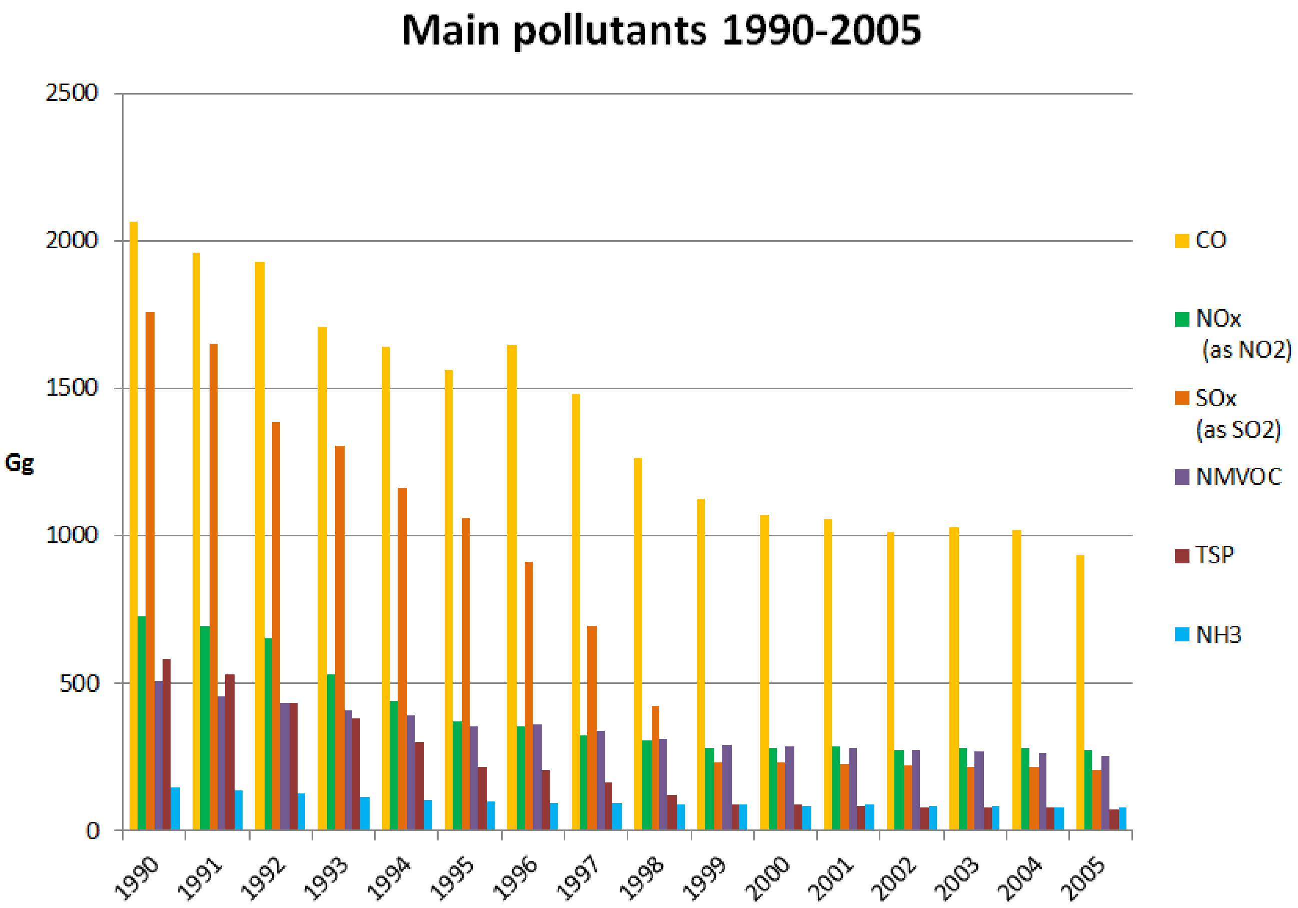


FIGURE 2-1 THE TREND IN THE DEVELOPMENT OF EMISSIONS IN THE PERIOD 1990–2005

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 CS history, implemented the emission limit values effective from the year 1998. This schedule was arranged to help to 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 had been shut down 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 were 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 2002 the Act No. 309/1991 Coll. Was replaced by Air Quality Act 86/2002 Coll.

2.1.9 THE TREND IN THE DEVELOPMENT OF EMISSIONS IN THE PERIOD 2005–2016

The level of air pollution in 2016 decreased in comparison with the year 2005 as follows: TSP by 16.6 %, SO_2 by 44.8 %, NOx by 38.7 %, CO by 12.5 %, VOC by 18.4 % and NH_3 emissions by 7 % (Figure 2-2).

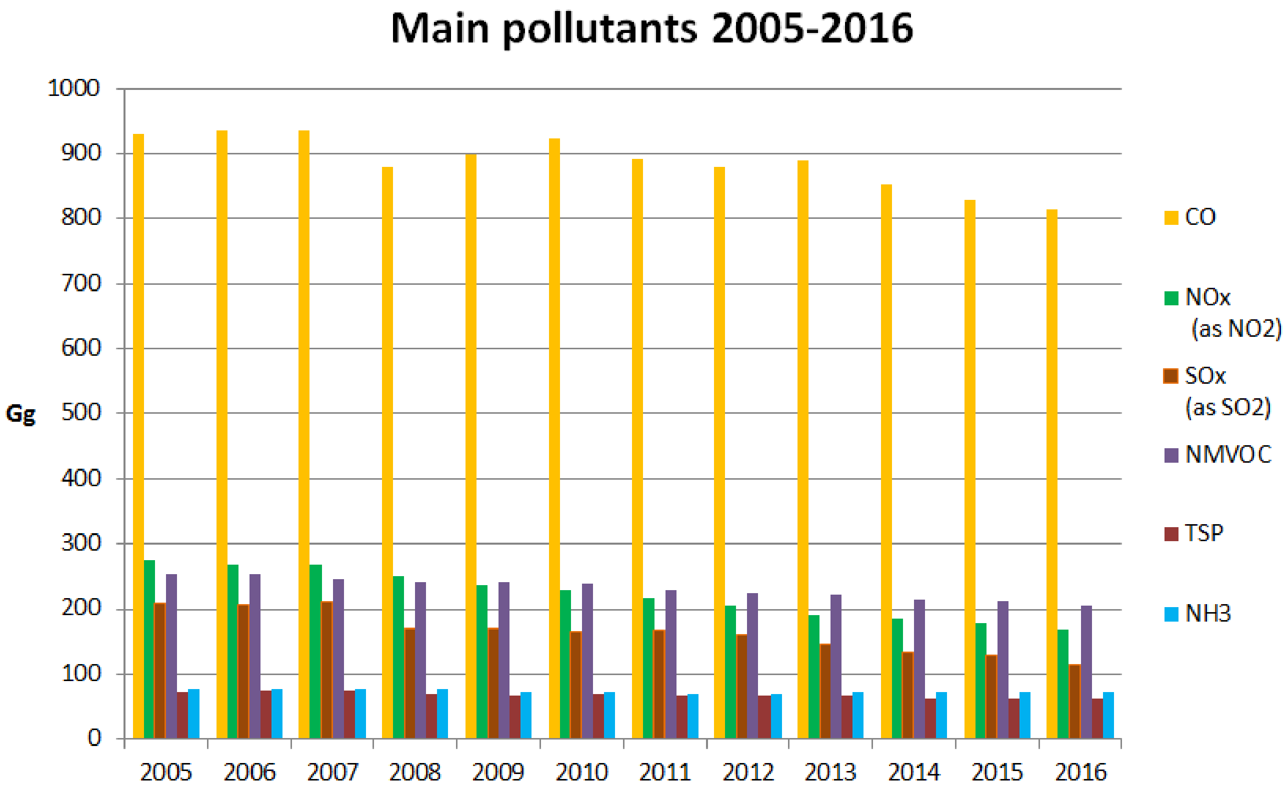


FIGURE 2-2 THE TREND IN THE DEVELOPMENT OF EMISSIONS IN THE PERIOD 2005–2016

2.1.10 LAST YEAR'S DEVELOPMENT

Economic indicators show overall trend of economic growth. GDP indicator against 2015 rose by 3.5 %. 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 2016 changed in comparison with the year 2016 as follows: VOC (-2.6 %), NH_3 (-0.4 %) TSP (-2.9 %), $PM_{2.5}$ (-3.2 %), PM_{10} (-3 %) and BC (-3.7 %). CO decreased by -1.6 %, NO_x -5.3 % and SO_2 by -11 %. 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.

2.2 CO, PM_{10}, PAH-4, HCB & DIOXINS

2.2.1 CARBON MONOXIDE (CO)

The total emission of carbon monoxide 2,064.7 kt in 1990 was lowered to approx. 952 kt in 2005 (-53.9 %). The decline of this emission was gradual and continued until 2016 with 815.3 kt. The total emission of carbon monoxide in 2016 was 1.6 % lower than in 2015 (828.8 kt). Despite these achievements the total emission of CO is since 1997 the highest in the emission inventory of the Czech Republic and potential for further significant reduction is practically exhausted without additional measures. The most important contribution to the total emission comes from sector 1A4bi (66.3 %). The second important value belongs to sector 1A2a (12.1 %).

2.2.2 PARTICULATE MATTER (PM_{10})

The PM10 emission in 1990 reached 428.6 kt. It lowered to 59.5 kt in 2005 (-86.1 %) and was 51.3 kt in 2016. The year-on-year change 2015-2016 was -3 % (52.9 kt in 2015). The most important sector is 1A4bi (57.2 %), followed by 3Dc (8.7 %).

2.2.3 POLYAROMATIC HYDROCARBONS (PAH-4)

The total emission of polyaromatic hydrocarbons (PAH-4) 280.2 t in 1990 was lowered to approximately 39.9 t in 2005 (-85.8 %). The decrease in 1998-1999 was caused by technical measurements coke facilities and shut-down of old installations. Due to higher share of biomass combustion there is an increase in amount of emission which was 45.7 t in 2016. The total emission of polyaromatic hydrocarbons (PAH-4) in 2016 was -2.6 % lower than in 2015 (46.9 kt).

The largely highest share of emissions concentrates in sector 1A4bi (98.1 %), which is the highest contribution of one sector to an emission in Czech emission inventory.

2.2.4 HEXACHLOROBENZENE (HCB)

The total emission of hexachlorobenzene (HCB) in 1990 was 105.5 kg and lowered to 14.4 t in 2005 (-86.4 %). There was a certain increase of this emission after 2005 which was 22 kg in 2016.The total emission of hexachlorobenzene (HCB) in 2016 was -3.9 % lower than in 2015 (22.9 kg). The sector 1A4bi dominantly contributes to the total emission by 82.6 %.

2.2.5 DIOXINS – POLYCHLORINATED DIBENZODIOXINS AND FURANS (PCDD/F)

Total emission of polychlorinated dibenzo-p-dioxines and furans (PCDD/F) in 1990 was 92.3 g I-TEQ. The same emission in 2005 was 61.0 g I-TEQ (-33.9% compared to 1990). The total emission polychlorinated dibenzo-p-dioxines and furans (PCDD/F) in 2016 was 29.3 g I-TEQ. The emission of polychlorinated dibenzo-p-dioxines and furans (PCDD/F) reported in 2015 was 35.3 g I-TEQ, which indicates year-on-year change -17.0%.

These four sectors contribute to 84.0 % of total emission: 1A4bi (31.6 %), 1A2a (23.6 %), 5E (14.5 %) and 2C1 (14.3 %).

2.3 EMISSIONS OF PRIORITY HEAVY METALS

2.3.1 CADMIUM (CD)

Total emission of cadmium in 1990 was 3.964 t. The same emission in 2005 was 1.548 t (-61 % compared to 1990). The emission of cadmium in 2016 was 1.133 t (-26.8 % compared to 2005). The emission of cadmium in 2015 was 1.179 t, which is year-on-year change -3.9 %. The three most contributing sectors to the total emission are: 1A4bi (52.9 %), 2C1 (13.2 %) and 1A1a (11.0 %).

2.3.2 MERCURY (HG)

Total emission of mercury in 1990 was 4,955 t. The same emission in 2005 was 3,489 t (-29.6% compared to 1990). The emission of mercury in 2016 was 2,648 t (2,710 t in 2015) which is -2.3 % and -24.1 % compared to 2005). The most important is the sector 1A1a (39.4 %), followed by 1A4bi (24.0 %) and 1A2a (8.0 %).

2.3.3 LEAD (PB)

Total emission of lead in 1990 was 328.4 t. The same emission in 2005 was 33.4 t (-89.8 % compared to 1990). The lower emission of lead was mainly caused by the ban of leaded fuel distribution in 2001. The emission of lead in 2016 lowered to 12.5 t (-62.6% compared to 2002). The emission of lead in 2015 was 15.7 t, which is year-on-year decrease by -20.4 %. The most contributing to the total emission are the sectors 2C1 (32.1 %), 1A3bvi (18.7 %), 1A1a (12.0 %) and 1A4bi (12.0 %).

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).

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 15-1 and Table 15-2 in Annex

3.2 ENERGY INDUSTRIES (NFR 1A1)

In the Table 3-1 there is the 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	1.1. Fuel combustion in boilers with a total nominal heat consumption above 5 MW
1A1c	Manufacture of solid fuels and other energy industries	3.4. Coal heat treatment (coke ovens, briquetting plant, low-temperature carbonization, drying)

3.2.1 PUBLIC ELECTRICITY AND HEAT PRODUCTION (NFR 1A1a)

The Table 3-2 shows the electricity generation from individual types of equipment. The Figure 3 1 shows the production shares in 2015

TABLE 3-2 ELECTRICITY BALANCE IN CR

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gross electricity production		84333	82578	84361	88198	83518	82250	85903	87477	87418	86913	86 148	83 892
Including:	thermal power plants [2]	55435	54802	55009	59375	54333	51682	53574	53951	51669	50015	50262	51143
	hydro power plants	2563	3027	3257	2524	2376	2983	3380	2664	2860	3639	2961	3071
	wind power plants	10	21	49	125	245	288	335	397	416	481	477	573
	solar power plats	-	-	-	2	13	89	616	2182	2149	2033	2123	2264
	nuclear power plants	26325	24728	26046	26172	26551	27208	27998	28283	30324	30745	30325	26841

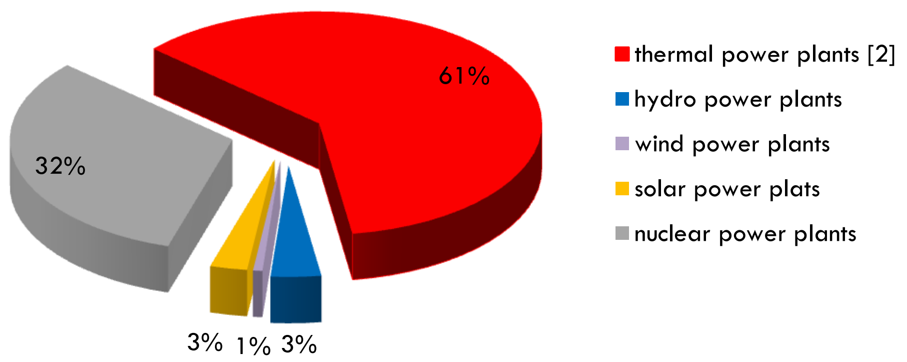


FIGURE 3-1 THE SHARE OF INDIVIDUAL TYPES OF ELECTRICITY GENERATION IN THE TOTAL ENERGY BALANCE IN 2015

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 plants (70 in 2016).

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 (67.48 %) and pulverized hard coal (10.52 %), 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

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: NMVOC, 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 TREND IN CATEGORY 1A1a

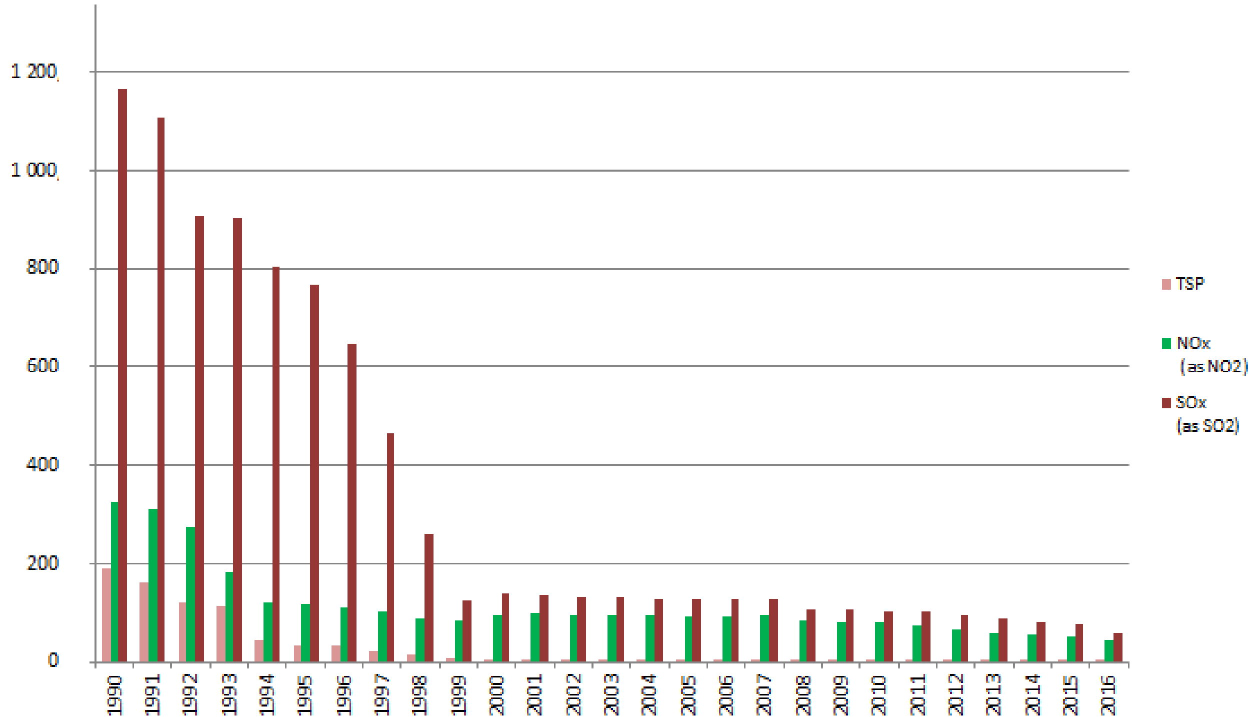


FIGURE 3-2 DEVELOPMENT OF EMISSIONS OF SELECTED POLLUTANT FROM CATEGORY 1A1A IN THE PERIOD 1990–2016

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 SO_2 and NO_x (58 and 53 %, respectively). In the case of TSP is decrease 45 %. 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 SO_2, NO_x and TSP in the period 2015–2016 was 23, 12 and 15 %, respectively.

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 1.4.1 and 1.6.1).

In addition to these general checks further validation mechanisms take place under international reporting performed annually since the reporting period 2003 pursuant to valid European legislation. Among other items it includes 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 PETROLEUM REFINING (NFR 1A1b)

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:

- Unipetrol Kralupy
- Unipetrol 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 2000–2016, 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 2000–2016 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 at petrochemical facilities in Litvínov, the obligation to monitor and calculate emissions of combustion flares had 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 1B2c are completed by preliminary emission estimate, calculated considering the average Sulphur content in the waste gas and its burnt amount. There will be added flaring emissions in 2014 and 2015.

The lowering of SO_2 emission in refinery Unipetrol in 2013 compared to years 2011 and 2012 is the result of extensive repairs of liquid sulphur equipment and successive trouble-free operation.

3.2.2.2 CONTRIBUTION TO INDUSTRIAL PRODUCTION

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 3-3).

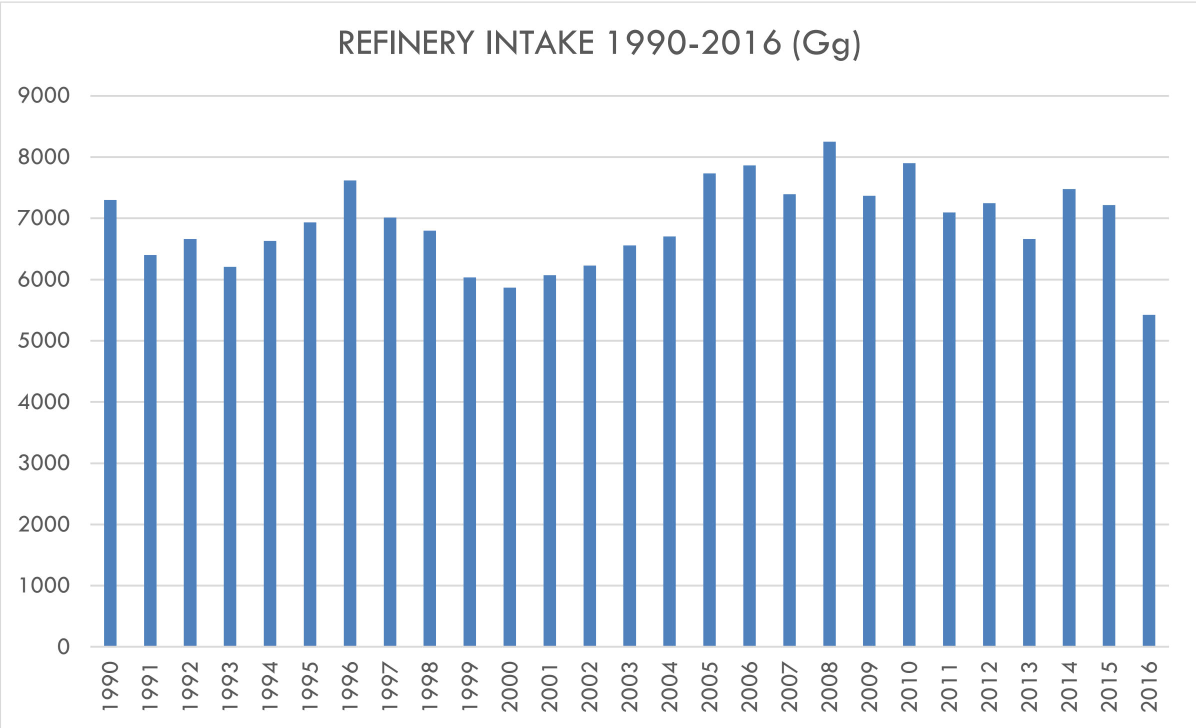


FIGURE 3-3 THE DEVELOPMENT OF CRUDE OIL CONSUMPTION

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). The strong decrease in 2016 was caused by operational accidents in both refineries Litvínov and Kraulupy.

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.

3.2.3 MANUFACTURING OF SOLID FUELS AND OTHER ENERGY INDUSTRIES (NFR 1A1c)

The chapter will supplied later.

3.3 MANUFACTURING INDUSTRIES AND CONSTRUCTION (NFR 1A2)

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). Raw 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 3-3 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	1.1. Fuel combustion in boilers with a total nominal heat consumption above 5 MW.
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	1.1. Fuel combustion in boilers with a total nominal heat consumption above 5 MW
		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
		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. Hot mix plants for bituminous mixtures and asphalt mixing plants,

NFR code	Longname	Classification pursuant Annex 2 to Act 201/2012 Coll.
		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 STATIONARY SOURCES

3.3.1.1 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).

3.3.1.2 METHODOLOGY FOR MANUFACTURING INDUSTRIES AND CONSTRUCTION

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 15-1 and Table 15-2.

3.3.1.3 THE DEVELOPMENT OF EMISSIONS FROM MANUFACTURING INDUSTRIES AND CONSTRUCTION

Amount of emissions from industrial combustion included in category 1A2 primarily depends on production in individual sectors. Trends for production in period 2000–2016 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.

3.3.2 MOBILE COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION

3.3.2.1 SOURCE CHARACTERISTIC AND 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.

3.3.2.2 ACTIVITY DATA

TABLE 3-4 FUEL CONSUMPTION BY NON - ROAD MOBILE MACHINERY IN CONSTRUCTION AND INDUSTRIES

1 A 2 f ii	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diesel Oil kt	47.0	35.0	49.0	45.0	53.0	54.0	52.0	48.0	47.0	45.0
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diesel Oil kt	49.0	44.0	36.0	45.0	52.0	50.0	47.0	50.0	52.0	48.0
Year	2010	2011	2012	2013	2014	2015	2016			
Diesel Oil kt	46.0	47.0	43.0	41.0	43.0	44.0	43.0			

3.3.2.3 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 3-5 EF METHOD USED FOR NON - ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES

	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
		PAHs							
	PCDD/ PCDF (dioxines/ furanes)	**benzo(a) pyrene**	**benzo(b) fluoranthene**	**benzo(k) fluoranthene**	**Indeno (1,2,3-cd) pyrene**	**PCBs**			
	NR	Tier 1	Tier 1	Tier 1	Tier 1	NR			

TABLE 3-6 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 3-7 EF USED FOR NON - ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES REGARDING OTHER POLLUTANTS IN THE CURRENT YEAR

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

3.3.2.4 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). Ammonia emission in this sector is negligable (below 0.5 t/year in last years).

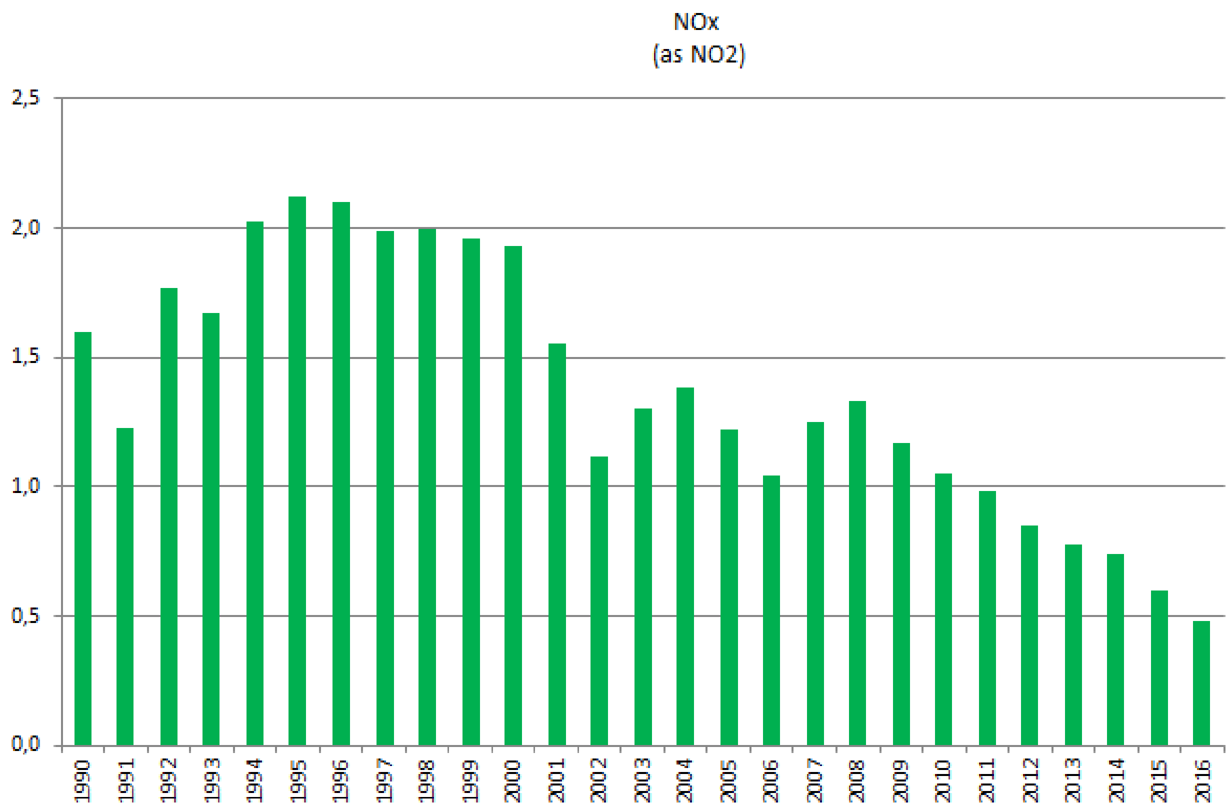


FIGURE 3-4 EMISSIONS (Gg) BY NON - ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES IN 1990–2016

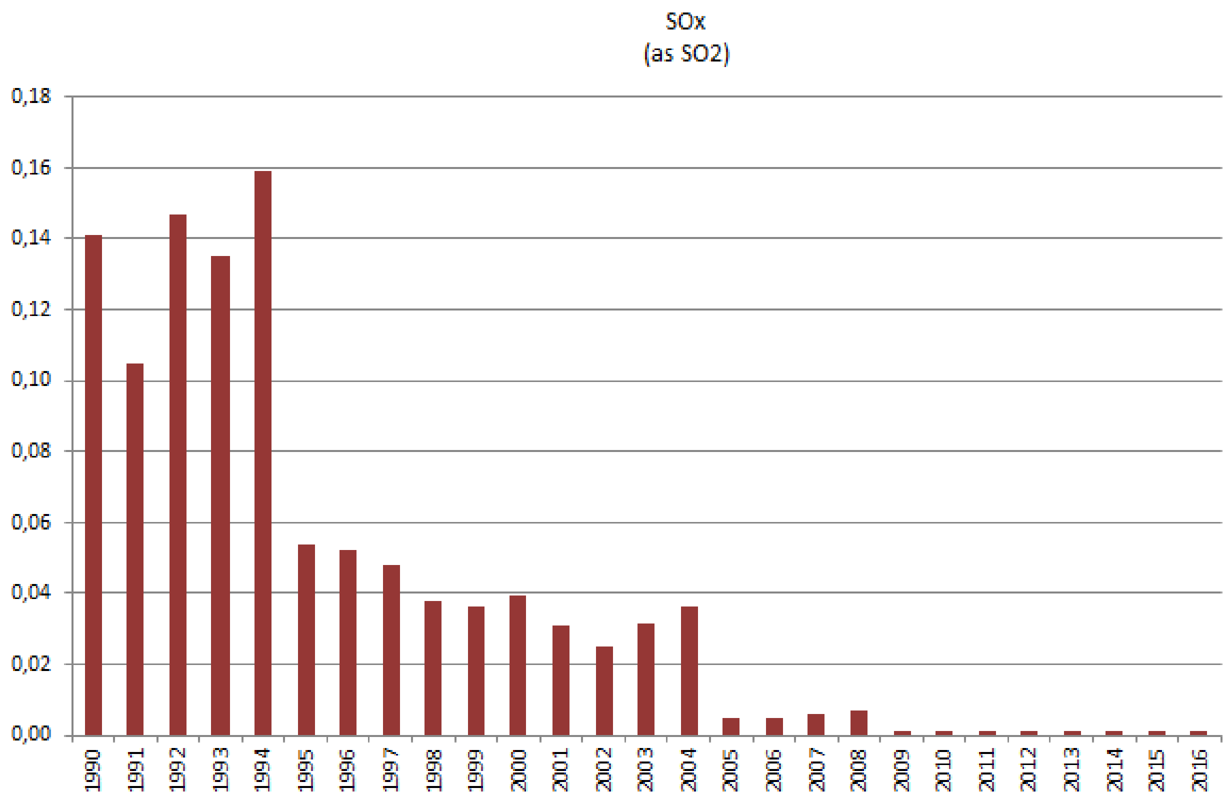


FIGURE 3-5 EMISSIONS (Gg) BY NON - ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES IN 1990–2016

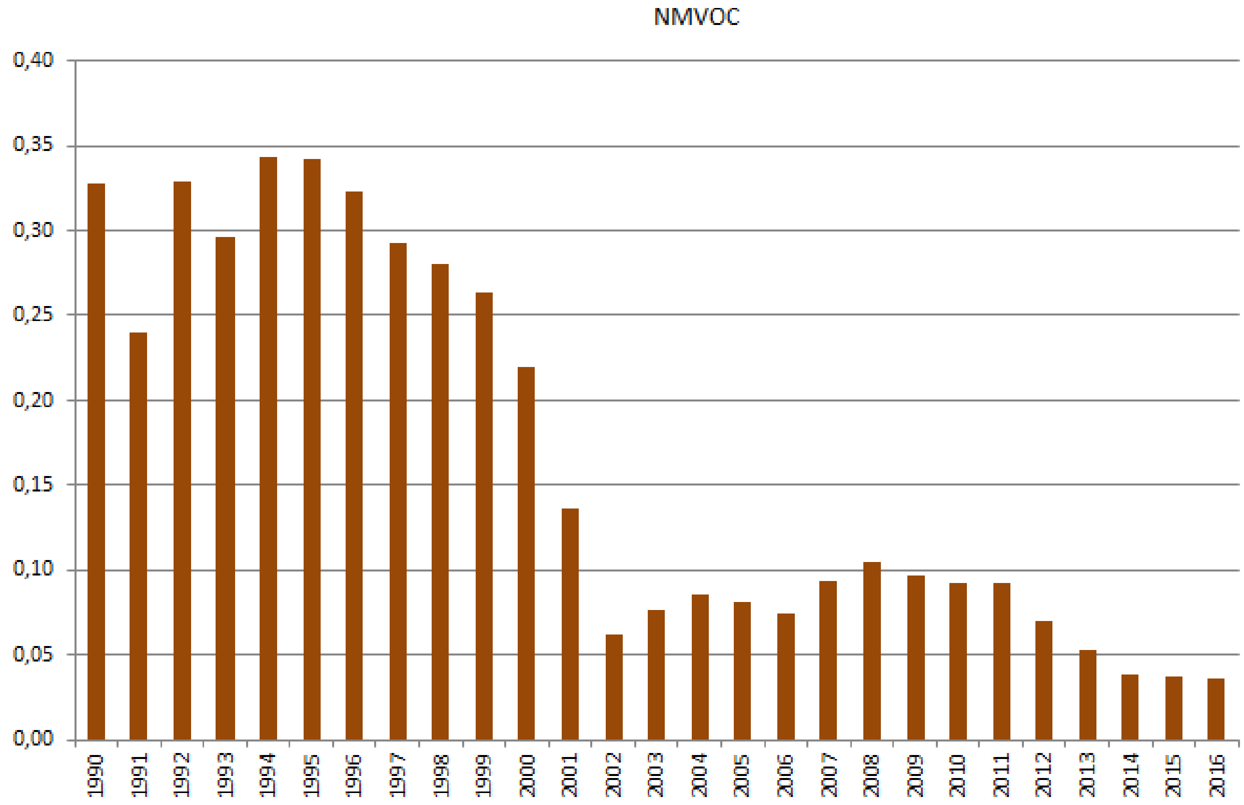


FIGURE 3-6 EMISSIONS (Gg) OF NMVOC BY NON - ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES IN 1990–2016

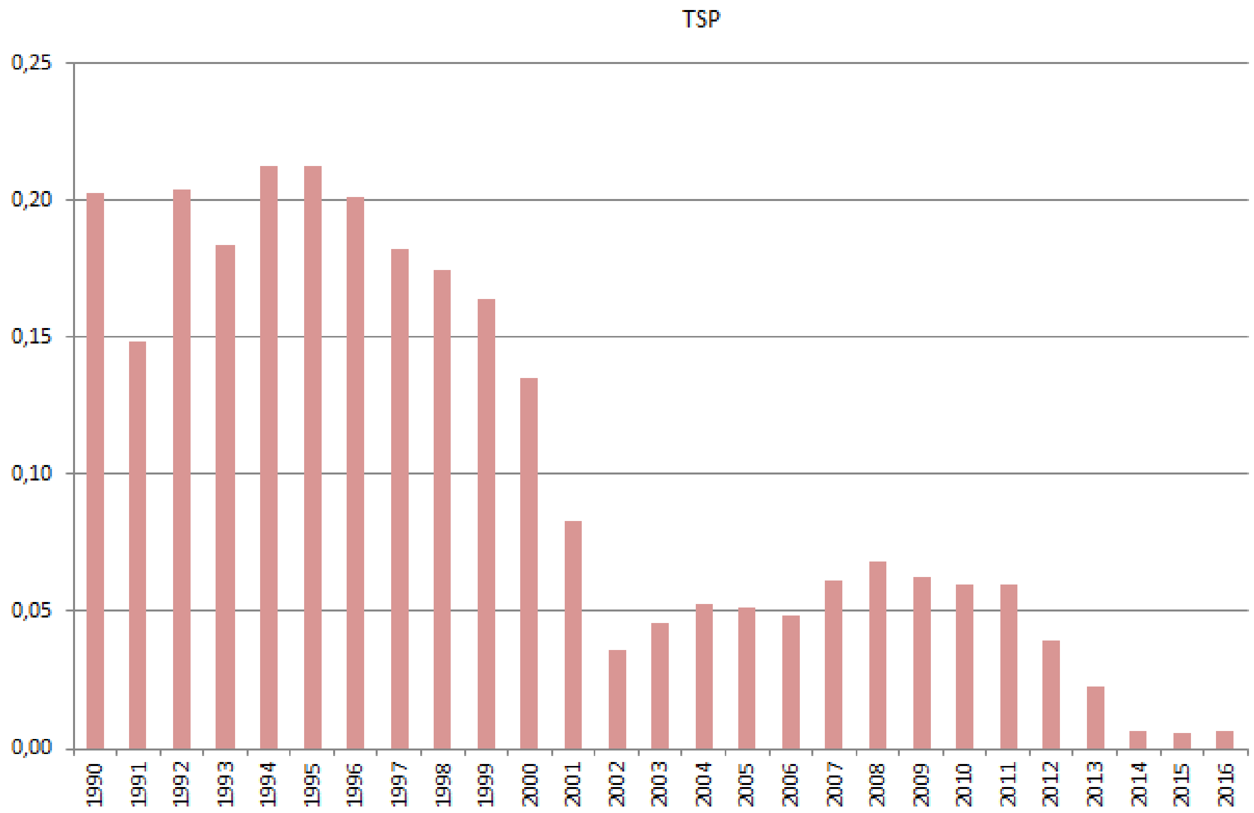


FIGURE 3-7 EMISSIONS (Gg) OF TSP BY NON-ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES IN 1990–2016

3.3.2.5 UNCERTAINTIES

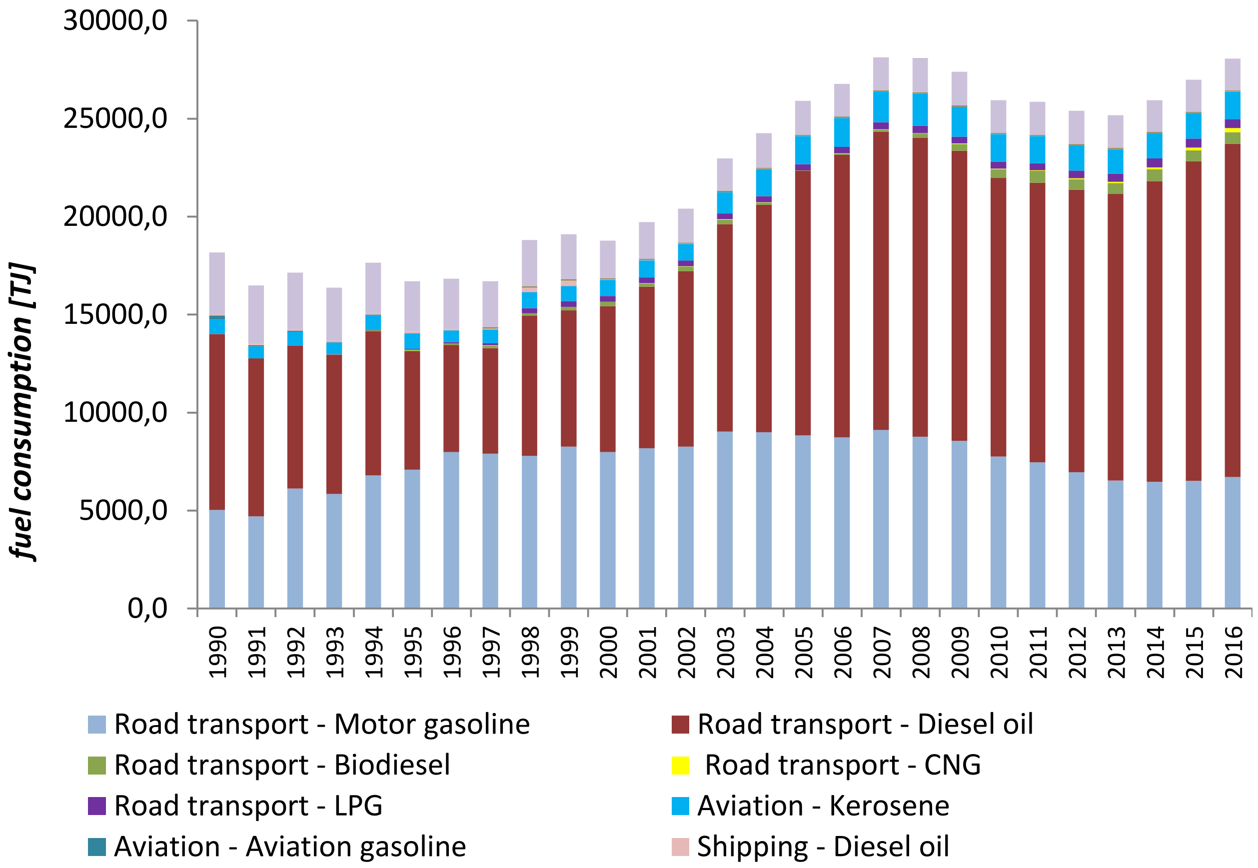
Uncertainty for a non - road mobile machinery in the construction and other industries was calculated according to the EMEP/EEA air pollutant emission inventory guidebook 2016. The uncertainties given here have been evaluated for all of time series (2000 – 2016) and all reported categories. The total combined 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.

3.4 MOBILE SOURCES

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 so detailed for a non-road transport and mobile sources. Activity data for all sectors are displayed below.

This chapter has been 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").

FIGURE 3-8 ANNUAL FUEL CONSUMPTION BY ALL MODES OF TRANSPORT /1990-2016/



3.4.1 CIVIL AVIATION (1.A.3.a)

Combustion 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 aircrafts are not included in this category but are reported under 1.A.5.b Military: Mobile Combustion.

3.4.1.1 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. The next step is to define a ratio between fuel consumption during LTO and Cruise phase of flights (see Table 3-8). 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 3-8 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

3.4.1.2 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 3-9. 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 are 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 an expert judgement, in the whole time period and the main criterion is a combination of the transport performance of a passenger air transport (only a small amount of domestic lines among Czech main airports) and freight air transport (MoT, 2016). The regular domestic flights using Jet Kerosene are, in comparison with international flights, represented by a very small percentage in the Czech Republic

TABLE 3-9 JET KEROSENE CONSUMPTION ACCORDING TO FLIGHT MODE IN 1990–2016

Jet kerosene consumption	Domestic Flights LTO	International Flights LTO	Domestic Flights Cruise	International Flights Cruise
	kt	kt	kt	kt
1990	NA	25.35	NA	143.65
1991	NA	20.85	NA	118.15
1992	NA	24.15	NA	136.85
1993	NA	20.10	NA	113.90
1994	NA	25.05	NA	141.95
1995	NA	27.00	NA	153.00
1996	0.01	19.35	0.06	109.65
1997	0.04	18.15	0.33	102.85
1998	0.07	17.10	0.66	96.90
1999	0.05	19.65	0.45	111.35
2000	0.05	28.78	0.45	163.23
2001	0.06	30.72	0.54	174.28
2002	0.05	26.53	0.45	150.48
2003	0.06	35.67	0.54	202.33
2004	0.08	45.86	0.72	260.14
2005	0.09	47.66	0.81	270.35
2006	0.11	48.85	0.99	277.16
2007	0.11	51.25	0.99	290.76
2008	0.07	54.27	0.63	307.74
2009	0.10	49.60	0.90	281.40
2010	0.08	46.46	0.72	263.54
2011	0.05	46.03	0.45	260.98
2012	0.04	42.88	0.36	243.12

Jet kerosene consumption	Domestic Flights LTO	International Flights LTO	Domestic Flights Cruise	International Flights Cruise
	kt	kt	kt	kt
2013	0.05	41.38	0.45	234.63
2014	0.03	42.44	0.27	240.57
2015	0.03	43.04	0.27	243.97
2016	0.03	46.34	0.27	262.67

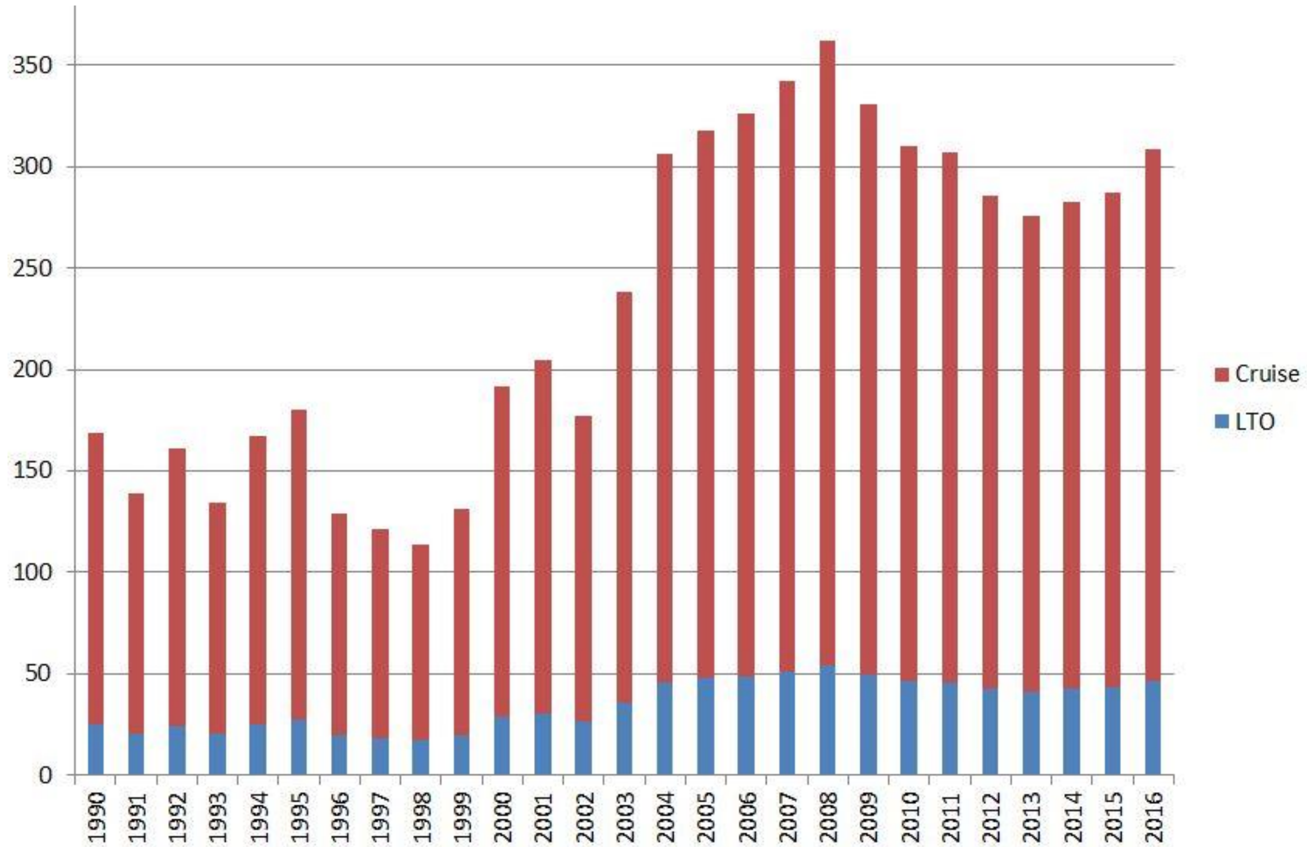


FIGURE 3-9 ANNUAL LTO AND CRUISE JET KEROSENE CONSUMPTION (Gg) IN INTERNATIONAL AVIATION IN 1990–2016

3.4.1.3 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 3-10 and Table 3-11). 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 to EIG 2016. PCDD/F and PCBs are not reported from Civil Aviation. Total emissions from each sector are combinations of emission factor, ratio of LTO and Cruise on a total fuel consumption and activity data.

TABLE 3-10 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 3-11 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 3-12 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 3-13 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 3-14 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 3-15 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

3.4.1.4 EMISSIONS

The most significant pollutants from aviation are NOx and CO. Emission trends depend mostly on transport performance of international and national aviation (see Figure 3-10). Emissions from international aviation continued to increased until 2008 and after this year, due to economic crisis started to decrease. The lowest emissions in last decade were in 2013. 2014 was the starting year of growth in international aviation transport performance and related emissions..

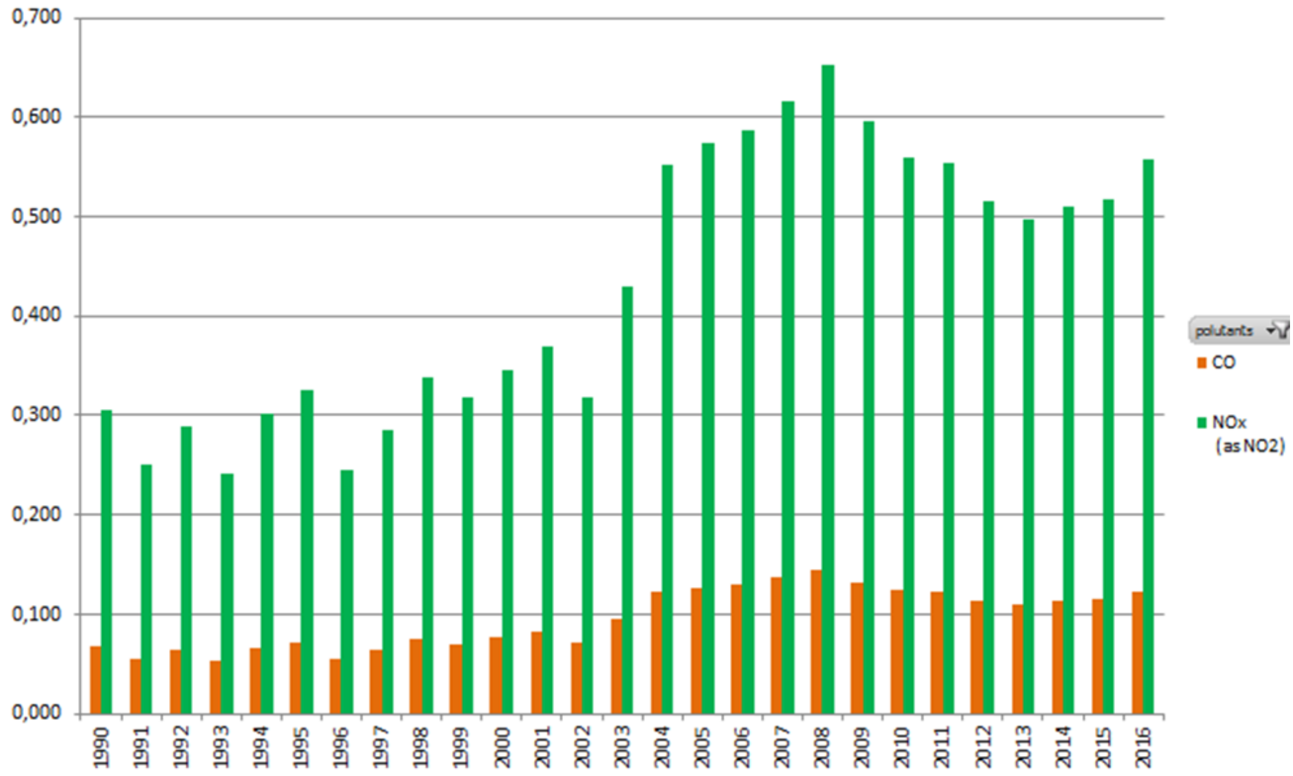


FIGURE 3-10 EMISSIONS (Gg) OF NOx AND CO FROM INTERNATIONAL AVIATION 1990 - 2016

Emissions from domestic aviation have no specific trend. Transport performance in domestic aviation is very low and strongly depends on a small fluctuation in number of flights made by particular domestic airline. In the years 2000 – 2004 emissions of CO fluctuated mostly around 380 t with the drop in 2001 (254 t). NOx fluctuated around 70 t with the drop to 50 t in 2001. In period 2005 – 2014 emissions of CO fluctuated mostly around 255 t with the drop in 2011 (127 t). NOx fluctuated around 55 t with the drop to 28 t in 2011. In past two years thanks to development in domestic aviation transport performance emissions of CO reached again 380 t and NOx 69 t.

3.4.1.5 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 (2000–2016) and both flight stages. Total combined uncertainty of national emissions within civil aviation is ±38.16 %. 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.

3.4.2 ROAD TRANSPORT (1.A.3.B)

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 sections. 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 newly by a type of fuel and EURO norms according COPERT V.

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 strenghtening of emission limits) 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. For split of 1.A.3.b i and ii (Passenger Cars and Light Duty Vehicles) see further in text.

3.4.2.1 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 were formerly included in the subsector 1A3b i Passenger Cars, because the differentiation between these two subsectors was not available owing to inappropriate structure of activity data provided by The Czech Statistical Office (CzSO). Next issue was 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.

3.4.2.2 ACTIVITY DATA

Activity data of a road transport 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 $g.km^{-1}$ according COPERT V database. The parameters necessary for distribution of this amount of fuels are given by the model, annual mileage and data in Car registry of Czech Republic.

3.4.2.3 EMISSION FACTORS

The COPERT V emission factors replaced EFs 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). The most important emission factors will be placed in Annexes of each category chapters by next submission.

3.4.2.4 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. 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 more dependent on vehicles activity.

To give a general overview of the emission trends, emissions of NOx, CO, NMVOC, SO_2, TSP and NH_3 are presented in as figures for the entire period 1990-2016 for the road transport and then for passanger cars (sector 1A3bi), light duty vehicles (1A3bii), heavy duty vehicles and buses (1A3biii) as well as motocycles and mopeds (1A3biv). For gasoline evaporations (1A3bv), NMVOC emissions are available. For automobile tyre and brake wear (1A3bvi) as well as automobile road abrasion (1A3bvii) emission trends for PM2.5, PM10 and TSP are available for the whole period 1990-2016.

Some trends are aparant, but detail report of Transport Research Center (CDV) will be available by the end of September 2018. Closer comment of the emission trends will therefore be given by the next submission.

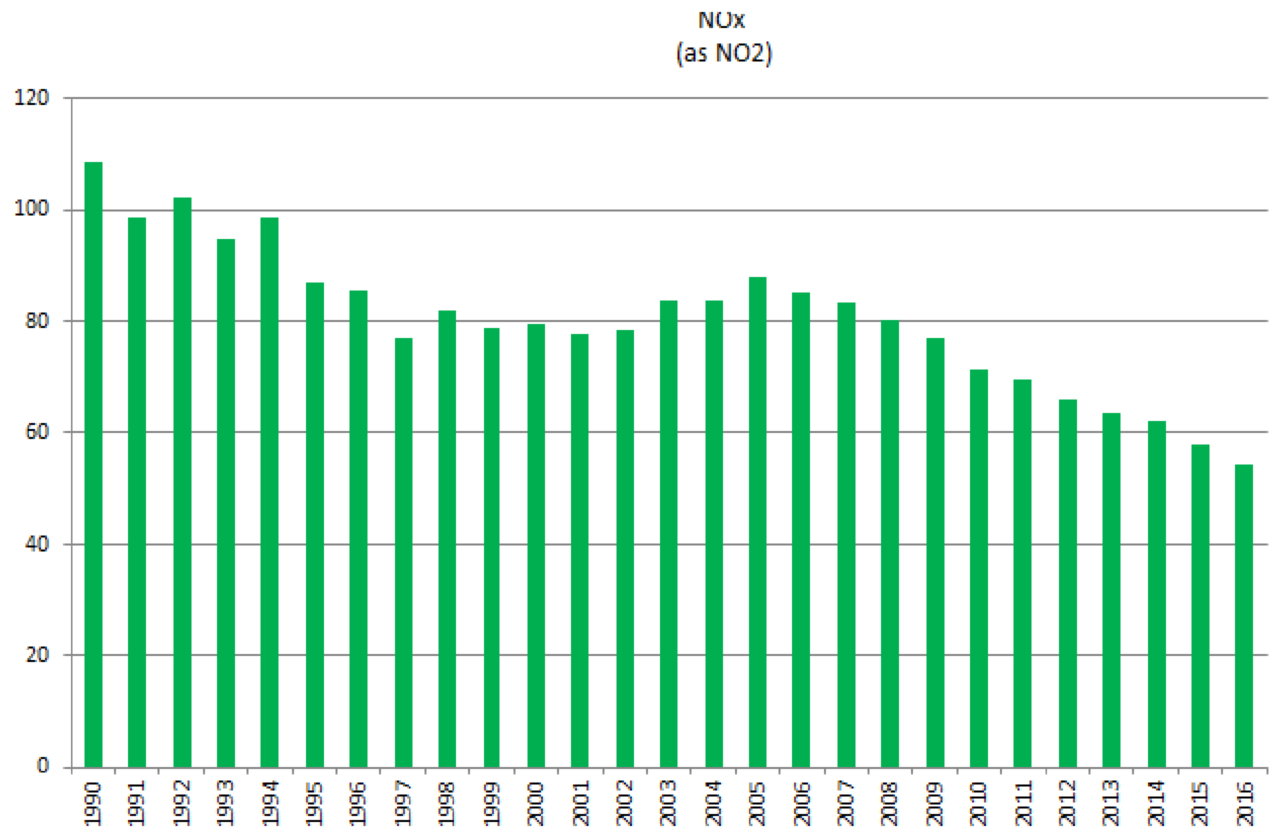


FIGURE 3-11 EMISSIONS (Gg) OF NO_X FROM ROAD TRANSPORT IN 1990-2016

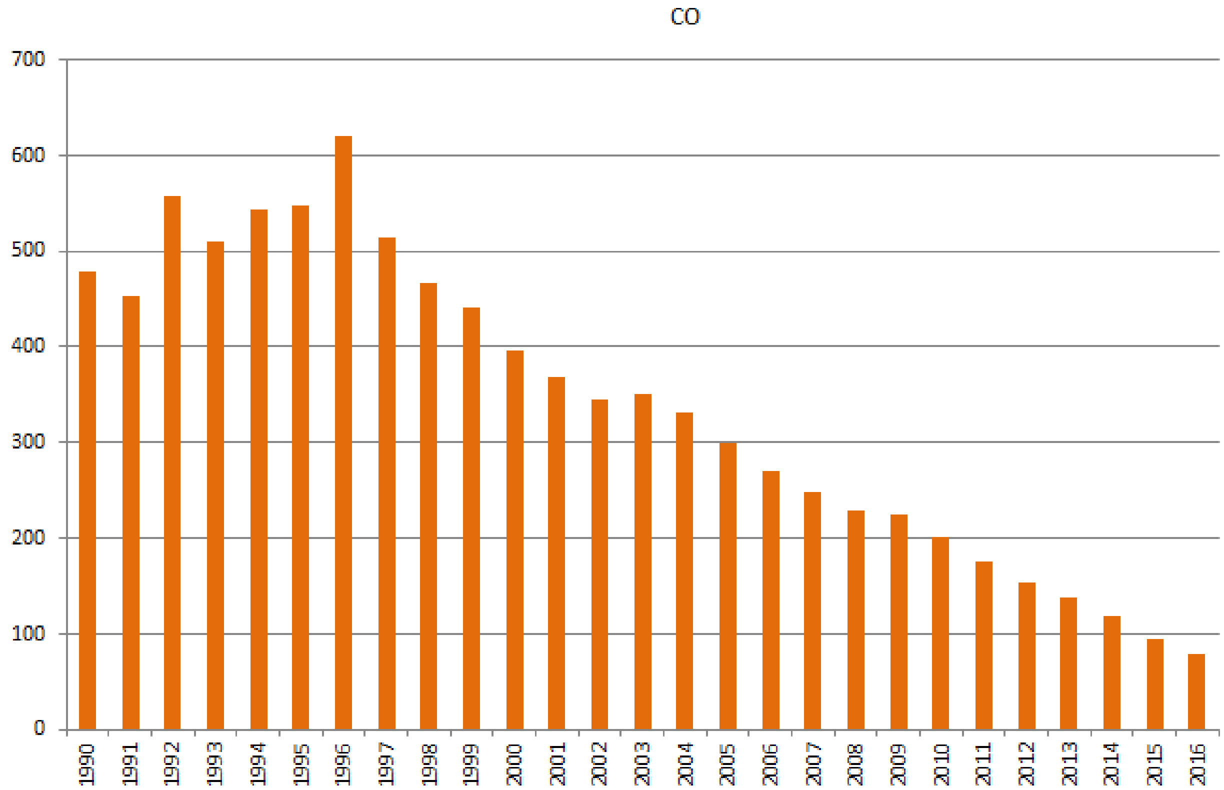


FIGURE 3-12 EMISSIONS (Gg) OF CO FROM ROAD TRANSPORT IN 1990-2016

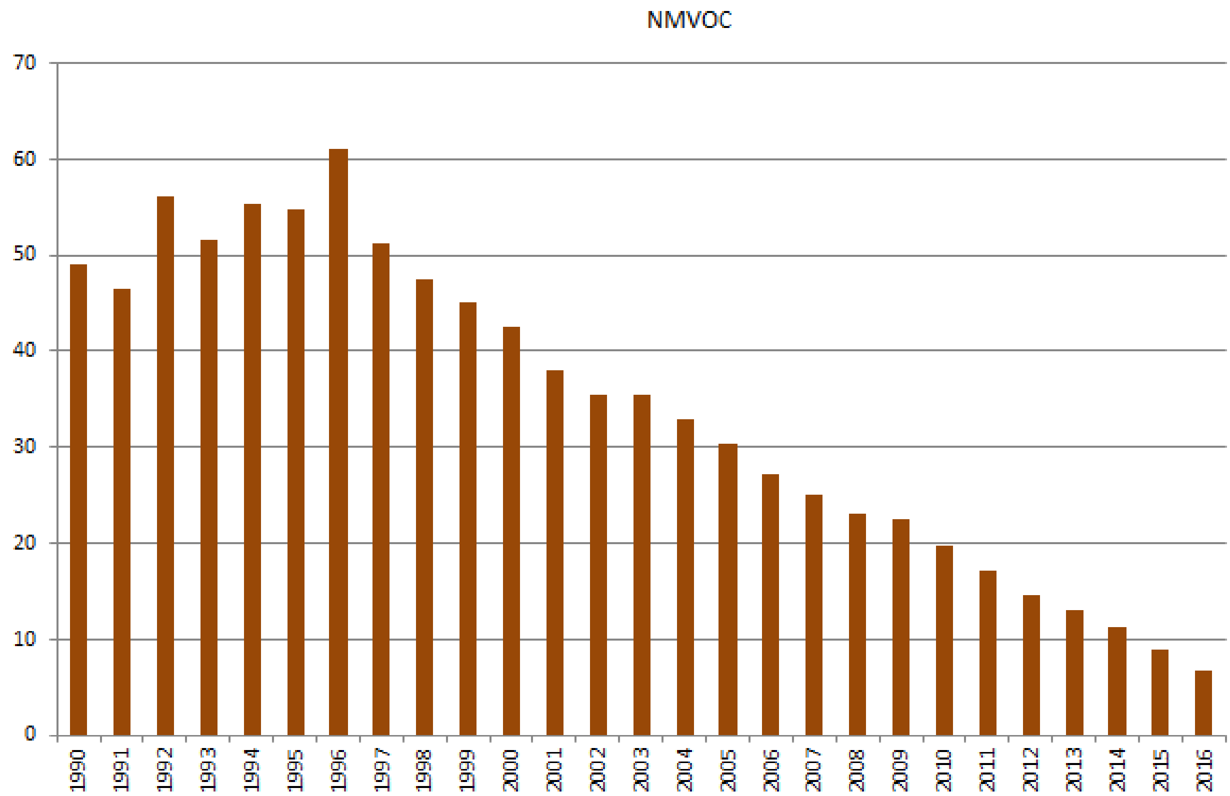


FIGURE 3-13 EMISSIONS (Gg) OF NMVOC FROM ROAD TRANSPORT IN IN 1990-2016

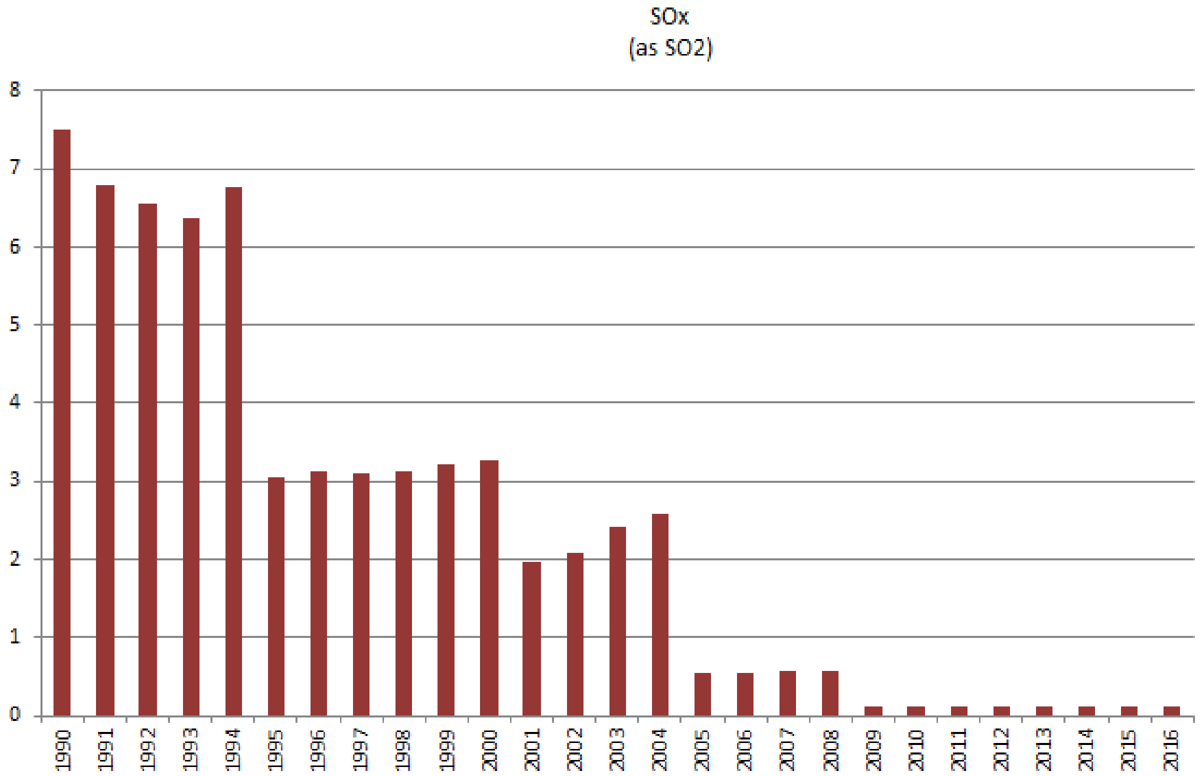


FIGURE 3-14 EMISSIONS (Gg) OF SO_2 FROM ROAD TRANSPORT IN IN 1990-2016

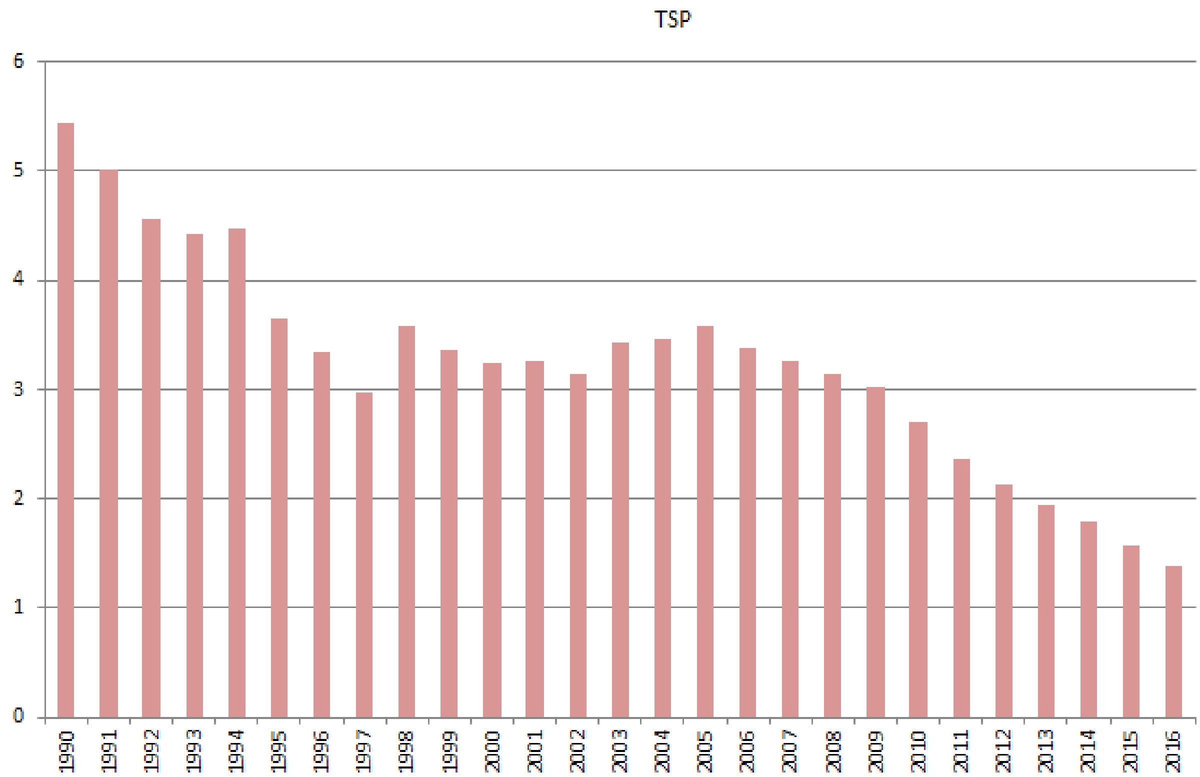


FIGURE 3-15 EMISSIONS (Gg) OF TSP FROM ROAD TRANSPORT IN IN 1990-2016

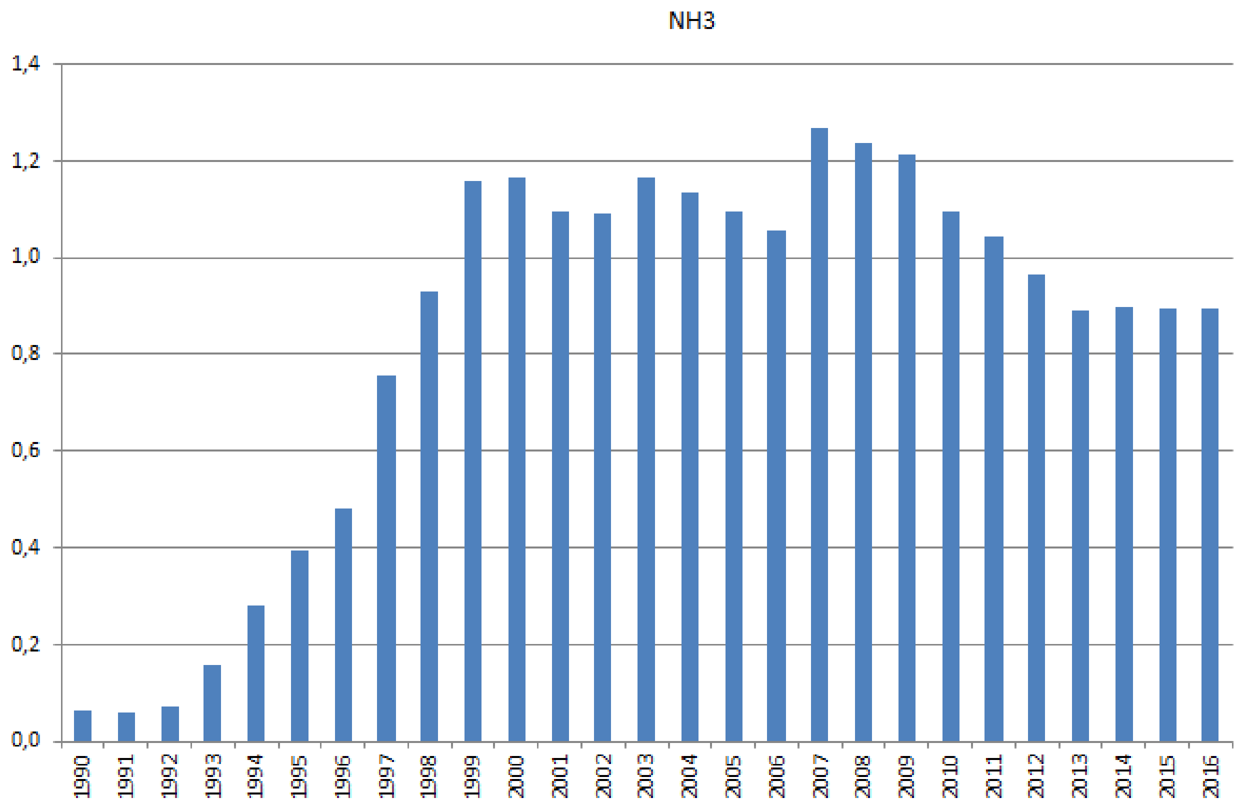


FIGURE 3-16 EMISSIONS (Gg) OF NH_3 FROM ROAD TRANSPORT IN IN 1990-2016

3.4.2.5 UNCERTAINTIES

Text will be updated by next submission in 2019.

3.4.2.6 PASSENGER CARS (1.A.3.B i)

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

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. The decrease of a fuel consumption stopped in 2013. With a renewal of economic growth 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 on a larger scale in the Czech Republic. Till then, there was not almost used bioethanol here, and biodiesel only in a very small share. In 2016 we can see an increase in consumption of biodiesel compared to 2015. In 2015 was implemented the increase of taxes for blends with high percentage of biodiesel, but costumers slowly accepted this change. The reason for ongoing bioethanol decrease was gasoline price which significantly decreased in 2015 and customers rather used cheaper gasoline 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 from 2012 till 2016.

TABLE 3-16 RATIO OF PCS – NON CATALYTIC SYSTEM AND CATALYTIC SYSTEM

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
uncontrolled	68%	63%	59%	53%	48%	44%	39%	34%	29%	24%	21%	18%	16%	15%	13%	12%	11%
medium controlled	32%	37%	41%	47%	52%	56%	61%	66%	71%	76%	79%	82%	84%	85%	87%	88%	89%

EMISSION FACTORS

The most important emission factors will be provided in Annex by next submission in 2019.

EMISSIONS

All emissions of pollutants displayed in figures below show specific development 1990 – 2016. SO2 emissions show a strong dependence on the increasing quality of fuels (lowered 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. In 2016 emissions from fuel combustion and TBRa reached 2570 t in total. Increase of NH3 emissions in last years is caused by further use of technology to reduce NOx emissions (SCR).

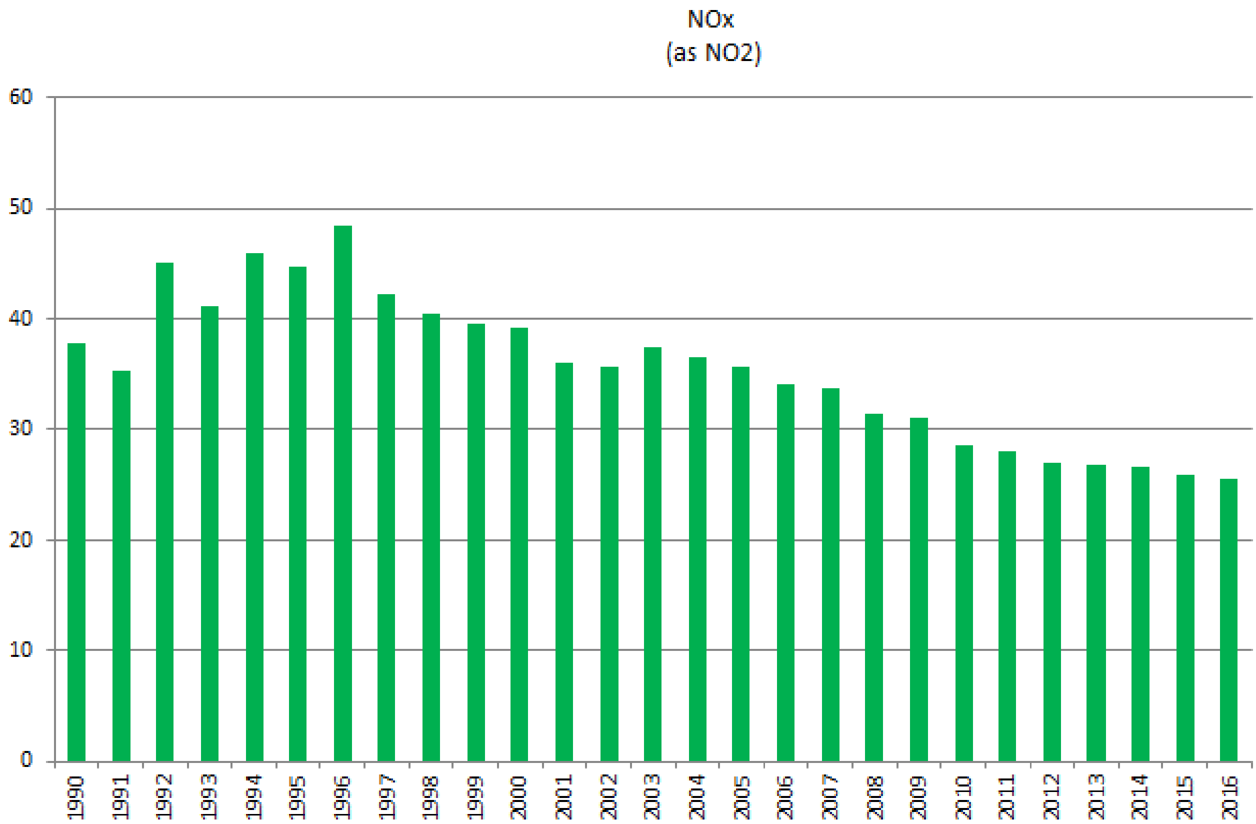


FIGURE 3-17 EMISSIONS (Gg) OF NO_X BY PCS IN 1990-2016

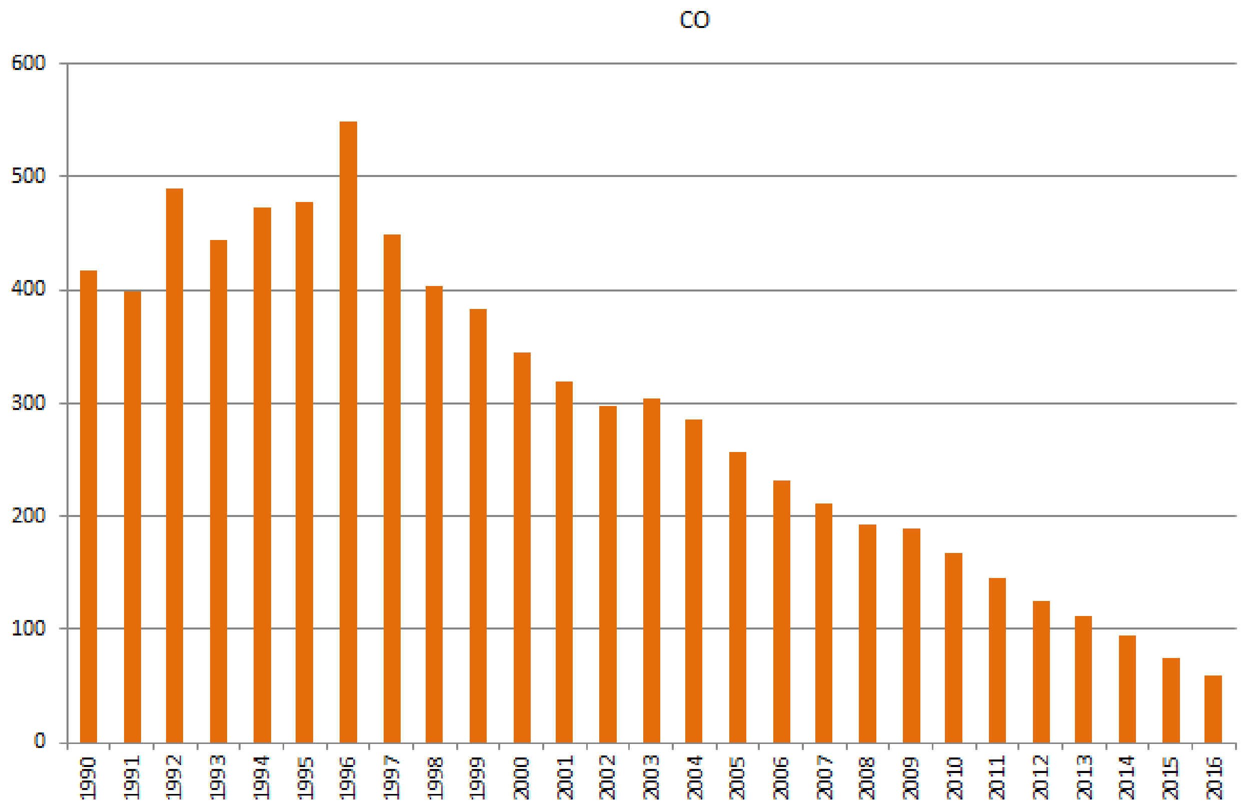


FIGURE 3-18 EMISSIONS (Gg) OF CO BY PCS IN 1990-2016

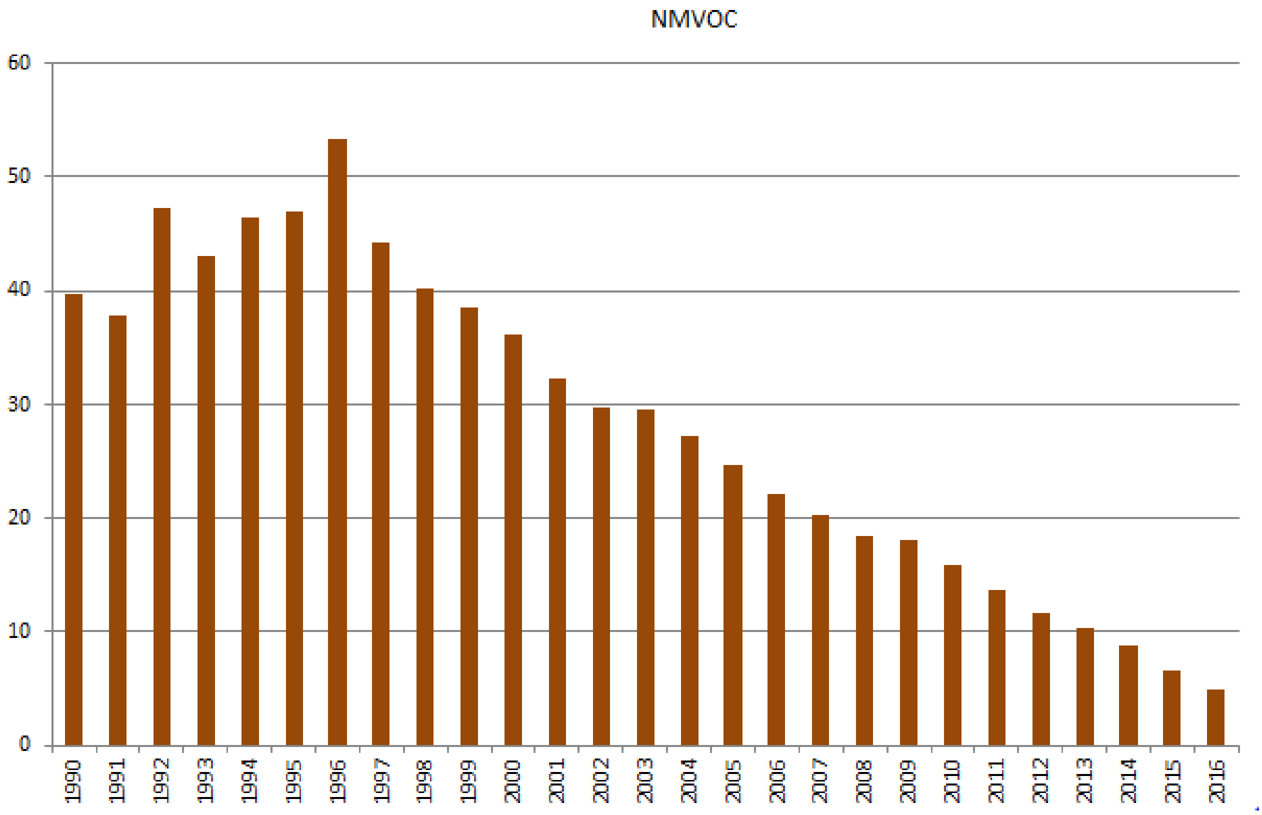


FIGURE 3-19 EMISSIONS (Gg) OF NMVOC BY PCS IN 1990-2016

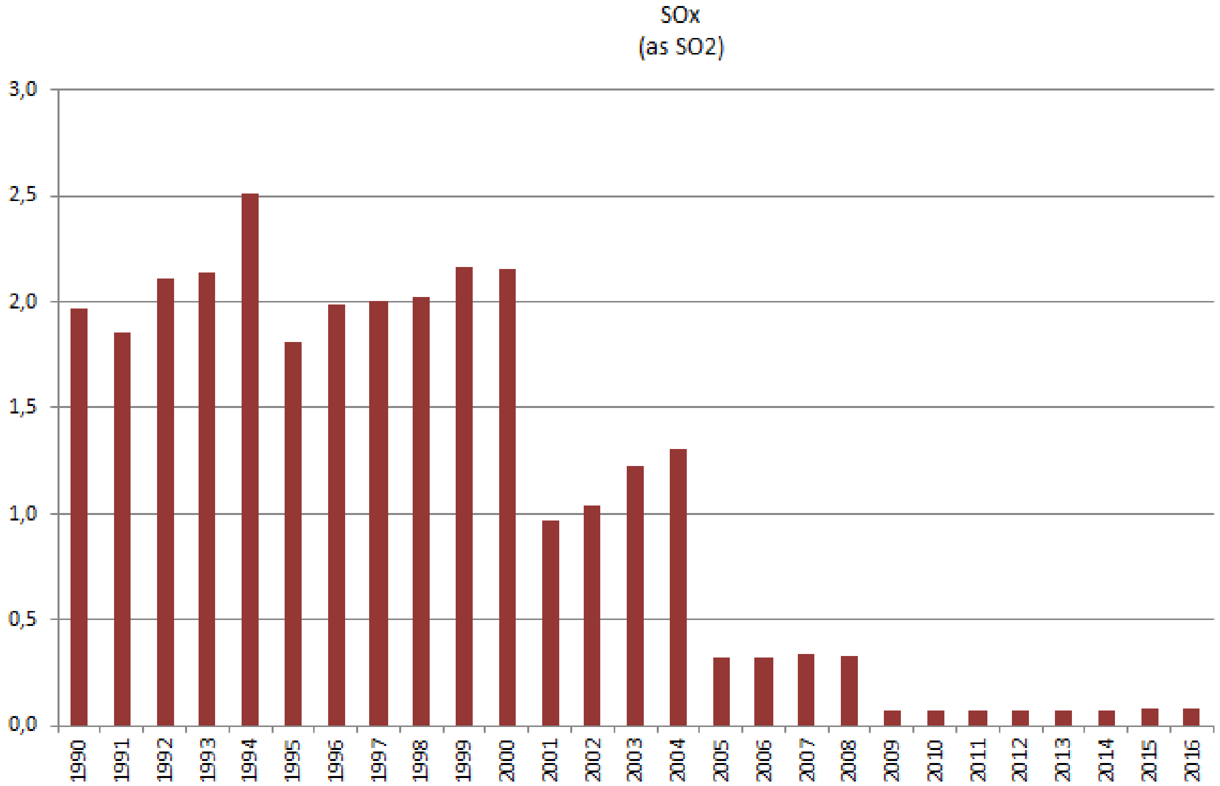


FIGURE 3-20 EMISSIONS (Gg) OF SO_2 BY PCS IN 1990-2016

FIGURE 3-21 Emissions (GG) of TSP by PCs in 1990-2016

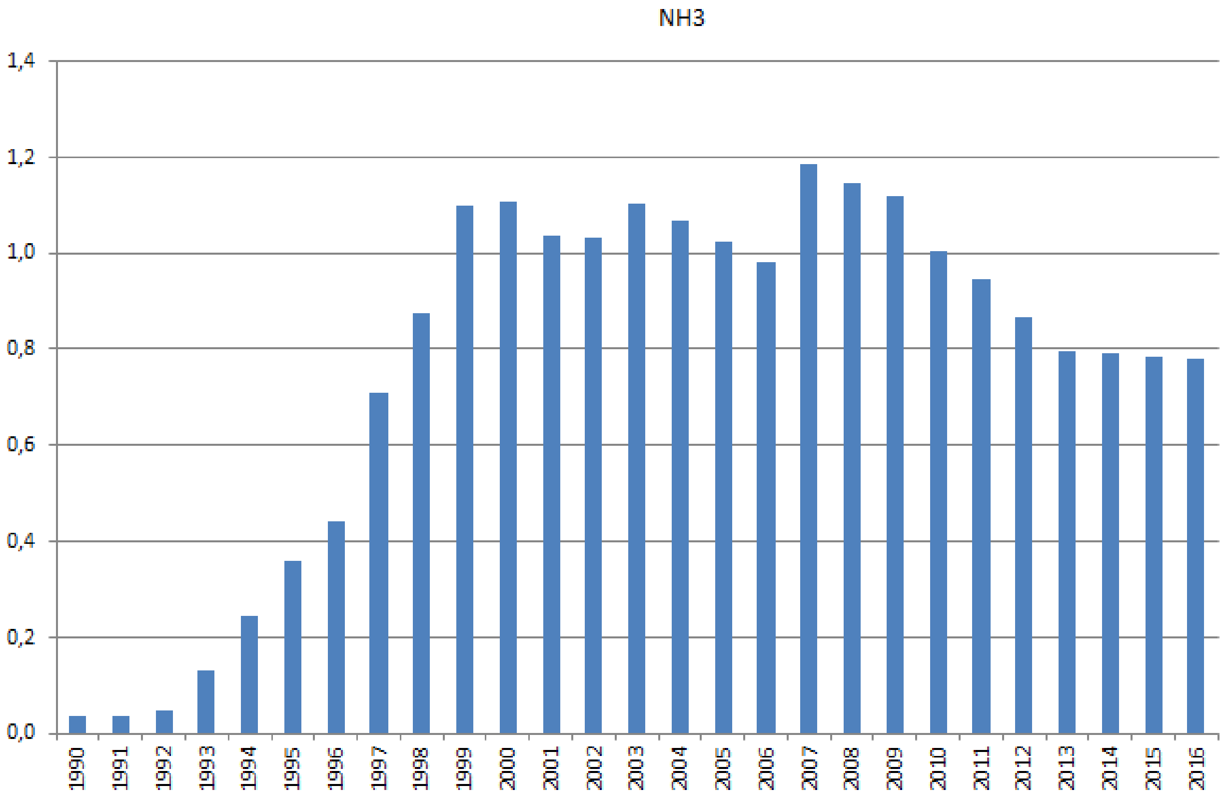


FIGURE 3-22 EMISSIONS (Gg) OF NH_3 BY PCS IN 1990-2016

3.4.2.7 LIGHT DUTY VEHICLES (1.A.3.B ii)

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

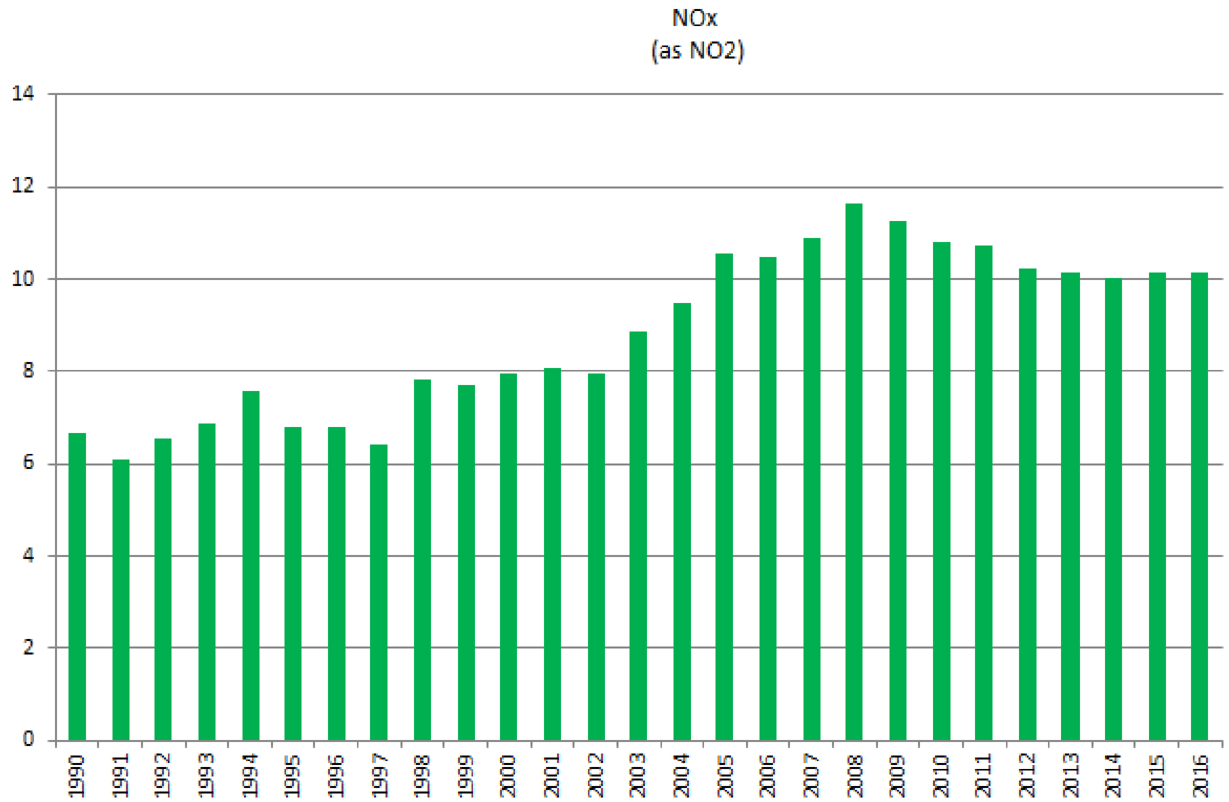


FIGURE 3-23 EMISSIONS (Gg) OF NO_X BY LDVS IN 1990-2016

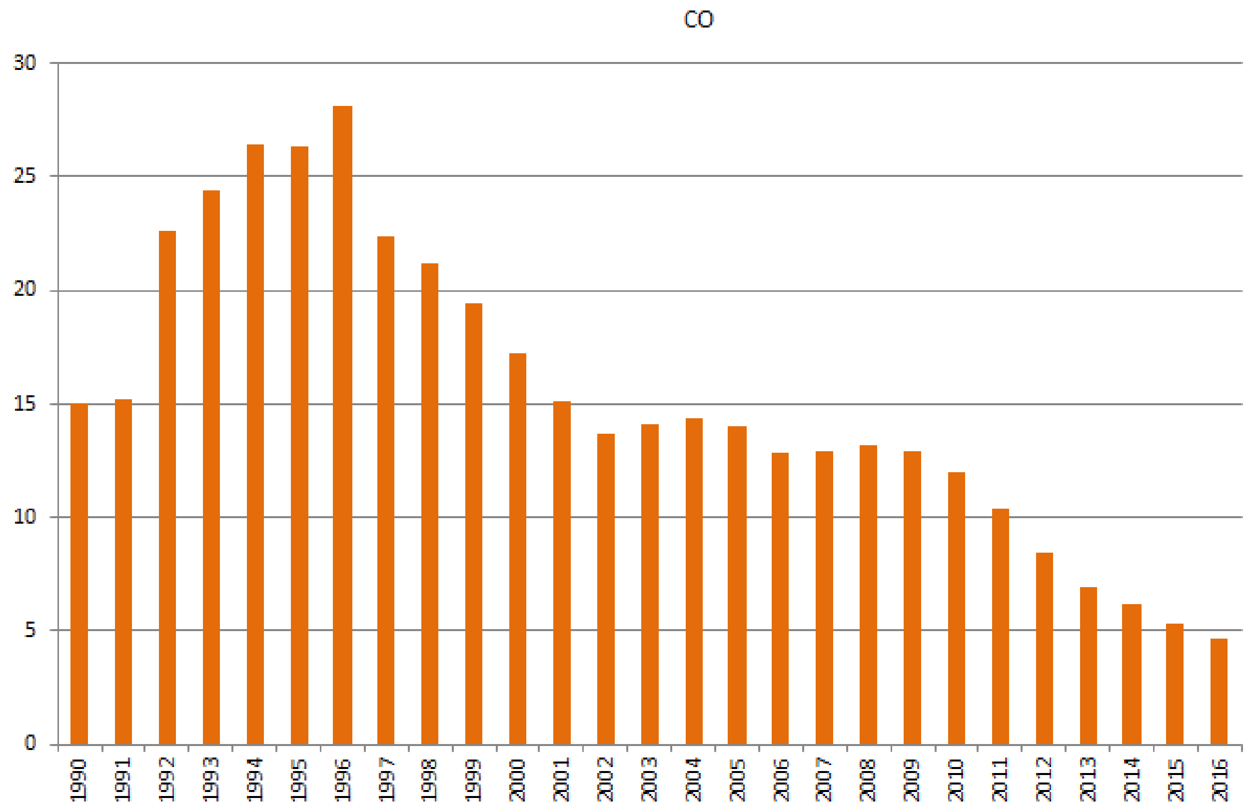


FIGURE 3-24 EMISSIONS (Gg) OF CO BY LDVS IN 1990-2016

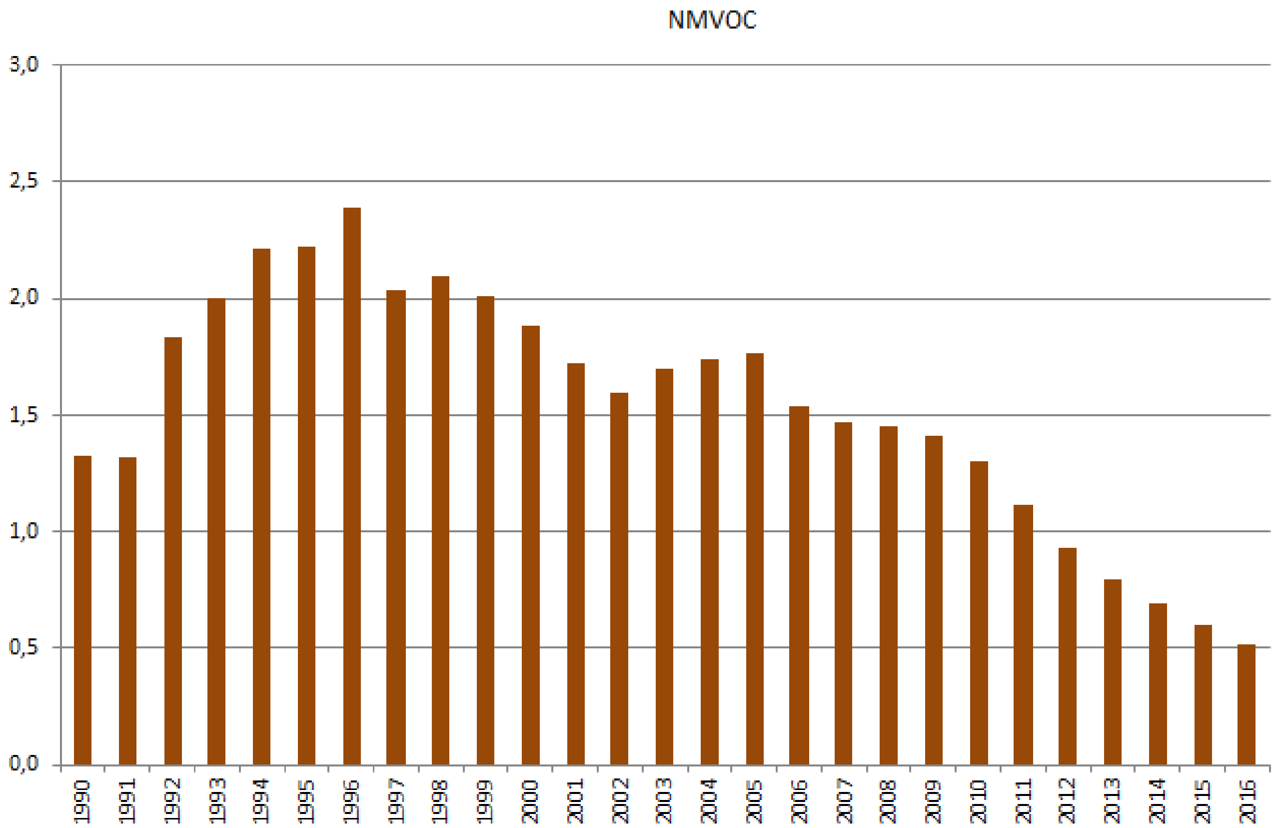


FIGURE 3-25 EMISSIONS (Gg) OF NMVOC BY LDVS IN 1990-2016

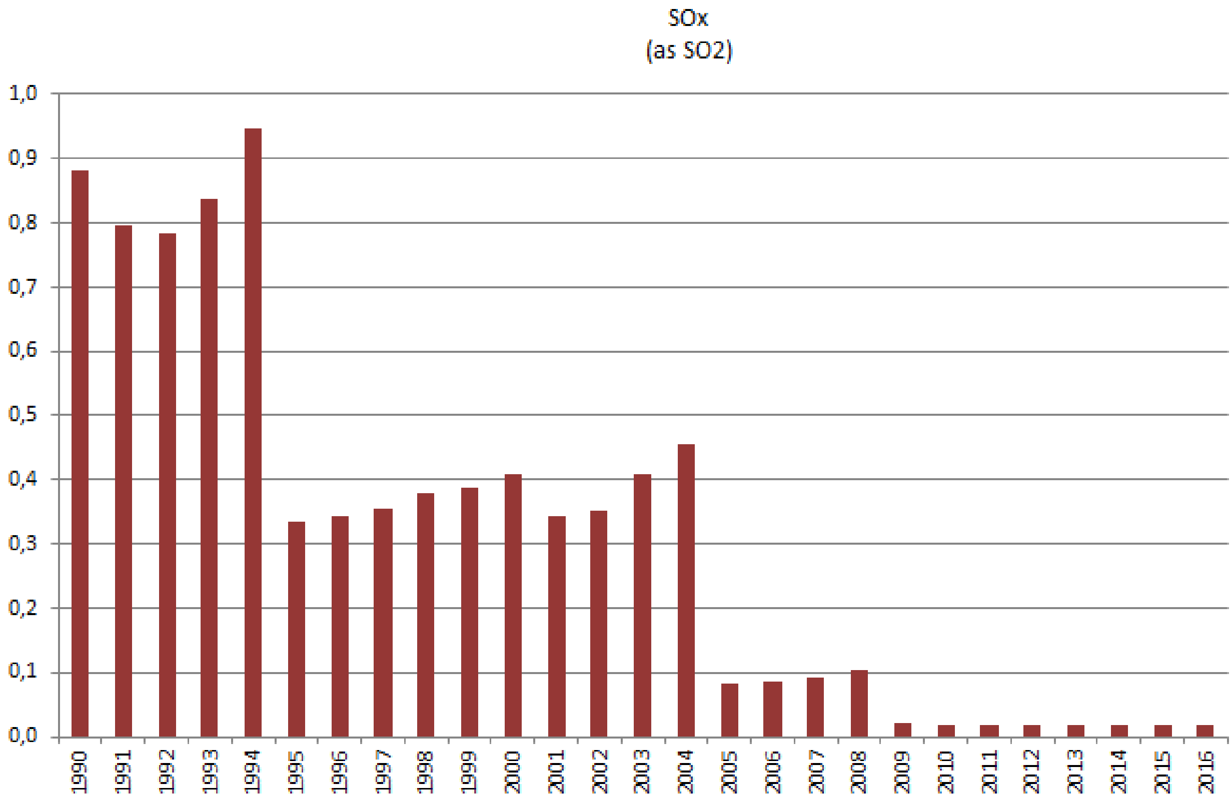


FIGURE 3-26 EMISSIONS (Gg) OF SO_2 BY LDVS IN 1990-2016

FIGURE 3-27 EMISSIONS (Gg) OF TSP BY LDVS IN 1990-2016

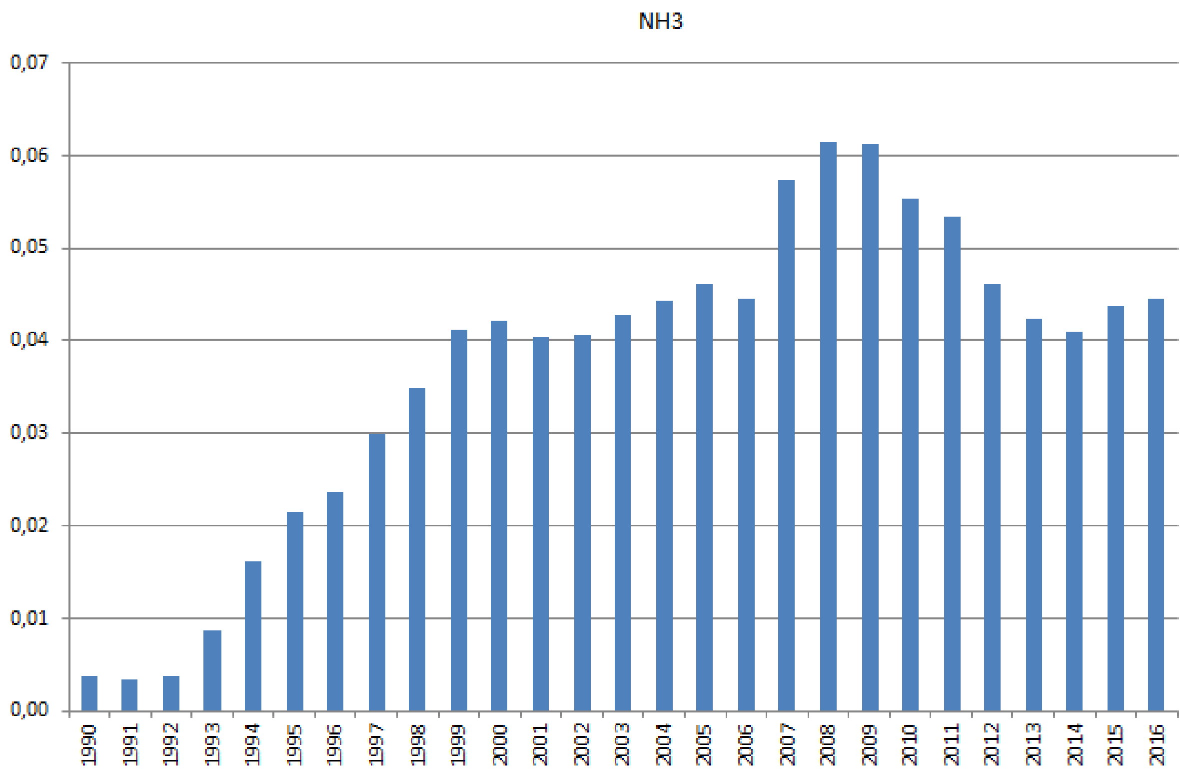


FIGURE 3-28 EMISSIONS (Gg) OF NH_3 BY LDVS IN 1990-2016

3.4.2.8 HEAVY DUTY VEHICLES (1.A.3.B iii)

- 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).

ACTIVITY DATA

Fuel consumptions of HDVs and buses show the same trends as those of PCs and all of them result from the same cause. Fuel consumptions of CNG buses show small peak in 2002 and 2003. The reason of decrease of CNG consumption in 2004 was the introduction of a CNG consumption tax. The steep increase of the CNG consumption from 2012 is caused by subsidies from public resources in order to encourage the use of CNG buses especially in public transport. In 2016, the increase in consumption for all types of fuels continued due to growing Czech economy and transport performance.

TABLE 3-17 FUEL CONSUMPTION BY HDVS AND BUSES /2000-2016/

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
2016	1609.27	1.1	116.2	582.7	11.3	42.1

FIGURE 3-29 OVERALL FUEL CONSUMPTION BY HDVS AND BUSES LDVS IN 2000-2016

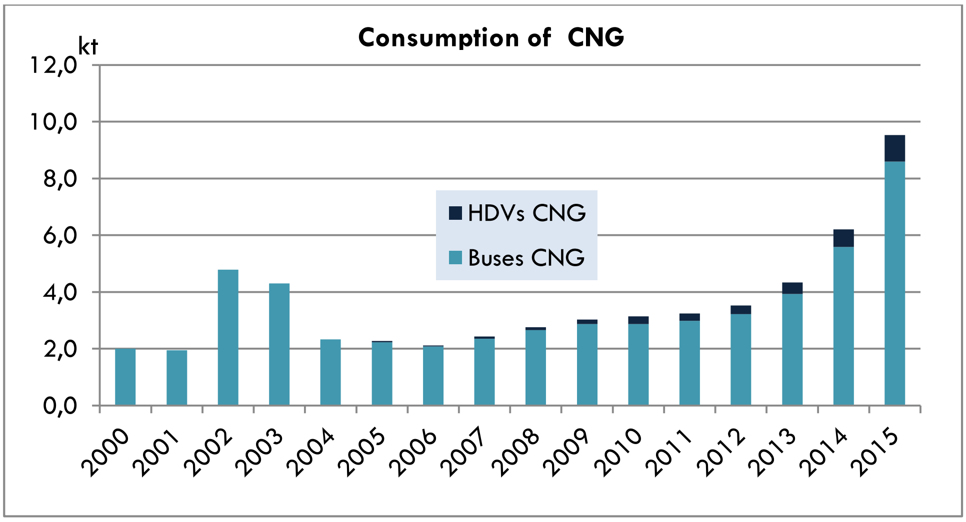


FIGURE 3-30 CNG CONSUMPTION BY HDVS AND BUSES LDVS IN 2000–2015

EMISSION FACTORS

The most important emission factors will be provided in Annex by next submission in 2019.

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.

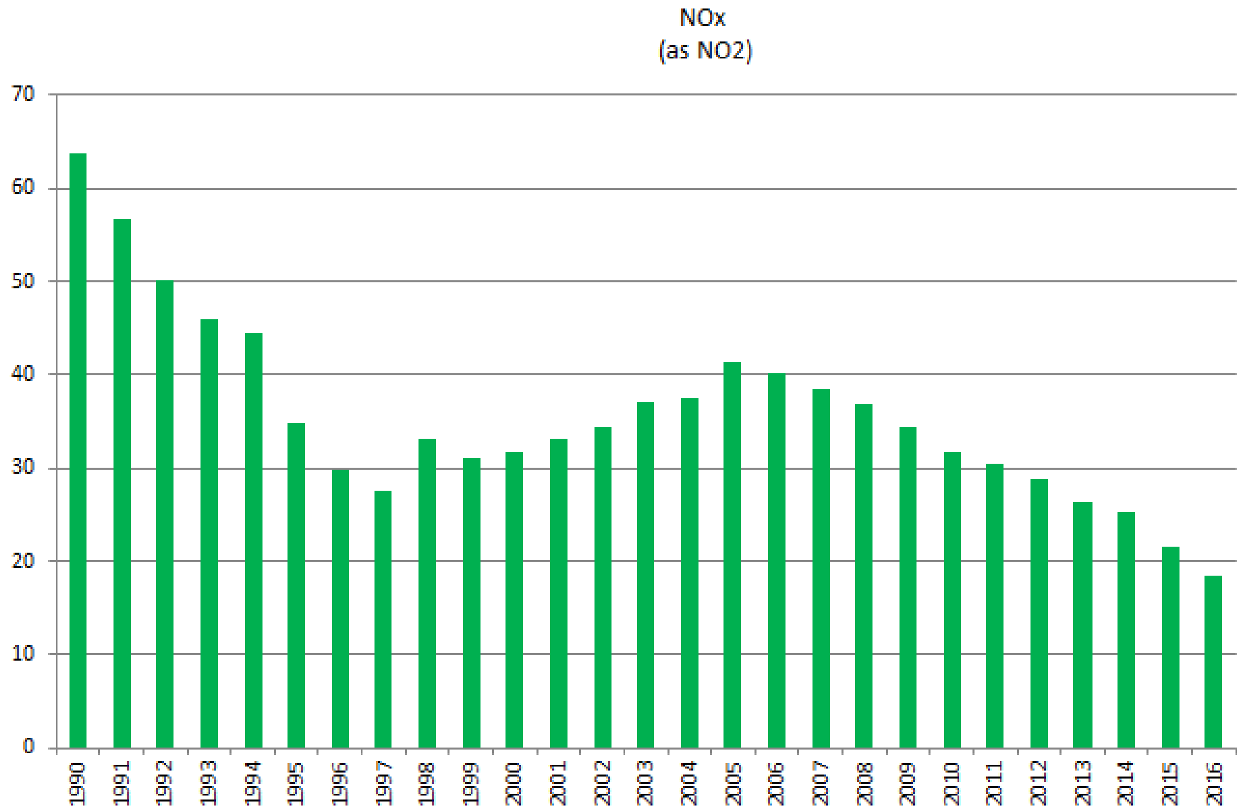


FIGURE 3-31 EMISSIONS (Gg) OF NO_x FROM HDVS AND BUSES IN 1990-2016

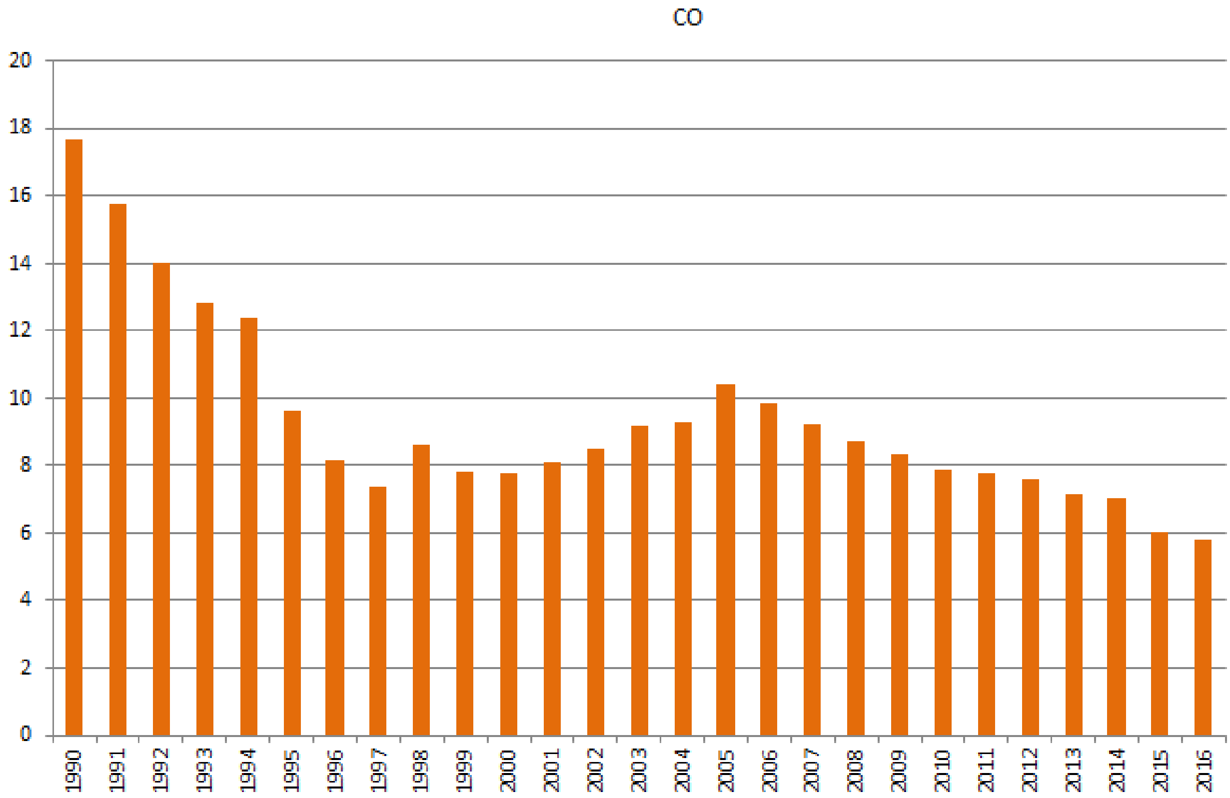


FIGURE 3-32 EMISSIONS (Gg) OF CO FROM HDVS AND BUSES IN 1990-2016

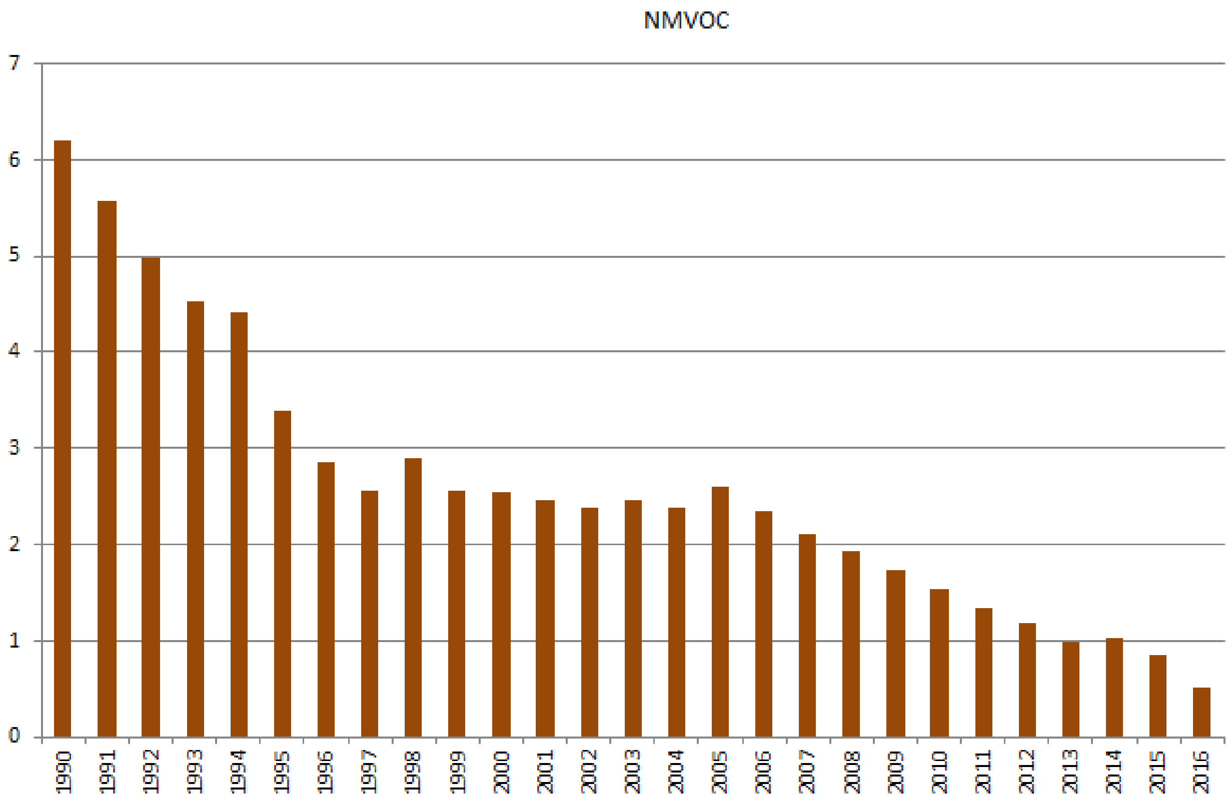


FIGURE 3-33 EMISSIONS (Gg) OF NMVOC FROM HDVS AND BUSES IN 1990-2016

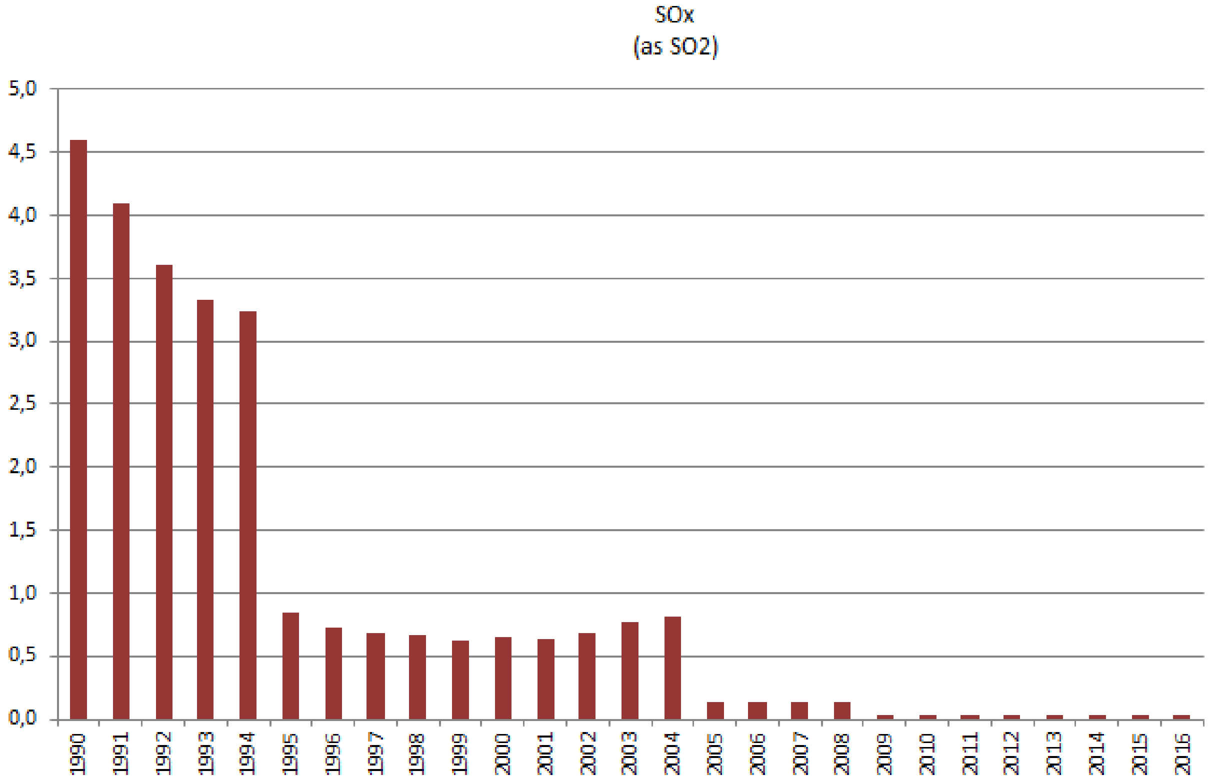


FIGURE 3-34 EMISSIONS (Gg) OF SO2 FROM HDVS AND BUSES IN 1990-2016

FIGURE 3-35 EMISSIONS (Gg) OF TSP FROM HDVS AND BUSES IN 1990-2016

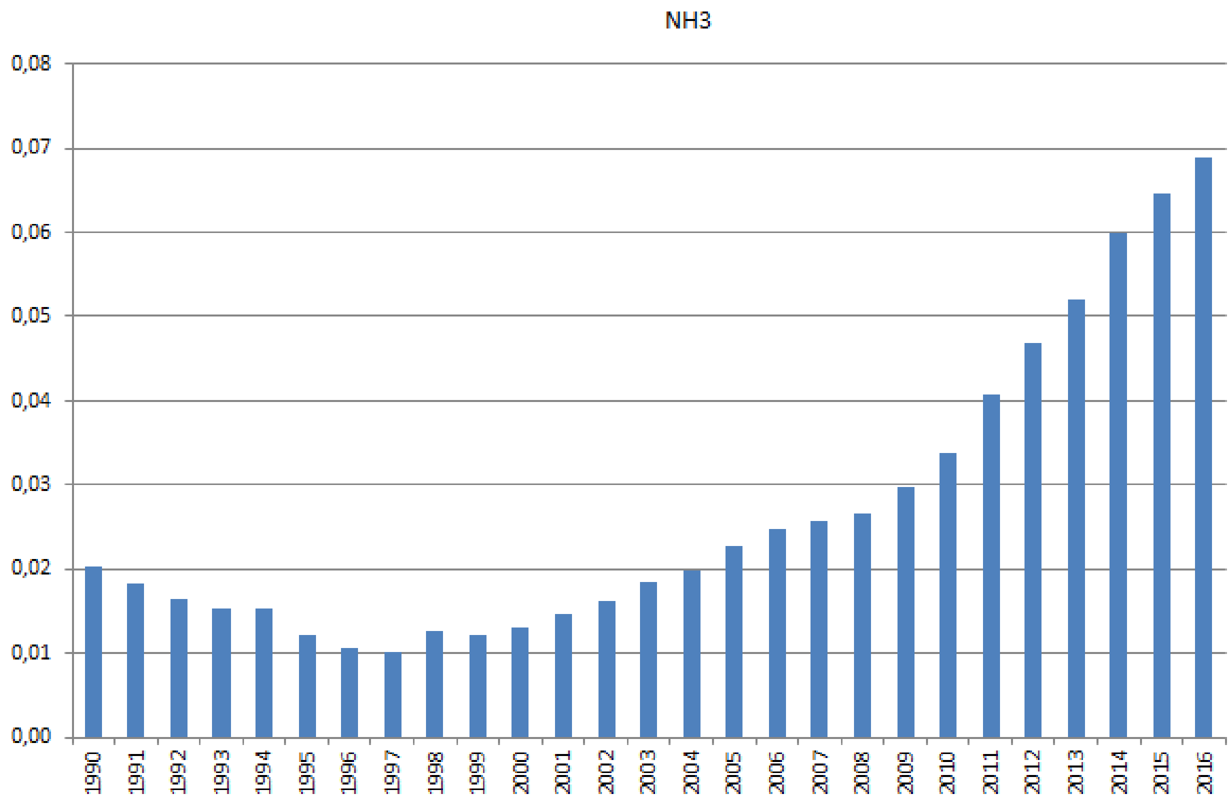


FIGURE 3-36 EMISSIONS (Gg) OF NH_3 FROM HDVS AND BUSES IN 1990-2016

3.4.2.9 MOPEDS AND MOTORCYCLES (1.A.3.B iv)

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 3-18 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
2016	13.0	0.6

EMISSION FACTORS

The most important emission factors will be provided in Annex by next submission in 2019.

EMISSIONS

Emissions from two – wheelers follow fuel consumption trend. Contribution to CO emissions seems to be quite significant considering lower total fuel consumption by motorcycles and mopeds.

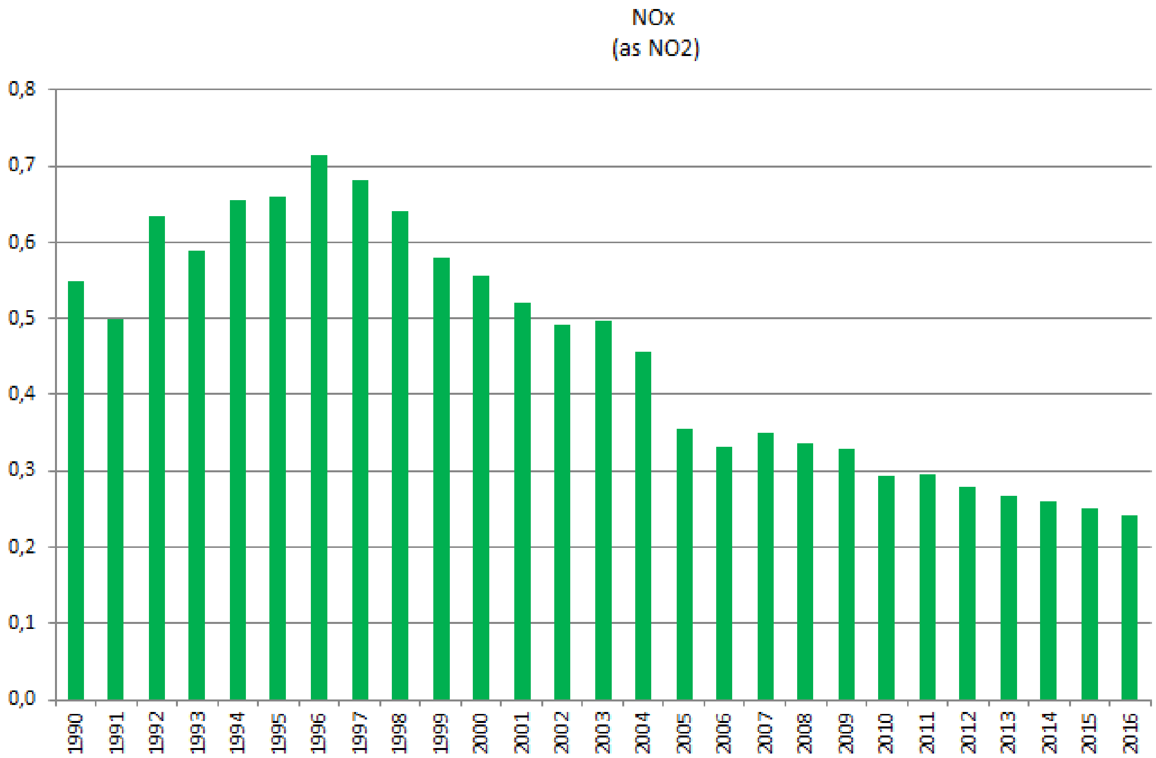


FIGURE 3-37 EMISSIONS (Gg) OF NO_X FROM TWO - WHEELERS IN 1990-2016

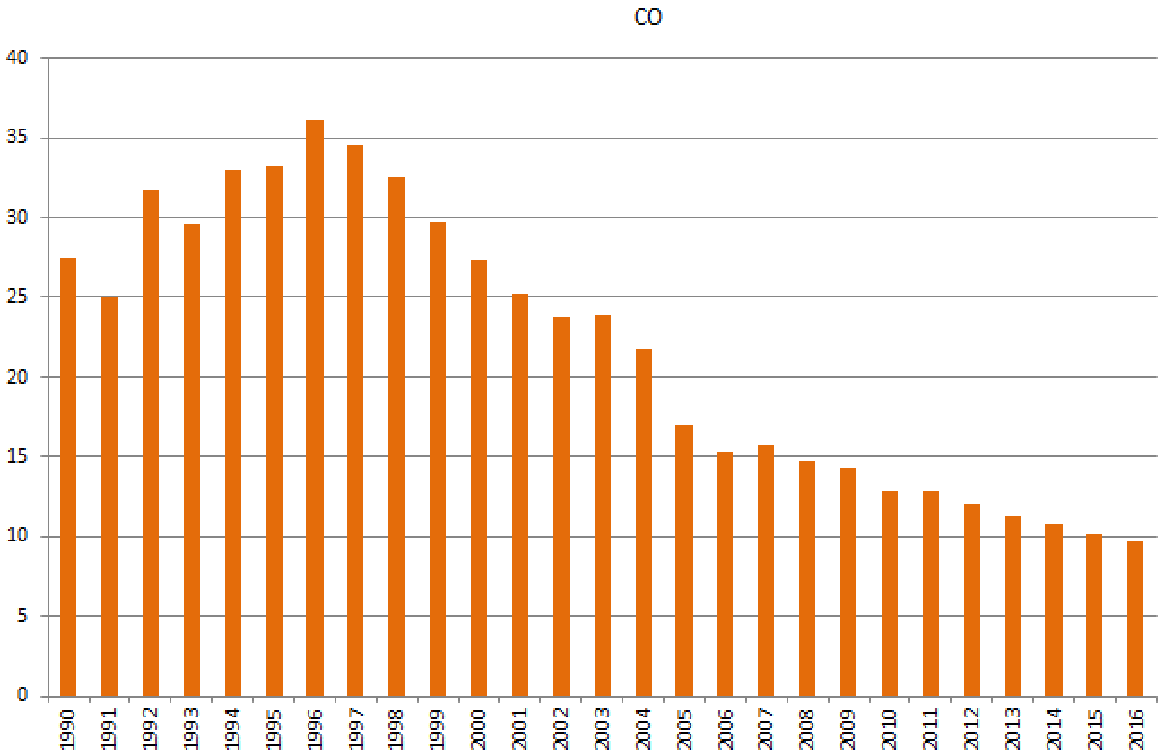


FIGURE 3-38 EMISSIONS (Gg) OF CO FROM TWO - WHEELERS IN 1990-2016

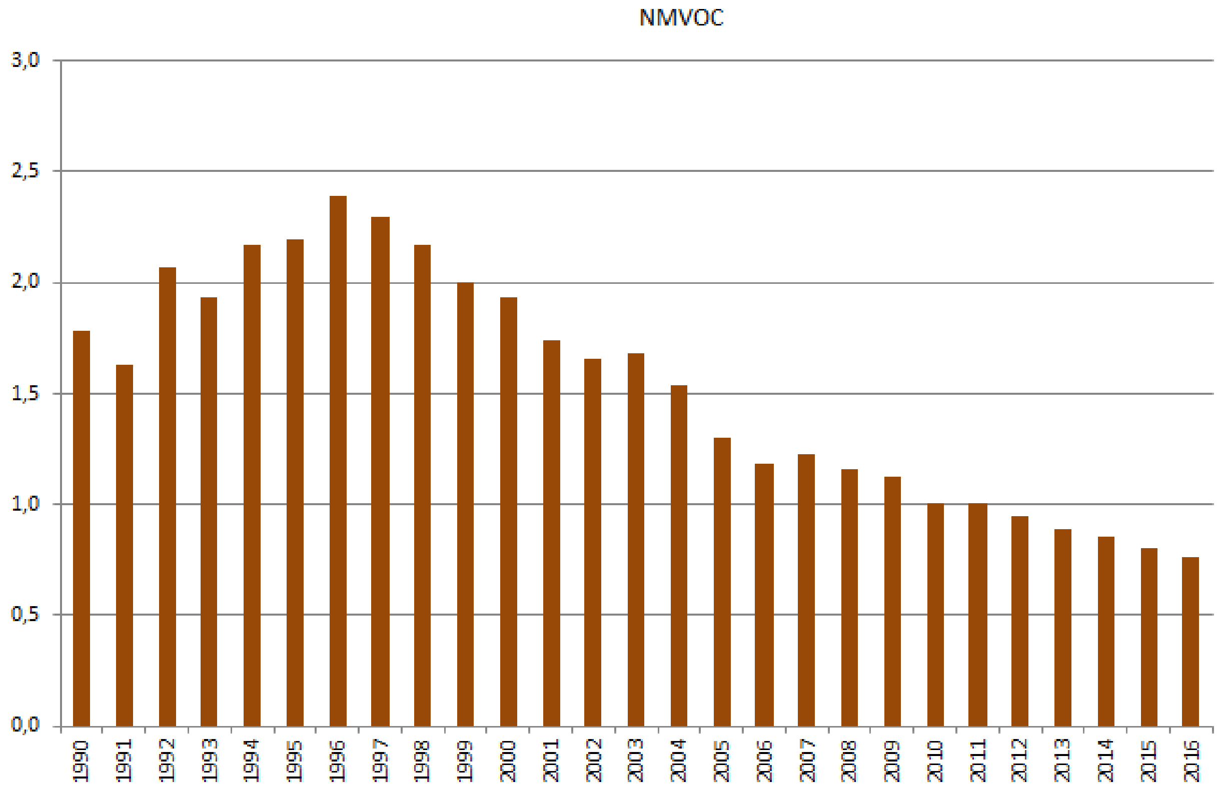


FIGURE 3-39 EMISSIONS (Gg) OF NMVOC FROM TWO - WHEELERS IN 1990-2016

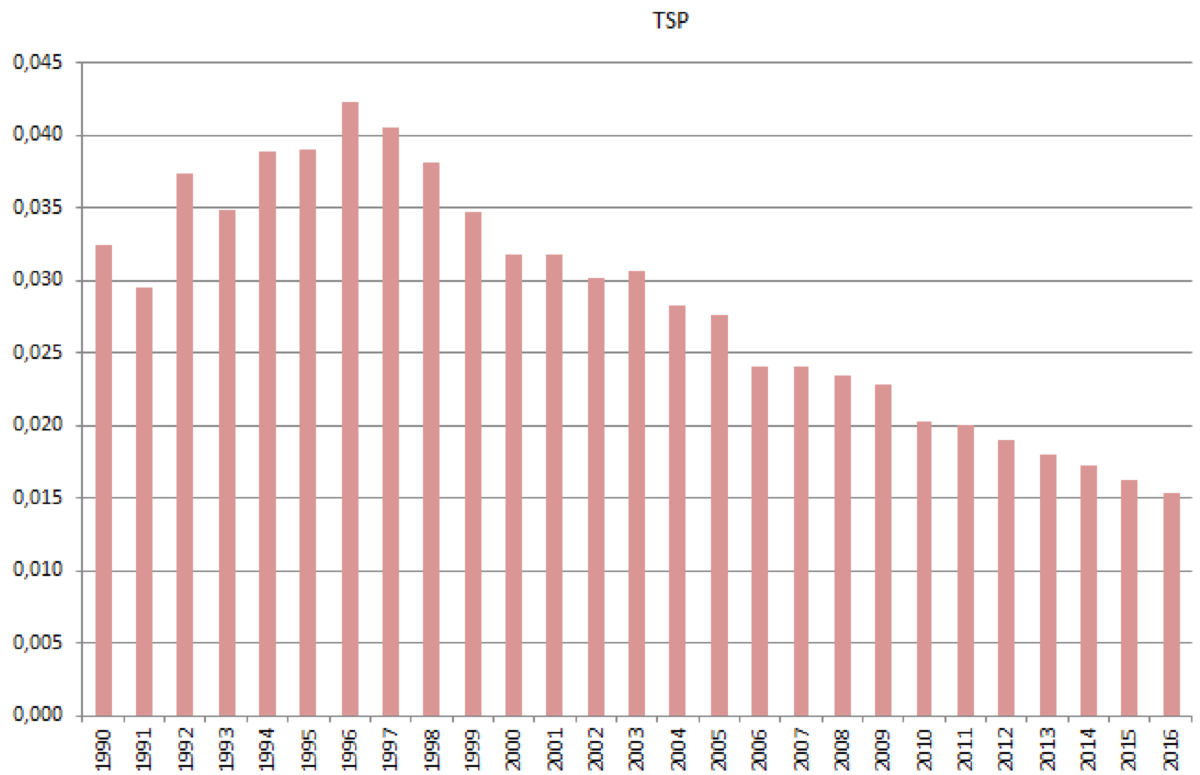


FIGURE 3-40 EMISSIONS (Gg) OF TSP FROM TWO-WHEELERS IN 1990-2016

3.4.2.10 GASOLINE EVAPORATION (1.A.3.b v)

NMVOC 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.

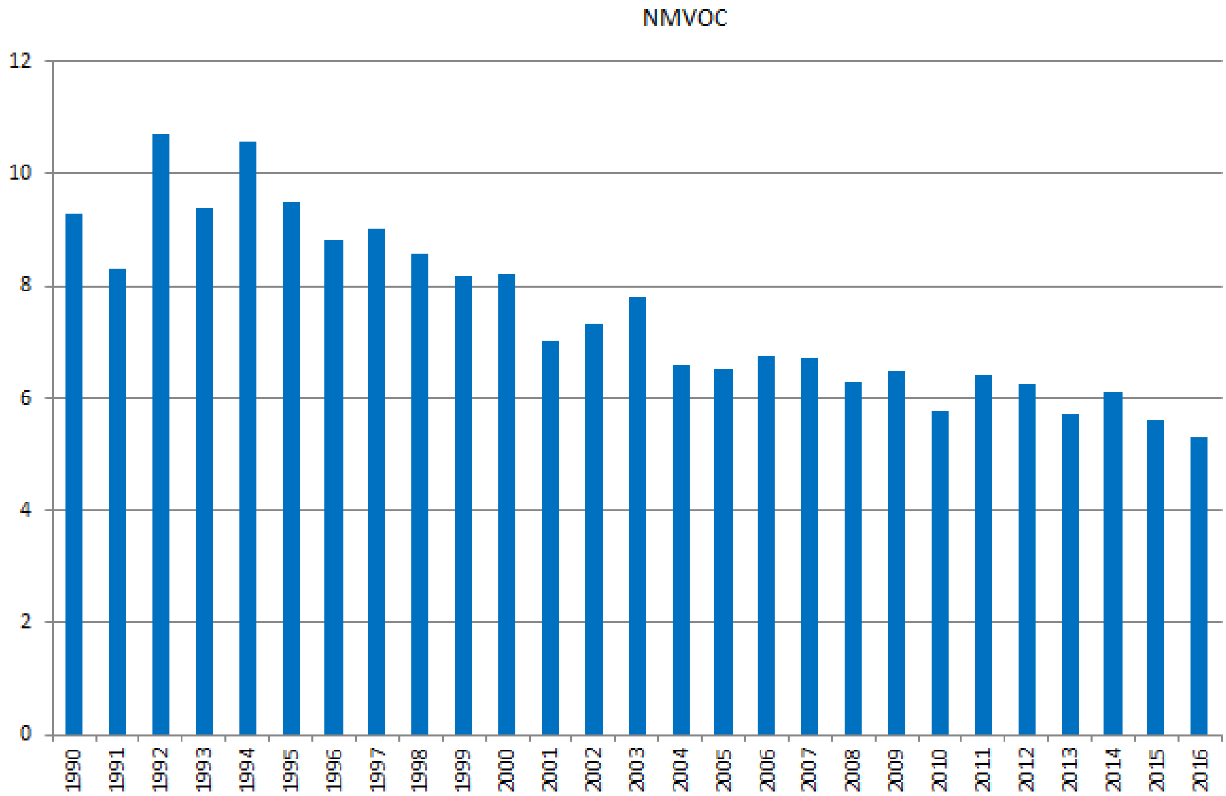


FIGURE 3-41 NMVOC EMISSIONS (Gg) FROM GASOLINE EVAPORATION

3.4.2.11 AUTOMOBILE TYRE AND BRAKE WEAR (1.A.3.B vi) AND AUTOMOBILE ROAD ABRASION (1.A.3.B vii)

METHOD

Determination of emissions from brake and tyre wear and road abrasion was calculated using model COPERT. A detailed description of the determination of the activity data will be made in submission in 2019.

EMISSION FACTORS

The most important emission factors will be provided in Annex by next submission in 2019.

EMISSIONS

All reported emissions from tyre, brake wear and road abrasion are connected directly to activity data. Emission levels in 2016 reached the highest value from 2000, because of constantly rising transport performance after economic crisis which ended end in 2013.

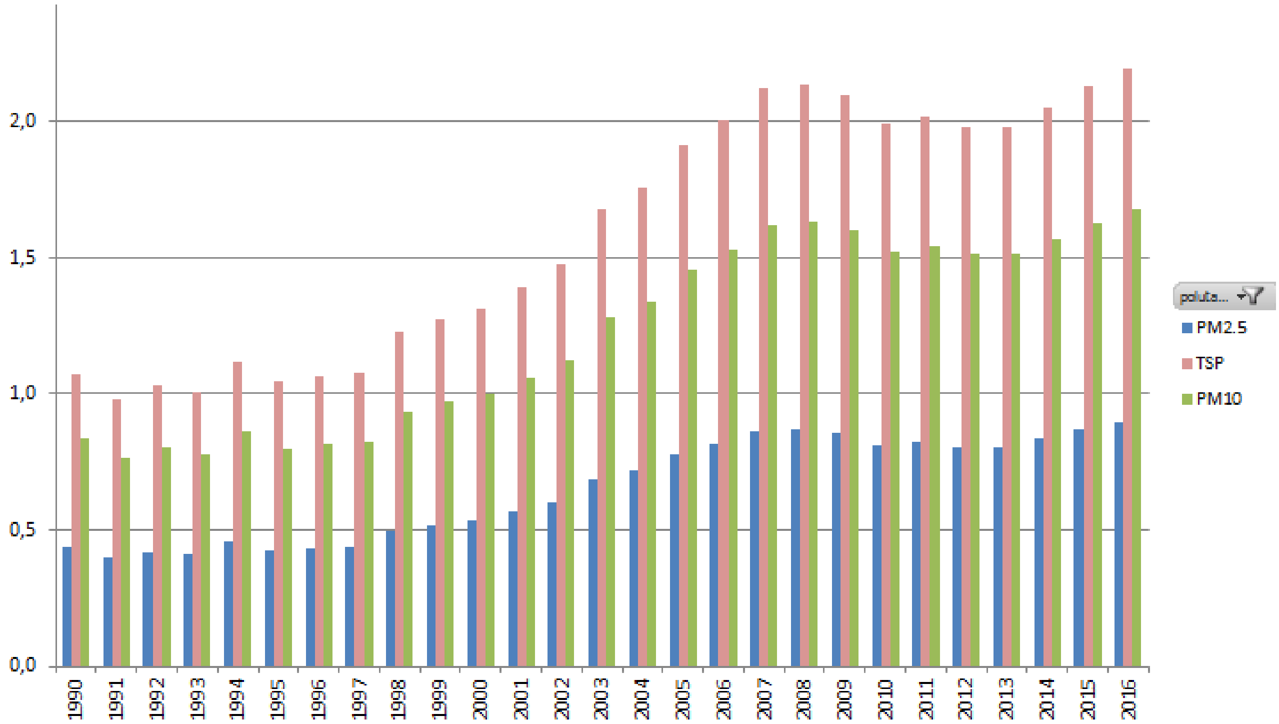


FIGURE 3-42 EMISSIONS (Gg) OF TSP, PM2.5 AND PM10 FROM AUTOMOBILE TYRE AND BRAKE WEAR IN 1990-2016

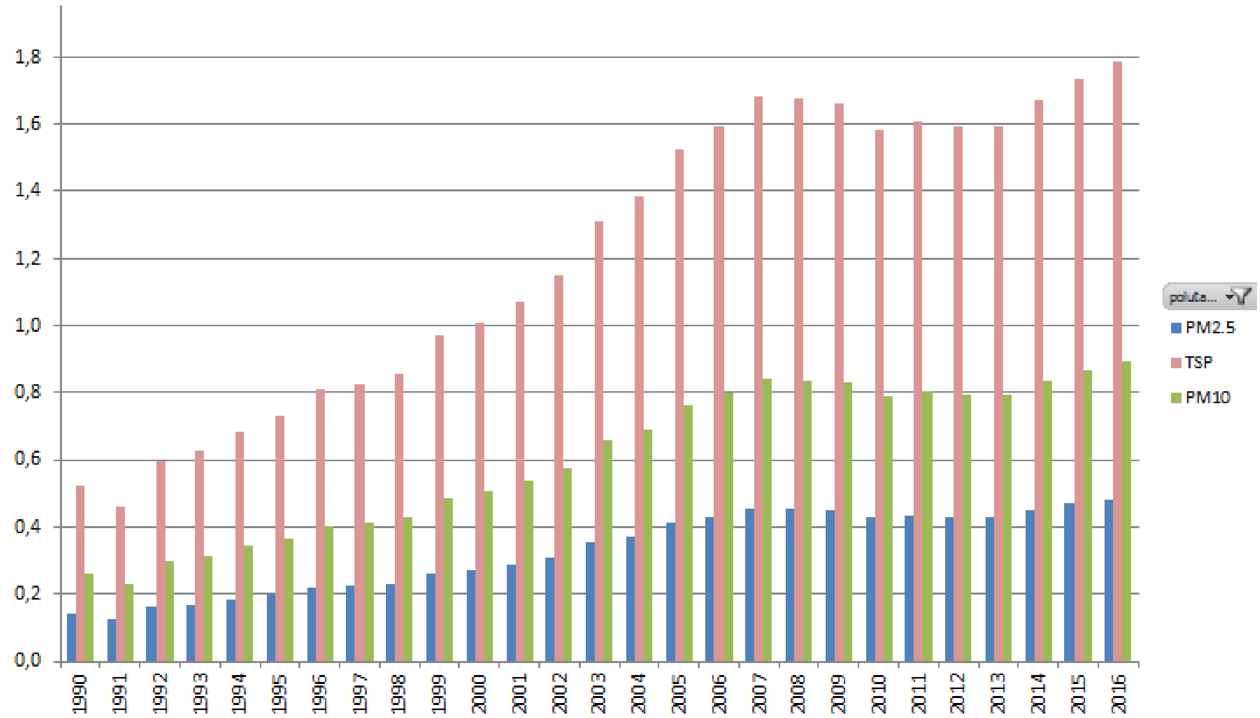


FIGURE 3-43 EMISSIONS (Gg) OF TSP, PM2.5 AND PM10 BY AUTOMOBILE ROAD ABRASION IN 1990-2016

3.4.3 RAILWAYS (1.A.3.C)

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.

3.4.3.1 METHOD

In present energy consumption share of locomotives powered by electricity on Czech railways 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 terms of energy inputs used by trains, diesel fuel is the only energy source that plays a significant role apart from electric power.

3.4.3.2 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 3-19 FUEL CONSUMPTION BY RAILWAYS

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Diesel Oil consumption kt	244	199	186	151	146	158	130	121	113	104
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Diesel Oil consumption kt	104	97	94	92	91	92	96	95	105	95
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**			
Diesel Oil consumption kt	92	90	87	85	86	83	85			

3.4.3.3 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 3-20 EF METHOD USED FOR RAILWAYS

	NOx (as NO_2)	**NMVOC**	**SOx (as SO_2)**	**NH_3**	**$PM_{2.5}$**	**PM_{10}**	**TSP**	**BC**	**CO**
Railways	**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 3-21 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 3-22 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

3.4.3.4 EMISSIONS

Emissions from railways are strongly dependent on fuel consumption. The only exception are SO_2 emissions influenced by increasing quality of fuel. Thanks 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. Regarding emissions of NOx and CO, presented in figures below, emission trend from 2012 till 2016 is fluctuating with no significant decrease or increase. 2016 emissions are higher (NOx – 2915 kt, CO – 1697 kt) compared to 2015. From 2000 the highest emissions occurred in 2008 because high transport performance caused by growth of national economy. With economic crisis came decrease of transport performance between 2009 – 2012.

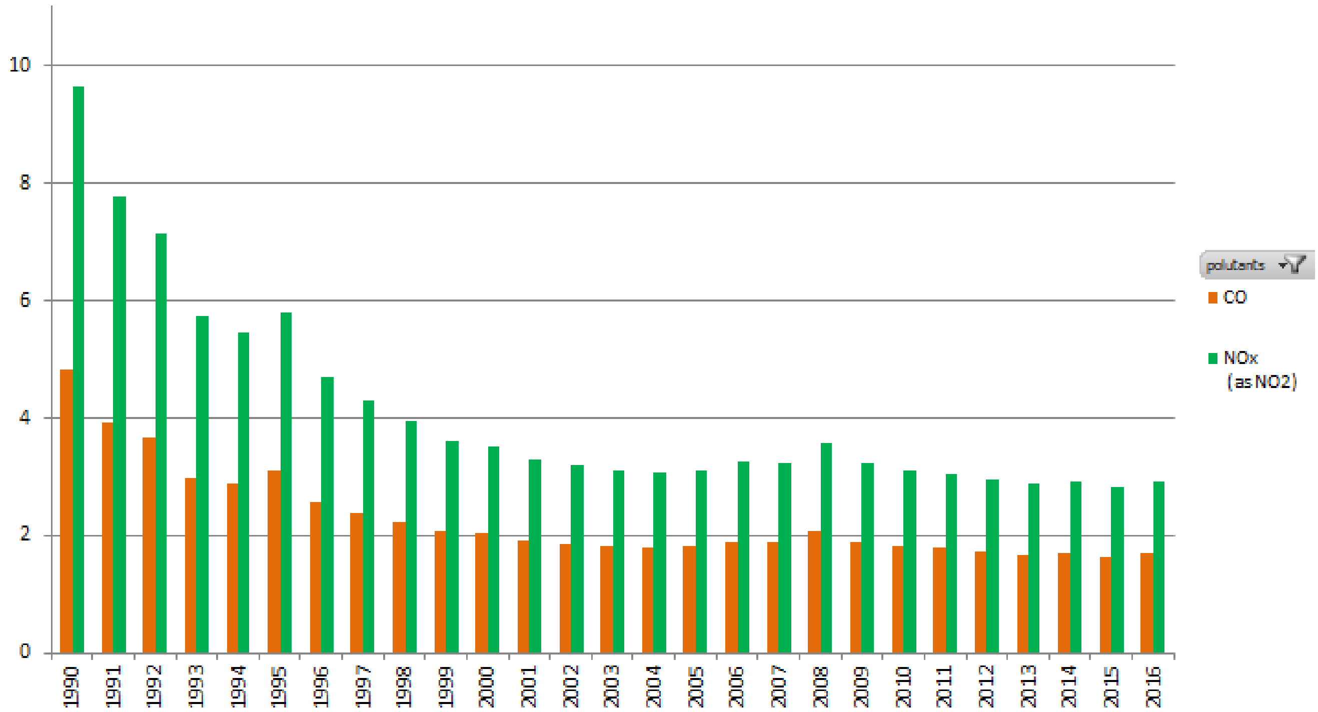


FIGURE 3-44 EMISSIONS (Gg) OF NO_X AND CO BY RAILWAYS IN 1990–2016

3.4.3.5 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 (2000–2016) and for all reported categories. The total combine uncertainty of national emissions from railways is ± 33.63 %. Uncertainty in activity data is up to 5 % and in EFs ranges from 50 up to 200 %. Especially heavy metals, NH3 and PAHs have less reliable EFs.

3.4.4 NAVIGATION (1.A.3.D)

3.4.4.1 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.

3.4.4.2 ACTIVITY DATA

Fuel consumption by national navigation is very low (see Table 3-23). 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 3-23 FUEL CONSUMPTION BY INLAND NAVIGATION

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fuel consumption	17	17	17	16	16	16	16	14	12	7	5	8	4	4
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Fuel consumption	6	5	6	5	4	5	4	3	5	2	3	4	4	

3.4.4.3 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 3-24 EF METHOD USED FOR INLAND NAVIGATION

PCs and LDVs	NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	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 3-25 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 3-26 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

3.4.4.4 EMISSIONS

Emissions from national inland navigation are strongly dependent on fuel consumption. Fuel consumption has no specifics trend and depend on random fuel consumption in particular year. 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. Most significant pollutants from national navigation are NO_x and CO. In emissions of these pollutant we can see increasing trend 2013 – 2016 (see figures below). Values of NOx emissions reached 136 t and CO 79 t. The highest values after 2000 were estimated in 2001.

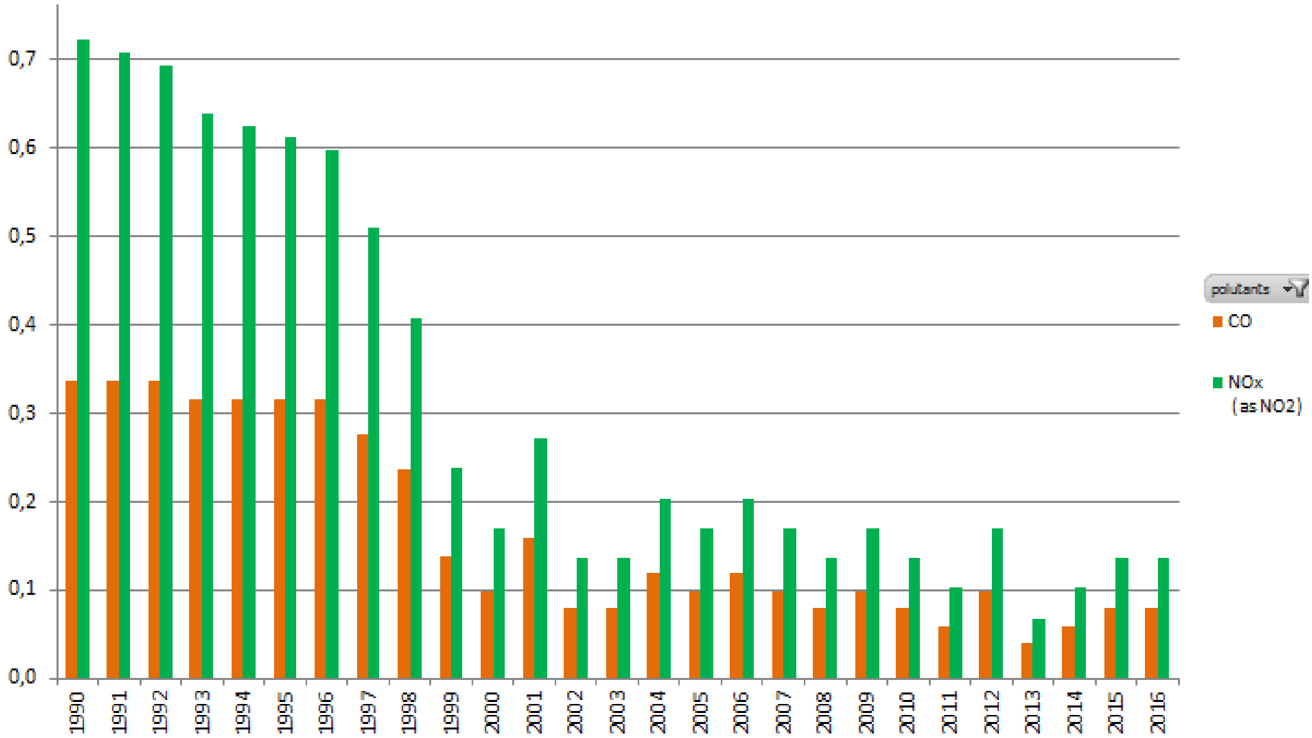


FIGURE 3-45 EMISSIONS (Gg) OF NO_X AND CO BY NATIONAL INLAND NAVIGATION IN1990–2016

3.4.4.5 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.

3.4.5 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.

3.4.5.1 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.

3.4.5.2 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)

3.4.5.3 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.

3.4.5.4 RECALCULATIONS AND IMPROVEMENTS

RECALCULATIONS

After necessary preparations the road transport was recalculated for the period 1990-2016, since 2008 fully according to the COPERT V model by Transport Research Centre (CDV) in summer 2018.

IMPROVEMENTS

As mentioned for recalculations, road transport had been recalculated by COPERT V model. In this extraordinary resubmission the emission figures for most frequent pollutants according passenger cars, light duty vehicles, heavy duty vehicles and buses as well as for two wheelers had been made available. Furthermore the category of former passenger cars was split into passenger cars and light duty vehicles.
Not all data are fully available at the moment so the detail fuel consumption data and an overview of emission factors will be presented in 2019 submission.

3.4.5.5 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

The greatest emphasis will be placed on preparing very complex and detailed activity data database for using COPERT 5 for estimating emissions from road transport in the next submission.

3.5 SMALL STATIONARY COMBUSTION AND NON-ROAD MOBILE SOURCES & MACHINERY (NFR 1A4)

Combustion sources for heat production or power generation are being categorized according NACE classification in mainly in NFR 1A4ai – district heating (NACE 35), NFR 1A4ci – agriculture (NACE 01–03) and tertiary sector (self-employment, offices, public health, education etc.). In a specific way there 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 3-27 there is a link between NFR category and classification pursuant Czech legislation.

TABLE 3-27 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.

3.5.1 STATIONARY SOURCES

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 (3.5.1.2).

3.5.1.1 COMMERCIONAL AND AGRICULTURE (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 15-1 and Table 15-2 in Annex.

3.5.1.2 RESIDENTIAL HEATING (NFR 1A4bi)

NFR sector 1A4bi includes emissions from local household heating, cooking and water warming. The emission inventory is prepared at Tier 2 approach.

ACTIVITY DATA

Fuel consumption is being ascertained by CZSO that hands over the data via international questionnaires to EUROSTAT and other institutions. These data represent basic input for emission inventory (Figure 3-46).
The consumption of individual coal fuels is being taken over directly from international questionnaire CZECH_COAL in natural units. The caloric values, stated summary in this questionnaire under item “For other uses”, do not correspond to real caloric values of coal fuels distributed to households. The recalculation to energy units was therefore done using caloric values annually ascertained by statistic census among fuel producers in structure of deliveries for power generation, industry and population [2]. This census also discovers other quality characteristics of coal fuels – ash, sulphur and carbon content. From biomass consumption stated in questionnaire CZECH_REN there was according statistic census of MIT segregated consumption of briquettes and pellets [3] For recalculation of LPG consumption from natural units (questionnaire CZECH_OIL) to energy units the calorific value 45.9 $MJ.kg^{-1}$ was used. Data about consumption of gaseous fuels for emission inventory are taken over directly from energy balance of EUROSTAT.
Data about distribution of total fuel consumption according combustion equipment type (**Chyba! Nenalezen zdroj odkazů.**), structure of combustion equipment in households, share of wet wood combustion and other parameters had been discovered by statistic census ENERGO 2015. The overview of combustion equipment structure in period 1990-2016 was prepared by combination these results with other statistics (SLDB, ENERGO 2004, sales of boilers).

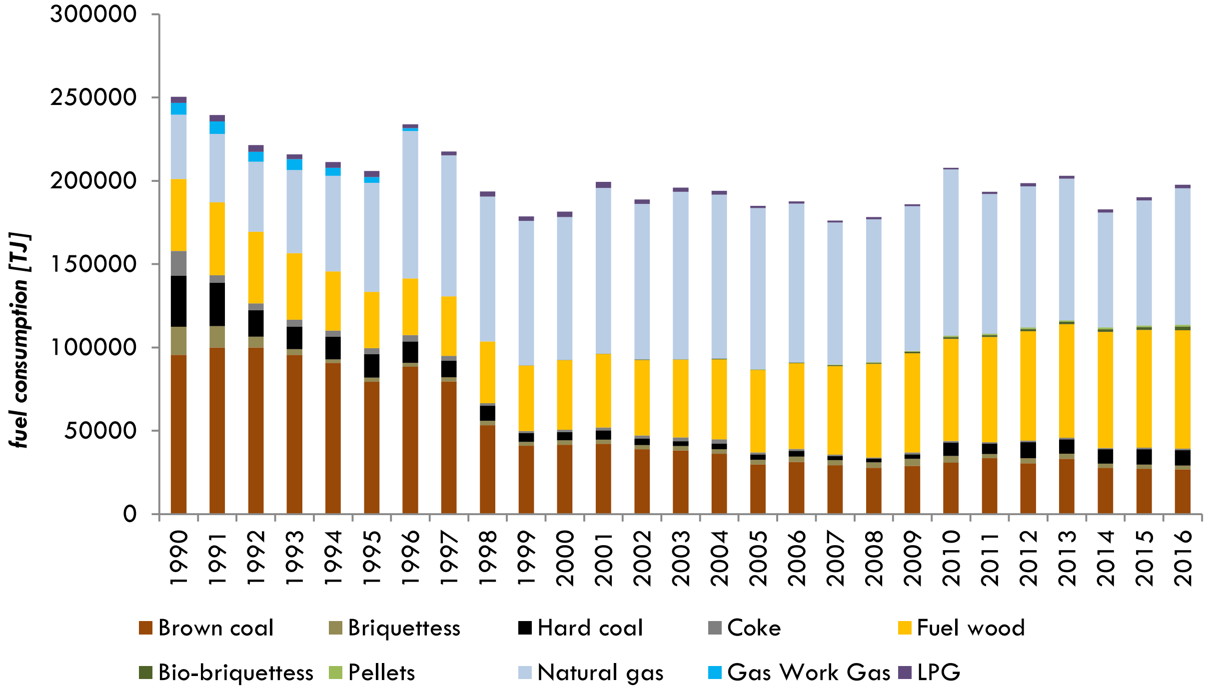


FIGURE 3-46 TREND OF FUEL CONSUMPTION IN SECTOR LOCAL HEATING OF HOUSEHOLDS IN PERIOD 1990-2016

TABLE 3-28 DISTRIBUTION OF SOLID FUEL CONSUMPTION ACCORDING TYPE OF HEATING EQUIPMENT IN 2016

installation type/fuel type	Brown coal	Briquettess	Hard Coal	Coke	Wood - dry	Wood - wet	Bio-briquettess	Pellets
					%			
Over-fire boilers	25	54	56	88	33	34	18	1
Under-fire boilers	37	24	17	10	20	16	10	1
Automatic boilers	25	4	17	1	3	2	4	49
Gasification boilers	7	4	5	0	15	10	8	0
Stoves, fireplaces	5	13	5	2	29	38	59	50

EMISSION FACTORS

Emission factors for solid fuels combustion were derived from results of VEC VŠB measurement at nominal heat rating for all monitored pollutants. The values were set for over-fire boilers, under-fire boilers, gasification boilers and automatic boilers. For category stoves, grates and cookers there were used same values of emission factors as for over-fire boilers (similar mode of combustion). Emission factors for other fuels were taken over from Air Pollutant Inventory Guidebook 2016 [4] and Methodology Instruction of CME. The overview of emission factors for emission inventory in household heating sector is available in Annex, Table 15-3 - Table 15-12.

UNCERTAINTIES

Uncertainties issue will be resolved later.

3.5.2 NON ROAD MOBILE MACHINERY (NFR 1.A.4)

Mobile machinery is typified as all machinery equipped with a combustion engine which is not primarily intended for transport on public roads and which is not attached to a stationary unit. The most important utilisation of mobile machinery is:

- 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

METHOD

Mobile sources reported under *NFR 1.A.4 (Non road mobile)* 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). Since agriculture emissions are the most important, it is paid more attention to them.

ACTIVITY DATA

Estimates of emissions regarding non road mobile sources 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 (seeTable 3-29). 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 3-29 FUEL CONSUMPTION BY NON ROAD MOBILE MACHINERY

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
1990	14.0	N/A	N/A	463	N/A
1991	14.0	N/A	N/A	460	N/A
1992	14.0	N/A	N/A	453	N/A
1993	14.0	N/A	N/A	440	N/A
1994	14.0	N/A	N/A	427	N/A
1995	14.0	N/A	N/A	425	N/A
1996	14.0	N/A	N/A	426	N/A
1997	14.0	N/A	N/A	393	15.0
1998	4.0	N/A	3.0	372	12.0
1999	4.0	N/A	3.0	366	11.0
2000	4.0	N/A	3.0	364	10.0
2001	4.0	N/A	3.0	357	10.0
2002	5.0	18.0	4.0	322	10.0
2003	4.0	13.0	4.0	308	8.0
2004	4.0	16.0	4.0	319	8.0
2005	5.0	17.0	5.0	316	8.0
2006	5.0	13.0	5.0	304	8.0
2007	5.0	19.0	6.0	301	8.0
2008	6.0	19.0	6.0	314	7.0
2009	4.0	21.0	6.0	311	6.0
2010	3.0	15.0	6.0	308	6.0
2011	5.0	14.0	6.0	316	6.0
2012	5.0	12.0	6.0	319	6.0
2013	5.0	13.0	6.0	319	6.0
2014	5.0	14.0	6.0	314	6.0
2015	9.0	13.0	6.0	316	6.0

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
2016	9.0	13.0	6.0	318	5.0

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 3-30 EF AND METHOD USED FOR NON ROAD MOBILE MACHINERY

	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 3-31 EF USED FOR NON ROAD MOBILE MACHINERY 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 3-32 DEFAULT EMISSION FACTORS FOR CALCULATION CO, NOX, TPS, AND NMVOC (STAGE III - EMEP 2006 (UPDATE 2011))

Category	CO	NMVOC	NO	TSP
	g/kWh	g/kWh	g/kWh	g/kWh
Tractor below 20 kW	8.38	3.82	14.40	2.22
Tractor 21 - 39 kW	5.50	1.10	6.40	0.60
Tractor 40 - 60 kW	5.00	0.70	4.00	0.40
Tractor 61 -99 kW	5.50	0.50	3.50	0.30
Tractor over 100 kW	3.50	0.50	3.50	0.30
Harvester over 120 kW	3.50	0.50	3.50	0.20
Sugar beet harvester over 120 kW	3.50	0.50	3.50	0.20
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.

3.5.2.1 1A4cii AGRICULTURE/FORESTRY/FISHING: OFF ROAD VEHICLES

KEY SOURCES EMISSIONS

Mobile agricultural machinery is a key source of NOx and CO. This category of mobile machinery is also an insignificant source of NMVOC and TPS.

OVERVIEW OF SHARES AND TRENDS IN EMISSIONS

Emissions originating from agricultural sources are computed based on diesel oil consumption in tractors and harvesters. In the Table 3-29 diesel oil consumption in agriculture in the Czech Republic is presented.

Diesel oil consumption in agriculture in the Czech Republic fluctuates between 314 000 tons and 319 000 tons throughout the time series. Emissions are also depended on tractors / harvesters efficiency and its composition.

METHODOLOGICAL ISSUES

Share of agricultural machinery newer than 10 years is quite low in the Czech Republic. It means, in most cases this machinery is not equipped by new and modern engines with low emission production.

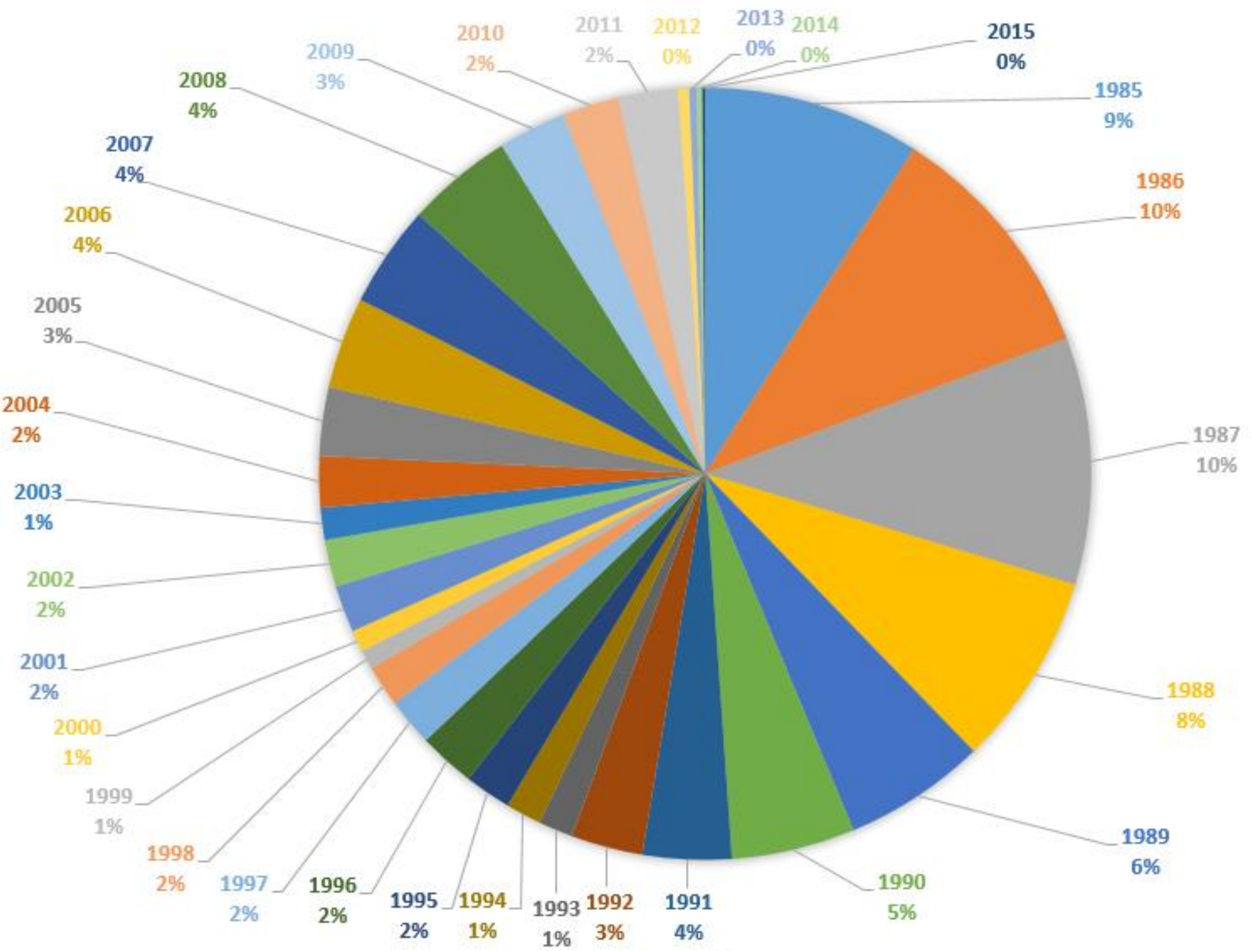


FIGURE 3-47 SHARE OF TRACTORS BY YEAR OF PRODUCTION

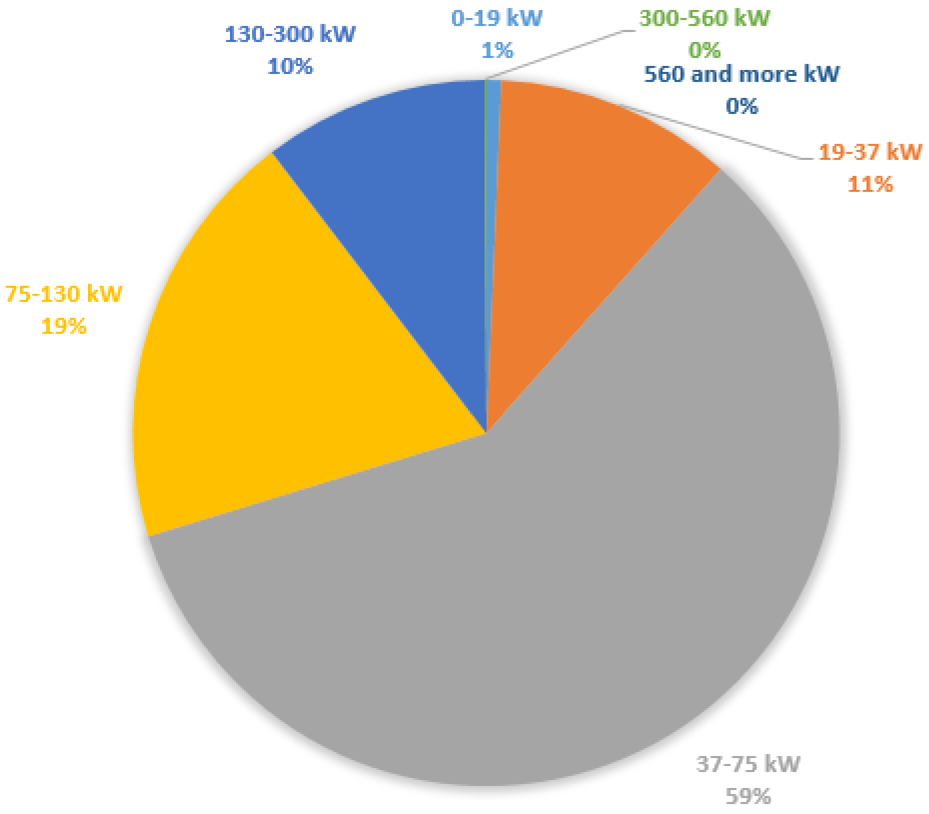


FIGURE 3-48 SHARE OF TRACTORS ACCORDING TO RATED OUTPUT

The most significant categories of agricultural machinery comprise tractors with efficiency 37 - 75 kW and 75 - 130 kW.

ACTIVITY DATA AND (IMPLIED) EMISSION FACTORS

Emissions from non-road agricultural mobile machinery were calculated using a Tier-2 methodology according to the EMEP/CORINAIR Emission Inventory Guidebook - 2006 (updated in 2011). Diesel oil consumption is taken from annual agricultural census coming from the official statistics (The Czech Statistical Office). For emissions of CO, NOx, TPS and NMVOC calculation default emission factors are used. In the table 6.4.b are these factors presented.

Emission factors have not been updated until 2016 and therefore could be rather uncertain.

The new methodology for calculation of national emission balance of non-road machinery calculated after 2017 will only include machines less than 15 years old assuming their intensive use with appropriate emission factor. The reason for their intensive use is the successive application of modern land farming technologies requiring tractors of higher rated outputs with estimated share 75 % of crop farming. Older tractors with lower rated output are successively being used in stock farming for moving of raw and other materials, at small farms and municipalities. This will reduce the number of machines for emission calculations to approx. 20 thousand tractors and all machines will be attributed under official emission factors Stage I – III.

UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The revision of tractors´ structure and update of emission factors will be performed during 2018 and the whole time series after 1990 will be revised.

SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There is planned to calculate a certain share of emission based on emission factors set down by Stage I – Stage III for tractors, which are obligated to fulfil these emission parameters.

EMISSIONS – TO BE UPDATED

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).

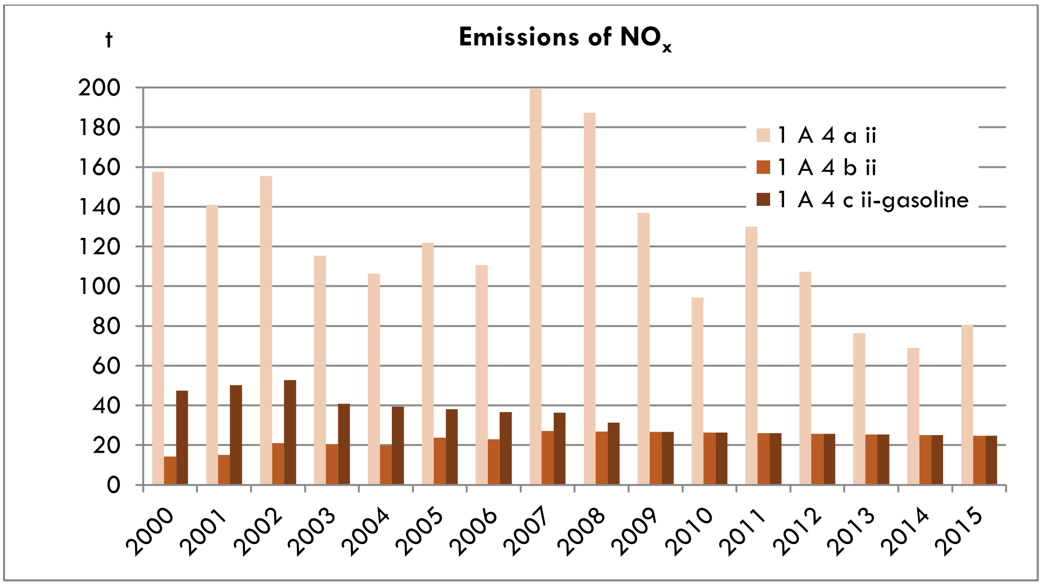


FIGURE 3-49 EMISSIONS FROM MOBILE COMBUSTION IN 2000–2015

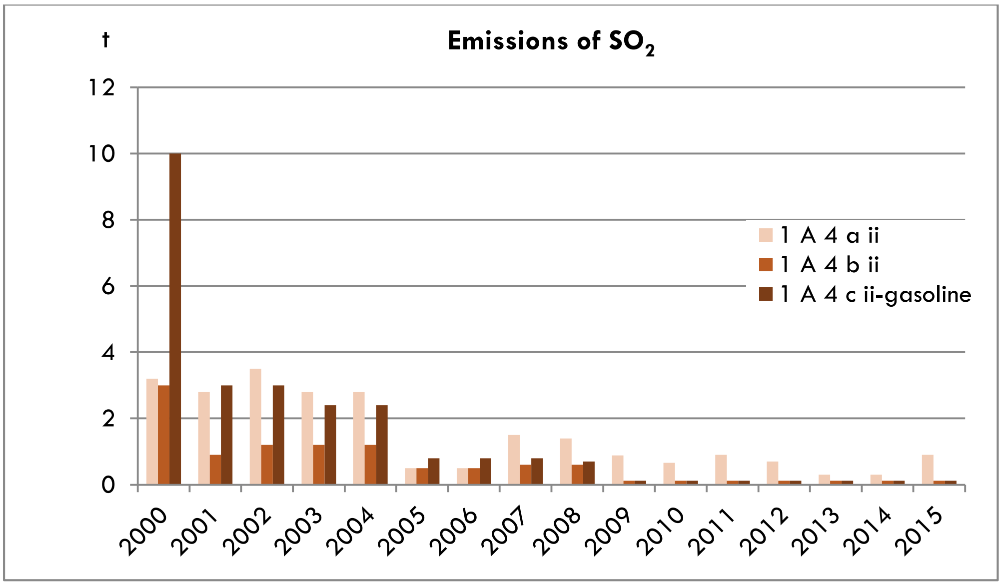


FIGURE 3-50 EMISSIONS FROM MOBILE COMBUSTION IN 2000–2015

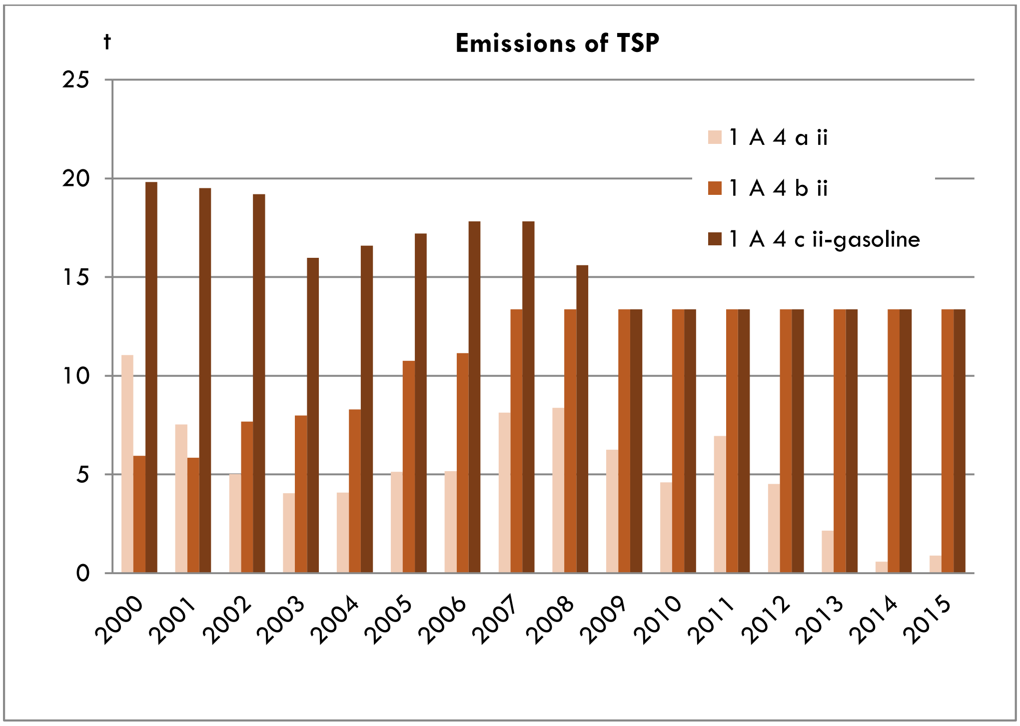


FIGURE 3-51 EMISSIONS FROM MOBILE COMBUSTION IN 2000–2015

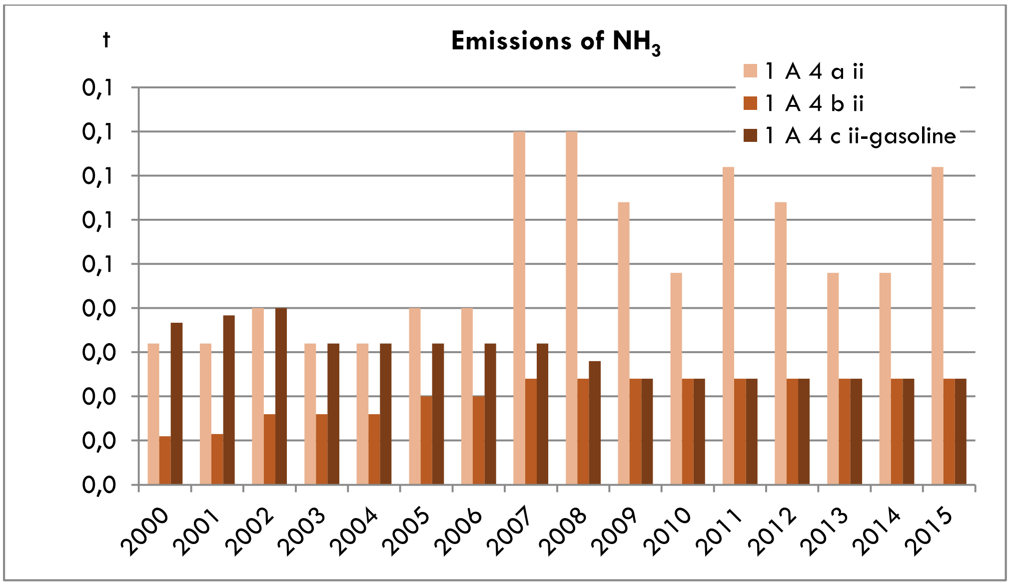


FIGURE 3-52 EMISSIONS FROM SMALL MOBILE COMBUSTION IN 2000–2015

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.

3.5.3 OTHER, MOBILE (MILITARY) (NFR 1.A.5.b) – to be updated

METHOD

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

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 3-34).

TABLE 3-33 FUEL CONSUMPTION BY OTHER MOBILE COMBUSTION

Category	**Year**									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1.A.5.b i Diesel Oil (kt)	N/A	N/A	9	7	7	6	7	7	9	9
1.A.5.b ii Jet Kerosene (kt)	N/A	N/A	18	13	16	17	13	19	19	21
	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.A.5.b i Diesel Oil (kt)	9	9	9	8	8	10				
1.A.5.b ii Jet Kerosene (kt)	15	14	12	13	14	13				

TABLE 3-34 FUEL CONSUMPTION BY OTHER MOBILE COMBUSTION

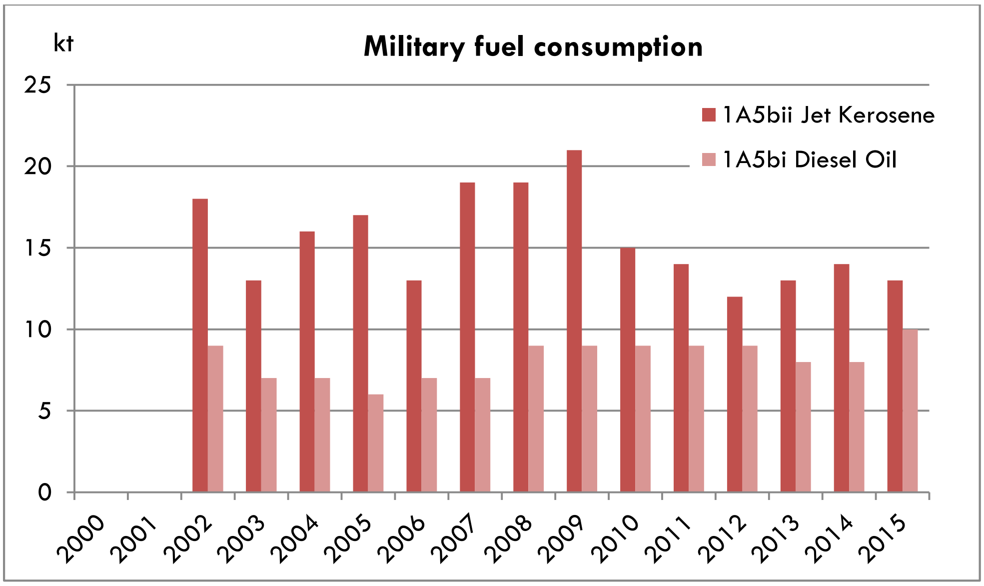


FIGURE 3-53 FUEL CONSUMPTION BY SMALL MOBILE COMBUSTION

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 3-35 EF METHOD FOR MILITARY 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*
Millitary Combustion	***CS***	***Tier 1***	***Tier 1***	***Tier 1***	***Tier 1***	***Tier 1***	***Tier 1***	***Tier 1***	***Tier 1***
		PAHs							
	PCDD/ PCDF (dioxines/ furanes)	*benzo(a) pyrene*	*benzo(b) fluoranthene*	*benzo(k) fluoranthene*	*Indeno (1,2,3-cd) pyrene*	*PCBs*			
	NR	***Tier 1***	***Tier 1***	***Tier 1***	***Tier 1***	***NR***			

TABLE 3-36 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 3-37 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

EMISSIONS

Fuel consumption is provided by CzSO from the year 2002. Emissions for all pollutants are calculated by Tier 2 EFs 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.

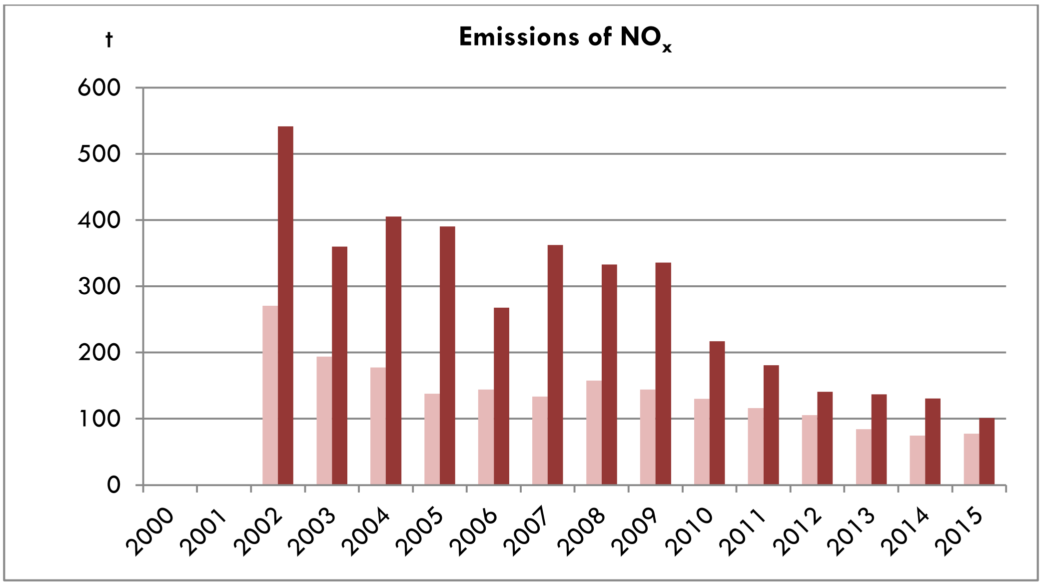


FIGURE 3-54 EMISSIONS BY MILITARY COMBUSTION IN 2000–2015

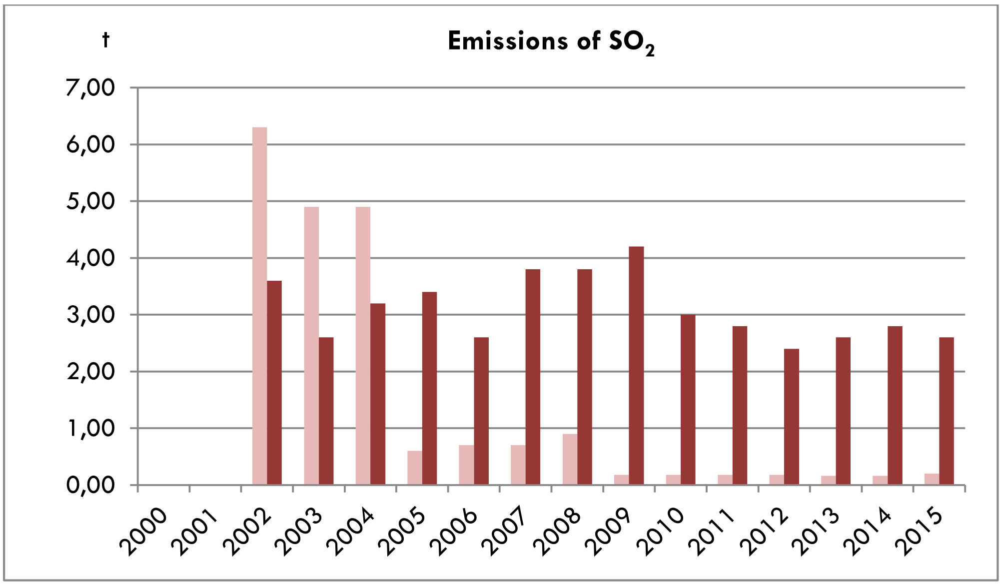


FIGURE 3-55 EMISSIONS BY MILITARY COMBUSTION IN 2000–2015

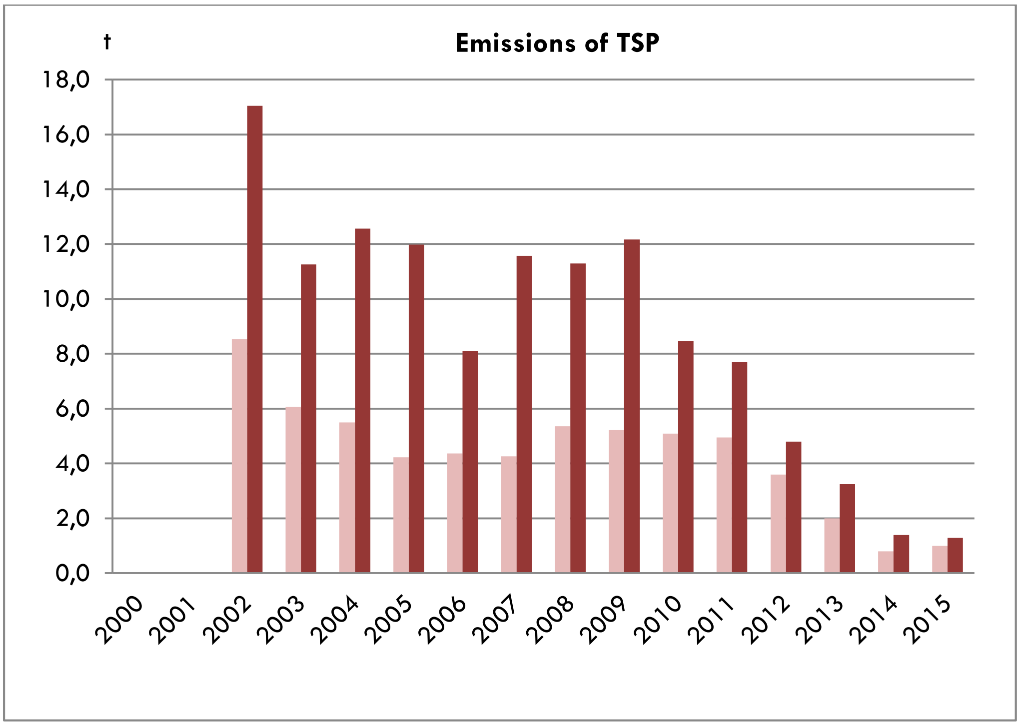


FIGURE 3-56 EMISSIONS BY MILITARY COMBUSTION IN 2000–2015

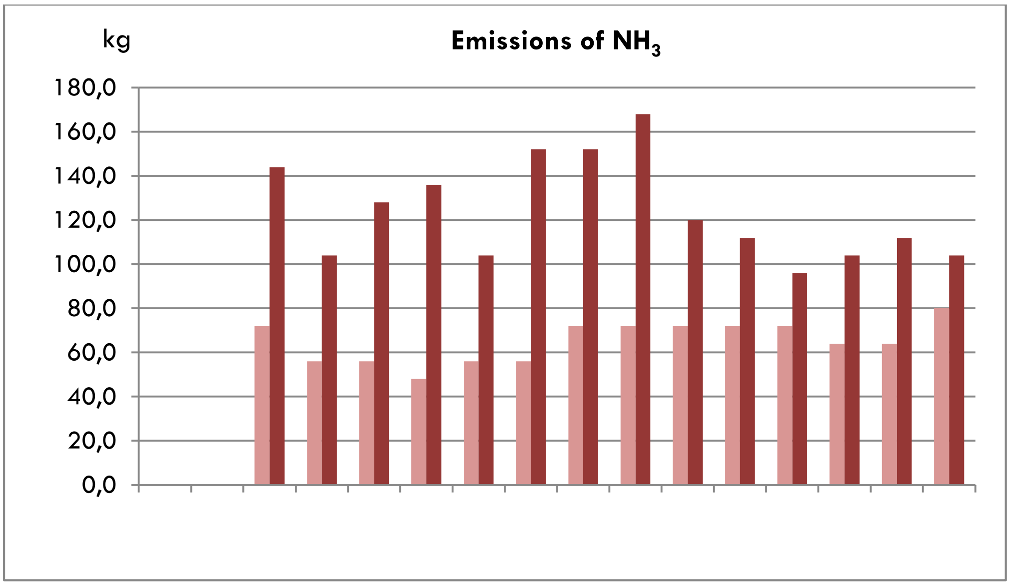


FIGURE 3-57 EMISSIONS BY MILITARY COMBUSTION IN 2000–2015

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 (2000–2016) 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 FUGITIVE EMISSIONS FROM SOLID FUELS (NFR 1B1)

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).

3.6.1 FUGITIVE EMISSIONS FROM SOLID FUELS: COAL MINING AND HANDLING (NFR 1B1a)

This chapter deals with fugitive emissions from coal mining and handling. In the Emission inventory guidebook 2016 there 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, there are being mined bituminous and lignite coal. Lignite is mined mainly in open cast mining, bituminous coal as underground mining. Emission factors for quantifying particulate emissions are taken from EIG. EFs for NMVOC are adapted to the conditions in the For estimate of NMVOC EF for underground coal mining firedamp composition and methane EF used in emission inventory for greenhouse gases was used. The EF for methane during years changed from 17.7 kg/Mg (in 1970) to 8.75 kg/Mg (recent value). Information on firedamp composition is available under http://www.okd.cz/cs/tezime-uhli/uhli-tradicni-zdroj-energie/dulni-plyny-a-metan or http://energetika.tzb-info.cz/kogenerace/5644-dulni-plyn-jako-druhotny-zdroj-energie-pro-kombinovanou-vyrobu-elektriny-a-tepla. Considering data available and expert consultation EF for NMVOC was estimated 0.56 kg/Mg. Firedamp is partly being combusted in cogeneration units.

Annual amount extracted coal is shown in Figure 3-58

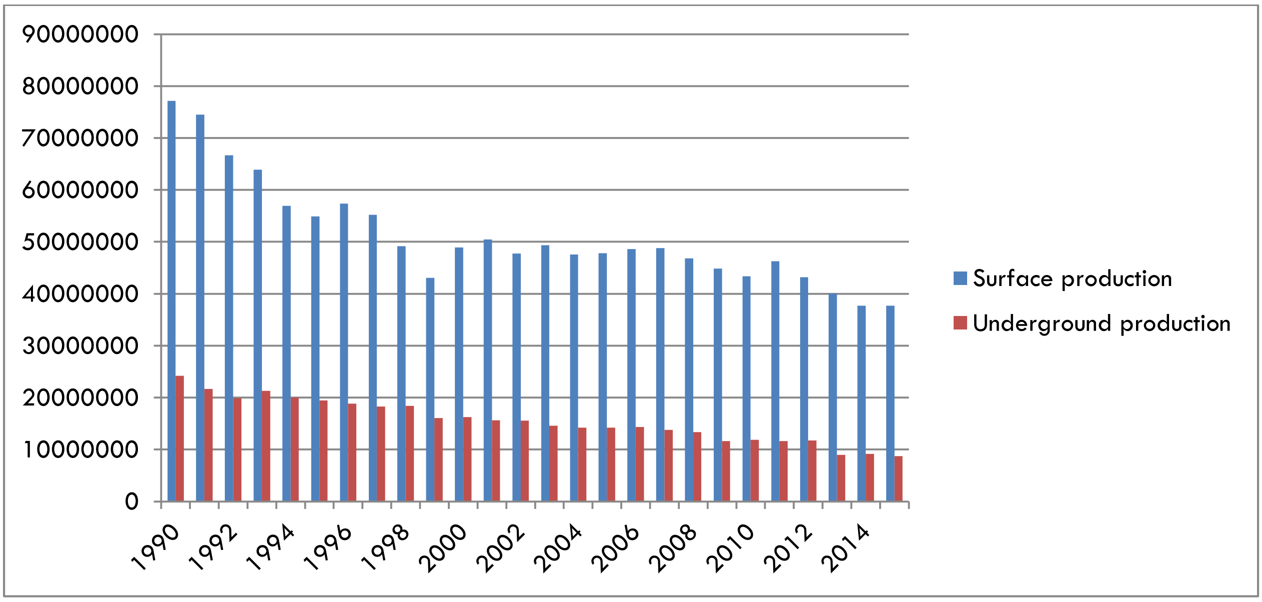


FIGURE 3-58 THE AMOUNT OF COAL EXTRACTED 1990–2015

3.6.2 SOLID FUEL TRANSFORMATION (NFR 1B1b)

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 reconstruction 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 3-38).

TABLE 3-38 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 3-59).

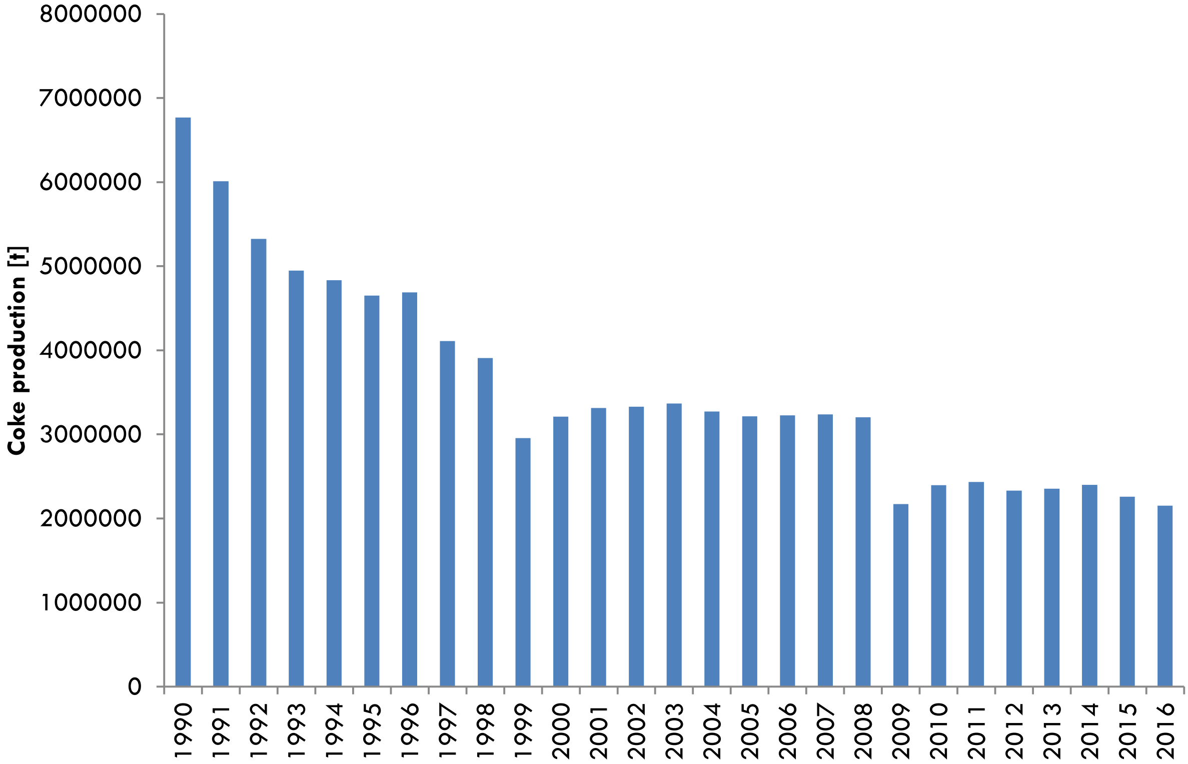


FIGURE 3-59 COKE PRODUCTION IN 1990-2016

From the perspective of emissions inventorying, the process of coke production is divided into six sectors (Table 3-39). 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 3-39 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 being 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 3-42)

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

- k_{1-5} – contribution coefficients for coking batteries with stamp charging operation
- k_{1-6} – contribution coefficients for coking batteries with stamp charging operation

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 3-40 and Table 3-41).

TABLE 3-40 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 3-41 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 3-42 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 had been 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 3-43).

TABLE 3-43 CONTRIBUTIONS OF INDIVIDUAL CONGENERS TO THE TOTAL SUM OF PAH

Process	benzo(a)pyrene		benzo(b)fluoranten e		benzo(k)fluoranten e		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

3.6.3 OTHER FUGITIVE EMISSIONS FROM SOLID FUELS (NFR 1B1c)

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.

3.7 FUGITIVE EMISSIONS FROM OIL FUELS – REFINING, STORAGE AND DISTRIBUTION (NFR 1B2)

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 2016 with exception of solvent use emissions (mainly category 2.D.3.a), where EIG 2013 methodology was used.

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 MINERAL PRODUCTS (NFR 2A)

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 2016 to key sources of PM_{10} (2.2 %) and TSP (2.9 %) 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)

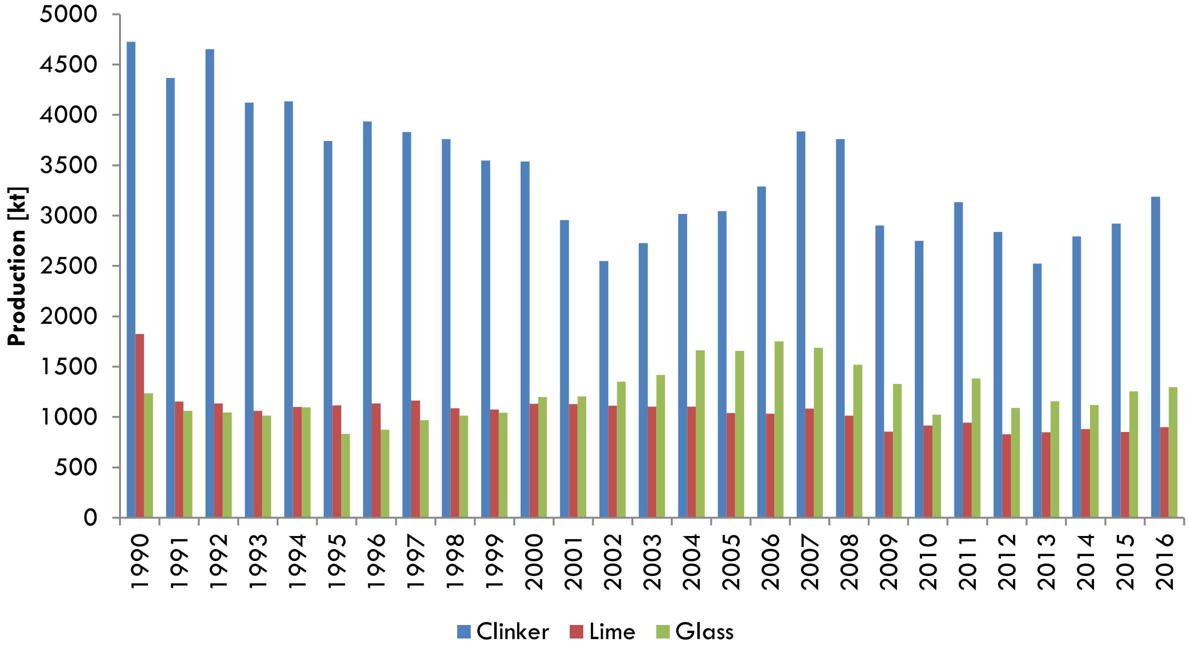


FIGURE 4-1 TREND OF CLINKER, LIME AND GLASS PRODUCTION IN 1990–2016

4.1.1 PRODUCTION OF CEMENT CLINKER, LIME, TREATMENT OF FIRE-RESISTANT CLAYS AND DESULFURIZATION PRODUCTS (NFR 2A1 AND NFR 2A2)

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 had 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
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 (NFR 2A3)

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 2016 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 [10] 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 or emissions factor. TSP and PM emissions for 1990 to 1994 will be added later.

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**;	5.13. Strip mines for fuel, ore, mineral raw materials and processing thereof, primarily the mining, drilling, dredging, separation, milling,

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.
2A5a	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 (1,5 - 4% weight) material[1)]		
	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 2016 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.

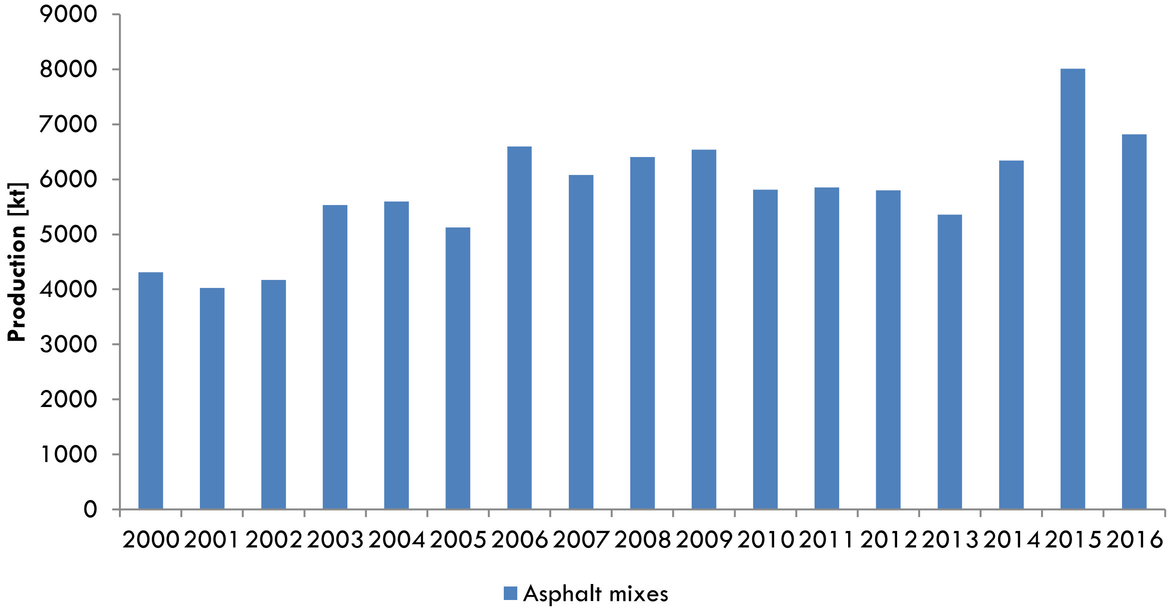


FIGURE 4-2 TREND OF ASPHALT MIXES PRODUCTION IN 2000-2016

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 (NFR 2A5b)

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	$kg.m^{-2}$

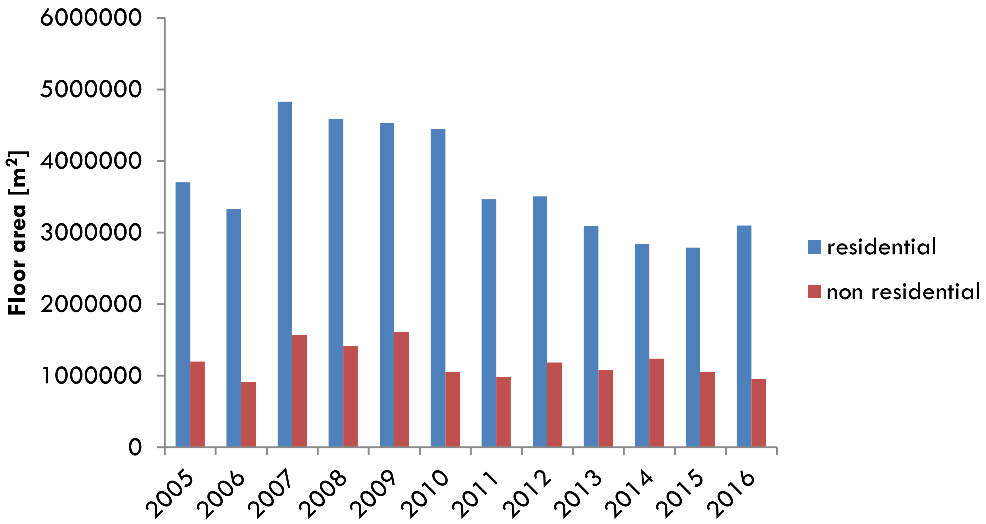


FIGURE 4-3 TREND OF BUILDING FLOOR AREA IN 2005-2016

4.2 CHEMICAL INDUSTRY (NFR 2B)

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.

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.

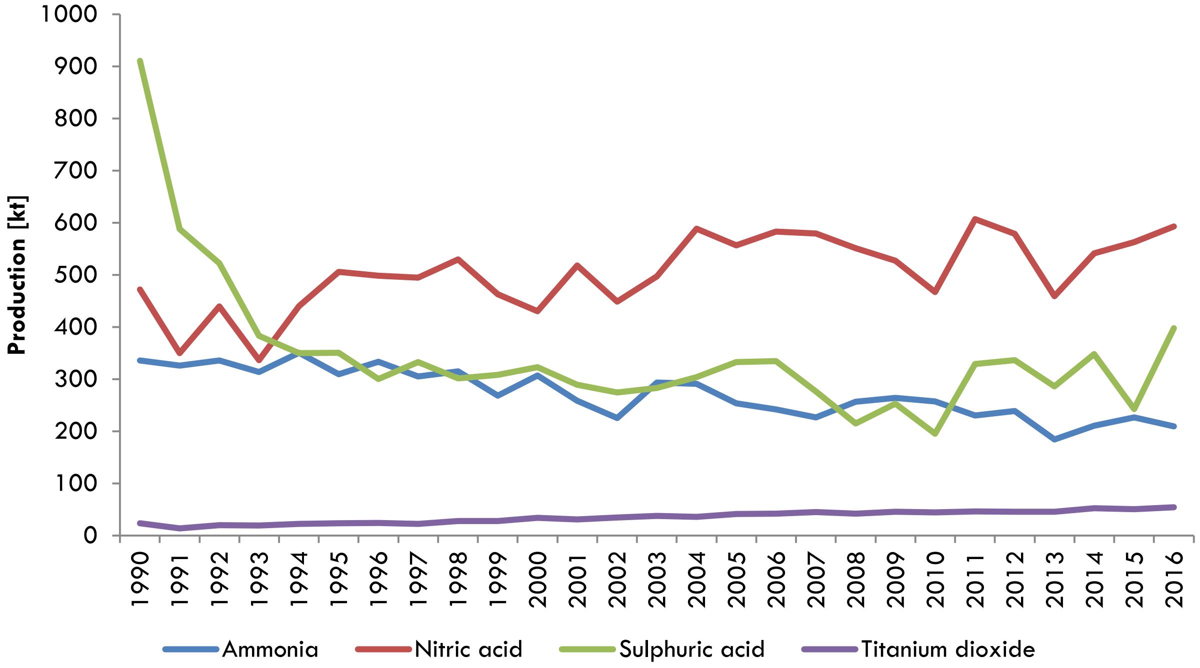


FIGURE 4-4 TREND OF AMMONIA, SULFUR ACID AND NITRIC ACID PRODUCTION IN 1990–2016

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
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 METAL PRODUCTION (NFR 2C)

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).

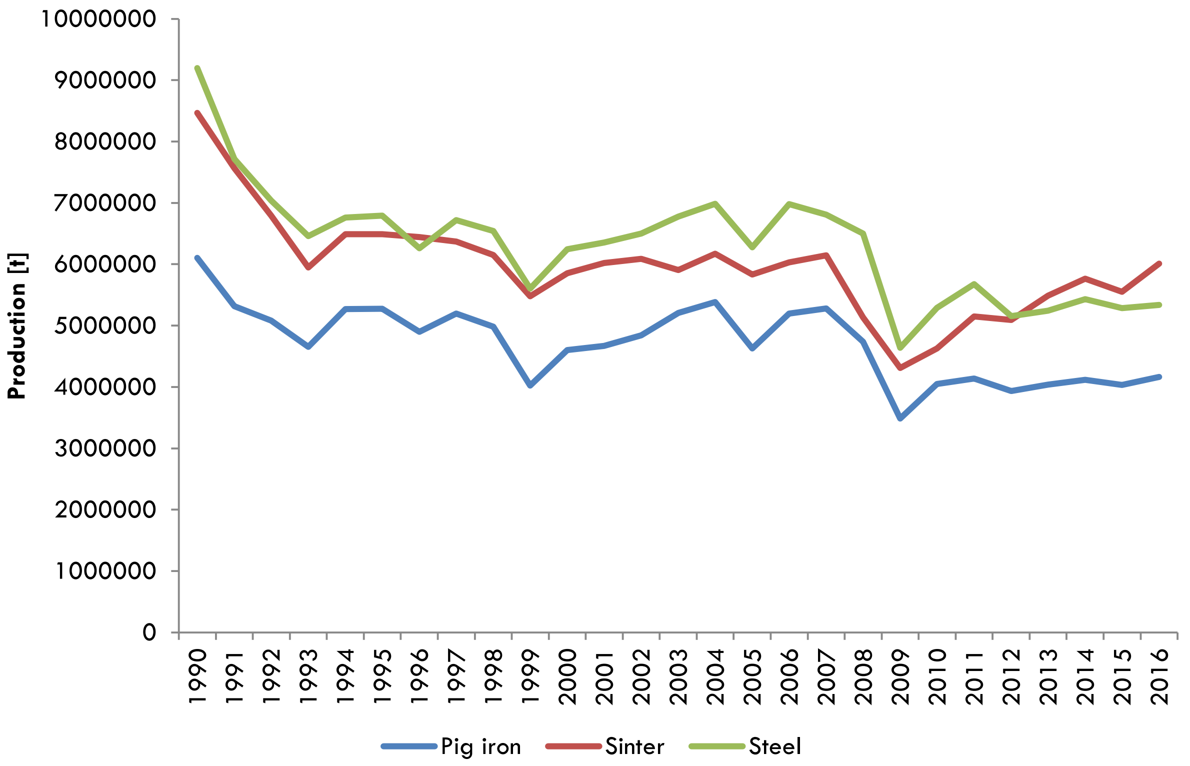


FIGURE 4-5 TREND OF PIG IRON, STEEL AND SINTER PRODUCTION IN 1990–2016

4.3.1 IRON PRODUCTION (NFR 2C1)

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 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
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 FACTORS

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 $TEQ.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g.t^{-1}$
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 (NFR 2C1)

In 2016 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 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.

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. 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.

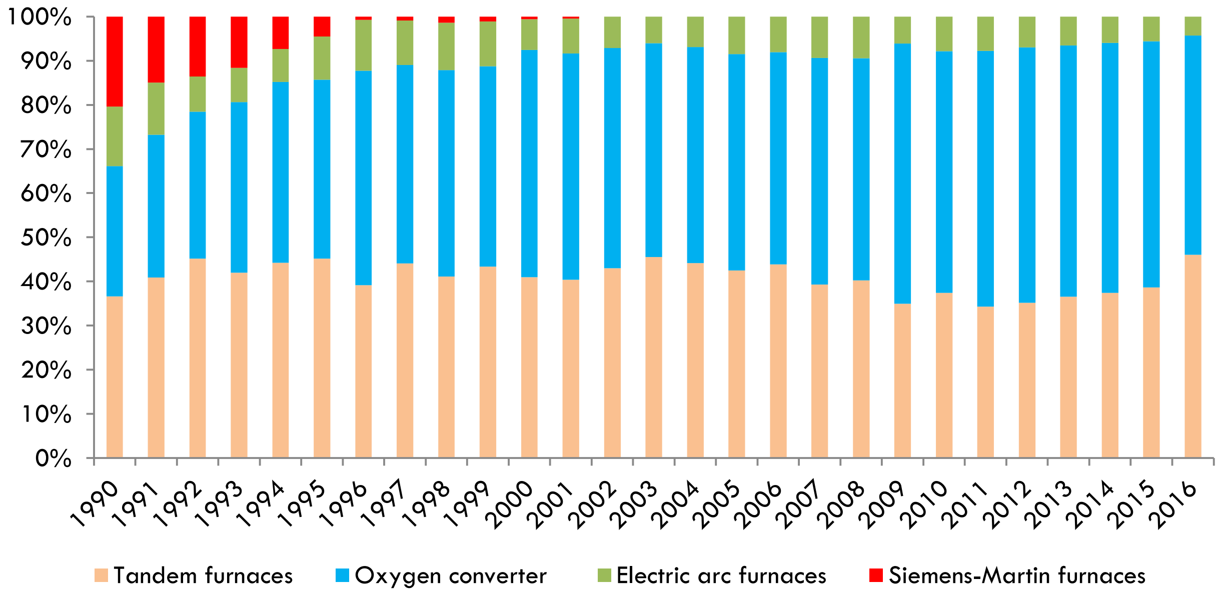


FIGURE 4-6 CRUDE STEEL PRODUCTION BY PROCESS IN 1990–2016

4.3.3 FERROUS METAL PROCESSING (NFR 2C2)

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 (NFR 2C2)

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
$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	μg $TEQ.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g.t^{-1}$
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 ROAD PAVING WITH ASPHALT (NFR 2D3b)

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 22.5 % by mass. On the other hand the total amount of cutback asphalt used in the Czech Republic is significantly lower than 1 Gg. There was a rapid decrease in the use of cutback asphalt since 1990s (VOCc).

Emulsified asphalt prevails as cold asphalt technology in the Czech Republic and due to a very low content of mainly paraffin emulsifier (0.5 % by mass), the total VOC emission for emulsified asphalt (VOCe) is almost comparable with cutback asphalt. The total emission of VOCs is the sum of both but activity data for emulsified asphalt collected by Road Construction Association are available since 2005.

The trend of VOCs emissions (TOTAL) in sector 2D3b Road paving with asphalt is significantly decreesing in late 1990s with a minimum in 2001 and relatively strong oscillation at approximately 0.5 - 0.6 Gg since 2007 until 2015 and steep drop in 2016 due to reduced use of cutback asphalt.

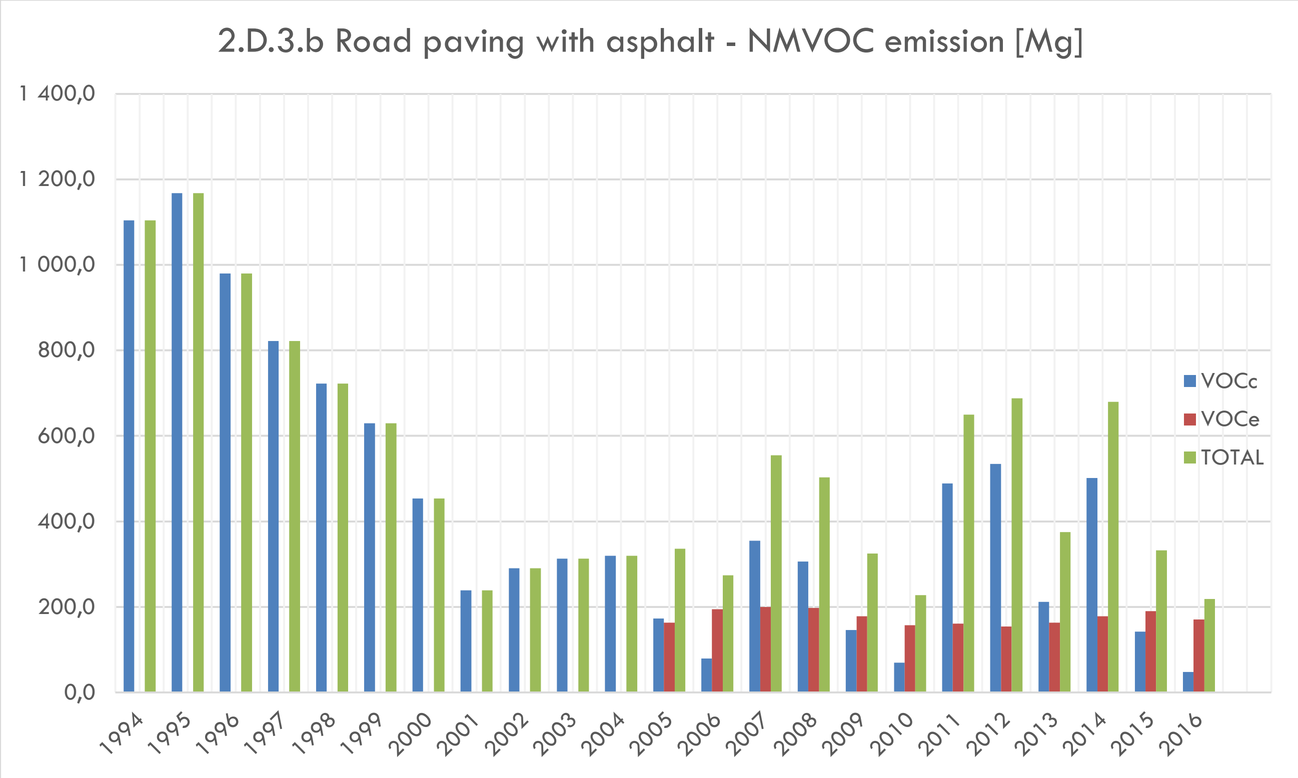


FIGURE 4-7 ROAD PAVING NMVOC EMISSIONS IN 1994 - 2016

4.5 ASPHALT ROOFING (NFR 2D3c)

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 2016 was less than 50 Gg. The reported NMVOC emissions are collected by emission database and can be found in the table below. Data for 1990s are not available and emission could therefore not be estimated.

TABLE 4-20 ASPHALT ROOFING NMVOC EMISSION IN 1990 – 2016 [MG]

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
3	3	10	5	4	7	3	2	2	4
2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
3	2	3	3	3	9	3			

4.6 FOOD PROCESSING, WOODWORKING, AND OTHER INDUSTRIES (NFR 2H-L)

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 4-8).

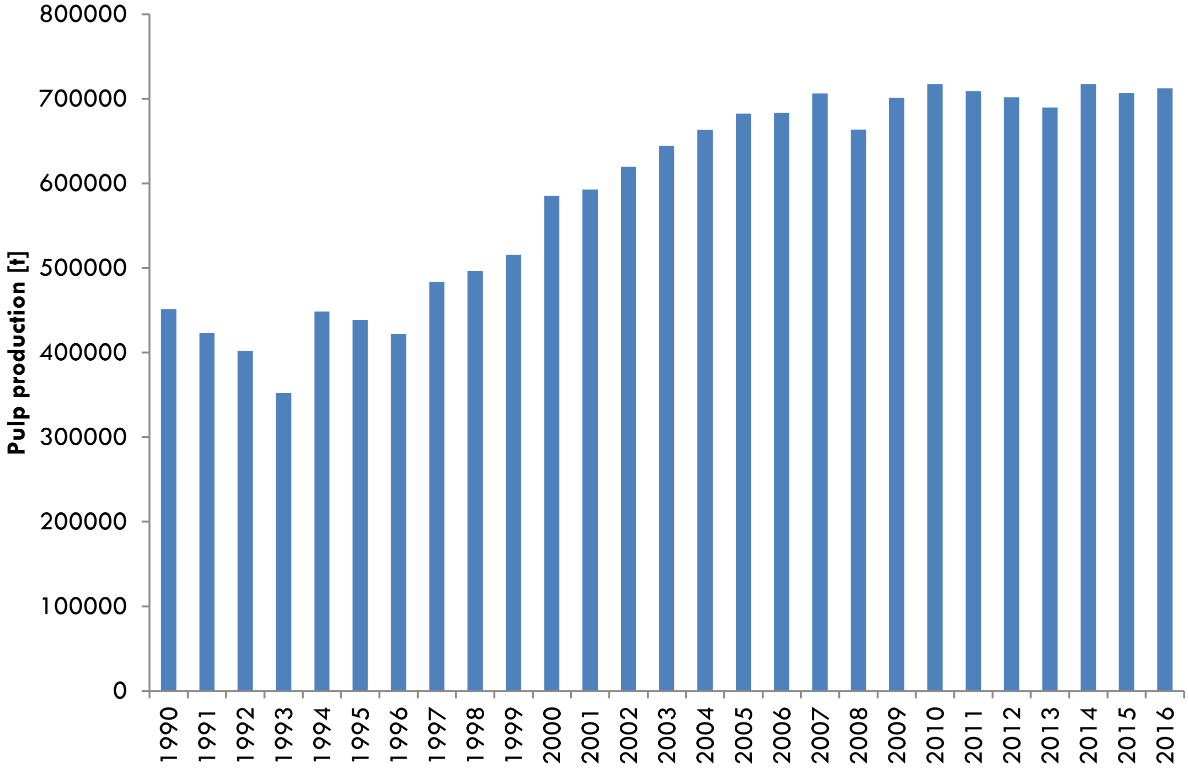


FIGURE 4-8 TREND OF PULP PRODUCTION IN 1990 2016

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
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 (EXCEPT 2.D.3.B AND 2.D.3.C) SOLVENT AND OTHER PRODUCT USE (2.D.)

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 4-9. 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.

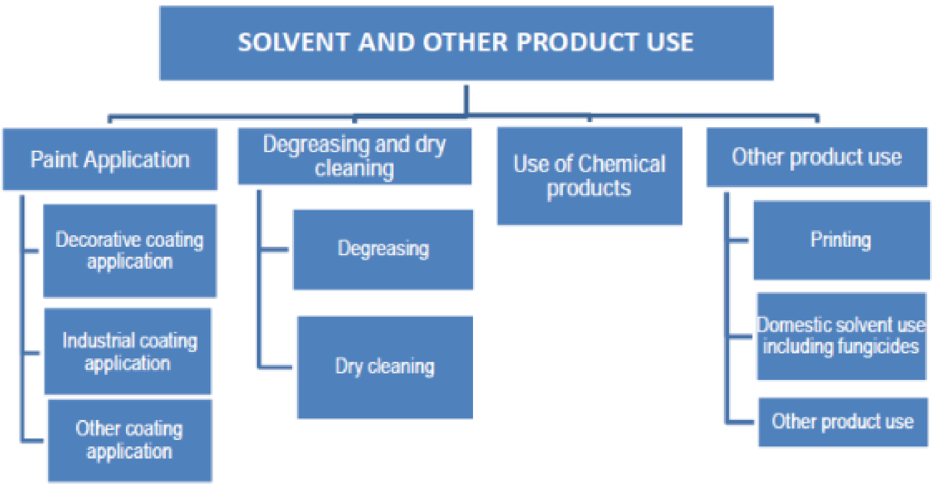


FIGURE 4-9 SOLVENT USE DIAGRAM

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 4-22

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	Includes emissions from paint application in	NMVOC

	application	construction and buildings and domestic use.	
	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 car components production, containers, tins and barrels, aircrafts, coating of plastics etc. This sector includes painting in site (bridges, buildings).	NMVOC
Degreasing and dry cleaning			
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

The solvent and other product use sector belongs to one of the largest pollution source of NMVOC emissions in Czech and it accounted for over 32 % of total NMVOC emissions. The largest share was for decorative coating application at 43 %, with the others being chemical products 15 %, domestic solvent use at 15 %, , degreasing 11 % and other solvent use 11 % (Figure 4-10).

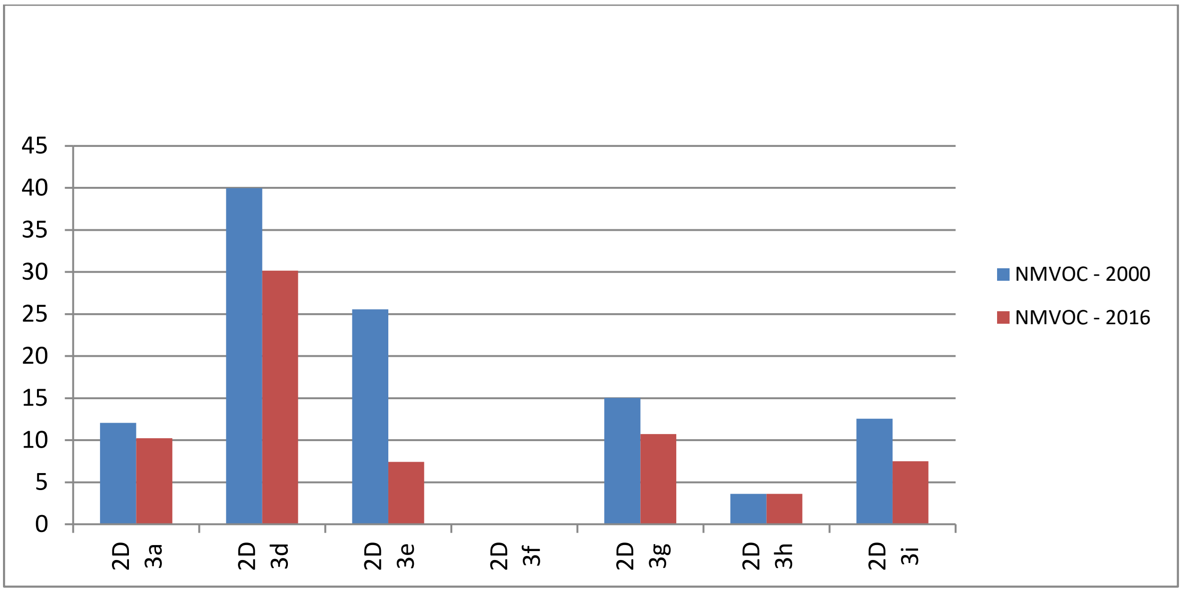


FIGURE 4-10 NMVOC EMISSIONS FROM SOLVENT AND OTHER PRODUCTION USE SECTOR IN 2000 AND 2016

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 4-11). 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 2016 (Table 4-23), 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 law No.35 at the 1967 yet. The next legal acts 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 NMVOC emissions very strictly. This system unification the Czech and EU legal acts, too. Other regulations come after later and implemented European Solvent Directive. 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.

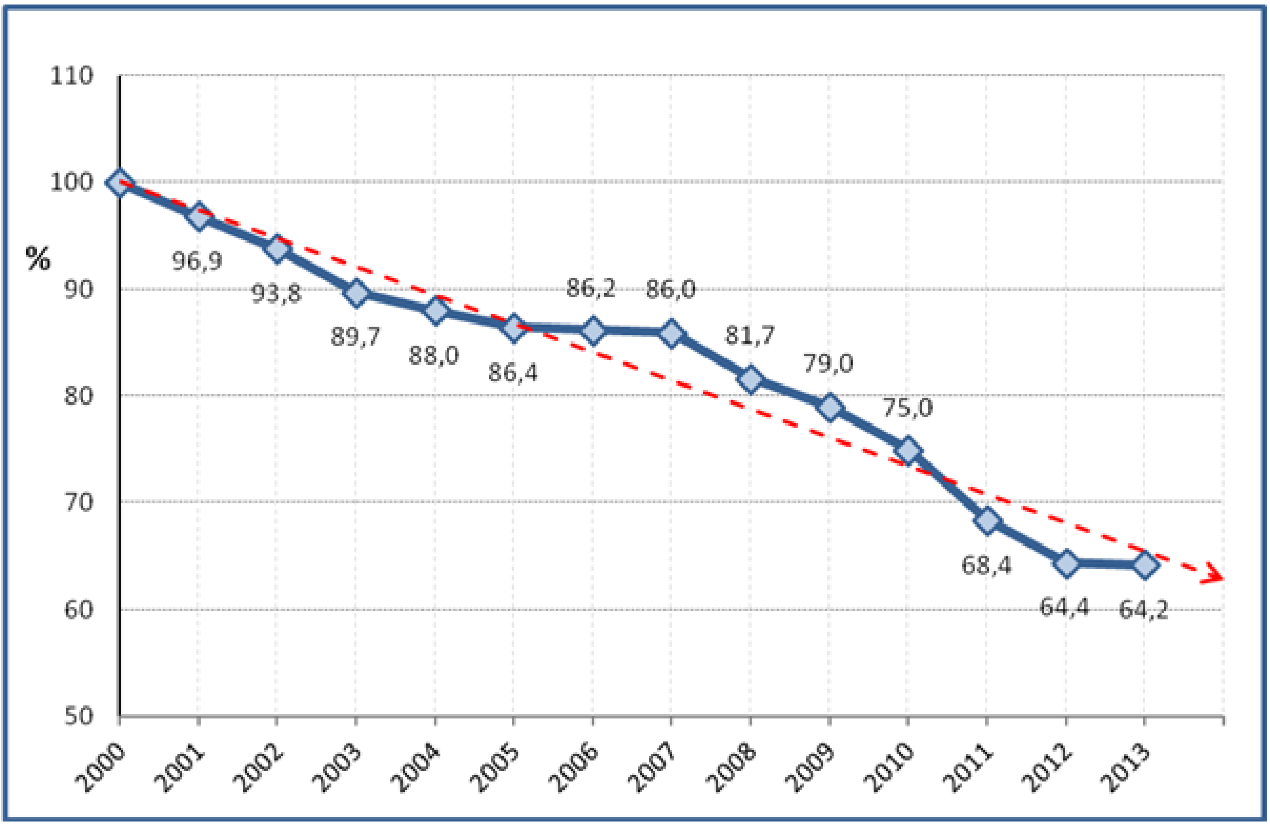


FIGURE 4-11 NMVOC EMISSIONS FROM THE SOLVENT AND OTHER PRODUCT USE SECTOR IN THE PERIOD 2000–2013

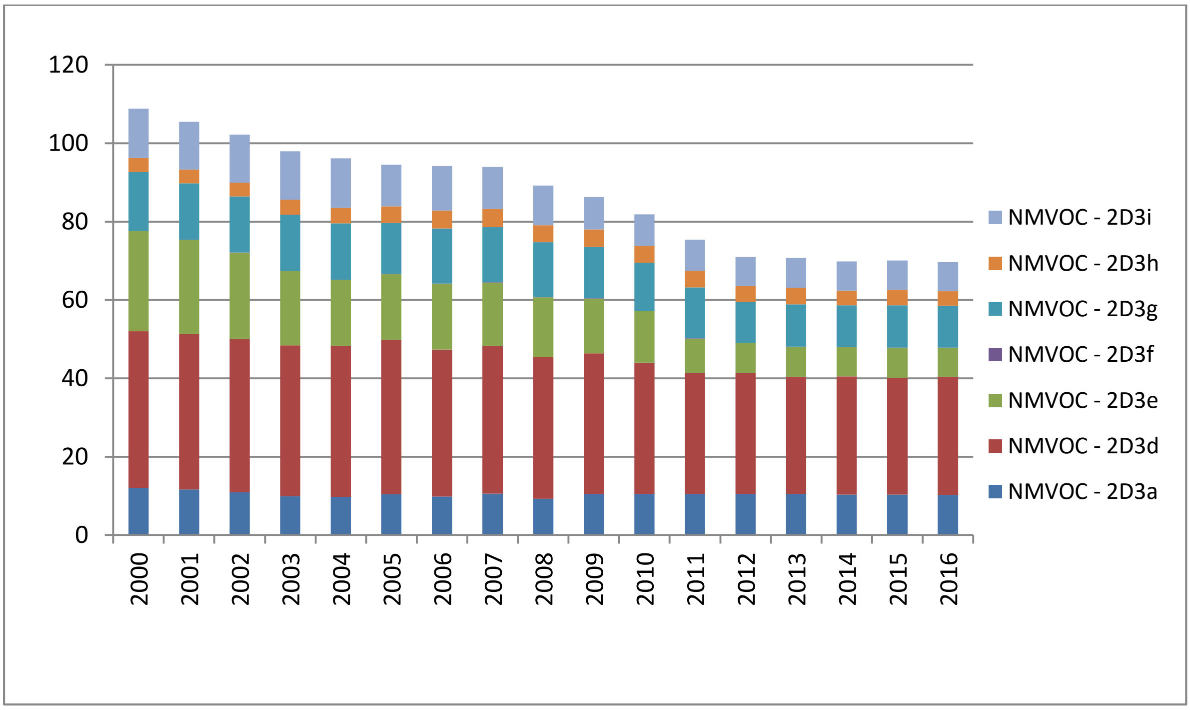


FIGURE 4-12 NMVOC EMISSIONS FROM THE SOLVENT AND OTHER PRODUCT USE SECTOR IN THE PERIOD 2000–2016 (MAIN SECTORS)

Table 4-23 NMVOC emissions in the period 1990–2016 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

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
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
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
2015	70,12	10,30	29,88	7,60	0,06	10,83	3,86	7,59
2016	69,71	10,22	30,18	7,41	0,06	10,71	3,62	7,51

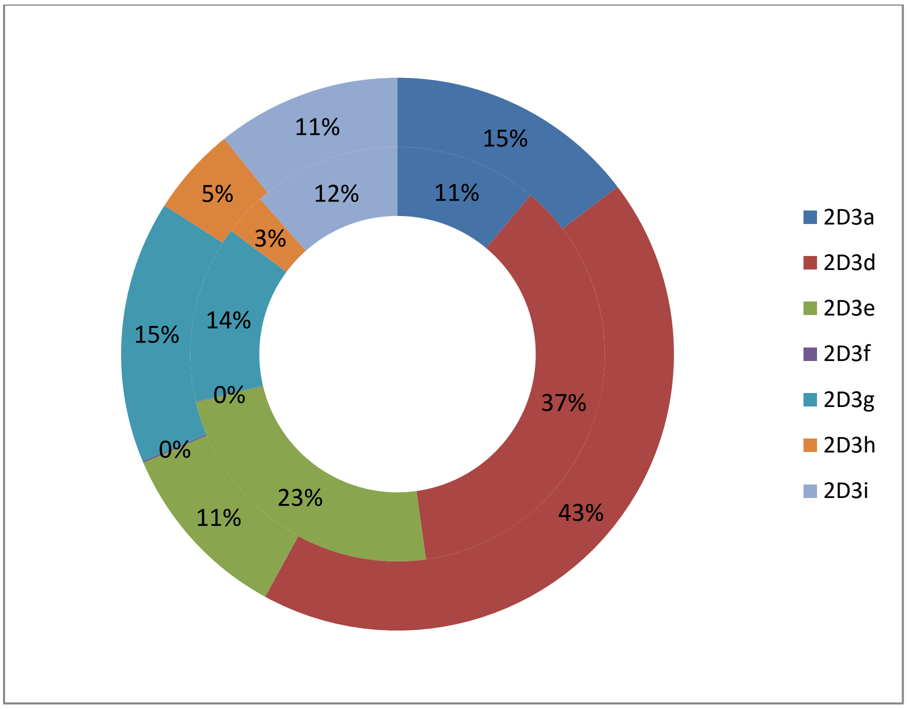


FIGURE 4-13 THE SHARE OF NMVOC EMISSIONS IN 2000 AND 2016 BY NFR 2D SUBCATEGORY CODES

Severe measurements were implemented for the reduction NMVOC 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 obsolate facilities.

Secondary measures have important influence in reduction of VOC emission too. These measures are mainly good 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 4-24 together with emission sources.

TABLE 4-24 INFORMATION SOURCES FOR THE NMVOC INVENTORY UNDER NFR 2.D.

NFR	Product group	SNAP	Activity where used	Reference, information sources
2.D.3.d	Coating application	060101	Manufacturing 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
		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

NFR	Product group	SNAP	Activity where used	Reference, information sources
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; 2.G	Other solvent and product use	060401	Glass wool enduction	Czech Statistical Office, expert estimate
		060402	Mineral wool enduction	Czech Statistical Office, expert estimate
		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 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) manufacturing 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

NFR´09	Source	description	SNAP activities
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	060107 060108 060109

4.7.3.2 METHODOLOGICAL ISSUES

Inventorying of NM VOC emission sector was made as research project VaV 520/3/97 "Establishment and performing of the National program of decreasing emission of NM VOC". While solving of this project there was turned to using NM VOC. One of the results was detailed inventory in the CORINAIR structure and verification earlier emission inventories. 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 for all types of paints. 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 of 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 Orders (No. 350 to 354/2002 Co.) and four Decrees of the Ministry of the Environment (No. 355 to 358/2002 Co.).

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

ACTIVITY DATA

In 1994–1997 there was made very detailed inventory study. A lot of companies were visited and information about technologies, emissions as well as 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 repairs.

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 there were emissions calculated based on activity data obtained 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 based on 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 SNAPs.

4.7.3.3 INVENTORY – CALCULATION PARTICULAR SNAP CATEGORY

SNAP 060101 MANUFACTURE OF AUTOMOBILES

In Czech Republic 1 344 182 cars were produced in 2016. The emissions are calculated using emission factor 35 g/m^2 .This EF was valid in time building all producer capacities (Škoda auto, TPCA and Hyundai). Automotive areas are based on BREF and expert's knowledge.

TABLE 4-26 TYPE OF AUTOMOBILES

Type of car	Area (m^2)	Production	emission (t/year)
Small	60	199 080	418.1
Big	90	1 145 102	3 607.0
Total emission			**4 025**

Data verification using EF from Guidebook

EF = 8 kg VOC/car,
All emission = 10 753 t
Abatement, average value 60 %; all emission after abatement 4 301.4 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 exist without obligation of making reports about VOC consumption.

Inventory calculation is based on technical expert estimate

In Czech Republic passengers car are registered 4 787 849 by the end of 2013. 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 860 t.

Data verification using EF from Guidebook

Total consumption paints	1 075.5 t	(technical estimate)
EF from guidebook	720 g/kg Paint	
Total emission	775 t VOC.	

The difference of both values is less than 10 %.

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	10 565 284 person
Used EF from Guidebook	EF 0,522 g/person
Emission is	5 515 t

Verification

Czech Republic are	4 380 000 household
Consumption paints	2,2 to 3,0 kg (from survey)
VOC Content assumption	40 %
Emission is	5 256 t

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

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 m^2 Al sheet
	13 945 312 m^2 Fe sheet
EF from Guidebook	90 g/m^2
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. Considering on the 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 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 2.D.3.e and 2.D.3.f)

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 4-27.

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) 409.8 t

Estimated emission		
number of middle source are 2650 (consumption to 500 kg)	emission	1 416 t
number of small source are 30 000 (consumption to 100 kg)	emission	3 000 t
total VOC emission		**4 825 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.

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 2016, NMVOC emissions from the NFR 2.D.3.g sector is 11 % 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	80
Total shown consumption solvents	3 662 t
Total shown emission VOC	280,3 t
Emission increase of 30%	364,4 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 4-28.

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

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 law (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 NMVOC 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;
- 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 (N2O) and methane (CH4) 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) is the most significant 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 2016 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 6 - 7 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. The Czech legislation is regularly revised and amended to fulfil new requirements of European legislation on the air protection.

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.

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 - Sheep

3B3 - Swine

3B4a - Buffalo

3B4d - Goats

3B4e - Horses

3B4f - Mules and asses

3B4gi - Laying hens

3B4gii - Broilers

3B4giii - Turkeys

3B4givt - 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

Based on the TETR review and recommendations, ammonia emission recalculation was performed by the end of the year 2017. Initially the emission of each category 3B from manure management also included the ammonia emission in category 3Da2a (Animal manure applied to soil). This approach was methodologically wrong, therefore the inadequacies were corrected. The ammonia emission recalculation also included new facts in rabbits population in the years 2005 – 2016, published at http://eagri.cz/public/web/file/542815/Zemedelstvi_2016_web.pdf and the emission in this category (3B4h) was revised. There were recalculated the whole time series since 1990 until 2016. The Figure 5-1. below show ammonia emissions in category 3B (Manure management) and presents the decreasing trend of ammonia emissions since 1990. The Figure 5-2 presents ammonia emission in category 3Da2a (Animal manure applied to soil).

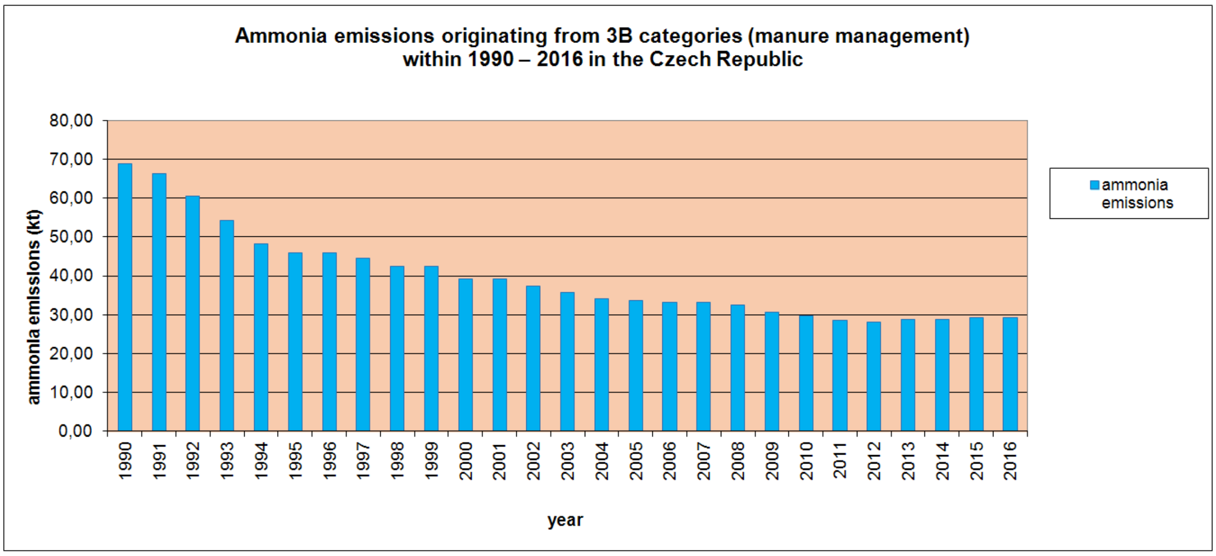


FIGURE 5-1 AMMONIA EMISSIONS ORIGINATING FROM 3B CATEGORIES WITHIN 1990 – 2016 IN THE CZECH REPUBLIC

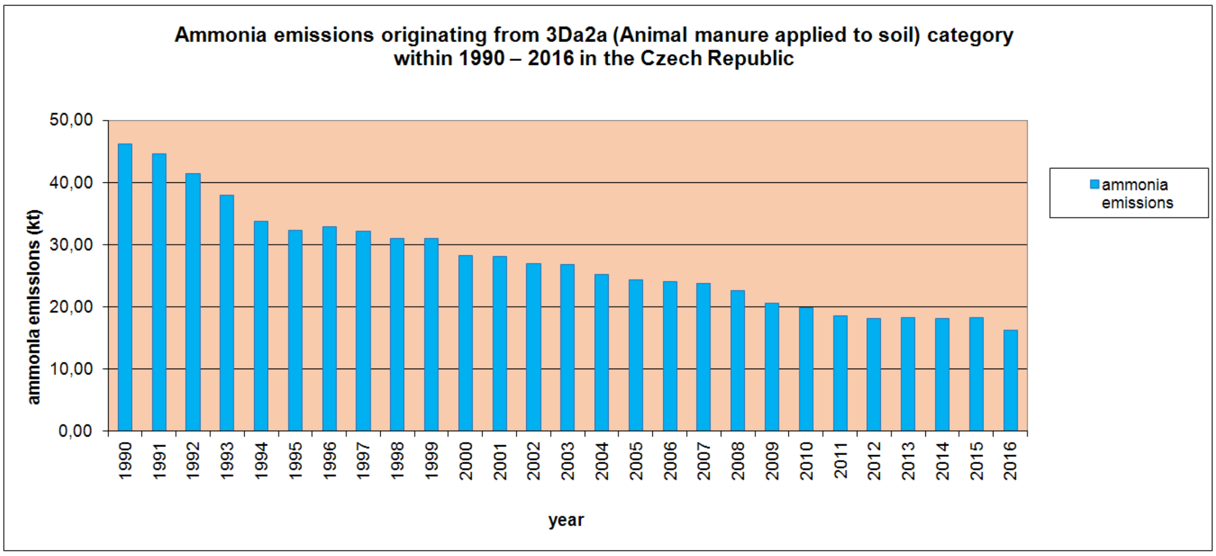


FIGURE 5-2 AMMONIA EMISSIONS ORIGINATING FROM 3DA2A CATEGORY WITHIN 1990 – 2016 IN THE CZECH REPUBLIC

Between 1990 and 2016 total ammonia emissions originating from categories 3B and 3Da2a have reduced by 60 %. 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 since 2002. Although a slight increase of animal population (cattle) is seen in recent years, ammonia emissions originating from categories 3B and 3Da2a have reduced by 22 % between 2005 and 2016.

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 2016. 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 5-1 animal population in the period 1990 – 2016 is shown.

TABLE 5-1 ANIMAL POPULATION IN THE PERIOD 1990-2016 (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	2015	2016
Cattle	1 343 686	1 353 685	1 352 822	1 373 560	1 407 132	1 415 658
Pigs	1 749 092	1 578 827	1 586 627	1 617 061	1 559 648	1 609 945
Poultry	21 250 147	20 691 308	23 265 358	21 463 815	22 508 192	21 313 958

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 implementation of regulation No. 377/2013 on manure storage and its utilisation 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 excrements 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 utilisation in the livestock breeding in the Czech Republic.
Compared to 2015, reducing effects on ammonia emissions resulting from slurry incorporation into soil within 24 hours after application were included in national emission factors in 2016. This obligation was incorporated in Czech legislation in 2009 with adaptation period 2009 – 2016 for farms to get equipped with suitable technology (slurry applicators, ploughs etc.) enabling to fulfil this duty.
The used country specific emission factors for key category of animals used in the Czech Republic for calculation of national ammonia emission balance since 2016 are introduced in Table 5-2.

TABLE 5-2 AMMONIA EMISSION FACTOR FOR KEY ANIMAL CATEGORY

animal category	national emission factors ($kgNH_3.ks^{-1}.rok^{-1}$)			
	housing + manure storage	manure application	pasture	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	8.4		21.0
cattle over 2 years (other categories) - solid	31.7		1.8	33.5
piglets - solid	1	1.8		2.8
sows - solid	3.1	3.4		6.5
sows - liquid	4.1	4.8		8.9
farrowing sows - solid	8.6	5.6		14.2
farrowing sows - liquid	7.4	8		15.4
rearing pigs - solid	3.1	2.1		5.2
rearing pigs - liquid	4.1	3.1		7.2
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

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 2016. Total nitrogen in manure was assessed and integrated into the Czech implementation of 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 2016. 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

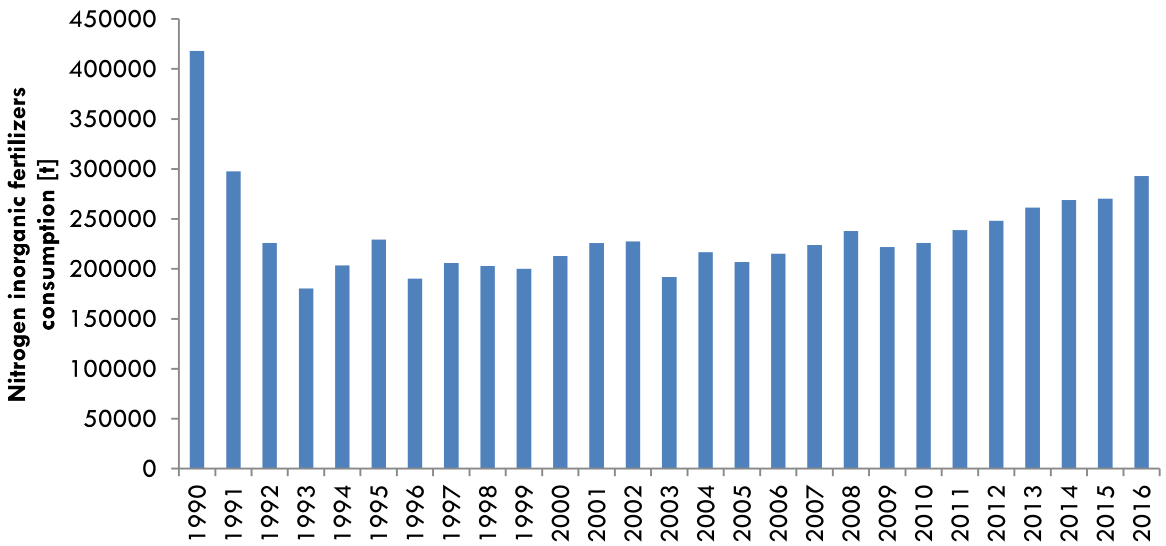


FIGURE 5-3 TREND OF ANNUAL USE OF NITROGEN INORGANIC FERTILIZERS IN 1990-2016 [T]

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 $kg.ha^{-1}$

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 5-4). 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.

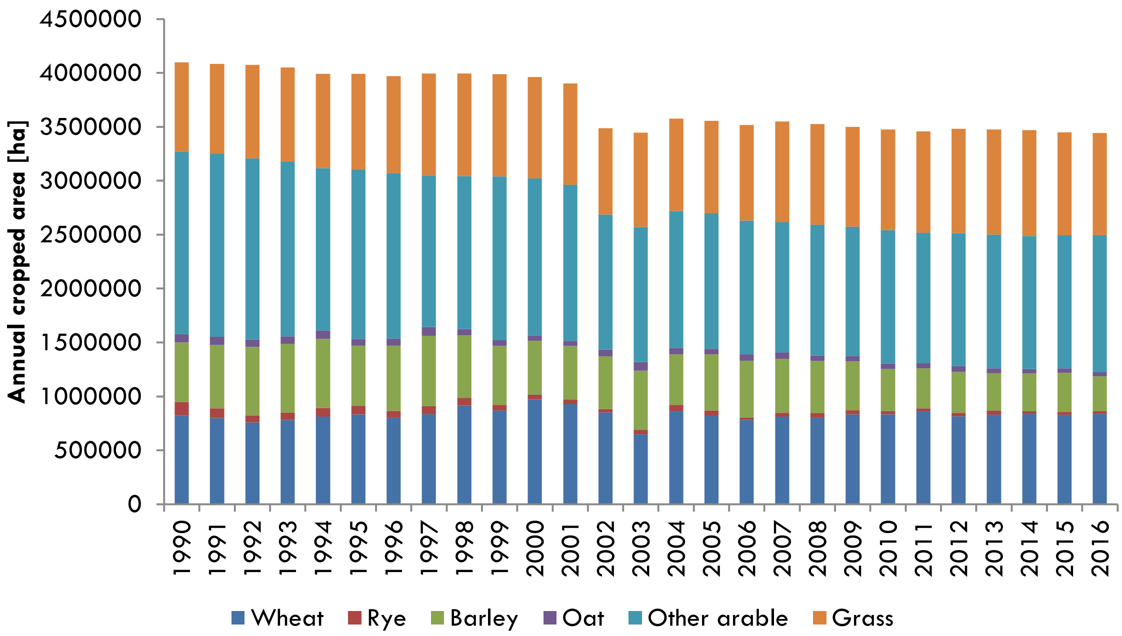


FIGURE 5-4 TREND OF ANNUAL CROPPED AREA IN 1990-2016 [HA]

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 5-3). 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 5-3 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 BIOLOGICAL TREATMENT OF WASTE – SOLID WASTE DISPOSAL ON LAND (NFR 5A)

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 excluding NMVOC.

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, version 2016 (Tier 1 approach). On the recommendation of the Technical Expert Review Team (TERT) emissions were recalculated using default emission factors. Initially, the lower level of EFs were used because of used technology. All large landfills (with capacity restriction pursuant to Annex 1, point 5.4. of Act No. 76/2002 Coll. on the integrated prevention) comply with the emission limitation principles in accordance with integrated permit (compaction, scrubbing, covering with inert material etc.). Moreover, most landfill gas in the Czech Republic gets extracted and burned in cogeneration units with energy recovery for different sectors according to NACE classification. It predominantly takes place in NFR sectors 1A4ai and 1A2gviii. There are no estimates available on the emission factors for the other pollutants.

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).). The basic source for aggregated information on waste production and treatment is data on annual reports from originators and authorized persons sent to the ISPOP. This database can be queried by year, area, treatment method and waste catalogue number. The whole republic and all types of waste were chosen in this case.

6.2.3 TREND IN CATEGORY 5A

Table 6. 2. presents the actualized amounts and proportions of deposited and incinerated solid municipal waste in the monitored time frame. Amounts of deposited waste were obtained also from ISOH, but only waste with catalogue number 20 03 01 (municipal waste) was selected. It is apparent that the proportion of landfilled waste is notably high although in the last years it has been decreasing slightly in favour of incineration (see also chapter 6.5.3 – 5C1a). Pursuant to State Energy Policy and Decree 352/2014 Coll., on the Waste Management Plan of the Czech Republic for period 2015–2024, amount of deposited municipal waste will continue to decrease together with increase of fees until it will be completely terminated in 2024. Emissions from deposited waste change depending exclusively on its amount.

TABLE 6-2 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	2 183	414	2 597	15.9 %	84.1 %
2003	2 379	406	2 784	14.6 %	85.4 %
2004	2 464	410	2 874	14.3 %	85.7 %
2005	2 562	387	2 949	13.1 %	86.9 %
2006	2 655	393	3 048	12.9 %	87.1 %
2007	2 716	391	3 106	12.6 %	87.4 %
2008	2 780	377	3 158	11.9 %	88.1 %
2009	2 757	360	3 116	11.5 %	88.5 %
2010	2 580	486	3 066	15.8 %	84.2 %
2011	2 420	613	3 034	20.2 %	79.8 %
2012	2 286	634	2 920	21.7 %	78.3 %
2013	2 201	638	2 838	22.5 %	77.5 %
2014	2 132	643	2 775	23.2 %	76.8 %
2015	2 071	632	2 703	23.4 %	76.6 %
2016	2 071	670	2 741	24.4 %	75.6 %

6.2.4 RECALCULATIONS IN NFR SECTOR 5A

Emissions of NMVOC, TSP, PM_{10} and $PM_{2.5}$ were recalculated using default emission factors in whole period 2000–2016 (see also chapter 6.2.2.). Activity data for historical period 1990–1999 are not available.

6.3 BIOLOGICAL TREATMENT OF WASTE – COMPOSTING (NFR 5B1)

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.

6.3.2 METHODOLOGY FOR COMPOSTING (NFR SECTOR 5B1)

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.

In previous years, for emission inventorying of composting plants were used only data reported by operators in the summary operation records based on the emission limits set in the permits of the individual sources. On the recommendation of the Technical Expert Review Team (TERT) emissions of NH_3 were calculated using emission factor from EMEP/EEA Air Pollutant Emission Inventory Guidebook, version 2016 (Tier 2).

Activity data (amount of composted waste) were obtained from Waste Management Information System (ISOH). For detailed information about this country-wide database, see chapter 6.2.2. Activity data are available since 2005, in previous years the symbol "NE" was used. Emissions of the other pollutants, reported by operators, were removed.

6.3.3 TREND IN CATEGORY 5B1

Trend in composting of organic waste shows Figure 6-1

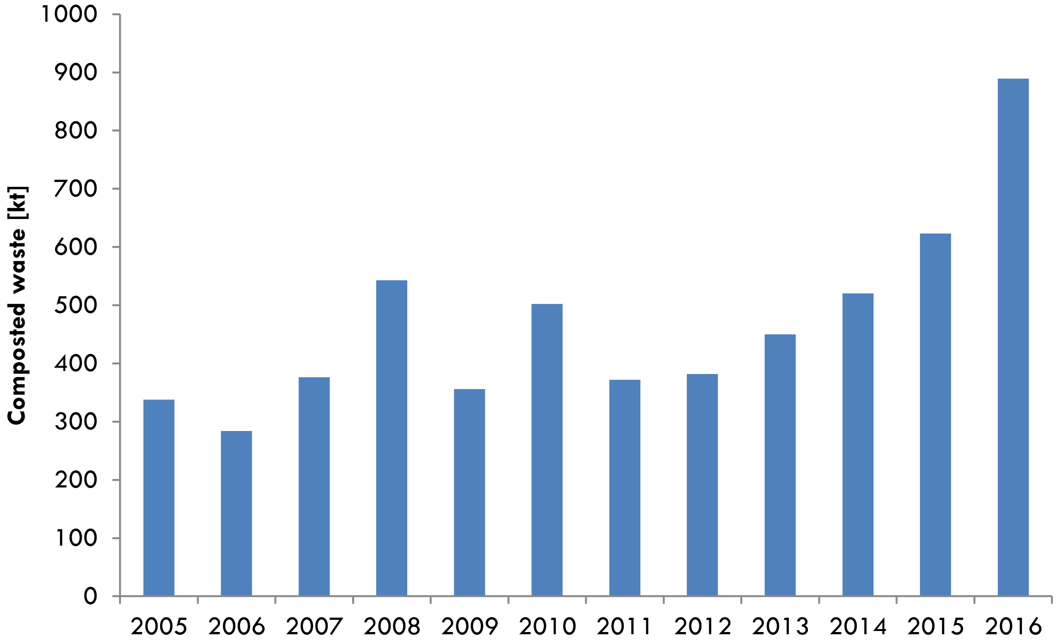


FIGURE 6-1 AMOUNT OF COMPOSTED ORGANIC WASTE IN PERIOD 2005–2016.

It is evident, that its amount increases significantly recently due to mainly rising interest in minimization of waste and its ecological utilization. Emissions of NH_3 depend exclusively on activity data, because composition of composted waste is almost constant.

6.3.4 RECALCULATIONS IN NFR SECTOR 5B1

Emissions NH_3 were calculated starting from year 2005, from which activity data are available. Emissions of the other pollutants, reported by operators, were removed (see also chapter 6.3.2.).

6.4 BIOLOGICAL TREATMENT OF WASTE –ANAEROBIC DIGESTION AT BIOGAS FACILITIES (NFR 5B2)

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. In 2016, 324 biogas stations were in operation in the Czech Republic.

6.4.2 METHODOLOGY FOR ANAEROBIC DIGESTION AT BIOGAS FACILITIES (NFR SECTOR 5B2)

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

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 reported by operators in this category come from emergency flares burning the excessive biogas. These emissions are included in various sectors according to NACE classification, mostly in 1A4ci.

6.5 WASTE INCINERATION (NFR 5C1a–5C1biv)

6.5.1 SOURCE CHARACTERISTIC

In these categories there 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 2014–2016, therefore symbol “NO” was used.

Most of facilities use heat generated by waste incineration. For smaller incinerators there 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 geographic 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 after 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 2000–2016 and 1990–1999 was different and is therefore described for each period separately.

6.5.2.1 METHODOLOGY FOR PERIOD 2000–2016

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 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, Tier 1 (Zn, Se). PM_{10} and $PM_{2,5}$ emissions are determined based on information about TSP 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 6-3.

TABLE 6-3 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)	PCBs (mg/t)
5C1a	24.5	11.7	0.7	3.15	3,15	0.10666	0.15	0.0000156
5C1bi	21000	150	0.6923	3.03845	3.03845	0.10666	0.139	4.150757

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)	PCBs (mg/t)
5C1biii	21000	150	0.6923	3.03845	3.03845	0.10666	0.04559	1.726015
5C1biv	21000	150	0.6923	3.03845	3.03845	0.10666	0.139	4.150757

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, PCBs, PM_{10}, $PM_{2,5}$ and BC) are calculated according to the methodology used for the period 2000-2016.

Specific emission factors set for purposes of emission inventory for the categories 5C1a–5C1biv in 1990-1999 are presented below inTable 6-4 and Table 6-5.

TABLE 6-4 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 6-5 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

Emissions reported in categories 5C1a–5C1biv include emissions from fuels used (it is possible due to low consumption). As additional fuel natural gas is mostly used, to a lesser extent liquid fuels.

6.5.3 TREND IN CATEGORY 5C1a

Figure 6-2 illustrates trend in amount of incinerated municipal waste in whole monitored period 1990–2016.

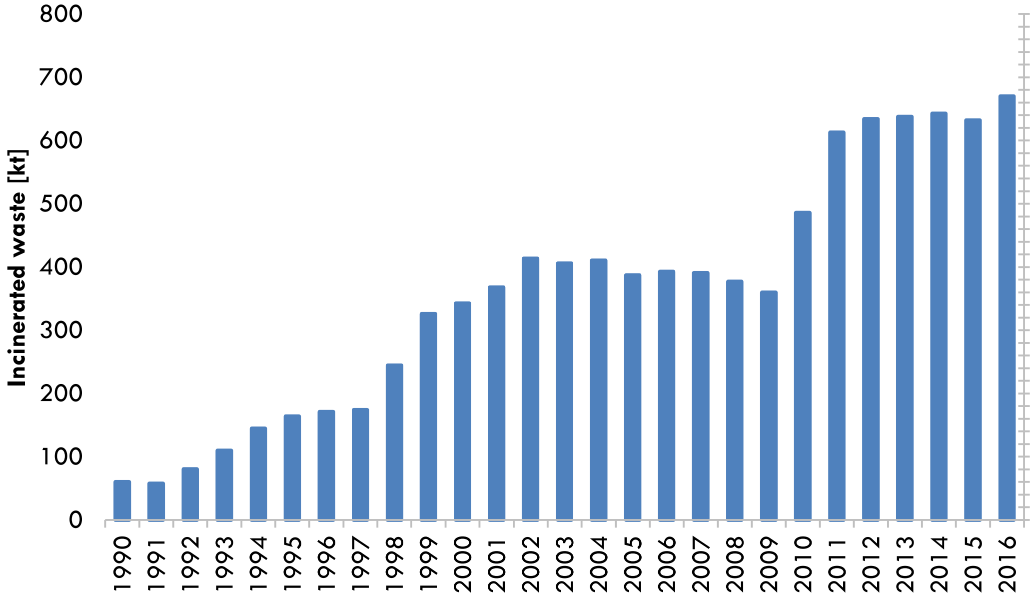


FIGURE 6-2 AMOUNT OF INCINERATED MUNICIPAL WASTE IN PERIOD 1990–2016.

There are currently four facilities for energetic utilisation of waste in the Czech Republic. Three of them: 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 were operated throughout the whole monitored timeframe 1990–2016. 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 clear from Figure 6-2 that the amount of incinerated waste has significantly increased in the last years. 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. The reconstruction mentioned above explains decrease of waste amount in 2009 when the plant was shut down. In the summer of 2016 new facility was put into operation: Plzeňská teplárenská, a.s. – Facility for energetic utilisation of waste Chotíkov.

Emissions of all pollutants in the period 2002-2016 show high consistency and mainly depend on the amount of waste.

In comparison with above mentioned period, 1990–2001 data show significant extremes. 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 TRENDS IN CATEGORIES 5C1bi–5C1biv

Figure 6-3 illustrates trend in amount of other waste types (industrial, clinical, sewage sludge) total and divided into individual NFR categories incinerated in whole monitored period 1990–2016.

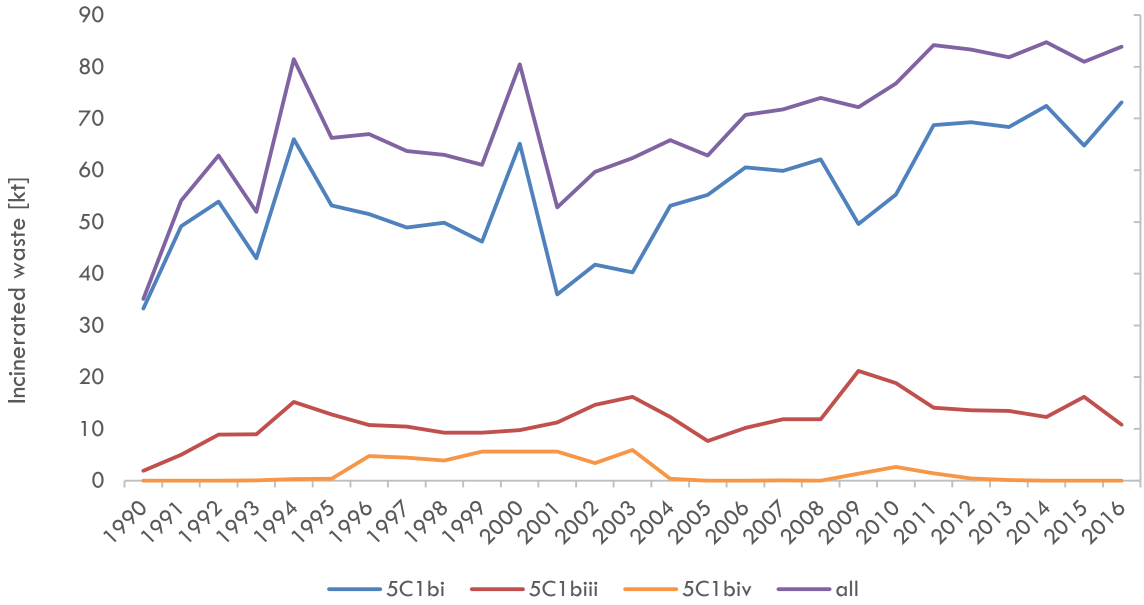


FIGURE 6-3 AMOUNT OF OTHER WASTE TYPES INCINERATED IN PERIOD 1990–2016

It is apparent that predominant type in whole reporting period is industrial waste. Amount of all types was very variable, especially in the period 1990–2001. Number of the facilities was also 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 of waste varied same as in category 5C1. This fact is also reflected in the variable amount of emissions of all pollutants.

In the period 2002-2016, following the adoption of the new legislation, slightly increasing trend in the amount of incinerated waste was stabilized. 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.

6.6 CREMATION (NFR 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)

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 415/2012 Coll., Point 6.13. Crematoria. They are set for TSP, NO_x, CO and NMVOC. 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). They are determined by periodic measurements with interval once a three calendar years. 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 6-6.

TABLE 6-6 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).

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 Science and are presented below in Table 6-7. 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 6-7 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
2000	75.94
2005	84.66
2008	84.72

6.6.3 TREND IN 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. These are the total emissions including emissions from fuels used that are minor due to low consumption.

As is apparent from Table 6-7, share of cremations has increased rapidly in monitored period, it has stabilized since 2005. Moreover, cremations of pets were started only in 2003.

6.7 OTHER WASTE INCINERATION (NFR 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 5C2)

This category includes e .g. open burning of crop residues, wood, leaves, straw or plastics.

Pursuant to § 16 paragraph 4 of Act 201/2012 Coll. only dry plant matter uncontaminated by chemical substances may be burned in an open fireplace. The municipality may issue a decree to establish the conditions for burning dry plant material in open fireplaces for the purpose of its disposal or place a ban on its burning.

Pursuant to § 19 of Regulation 415/2012 Coll. dry vegetable waste is not classified as waste but as biomass, symbol “NO” therefore was used.

6.9 WASTEWATER HANDLING (NFR 5D1–5D3)

6.9.1 SOURCE CHARACTERISTIC

Waste water treatment is the process of removing contaminants from wastewater, both municipal and industrial. Waste water treatment plants are only an insignificant source of NMVOC. There are divided mainly by the type of the purification process: mechanical, biochemical and chemical. Large plants generally combine more of purification processes. Further cleaning takes place in so-called recipient, i. e. natural watercourse.

Discharge of waste waters into recipients is governed by Act 254/2001 Coll. (water Act) and by its implementing regulations.

For waste water treatment plants (both domestic and industrial), only technical condition of operation is set in Annex 8 to the Regulation 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)

In the Summary operation records are reported emissions NO_x, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO originating from flares. These emissions were removed from sectors 5D1-5D2 and included in 1A4ai (5D1) and different industrial sectors according to NACE classification (5D2).

Emissions NMVOC from waste water treatment were supplemented. Activity data, i.e. amount of waste water discharged into sewerage system, were obtained from public database of Czech Statistical Office (CZSO). Data are available in division mentioned above since 2003, only total amount in years 2002-2002 is known. In this period, all emissions were reported in predominant sector 5D1, for 5D2 symbol "IE" was used. Historical data 1990–1999 are not available. Emission factor for NMVOC was adopted from EMEP/EEA Air pollutant Emission Inventory Guidebook, version 2016 (Tier 1). Activity data for sector 5D3 are not available.

6.9.3 TREND IN CATEGORIES 5D1-5D2

Trend in amount of discharged waste water in period 2003–2016 is illustrated bellow in Figure 6-4.

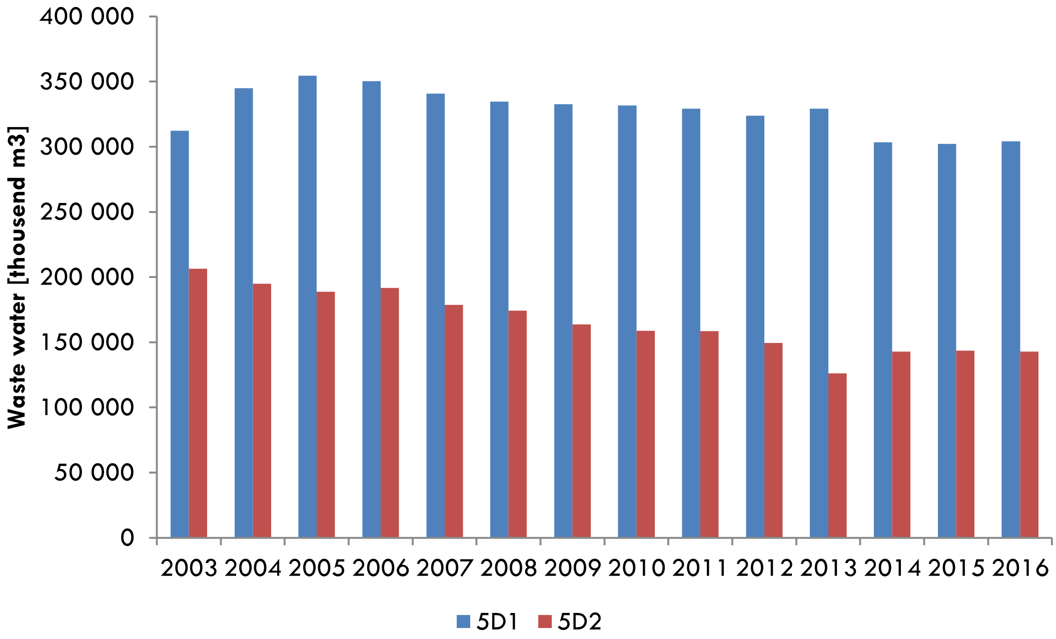


FIGURE 6-4 TREND IN WASTEWATER HANDLING IN THE PERIOD 2003–2016

6.9.4 RECALCULATIONS IN NFR SECTORS 5D1–5D2

Emissions NMVOC in division into categories 5D1 and 5D2 were calculated for period 2003–2016. In years 2000–2002 all emissions were reported in predominant sector 5D1, for 5D2 symbol "IE" was used. Historical data 1990–1999 are not available (see also chapter 6.9.2.). Emissions from flares reported by operators were removed.

6.10 OTHER WASTE (NFR SECTOR 5E)

6.10.1 SOURCE CHARACTERISTIC

This sector includes biodegradation and solidification facilities and sanitation facilities. The facilities mentioned above reduce the danger that waste poses to the environment. In addition, car and building fires are included in this category.

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.

6.10.3 CAR AND BUILDING FIRES

6.10.3.1 SOURCE CHARACTERISTIC

In accordance with EMEP/EEA Air pollutant Emission Inventory Guidebook, version 2016, accidental fires of car and buildings are included in this category. Emissions of particulates, some heavy metals and PCDD/F are predominantly emitted.

6.10.3.2 METHODOLOGY FOR CAR AND BUILDING FIRES

For emission inventorying emission factors from EMEP/EEA Air pollutant Emission Inventory Guidebook, version 2016, in division into EFs for fires of cars, apartment buildings, detached houses and industrial buildings were used (Tier 2).

Activity data (number of fires) were obtained from Statistical Yearbooks of Fire Rescue Service of the Czech Republic (FRS CR). They are available since 1991 and are accessible to the public on http://www.hzscr.cz/clanek/statisticke-rocenky-hasicskeho-zachranneho-sboru-cr.aspx. Data since 2004 are available also in English on http://www.hzscr.cz/hasicien/article/statistical-yearbooks.aspx.

6.10.3.3 TREND IN CATEGORIES 5E (CAR AND BUILDING FIRES)

Fire numbers of cars, apartment buildings, detached houses and industrial buildings are illustrated bellow in

FIGURE 6-5 NUMBER OF FIRES IN 1991–2016

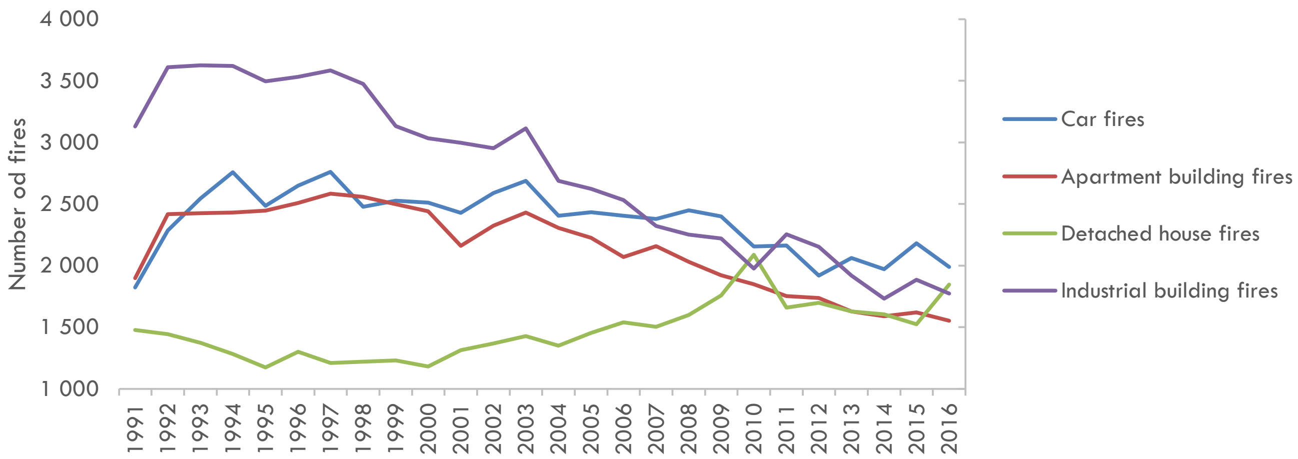


FIGURE 6-5 NUMBER OF FIRES IN 1991–2016

Accidental fires of car and buildings are mostly caused by negligence (smoking, incorrect heater operation, manipulation with burning ashes, ignition of food by cooking, incorrect handling, etc.) or technical failures. Atmospheric conditions (drought, direction and speed of wind, etc.) also have a great impact. The decreasing trend indicates mainly the influence of escalating fire prevention.

6.10.4 RECALCULATIONS IN NFR SECTOR 5E

Category 5E was in addition to originally presented activities (biodegradation, solidification and sanitation facilities) supplemented by car and building fires. Recalculation was carried out for the period 1991–2016 for which activity data are available (see also chapter 6.10.3.2.).

7 OTHER AND NATURAL EMISSION

7.1 VOLCANOES (NFR 11A)

There is no active volcano on the territory of the Czech Republic, there are only residues of volcanic activity from various periods of the geological past (about 20 extinct volcanoes), therefore symbol "NO" was used.

7.2 FOREST FIRES (NFR 11B)

7.2.1 SOURCE CHARACTERISTIC

In the case of forest fires, CO and NMVOC are emitted predominantly. To a lesser extent, emissions of NO_x, NH_3, SO_2 and particulates are produced.

7.2.2 METHODOLOGY FOR FOREST FIRES (NFR SECTOR 11B)

For emission inventorying emission factors from the EMEP/EEA Air pollutant Emission Inventory Guidebook, version 2016, were used (Tier 2). In the case of Czech Republic, EFs for temperate forests were chosen.

Activity data (hectares of burned area) were obtained from Statistical Yearbooks of Fire Rescue Service of the Czech Republic (FRS CR). They are available since 1996 and are accessible to the public on http://www.hzscr.cz/clanek/statisticke-rocenky-hasicskeho-zachranneho-sboru-cr.aspx.

For the period 1996–2016 emissions of NO_x, CO, NMVOC, SO_2 a NH_3 were calculated. For these pollutants, emission factors in kg/ha are stated. Emission factors for particulates including BC are stated in g/kg of wood, these data are not available.

7.2.3 TREND IN CATEGORY 11B

Figure 7-1illustrates development of forest areas affected by fire in 1996-2016.

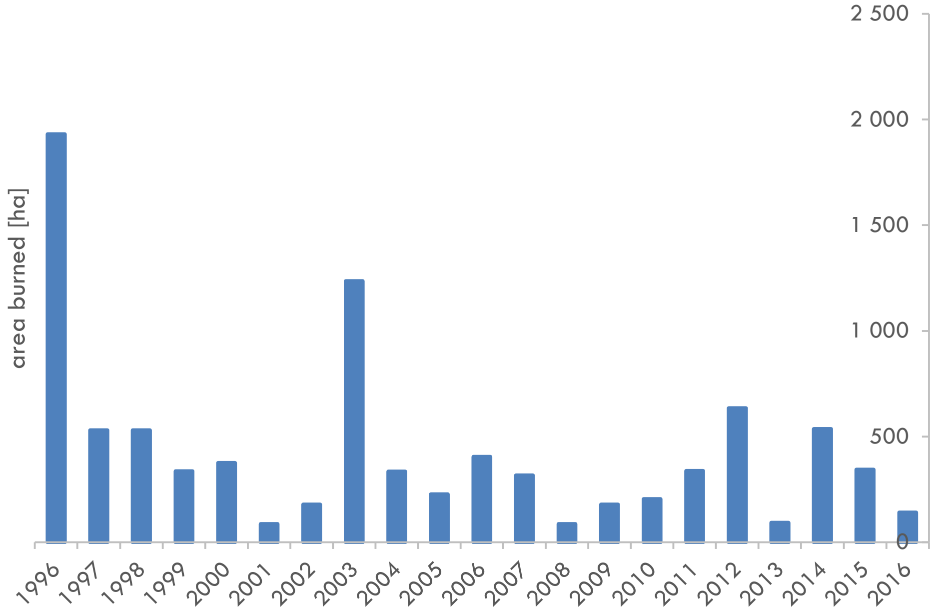


FIGURE 7-1 TREND IN FOREST FIRES IN THE PERIOD 1996–2016

Size of forest areas affected by fire depends mainly on atmospheric conditions (drought, hot weather, precipitation, direction and speed of wind, etc.). Forest fires can be caused either by natural origin (lightning strikes, self-ignition) or by negligence (smoking, setting fire in the wild).

7.2.4 RECALCULATIONS IN NFR SECTOR 11B

Emissions of NO_x, CO, NMVOC, SO_2 a NH_3 for category 11B were calculated in the period 1996–2016, for which activity data are available.

8 RECALCULATIONS AND IMPROVEMENTS

The first set of data for period 1990–2016 in NFR format 2014 was reported in 2018. Several corrections of reported data were performed including particularly:-

- Correction of CO emission for steel production in 2005 (+11 kt).
- Removal of some errors and duplicities in reported data (2008).
- Preliminary estimate (2014, 2015) of flared sulphur in refineries (+7 kt of SO2).
- Completion of household emissions estimate (water warming, update in fuel structure).

There are planned improvements in sector of road transport after implementation of COPERT 5 model at CDV in 2018. There was updated the tractor and non-road machinery fleet at VUZT and is expected recalculation of related time series.

Due to above mentioned improvements we expect to present updated submission by the end of spring 2018

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

Projections in energy and industrial sectors (1A1 and 1A2)

The scenarios of trends in the GDP used in this projection are based on predictions made by company EGÚ Brno, a. s., for the Electricity Market Operator (OTE). These projections are made every year and approved by a group of experts organized by the OTE.

Other important information for modelling emissions in energy and industrial sectors is the availability of domestic coal. Solid fuels, especially brown coal, will continue to be a decisive domestic primary energy source in the near future. These sources will depend on the binding nature of administrative territorial environmental limits on brown coal mining. Capacities of mining respects the Governmental decision 827/2015, which partially releases territorial environmental limits at the Bílina mine and keeps them at the ČSA mine. As regards brown coal prices, they are derived from hard coal prices. It is expected that the brown coal price will reach about 75% of hard coal price.

Quite dramatic development is observed in hard coal mining. Hard coal mining becomes cost ineffective and the mining company OKD shortened economically exploitable reserves. Moreover, in 2016 the OKD Company filed bankruptcy. The insolvency proceedings were kept off after all but the future of domestic hard coal mining is not very clear.

The energy consumption and production scenario of the projections is in compliance with the "Optimized scenario" of the State Energy Policy. The scenarios evaluated in the frame of the State Energy Policy were based on three priorities: safety – sustainability – competitiveness. Constrains were set for acceptable development of the primary energy mix and electricity generation. Various scenarios within these constrains were analysed. The "Optimized scenario" represents the most presumable energy system development.
The most important assumptions were used for model calculations of emissions:

a. The Temelín nuclear power plant will remain in normal operation for the whole monitored period (2000 – 2035).

b. The operation license for the Dukovany nuclear power plant will be prolonged and the power plant will be gradually decommissioned in the period 2035 – 2037.

c. The tender for new nuclear units in the nuclear power plant Temelin was cancelled and possible introduction of new nuclear units was postponed after 2030.

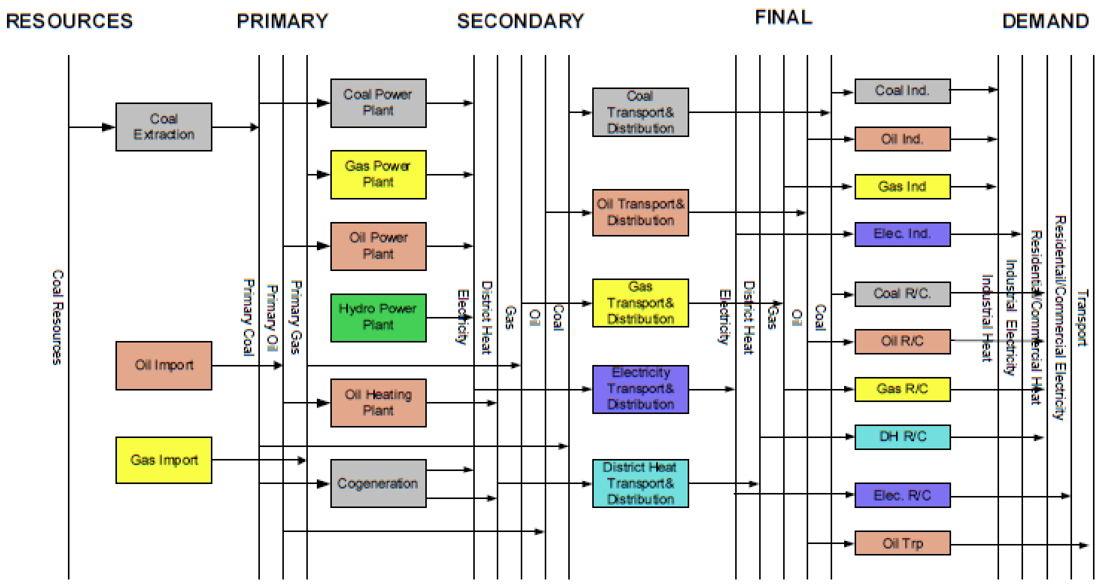
d. The territorial environmental limits on mining of brown coal will be retained at the ČSA mine and partly relaxed at the Bílina mine.

e. No limits will be introduced on the import of petroleum, gas and hard coal.

f. Imports and exports of electricity will be limited by technical capabilities of transmission lines.

The bottom-up MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impacts) model was used for the projections of basic pollutants from energy and industrial sectors. The model was developed at IIASA (International Institute for Applied Systems Analysis) and designed for the optimization of energy system. The main principle of the MESSAGE is optimization of an objective function under a set of constraints. The model uses input data for individual emission sources from the EU ETS database (e.g. emissions, fuel consumption and fuel parameters). Electricity, heat production and financial support of renewable sources are provided by Energy regulatory office. Energy or industrial companies are directly contacted to get information about future plans (constructions of new sources or shutdowns), technical details, life expectancy, investment and operating costs. The Ministry of Industry and Trade (The State Energy Policy) and OTE, a.s. provides information regarding the development of energy production and consumption. Further data are obtained from the association for energy information and statistics (ENERGOSTAT).

The model energy outputs are in compliance with the Czech Statistical Office energy balance and with the State Energy Policy.



The economic recovery after the recession in 2008-2009 is followed by a decrease of the total domestic consumption of primary energy sources (PES) after 2015. The energy saving tendency will overweigh or at least compensate the energy consumption growth driven by the growing economy in the following periods. The fluctuations of the PES consumption result from changes of electricity exports. The RES share is continually increasing in accordance with the State Energy Policy. The biggest role among RES plays and will play biomass.

The final energy consumption was strongly influenced by the economic recession starting in the year 2008. Therefore, an increase in energy efficiency will be compensated by the higher economic growth starting in 2014. A small energy consumption growth in tertiary and industrial sectors will partially offset a decline in the households sectors. The total final energy consumption shows a slight increase.

The total electricity generation from coal is decreasing. Gas, nuclear energy and renewable energy overtake the role of coal. The first new nuclear unit is planned for the year 2033 as partial replacement of the nuclear power plant Dukovany, which will be decommissioned in the period 2035 – 2037.

Due to preferential feed-in tariffs for electricity produced from renewable energy sources, namely electricity from photovoltaic panels, there was an extremely rapid increase of photovoltaic electricity production up to year 2010. Since the rapid growth of photovoltaic power plants caused a significant increase of electricity price, the government adopted measures to cut further installations of big photovoltaic plants after the year

2010. Further development of renewable energy sources is in accordance with the "Optimized scenario of the State Energy Policy.

As the demand for district heat, mainly in households, sinks the total district heat generation decreases. Heat generation from coal remains crucial for heat supply of households and so the coal share, in contrast to electricity generation, does not decline so quickly.
Contrary to fossil fuels, the RES share in heat generation shows a fast growth with biomass being the main driver. The increasing amount of biomass will be covered by energy crops and plants.

Combustion emissions in industry (1A2) were calculated according to the trends in gross added value in industry according to EGÚ Brno, a. s.

For the energy sectors 1A1 and 1A2 emission factors according to REZZO and latest inventory were used for the base year. For further years expected emission limitations due to new legislation (e.g. Industrial Emissions Directive and corresponding Czech legislation) were included.

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 on 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

PROJECTIONS OF INDUSTRIAL PROCESSES (SECTOR 2)

A combined procedure with the EFOM/ENV (company ENVIROS, s.r.o.) model and a table processor was used for projections of trends of activity data (production) in basic pollutants from industrial processes. The projection was concerned only with activities with a major contribution to emissions. Other emissions and

activities with a minor contribution were derived on the basis of an increase in GDP in the processing industry, amongst other things, because of the lack of information on potential future trends (e.g. production of steel, coke, polymers, nitric acid, etc.).
The implied emission coefficients from the latest inventory were used for emissions calculations.

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 there 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).

10 REPORTING OF GRIDDED EMISSIONS AND LPS

The preparation of gridded emissions for the year 2015 required extension of expert team for the sphere of GIS applications (IDEA ENVI, Ltd.). Emissions of individually monitored sources are being taken over into EMEP grid using coordinates of individual chimneys (approx. 50 thousand items) and emissions of collectively monitored sources are being splitted using area criterions among national totals reported in IIR.

10.1 EMISSION GRIDDING IN GNFR STRUCTURE FOR EMEP GRID

10.1.1 INDIVIDUALLY MONITORED SOURCES – POWER GENERATION, INDUSTRY, WASTE COMBUSTION ETC.

Each significant individually monitored source in emission database REZZO is identified besides by defined chimney coordinates. Less important sources are located by address site in RUIAN registry. Integral part of application for reporting preparation there also is the unique location of each source coordinates in EMEP grid. The processing of individually monitored sources therefore takes place in two steps:

- GNFR code allocation for each individually monitored source using previous NFR code allocation used for emission reporting.
- Summary emission of each GNFR at the level of each EMEP grid element, namely 0.1° x 0.1° grid cell.

10.1.2 COLLECTIVELY MONITORED SOURCES

For each source group the gridding take place into EMEP grid by using GIS. For some groups of sources, for example road transport, further information like 5-year transport census is being used for EMEP gridding. For emission distribution by use of solvents at smaller facilities (printing houses, car repair shops etc.) a specific model using number of inhabitants in town and villages is being applied. Emission allocation to each EMEP grid element takes place at most of categories at the lowest NFR level and consequently sum at GNFR level either using other categories of collectively monitored sources or sum of individually monitored sources is being done.

10.1.2.1 LOCATION USING NUMBER OF INHABITANTS AND HOUSEHOLD HEATING MODEL

The criterion of number of inhabitants in town and villages was used for emission distribution in 2D category – organic solvent use, paints and adhesives use in households by assessment of location size and its allocation considering number of communal service facilities for categories of non-industrial use of organic solvents, paints, adhesives and other VOC containing substances. Furthermore this criterion is being used for emission distribution for construction works (NFR 2A5b) and a part of non-road transport (NFR 1A2gvii, 1A4aii, 1A4bii a 1A5b).

For significant category of household heating 1A4bi that is part of GNFR C-Other Stationary Combustion, national emission calculation model for household heating (see3.5.1.2) is being applied. Emissions of each community or part of larger city are being allocated to central point of the built-up area of the community or part of it (in number of 6392) being attributed to individual part of EMEP grid..

10.1.2.2 LOCATION USING GIS LAYERS

Emissions of following categories are being allocated by specific GIS layers:

- Road transport emission using road network layer (accumulated routes of approx. 70% of road vehicles and uncounted routes); passenger, load and bus transport are being assessed separately
- Emissions of other means of transport (railways, water routes)
- Emissions of agricultural and forest machinery (NFR 1A4cii)

- Emissions of manure application (NFR 3Da1) and agricultural works (NFR 3Dc)
- Emissions of waste ze skladování (NFR 5A)

Emissions of following categories are being distributed by specific location methodology:

- Air transport emissions (LTO cycle) according public airport location
- Coal mining emissions (brown coal and hard coal) by assuming average emission for each part of EMEP grid in coal mining locations
- Emissions of livestock farming using case study
- Emissions of minerals mining using Mineral information system (SurIS) (NFR 2A5a)

10.2 LPS DATA

Last submission (data for year 2016) was provided in April 2018.

10.2.1 SOURCE CHARACTERISTIC

Large Point Sources (LPS) are defined as facilities whose emissions within one operation unit exceed at least one of the threshold values for the 14 pollutants identified in Table 1 of the EMEP Reporting Guidelines (SO_2, NO_x, CO, NMVOCs, NH_3, $PM_{2.5}$, PM_{10}, Pb, Cd, Hg, PAHs, PCDD/F, HCB, PCBs). Large Combustion sources with rated thermal input greater than 300 MW are also included.

10.2.2 METHODOLOGY FOR LPS

LPS are ranked among specified stationary sources and they are registered within the REZZO 1 category. The majority of data on pollutants is obtained from the Summary operation records, remaining emissions are calculated using national emission factors (see chapters for appropriate NFR sectors). NH_3 emissions for GNFR K (AGRICULTURE – LIVESTOCK) are not registered by the REZZO database, they were obtained from Integrated Pollution Register of the Environment (IPR). It is an electronic structured database about environmental pollution from the industrial and agricultural facilities accessible to the public in https://www.irz.cz/.
Individual sources of operation unit are aggregated according to GNFR sector and stack height classes listed in Table 2 of the EMEP Reporting Guidelines.

10.2.3 LPS IN THE CZECH REPUBLIC

For 2015, Czech Republic reported emissions from 570 facilities divided into 859 LPS. The largest share is livestock production (50 %), followed by industry (22 %).

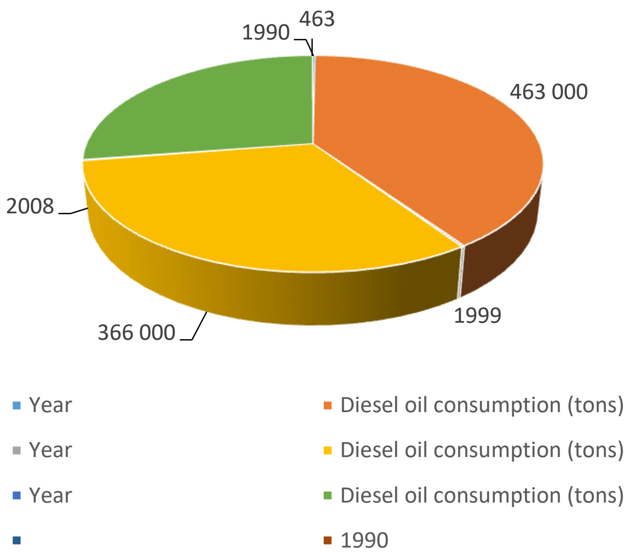


FIGURE 10-1 SHARE OF GNFRS IN THE TOTAL LPS NUMBER

11 ABBREVIATIONS

AD	*Activity Data*
CDV	*Transport Research Centre*
CEI	*Czech Environmental Inspectorate*
CHMI	*Czech Hydrometeorological Institute*
CME	*Czech Ministry of the Environment*
CS	*Country Specific*
CZSO	*Czech Statistical Office*
EFs	*Emission Factors*
EIG	*Emission Inventory Guidebook*
IPR	*Integrated Pollution Register of the Environment*
ISPOP	*Integrated System for Fulfilment of Reporting Duties*
MSW	*Municipal Solid Waste*
NR	*Not Reported*
REZZO	*Register of Emissions and Stationary Sources*
SVUOM	*National Research Institute for the Protection of Materials*
SWDS	*Solid Waste Disposal Sites*
VUZT	*Research Institute of Agricultural Technology*
WMP	*Waste Management Plan*

12 FIGURES

13 REFERENCES

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14 TABLES

15 APPENDIX

TABLE 15-1 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	1.653	0.125	2.24	0.829	9.1	1	9.7	45	8.8
		5 - 50	1.653	0.125	2.24	0.829	9.1	1	9.7	45	8.8
		50 - 100	1.653	0.125	2.24	0.829	9.1	1	9.7	45	8.8
		>100	4.071	0.292	2.965	0.76	9.1	1	3.374	45	8.8
Pulverized coal-fired boilers	Hard Coal	<5	0.515	0.048	0.476	0.122	4.5	7.8	3.399	23	19
		5 - 50	0.515	0.048	0.476	0.122	4.5	7.8	3.399	23	19
		50 - 100	0.515	0.048	0.476	0.122	4.5	7.8	3.399	23	19
		>100	2.722	0.268	0.668	0.339	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

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}
		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
		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
Fluidized bed boiler	Hard Coal	<5	0.515	0.048	0.476	0.122	4.5	9	3.399	23	90
		5 - 50	0.515	0.048	0.476	0.122	4.5	9	3.399	23	90
		50 - 100	0.515	0.048	0.476	0.122	4.5	9	3.399	23	90
		>100	0.515	0.048	0.476	0.122	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

	projekt VaV520/1/97	
	EMEP/EEA air pollutant emission inventory guidebook 2016, Tier 2	
	national emission factors [citace]	MODLÍK, M., 2017. Emisní faktory těžkých kovů a POPs ze spalovacích procesů. [Emission factors of heavy metals and POPs from combustion processes]. Praha: ČHMÚ. [online]. [cit. 5. 3. 2018]. Dostupné z WWW / Available at: http://portal.chmi.cz/files/portal/docs/uoco/oez/embil/EmisniFaktoryTKaPOPs.pdf
	expert estimation	

TABLE 15-2 SUMMARY OF POPS EMISSION FACTORS FOR BOILERS IN CATEGORY 1A1, 1A2, 1A4AI, 1A4CI

Type of fire place	Fuel type	Thermal capacity MW	PCDD_F ng.GJ^{-1}	BaP µg.GJ^{-1}	BbF µg.GJ^{-1}	BkF µg.GJ^{-1}	InP µg.GJ^{-1}	PAH µg.GJ^{-1}	HCB µg.GJ^{-1}	PCBs µg.GJ^{-1}
Fixed bed boiler	Brown Coal	<5	4.986	320.061	518.482	518.482	400.322	1757.347	6.7	5.059
		5 - 50	7.68	3.147	7.973	4.047	4.203	19.37	6.7	0.757
		50 - 100	7.68	3.147	7.973	4.047	4.203	19.37	6.7	0.757
		>100	7.68	3.147	7.973	4.047	4.203	19.37	6.7	0.757
Fixed bed boiler	Hard Coal	<5	14.657	10.975	18.54	10.966	5.956	46.437	6.7	8.073
		5 - 50	2.299	2.4	4.768	3.085	2.08	12.33	6.7	0.395
		50 - 100	2.299	2.4	4.768	3.085	2.08	12.33	6.7	0.395
		>100	2.299	2.4	4.768	3.085	2.08	12.33	6.7	0.395
Fixed bed boiler	Biomass	<5	100	10000	16000	5000	4000	35000	5	0.007
		5 - 50	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		50 - 100	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		>100	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
Pulverized coal-fired boilers	Brown Coal	<5	6.525	1.971	2.731	2.324	2.095	9.121	6.7	1.066
		5 - 50	6.525	1.971	2.731	2.324	2.095	9.121	6.7	1.066
		50 - 100	6.525	1.971	2.731	2.324	2.095	9.121	6.7	1.066
		>100	1.925	4.653	6.187	4.915	5.664	21.419	6.7	0.547
Pulverized coal-fired boilers	Hard Coal	<5	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
		5 - 50	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
		50 - 100	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
		>100	1.314	2.844	5.433	3.786	3.662	15.725	6.7	1.176
Pulverized coal-fired boilers	Biomass	<5	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		5 - 50	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		50 - 100	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		>100	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
Fluidized bed boiler	Brown Coal	<5	2.778	5.148	7.621	5.321	5.559	23.649	6.7	1.449
		5 - 50	2.778	5.148	7.621	5.321	5.559	23.649	6.7	1.449

Type of fire place	Fuel type	Thermal capacity MW	PCDD_F ng.GJ^{-1}	BaP µg.GJ^{-1}	BbF µg.GJ^{-1}	BkF µg.GJ^{-1}	InP µg.GJ^{-1}	PAH µg.GJ^{-1}	HCB µg.GJ^{-1}	PCBs µg.GJ^{-1}
		50 - 100	2.778	5.148	7.621	5.321	5.559	23.649	6.7	1.449
		>100	2.778	5.148	7.621	5.321	5.559	23.649	6.7	1.449
Fluidized bed boiler	Hard Coal	<5	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
		5 - 50	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
		50 - 100	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
		>100	2.055	2.271	5.066	2.64	2.232	12.209	6.7	0.244
Fluidized bed boiler	Biomass	<5	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		5 - 50	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		50 - 100	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
		>100	11.348	46.462	144.329	67.897	33.073	291.761	5	2.233
All type of boilers	Liquid fuels	<5	2.5	3.678	12.673	3.968	6.484	26.803	-	3.334
		5 - 50	2.5	3.678	12.673	3.968	6.484	26.803	-	3.334
		50 - 100	2.5	3.678	12.673	3.968	6.484	26.803	-	3.334
		>100	2.5	3.678	12.673	3.968	6.484	26.803	-	3.334
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	-

	projekt VaV520/1/97	
	EMEP/EEA air pollutant emission inventory guidebook 2016, Tier 2	
	national emission factors [citace]	MODLÍK, M., 2017. Emisní faktory těžkých kovů a POPs ze spalovacích procesů. [Emission factors of heavy metals and POPs from combustion processes]. Praha: ČHMÚ. [online]. [cit. 5. 3. 2018]. Dostupné z WWW / Available at: http://portal.chmi.cz/files/portal/docs/uoco/oez/embil/EmisniFaktoryTKaPOPs.pdf
	expert estimation	

Summary of HMs emission factors for gas turbines and stationary engines in category 1A1, 1A2, 1A4ai, 1A4ci

Type of fire place	Fuel type	Thermal capacity	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
		MW	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$
Gas turbines	Gaseous fuels	-	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.0112	0.0015
Stationary engines	Gaseous fuels	-	0.04	0.003	0.1	0.05	0.05	0.01	0.05	0.2	2.91
Stationary engines	Liquid fuels	-	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81

Summary of POPs emission factors for gas turbines and stationary engines in category 1A1, 1A2, 1A4ai, 1A4ci

Type of fire place	Fuel type	Thermal capacity	PCDD_F	BaP	BbF	BkF	InP	PAH	HCB	PCBs
		MW	$ng.GJ^{-1}$	$\mu g.GJ^{-1}$	$\mu g.GJ^{-1}$	$\mu g.GJ^{-1}$	$\mu g.GJ^{-1}$	$\mu g.GJ^{-1}$	$\mu g.GJ^{-1}$	$\mu g.GJ^{-1}$
Gas turbines	Gaseous fuels	-	0.5	0.56	0.84	0.84	0.84	3.08	0.00308	-
Stationary engines	Gaseous fuels	-	0.57	1.2	9	1.7	1.8	13.7	-	-
Stationary engines	Liquid fuels	-	0.99	116	502	98.7	187	903.7	0.22	0.00013

Summary of HMs emission factors for rafinery gas

Type of fire place	Fuel type	Thermal capacity	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
		MW	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$	$mg.GJ^{-1}$
Process furnaces	Rafinery gas	-	1.79	0.712	0.086	0.343	2.74	2.22	3.6	0.42	25.5

Summary of POPs emission factors for rafinery gas

Type of fire place	Fuel type	Thermal capacity	PCDD_F	BaP	BbF	BkF	InP	Total_PaH	HCB	PCBs
		MW	ng TEQ.GJ^{-1}	µg.GJ^{-1}	µg.GJ^{-1}	µg.GJ^{-1}	µg.GJ^{-1}	mg.GJ^{-1}	µg.GJ^{-1}	µg.GJ^{-1}
Process furnaces	Rafinery gas	-	-	0.669	1.14	0.631	0.631	3.071	-	-

TABLE 15-3 EMISSION FACTORS - BROWN COAL, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	100.9	87.5	198.0	129.7	100.9	VEC VŠB
SO2	$g.GJ^{-1}$	712xSp	712xSp	712xSp	712xSp	712xSp	VEC VŠB
NH3	$g.GJ^{-1}$	0.3	0.3	0.3	0.3	0.3	EIG 2016
CO	$g.GJ^{-1}$	5078.1	4427.6	500.5	585.5	5078.1	VEC VŠB
NMVOC	$g.GJ^{-1}$	1449.1	429.2	12.2	42.9	1449.1	VEC VŠB
TSP	$g.GJ^{-1}$	947.1	179.5	43.9	22.6	947.1	VEC VŠB
PM10	$g.GJ^{-1}$	861.8	163.4	39.9	20.6	861.8	VEC VŠB[1)]
PM2.5	$g.GJ^{-1}$	848.6	160.8	39.3	20.3	848.6	VEC VŠB[1)]
BC	$g.GJ^{-1}$	54.3	10.3	2.5	1.3	54.3	VEC VŠB[2)]
As	$mg.GJ^{-1}$	8.0	8.7	19.2	16.4	8.0	VEC VŠB
Cd	$mg.GJ^{-1}$	0.3	0.6	0.5	0.9	0.3	VEC VŠB
Cr	$mg.GJ^{-1}$	83.4	3.0	11.4	9.7	83.4	VEC VŠB
Cu	$mg.GJ^{-1}$	10.2	5.3	25.6	7.9	10.2	VEC VŠB
Hg	$mg.GJ^{-1}$	8.8	2.6	3.0	1.8	8.8	VEC VŠB
Pb	$mg.GJ^{-1}$	14.1	24.2	41.4	19.7	14.1	VEC VŠB
Ni	$mg.GJ^{-1}$	7.9	3.3	7.1	7.1	7.9	VEC VŠB
Se	$mg.GJ^{-1}$	2.3	2.2	4.5	5.8	2.3	VEC VŠB
Zn	$mg.GJ^{-1}$	43.1	76.5	100.3	96.7	43.1	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	384.6	124.4	0.1	0.7	384.6	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	214.5	54.4	0.7	1.6	214.5	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	165.8	58.0	0.2	0.8	165.8	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	183.0	51.0	0.3	0.6	183.0	VEC VŠB
4PAH	$mg.GJ^{-1}$	947.9	287.8	1.3	3.7	947.9	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
HCB	$\mu g.GJ^{-1}$	2.0	2.0	0.7	0.5	2.0	VEC VŠB
PCDD-F	$ng\ TEQ.GJ^{-1}$	60.6	29.3	33.4	3.2	60.6	VEC VŠB
PCB's	$\mu g.GJ^{-1}$	3.3	1.4	0.6	0.5	3.3	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

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

Note.: [yellow highlight] The emission factors were taken from the measurement of the under-fire boilers.

TABLE 15-4 EMISSION FACTORS - HARD COAL, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	129.0	162.7	196.0	167.4	129.0	VEC VŠB
SO2	$g.GJ^{-1}$	712xSp	712xSp	712xSp	712xSp	712xSp	VEC VŠB
NH3	$g.GJ^{-1}$	0.3	0.3	0.3	0.3	0.3	EIG 2016
CO	$g.GJ^{-1}$	4935.4	2625.3	383.5	739.8	4935.4	VEC VŠB
NMVOC	$g.GJ^{-1}$	488.9	631.3	5.4	72.1	488.9	VEC VŠB
TSP	$g.GJ^{-1}$	642.3	212.6	71.1	80.1	642.3	VEC VŠB
PM10	$g.GJ^{-1}$	584.5	193.5	64.7	72.9	584.5	VEC VŠB[1)]
PM2.5	$g.GJ^{-1}$	575.5	190.5	63.7	71.8	575.5	VEC VŠB[1)]
BC	$g.GJ^{-1}$	36.8	12.2	4.1	4.6	36.8	VEC VŠB[2)]
As	$mg.GJ^{-1}$	5.6	0.4	2.7	2.7	5.6	VEC VŠB
Cd	$mg.GJ^{-1}$	0.2	0.1	0.1	0.1	0.2	VEC VŠB
Cr	$mg.GJ^{-1}$	16.3	6.4	2.0	2.0	16.3	VEC VŠB
Cu	$mg.GJ^{-1}$	6.8	2.0	12.4	12.4	6.8	VEC VŠB
Hg	$mg.GJ^{-1}$	0.9	0.7	0.6	0.6	0.9	VEC VŠB
Pb	$mg.GJ^{-1}$	28.5	11.7	32.3	32.3	28.5	VEC VŠB
Ni	$mg.GJ^{-1}$	4.9	0.6	3.8	3.8	4.9	VEC VŠB
Se	$mg.GJ^{-1}$	8.4	5.6	4.3	4.3	8.4	VEC VŠB
Zn	$mg.GJ^{-1}$	52.7	7.6	20.0	20.0	52.7	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	316.2	186.0	0.1	39.2	316.2	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	262.9	125.7	1.1	68.0	262.9	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	109.7	88.7	0.4	12.9	109.7	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	246.9	113.7	0.5	35.5	246.9	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
4PAH	**mg.GJ^{-1}**	935.6	514.1	2.0	155.7	935.6	VEC VŠB
HCB	**µg.GJ^{-1}**	2447.7	1299.9	22.8	22.8	2447.7	VEC VŠB
PCDD-F	**ng TEQ.GJ^{-1}**	136.2	346.2	2202.4	2202.4	136.2	VEC VŠB
PCB's	**µg.GJ^{-1}**	2.1	4.3	16.1	16.1	2.1	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

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

Note.:

(shaded cells) Emission factor values were taken from the measurements of hard coal combustion in the automatic boiler.

TABLE 15-5 EMISSION FACTORS - BKB, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	51.4	71.9	198.0	129.7	51.4	VEC VŠB
SO2	$g.GJ^{-1}$	712xSp	712xSp	712xSp	712xSp	712xSp	VEC VŠB
NH3	$g.GJ^{-1}$	0.3	0.3	0.3	0.3	0.3	EIG 2016
CO	$g.GJ^{-1}$	13907.2	5934.5	500.5	585.5	13907.2	VEC VŠB
NMVOC	$g.GJ^{-1}$	2844.3	871.6	12.2	42.9	2844.3	VEC VŠB
TSP	$g.GJ^{-1}$	916.5	84.0	43.9	22.6	916.5	VEC VŠB
PM10	$g.GJ^{-1}$	834.0	76.5	39.9	20.6	834.0	VEC VŠB1)
PM2.5	$g.GJ^{-1}$	821.1	75.3	39.3	20.3	821.1	VEC VŠB1)
BC	$g.GJ^{-1}$	52.6	4.8	2.5	1.3	52.6	VEC VŠB2)
As	$mg.GJ^{-1}$	8.0	8.7	19.2	16.4	8.0	VEC VŠB
Cd	$mg.GJ^{-1}$	0.3	0.6	0.5	0.9	0.3	VEC VŠB
Cr	$mg.GJ^{-1}$	83.4	3.0	11.4	9.7	83.4	VEC VŠB
Cu	$mg.GJ^{-1}$	10.2	5.3	25.6	7.9	10.2	VEC VŠB
Hg	$mg.GJ^{-1}$	8.8	2.6	3.0	1.8	8.8	VEC VŠB
Pb	$mg.GJ^{-1}$	14.1	24.2	41.4	19.7	14.1	VEC VŠB
Ni	$mg.GJ^{-1}$	7.9	3.3	7.1	7.1	7.9	VEC VŠB
Se	$mg.GJ^{-1}$	2.3	2.2	4.5	5.8	2.3	VEC VŠB
Zn	$mg.GJ^{-1}$	43.1	76.5	100.3	96.7	43.1	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	106.6	21.8	0.1	0.7	106.6	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	256.7	31.4	0.7	1.6	256.7	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	80.5	18.7	0.2	0.8	80.5	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	182.0	15.1	0.3	0.6	182.0	VEC VŠB
4PAH	$mg.GJ^{-1}$	625.8	87.0	1.3	3.7	625.8	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
HCB	**µg.GJ^{-1}**	2.0	2.0	0.7	0.5	2.0	VEC VŠB
PCDD-F	**ng TEQ.GJ^{-1}**	60.6	29.3	33.4	3.2	60.6	VEC VŠB
PCB's	**µg.GJ^{-1}**	3.3	1.4	0.6	0.5	3.3	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

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

Note.:

(blue)	Emission factor values were taken from the measurements of brown coal combustion at nominal heat output.
(green)	Emission factor values were taken from the measurements of briquette combustion at lower heat output.

TABLE 15-6 EMISSION FACTORS - COKE, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	129.0	162.7	196.0	167.4	129.0	VEC VŠB
SO2	$g.GJ^{-1}$	712xSp	712xSp	712xSp	712xSp	712xSp	VEC VŠB
NH3	$g.GJ^{-1}$	0.3	0.3	0.3	0.3	0.3	EIG 2016
CO	$g.GJ^{-1}$	4935.4	2625.3	383.5	739.8	4935.4	VEC VŠB
NMVOC	$g.GJ^{-1}$	488.9	631.3	5.4	72.1	488.9	VEC VŠB
TSP	$g.GJ^{-1}$	642.3	212.6	71.1	80.1	642.3	VEC VŠB
PM10	$g.GJ^{-1}$	584.5	193.5	64.7	72.9	584.5	VEC VŠB[1)]
PM2.5	$g.GJ^{-1}$	575.5	190.5	63.7	71.8	575.5	VEC VŠB[1)]
BC	$g.GJ^{-1}$	36.8	12.2	4.1	4.6	36.8	VEC VŠB[2)]
As	$mg.GJ^{-1}$	5.6	0.4	2.7	2.7	5.6	VEC VŠB
Cd	$mg.GJ^{-1}$	0.2	0.1	0.1	0.1	0.2	VEC VŠB
Cr	$mg.GJ^{-1}$	16.3	6.4	2.0	2.0	16.3	VEC VŠB
Cu	$mg.GJ^{-1}$	6.8	2.0	12.4	12.4	6.8	VEC VŠB
Hg	$mg.GJ^{-1}$	0.9	0.7	0.6	0.6	0.9	VEC VŠB
Pb	$mg.GJ^{-1}$	28.5	11.7	32.3	32.3	28.5	VEC VŠB
Ni	$mg.GJ^{-1}$	4.9	0.6	3.8	3.8	4.9	VEC VŠB
Se	$mg.GJ^{-1}$	8.4	5.6	4.3	4.3	8.4	VEC VŠB
Zn	$mg.GJ^{-1}$	52.7	7.6	20.0	20.0	52.7	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	316.2	186.0	0.1	39.2	316.2	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	262.9	125.7	1.1	68.0	262.9	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	109.7	88.7	0.4	12.9	109.7	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	246.9	113.7	0.5	35.5	246.9	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
4PAH	**$mg.GJ^{-1}$**	935.6	514.1	2.0	155.7	935.6	VEC VŠB
HCB	**$\mu g.GJ^{-1}$**	2447.7	1299.9	22.8	22.8	2447.7	VEC VŠB
PCDD-F	**$ng\ TEQ.GJ^{-1}$**	136.2	346.2	2202.4	2202.4	136.2	VEC VŠB
PCB's	**$\mu g.GJ^{-1}$**	2.1	4.3	16.1	16.1	2.1	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

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

Note.:

Emission factor values were taken from the measurements of hard coal combustion.

TABLE 15-7 EMISSION FACTORS - DRY WOOD, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	61.9	67.8	87.9	83.4	61.9	VEC VŠB
SO2	$g.GJ^{-1}$						
NH3	$g.GJ^{-1}$	70.0	70.0	37.0	37.0	70.0	EIG 2016
CO	$g.GJ^{-1}$	4851.8	4170.8	157.9	2507.2	4851.8	VEC VŠB
NMVOC	$g.GJ^{-1}$	705.8	823.8	2.4	286.4	705.8	VEC VŠB
TSP	$g.GJ^{-1}$	97.9	95.2	10.2	49.0	97.9	VEC VŠB
PM10	$g.GJ^{-1}$	93.0	90.5	9.7	46.5	93.0	VEC VŠB1)
PM2.5	$g.GJ^{-1}$	90.6	88.1	9.4	45.3	90.6	VEC VŠB1)
BC	$g.GJ^{-1}$	9.1	8.8	0.9	4.5	9.1	VEC VŠB2)
As	$mg.GJ^{-1}$	1.1	1.1	0.4	0.4	1.1	VEC VŠB
Cd	$mg.GJ^{-1}$	11.0	1.0	1.3	1.3	11.0	VEC VŠB
Cr	$mg.GJ^{-1}$	39.6	3.1	3.7	3.7	39.6	VEC VŠB
Cu	$mg.GJ^{-1}$	9.3	3.0	5.7	5.7	9.3	VEC VŠB
Hg	$mg.GJ^{-1}$	7.2	4.2	1.9	1.9	7.2	VEC VŠB
Pb	$mg.GJ^{-1}$	2.8	16.9	13.2	13.2	2.8	VEC VŠB
Ni	$mg.GJ^{-1}$	5.1	2.7	1.6	1.6	5.1	VEC VŠB
Se	$mg.GJ^{-1}$	2.1	0.3	0.4	0.4	2.1	VEC VŠB
Zn	$mg.GJ^{-1}$	26.6	26.6	61.6	61.6	26.6	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	92.1	68.0	0.2	17.5	92.1	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	72.4	34.1	0.8	10.5	72.4	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	47.9	26.1	0.2	6.1	47.9	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	61.5	48.8	0.1	10.5	61.5	VEC VŠB
4PAH	$mg.GJ^{-1}$	273.9	177.0	1.3	44.6	273.9	VEC VŠB
HCB	$\mu g.GJ^{-1}$	2.4	0.6	17.2	17.2	2.4	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
PCDD-F	**ng TEQ.GJ^{-1}**	19.4	24.7	5.5	5.5	19.4	VEC VŠB
PCB's	**µg.GJ^{-1}**	2.3	4.4	0.7	0.7	2.3	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

Note.:

Emission factor values were taken from the measurements of wood-dry combustion in the gasification boiler at nominal heat output.

TABLE 15-8 EMISSION FACTORS - WET WOOD, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	58.3	67.8	87.9	68.3	58.3	VEC VŠB
SO2	$g.GJ^{-1}$						
NH3	$g.GJ^{-1}$	70.0	70.0	37.0	37.0	70.0	EIG 2016
CO	$g.GJ^{-1}$	7730.9	4170.8	157.9	2899.8	7730.9	VEC VŠB
NMVOC	$g.GJ^{-1}$	1672.9	823.8	2.4	203.2	1672.9	VEC VŠB
TSP	$g.GJ^{-1}$	482.6	95.2	10.2	46.7	482.6	VEC VŠB
PM10	$g.GJ^{-1}$	458.5	90.5	9.7	44.3	458.5	VEC VŠB1)
PM2.5	$g.GJ^{-1}$	446.4	88.1	9.4	43.2	446.4	VEC VŠB1)
BC	$g.GJ^{-1}$	44.6	8.8	0.9	4.3	44.6	VEC VŠB2)
As	$mg.GJ^{-1}$	1.1	1.1	0.4	0.4	1.1	VEC VŠB
Cd	$mg.GJ^{-1}$	11.0	1.0	1.3	1.3	11.0	VEC VŠB
Cr	$mg.GJ^{-1}$	39.6	3.1	3.7	3.7	39.6	VEC VŠB
Cu	$mg.GJ^{-1}$	9.3	3.0	5.7	5.7	9.3	VEC VŠB
Hg	$mg.GJ^{-1}$	7.2	4.2	1.9	1.9	7.2	VEC VŠB
Pb	$mg.GJ^{-1}$	2.8	16.9	13.2	13.2	2.8	VEC VŠB
Ni	$mg.GJ^{-1}$	5.1	2.7	1.6	1.6	5.1	VEC VŠB
Se	$mg.GJ^{-1}$	2.1	0.3	0.4	0.4	2.1	VEC VŠB
Zn	$mg.GJ^{-1}$	26.6	26.6	61.6	61.6	26.6	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	230.6	68.0	0.2	2.9	230.6	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	156.9	34.1	0.8	6.2	156.9	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	108.7	26.1	0.2	1.6	108.7	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	208.6	48.8	0.1	2.6	208.6	VEC VŠB
4PAH	$mg.GJ^{-1}$	704.8	177.0	1.3	13.3	704.8	VEC VŠB
HCB	$\mu g.GJ^{-1}$	2.4	0.6	17.2	17.2	2.4	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
PCDD-F	**ng TEQ.GJ^{-1}**	22.6	24.7	5.5	5.5	22.6	VEC VŠB
PCB's	**µg.GJ^{-1}**	4.5	4.4	0.7	0.7	4.5	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

Note.:

Emission factor values were taken from the measurements of wood-dry combustion at nominal heat output.

TABLE 15-9 EMISSION FACTORS - BIO-BRIQUETTES, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	61.9	67.8	87.9	83.4	61.9	VEC VŠB
SO2	$g.GJ^{-1}$						
NH3	$g.GJ^{-1}$	12.0	12.0	12.0	12.0	12.0	EIG 2016
CO	$g.GJ^{-1}$	4851.8	4170.8	157.9	2507.2	4851.8	VEC VŠB
NMVOC	$g.GJ^{-1}$	705.8	823.8	2.4	286.4	705.8	VEC VŠB
TSP	$g.GJ^{-1}$	97.9	95.2	10.2	49.0	97.9	VEC VŠB
PM10	$g.GJ^{-1}$	93.0	90.5	9.7	46.5	93.0	VEC VŠB[1)]
PM2.5	$g.GJ^{-1}$	90.6	88.1	9.4	45.3	90.6	VEC VŠB[1)]
BC	$g.GJ^{-1}$	9.1	8.8	0.9	4.5	9.1	VEC VŠB[2)]
As	$mg.GJ^{-1}$	1.1	1.1	0.4	0.4	1.1	VEC VŠB
Cd	$mg.GJ^{-1}$	11.0	1.0	1.3	1.3	11.0	VEC VŠB
Cr	$mg.GJ^{-1}$	39.6	3.1	3.7	3.7	39.6	VEC VŠB
Cu	$mg.GJ^{-1}$	9.3	3.0	5.7	5.7	9.3	VEC VŠB
Hg	$mg.GJ^{-1}$	7.2	4.2	1.9	1.9	7.2	VEC VŠB
Pb	$mg.GJ^{-1}$	2.8	16.9	13.2	13.2	2.8	VEC VŠB
Ni	$mg.GJ^{-1}$	5.1	2.7	1.6	1.6	5.1	VEC VŠB
Se	$mg.GJ^{-1}$	2.1	0.3	0.4	0.4	2.1	VEC VŠB
Zn	$mg.GJ^{-1}$	26.6	26.6	61.6	61.6	26.6	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	92.1	68.0	0.2	17.5	92.1	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	72.4	34.1	0.8	10.5	72.4	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	47.9	26.1	0.2	6.1	47.9	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	61.5	48.8	0.1	10.5	61.5	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
4PAH	**$mg.GJ^{-1}$**	273.9	177.0	1.3	44.6	273.9	VEC VŠB
HCB	**$\mu g.GJ^{-1}$**	2.4	0.6	17.2	17.2	2.4	VEC VŠB
PCDD-F	**$ng\ TEQ.GJ^{-1}$**	19.4	24.7	5.5	5.5	19.4	VEC VŠB
PCB's	**$\mu g.GJ^{-1}$**	2.3	4.4	0.7	0.7	2.3	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

Note.: Emission factor values were taken from the measurements of wood-dry combustion

TABLE 15-10 EMISSION FACTORS - PELLETS, NOMINAL HEAT OUTPUT

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
NOx	$g.GJ^{-1}$	61.9	67.8	87.9	83.4	61.9	VEC VŠB
SO2	$g.GJ^{-1}$						
NH3	$g.GJ^{-1}$	12.0	12.0	12.0	12.0	12.0	EIG 2016
CO	$g.GJ^{-1}$	4851.8	4170.8	157.9	2507.2	4851.8	VEC VŠB
NMVOC	$g.GJ^{-1}$	705.8	823.8	2.4	286.4	705.8	VEC VŠB
TSP	$g.GJ^{-1}$	97.9	95.2	10.2	49.0	97.9	VEC VŠB
PM10	$g.GJ^{-1}$	93.0	90.5	9.7	46.5	93.0	VEC VŠB[1)]
PM2.5	$g.GJ^{-1}$	90.6	88.1	9.4	45.3	90.6	VEC VŠB[1)]
BC	$g.GJ^{-1}$	9.1	8.8	0.9	4.5	9.1	VEC VŠB[2)]
As	$mg.GJ^{-1}$	1.1	1.1	0.4	0.4	1.1	VEC VŠB
Cd	$mg.GJ^{-1}$	11.0	1.0	1.3	1.3	11.0	VEC VŠB
Cr	$mg.GJ^{-1}$	39.6	3.1	3.7	3.7	39.6	VEC VŠB
Cu	$mg.GJ^{-1}$	9.3	3.0	5.7	5.7	9.3	VEC VŠB
Hg	$mg.GJ^{-1}$	7.2	4.2	1.9	1.9	7.2	VEC VŠB
Pb	$mg.GJ^{-1}$	2.8	16.9	13.2	13.2	2.8	VEC VŠB
Ni	$mg.GJ^{-1}$	5.1	2.7	1.6	1.6	5.1	VEC VŠB
Se	$mg.GJ^{-1}$	2.1	0.3	0.4	0.4	2.1	VEC VŠB
Zn	$mg.GJ^{-1}$	26.6	26.6	61.6	61.6	26.6	VEC VŠB
Benzo(a)pyrene	$mg.GJ^{-1}$	92.1	68.0	0.2	17.5	92.1	VEC VŠB
Benzo(b)fluorantene	$mg.GJ^{-1}$	72.4	34.1	0.8	10.5	72.4	VEC VŠB
Benzo(k)fluorantene	$mg.GJ^{-1}$	47.9	26.1	0.2	6.1	47.9	VEC VŠB
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	61.5	48.8	0.1	10.5	61.5	VEC VŠB
4PAH	$mg.GJ^{-1}$	273.9	177.0	1.3	44.6	273.9	VEC VŠB
HCB	$\mu g.GJ^{-1}$	2.4	0.6	17.2	17.2	2.4	VEC VŠB

Pollutant	Unit	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves	Reference
PCDD-F	**ng TEQ.GJ^{-1}**	19.4	24.7	5.5	5.5	19.4	VEC VŠB
PCB's	**µg.GJ^{-1}**	2.3	4.4	0.7	0.7	2.3	VEC VŠB

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

Note.: Emission factor values were taken from the measurements of wood-dry combustion.

TABLE 15-11 EMISSION FACTORS - NATURAL GAS

Pollutant	Unit	-	Reference
NOx	$g.GJ^{-1}$	38.2	MZP
SO2	$g.GJ^{-1}$	58,7xS	MZP
NH3	$g.GJ^{-1}$		
CO	$g.GJ^{-1}$	9.4	MZP
NMVOC	$g.GJ^{-1}$	1.9	MZP
TSP	$g.GJ^{-1}$	0.6	MZP
PM10	$g.GJ^{-1}$	0.6	MZP[1)]
PM2.5	$g.GJ^{-1}$	0.6	MZP[1)]
BC	$g.GJ^{-1}$	0.031	MZP[2)]
As	$mg.GJ^{-1}$	0.12	EIG 2016
Cd	$mg.GJ^{-1}$	0.00025	EIG 2016
Cr	$mg.GJ^{-1}$	0.00076	EIG 2016
Cu	$mg.GJ^{-1}$	0.000076	EIG 2016
Hg	$mg.GJ^{-1}$	0.68	EIG 2016
Pb	$mg.GJ^{-1}$	0.0015	EIG 2016
Ni	$mg.GJ^{-1}$	0.00051	EIG 2016
Se	$mg.GJ^{-1}$	0.011	EIG 2016
Zn	$mg.GJ^{-1}$	0.0015	EIG 2016
Benzo(a)pyrene	$mg.GJ^{-1}$	0.00056	EIG 2016
Benzo(b)fluorantene	$mg.GJ^{-1}$	0.00084	EIG 2016
Benzo(k)fluorantene	$mg.GJ^{-1}$	0.00084	EIG 2016
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$	0.00084	EIG 2016
4PAH	$mg.GJ^{-1}$	0.003	EIG 2016
HCB	$µg.GJ^{-1}$		
PCDD-F	$ng\ TEQ.GJ^{-1}$	1.5	EIG 2016
PCB's	$µg.GJ^{-1}$		

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

S – sulfur content in a raw sample of liquid fuels ($mg.m^{-3}$)

TABLE 15-12 EMISSION FACTORS - LPG

Pollutant	Unit	-	Reference
NOx	$g.GJ^{-1}$	39.1	MZP
SO2	$g.GJ^{-1}$	0,4xS	MZP
NH3	$g.GJ^{-1}$		
CO	$g.GJ^{-1}$	10.0	MZP
NMVOC	$g.GJ^{-1}$	2.0	MZP
TSP	$g.GJ^{-1}$	9.8	MZP
PM10	$g.GJ^{-1}$	9.8	MZP[1)]
PM2.5	$g.GJ^{-1}$	9.8	MZP[1)]
BC	$g.GJ^{-1}$	0.8	MZP[2)]
As	$mg.GJ^{-1}$		
Cd	$mg.GJ^{-1}$		
Cr	$mg.GJ^{-1}$		
Cu	$mg.GJ^{-1}$		
Hg	$mg.GJ^{-1}$		
Pb	$mg.GJ^{-1}$		
Ni	$mg.GJ^{-1}$		
Se	$mg.GJ^{-1}$		
Zn	$mg.GJ^{-1}$		
Benzo(a)pyrene	$mg.GJ^{-1}$		
Benzo(b)fluorantene	$mg.GJ^{-1}$		
Benzo(k)fluorantene	$mg.GJ^{-1}$		
Indeno(1,2,3-cd)pyrene	$mg.GJ^{-1}$		
4PAH	$mg.GJ^{-1}$		
HCB	$\mu g.GJ^{-1}$		
PCDD-F	ng $TEQ.GJ^{-1}$		
PCB's	$\mu g.GJ^{-1}$		

1) Ratio of PMx in TSP was taken from z EIG 2016

2) Ratio of BC in PM2,5 was taken from EIG 2016

S – sulfur content in a raw sample of liquid fuels ($g.kg^{-1}$)

Annex 11 to Regulation No 415/2012 Sb.

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 2). 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.
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

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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.

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).