2020

CZECH INFORMATIVE INVENTORY REPORT 2020

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

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Czech Hydrometeorological Institute

Subtitle:	Emission inventories from the base year of the protocols to year 2018
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Abstract:	This document informs about the method of compiling emission inventories in the Czech Republic
Front page picture:	The castle Kost, August 2016

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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 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 2020 reporting.

Since 2019, part of documentation for emission inventory processing is electronic (e-Annex) inclusive EMRT summary, placed on CHMI web sites. See e-ANNEX.

MAIN UPDATES PRESENTED IN IIR 2020

The Czech IIR 2020 submission presents results of emission inventory 1990–2018, including most recalculations recommanded in STAGE 3 Review (2015), EMRT Review 2017, 2018 and 2019. Time series for road transport and all pollutants were recalculated due to COPERT V updates. Emissions from NFR 3B (NMVOC and NO_X emissions) and NFR 2H2 (NMVOC emissions) were added to the existing emission inventory. To keep consistence with emission ceiling set based on previous inventories prepared without NMVOC and NO_X emissions in NFR sectror 3B, Czechia applied for adjustment for these emissions in national totals for compliance.

SIGNIFICANT EMISSION TRENDS IN THE CZECH REPUBLIC

Considering the above mentioned emission recalucalions, updated emission trends are presented for period 1990–2018. 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 2017 and 2018 shows an effect of warmer heating period in 2018 and thus lower degree-days number as well as 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 and Temporary plan to LCP emissions reduction that lowered NO_X emissions by 2.51 kt and SO_X emissions even by 7.28 kt in sector 1A1a. Emissions from household heating showed a slight decrease due to warm heating season (app. 1–2 %). There was also a small increase in fuel consumption from mobile sources due to growing economy (GDP + 2.8 %).

Among main pollutants emissions of SO_X showed the most significant decrease against 2017 (-12.2 %), mostly caused by efficient deslphurization. Emissions of ammonia lowered -3.9 % and nitrogen oxides -3.8 %. NMVOC emissions decreased -0.9 % and TSP -0.8 % where the decrease of PM_{10} was -1.7 % and $PM_{2.5}$ -2.2 %. This can be attributed to warmer heating season and modernization of solid fuel household heating boilers. Increase of Cd emission (+16.7 %) is high in percentage. Mercury emission remained the same as in 2017. Se emission rose by +1.8 %. Cu emission grew +0.4 %, Cr +1.0 %, Zn +2.9 % and Lead +8.3 %,. Significant decreases showed Ni (-5.6 %) and As (-13.3 %).

SHARE OF CATEGORIES IN THE CZECH REPUBLIC IN 2018

The sector of residential heating (NFR 1A4bi) still contributes significantly to air pollution, specifically PM_{10} emissions 58.7 %, $PM_{2.5}$ emissions 73.9 %, carbon monoxide 66.8 % and benzo[a]pyrene by 97.6 %. The decisive share of the public sector energy (NFR 1A1a) prevailed in emissions of Sulphur dioxide 51.3 % and mercury 40.0 %. So far lead is concerned 29.2 % of emission was emitted by the sector 2G. The public electricity (24.4 %), passenger cars (18.0 %), off-road machinery (8.4 %) and road freight transport sector over 3.5 tonnes (NFR 1A3biii) with 8.4 % created 59.2 % of nitrogen oxide emissions. The most significant sources of emissions of NMVOCs are found in the sector 1A4bi household heating with share 42.9 %. The main source of ammonia emissions is agriculture (NFR 3B), whose share of total emissions is 76.7 % Below please find the main emissions in the years 1990–2018.

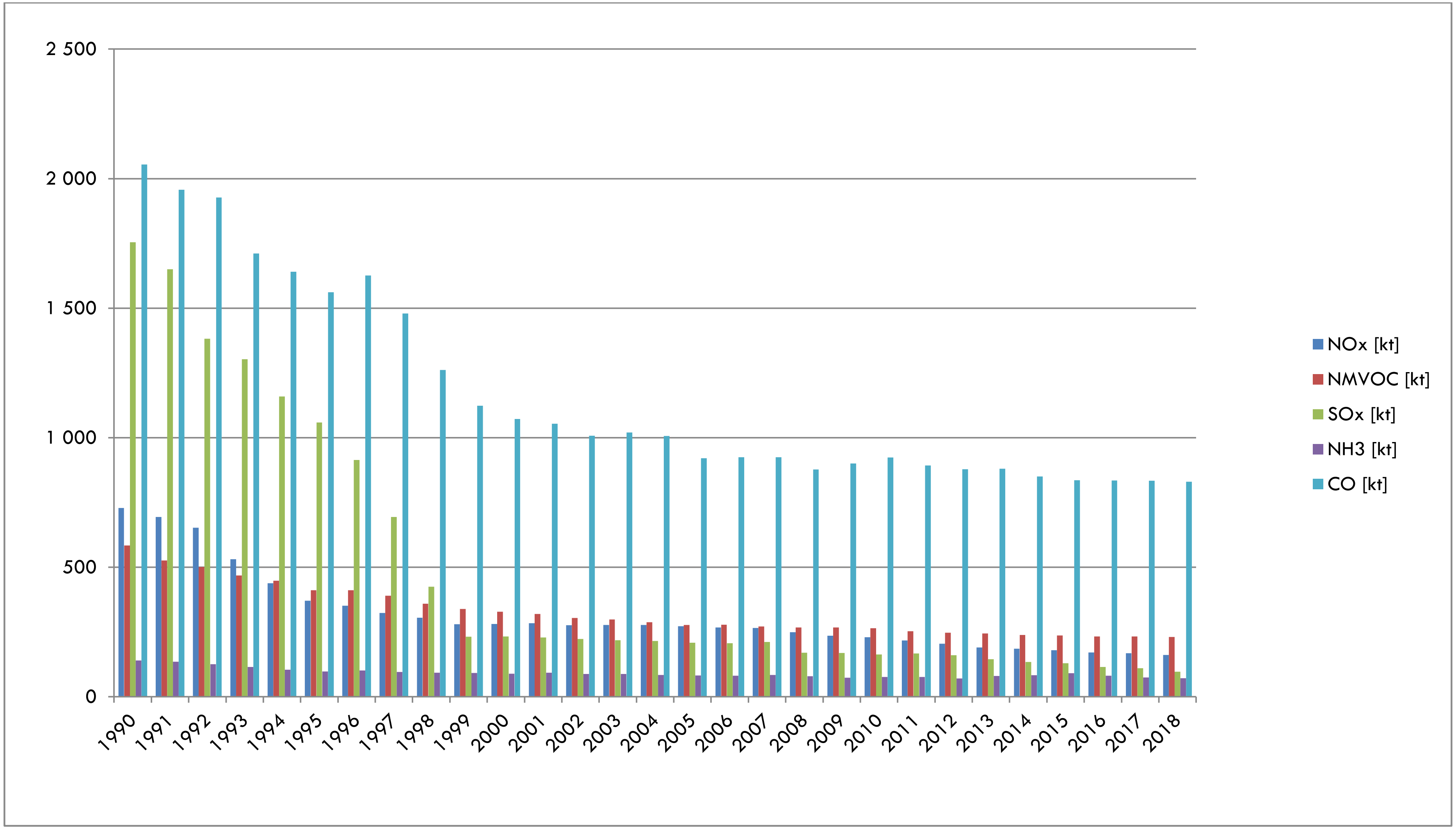

FIGURE 0-1TRENDS OF MAIN POLLUTANS IN 1990–2018

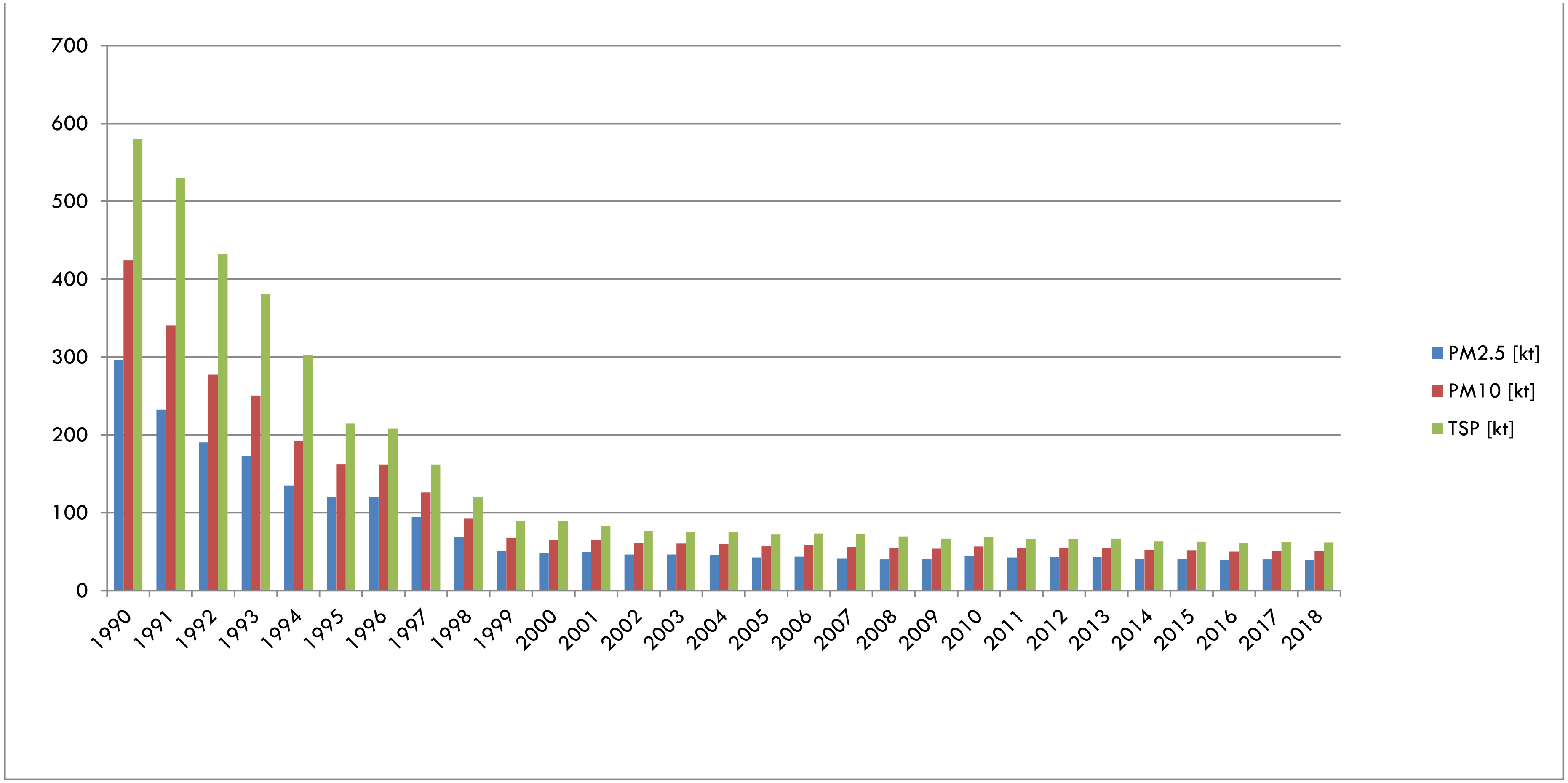

FIGURE 0-2 TRENDS OF PARTICULAR MATTER EMISSIONS IN 1990–2018

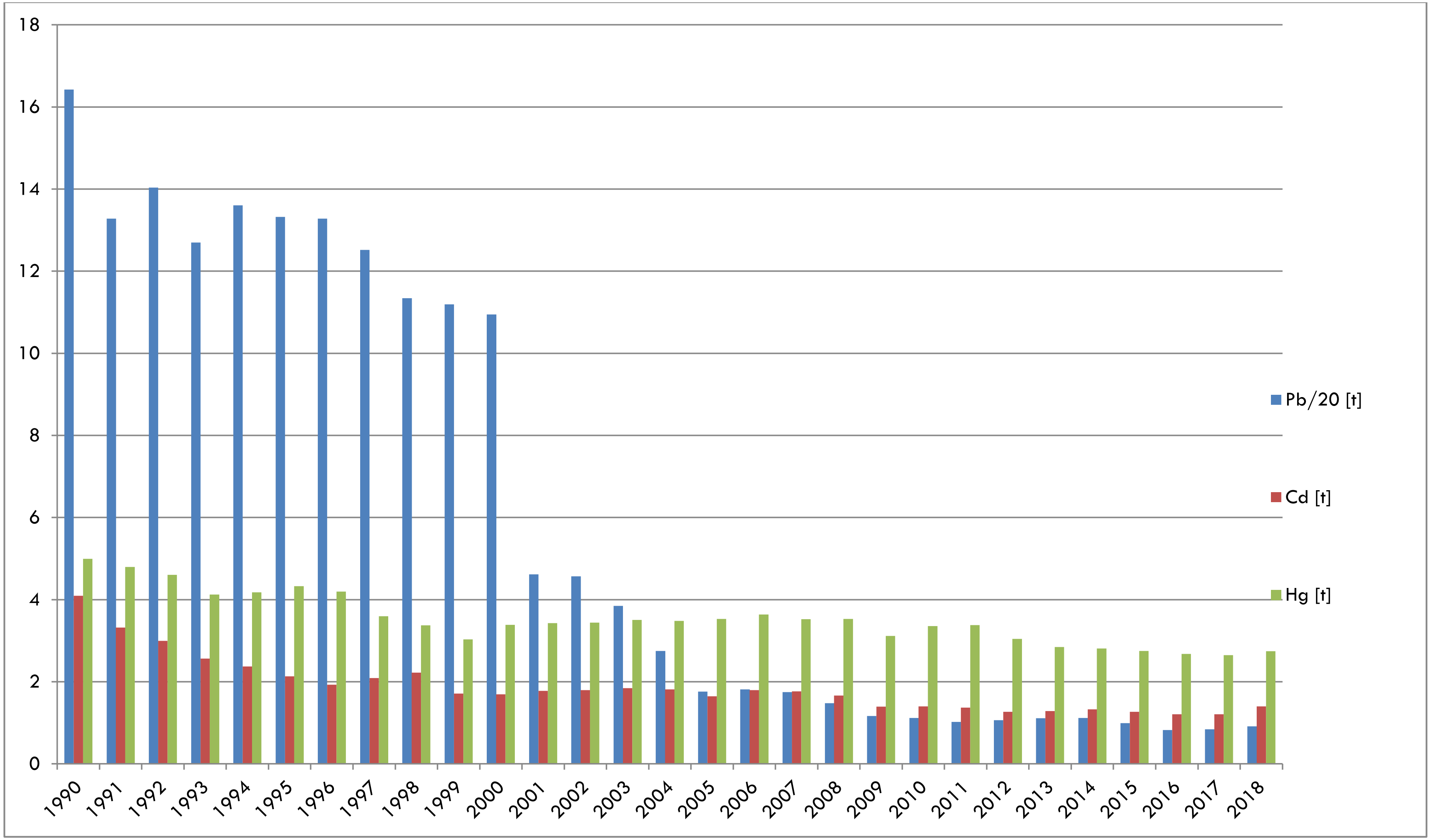

FIGURE 0-3 TRENDS OF HEAVY METALS IN 1990–2018

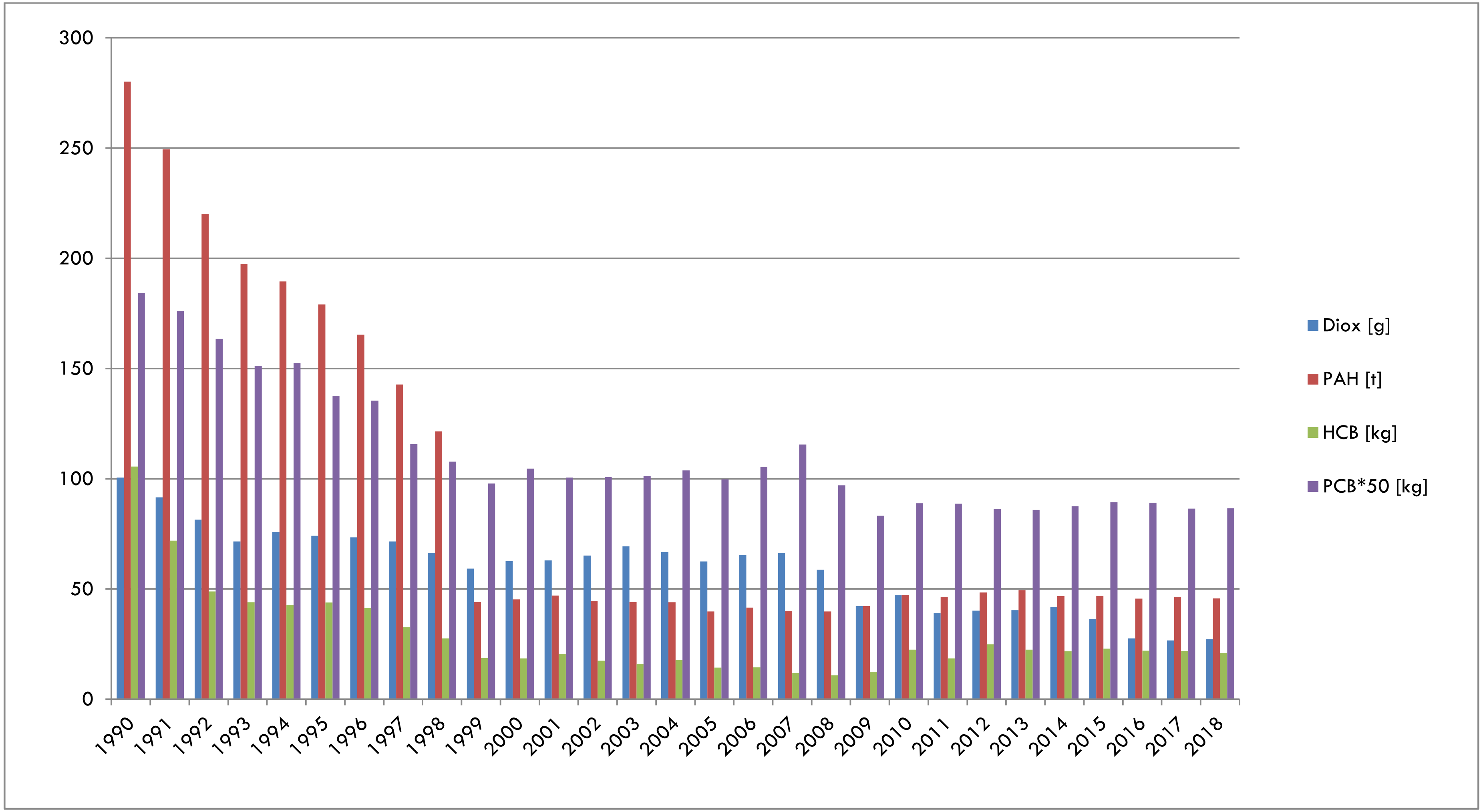

FIGURE 0-4 TRENDS OF POPS EMISSIONS IN 1990–2018

1 INTRODUCTION

The date of the last edit of the chapter: 15/03/2020

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.
- 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.
- 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.
- 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.
- Protocol on Further Reduction of Sulphur Emissions. It was agreed in Aarhus, in 1994, came into force on August 5, 1998.
- Protocol on Heavy Metals. It was adopted in 1998, entered into force on 29 December 2003. 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.
- Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. It was adopted Nov. 30, 1999, entered into force on 17 May 2005.

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: 15/03/2020

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. Data reported for sector Solvent use are only being used for NMVOC 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.

The above mentioned classification is mainly valid for main pollutants´ emissions estimates, less for heavy metal emissions and POPs where individually reported data about fuel consumption, production volume and abatement techniques for TSP emissions are used.

1.3 INVENTORY PREPARATION PROCESS

The date of the last edit of the chapter: 15/3/2020

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 Agriculture 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: 15/03/2020

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.

The 2020 submission presents:

- Submission (1990–2018) of emissions in all categories.
- Due to update of model COPERT V Recalculation (1990–2018) of emissions in road transport categories 1A3bi Passanger cars, 1A3bii Light duty vehicles, 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). See Chapter 3.

- Ammonia combustion emissions in sectors 1A were completed. For further details please refer to Chapter 3.
- Notation keys for both, emissions and activity data were thoroughly revised and updated in NFR tables.
- Comment to EMRT findings was adpoted in chapter 12 and for details please refer to e-ANNEX.
- Submission of NO_X and NMVOC emissions (1990–2018) in category 3B Manure management was performed using the methodology and EFs listed in EMEP/EEA EIG [5] (see chapter 5.1).
- Emissions (1990–2018) from 2H2 Food and beverages industry were submitted.
- Historical data in categories 5A, 5D1 and 5D2 were estimated (see chapters 6.1.1 and 6.6.1)
- New emissions previously reported as NE were reported, see e-ANNEX (e.g. NFR 1B2b).
- New chapters Adjustments and EMRT 2017 – 2019 were added.
- Supplement of detail methodology in e-ANNEX (e.g. sector 2D).

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. For searching between REZZO and NFR sectors please see file REZZO-NFR code in e-ANNEX.

The use of emissions reported by source operators does not in some cases correspond the EMEP/EEA EIG [5] methodology. Namely in categories where operated stationary sources do not reach set treshold of named sources. Only for natural gas consumption there are sufficient data available enabling emission calculation from the whole fuel consumption.

Significant year to year changes for some very low emissions (usually less than 0.001 kt) may be caused by methodology of reported data in categories with named sources. These emissions mostly come from annual one-time measurements performed to prove meeting emission limits when pollutant concentrations may depend on current equipment condition škodlivin, fuel burned, material inputs or abatement efficiency.

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 0). 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 kt of NMVOC 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 4.4)

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 6.1)

1.4.1.1 EMISSION FACTORS USED

As stated above, emission of the most important point sources are being reported in Summary Operational Evidence (SOE). 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 $PM_{2.5}$ and PM_{10} as portion of TSP reported emissions. There is similar situation concerning emissions of heavy metals and POPs. For further information see following chapters. Newly, emission factors for category 2H2 were supplied. Detailed information on some categories is given in e-ANNEX.

1.4.1.2 ACTIVITY DATA USED

Activity data of individually monitored sources are usually gained from reported data of SOE. 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. Detailed information on some categories is given in e-ANNEX.

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 fuel consumption data of CZSO and boiler structure from cenzus ENERGO 2015 (CZSO).

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 in 2018. For non-road transport (1A4cii) the tractor and non road machinery fleet composition as well as related emissions were throughly revised in 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, EMEP/EEA EIG [5], 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. Detailed information on some categories is given in e-ANNEX.

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, census Energo 2015, data from technical inspection of operated cars, waste data ISOH 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. Detailed information on some categories is given in e-ANNEX.

1.4.3 CONDENSABLE COMPONENT IN PM_{10} AND $PM_{2.5}$ EMISSION FACTORS

In general, emissions from individually monitored sources do not contain a condensable component, because according to Czech legislation, the sampling for total suspended particulate matter determination is performed by a heated apparatus to a temperature higher than the dew point of the exhaust gas (usually 70–160°C). These are mainly NFR 1A1 and NFR 1A2 sources.

As far as collectively monitored sources, national emission factors from household heating (1A4bi) are determined on the basis of sampling performed in the dilution tunnel. The sampling temperature was about 40 ° C. The EFs thus determined contain a high proportion of the condensable component. Emissions from transport are calculated by COPERT emission model. EF are also determined by dilution methods (including the use of dilution tunnels or systems using dilution after sampling) so they contain a condensable component.

1.4.4 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 SOE 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. 40 000 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 NO_X (as NO_2) 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 2018. 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 (as NO_2), 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, Cd and PCDD/F.

TABLE 1-2 KEY NFR SOURCES OF AIR QUALITY POLLUTANTS IN THE CZECH REPUBLIC IN 2018

Component	Key categories (Sorted from high to low from left to right)								Total (%)
SO_X	1A1a (51.3 %)	1A4bi (20.3 %)	1A2a (5.5 %)	1A2c (4.7%)					81.8
NO_X	1A1a (24.4 %)	1A3bi (18.0 %)	1A4cii (8.4 %)	1A3biii (8.4%)	1A4bi (8.1 %)	1A3bii (6.4 %)	1A2f (5.1 %)	1A4ai (4.2 %)	83.1
NH_3	3Da1 (32.3 %)	3Da2a (19.7 %)	3B1b (13.8 %)	3B1a (11.0%)	1A4bi (6.8 %)				83.5
NMVOC	1A4bi (42.9 %)	2D3d (11.7 %)	2D3a (5.5 %)	2D3g (4.5%)	3B1b (4.0 %)	2D3i (3.1 %)	3B1a (2.8 %)	2D3e (2.8 %) 1A3bv (2.7 %)	80.2
CO	1A4bi (66.8 %)	1A2a (10.9 %)	1A3bi (8.3 %)						85.9
TSP	1A4bi (51.7 %)	3Dc (7.2 %)	1B1a (6.3 %)	1A1a (4.0%)	1A3bvi (3.7 %)	1A3bvii (3.0 %)	2A5a (2.7 %)	3B4gi (2.5 %)	81.0
PM_{10}	1A4bi (58.7 %)	3Dc (8.8 %)	1A1a (4.0 %)	1B1a (3.6%)	1A3bvi (3.5 %)	2G (2.5 %)			81.1
$PM_{2.5}$	1A4bi (73.9 %)	1A1a (3.7 %)	1A4cii (2.9 %)						80.5
Pb	2G (29.2 %)	2C1 (20.4 %)	1A3bvi (13.3 %)	1A1a (8.4%)	1A4bi (8.3 %)	2C5 (4.3 %)			83.8
Hg	1A1a (40.0 %)	1A4bi (23.8 %)	1A2a (7.3 %)	5C1bv (5.2%)	2C1 (4.3 %)				80.7
Cd	1A4bi (44.5 %)	2A3 (13.3 %)	2C1 (9.3 %)	1A1a (9.0 %)	2G (8.9 %)				85.0
DIOX	1A4bi (33.4 %)	1A2a (22.3 %)	5E (14.3 %)	2C1 (11.9 %)					81.9
PAH	1A4bi (98.2 %)								98.2
HCB	1A4bi (82.1 %)								82.1

1.6 QA/QC AND VERIFICATION METHODS

The date of the last edit of the chapter: 03/04/2020

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 combined system including processing of reported data of individual facilities (emissions or activity data enabling emissions calculations based on emission factors) and emission calculations based on national statistics and emission factors. 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 EMEP/EEA EIG [5]. 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 EIG [5] 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)

Notation key: ´**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. For application of notation key ´NE´ we mostly accept recommendation contained in EFs tables of EMEP/EEA EIG [5].

The ´NE´ notation key table is available in the appendix e-ANNEX.

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	Reason for IE
1A4aii	Commercial/institutional: Mobile	1990–1997 (i) included in 1A3b
1A4bii	Residential: Household and gardening (mobile)	1990–1997 (i) included in 1A3b
1A4ci	Agriculture/Forestry/Fishing: Stationary	NH_3 1990–2014 included in 1A4ai
1A5a	Other stationary (including military)	1990–2015 (g) included in 1A4ai
1B2aiv	Fugitive emissions oil: Refining / storage	1990 NMVOC included in 1A1b
2A2	Lime production	1990–1999 included in 1A2f
2A3	Glass production	1990–1999 included in 1A2f
2A6	Other mineral products	1990–1999 included in 1A2f
2B6	Titanium dioxide production	1990–1999 included in 1A2c
2D3c	Asphalt roofing	1990–1999 included in 1A2f
2H1	Pulp and paper industry	1990–1999 included in 1A2d
3Da3	Urine and dung deposited by grazing animals	1990–2016 (h) included in 3Da2a
5C1bii	Hazardous waste incineration	(f) included in 5C1bi, 5C1biii

2 EXPLANATION OF KEY TRENDS

The date of the last edit of the chapter: 03/04/2020

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 1990–2018 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 (AS NO_2))

The emission of nitrogen oxides of 729.1 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 272.3 kt (-62.7 % compared to 1990). The further decline was relatively slight to 161.6 kt in 2018. The total emission o nitrogen oxides decreased year-on-year by 3.8 % (168.0 kt in 2017). 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 (24.4 %), 1A3bi (18.0 %), 1A4cii (8.4 %) 1A3biii (8.4 %) and 1A4bi (8.1 %).

2.1.2 SULPHUR DIOXIDE (SO_2)

The total sulphur dioxide emission of 1,754.5 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 96.5 kt in 2018 (-53.7 compared to 2005). The achievements in SO_2 abatement in 1990–1999 and later belong to the most significant in Czech emission inventory (-94.5 %, year 2018 compared to 1990). The year-on-year emission of sulphur dioxide lowered by -12.2 % (109.9 kt in 2017). The most emission is being contributed by sector 1A1a (51.3 %) and 1A4bi (20.3 %).

2.1.3 AMMONIA (NH_3)

Emission of ammonia in 1990 was 139.9 kt and declined in 2005 to 82.4 kt (-41.1 %) and lowered further to 71.8 kt in 2018 (-48,7 compared to 1990). On year-on-year basis there was -3.9 % decrease of the total ammonia emission (74.7 kt in 2017).

Main contributing sectors to the final emission are in agriculture 3Da1 (32.3 %), 3Da2a (19.7 %), 3B1b (13.8 %), 3B1a (11.0 %) and 1A4bi (6.8 %) that make 83.5 % as sum.

2.1.4 VOLATILE ORGANIC COMPOUNDS (NMVOC)

The NMVOC emission in 1990 reached 583.6 kt and lowered to 277.3 kt in 2005 (-52.5 %). In general the reduction trend remained and the total emission in 2018 amounted 231.0 kt. The total emission of NMVOC decreased by -0.9 % in 2018 compared to 2017 (233.1 kt). There are two sectors with the highest share of total emission: 1A4bi (42.9 %) and 2D3d (11.7 %).

2.1.5 TOTAL SUSPENDED PARTICLES (TSP)

The TSP emission of 580.5 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 72.0 kt in 2005 (-87.6 %) and slowly decreased to 61.8 kt in 2018 (-89.4 % compared to 1990). 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 decreased by -0.8 % (62.3 kt in 2017). The most contributing sector is 1A4bi (51.7 %), other sectors are below 10 %.

2.1.6 PARTICULATE MATTER ($PM_{2.5}$)

The $PM_{2.5}$ emission in 1990 amounted 296.4 kt. It dropped to 42.6 kt in 2005 (-85.6 %) and was 39.3 kt in 2018, which is -86.7 % compared to 1990. The year-on-year change 2017–2018 makes -2.2 % (40.2 kt in 2017) mostly due to warm heating season in 2018. The highest share of total emission comes from sector 1A4bi (73.9 %).

2.1.7 BLACK CARBON (BC)

The total BC emission in 1990 was 18.6 kt. It decreased to 6.0 kt in 2005 (-67.7 %) and 4.7 kt in 2018, which is -74.7 % compared to 1990. The BC emission in 2018 remained close to 4.8 kt in 2017 (-2.2 %).

2.1.8 THE TREND IN THE DEVELOPMENT OF EMISSIONS IN THE PERIOD 1990–2005

The overview of emissions from 1990 to 2018 is in the graphs in the Executive Summary.

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 1993–1998 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 2005–2018

The level of air pollution in 2018 decreased in comparison with the year 2005 as follows: TSP by -14.2 %, SO_2 by -53.7 %, NO_X (as NO_2) by -40.7 %, CO by -9.8 %, NMVOC by -16.7 % and NH_3 emissions by 12.9 %

2.1.10 LAST YEAR'S DEVELOPMENT

Economic indicators show overall trend of economic growth. GDP indicator against 2017 rose by 2.8 % in 2018. The total fuel consumption for heat production partly decreased due to warmer weather during heating season and fossil fuels power generation remained practically same as in 2017. 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 0-1 and Figure 0-2. The level of air pollution in 2018 changed in comparison with the year 2017 as follows: NMVOC (-0.9 %), NH_3 (-3.9 %), TSP (-0.8 %), $PM_{2.5}$ (-2.2 %), PM_{10} (-1.7 %) and BC (-2.2 %). CO decreased by -0.5 %, NO_X (as NO_2) -3.8 % and SO_2 by -12.3 %. The trend of heavy metals and POPs is strongly dependent on trends in individual categories. While emissions with core source of residential heating showed slight decrease (PAHs -1.1 %) due to bit warmer heating season. Changes in heavy metals (mainly due to incerase of emissions in category 2A3 Glass production) are as follows: As -13.3 %, Ni -5.6 %, Cu +0.4 %, Cr +1.0 % , Se + 1.8 %, Zn +2,9 %, Pb +8.3 % and Cd +16.7 %. The increase of Cd emission is related to changes in production capacity of most important producer of glass tubes, technical and utility glass and glass pearls (Preciosa Ornela, plc.). Hg emission remained almost the same.

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

2.2.1 CARBON MONOXIDE (CO)

The total emission of carbon monoxide 2,054.3 kt in 1990 was lowered to 920.8 kt in 2005 (-55.2 %). The decline of this emission was gradual and continued until 2018 with 830.5 kt (-59.6 % compared to 1990). The year-on-year change (834.4 kt in 2017) was -0.5 %. Despite these achievements the total emission of CO is the highest in the emission inventory of the Czech Republic. The most important contribution to the total emission comes from sector 1A4bi (66.8 %). The second important value belongs to sector 1A2a (10.9 %) followed by 1A3bi (8.3 %).

2.2.2 PARTICULATE MATTER (PM_{10})

The PM_{10} emission in 1990 reached 424.4 kt. It lowered to 57.1 kt in 2005 (-86.5 %) and was 50.6 kt in 2018, which is lower (-1.7 %) than in 2017 (51.5 kt). The most important sector is 1A4bi (58.7 %), followed by 3Dc (8.8 %).

2.2.3 POLYAROMATIC HYDROCARBONS (PAH-4)

The total emission of polyaromatic hydrocarbons (PAH-4) 280.1 t in 1990 was lowered to approximately 39.8 t in 2005 (-85.8 %). The decrease in 1998–1999 was caused by technical measurements coke facilities and shut-down of old installations. The total emission of polyaromatic hydrocarbons (PAH-4) in 2017 was 46.5 t due to colder heating season. There is a small year-on-year decrease in amount of emission which was 46.1 t in 2018 (-0.9 %).

The largely dominant share of emissions concentrates in sector 1A4bi (98.2 %), 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 t and lowered to 14.4 t in 2005 (-86.4 %). There was a certain increase of this emission after 2005 which was 21.9 t in 2017. The total emission of hexachlorobenzene (HCB) in 2018 was 21 t and that makes year-on year decrease -4.1 %. The sector 1A4bi dominantly contributes to the total emission by 82.1 %.

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

Total emission of polychlorinated dibenzo-p-dioxines and furans (PCDD/F) in 1990 was 100.5 g I-TEQ. The same emission in 2005 was 62.5 g I-TEQ (-37.8% compared to 1990). The total emission polychlorinated dibenzo-p-dioxines and furans (PCDD/F) in 2018 was 27.3 g I-TEQ. The emission of polychlorinated dibenzo-p-dioxines and furans (PCDD/F) reported in 2017 was 26.7 g I-TEQ, which is year-on-year change +2.2 %.

These four sectors contribute to 82.7 % of total emission: 1A4bi (33.4 %), 1A2a (22.3 %), 5E (14.3 %) and 2C1 (11.9 %).

2.3 EMISSIONS OF PRIORITY HEAVY METALS

2.3.1 CADMIUM (Cd)

Total emission of cadmium in 1990 was 4.1 t. The same emission in 2005 was 1.7 t (-58.5 % compared to 1990). The emission of cadmium in 2018 was 1.4 t (-17.6 % compared to 2005). The emission of cadmium in 2017 was 1.2 t, which is year-on-year change +16.7 %. The most contributing sectors to the total emission are: 1A4bi (44.5 %), 2A3 (13.3 %), 2C1 (9.3 %), 1A1 (9.0 %) and 2G (8.9 %) that make 85.0 % together.

2.3.2 MERCURY (Hg)

Total emission of mercury in 1990 was 5.0 t. The same emission in 2005 was 3.5 t (-30.0% compared to 1990). The emission of mercury in 2018 was 2.7 t (almost same as in 2017) and -22.9 % compared to 2005. The most important is the sector 1A1a (40.0 %), followed by 1A4bi (23.8 %) and 1A2a (7.3 %).

2.3.3 LEAD (Pb)

Total emission of lead in 1990 was 328.5 t. The same emission in 2005 was 35.2 t (-89.3 % 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 2018 lowered to 18.3 t (-48.0 % compared to 2005). The emission of lead in 2017 was 16.9 t, which is year-on-year increase 8.3 %. The most contributing to the total emission are the sectors 2G (29.2 %), 2C1 (20.4 %), 1A3bvi (13.3 %), 1A1a (8.4 %) and 1A4bi (8.3 %).

3 ENERGY (NFR SECTOR 1)

The date of the last edit of the chapter: 03/04/2020

This sector includes all combustion emissions (stationary and mobile). Furthermore, it includes fugitive emissions from the energy sector. The emission data of stationary sources included in this sector are based – with exception of (households, army and coal mining) - on operator-reported emissions or on calculations based on other reported data, mainly fuel consumption.

Stationary sources operators listed in Annex 2 of Act 201/2012 Coll. are obliged not to exceed the emission limits set and fulfill other conditions of the operation permit. For stationary combustion sources these obligations are obligatory for all combustion sources exceeding rated thermal input 0.3 MWt.

Specific emission limit values for stationary combustion plants are stated in Annex 2 to Regulation 415/2012 Coll. They are set for SO_2, NO_X (as NO_2), TSP and CO (for gaseous fuels only NO_X 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. The ammonia emissions are calculated using emission factors (equipment below 5 MW input) and at some sources with $DeNO_x$ technology reported by source operatorr. For inventorying of HMs and POPs please refer below.

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 can be for limited number of sources calculated using the emissions reported in the nearest year and activity data (individual emission factors). Emissions of pollutants that are not reported at all are calculated from activity data (for combustion sources 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 EIG [5], (Tier 2).

Emissions of road mobile sources are estimated according recommendation in COPERT model, for non road machinery we mainly use emission factors of EMEP/EEA EIG [5] and activity data of national statistics.

The sectors are the most important sources in key category for emissions of: SO_X (1A1a - 51.3 %), NO_X (24.4 % - 1A1a; 1A3bi – 18.0 %), NMVOC (42.9 % - 1A4bi), CO (66.8 % - 1A4bi), TSP (51.7 % - 1A4bi), PM_{10} (58.7 % - 1A4bi), $PM_{2.5}$ (73.9 % - 1A4bi), Hg (40.0 % - 1A1a), Cd (44.5 % - 1A4bi), PCDD/F (33.4 % - 1A4bi), PAH (98.2 % - 1A4bi) and HCB (82.1 % - 1A4bi).

3.1 LARGE STATIONARY SOURCES (NFR 1A1; 1A2; 1A3e; 1A4)

This chapter covers emissions of the most important group of combustion sources like power generation (public and industrial), heat generation for district heating and technologic combustion processes in industry, like solid fuels transformation or combustion processes in manufacturing and processing of metals, raw materials, chemicals etc.

Some specific informaton about combustion processes in sector of services (1A4ai), agriculture (1A4ci), military (1A5i) and households (1A4bi) is given in chapter 3.2.

The criterion for source allocation to 1A1a category there is the nominal thermal input and classification NACE. 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. This sector is characterized by a relatively small number of facilities (68 in 2018).

Category 1A1b includes fuel combustion in boilers and process furnaces in refineries. Category 1A1c covers fuel combustion in boilers and coal heat treatment (namely coke ovens, briquetting plants, and drying). Category 1A3e includes only emission from gas turbines operation for gas transit.

Distribution of the combustion sources into categories 1A2a to 1A2gviii 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. There applies specific classification for emissions from fuels used for technology processes. In the e-ANNEX is placed link between NFR category and classification pursuant Czech legislation (technological sources with combustion of fuel only).

Development of fuel base for stationary sources divided into aggregated sectors (GNFR) in period 1990–2018 is illustrated below in to Figures 3-1 to 3-3.

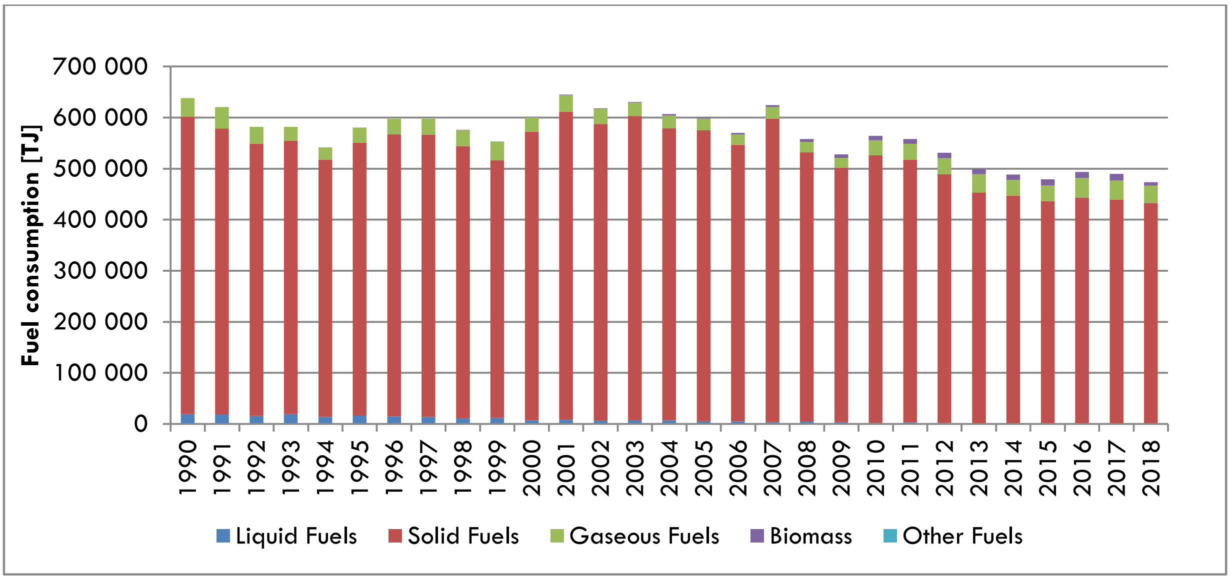

FIGURE 3-1 TREND IN FUEL CONSUMPTION FOR GNFR SECTOR A_PUBLICPOWER

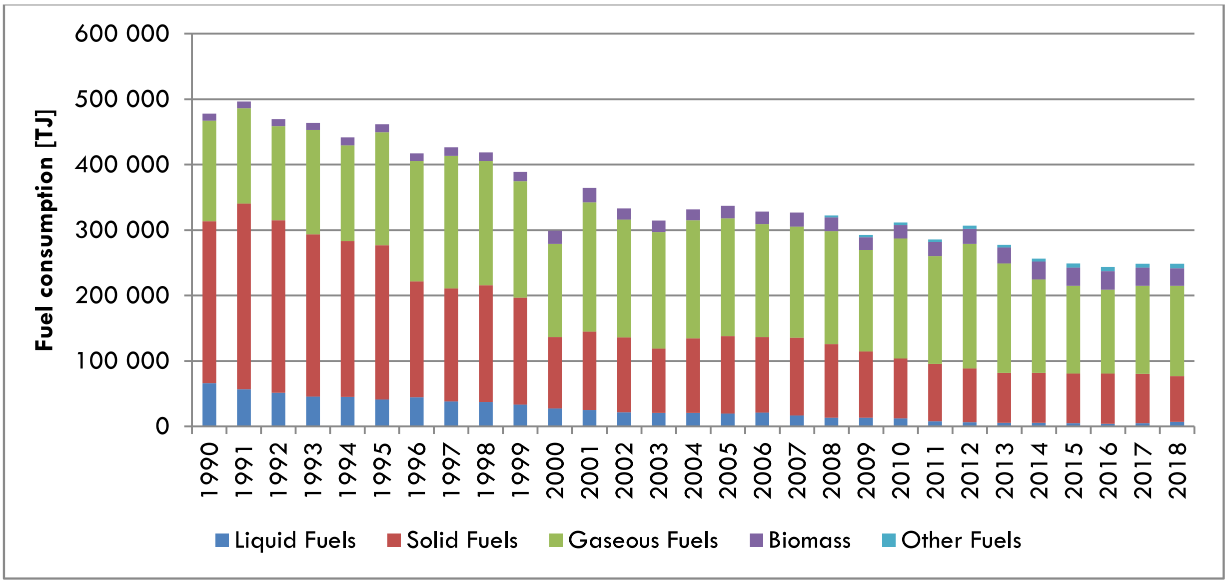

FIGURE 3-2 TREND IN FUEL CONSUMPTION FOR GNFR SECTOR B_INDUSTRY

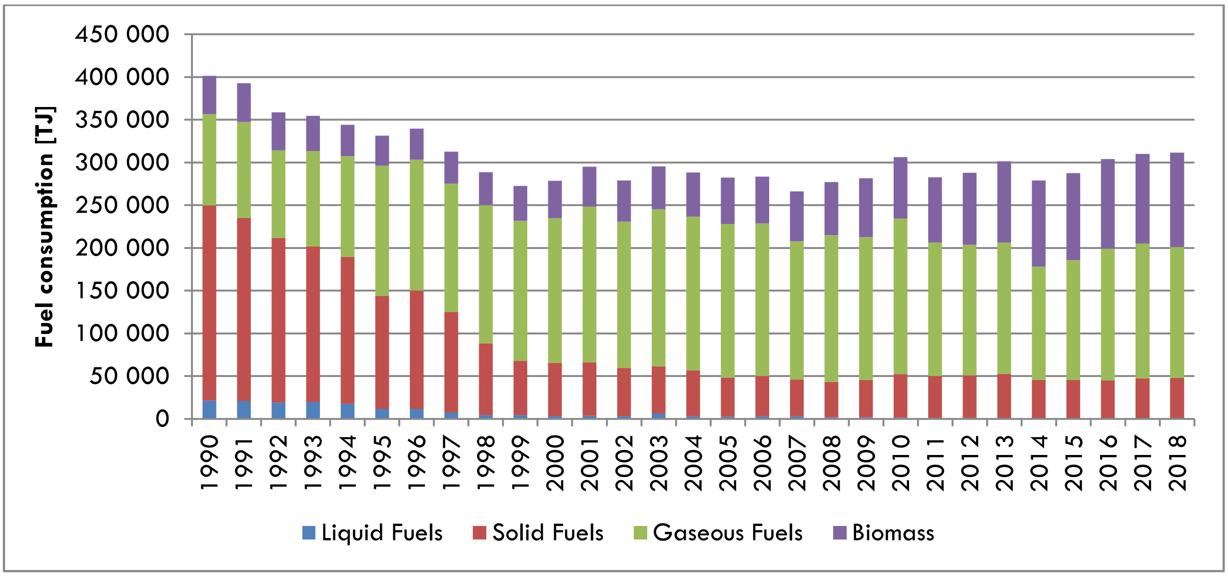

FIGURE 3-3 TREND IN FUEL CONSUMPTION FOR GNFR SECTOR C_OTHERSTATIONARYCOMB

Category NFR 1A1b includes indirect heating in oil refineries. 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 processed is presented in the chart below (Figure 3-4).

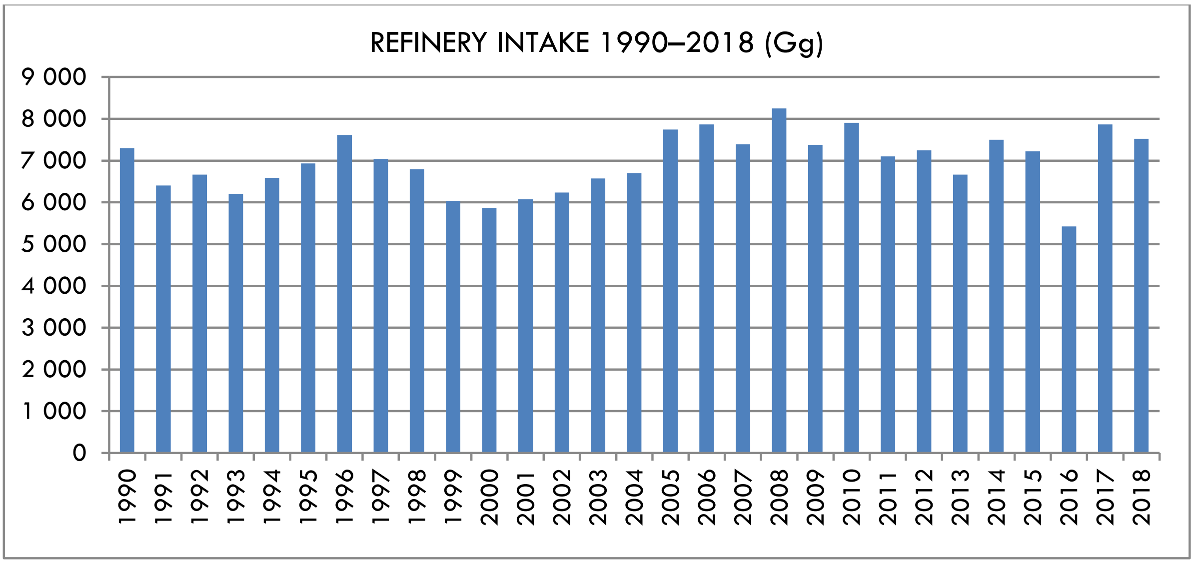

FIGURE 3-4 THE DEVELOPMENT OF CRUDE OIL CONSUMPTION 1990–2018

Crude oil refining is essential 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 Kralupy.

Category NFR A1c Manufacture of solid fuel and other energy industries includes indirect heating in coal processing to other fuel – solid fuel transformation. There is only one technology for coal gasification in Czech Republic. It is gasworks of company Sokolovská uhelná near a lignite mine. The facility produced town gas until 1996 and after end of utilisation in public network was replaced by generator gas, after purification combusted on site for power generation. There is a long tradition of coke production in Czech Republic, mainly for pig iron and steel production. Consequently, coke was also produced for household heating and smaller heating plants. Currently, there are three coke plants in operation in Ostrava region, producing mainly metallurgy coke.

Sources for district or kolac 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).

3.1.1 EMISSION FACTORS AND CALCULATIONS

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 and other 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.

The specific emission limit values for these plants are stated in Annex 2 to Regulation 415/2012 Sb. (see e-ANNEX). 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 1A1, 1A2, 1A3ei, 1A4ai and 1A4ci. NH_3 emissions for 1A2 and 1A4ai were newly calculated for all instalation under 5 MW thermal input (37 g/GJ for biomass, 0.2 g/GJ for coal). For categories not assuming operation of equipment with rated thermal input below 5 MW we use notation key NA for ammonia emission. For sector 1A2a the TSP and PMs emission lowered significantly since 2016 due to installation of modern bag filters. In the e-ANNEX there are placed emission factors for calculation of HMs, NMVOCs, POPs, NH_3 emissions and for some fuels TSP and SO_2.

3.1.2 UNCERTAINTIES AND QA/QC PROCEDURES

According to national legislation, emissions for large stationary sources belonging to sector 1A are determined on the basis of continuous or periodic measurements that are in compliance with European legislation (IED, MPCD and previous directives). The uncertainty of the sum of emissions from those sources is below 5 %, see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 1A1a is the same as in case of other stationary point sources, see also chapter 1.6 (QA/QC and verification methods).

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, NO_X (as NO_2) 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, NO_X (as NO_2) and TSP emission outlier test:
- significant difference in reported and expected SO_2, NO_x (as NO_2) and TSP emissions,
- consistency with emission trend at national level

3.1.3 PLANNED IMPROVEMENTS

No improvements are planned. Th echapter is considered to be final.

3.2 SMALLER AND AREA STATIONARY SOURCES (NFR 1A4 AND 1A5)

Combustion sources for heat production or power generation are being categorized according NACE classification in NFR 1A4ai – District heating (NACE 35), NFR 1A4ci – Agriculture/Forestry/Fishing (NACE 01–03) and tertiary sector (Commercial/institutional - services, offices, public health, education etc.). In a specific way there are then divided among NFR sectors of sources where processing combustion – processing heating, drying of agricultural products etc. take place. Combustion sources used in army are allocated in sector 1A5a. The methodology for emission calculation (take over of reported data or its calculation from fuel heat content) for sectors 1A4ai and 1A4ci is the same as in the case of sector 1A1a (see chapter 3.1).

For emission reporting of individually not monitored sources (boilers below 0.3 MW heat input, except from households) the gas consumption is estimated using total consumption in Czech Republic (CZSO data) after deduction of natural gas consumption of all individually and collectively monitored sources (households heating). The rest consumption based on emission factors is used for emission calculation in category 1A4ai. For other fuels, exploited in limited scope, such calculation does not take place.

Residential sources in sector 1A4bi belong among collectively monitored sources and they are described in the next part of chapter. NFR sector 1A4bi includes emissions from local household heating, cooking and water warming. The emission inventory is prepared at Tier 2 approach.

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 3-5). 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 (Table 3-1), structure of combustion equipment in households, share of wet wood combustion and other parameters has been discovered by statistic census ENERGO 2015. The overview of combustion equipment structure in period 1990–2018 was prepared by combination these results with other statistics (SLDB, ENERGO 2004, sales of boilers).

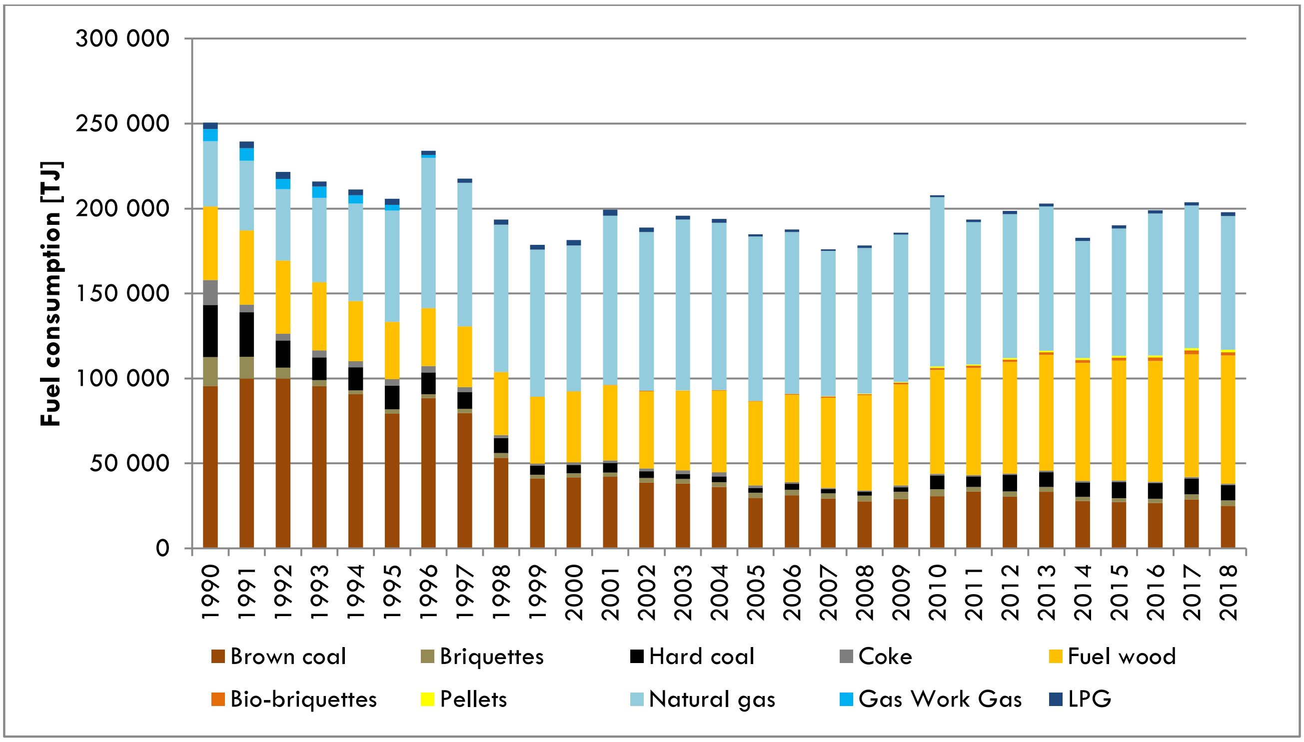

FIGURE 3-5 TREND OF FUEL CONSUMPTION IN SECTOR LOCAL HEATING OF HOUSEHOLDS IN PERIOD 1990–2018

TABLE 3-1 DISTRIBUTION OF SOLID FUEL CONSUMPTION ACCORDING TYPE OF HEATING EQUIPMENT IN 2018

Installation type / fuel type	Brown coal	Briquettes	Hard coal	Coke	Wood - dry	Wood - wet	Bio-briquettes	Pellets
				%				
Over-fire boilers	25	55	55	89	33	34	18	1
Under-fire boilers	31	21	14	8	17	14	9	1
Automatic boilers	31	6	21	1	4	3	5	54
Gasification boilers	8	4	5	0	17	12	10	0
Stoves/fireplaces	5	14	5	2	30	38	59	45

3.2.1 EMISSION FACTORS AND CALCULATIONS

Combustion ammonia emissions for equipment below 5 MW until 2014 is performed solely from total fuel consumption and emissions are reported only in NFR 1A4ai. For data since 2015 ammonia emissions are calculated in individual categories 1A2 and 1A4. Emission factors for solid fuels combustion (NFR 1A4bi) 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 EMEP/EEA EIG [5] and Methodology Instruction of CME. The overview of emission factors for emission inventory in household heating sector and more information about combustion measurements of VEC VŠB is available in e-ANNEX.

3.2.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

3.2.3 PLANNED IMPROVEMENTS

Further measurements of Hg emissions from combustion in residental plants are planned to be made in cooperation with VEC VŠB in the coming years, which will refine the EFs used for residental sector.

3.3 ROAD TRANSPORT EMISSIONS (NFR 1A3)

The chapters 3.3. and 3.6. were 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 country specific "CS".

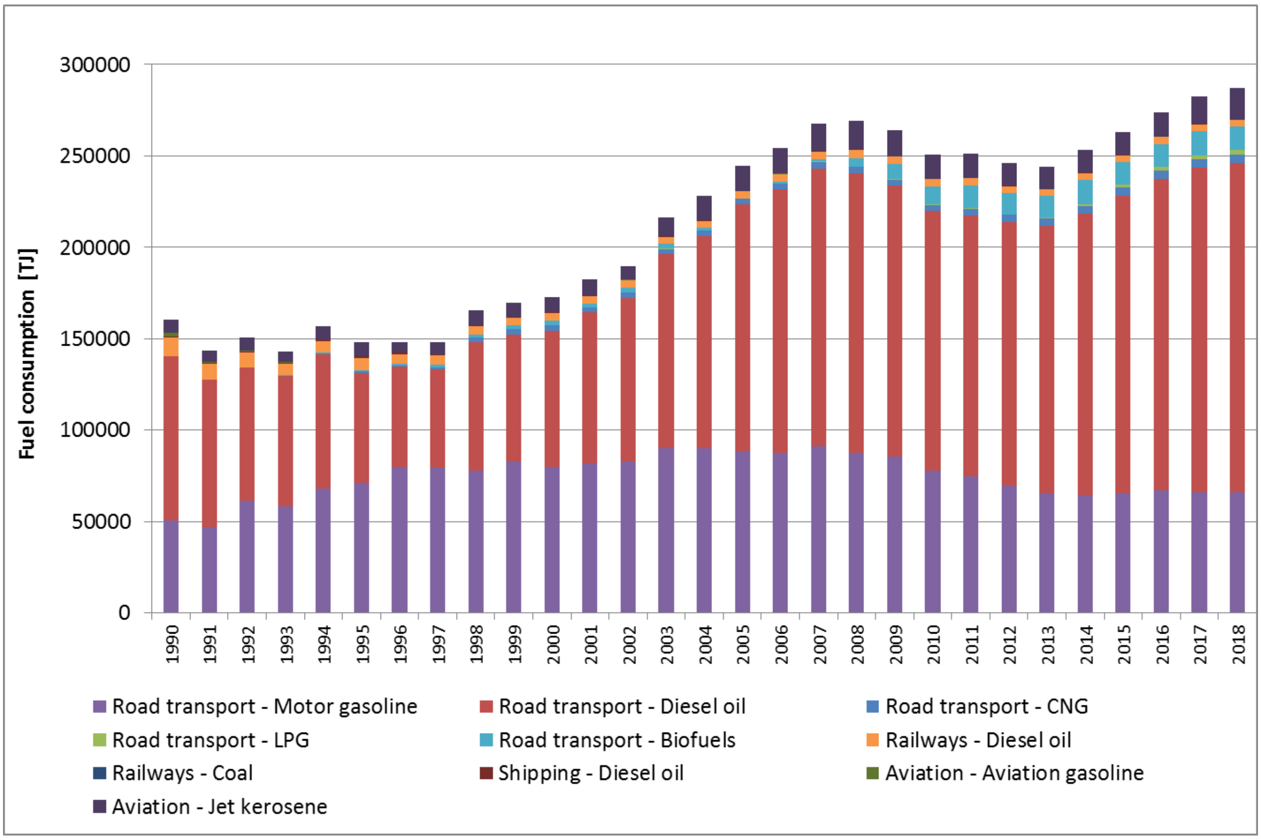

FIGURE 3-6 ANNUAL FUEL CONSUMPTION BY ALL MODES OF TRANSPORT 1990–2018

The chapter 3.3 presents most significant category: emissions from road transport in the Czech Republic. 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 5 categories.

Since 2005, emissions of NO_X (as NO_2), NMVOC, $PM_{2.5}$ and other from road transports have decreased sharply due to use of catalytic-converters and engine improvements (a result of a continual strengthening of emission limits) and a higher quality of fuels. For buses and heavy duty vehicles (over 3.5 t of 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.

In chapters below are given an overall view and basic information about subcategories in road transport. More detailed information about particular subcategories is given in their own subchapters. Content and structure of these subchapters are not uniform, because every subcategory has its own important information to point out.

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

- 1A3bi Passenger Cars
- 1A3bii Light Duty Vehicles
- 1A3biii Heavy Duty Vehicles
- 1A3biv Mopeds & Motorcycles
- 1A3bv Gasoline Evaporation (see chapter 3.4)
- 1A3bvi Automobile tyre and brake wear (see chapter 3.4)
- 1A3bvii Automobile road abrasion (see chapter 3.4)

3.3.1 METHODOLOGY AND RESULTS

Methodology for the calculation of emissions from road transport is based on COPERT 5 model in Tier 3. The basis for emission calculations in COPERT 5 are numbers of vehicles, average annual mileage and average total mileage for COPERT categories. Other important variables are:

- CS meteorological information.
- EU average information about driver behaviour (trip length, trip duration, average speed on different roads etc.).
- Technical parameters of vehicles (technologies for emissions reduction, A/C in vehicles, tank size, number of axles…).
- Fuel quality and composition of fuel.
- Calorific value of fuels (from CZSO).

This is an only brief summary. Full description of COPERT 5 program is possible to find here: https://www.emisia.com/utilities/copert/documentation/. COPERT 5 is based on EMEP EEA Emission inventory guidebook 2019. Full methodology of application COPERT 5 in CZ is described in Pelikán, Brich 2017 and Pelikán, Brich 2018.

Due to changes in activity data methodology, and extensive changes in COPERT made by program developer concerning emission factors emissions in the whole time series was changed (see chapter 8.1). Because of lack of time, projections will be recalculated in the next year submission.

3.3.1.1 ACTIVITY DATA

ADs for the COPERT program are gained from two large databases - Czech Car Registry (CCR) and a database of Technical Control Stations (TCS). CCR contains information about numbers of vehicles and technical details of vehicles registered in particular categories in CZ. TCS define annually traffic performance for a particular car. By combining these two databases is possible to obtain numbers of vehicles, average annual mileage and average total mileage for all of 372 COPERT categories which are relevant in CZ. Results are in full accuracy four years before actual reported year. The reason is that new private cars in CZ have to undertake technical control after four years after signing in CCR. To have precise emissions estimates is necessary to recalculate those four years backward repeatedly. This calculation procedure was developed by Brich in 2014, and this methodology was certified by Czech MoT. COPERT uses these ADs to calculate fuel consumption in all categories. Fuel consumption in categories is normalized with the help of total fuel consumption provided by CZSO.

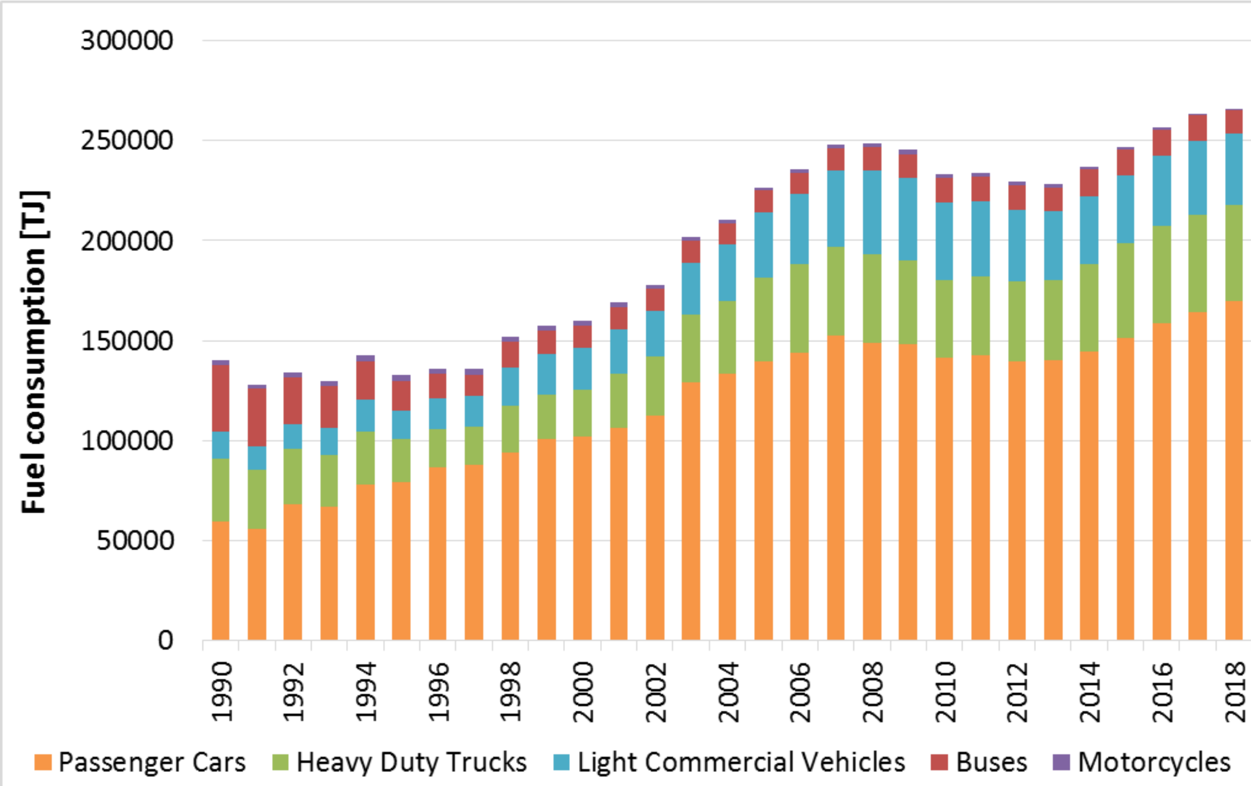

FIGURE 3-7 ANNUAL FUEL CONSUMPTION BY ROAD TRANSPORT 1990–2018

Figure 3-7 shows trends in fuel consumption 1990–2018 by particular vehicle categories. General rising trend of fuel consumption by PCs and LCVs is in line with general trend in the whole Europe. There is an obvious influence of the economic crisis between 2008 and 2013 to fossil fuels consumption. From 2014 there is a significant increase of fuel consumption of main fossil fuels. In 2016 almost 10 % lower prices of diesel and gasoline influenced increase of fossil fuels consumption. The consumption of gasoline fluctuated around 90 000 TJ from 2002 to 2009, but it has started to decline significantly since 2010. It even reached a value of 64 000 TJ in 2014. This decline is caused especially by the downward trend in an average fuel consumption of modern passenger cars. In 2013 the gasoline consumption decreased to 65 304 TJ. Since then gasoline fuel consumption is fluctuating around this value (2018 – 68 682 TJ). Fuel consumption of diesel was growing steadily after 2000. Steep increase has begun after 2013 and was connected to economic growth and growing popularity of diesel PCs. In 2018 diesel consumption reached 180 193 TJ. Trend of increase is less intense compared to previous years.

Till 2008, there was not used bioethanol in the wide range in the Czech Republic and biodiesel only in a small share. Since 2008 the consumption of gasoline has also included the consumption of bioethanol, which has been added to all gasoline in the amount of 2 % since January 1, 2008. The share of bioethanol as a renewable resource in gasoline reached a value 4.1 % in 2010 and the share of fatty acid methyl esters (FAME) as a renewable resource in diesel oil reached a value 6 % in 2010 and both values will remain unchanged in the coming years. Share of biofuels in fossil fuels is increasing too (6.8 % in 2010 and 8.5 % in 2015). In 2016 and 2018 we can see an increase in consumption of biodiesel compared to 2015. In 2015 was implemented the decrease of taxes for blends with a high percentage of biodiesel, but customers slowly accepted this change. Bioethanol shows no specific long-term trend. Between 2014 and 2018 there were some fluctuations caused by a variable ratio between price of petrol and bioethanol.

CNG buses are used in the Czech Republic from 1994 and using CNG PCs has started after the year 2000. 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. Other subsidies were determined for CNG LDVs and which PCs has been used by local authorities. Consumption of LPG continuously grows until 2016. After 2016 there is slight decrease most likely caused by low prices of diesel and gasoline.

3.3.1.2 EMISSION FACTORS

Emission factors are based on model COPERT 5 in version 3 in Tier 3 level of. COPERT methodology is in line with EMEP/EEA EIG [5]. Generally, EFs are composed from Hot EFs, Cold EFs and they are additionally dependent on vehicle category and driving mode (share of urban, rural, highway driving). There are a few types of EFs from which are final EF composed (dependent on the type of pollutant):

- Hot emission factors – for engine operating at normal temperature. Relevant for all pollutants.
- Cold emission factors – for cold engine after start. Relevant for all pollutants.
- Emission factors from lubricant consumption – relevant for SO_2 and heavy metals.
- Additional influence of A/C – relevant for SO_2, and heavy metals.
- Mileage degradation – relevant for NO_X (as NO_2), CO and NMVOC.

3.3.1.3 EMISSIONS

Emissions were calculated on the basis of the total consumption in 372 COPERT vehicle categories which are relevant in CZ. COPERT separately calculate emissions from hot engines, cold engines, emission originates from A/C, and SCR usage (diesel cars) and emissions caused by lubricant consumption during burning processes. A gradually increasing share of road transport in total emissions in the Czech Republic became evident during the ’90s and this trend continued until 2007. Individual road and freight transport make the greatest contribution.

Emission downwards trends of NO_X (as NO_2), NMVOC, and CO depend on different EU regulations which came into force and on ongoing technical development (engines, catalysts etc.). SO_2 shows the strong dependence on the increasing quality of fuels (sulphur content) bringing a significant downward trend which is slightly influenced by increases in fuel consumption. The share of PM 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. Pb is strongly dependent on fuel consumption and its content in fuel. To give a general overview of the emission trends, emissions of NO_X, NMVOC, PM and CO are presented in figures below for the entire period 1990–2018 for the road transport.

NO_X (as NO_2) emissions were decreasing until 2002 (see Figure 3-8). The increase of emissions after this year was connected with economic growth and shift from gasoline to diesel passenger cars and light duty vehicles and increase traffic performance, especially by heavy duty vehicles. There was a significant increase of traffic performance by passenger cars and light duty vehicles after 2001, however improving technologies of NO_X (as NO_2) reduction stopped increase of NO_X (as NO_2) emissions especially in PCs subcategory. From 2005 overall NO_X (as NO_2) emissions have been decreasing because of a less intense increase of traffic performance in all modes of transport except diesel passenger cars. The decreasing of traffic performance by gasoline-fuelled cars plays a minor role in all categories. In 2016 and 2017 steep decrease of NO_X (as NO_2) emissions was stopped because of economic growth and lower prices of fuels compared to previous years. In 2018 we can see decrease in NO_X (as NO_2) emissions caused by decrease of traffic performance by LCVs, HDTs and buses. Generally, the main emitters of NO_X (as NO_2) emissions are diesel passenger cars and heavy duty vehicles.

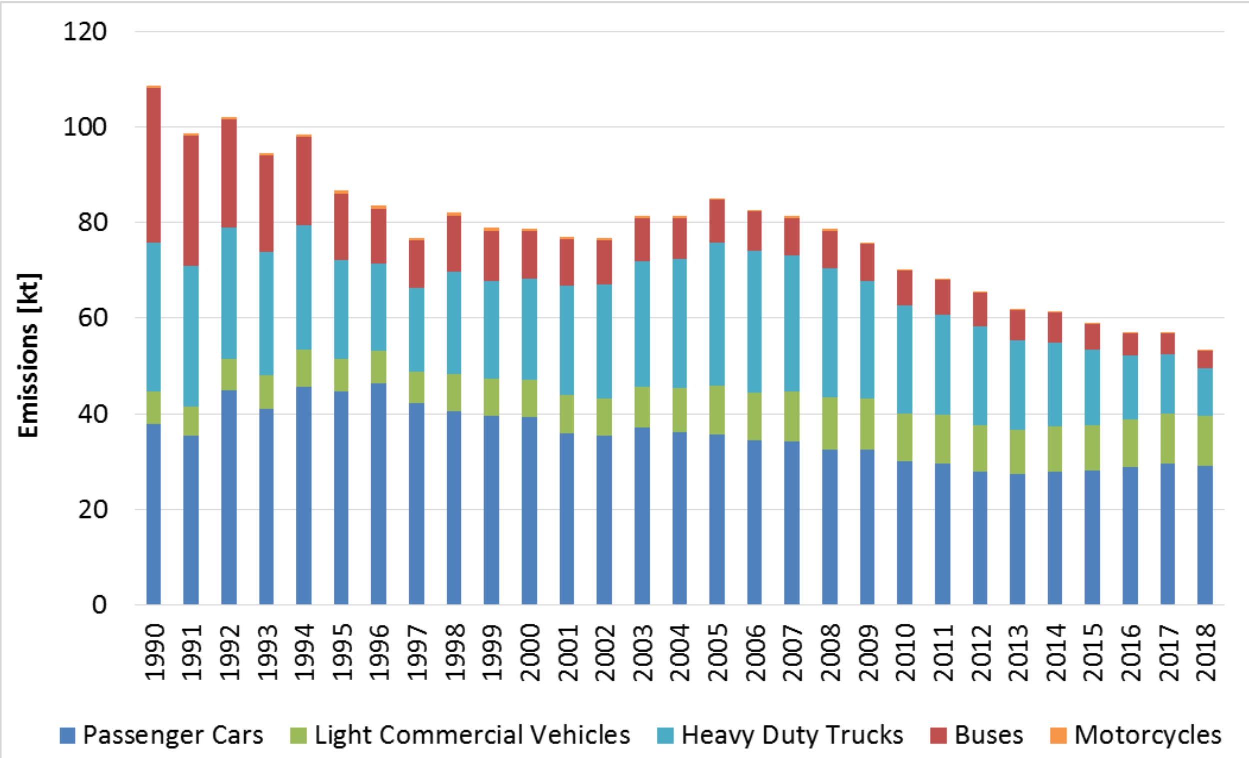

FIGURE 3-8 ANNUAL EMISSIONS OF NO_X (AS NO_2) BY ROAD TRANSPORT 1990–2018

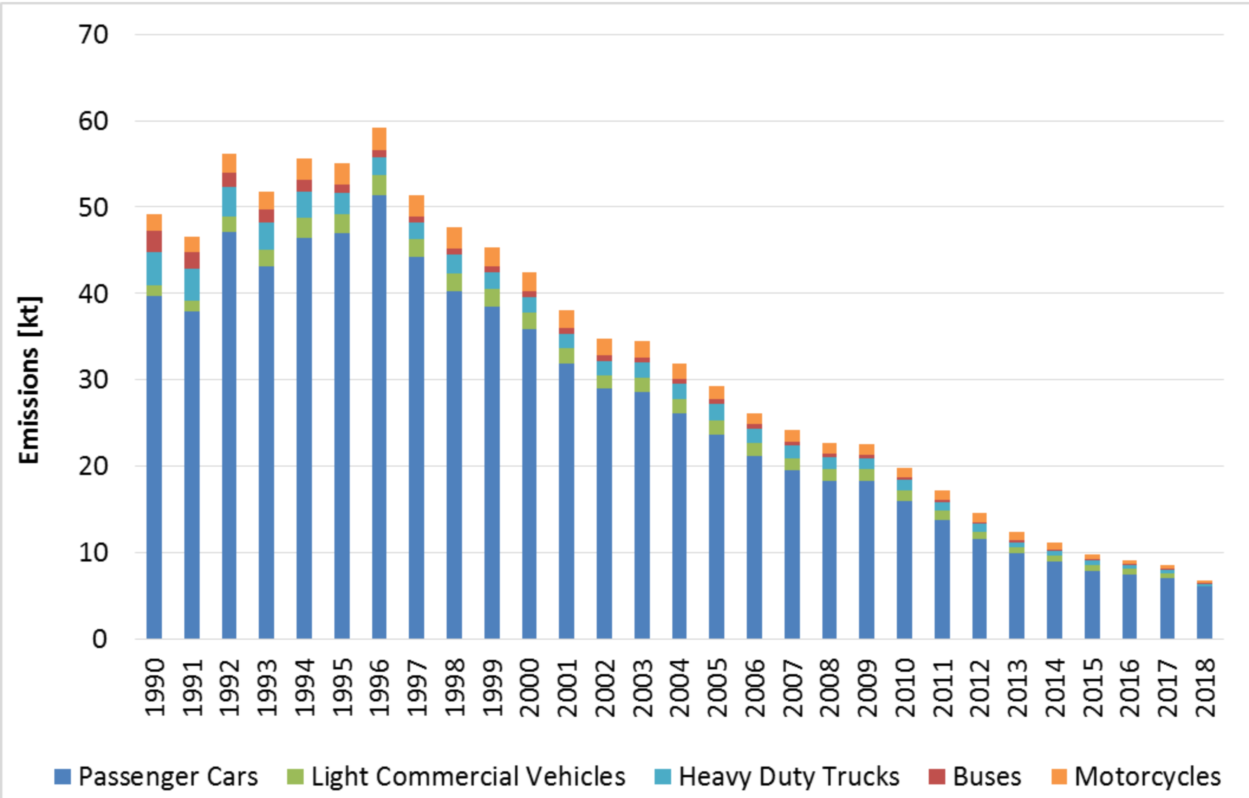

FIGURE 3-9 ANNUAL EMISSIONS OF NMVOC BY ROAD TRANSPORT 1990–2018

Figure 3-9 shows constantly decreasing trend in NMVOC exhaust emissions after 1996, connected mainly with decreasing traffic performance of gasoline fuelled cars and enhancing emission control technologies. Between

2015 and 2017 steep decrease of NMVOC emissions was stopped because of economic growth and lower prices of gasoline compared to previous years. Motorcycles have not such advanced emission control technologies which cause a relatively big share of NMVOC production compared to traffic performance. The next reason is that motorcycles fleet in CZ was especially in the ´90s quite old. The main cause of the more significant decrease of NMVOC exhaust emissions in 2018 is a decrease of traffic performance of the largest emitters – petrol fuelled vehicles in general.

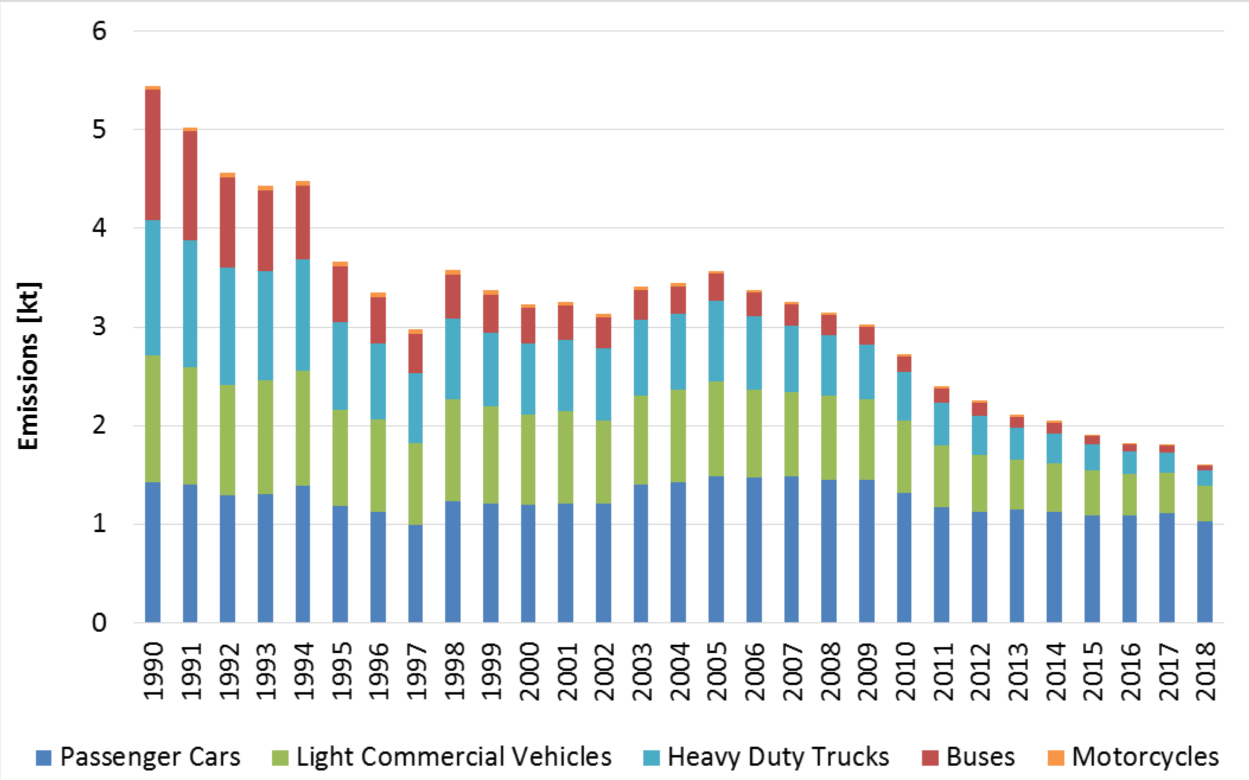

FIGURE 3-10 ANNUAL EMISSIONS OF $PM_{2.5}$, PM_{10} AND TSP BY ROAD TRANSPORT – EXHAUST EMISSIONS 1990–2018

Figure 3-10 represents exhaust emissions of particulate matter. In road transportation, all PM emissions are considered as $PM_{2.5}$ because of the technology of combustion which emitters mostly this type of PM. PM emissions were decreasing until 1997. Trend in emission production by road transport after this year is unsteady – dependent on changing traffic performance and economic situation. Continual decrease came in 2006, after involving Euro 4 (IV) standard with a significantly lower limit for PM. The main emitters of PM are at present passenger cars. On ´90s it was passenger cars, light duty vehicles, heavy duty vehicles and buses approximately on the same level. Due to enhancing of particulate filters technologies and lower pressure of exhaust gases in HDTs, buses and partly LCVs engines, share of PM emissions, from these categories, has been significantly decreasing especially after 2010. In case of buses, low PM production has been influenced by significant subsidies from public resources to encourage the use of CNG buses after 2012. In 2018 we can see decrease in PM exhaust emissions caused by the decrease of traffic performance by LCVs, HDTs and buses.

Figure 3-11 shows a steady downward trend in CO emissions for all categories since1997. Trend in emission production before this year is unsteady – dependent on changing traffic performance, economic and political situation. Lowering emission production is mostly connected with the modernization of the car fleet in CZ and removing old passenger cars (Pre – Euro). Another factor is decreasing of traffic performance of gasoline cars which are the main emitters of CO. Combustion in 2-stroke engines produce extremely high emissions of CO and motorcycles have not such advanced emission control technologies which cause a relatively big share of CO production compared to traffic performance. The next reason is that motorcycles fleet in CZ was especially in ´90s quite old. 4-stroke motorcycles have much lower emissions production and their growing share in motorcycle fleet improves emission behaviour of motorcycles category in last years.

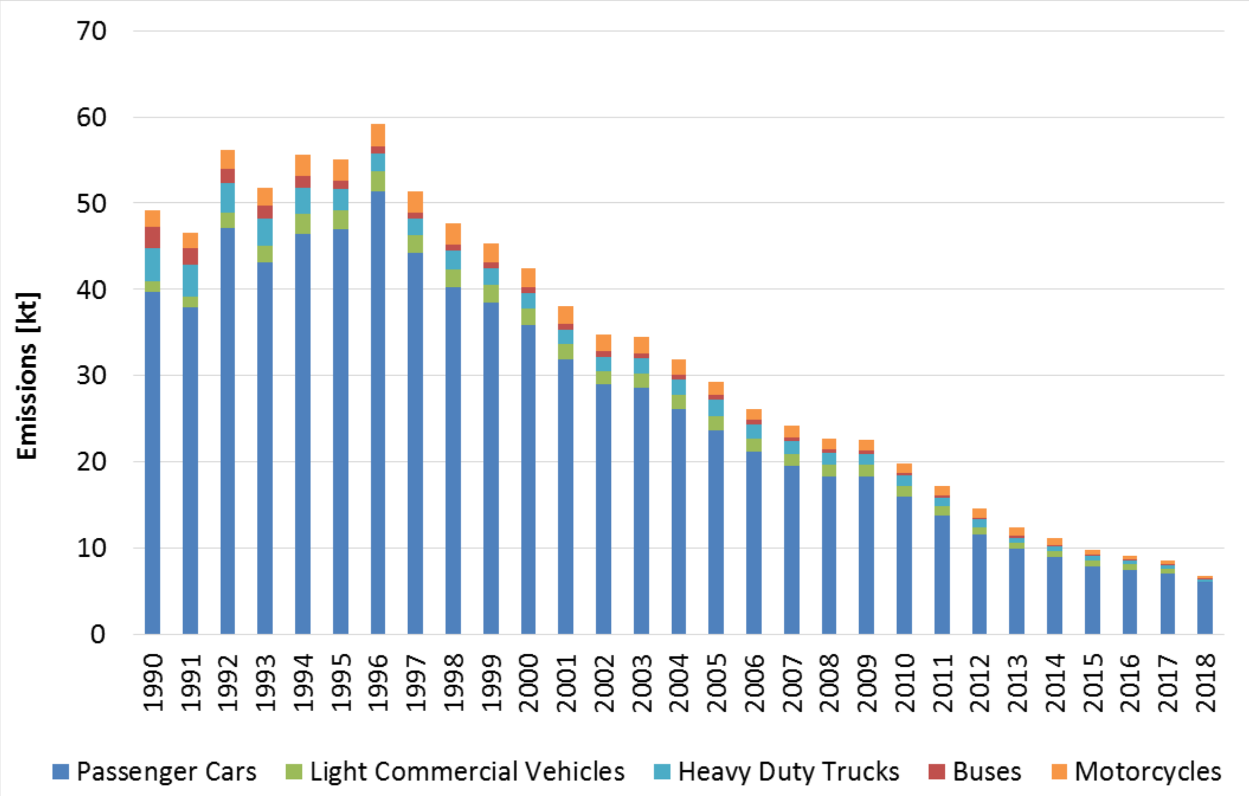

FIGURE 3-11 ANNUAL EMISSIONS OF CO BY ROAD TRANSPORT 1990–2018

3.3.1.4 UNCERTAINTIES

Uncertainty in road transport was calculated according to EMEP/EEA EIG [5]. The uncertainty given here has been evaluated for all of time series (2000–2018). Total combined uncertainty of national emissions within road transport is ± 31.27 %. Uncertainty in activity data is up to 3 %. Uncertainty in EFs ranges from 50 to 200 %. Especially heavy metals, NH_3 and PAHs have less reliable EFs.

3.3.2 PASSENGER CARS (1A3bi)

- passenger gasoline cars Pre-Euro,
- 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).

3.3.2.1 ACTIVITY DATA

General rising trend of fuel consumption by PCs is in line with general trend in the whole Europe (see figure 3-12). In 2007, the economic crisis started in the Czech Republic and influenced overall fuel consumption. The decrease of a fuel consumption stopped in 2012. With a renewal of economic growth, the fuel consumption started to increase again. The most significant was a decrease in gasoline consumption. Decrease of gasoline consumption stopped in 2013 and fluctuates slightly around 65 000 TJ. Diesel oil consumption wasn´t so much influenced. In 2014, the overall fuel consumption reached the same level as had been usual in years before the crisis. Figure 3-12 shows growing share of diesel oil compared to petrol. The reason is growing popularity of diesel cars because of their lower fuel consumption and lower price of diesel oil (especially in warm part of the year) compared to petrol cars.

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. Since 2014 consumption of fluctuates around 10 000 TJ. In 2015 was implemented the increase of taxes for blends with a high percentage of biodiesel, but customers slowly accepted this change. The reason for bioethanol decrease was gasoline price which significantly decreased in 2015 and customers rather used cheaper gasoline than blends with a high percentage of biofuels. Consumption of bioethanol started to increase since 2017 again. CNG started to be used from 2002 in the Czech Republic but a rise in the use of this fuel dates back to 2008. There was a significant increase of CNG share from 2012 till 2017. Still, the share of CNG on fuel consumption is really small.

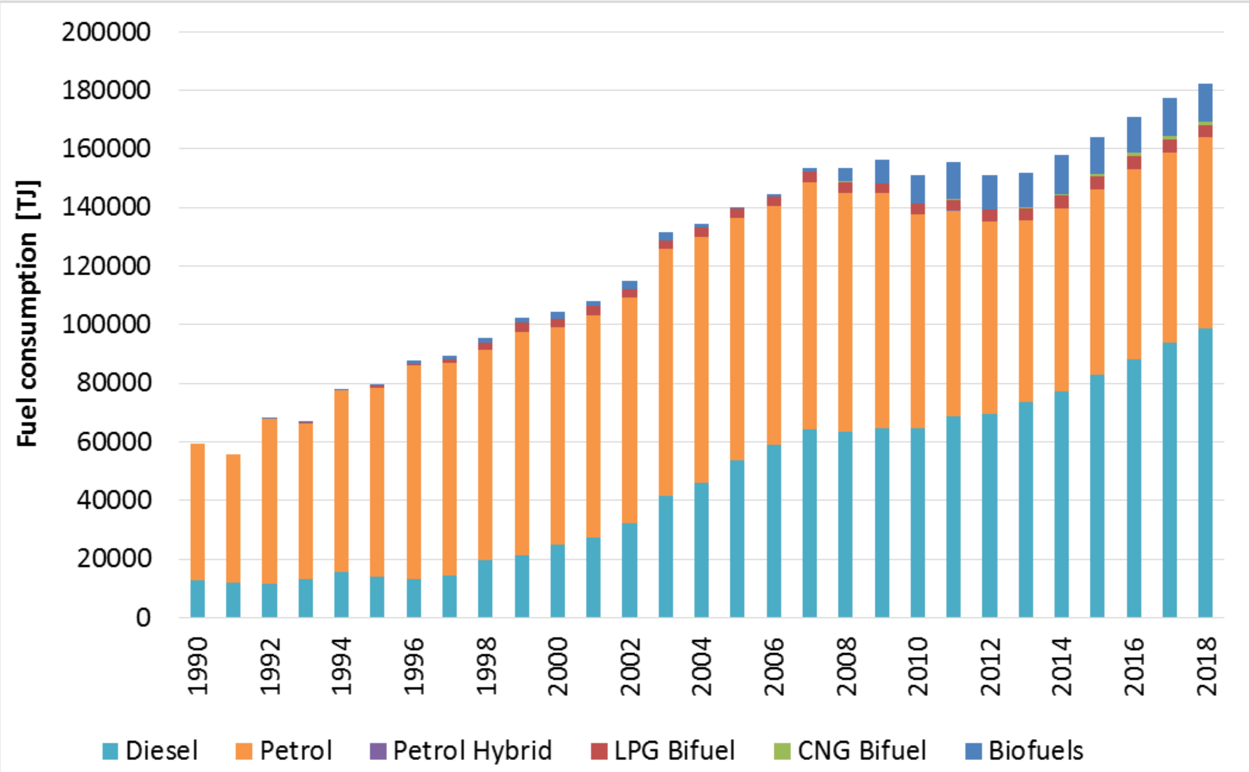

FIGURE 3-12 ANNUAL FUEL CONSUMPTION BY PASSENGER CARS 1990–2018

3.3.2.2 EMISSION FACTORS

In this chapter are presented implied EFs of pollutants for which is subcategory of passenger cars a key category (CO and NO_X (as NO_2)). Emission factors are based on COPERT model on Tier 3 level. Implied EFs for most important fuels were extracted from COPERT program (see Figure 3-13 and Figure 3-14).

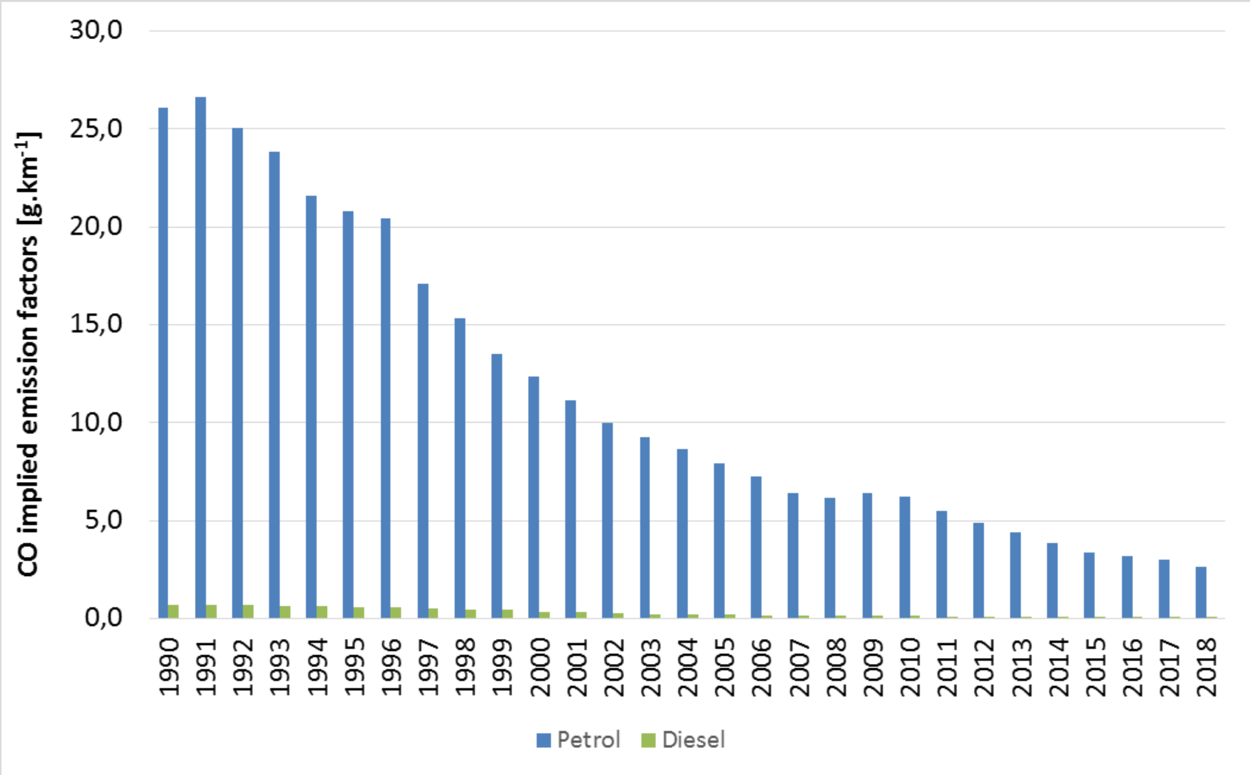

FIGURE 3-13 IMPLIED EMISSION FACTORS OF PASSENGER CARS FOR CO 1990–2018

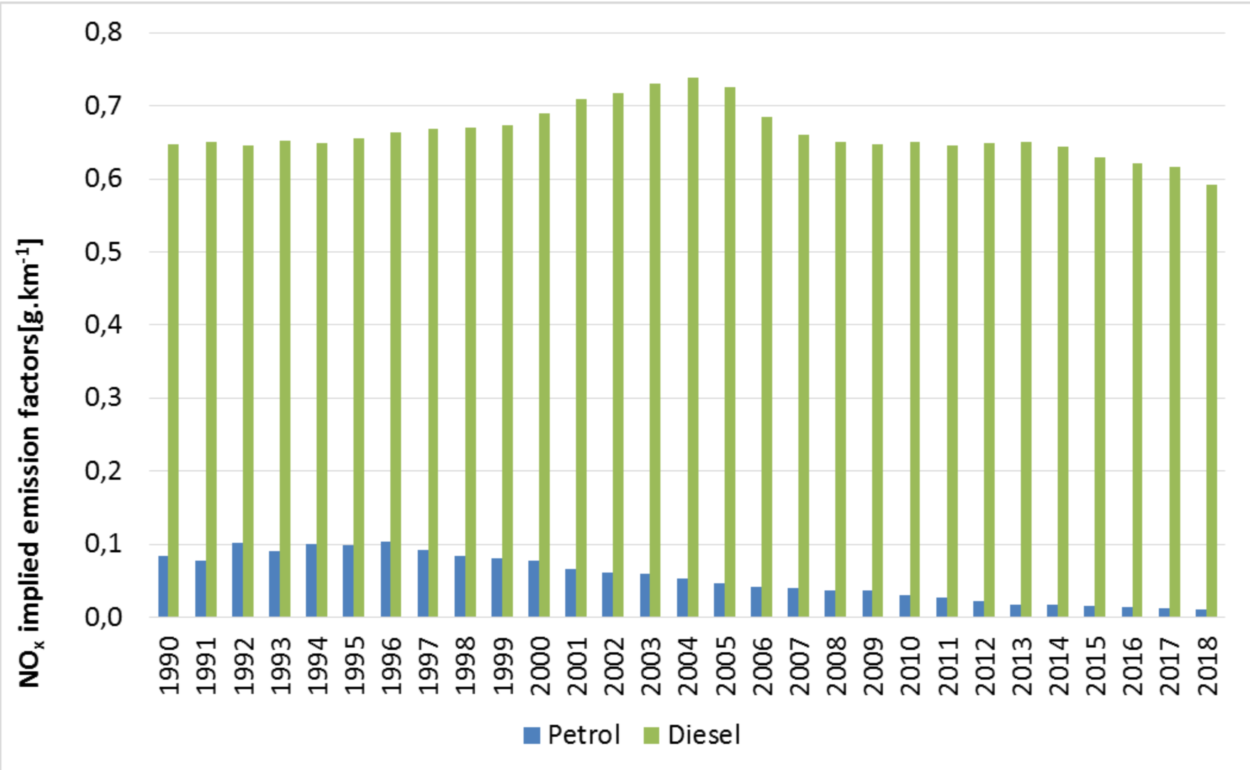

FIGURE 3-14 IMPLIED EMISSION FACTORS OF PASSENGER CARS FOR NO_X (AS NO_2) 1990–2018

3.3.2.3 EMISSIONS

Emissions values of all pollutants can be easily found in national inventory files (NFR) presented on web pages of Centre on Emission Inventories and Projections (see: http://www.ceip.at). Brief description of emissions of pollutants or which is subcategory of Road transport key category is stated in chapter 3.3.1.3.

3.3.3 LIGHT DUTY VEHICLES (1A3BII)

- 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.

Activity data of LDVs subcategory are briefly described and overall fuel consumption can be found in the chapter 3.3.1.1. Most important fuel is diesel oil which share is more than 90 % in whole time series 1990 – 2018.

LCVs emissions of all pollutants can be easily found in national inventory files (NFR). Brief description of NO_X, NMVOC and PM from LCVs subcategory is stated in chapter 3.3.1.3.

Implied EFs of NO_X (as NO_2), for which is subcategory of LDVs a key category, are displayed at the Figure 3-15. Emission factors are based on the COPERT model on Tier 3 level. Implied EFs for most important fuels were extracted from COPERT program.

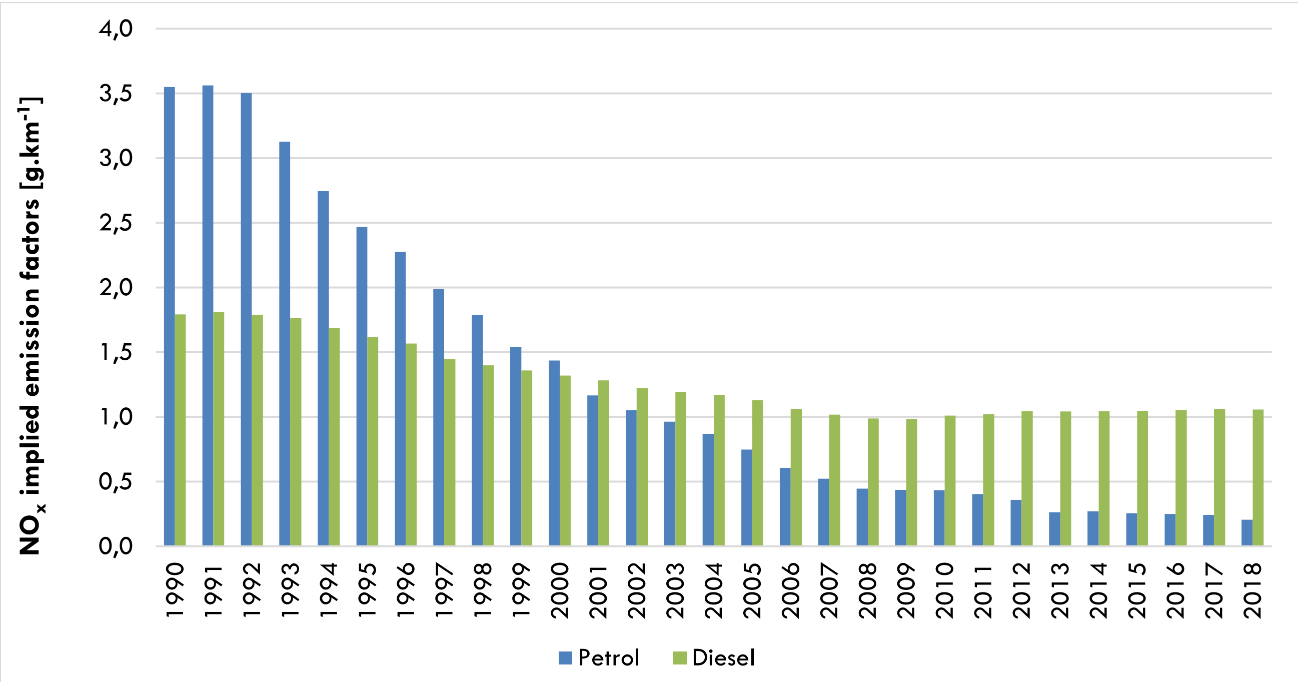

FIGURE 3-15 IMPLIED EMISSION FACTORS OF LIGHT DUTY VEHICLES FOR NO_X (AS NO_2) 1990–2018

3.3.4 HEAVY DUTY VEHICLES AND BUSES (1A3BIII)

- 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 of HDVs and Buses subcategory are briefly described and overall fuel consumption can be found in the chapter 3.3.1.1. Most important fuel is diesel oil which share is more than 99 % in whole time series 1990 – 2019.

HDTs emissions of all pollutants can be easily found in national inventory files (NFR). Brief description of NO_X, NMVOC and PM from LCVs subcategory is stated in chapter 3.3.1.3.

Implied EFs of NO_X (as NO_2) for which is subcategory of HDVs and Buses a key category are displayed at the Figure 3-16. Emission factors are based on the COPERT model on Tier 3 level. Implied EFs for most important fuels were extracted from COPERT program.

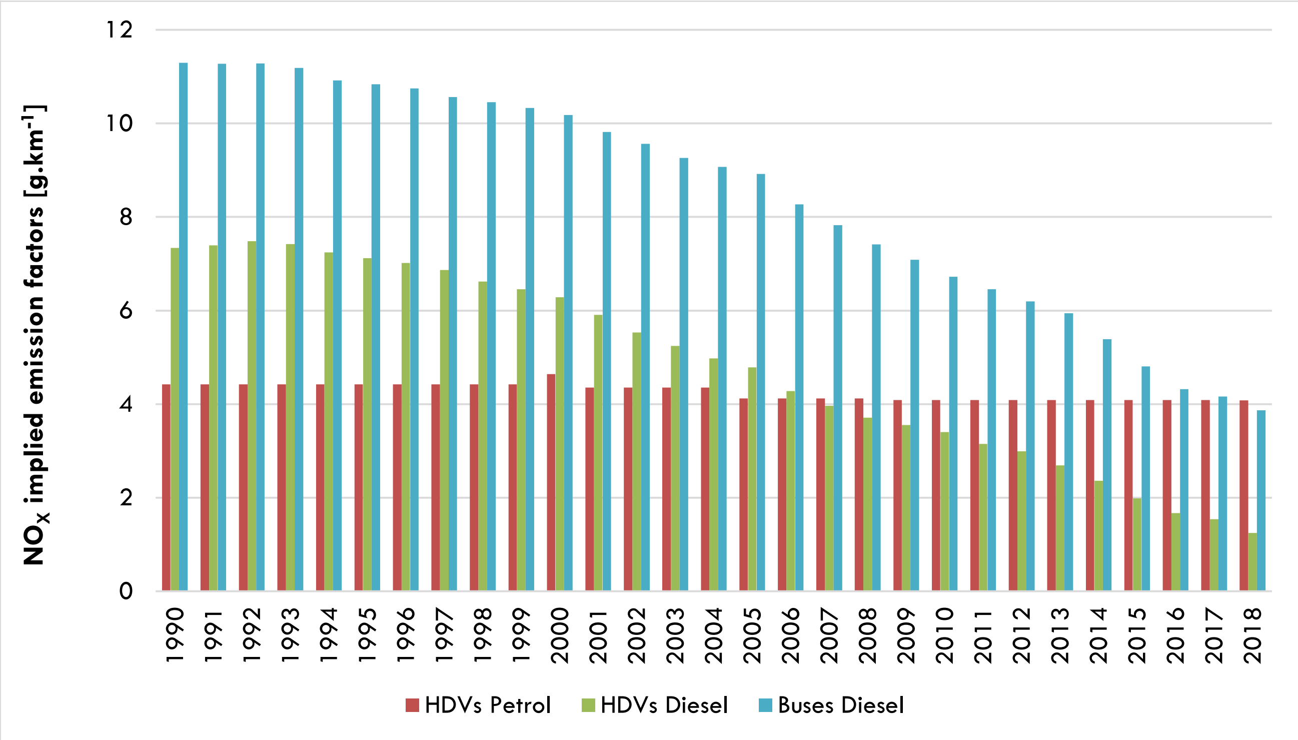

FIGURE 3-16 IMPLIED EMISSION FACTORS OF HEAVY DUTY VEHICLES AND BUSES FOR NO_X (AS NO_2) 1990–2018

3.3.5 MOPEDS AND MOTORCYCLES (1A3BIV)

Activity data of Motorcycles subcategory are briefly described and overall fuel consumption can be found in the chapter 3.3.1.1. Only fuel using in CZ is gasoline. Emissions values of all pollutants produced by Motorcycles can be easily found in national inventory files (NFR). Brief description of NO_X, NMVOC and PM from L- subcategory is stated in chapter 3.3.1.3. Motorcycles are not stated as a key category for any pollutant, therefore there is not any detailed description of implied emission factors in this chapter.

3.4 GASOLINE EVAPORATION AND ABRASION (NFR 1A3bv; 1A3bvi and 1A3bvii)

NMVOC emissions in the subcategory 1A3bv of road transport took into consideration gasoline evaporation and were estimated by the model COPERT in Tier 3 mode. To estimate these emissions, statistical data regarding the number of vehicles with or without emission control are taking into account. The Tier 3 method is based on a number of input parameters, which include fuel vapour pressure, vehicle tank size, fuel tank fill level, canister size, diurnal temperature variation and cumulative mileage. The Copert 5 is used for the calculation of emissions from tyre, brake and road abrasion. Tier 2 methodology is used because no Tier 3 method has been developed yet.

The COPERT 5 is used for the calculation of emissions from tyre, brake and road abrasion. Tier 2 methodology is used because Tier 3 method has not been developed yet.

3.4.1 EMISSION FACTORS AND CALCULATIONS

All processes which are taken account in the calculation of evaporation are shown in Figure 3-17. Activity data for relevant subcategories are displayed in the Figure 3-18. The main sources of evaporative NMVOC emissions are petrol passenger cars and motorcycles.

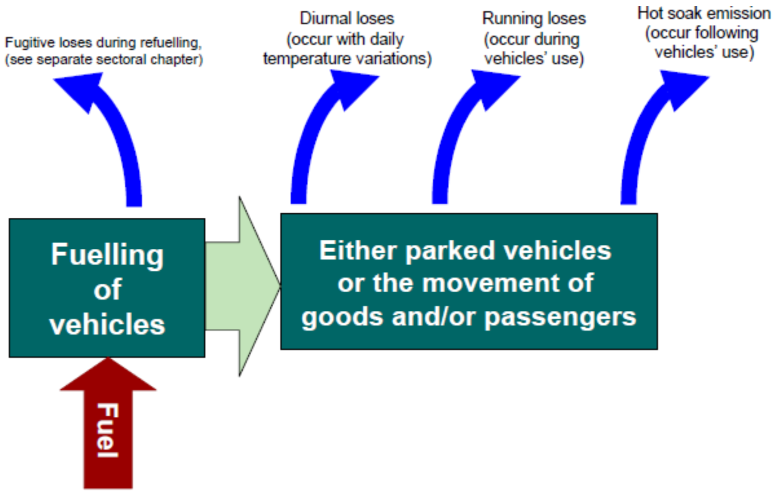

FIGURE 3-17 PROCESSES RESULTING IN EVAPORATIVE EMISSIONS OF NMVOC (SOURCE: EMEP/EEA EIG 2019)

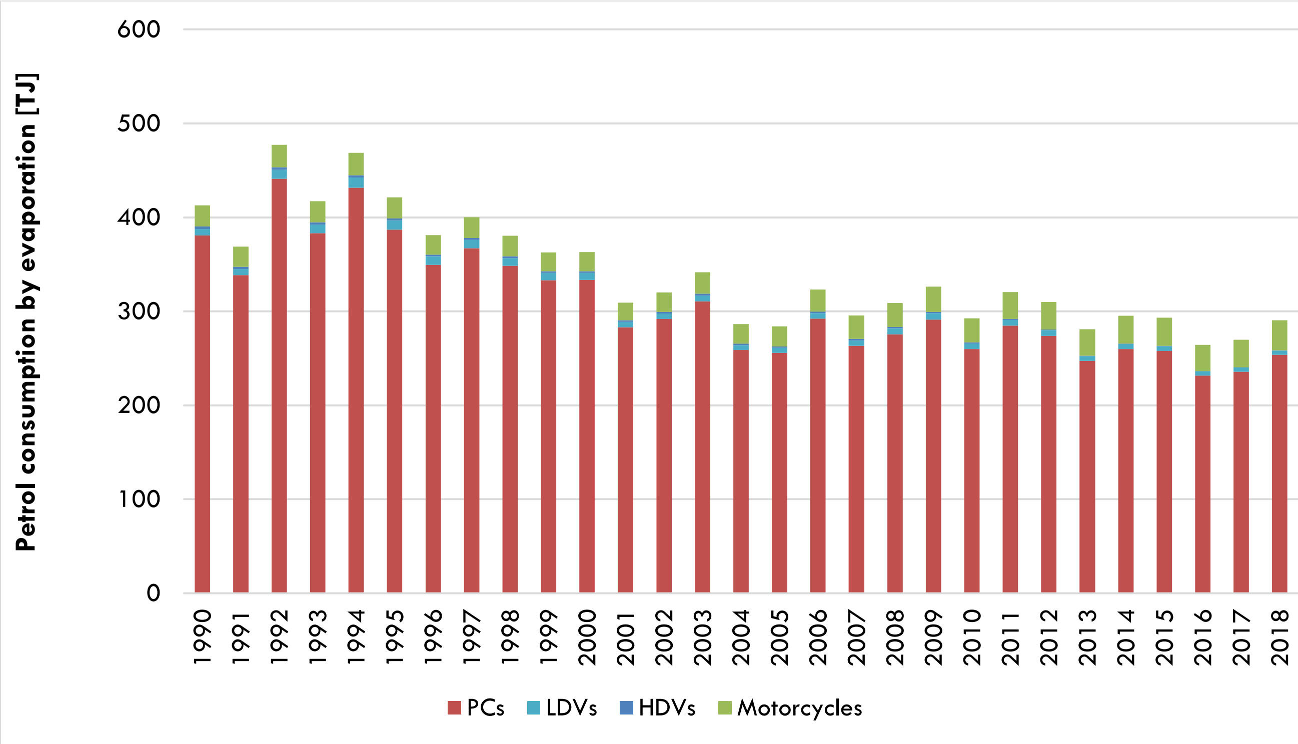

FIGURE 3-18 ANNUAL PETROL CONSUMPTION BY EVAPORATION IN RELEVANT SUBCATEGORIES 1990–2018

Unlike other subcategories, key activity data for abrasion are only traffic performance of car fleet in the Czech Republic (see Figure 3-19). In the graph is clearly seen the development of traffic performance after 1990 and its decrease due to the economic crisis. After 2013 traffic performance started to increase again in a steep way.

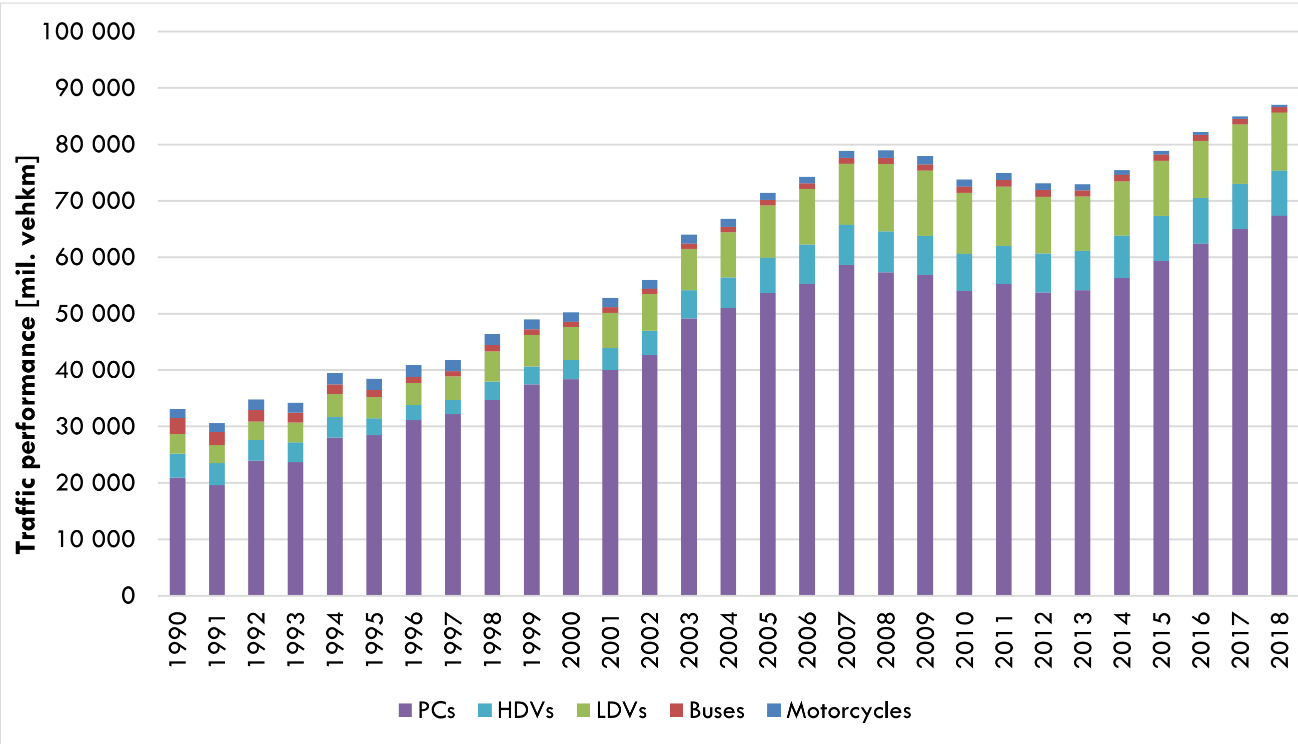

FIGURE 3-19 ANNUAL TRAFFIC PERFORMANCE IN RELEVANT SUBCATEGORIES 1990–2018

In this chapter are presented implied EFs of pollutants for which is a subcategory of passenger cars a key category (PM_{10} and Pb). Emission factors are based on the COPERT model on Tier 2 level. Implied EFs for all vehicle categories were extracted from COPERT program (see Figure 3-20 and Figure 3-21).

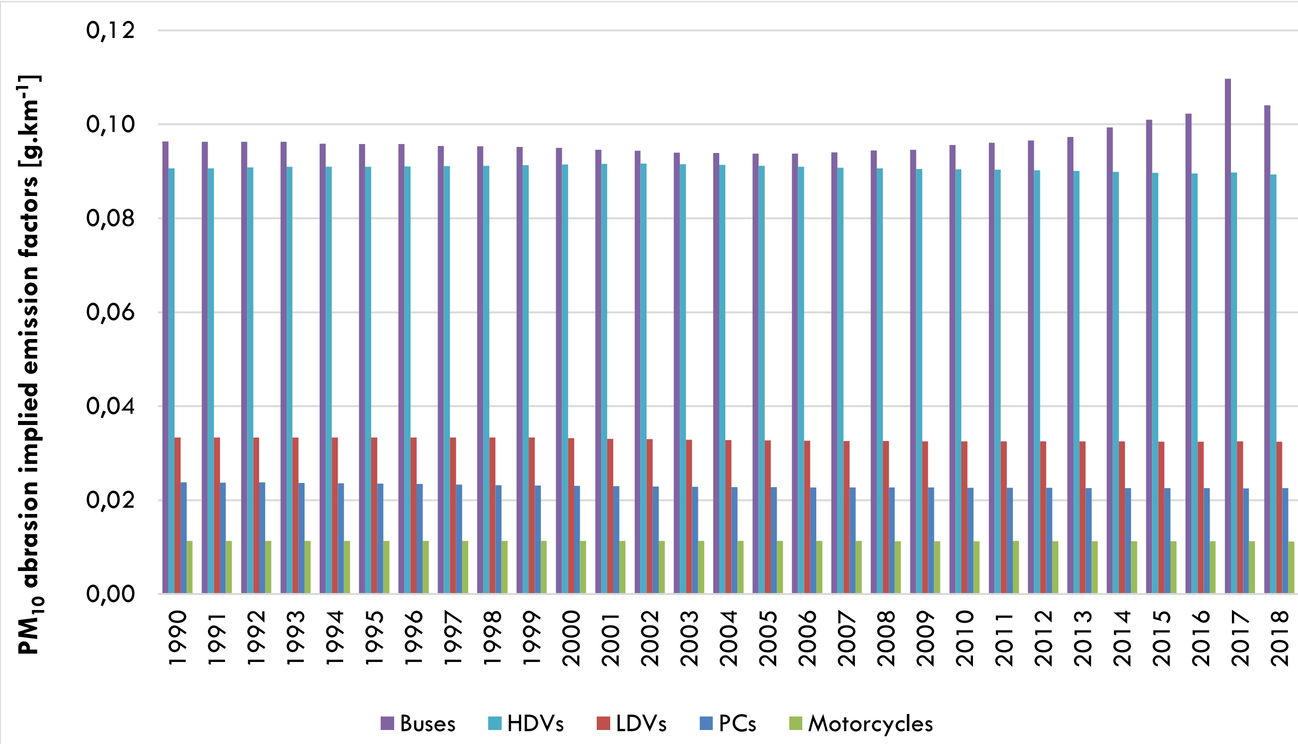

FIGURE 3-20 IMPLIED EMISSION FACTORS FROM TYRE, BREAK AND ROAD ABRASION FOR PM_{10} 1990–2018

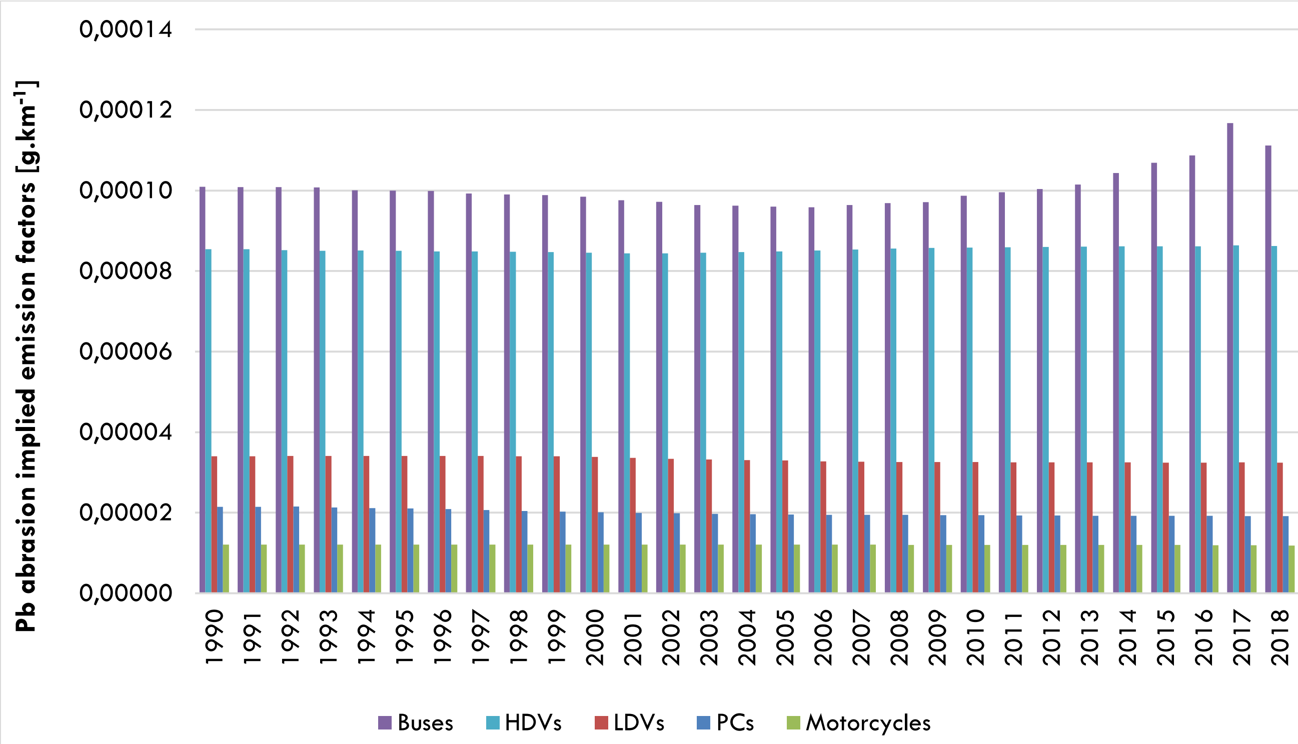

FIGURE 3-21 IMPLIED EMISSION FACTORS FROM TYRE, BREAK AND ROAD ABRASION FOR Pb 1990–2018

Emissions values of all pollutants produced by process of evaporation and by tyre, break or road abrasion can be easily found in national inventory files (NFR).

3.4.2 UNCERTAINTIES AND QA/QC PROCEDURES

Uncertainty for tyre, break and road abrasion was calculated according to EMEP/EEA EIG [5]. The uncertainty given here has been evaluated for all of time series (2000–2018). Total combined uncertainty of national emissions within sector is ± 34.43 %. Uncertainty in activity data is up to 5 %. Uncertainty in EFs ranges from 50 to 150 %. Especially heavy metals have less reliable EFs.

3.4.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

3.5 NON ROAD TRANSPORT

This chapter contains information about emissions from aviation, railway and inland navigation. Emission from Pipeline transport (1A3e) are listed in chapter 3.1.

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 1A3a emissions of both national (domestic) and international civil aviation are reported with respect to distinctive flight phases: the LTO (Landing/Take-off: 0–3,000 feet) and the Cruise (above 3,000 feet). Emissions from military aircraft are not included in this category but are reported under 1A5b Military: Mobile Combustion.

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.

Inland naviagtion includes goods transport on navigable parts of rivers (Vltava, Labe) and leisure boats on rivers, channels and reservoirs.

3.5.1 EMISSION FACTORS AND CALCULATIONS

Emission factors are Tier 2 for main pollutants used from the EMEP/EEA EIG [5]. The exceptions are SO_X and Pb emissions based on country-specific contents of pollutants in fuels. Activity data are gained from CZSO.

3.5.1.1 CIVIL AVIATION

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. These are the numbers for "fuel sold" not "fuel used". CDV every year makes its own estimate of fuel used in the Czech Republic by domestic Aviation. Emissions estimates are made on the basis of overall fuel consumption by domestic flights. The source of activity data is Transport yearbook published every year by the Ministry of transport. A process of estimating emission is based on fuel consumption of aviation gasoline and jet kerosene obtained from the Czech Statistical Office (CZSO). This fuel consumption is:

- In the case of aviation gasoline considered to be used fully by domestic flights.
- In the case of jet kerosene divided between domestic and international flights using the ratio between transport performance in domestic and international aviation calculated on basis of data from Transport yearbook published every year by the Ministry of transport.

The important step is to define a ratio between fuel consumption during LTO and Cruise phases of flight (see Table 3-2). 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 3-2 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

Activity data are gained from CZSO and are divided between LTO and Cruise flight mode according to the ratio which is stated in the Table 3-2. 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, 1A2gvii and 1A4a respectively. Jet kerosene consumption in Civil Aviation and International Aviation are divided on the basis of expert judgment, 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, 2018).

The emission factors are derived from the internal database of the Transport Research Centre, which contains the default emission factors taken from EMEP/EEA EIG [5] database (Tier 1), and also those that have country-specific character (see Table 3-3 to Table 3-5). Tier 1 EFs were taken from other modes of transport (jet kerosene – road diesel oil, aviation gasoline - road gasoline) according to EMEP/EEA EIG [5]. PCDD/F and PCBs are not reported from Civil Aviation. Total emissions from each sector are combinations of emission factor, a ratio of LTO and Cruise on total fuel consumption and activity data. Category of civil aviation is not a key category for any pollutant. Despite this fact, in the Table 3-3 are presented EFs for most significant pollutants produced by civil aviation and their calculation methods.

TABLE 3-3 EF METHOD AND EFs FOR MOST SIGNIFICANT POLLUTANTS USED FOR CIVIL AVIATION INDUSTRIES IN CURRENT YEAR (g/kg)

Subsector	Method CO	Method NO_x (as NO_2)	Method NMVOC	EF CO	EF NO_x (as NO_2)	EF NMVOC
Jet kerosene LTO	CS	CS	CS	2.7	12.50	1.59
Jet kerosene Cruise	CS	CS	CS	2.2	12.50	1.59
Aviation Gasoline LTO and Cruise	CS	CS	CS	126.4	21.87	26.01

3.5.1.2 RAILWAYS

At present, the energy consumption share of locomotives powered by electricity on the Czech railways is 54 %. Use of electricity, instead of diesel fuel, to power locomotives has been continually increasing and electricity now provides 86 % of all railway traffic volumes. Railways' power stations for generation of traction current are allocated to the stationary component of the energy sector (1A1a) and are not included in the 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. Coal-fuelled locomotives are used only for recreational purposes and rides. Emissions are calculated from fuel consumption (CS or Tier 1 level) because there are no available data about traffic performance on the Czech railways at present.

Regular railway operation uses only diesel oil. Coal is used solely within historical rides and the percentage of its consumption is very small. In general, fuel consumption by railways has a slightly decreasing trend from 2000. The only exception is the period 2005–2008. After this, the increase stopped at approx. 3 700 TJ per year because of the economic crisis and replacement of diesel-powered locomotives by electric ones. In 2018 was diesel consumption 3 694 TJ. Coal consumption data are available since 2005 (bituminous coal) for purposes of historical rides. Until 2014 1 kt of bituminous coal was burnt every year. Since 2014 there has been used some lignite too (1 kt every year until 2018). Total coal consumption reached 27 TJ in 2018. These small fluctuations mean big percentual difference in emissions from solid fuels because of relative change ± 100 % of fuel consumption.

Emission factors are stated in unit $g.kg^{-1}$ of fuel, because of the methodology described higher. Coal EFs are, according to the recommendation in EMEP/EEA EIG [5] for Railways, used from part of Guidebook focused on 1A4 - small combustion, (Medium size (>1 MWth to <=50 MWth) boilers, coal fuelled). Category of railways is not a key category for any pollutant. Despite this fact in the Table 3-4 are presented EFs for most significant pollutants produced by railways and their calculation methods.

Emission factors for benzo[k]fluoranthene and Indeno[1,2,3-cd]pyrene are not stated in a corresponding EMEP/EEA EIG [5]. According to the recommendation from the EIG, HDTs Tier 1 EFs are used for railway. EFs for PM_{10} and $PM_{2.5}$ are according Tier 1 EFs from EMEP/EEA EIG [5]. Ratio between $PM_{2.5}$ and PM_{10} emissions is 95.1 % of PM_{10} and is in line with EFs from EMEP/EEA EIG [5].

TABLE 3-4 EF METHOD AND EFs FOR MOST SIGNIFICANT POLLUTANTS USED FOR RAILWAYS IN CURRENT YEAR

Fuel type	Method CO	Method NO_x (as NO_2)	EF CO	EF NO_x (as NO_2)
Diesel Oil	CS	CS	19.7 $g.kg^{-1}$	33.9 $g.kg^{-1}$
Coal	Tier 1	Tier 1	2000 $g.GJ^{-1}$	160 $g.GJ^{-1}$

3.5.1.3 NAVIGATION

Fuel consumption by national navigation is very low. The CZSO provides only data regarding diesel oil consumption within the recreational fleet, which basically represents most of the fuel consumption by national navigation in the Czech Republic. The Czech merchant fleet doesn´t exist. Activity data (diesel oil consumption in TJ) can be easily found in national inventory files (NFR).

Emission factors used for heavy metals and PAHs are not stated in the EMEP/EEA EIG [5]. HDTs Tier 1 EFs are used for inland navigation. EFs are only applied to diesel oil owing to a lack of data. Category of navigation is not a key category for any pollutant. Despite this fact, there are presented in the Table 3-5 EFs for most significant pollutants produced by navigation and their calculation methods. PM_{10} EF is CS. EF for $PM_{2.5}$ EF was derived with the help of ratio between $PM_{2.5}$ and PM_{10} EF (90.3 %) stated in EMEP/EEA EIG [5] (Tier 1 – marine diesel oil/marine gas oil).

TABLE 3-5 EF METHOD AND EFS FOR MOST SIGNIFICANT POLLUTANTS USED FOR INLAND NAVIGATION IN CURRENT YEAR ($g.kg^{-1}$)

Fuel type	Method CO	Method NO_X (as NO_2)	EF CO	EF NO_X (as NO_2)
Diesel Oil	CS	CS	19.7	33.9

3.5.2 UNCERTAINTIES AND QA/QC PROCEDURES

Uncertainty was calculated according to EMEP/EEA EIG [5]. The uncertainty given here has been evaluated for all of time series (2000–2018).

Total combined uncertainty of national emissions within civil aviation for both flight stages is ± 36.80 %. 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.

The total combined uncertainty of national emissions from railways for all reported categories is ± 34.43 %. Uncertainty in activity data is up to 5 % and in EFs ranges from 50 up to 200 %. Especially heavy metals, NH_3 and PAHs have less reliable EFs.

The total combined 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 have less reliable EFs.

3.5.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

3.6 OTHER NON-ROAD MOBILE SOURCES & MACHINERY (NFR 1A2f; 1A4; 1A5)

This chapter contains information about emissions from operation of machines (e.g. mining and construction machines like excavators, caterpillars and loaders, transport inside industrial areals, gardening), agriculture and forest machines and consumption of aviation fuels petrol and diesel oil in further sectors (services, integrated rescue system and military).

The most contributing emission comes from operation of agricultural machinery (1A4cii), mainly represented by tractors. Emissions of CO, NMVOC, NO_X (as NO_2), TPS occurring from agricultural non-road machinery operation has been recalculated. Emissions of NH_3, SO_X, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs have been newly calculated. All produced emissions were recalculated the whole time series since 1990 until 2018. The key step for emission data revision was opening of the non-road vehicles database running together with road vehicles database by the Czech ministry of transport. Included data have been sorted according to age and engine power into groups of tractors according to relevant efficiency for categorization into Stage I - V.

Estimates of emissions regarding non-road mobile sources are used in category 1A4aii diesel oil and jet kerosene. In 1A4cii, there is consumed diesel oil and gasoline there and in the 1A4bii only gasoline. The operation of agricultural machinery (1A4cii) cover the major part of fuel consumption of small combustion, others are negligible. There are no other ADs regarding other fuels potentially used in the Czech Republic.

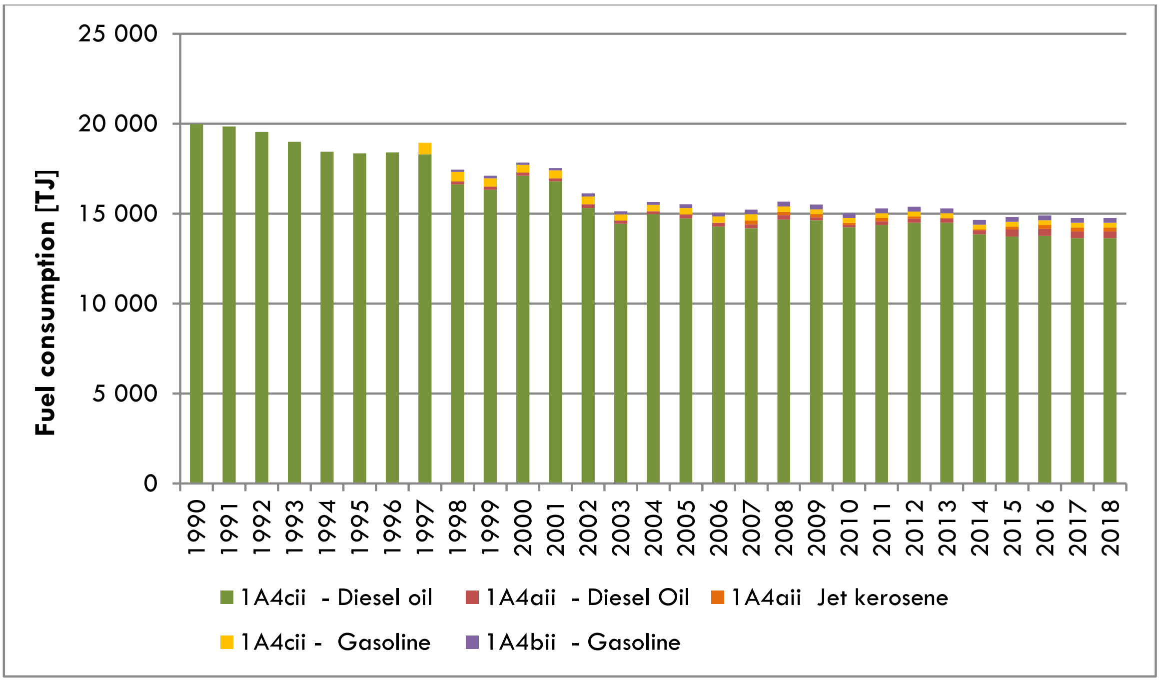

FIGURE 3-22 ANNUAL FUEL CONSUMPTION BY NON ROAD MOBILE MACHINERY 1990–2018

3.6.1 EMISSION FACTORS AND CALCULATIONS

Activity data for each categories are prepared on basis of statisctical census of CZSO. For sector 1A4cii there was gained the total diesel fuel consumption allocated in detail to each category of the machines according to year of production and performance related parameter.

Emission factors are Tier 2 for main pollutants used from the EMEP/EEA EIG [5]. Exceptions are emissions of SO_X, Pb. Those are country-specific and based on a content of pollutants in fuels. Heavy metals and PAHs are calculated on Tier 1 level. Category of mobile combustion in manufacturing industries is not a key category for any pollutant.

3.6.1.1 MOBILE COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION (1A2FII)

Emission factors are Tier 2 for main pollutants used from the EMEP/EEA EIG [5]. Exceptions are emissions of SO_X, Pb. Those are country-specific and based on a content of pollutants in fuels. Heavy metals and PAHs are calculated on Tier 1 level. Category of mobile combustion in manufacturing industries is not a key category for any pollutant.

Emission factors are mainly used from the EMEP/EEA EIG [5]. The exceptions are SO_X emissions based on country-specific contents of pollutants in fuels. Table 3-6 shows the method for used EF. Those EFs which are Tier 1 according to EMEP/EEA EIG [5] are not changing in the time, and therefore they are not stated in the table are stated only CS EFs and Tier 2 EFs which are changing in time.

TABLE 3-6 EF METHOD AND EFS FOR MOST SIGNIFICANT POLLUTANTS USED FOR NON - ROAD MOBILE MACHINERY IN THE CONSTRUCTION AND OTHER INDUSTRIES IN CURRENT YEAR ($g.kg^{-1}$)

Sector	Fuel type	Method CO	Method NO_x (as NO_2)	EF CO	EF NO_x (as NO_2)
1 A 2 gvii	**Diesel Oil**	Tier 2	Tier 2	6.104	3.643

3.6.1.2 COMMERCIAL/INSTITUTIONAL/RESIDENTIAL

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 utilization of mobile machinery is:

- 1A4aii Commercial/Institutional: Mobile
- 1A4bii Residential: Household and Gardening: Mobile
- 1A4cii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery

This chapter does not include agricultural machinery emissions (see 3.6.1.4).

Gasoline-driven lawn mowers used for gardening are included in 1A4bii, tractors, harvesters, chain saws, gasoline off-road vehicles and other machinery used in agriculture and forestry (1A4cii). Since agriculture emissions are the most important, it is paid more attention to them. Mobile sources reported under NFR 1A4 (Non-road mobile) represent versatile equipment and means of transport like diesel non-road machinery (e.g. forklifts). In this subcategory is also reported helicopters and airplanes used for institutional purposes (rescue, police…) fuelled by jet kerosene and aviation gasoline (1A4aii). Data about fuel consumption of helicopters merged with other fuel consumption data in this category. This is the way how CZSO collecting primary activity data and provides for emission calculations. According to the review from October 2019 this is not correct and emissions from all helicopters and aeroplanes should be included in 1A3aii. Currently, the Czech Republic is working together with CZSO on separating data. This issue should be solved at the end of 2021 with results of the project financed by the Czech government and focused on improving emission calculations from aviation sector.

Emission factors for main pollutants are Tier 2 EMEP/EEA EIG [5]. Exceptions are emissions of SO_X, Pb. Those are country-specific and based on the content of pollutants in fuels. Heavy metals and PAHs are calculated on Tier 1 level. 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. Category of non-road machinery is a key category for NO_X (as NO_2) and $PM_{2.5}$. In the Table 3-7 below are presented EF of these pollutants and also for CO which is another significant pollutant produced by non-road mobile machinery and their calculation methods.

TABLE 3-7 EF METHOD AND EFS FOR MOST SIGNIFICANT POLLUTANTS USED FOR NON ROAD MOBILE MACHINERY IN CURRENT YEAR ($g.kg^{-1}$)

Subsector	Fuel type	Method CO	Method NO_X (as NO_2)	Method NMVOC	EF CO	EF NO_X (as NO_2)	EF NMVOC
1 A 4 a ii	**Diesel Oil**	Tier 2	Tier 2	Tier 2	6.104	3.642	0.554
	Jet Kerosene	Tier 2	Tier 2	Tier 2	6.037	3.133	0.533
1 A 4 b ii	**Gasoline**	Tier 2	Tier 2	Tier 2	737.585	3.973	62.546
1 A 4 c ii	**Gasoline**	Tier 2	Tier 2	Tier 2	737.585	3.973	62.546

3.6.1.3 MILITARY

Basically, all military ground transport fuelled by diesel oil (1A5bi) and military aviation fuelled by jet kerosene (1A5bii) is included in this category. There is no Military Navigation (1A5biii) in the Czech Republic, so this is not reported.

Activity data used for the Czech Military are gathered by the CZSO. In this subsector are used jet kerosene (data from 2002) and diesel oil. The peak of fuel consumption was in 2009. Afterward, the trend of fuel consumption is almost decreasing – started by the economic crisis. In the last years, trend of fuel consumption has begun to be unsteady.

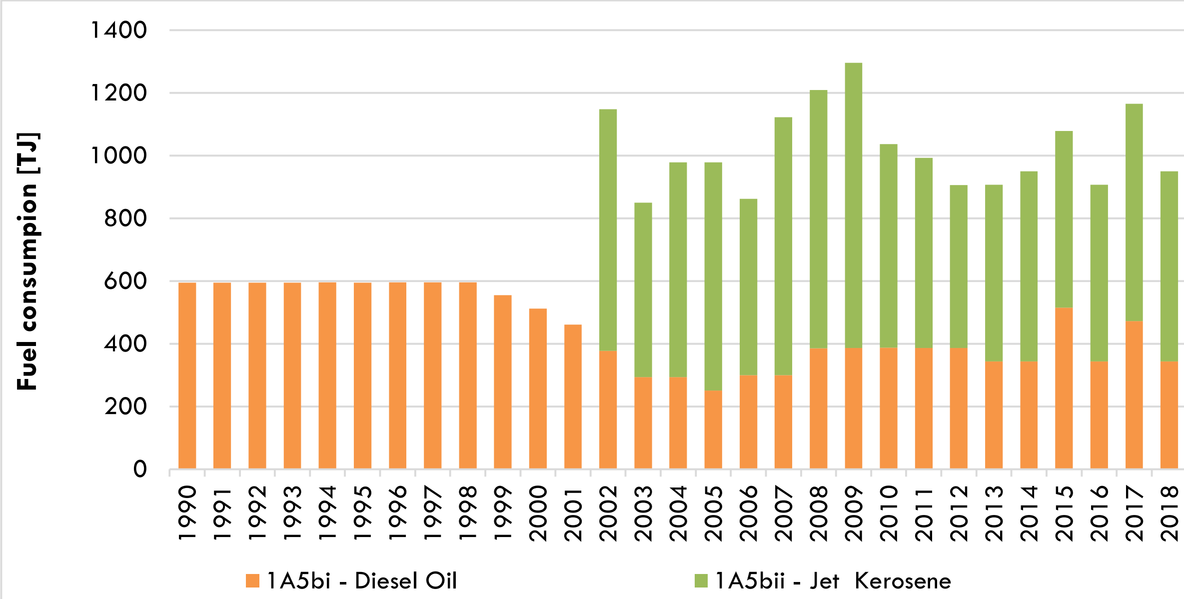

FIGURE 3-23 ANNUAL FUEL CONSUMPTION BY OTHER MOBILE SOURCES 1990–2018

Emission factors are Tier 2 for main pollutants used from the EMEP/EEA EIG [5]. Exceptions are emissions of SO_X, Pb. Those are country-specific and based on the content of pollutants in fuels. Heavy metals and PAHs are calculated on Tier 1 level. Category of other mobile sources is not a key category for any pollutant. Despite this fact, in the Table 3-8 are presented EFs for most significant pollutants produced by other mobile sources and their calculation methods.

TABLE 3-8 EF METHOD AND EFS FOR MOST SIGNIFICANT POLLUTANTS USED FOR OTHER MOBILE SOURCES IN CURRENT YEAR ($g.kg^{-1}$)

Sector	Fuel type	Method CO	Method NO_X (as NO_2)	EF CO	EF NO_X (as NO_2)
1A5bi	**Diesel Oil**	Tier 2	Tier 2	6.037	3.133
1A5bii	**Jet Kerosene**	Tier 2	Tier 2	6.037	3.133

3.6.1.4 AGRICULTURE/FORESTRY/FISHING: OFF-ROAD VEHICLES AND OTHER MACHINERY

In past, calculated relevant emissions occurring during operation of agricultural machinery (mostly tractors) were relatively high in comparison with other sectors using similar types of diesel engines. It was cause for revision of used emissions factors, activity data and for updating this section (June 2018). Emission data for wood processing tool (wood cutting) are available 1997 onwards.

The key step for activity data revision was opening of the road and non-road vehicles database running by the Czech ministry of transport. Included data have been sorted according to age and engine power into groups of tractors according to relevant efficiency for categorization into Stage I - V.

For calculation of emissions tractors less than 15 years old are taking into consideration. The reason for this approach is an assumption that intensive land farming (estimated share 75 % of crop farming in the Czech Republic) require new tractors with higher rated power for aggregation of some field operation into just one. From economical point of view tractors older than 15 years are not used for most significant field operations. It means these tractors do not represent a significant share of agricultural activities and operations. It is a high projection that they are not significant sources of emissions into air.

Currently, older tractors with lower rated power 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 included in emission calculations to approx. 20 thousand tractors.

In Figure 3-24 share of tractors produced within last 30 years is presented. From the total number of tractors putted into operation in the Czech Republic within last 30 years only 8 % is newer than 10 years. From the total number of tractors there is approximately 35 % share of tractors putted into operation within last 30 years.

On the Figure 3-25 share of tractors structured according to rated power is shown. Only tractors putted into operation within last 30 years have been taken into account. The most significant categories of agricultural machinery comprise tractors with efficiency 37–75 kW and 75–130 kW.

Mobile agricultural machinery is a key source of NO_X (as NO_2) and CO. This category of mobile machinery is also an insignificant source of NMVOC and TPS. For national estimation of mentioned emissions produced by agricultural machinery in the Czech Republic the Tier 2 approach is used according to the 1A4 Non road mobile machinery 2016 EMEP/EEA EIG [5] –Update May 2017 (table 3.6. of the Guidebook). Diesel oil consumption is taken from CZSO. Emissions originating from non-road agricultural machinery operations are depended on type, age and engine output of tractors/harvesters.

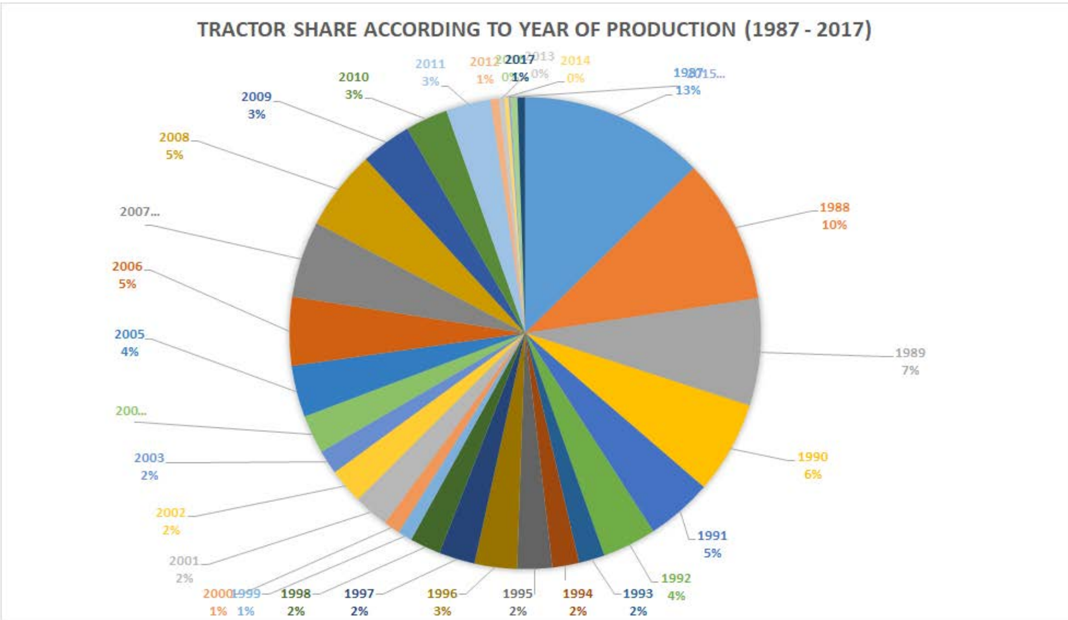

FIGURE 3-24 SHARE OF TRACTORS BY YEAR OF PRODUCTION

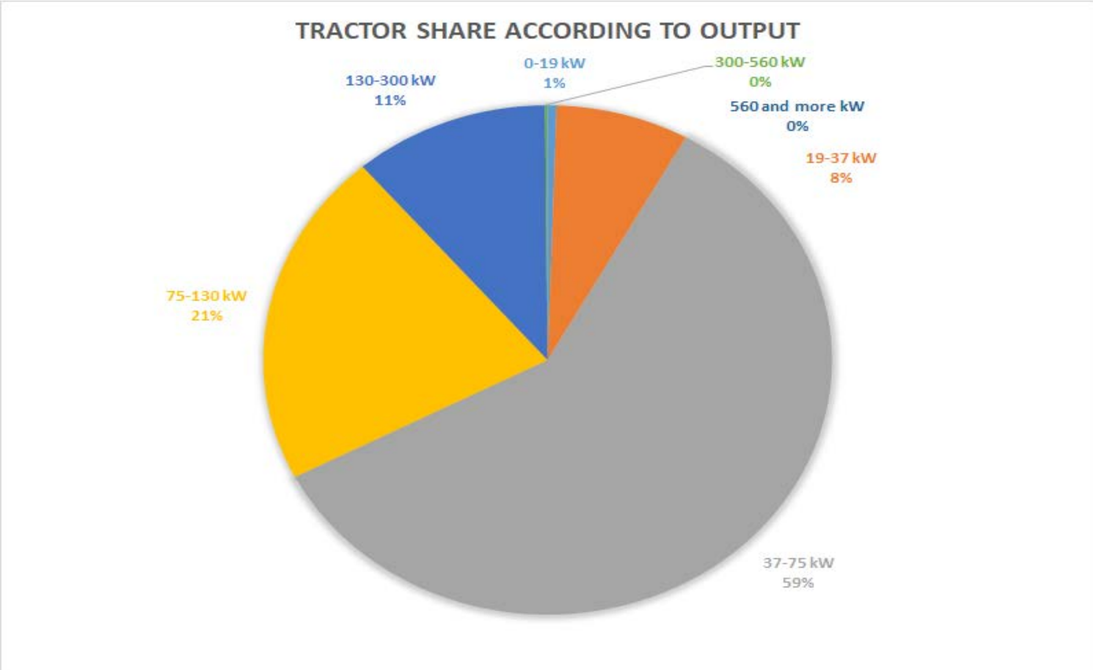

FIGURE 3-25 SHARE OF TRACTORS ACCORDING TO RATED POWER

3.6.2 UNCERTAINTIES AND QA/QC PROCEDURES

Uncertainty for non-road mobile machinery in the construction and other industries was calculated according to the EMEP/EEA EIG [5]. The uncertainties given here have been evaluated for all of time series (2000–2018) and all reported categories. The total combined uncertainty of national emissions from non - road mobile machinery is ± 36.75 %. 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.

For agriculture mobile machinery there was insufficient data available to assess the uncertainty of the calculations. The same calculation system has been used for the whole series.

3.6.3 PLANNED IMPROVEMENTS

Wood processing tools emissions (mainly wood cutting) will be estimated for the period 1990–1996 using wood cutting data.

3.7 FUGITIVE EMISSIONS FROM FUELS (NFR 1B)

The source category Solid fuels (1B1) consists of three sub-source categories:

- 1B1a Coal mining
- 1B1b Coal transformation
- 1B1c Other.

The source category Oil fuels (1B2) consists of next sub-source categories:

- 1B2a Oil extraction, refining/storage and distribution of oil product
- 1B2b Gas extraction

- 1B2c Venting and flaring
- 1B2d Other fugitive emissions from energy production.

The category 1B1 deals with fugitive emissions from coal mining and handling, transformation and other sources. In the Czech Republic, there are mined bituminous coal and lignite. Lignite at the present mined in open cast mining, bituminous coal as underground mining. Since 1990s the mining of coal significantly lowered and the coal import grew up. Lignite is mostly mined in North-West Bohemia and bituminous coal is mined in Silesia (North-East of Czechia) where there is located part of Silesian basin. An important input for metallurgical production there is the coke production located nearby bituminous coal mining in Ostrava and Třinec. There is one facility forcoal gasification Sokolovská uhelná. The trend of lignite and bituminous coal mining is aparent in the Figure 3-26.

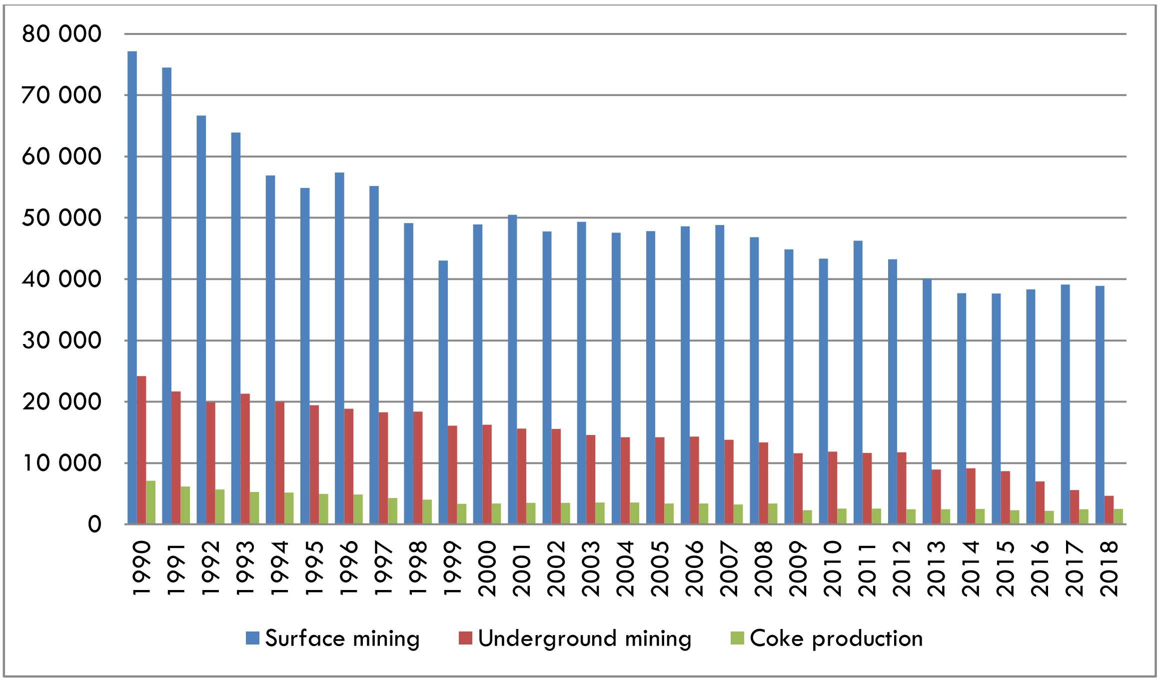

FIGURE 3-26 SURFACE AND UNDERGROUND MINING AND COKE PRODUCTION (kT/YEAR)

This category 1B1c includes emission of coal sorting and drying mainly in sorting plants producing coal for household consumption, coke plants and irregularly reported wood coal production emissions.

The category 1B2 deals with fugitive emissions from Oil extraction, refining/storage and distribution of oil products. There are only limited deposits of oil and gas in the Czech Republic located in Southern Moravia and so the fossile fules import plays an important role in the foreign trade. Oil processing to fules takes place in two refineries (Litvínov and Kralupy nad Vltavou) with consequent petrochemical facilities. Further processing of specific semiproducts from oil refineries takes place in company Paramo (refineries in Pardubice and Kolín).

Distribution network of fuels includes 4000 public petrol stations and further approx. 2500 stations not accesible to general public (mostly for distribution of diesel fuel) or with limited access. Multi-purpose petrol stations prevail and the number of stations with biofuels and other fuels distribution (mainly CNG) grows.

NMVOC emissions from oil drilling comes from oil storage and filling railway transport tanks. Emission from process leakages of accompanying oil gas is therefore due to low amount not calculated. The most significant emission comes from refinery oil processing and includes oil as well as oil products storage (NMVOC emissions), catalytic convertors regeneration (emission of NO_X and SO_2) and refinery flaring (emission of NO_X and SO_2). Emissions from consequent petrochemical processing of oil products inclusive flaring emissions are allocated in category 2B10a.

3.7.1 METHODOLOGY AND RESULTS

In the Czech Republic, there are being mined bituminous (underground) 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 EMEP/EEA EIG [5]. EFs for NMVOC are adapted to the conditions in the Czech coal mines. EFs depend on geological conditions, the composition and amount of firedamp. Considering data available and expert consultation EF for NMVOC was estimated 0.56 kg/Mg. Firedamp from undeground mining is partly being combusted in cogeneration units.

For category 1B1b solid fuel transformation source operator reported emissions are used (coke production and gasification). Emissions from the coke production process are being ascertained according to a unified methodology of quantifying emissions from coking plants (see e-ANNEX).

Category 1B2 presents reported emissions excluding only emissions from oil fuels distribution. Refinery emissions may fluctuate depending on the product´s demand, sulphur content and the current operating conditions of each facility.

Category 1B2d considers for emission estimate total sales of diesel oil and petrol (CZSO data) and national emission factors reflecting obligatory recovery equipment at petrol stations in Czechia (valid approximately since 1999).

For emission from diesel oil distribution emission factor 16.8 g/t diesel oil is used for the whole time series. For petrol distribution in 1990–1992 emission factor 1.022 g/t was used withous regeneration. Until 1998, according law, we assume successive instalation of stage 1 and 2 regeneration and 1999 onwards emission factor 70 g/t is used.

Due to changes in integrated permits in refineries (Claus plants and flares) and petrochemical processes there had been changed in 2014 the obligation to monitor and report emissions of combustion flares. According to the agreement with the source operator the emissions of SO_2 and NO_X reported according E-PRTR regulation, these were used for completion of reported emissions (NFR 1B2c and partly 2B10a too).

The inventory of fugitive NMVOC emissions in gas industry includes balance of gas leakages in the whole chain from extraction to import, storage, compression stations and distribution to end users. The performed inventory is closely linked to GHG (CH_4) inventory in the appropriate sector. For our calculation there were used national emission factors of IPCC balance and NMVOC emission calculated as long-term share of higher hydrocarbons in natural gas 4.02 % (w).

3.7.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

3.7.3 PLANNED IMPROVEMENTS

For sector NFR 1B2 we intend to prepare more transparent decription of emission estimate and possible adding of some emissions according EMRT recommendation.

4 INDUSTRIAL PROCESSES (NFR SECTOR 2)

The date of the last edit of the chapter: 03/04/2020

For emission estimates from industrial processes in the Czech Republic combined system described in chapter 1.4 is used. The emissions from industrial processes listed in Annex 2 to Act No. 201/2012 Coll. are monitored. Emissions from these sources for the whole period are ascertained by source operators themselves, who carry out authorized measurements or in exceptional cases by calculations/computations using emission factors. Unless source emissions listed in Annex 2 are ascertained (sector 2B1 Ammonia production) or are ascertained only for more important sources (NMVOC emissions in sectoru 2H2 Food processing), the inventory performed using EMEP/EEA EIG [5] methodology. Inventorying of emissions from processes not listed in Annex 2 (e.g. 2A5b Construction and demolition) is done according to methodologies contained in EMEP/EEA EIG [5] with exception of solvent use emissions (mainly category 2D3a), where EMEP/EEA EIG [5] was used. Emissions in sector 2D Solvent use are estimated by specific way, where emissions of significant sources are monitored in detail by annual SOE reporting but household emissions and not-named sources can be estimated only by available statical methods or in cooperation with producers´ associations. These emissions contribute to majority of total emission from Solvent use. Emissions are determined based on a material balance in statistics of production and imports, data from the largest producers and users, etc. Below please find industrial processes that belong to key categories.

Sector industrial processes also includes sources that are difficult for inventorying to split between combustion process emissions and emissions from use of raw materials as raw material processing and metallurgy. According to recommended practice the combustion emissions by agglomerate production should be reported separately; emissions of NO_X, SO_2 and CO in category 1A2a and other emissions (TSP, HMs and POPs) in category 2C1. Current way of emission iventory processing does not reliably enable to separate common reported emissions in mentioned sectors and TSP emissions from combustion processes linked to input preparation for metallurgy are therefore reported in sector 1A2.

Annual emissions closely depend on main industrial indicators of production (steel, clinker, etc.) as well as economic (GDP) that correlate industrial indicators like passenger cars production linked to other production sectors in the Czech Republic. Activity data of the most important production facilities are based on REZZO database, as well as in cooperation with CZSO, producers´ asociations.

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

The sectors belong to key categories (except Solvent use) for: TSP - 2A5a Quarrying and mining (2.7 %), PM_{10} – 2G Tobacco (2.5 %), Pb – 2G Fireworks (29.2 %), 2C1 Iron and steel (20.4%), 2C5 Lead production (4.3 %), Hg – 2C1 Iron and steel (4.3 %), Cd – 2A3 Glass production (13.3 %), 2C1 Iron and steel (9.3 %) and 2G Tobacco (8.9 %), PCDD/F – 2C1 Iron and steel (11.9 %).

The following chapters describe the method of calculation for sub-sectors.

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 2018 to key sources of TSP (2.7 %) emissions. Activity data of the most important production facilities are based on REZZO database in cooperation with CZSO, SVV and SVC.

For more details of glass and clinker production please refer to information in section Individually monitored sources.

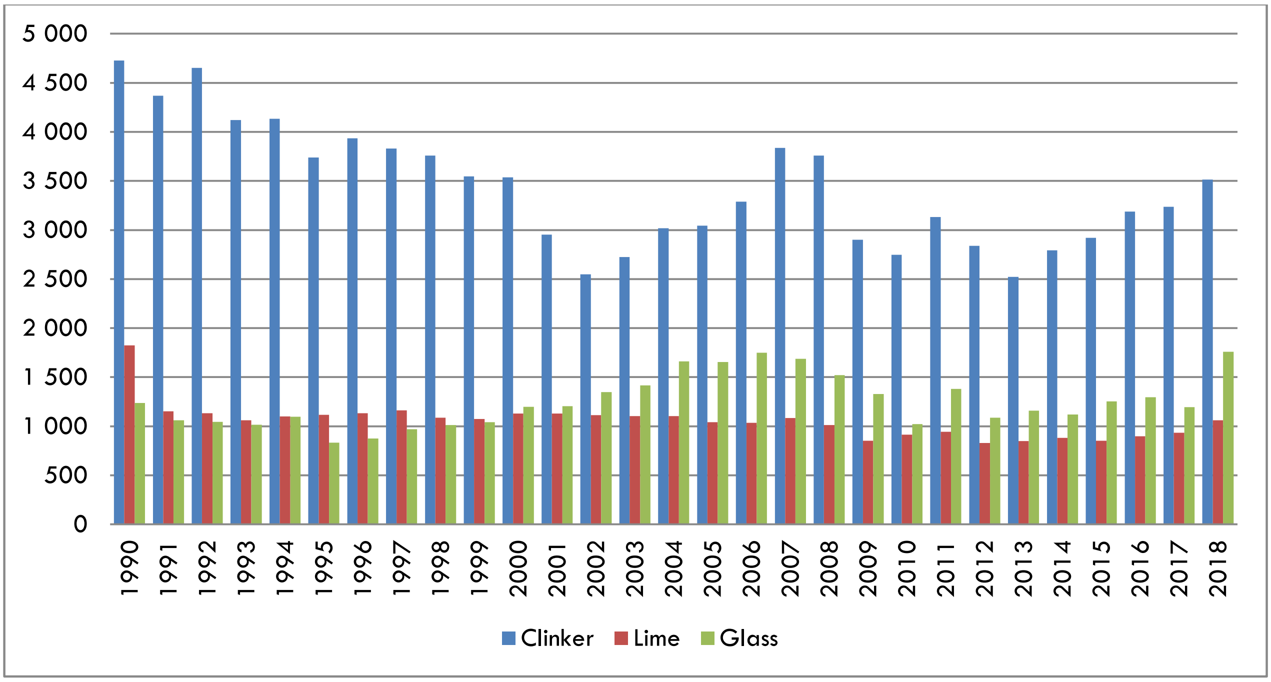

FIGURE 4-1 TREND OF CLINKER, LIME AND GLASS PRODUCTION IN 1990–2018 (kt)

NFR sectors 2A do not mostly belong to key categories. The methodology of emission monitoring is long term constant for all sectors and is based, with exception of sector 2A5b Construction and demolition, on reported source emissions underlying annual reporting duty. A part of operation permit for all rotary clinkern kilns there is the possibility of waste co-combustion. Emissions of heavy metals and POPs for waste co-combustion cannot be separated from process emissions and are therefore reported in sector 1A2a. Emissions of raw material and product handling exhuasted by managed exhaust there are based than on one-time measurements in prescribed intervals. For raw material mining in sector 2A5a and recycling lines of construction wastes (allocated in sectoru 2A6) emissions are mainly ascerteined by calculation using emission factors. National statistics do not provide any demolition data.

In the period 1990–2002 there was a significant decrease in production of construction materials. 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 produce cement clinker in rotary furnaces using a dry process with preheating. Lime is produced in rotary or shaft furnaces. Currently, there are 6 lime production facilities (exclusive facilities which are part of sugar factories). The production of glass is an energy-intensive high-temperature activity producing by oxidation of combustion air and from compounds contained in raw materials present in molten glass mixtures. In the Czech Republic is at present app. 60 operational glass works that melt 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, SO_X, NO_X, 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. 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. Similarly, emission from non-combustion processes by other processing of minerals incl. glass fibres and other isolants are included in category 2A6.

The most significant emissions are generated by the mining sector (excluding fuels). Mining in the Czech Republic has a very long tradition ranging over many centuries. The products extracted through the mining industry serve today as inputs for a number of very important industries, for example: power generation, building and construction industry, ceramics, glass industry, chemical industry, food industry and other specific sectors.

Until 1994, emission estimate from the NFR 2A5a category was not performed according raw material extraction. Since 1995 these emissions have been ascertained. Until 2002, all mining sites were included among the listed sites. Since 2002, emissions are reported only mining sites with a capacity exceeding 25 m^3/day, but they account for the largest share. Emissions are calculated by source operators using emission factors related to the amount of raw materials consumed, which corresponds to the Tier 1 level. In 2008, the legislation that brought about the change in the obligatory reported emissions was amended in 2008, however, it was not possible to make sufficiently accurate estimates to allow data synchronization between 2008 and 2009. Since 2016, calculations have been carried out in a more detailed manner, covering individual technological operations, incl. the use of abatement (ie Tier 2 level). The emission factors are published by the Ministry of the Environment in the Bulletin.

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. 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.

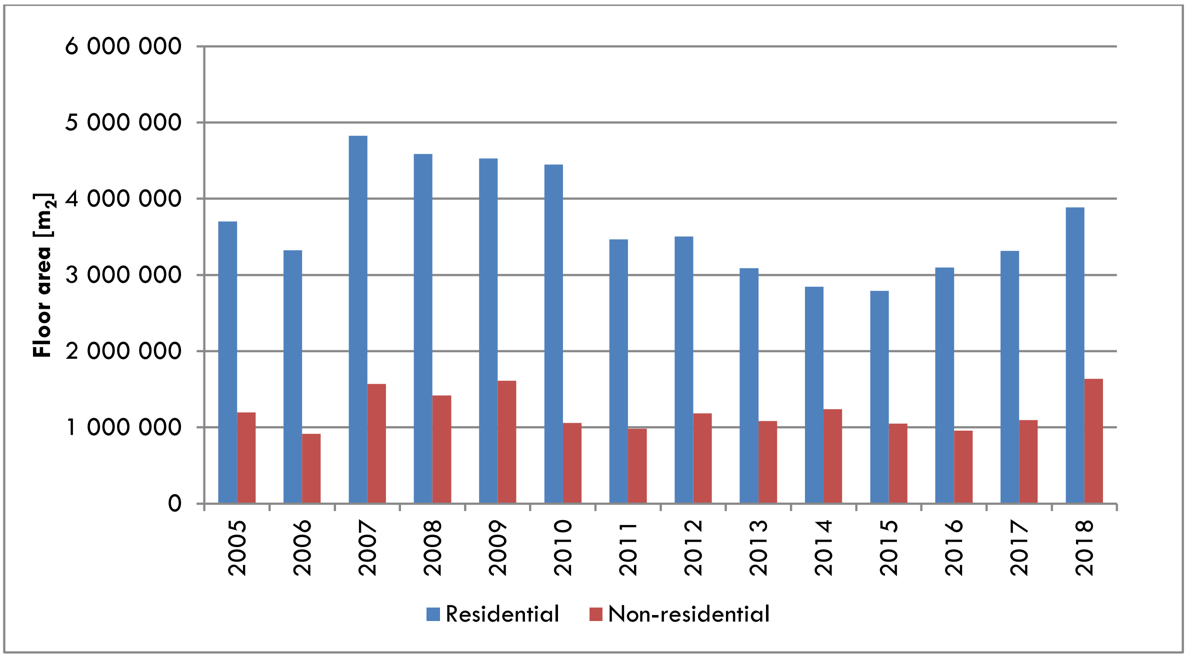

FIGURE 4-2 TREND OF BUILDING FLOOR AREA IN 2005–2018

4.1.1 EMISSION FACTORS AND CALCULATIONS

Methodology based on emission calculation using emission factors is used only for calculation of emissions in category 2A5b. To calculate the emissions, emission factors from the CEPMEIP database were used.

TABLE 4-1 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	$kg.m^{-2}$

For some categories, source operators use their own calculation and annual emission reporting using emission factors stated in Bulletin of Ministry of Environment. For further detail please see e-ANNEX.

4.1.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

4.1.3 PLANNED IMPROVEMENTS

In the next reporting period there will be estimated the emissions of quarrying and mining of minerals other than coal (NFR 2A5a) for the period 1990–1993.

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. Chemical inustry can be divided into: fundamental chemistry, crude oil processing, farmaceuticals, rubber industry and plastics processing as well as paper production. Products of chemical industry are mostly inputs for other industrial branches. Emissions of combustion processes in this sector are being reported in NFR sector 1A2c. Process emissions for facilities stated in Annex 2 include NFR sectors 2B1, 2B2 and 2B6. Process emissions for production and processing of other inorganic substances, the whole production and processing of organic substances are included in NFR sector 2B10a, where the largest emissions (mainly SO_2 and NMVOC) are reported. There are no production facilities in the Czech Republic in categories 2B3, 2B5 and 2B7. There is no information about any sources allocation in category 2B10b Storage, handling and transport of chemical products and we assume that these activities take place in areals of above mentioned production facilities and are included in reported emissions. Activity data of main productions are based on REZZO database and CZSO data (Figure 4-3).

NFR 2B sectors do not belong to key categories. The methodogy of emission monitoring is long term constant for all sectors and with exception of sectoru 2B1 Ammonia production, based on reported emissions of sources with annual reporting obligation. Emissions of these sources are being determined on the basis of one-time measurements of the sources operators in prescribed intervals.

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 for tar prosessing. These emissions 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.

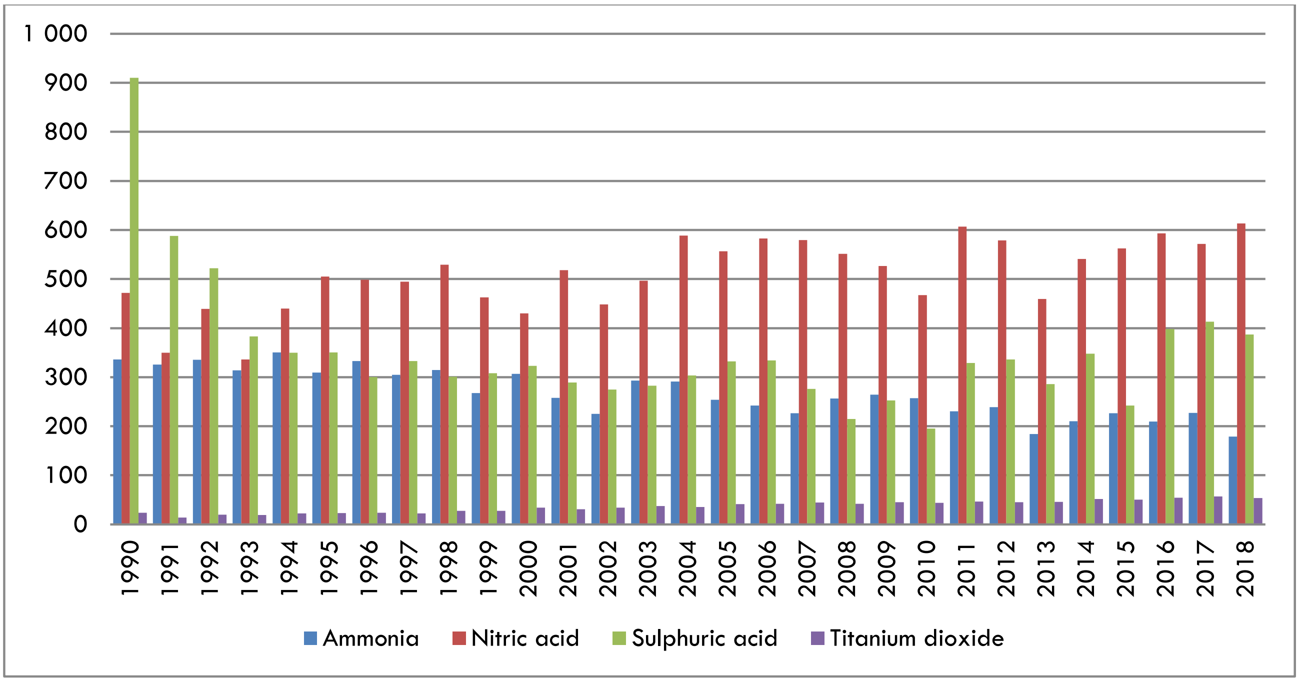

FIGURE 4-3 TREND OF AMMONIA, SULFURIC ACID, NITRIC ACID AND TITANIUM DIOXIDE PRODUCTION IN 1990–2018 (kt)

4.2.1 EMISSION FACTORS AND CALCULATIONS

Emission factors are used only for calculation of emissions in category 2B1. To calculate the emissions, emission factors from the Emission Inventory Guidebook [5].

4.2.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

4.2.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

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. According to the recommended practice, emissions from production technology processes using fules (production of iron and steel) are reported in category 2C1. Other processes namely direct process heating of mean-products and products , air, gas and raw material heaters are allocated in sectors 1A2a. There is no information available for sources allocated in category 2C7d Storage, handling and transport of metal products and we assume that these activities take place in areals of above mentioned production facilities and are included in reported emissions.

In sector 2C there are identified key categories. The methodology of monitoring emissions of main pollutants for all sectors is long term constant and based, with exception of CO emissions in sectoru 2C1 Iron and steel production, on reported emissions of sources underlying annual reporting obligation. Emissions are being namely assessed by one-time measurement in prescribed intervals. Emissions of CO from steel owen have been calculated on basis of steel production aned emission factor assessed by source operator as last-years´-measurement since

2014. Emissions of HMs and POPs are calculated on basis of emission factors in Table 4-2 to Table 4-5. Activity data were collected on the REZZO database and sectoral statistics HŽ, plc.

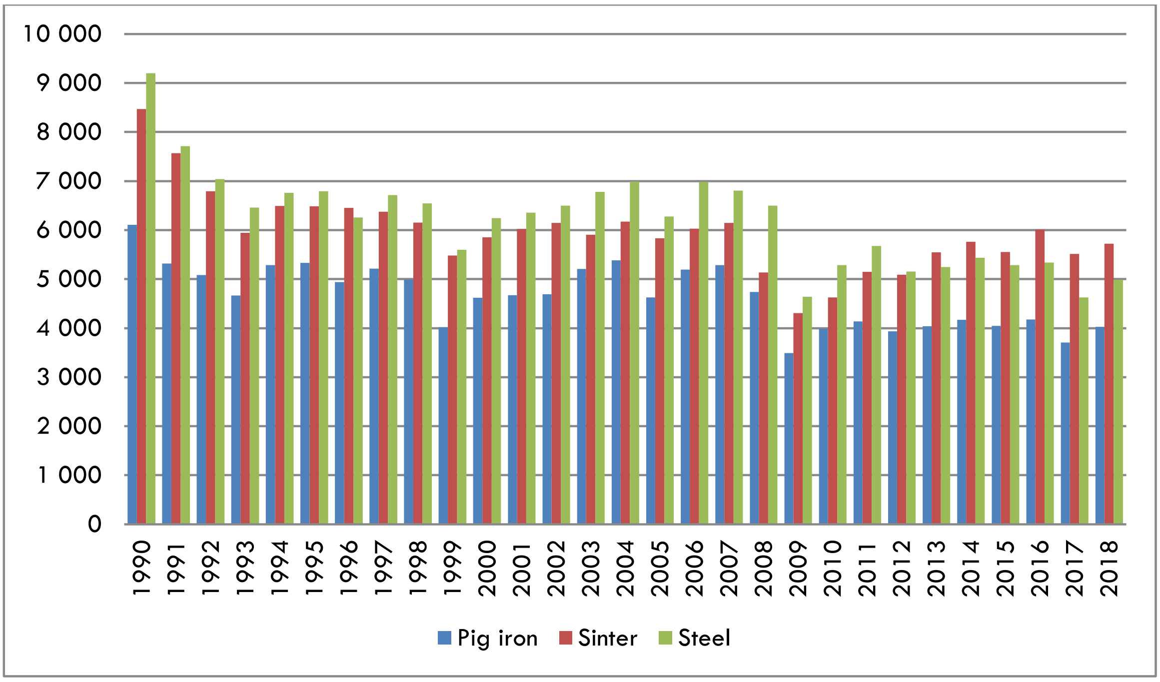

FIGURE 4-4 TREND OF PIG IRON, STEEL AND SINTER PRODUCTION IN 1990–2018 (kt)

In the Czech Republic there were three works with integrated metals production (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 smaller steelworks start with the production of steel in electric arc furnaces.

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 e-ANNEX file REZZO-NFR code. Emission inventory in this sector is being performed on the basis of one-time measurements in prescribed intervals.

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 in e-ANNEX file REZZO-NFR code. 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.

4.3.1 EMISSION FACTORS AND CALCULATIONS

For emission inventory of heavy metals and POPs during pig iron casting emission factors based on the measurement results had been set.

TABLE 4-2 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 I-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	0.01	0.087	0.534	0.246	0.113	0.98
Bag filter	11.105	1.285	0.662	1.504	79.663	0.01	0.029	0.177	0.082	0.038	0.325

Emissions of TSP, SO_2, NO_X 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 4-3, Table 4-4). Emissions of other pollutants reported under UN CLRTAP are being estimated based on emission factors according EMEP/EEA EIG [5] - Tier 2.

TABLE 4-3 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}	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g.t^{-1}$
854.149	34.387	24.54	5.982	1.433	0.03	0.176	0.071	0.035	0.311	30

TABLE 4-4 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}	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g.t^{-1}$
549.75	9.459	7.652	1.942	0.082	0.471	5.839	1.976	0.246	8.532	30

Emissions of TSP, NO_X 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 $\mu g.t^{-1}$. Emissions of other pollutants according UN CLRTAP are being based on EMEP/EEA EIG [5] – Tier 2 emission factors.

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, NO_X 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 EMEP/EEA EIG [5] – Tier 2. The emission factor for Pb according EIG 2019 300 g. t^{-1} of steel was adapted to more real value 30 g. $t^{-1}$of steel.

National emission factors have only been used for emission inventory of heavy metals and POPs for cupola ovens .

TABLE 4-5 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 I-	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$mg.t^{-1}$	$\mu g.t^{-1}$
149.8	5	7	12	0.481	0.502	2.668	1.207	0.176	4.553	1023.024

4.3.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

4.3.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

4.4 SOLVENT USE (NFR 2D)

The date of the last edit of the chapter: 03/04/2020

This chapter describes solvents and other product use. The use of solvents and products containing solvents leads to emissions of non-methane volatile organic compounds (NMVOCs) into the atmosphere.

The solvent and other product use sector belongs to one of the largest pollution source of NMVOC emissions in Czech and it accounted for almost 30 % of total NMVOC emissions. The largest share (2018) was for decorative coating application at 42.4 %, domestic solvent use 20.0 %, chemical products 16.3 %, other solvent use 11.2 % and degreasing 10.1 %.

The main activities leading to air pollutant emissions in the Solvent Use sector in the Czech Republic are coatings application in industry and households, degreasing and other applications of solvent containing products, such as printing and the use of adhesives. Emissions of NMVOCs also arise by the manufacturing and use of paints, in the pharmaceutical, plastic, leather and textile industries, wood preservation, glass fiber production, use of household and solvent-containing detergents and extraction of fats and oils. The range of monitored categories is shown in the table below.

TABLE 4-6 ACTIVITIES AND EMISSIONS REPORTED FROM THE SOLVENT AND OTHER PRODUCT USE SECTOR

NFR	Source	Description
Paint application		
2D3d	1. Decorative coating application	Includes emissions from paint application in 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.
	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).
Degreasing and dry cleaning		
2D3e	Degreasing	Includes emissions from degreasing, electronic components manufacturing and other industrial cleaning.
2D3f	Dry cleaning	Includes emissions from dry cleaning.
Chemical products		
2D3g	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.
Other product use		
2D3b	Road paving with asphalt	Solvents emissions from construction and repairs of roads, pavements and other solid surfaces.
2D3c	Asphalt roofing	NMVOC emissions from production of asphalt roofing materials
2D3h	Printing	Solvents emissions from printing industry.
2D3a	Domestic solvent use including fungicides	NMVOC emissions from the use of personal care, adhesive and sealant and household cleaning products
2D3i	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.

Category Solvents use belongs to the key sources of NMVOC emissions with a share of 27.6 % (key categories). It covers the widest range of technological activities from all the monitored categories. As point monitored sources, the largest number of technological equipment is registered in category of solvent applications (almost 4000 installations, including one or more equipments such as paint boxes, degreasing baths, printing machines, etc.). Unlike the EU Directive, the lower limits for the inclusion of these resources among the individually monitored sources are significantly lower and in many cases they start at 0.6 t of the yearly projected solvent consumption. Thousands of other sources, particularly in the decorative painting and surface maintenance sector, are below the limit and a significant part of the emissions is also produced by households.

Emission inventories for solvents are based on model estimates, as direct and continuous emissions are only measured from a limited number of sources. The model for calculating the total amount of used solvent is used and emissions are calculated for industrial sectors, households for the stated NFR sectors. The modelling of solvents emision is done by estimating the amount of used solvents consumed, knowledges of production volume, export and import product with solvent content. All relevant solvents shall be estimated, or at least those together representing more than 90 % of the total pollutant emission.

The motor industry, which applies a significant proportion of paints and solvents, is one of the most important industries in the Czech Republic. It produces more than 20 % of the production volume, directly employs more than 120,000 people and produces more than 1.4 million passenger cars per full capacity. Passenger cars are produced in three major car facilities - Škoda Auto, owned by the Volkswagen Group, Toyota Peugeot Citroën Automobile Czech and Hyundai. Trucks are manufactured only by Tatra and Scharzmüller that mainly manufactures trucks accessories. Iveco Czech Republic and SOR Libchavy are focused on the production of buses. There are also many major suppliers in the Czech Republic for the domestic and foreign automotive industry. Škoda Transportation produces trams, locomotives and train sets.

The printing industry in the Czech Republic is at a high level, comparable to the advanced countries. The most used technique was offset in the past. In 2004, according to the survey, it was about 80 % of the polygraphic output. In the years to come, no such detailed investigation has already been carried out, however, it is possible to assume an increase in the share, especially for digital printing, to 50 % and a significant decrease in offset printing below 30 %. As in the whole of Europe, there is a drop in demand for some types of ink that is being replaced by digital printing (printing of labels, books, printed matters, etc.) and by spreading electronic media.

Paints and coatings protect materials and significantly increase the durability of many objects. Regarding vehicles, coatings serve as corrosion protection. Decorative, protective and architectural coatings are the largest application area of paints and coatings. Residential construction has a rising demand for facade and interior wall paints, forecast that about 58 % of all paints and coatings will be utilized in the construction. Another important application is the transport segment and road construction. Besides the division by various application areas, mainly the paints and coatings are based on acrylics, vinyl, alkyd, epoxy, polyurethane (PUR), and polyester.

The smallest share of emissions includes the production of asphalt roofing materials and the road paving with cuback asphalt and asphalt emulsions.

In the years 2013–2014, an external evaluation was carried out by our contractor (SVUOM) to assess the estimation of NMVOC emissions from scattered sources, including NMVOC emissions from solvents and other products. Emissions were estimated based on the volume of production or other activity indicators by calculating the amount of emissions using emission factors. In addition to the EMEP/EEA Emission Inventory Guidebook, national emission factors, based on data reported by individually monitored sources, were used for some categories. Currently, the data of this study are refined.

4.4.1 EMISSION FACTORS AND CALCULATIONS

Emissions are estimated using a combination of top-down data (from National statistical office, the Ministry of Industry and Trade of the Czech Republic, National Associations, data collected from REZZO) and with bottom-up data from inquires in solvent consumption and expert technical estimations. For pollutant or NMVOC product the mass balance counts: Consumption = (production + imports) – (exports +destruction/disposal).

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 other expert estimates. The statistic statement of Customs Administration of the Czech Republic is also significant source of date and information. For emissions in category 2D3a we newly use recommended emission factor 1.2 kg/capita/year according EMEP/EEA EIG 2019 [5] Tier 1.

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 experts, on basis of 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 has been estimated.

Data on production, import and export amounts of solvents and solvent containing products are collected from National statistical office. A lot of data and trends in production of many branches are gain from publishing Panorama of the Manufacturing Industry of the Czech Republic. The publication is elaborated by the MIT in close cooperation with the Czech Statistical Office and the Confederation of Industry of the Czech Republic. The aim of this yearbook is to provide expert information on the development of the manufacturing industry as well as present the results of industrial companies operating in the Czech Republic. They are also basis for the monitoring of production with the possibility to predict further developments. Import and export figures are available on National Statistic office, too. Where data on the overall consumption is available from the bottom up approach, it is used for those years; data for the years in between is interpolated. Unfortunately due to confidentiality in some sectors no activity data are available. In such case we use expert estimate considering earlier data.

Emission factors are based on the values in the EMEP/EEA EIG 2019 [5] and adjusted on a country specific basis according to the assessment of some individual sectors. Emission factors can be defined from surveys of specific industrial activities or as aggregated factors from industrial branches or sectors. In some sectors corresponds emission factor with VOC Solvents Directive. Furthermore, emission factors may be characteristic for the use pattern of certain products.

Capture and destruction (abatement) of solvents lower the pollutant emissions must be in principle estimated for each pollutant in all industrial activities and for all uses of pollutant containing products.

More detail information including activity data, emission factors and emission estimates for NMVOC inventory by different sub-categories are presented in the e-ANNEX.

4.4.2 UNCERTAINTIES AND QA/QC PROCEDURES

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 Emission inventory guidebook [5], to range from 50 to 200 %.

4.4.3 PLANNED IMPROVEMENTS

We intend to complete the methodology information for emission estimate and update of the chapter.

4.5 OTHER PRODUCT USE (NFR 2G)

Category 2G in The Czech Republic includes following activities: use of fireworks, use of tobacco and use of shoes. All activity data was obtained from national statistics of Czech Statistical Office.

Use of fireworks during various festive occasions in the Czech Republic is in last years very popular (see Figure 4-5). Almost all fireworks used here are assumed to be imported since the CZ has no known significant producer of fireworks. Activity data were found in External Trade Database in cross-border concept (https://apl.czso.cz/pll/stazo/STAZO.STAZO?jazyk=EN&prvni=N)In the database can be searched based on year and commodity code according to customs nomenclature (http://www.kodyzbozi.cz/). In this case, commodity code 36041000 (Fireworks) was selected. Data are available from 1999.

Tobacco consumption shows moderate decrease (see Figure 4-6) mainly caused by complete ban on smoking in public areas (including restaurants, cafes, pubs and bars) and rise of prices of tobacco products. Activity data for tobacco combustion were obtained from Catalogue of Products (https://www.czso.cz/csu/czso/food-consumption-2018, Table 2), in which is listed yearly cigarette consumption per capita. Emissions were calculated assuming that one cigarette contains 1 g of tobacco (EMEP/EEA EIG [5]).

On the other hand, production of shoes decreased significantly compared to the 1990s, most of shoes is imported at present (see Figure 4-7). Production of shoes was obtained from Public database – Manufacture of selected Products (https://vdb.czso.cz/vdbvo2/faces/en/index.jsf?page=statistiky#katalog=30835). Data are available from 1993.

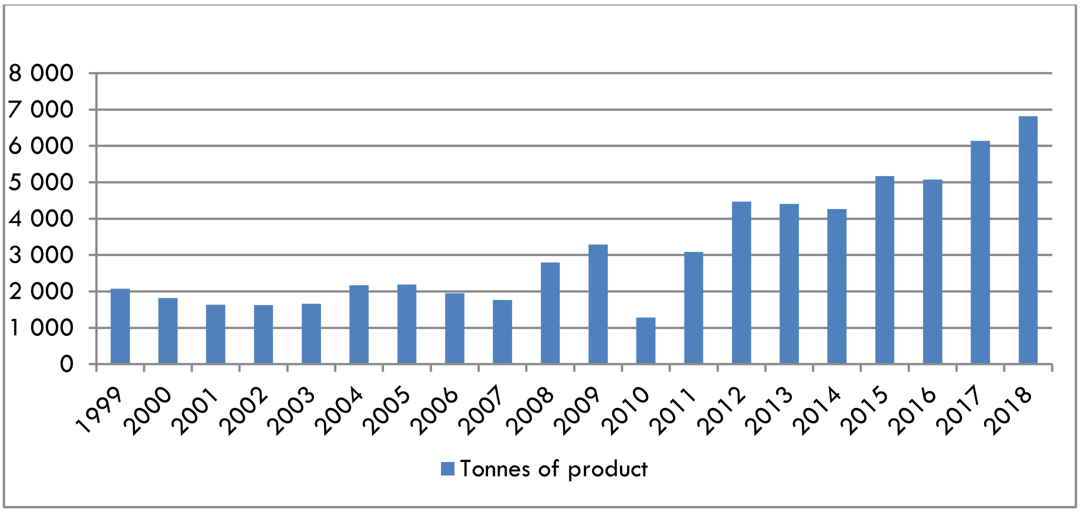

FIGURE 4-5 THE TREND IN FIREWORKS IMPORT IN THE PERIOD 1999–2018

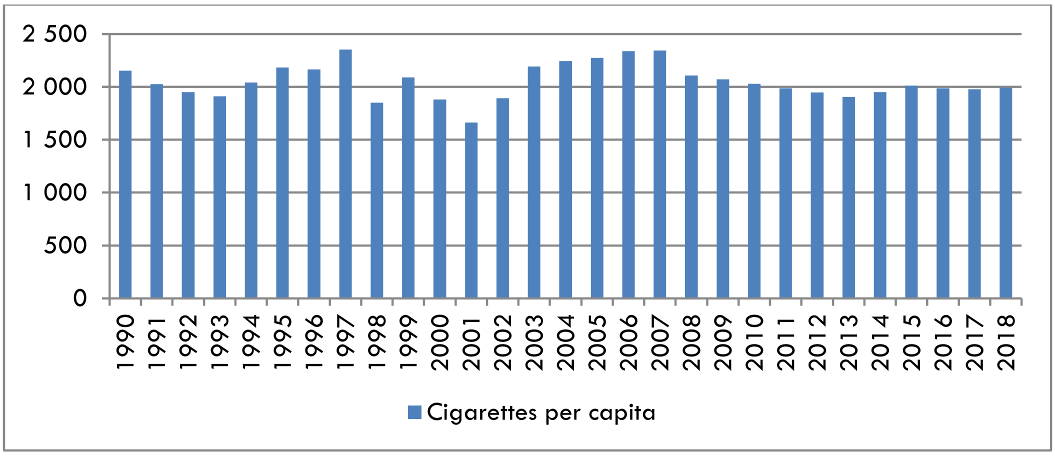

FIGURE 4-6 THE TREND IN TOBACCO SMOKING IN THE PERIOD 1990–2018

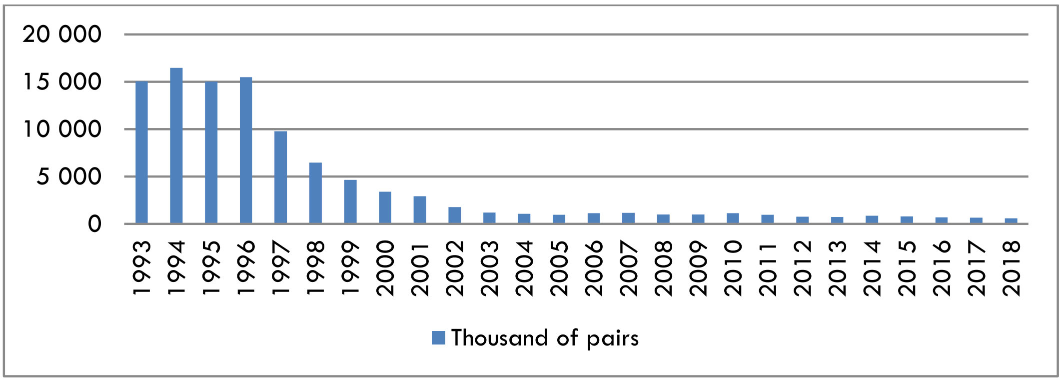

FIGURE 4-7 THE TREND IN THE SHOES PRODUCTION IN THE PERIOD 1993–2018

4.5.1 EMISSION FACTORS AND CALCULATIONS

For all groups of processes, emission factors from EMEP/EEA EIG [5], were used. They are listed in tables 3-13 to 3-15. In all cases it is Tier 2 approach.

4.5.2 UNCERTAINTIES AND QA/QC PROCEDURES

Emissions for sector 2G are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 2G is the same as in case of other colectivelly monitored sources, see also chapter 1.6 (QA/QC and verification methods).

4.5.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

4.6 OTHER INDUSTRY PRODUCTION AND WOOD PROCESSING (NFR 2H; 2I)

The consumer industry has a long-standing tradition in the Czech Republic. Textile, shoe or food products have, in the past, been a significant part of the exported goods. However, after 1990 privatization in certain number of enterprises the production was reduced or completely stopped. At present, in beverages branch the major beer production capacity is represented by several large factories, dozens of smaller and almost 400 mini-breweries. In the field of wood processing, the production of pulp is significant, but much of the wood is exported without further processing. Trend of pulp production in 1990–2018

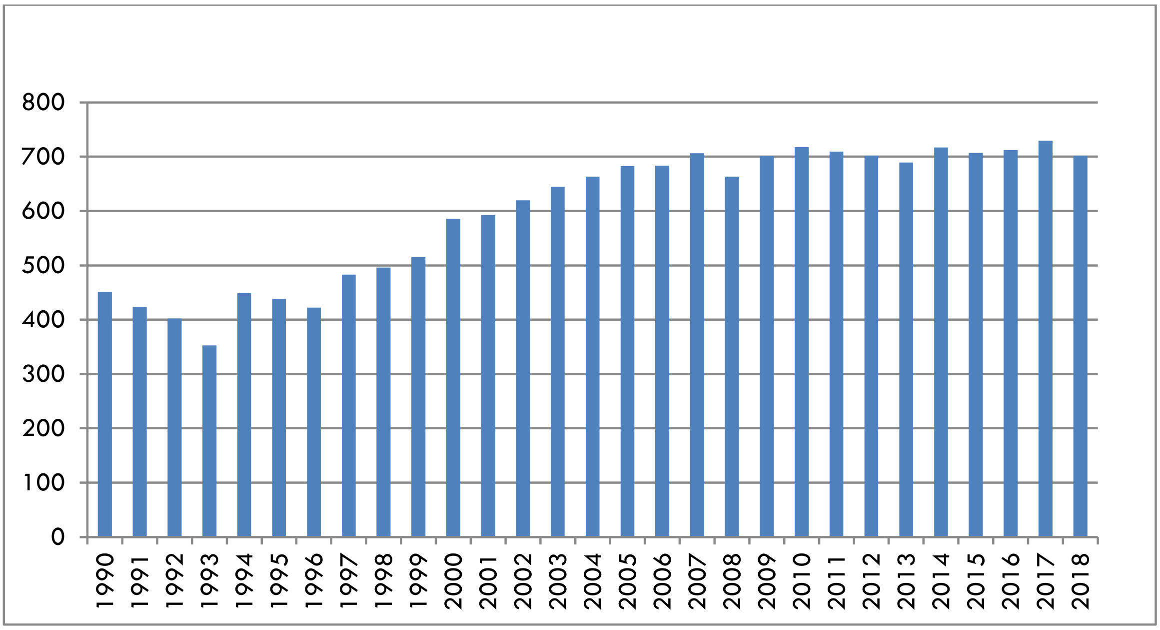

FIGURE 4-8 TREND OF PULP PRODUCTION IN 1990–2018 (kt)

There are currently two large production plants for pulp production. Sulphate pulp is produced at Mondi Štětí. Sulphite pulp for the paper industry was produced by Biocel Paskov until 2012, and since 2015 there has been a transition from paper pulp production to chemical pulp for the production of viscose fibers. The biggest wood processing plant producing OSB boards and other products is Kronospan Jihlava. There is a long tradition of sugar production, currently producing almost same quantity as before 1990 at seven sugar factories.

The definition of sources according to the national classification usually includes the entire production process not divided into partial processes. In accordance with the recommended practice, emissions from combustion processes are reported in categories 1A2d, 1A2e or 1A2gviii.

4.6.1 EMISSION FACTORS AND CALCULATIONS

Newly, emission factors for category 2H2 were supplied. Detailed information on some categories is given in e-ANNEX.

4.6.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

4.6.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

4.7 OTHER (NFR 2J AND 2K; 2L)

The Czech Republic is Party of Stockholm Convention and fulfils its obligations. While acceeding the Convention there were ascertained data about emissions and use of POPs (NFR 2J and 2K).

The system of emission inventory in Czech Republic enables allocation of most individually monitored sources into specific NFR categories. Emissions of sources that could not be allocated to other NFR categories are alloctaed in category 2L even there are not in some cases emissions solely attributed to bulk material handling (2L Other production, consumption, storage, transportation or handling of bulk products).

4.7.1 EMISSION FACTORS AND CALCULATIONS

For NFR 2J and 2K there is used notation key “NO” (not occurring), e.g. categories or processes within a particular source category that do not occur within a Party.

In category 2L there are stated emissions reported in Summary Operational Evidence (SOE) of individually monitored sources. Emission factors therefore are not used in this category.

4.7.1.1 PRODUCTION OF POPS (2J)

This chapter deals with the production of persistent organic pollutants (POPs)and pesticides. Neither the twelve initial POPs under the Stockholm Convention (Aldrin, Dieldrin, Chlordane, Toxaphene, Mirex, Endrin, Heptachlor, Hexachlorobenzene (HCB), Polychlorinated biphenyls (PCB), DDT, Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF)) nor PAHs are produced in the Czech Republic

4.7.1.2 CONSUMPTION OF POPS AND HEAVY METALS (2K)

None of the twelve initial POPs under the Stockholm Convention (Aldrin, Dieldrin, Chlordane, Toxaphene, Mirex, Endrin, Heptachlor, Hexachlorobenzene (HCB), Polychlorinated biphenyls (PCB), DDT, Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF)) are consumed/on sale in the Czech Republic.

4.7.1.3 OTHER PRODUCTION, CONSUMPTION, STORAGE, TRANSPORTATION OR HANDLING OF BULK PRODUCTS (2L)

The emission specification according EMEP/EEA EIG [5] includes emissions from other production, consumption, storage, transport or handling of bulk products. Emission reported in category 2L can be allocated as “Other production” and come from Emission database. Category 2L includes all emissions in processes without fuel combustion that are not allocated in previous categories.

This chapter includes emissions specified in EMEP/EEA EIG [5] as other production, consumption, storage, transport or handling of bulk products.

Emissions reported in category 2L belong to sources specified as “Other production” and come from the reported emissions of Summary operation evidence (SOE). The category 2L includes all emissions from processes without fuel combustion not alloacted to any of previous categories, namely: Production or processing of syntetic polymers and composites, surface treatment of metals, plastics and other non metalic items and other processing and other stationary sources not allocated elsewhere (e.g. hygiene products, feed material production etc.).

The conditions of emission reporting are set by national law for this category. Annex 8 to decree 415/2012 Sb. includes emission limits for some national categories given in overview of emission limits of selected pollutants. For these emissions one-time measurements are performed that are used for calculations of annual emissions based on relevant activity data. The most important emission comes from category Production and processing of other synthetic polymers and production of composites, Surface treatment of metals and plastics and other non-metallic objects and processing and Other sources (e.g. cooling installation).

The emissions related to storage, transport or handling of products are sometimes included in emissions from a certain production. This concerns only metallurgy areals, and in some cases where the operation conditions are set by Integrated permit according IPPC directive. For other facilities, material transport or handling the emissions are not calculated mainly due to unvailable appropriate activity data.

4.7.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

4.7.3 PLANNED IMPROVEMENTS

Emissions of sources classified under Category 2L will be inspected in more detail and, if not covered by EMEP/EEA EIG [5], will be reclassified.

5 AGRICULTURE (NFR SECTOR 3)

The date of the last edit of the chapter: 15/03/2020

The agricultural sector consists of the following categories:

- 3B Manure management;
- 3Da1 Inorganic N fertilizers (includes also urea application);
- 3Da2a Animal manure applied to soils;
- 3Da3 Urine and dung deposited by grazing animals;
- 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products;
- 3F Field burning of agricultural residues.

The agricultural sector is responsible for more than 85 % of NH_3 emissions in the Czech Republic. Emissions from animal breeding represent more than 62 % share in total ammonia emission while the fertilizers application contributes by more than 29 % of share. Other sectors like municipal and industrial waste incineration contribute by approximately 9 % share in total ammonia emission.

In the Czech Republic category 3F field burning of agricultural residues is prohibited by the law on the air protection. It means, emissions occurring from this category are not considered in the IIR.

NH_3 emissions have decreased rapidly between 1990 and 2018 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 decade as a result of crises on the pig market. It is expected a slight increase of pig production in the Czech Republic.

The main sources of ammonia emissions in the Czech Republic represent manure management (cat. 3.B) by 40 % share in total ammonia emission followed by inorganic N fertilizers application (cat. 3Da1) by 29 % share and animal manure application to soils (cat. 3Da2a including cat. 3Da3) by 22 % of share. Other non-agricultural sources are biological treatment of waste – composting (cat. 5B1), municipal and industrial waste incineration (cat. 5C1A and 5C1bi) contribute by approximately 9 % share in total ammonia emission, residential: Stationary (cat. 1A4bi), chemical industry, transport and so on. These non-agricultural sources represent approximately 9 % share in total ammonia emission.

The Figure 5-1 shows ammonia emission development between years 2000–2018 in the Czech Republic membered according to significance of ammonia emissions sources. The reference value of ammonia emission for the year 2005 (82.4 kt) is shown on the picture. The red line expresses the Czech ammonia emissions ceiling for the year 2020. Current behavior of ammonia emissions between years 2000–2018 indicates a potential for fulfilment of the ammonia emissions ceiling for 2020.

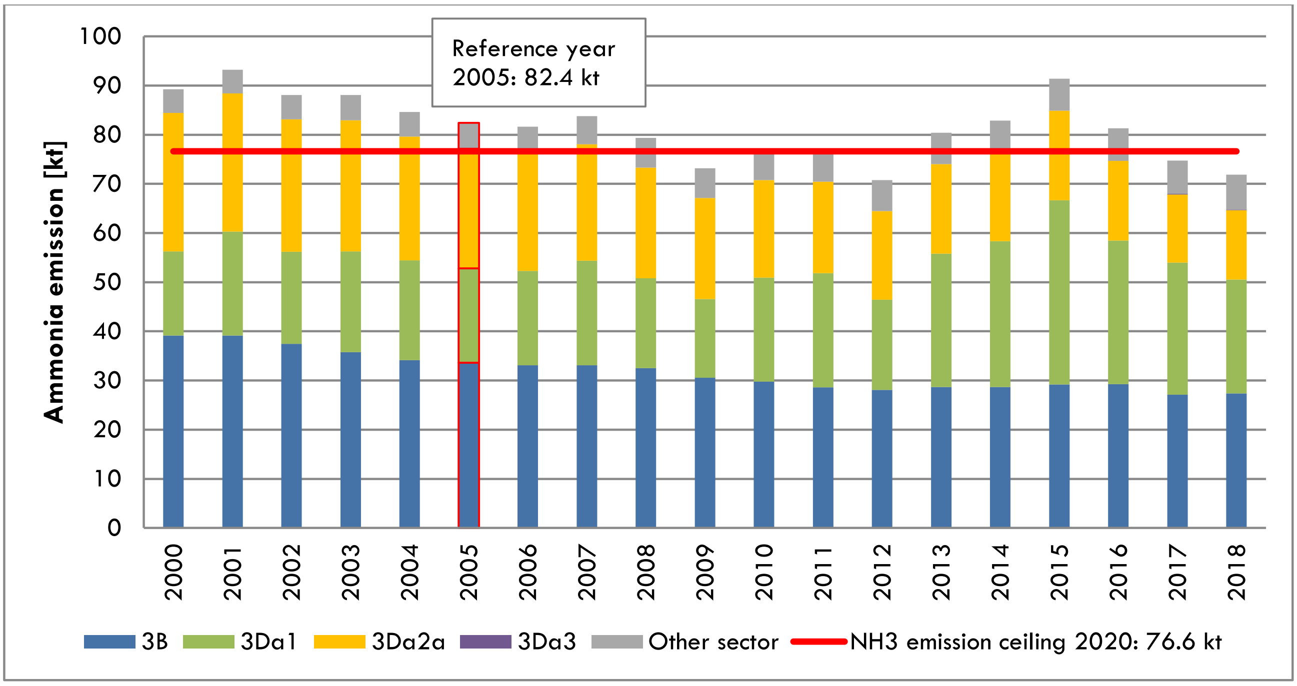

FIGURE 5-1 AMMONIA EMISSIONS DEVELOPMENT BETWEEN YEARS 2000–2018 IN THE CZECH REPUBLIC

The following chapters describe the method of calculation for sub-sectors.

5.1 MANURE MANAGEMENT (NFR 3B), ANIMAL MANURE APPLIED TO SOIL (NFR 3Da2a), URINE AND DUNG DEPOSITED BY GRAZING ANIMALS (NFR 3Da3)

Based on the TERT review and recommendations concerning calculation of NO_X (as NO_2) and NMVOC these emissions were calculated in 2019. The calculated data were part of emissions reported on 15th February 2020.

Ammonia emissions occurring from animals breaded on pasture (key category 3B1b Non-dairy cattle) originally included into category 3B1b manure management until 2017 has been recalculated. Since 2018 these emissions are incorporated into category 3Da3 Urine and dung deposited by grazing animals.

Cattle (3B1a and 3B1b) are the largest contributors to NH_3 emissions. Approximately at 60 % of the total national ammonia emissions belong to cattle (3B1a and 3B1b). Swine (3B3) and poultry (3B4) are also key sources of ammonia emissions that contribute for 20 % of the total and 10 %, respectively.

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 3B4h Other livestock, emission from rabbits are calculated.

Number of animals is taken from annual agricultural census coming from the official statistics (The Czech Statistical Office). In the Figure 5-2 animal population in the period 1990–2018 is shown.

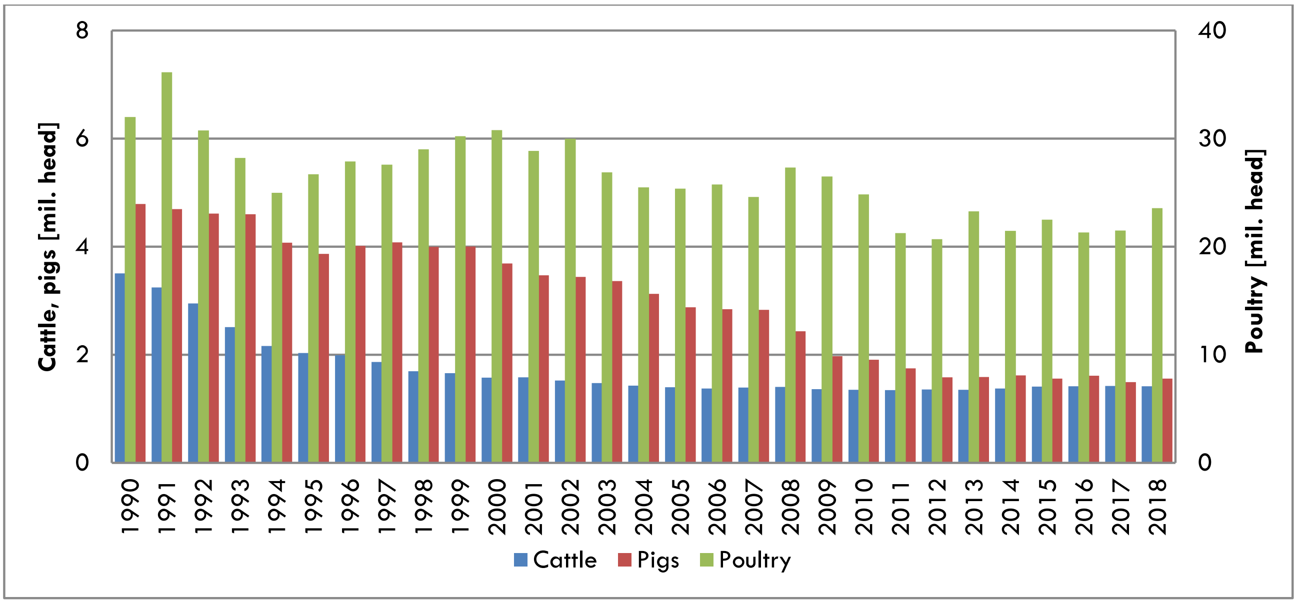

FIGURE 5-2 ANIMAL POPULATION IN THE PERIOD 1990–2018

5.1.1 EMISSION FACTORS AND CALCULATIONS

For national estimation of ammonia emissions from animal breeding in the Czech Republic the Tier 2 approach is used according to the 3.B Manure management EMEP/EEA EIG [5]. Each category of animals is multiplied by the country specific emission factors.

For national estimation of PM emissions from animal breeding in the Czech Republic the Tier 1 approach is used according to the 3.B Manure management EMEP/EEA EIG [5]. Each category of animals is multiplied by the default specific emission factors.

For national estimation of NO_X (as NO_2) and NMVOC emissions from animal breeding in the Czech Republic the Tier 1 approach is used according to the 3.B Manure management EMEP/EEA EIG [5]. Each category of animals is multiplied by the default specific emission factors.

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

- Type of animal housing

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

Result of these analyses was a comparison of nitrogen production in different types of housing systems. Nitrogen losses in 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 utilization 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 since 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 fulfill this duty.

Based on data published in April of 2018 by the Czech statistical office in the “Farm Structure Survey – 2016” (https://www.czso.cz/csu/czso/farm-structure-survey-2016) reducing effects on ammonia emissions resulting from slurry incorporation by low emission slurry applicators were included in national emission factors since 2017.

The country specific ammonia emission factors for key category of animals used in the Czech Republic for calculation of national ammonia emission balance since 2017 are introduced in Table 5-1.

TABLE 5-1 NATIONAL AMMONIA EMISSION FACTORS (KG NH3.ANIMAL PLACE-1.YEAR-1)

Animal category	Manure management	Animal manure applied to soils	Urine and dung deposited by grazing animals	Total
Cattle less than 1 year (calf) - solid	5.4	4.2		9.6
Cattle 1 - 2 years (bulls) - solid	6.7	4.2		10.9
Cattle 1 - 2 years (heifers) - solid	6.7	4.2		10.9
Cattle over 2 years (bulls) - solid	9.7	4.2		13.9
Cattle over 2 years (heifers) - solid	9.7	4.2		13.9
Cattle over 2 years (dairy cows) - solid	27.7	8.4		36.1
Cattle over 2 years (dairy cows) - liquid	12.6	8.4		21
Cattle over 2 years (other category) - solid	31.7	8.4		40.1
Cattle over 2 years (other category) - pasture	-	-	1.8	-
Piglets - liquid	1	1.8		2.8
Sows - solid	4.1	3.4		7.46
Sows - liquid	3.1	3.4		6.5
Farrowing sows - solid	8.6	5.6		14.2
Farrowing sows - liquid	7.4	5.6		13
Rearing pigs - solid	3.1	2.1		5.2
Rearing pigs - liquid	4.1	2.2		6.27
Chicken	0.16	0.1		0.23
Laying hens - solid	0.22	0.1		0.32
Laying hens - liquid	0.16	0.1		0.26

Based on data published in April of 2018 by the Czech statistical office in the “Farm Structure Survey – 2016” (https://www.czso.cz/csu/czso/farm-structure-survey-2016) reducing effects on ammonia emissions resulting from manure and slurry incorporation by low emission slurry applicators were included in national emission factors since 2017. According to results of this survey there was found that prevailing part of solid and liquid manure is applied by low ammonia emissions techniques. In compliance with the Guidance of TFRN an obligation to use low ammonia emission application techniques was ordained by the Czech law on fertilizers utilization in 2009. This obligation was incorporated in the Czech legislation in 2009 with adaptation period 2009–2016 for farms to utilize some subsidy programs and get equipped with suitable technology (slurry applicators, ploughs etc.) enabling to fulfill this duty. For example for cattle, value 4.2 kg NH_3/place/year presents 30% of ammonia emissions reduction joined with incorporation of slurry and solid manure within 24 hours. An original EF which has not been changed since 2000 till 2016 was 6.0 kg NH_3/place/year and presented a value of reference technique (untreated slurry or solid manure spread over the whole soil surface without incorporation). Database used for the EF is not updated annually. It was the first case as a reaction on significant changes in low ammonia emission application techniques utilization in the Czech agriculture which has been produced by changes in the Czech legislation.

The ratio of mentioned cattle housed in stables and bred on pasture was 100 % : 0 % and was without any changes for all time series between years 2000–2016. As already indicated in the IIR 2018 based on the TERT review and recommendations (from year 2017) to calculate ammonia emissions originating from pastured animals a minimal part of cattle (35%) especially meat types of cattle was "moved" from category 3B to category 3Da3 since 2017.

TABLE 5-2 RATIO: STABLE AND PASTURE

Year	Ratio – stable:pasture
2005	100 : 0
2010	100 : 0
2016	100 : 0
2017	65 : 35
2018	65 : 35
2019	55 : 45 expected value
2020	45 : 55 expected value

The estimation of PM emissions has been carried out according to the Tier 1 approach. The calculation method takes into account the presence of animals in the animal housing (Average animal population – AAP). Although PM emissions occur from housed and free-range or grazing animals, the measurement is focused on housed livestock only, since EFs for grazing livestock are not available. EFs for PM_{10}, $PM_{2.5}$ and TSP were adopted from EMEP/EEA EIG [5].

5.1.2 UNCERTAINTIES AND QA/QC PROCEDURES

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

5.1.3 PLANNED IMPROVEMENTS

Based on the TERT recommendation regarding to calculation NH_3, and NO_X, emissions from 3B and 3D using the Tier 2 method there is planned change of methodology for ammonia emission calculation from TIER 1 to TIER 2 methodology. A preliminary calculation of ammonia emissions according to the TIER 2 methodology by using the Manure Management N-flow tool was carried out by the end of year 2019. This process was realized in closed cooperation with the Czech expert group for greenhouse gases calculation. During year 2020 there is planned a verification of activity data and calculated values. With the authors of the N flow tool there is also planned a key discussion about implementation of ammonia abatement measures into calculation.

5.2 CROP PRODUCTION AND AGRICULTURAL SOILS (NFR 3D – NH_3 EMISSIONS)

The activity data on N fertilizers application are provided by the Czech Statistical Office and are based on the fertilizer consumption in the Czech Republic, see Table 5-2.

TABLE 5-3 CONSUMPTION OF SYNTHETIC FERTILIZERS

Crop year	Consumption (tonnes of nutrients)			
	Fertilizers, total	Nitrogenous (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
2006/07	301 864	223 684	47 083	31 097
2007/08	320 042	237 875	49 034	33 133
2008/09	278 198	221 667	35 218	21 313
2009/10	281 484	225 982	35 078	20 424
2010/11	303 927	238 554	39 991	25 382
2011/12	318 225	248 024	43 001	27 199
2012/13	337 764	261 216	47 053	29 495
2013/14	353 989	268 892	50 847	34 250
2014/15	357 668	270 023	52 005	35 641
2015/16	385 739	292 750	54 401	38 589
2016/17	380 659	285 739	56 194	38 725
2017/18	374 995	281 271	54 969	38 755

Presented data express N fertilizer consumption in seasonal year, not in calendar year.

5.2.1 EMISSION FACTORS AND CALCULATIONS

Based on the TERT review and recommendations concerning methods of ammonia emissions calculation originating from synthetic N fertilizers application (3.D.a.1) these emissions were completely recalculated in the end of the year 2019. The recalculated data were part of emissions reported on 15th February 2020. 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.

5.2.2 UNCERTAINTIES AND QA/QC PROCEDURES

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

5.2.3 PLANNED IMPROVEMENTS

There is planned an improvement in unification of some differences dealing with mineral fertilizer consumptions presented in FAO database, IFASTAT database, Eurostat database and Czech Statistical Office database.

5.3 CROP PRODUCTION AND AGRICULTURAL SOILS (NFR 3D – PM EMISSIONS)

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.

Cropped areas of individual crops at the level of administrative regions were obtained from the annual report of the Czech Statistical Office. 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.

5.3.1 EMISSION FACTORS AND CALCULATIONS

According to the Tier 2 methodology 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:

$$E_{PM} = \sum_{i=1}^{I} \sum_{n=0}^{N_{i\_k}} EF_{PM\_i\_k} \, . \, A_i \, . \, n$$

with the following variables:

- E_{PM} – emissions of PM_{10} or $PM_{2.5}$ from the i_{th} crop in $kg.a^{-1}$
- I – number of crops grown
- A_i – annual cropped area of the i_{th} crop in ha
- N_{i_k} – number of times the k_{th} operation is performed on the i_{th} crop, in a^{-1}
- $EF_{PM\_i\_k}$ – EF for the k_{th} operation of the i_{th} crop, in $kg.ha^{-1}$

Emission factors for PM_{10} and $PM_{2.5}$ were adopted from EMEP/EEA EIG [5] 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. Total emission of PM_{10} or $PM_{2.5}$ for a given region is determined by the sum of individual emissions of PM for individual operations and individual crops.

TABLE 5-4 FREQUENCY OF FARMING OPERATIONS DURING THE COURSE OF THE YEAR FOR INDIVIDUAL TYPES OF CROPS

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

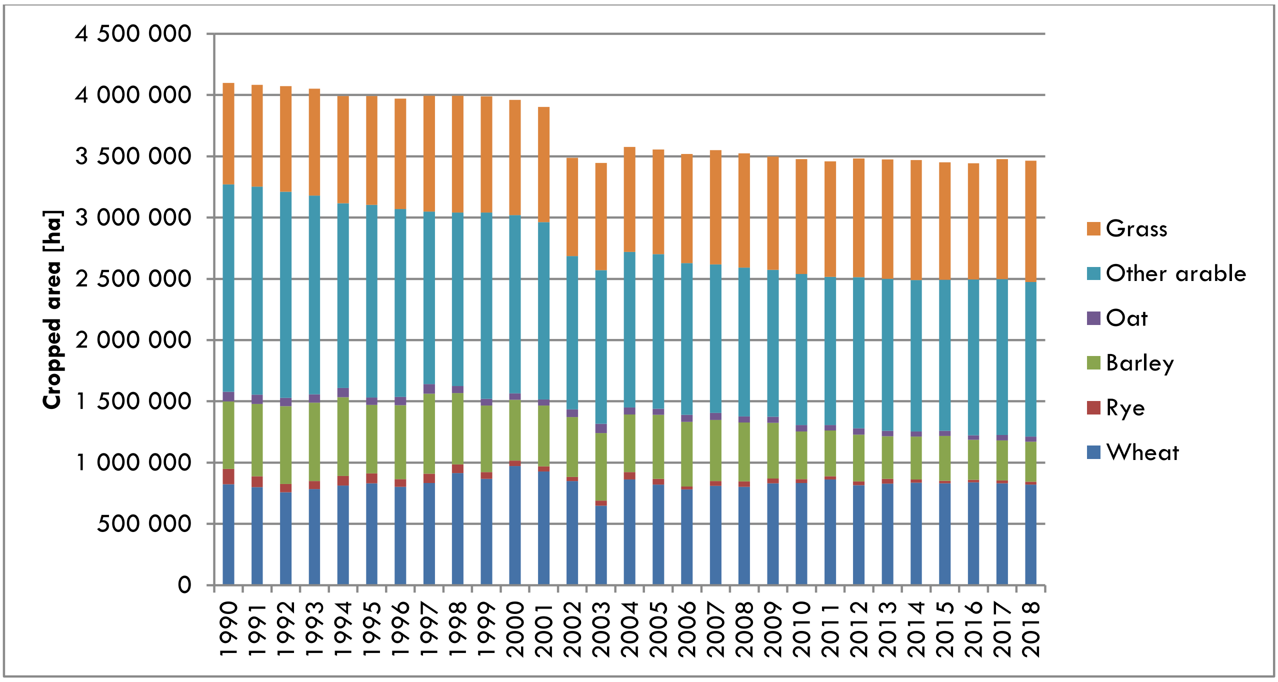

FIGURE 5-3 TREND OF ANNUAL CROPPED AREA IN 1990–2018

5.3.2 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

5.3.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

5.4 OTHER (NFR 3Df, 3F AND 3I)

In the Czech Republic category 3 F field burning of agricultural residues is prohibited by the law on the air protection, thus emissions occurring from this category are not considered in the IIR.

In case of use of pesticides more detailed data as a source for HCB emissions calculation is not available. In accordance with Regulation (EC) No 1185/2009 of the European Parliament and of the Council of 25 November 2009 concerning statistics on pesticides the CZSO in cooperation with the Central Institute for Supervising and Testing in Agriculture (UKZUZ) monitor pesticide consumption in the Czech Republic in scale specified in Annex III of the Regulation. According to the Regulation the pesticide consumption has been monitored since 2011.

Consumption of pesticides is available at website of UKZUZ: http://eagri.cz/public/web/ukzuz/portal/pripravky-na-or/ucinne-latky-v-por-statistika-spotreba/statistika-uvadeni-ul-por-na-trh/

In the Czech list of pesticides using active substance with a potential for HCB emissions Chlorothalonil is mentioned only. Annual consumption of Chlorothalonil is on the level of 50 tonnes.

Treatment of straw with NH_3 to increase its value as a feed for ruminant livestock is not common practice in the Czech Republic. It means, emissions of NH_3 occurring from this category NFR 3I are not considered in the IIR.

5.4.1 UNCERTAINTIES AND QA/QC PROCEDURES

The chapter will supplied later.

5.4.2 PLANNED IMPROVEMENTS

Emission factors and calculations have not been used yet. In future the EMEP/EEA EIG [5] is planned to be used. There is also planned to obtain relevant data on emissions (emission factor) of HCB originating from Chlorothalonil.

6 WASTE (NFR SECTOR 5)

The date of the last edit of the chapter: 15/03/2020

This sector includes both individually monitored sources (5B2, 5C1a–5C1bv, 5E – Biodegradation and solidification facilities and Sanitation facilities) and colectivelly monitored sources (5A, 5B1, 5D1–5D2, 5E – Car and buildings fires). Links between NFR category and classification pursuant Czech legislation are listed in TABLE 6-1 below.

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

The sources belong to key categories only for Hg – 5C1bv (5.2 %) and PCDD/F – 5E Car and building fires (14.3 %).

According to Report on the Environment of the Czech Republic 2018 (see e-ANNEX), published by Czech Environmental Information Agency (CENIA), at present, the crucial trend in waste management is the effort to move towards a circular economy where material flows are closed in long time cycles and the emphasis is put on waste prevention, reuse of products, recycling and conversion to energy instead of extraction of raw materials and increasing landfills.

Total waste generation, in which the largest share (95.3% in 2018) is held by the generation of non-hazardous waste, rose since 2009 to 37,784.8 thous. t in 2018. Municipal waste generation also increased in the reporting period to 5,782.1 thous. t.

Every year since 2009, the generation of packaging waste has risen to 1,296.9 thous. t in 2018. A declining trend has long been observed in the generation of hazardous waste (in the period 2009–2018 it dropped to a total of 1,768 thous. t).

The total waste treatment is dominated by waste recovery, particularly material, the proportion of which has long been increasing (Figure 6-1). Between 2009–2018, the share of waste used for material recovery grew to 83.4% and the share of waste used for energy recovery to 3.6%. The share of waste disposed of by landfilling is reducing (to 9.4% in 2018) in favour of material and energy recovery.

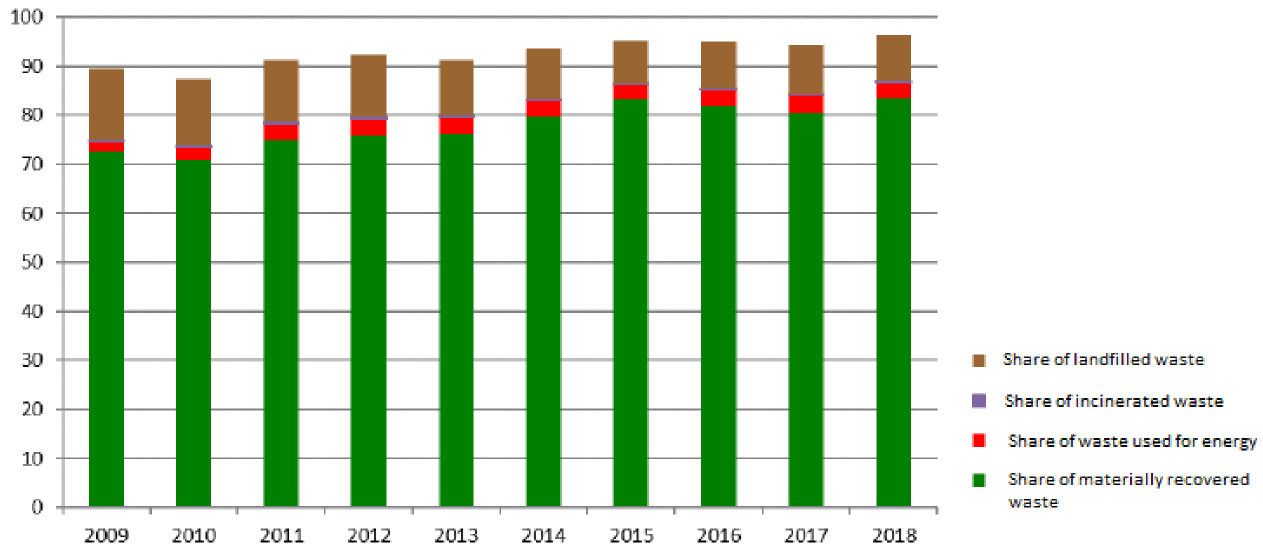

FIGURE 6-1 PROPORTION OF SELECTED WASTE TREATMENT METHODS IN THE TOTAL WASTE GENERATION IN THE PERIOD 2009–2018

The following chapters describe the method of calculation for sub-sectors.

6.1 BIOLOGICAL TREATMENT OF WASTE – SOLID WASTE DISPOSAL ON LAND (NFR 5A)

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

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.

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 (TGM WRI), 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.

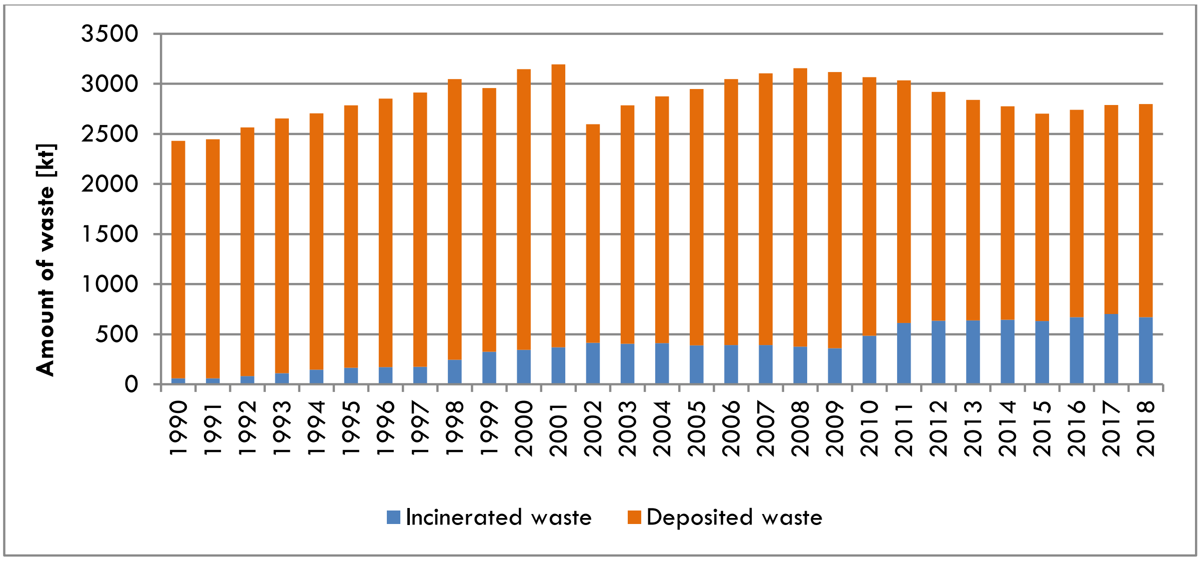

FIGURE 6-2 COMPARISON OF THE AMOUNT OF DEPOSITED AND INCINERATED MUNICIPAL WASTE IN THE PERIOD 1990–2018

Figure 6-2. presents the actualized amounts 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 6.3 – NFR 5C1a). Pursuant to State Energy Policy and Decree 352/2014 Coll. (see e-ANNEX), 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.

6.1.1 EMISSION FACTORS AND CALCULATIONS

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 EIG [5], (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.

Emissions for historical period 1990–1999 were supplemented. Activity data were estimated based on National Greenhouse Gas Inventory Report of the Czech Republic submited 2017 (http://portal.chmi.cz/files/portal/docs/uoco/oez/nis/nis_do_cz.html). In this report, only amount of deposited municipal solid waste (MSW) is given. In year 2002 (first year with data available in ISOH), the ratio between among deposited MSW and total waste was stated assuming that in previous years it was similar. Using this factor (0.3) amounts of total deposited waste in 1990–1999 were calculated. Data 2000–2001 were corrected also using this factor (initialy, only MSW was considered by mistake).

6.1.2 UNCERTAINTIES AND QA/QC PROCEDURES

Emissions for sector 5A are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 5A is the same as in case of other colectivelly monitored sources, see also chapter 1.6 (QA/QC and verification methods).

6.1.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

6.2 BIOLOGICAL TREATMENT OF WASTE – COMPOSTING AND ANAEROBIC DIGESTION AT BIOGAS FACILITIES (NFR 5B)

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

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

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

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

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

Activity data (amount of composted waste) were obtained from Waste Management Information System (ISOH). For detailed information about this country-wide database, see chapter 6.1. Activity data are available since 2005, in previous years the symbol "NE" was used. Emissions of the other pollutants, reported by operators, were removed.

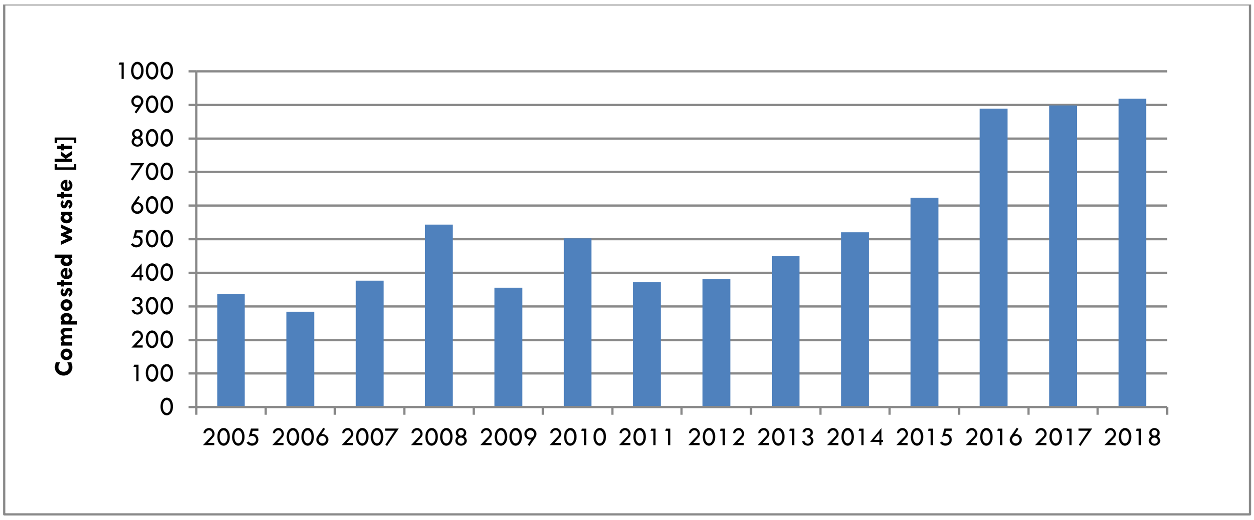

FIGURE 6-3 THE TREND IN THE WASTE COMPOSTING IN THE PERIOD 2005–2018

As is shown in Figure 6-3 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.

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 2018, 335 biogas stations were in operation in the Czech Republic.

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 (as NO_2), 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.

6.2.1 EMISSION FACTORS AND CALCULATIONS

Emissions of NH_3 for composting were calculated using emission factor from EMEP/EEA EIG [5], (Tier 2).

6.2.2 UNCERTAINTIES AND QA/QC PROCEDURES

Emissions of NH_3 for sector 5B1 are calculated based on official statistics and default emission factor, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 5B1 is the same as in case of other colectivelly monitored sources, see also chapter 1.6 (QA/QC and verification methods).

6.2.3 PLANNED IMPROVEMENTS

In coming years, an effort to obtain activity data and submit historical emissions for sector 5B1 will be made.

6.3 WASTE INCINERATION (NFR 5C1A–5C1BIV)

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 2014–2018, therefore symbol "NA" 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 (IČO), 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.

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 1990–2018. 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.

The trend showing amounts of municipal and other waste incineration in years 1999–2018 is illustrated in Figure 6-4 and

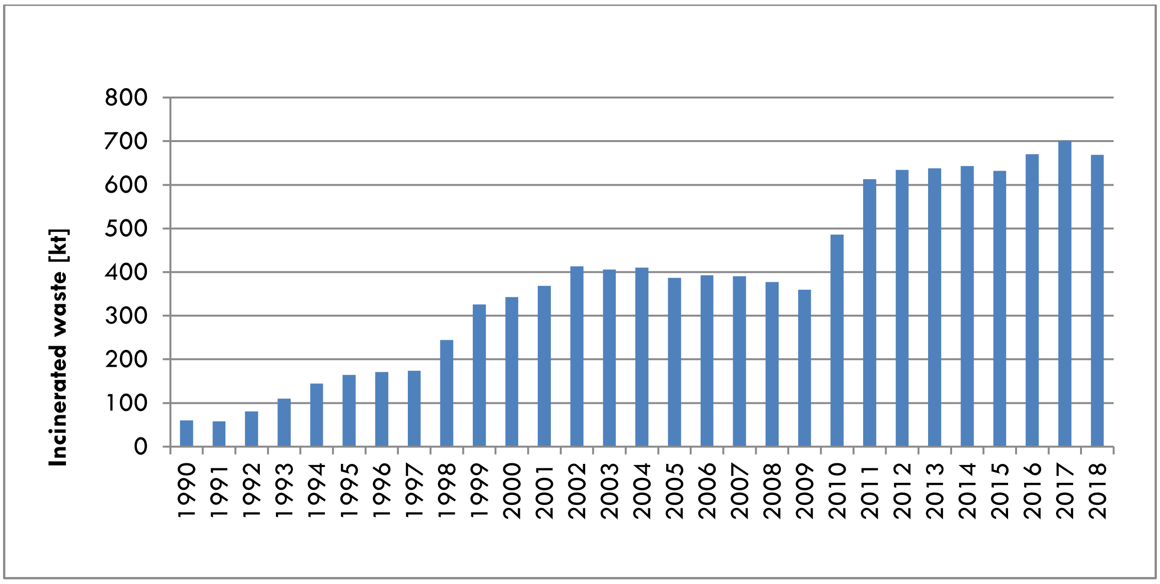

FIGURE 6-4 THE TREND IN THE MUNICIPAL WASTE INCINERATED IN THE PERIOD 1990–2018

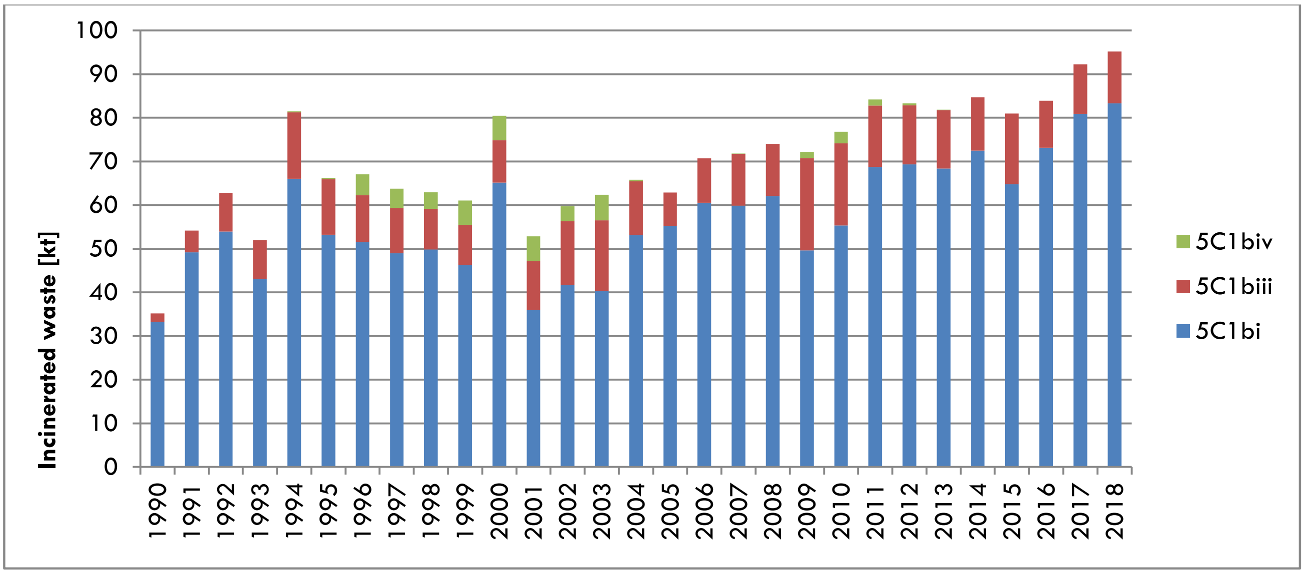

FIGURE 6-5 THE TREND IN THE OTHER WASTE INCINERATED IN THE PERIOD 1990–2018

It is clear from Figure 6-4 that the amount of incinerated municipal 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

Emissions of all pollutants in the period 2002–2018 show high consistency and mainly depend on the amount of waste. In the summer of 2016 new facility was put into operation: Plzeňská teplárenská, a.s. – Facility for energetic utilisation of waste Chotíkov. This is related to the increase in emissions of all pollutants reported, in particular PCDD/F. During testing operation installation of all necessary technologies for reducing emissions gradually took place. After its completion emissions decrease again, in inventorying for year 2018 noticeable decrease is apparent.

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.

It is apparent from Figure 6-5 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 2002–2018, 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. In 2017, the capacity of two incinerators of industrial waste was increased, which was reflected in its quantity.

6.3.1 EMISSION FACTORS AND CALCULATIONS

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 2000–2018 and 1990–1999 was different and is therefore described for each period separately.

6.3.1.1 METHODOLOGY FOR PERIOD 2000–2018

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 (as NO_2), 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.

TABLE 6-2 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
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

6.3.1.2 METHODOLOGY FOR PERIOD 1990–1999

Fundamental for the inventorying were also the data of summary operational records (SOE). 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 EIG [5] 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 2000–2018.

Specific emission factors set for purposes of emission inventory for the categories 5C1a–5C1biv in 1990–1999 are presented below in Table 6-3 and Table 6-4.

TABLE 6-3 EMISSION FACTORS OF BASIC POLLUTANTS FOR CATEGORIES 5C1a–5C1biv IN 1990–1999

NFR sector	TSP (kg/t)	SO_2 (kg/t)	NO_x (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 6-4 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.

6.3.2 UNCERTAINTIES AND QA/QC PROCEDURES

According to national legislation, emissions for stationary sources belonging to sectors 5C1a–5C1biv are determined on the basis of continuous or periodic measurements that are in compliance with European legislation (IED and previous directives). The uncertainty of the sum of emissions from those sources is below 5 %, see also chapter 1.7 (General uncertainty evaluation).

QA/QC for categories 5C1a–5C1biv is the same as in case of other stationary point sources, see also chapter 1.6 (QA/QC and verification methods).

6.3.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

6.4 CREMATION (NFR 5C1bv)

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.

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 Figure 6-6, share of cremations has increased rapidly in monitored period, it has stabilized since 2005. Moreover, cremations of pets were started only in 2003. This increasing trend is illustrated also in Figure 6-6.

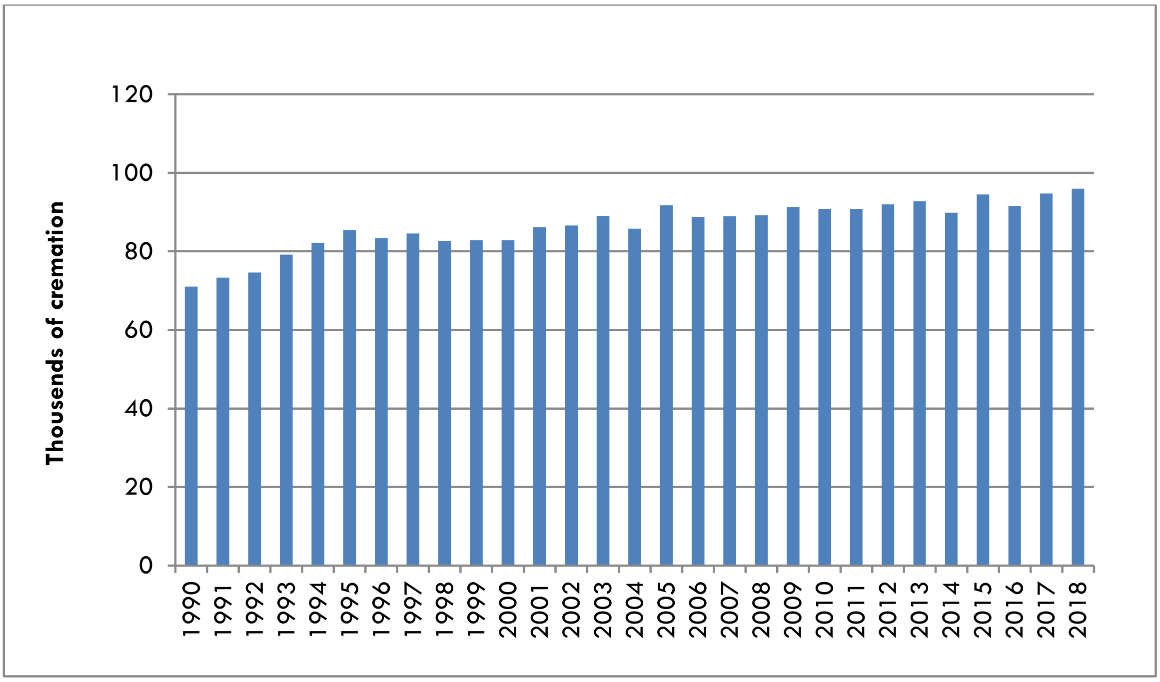

FIGURE 6-6 THE TREND IN THE CREMATION IN THE PERIOD 1990–2018

6.4.1 EMISSION FACTORS AND CALCULATIONS

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 (as NO_2), 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 6-5

TABLE 6-5 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
NO_X	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 EIG [5], (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 (see e-ANNEX), and are presented below. 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 6-6 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

6.4.2 UNCERTAINTIES AND QA/QC PROCEDURES

According to national legislation, emissions of TSP, NO_X (as NO_2), CO and NMVOC and SO_2 for stationary sources belonging to sector5C1bv are determined on the basis of periodic measurements. The uncertainty of the sum of emissions from those sources is below 5 %. Emissions of other pollutants are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 5C1bv is the same as in case of other stationary point sources, see also chapter 1.6 (QA/QC and verification methods).

6.4.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

6.5 OTHER WASTE INCINERATION AND OPEN BURNING OF WASTE (NFR 5C1bvi AND NFR 5C2)

There are no facilities belonging to the category 5C1bvi in the Czech Republic. This category includes e .g. small waste oil burners used in motor garages; whose operation was terminated.

The category NFR 5C2 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.

6.5.1 EMISSION FACTORS AND CALCULATIONS

Because no such facility exists in the Czech Republic, this chapter is irrelevant.

6.5.2 UNCERTAINTIES AND QA/QC PROCEDURES

Because no such facility exists in the Czech Republic, this chapter is irrelevant.

6.5.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

6.6 WASTEWATER HANDLING (NFR 5D1–5D3)

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.

Trend in amount of discharged waste water in period 1990–2018 is illustrated bellow.

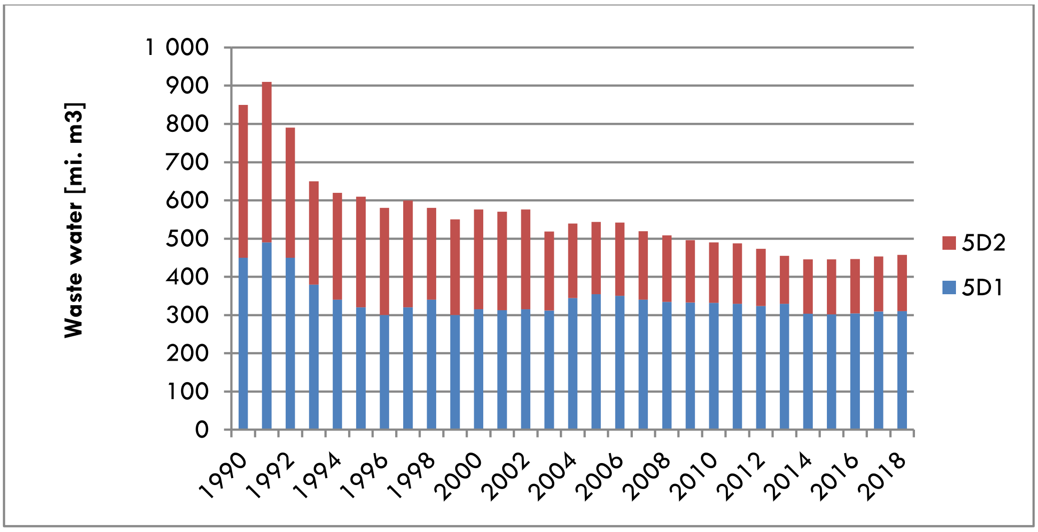

FIGURE 6-7 TREND IN WASTEWATER HANDLING IN THE PERIOD 1990–2018

6.6.1 EMISSION FACTORS AND CALCULATIONS

In the Summary operation records are reported emissions NO_X (as NO_2), 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).

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 2000–2002 is known.

Emissions for historical period 1990–1999 were supplemented. Activity data were estimated based on document of CZSO (Waste water discharged into public sewers), see e-ANNEX. Data 2000–2002 were specified using awerage ratio between subcategorie 5D2 and total amount of discharged waste water in 1990–1999, the symbol "IE" was removed .

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.

6.6.2 UNCERTAINTIES AND QA/QC PROCEDURES

Emissions of NMVOC for sector 5D are calculated based on official statistics and default emission factor, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 5D is the same as in case of other colectivelly monitored sources, see also chapter 1.6 (QA/QC and verification methods).

6.6.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

6.7 OTHER WASTE (NFR 5E)

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.

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.

The sanitation 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.

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.

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.

Fire numbers of cars, apartment buildings, detached houses and industrial buildings are illustrated below.

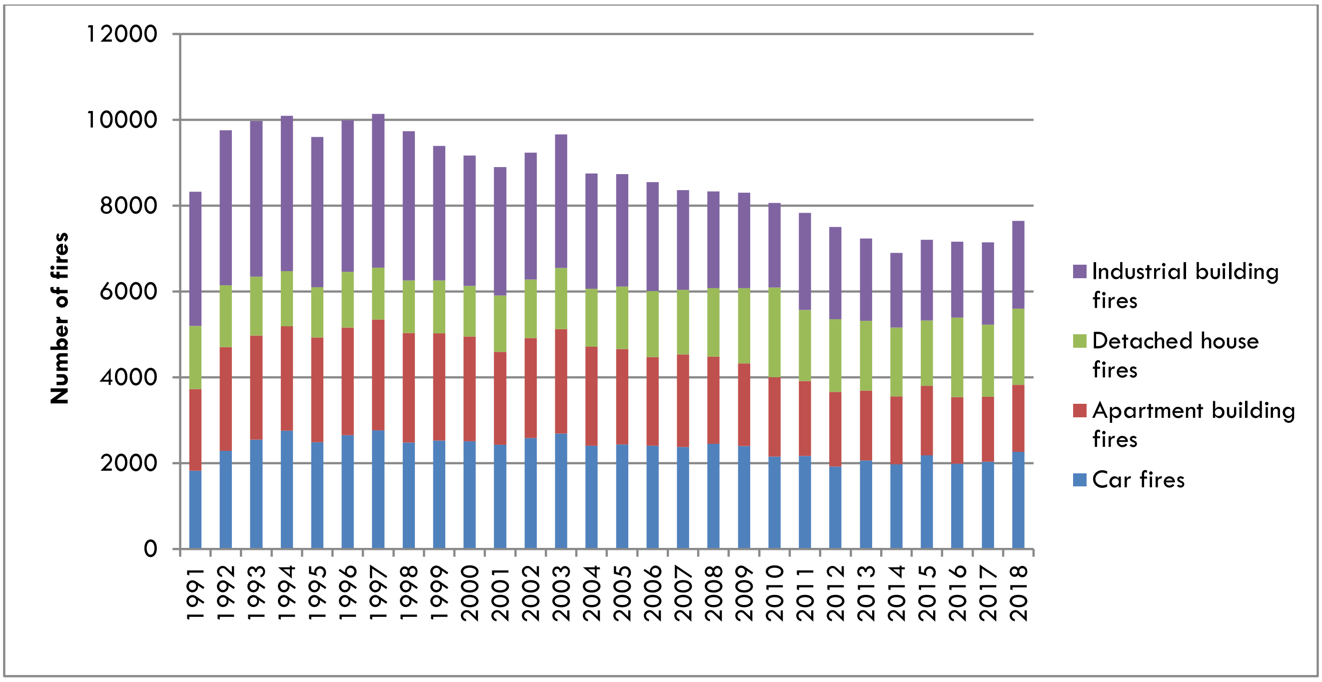

FIGURE 6-8 THE TREND OF FIRES IN THE PERIOD 1991–2018

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.

6.7.1 EMISSION FACTORS AND CALCULATIONS

In category biodegradation and solidification facilities and sanitation facilities, only small amount of emissions NO_x (as NO_2), NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP a CO is emitted. Emissions of NO_x (as NO_2), 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.

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). Overview of used emission factors is presented below. Emission factors for car and buildings fires

TABLE 6-7 EMISSION FACTORS FOR CAR AND BUILDINGS FIRES

Pollutant	Unit	Car fire	Apartment building fire	Detached house fire	Industrial building fire
TSP	kg/fire	2.3	43.78	143.82	27.23
PM_{10}	kg/fire	2.3	43.78	143.82	27.23
$PM_{2.5}$	kg/fire	2.3	43.78	143.82	27.23
Pb	g/fire	NE	0.13	0.42	0.08
Cd	g/fire	NE	0.26	0.85	0.16
Hg	g/fire	NE	0.26	0.85	0.16
As	g/fire	NE	0.41	1.35	0.25
Cr	g/fire	NE	0.39	1.29	0.24
Cu	g/fire	NE	0.91	2.99	0.57
PCDD/F	mg/fire	0.048	0.44	1.44	0.27

6.7.2 UNCERTAINTIES AND QA/QC PROCEDURES

Emissions for individually monitored sources (biodegradation and solidification facilities and sanitation facilities) are only reported in the Summary operation records and are based on calculations. Uncertainty will be estimated later.

Emissions for car and buildings fires are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 5E is the same as in case of other sources (dividied into individually and collectivelly monitored), see also chapter 1.6 (QA/QC and verification methods).

6.7.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

7 OTHER AND NATURAL EMISSIONS

The date of the last edit of the chapter: 15/03/2020

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.

In the case of forest fires, CO and NMVOC are emitted predominantly. To a less extent, emissions of NO_X (as NO_2), NH_3, SO_2 and particulates are produced.

7.1 FOREST FIRES (NFR 11B)

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. Figure 7-1 illustrates development of forest areas affected by fire in 1996–2018.

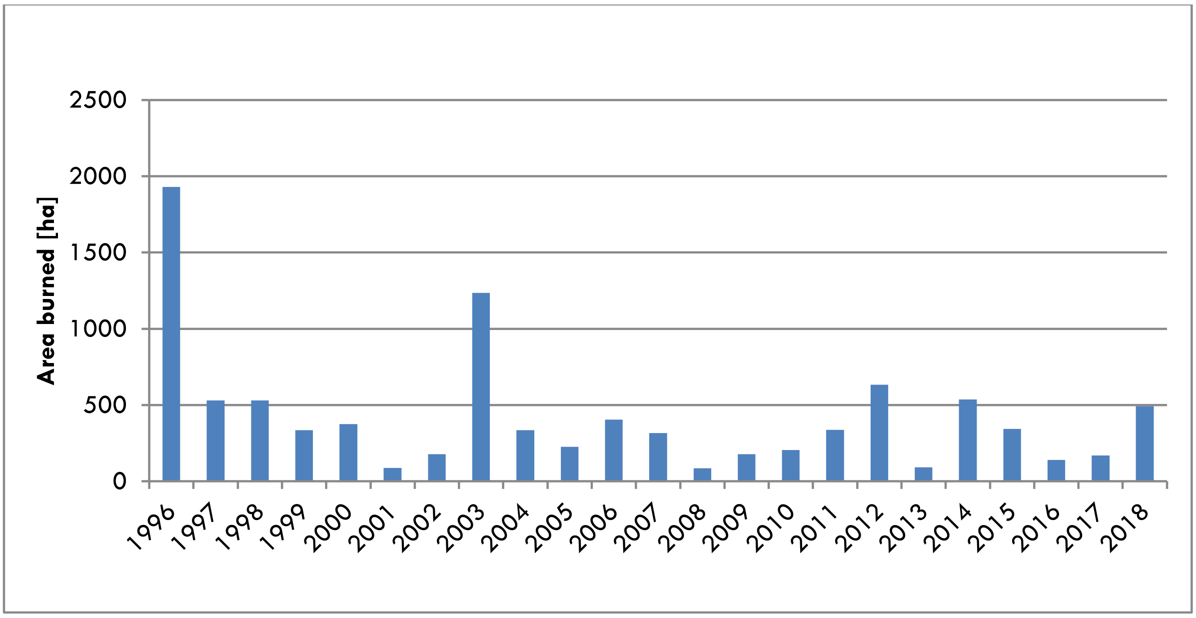

FIGURE 7-1 TREND IN FOREST FIRES IN THE PERIOD 1996–2018

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).

7.1.1 EMISSION FACTORS AND CALCULATIONS

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.

For the period 1996–2018 emissions of NO_X (as NO_2), 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.

7.1.2 UNCERTAINTIES AND QA/QC PROCEDURES

Emissions for sector 11B are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter 1.7 (General uncertainty evaluation).

QA/QC for category 5D is the same as in case of other colectivelly monitored sources, see also chapter 1.6 (QA/QC and verification methods).

7.1.3 PLANNED IMPROVEMENTS

No improvements are planned, the chapter is considered to be final.

8 RECALCULATIONS AND IMPROVEMENTS

The date of the last edit of the chapter: 15/03/2020

8.1 RECALCULATIONS

The full set of data for period 1990–2018 in NFR format 2019 was reported in 2020. Several corrections of reported data were performed including particularly:

- Recalculation (1990–2018) of emissions in Road transport categories by Transport Research Center (CDV) using updated COPERT 5 model (see Chapter 3).
- Ammonia combustion emissions in sectors 1A were revised.
- Emissions in sectors 2D3a and 2D3d were revized (see Chapter 12).
- Emissions (1990–2018) from 2H2 Food and beverages industry were added.
- Submission of NO_X and NMVOC emissions (1990–2018) in category 3B Manure management using the methodology and EFs listed in EMEP/EEA EIG [5] (see chapter 5.1).
- Historical data (1990–1999) in categories 5A, 5D1 and 5D2 were estimated (see chapters 6.1.1 and 6.6.1).

8.1.1 1A3b ROAD TRANSPORT

All time series for road transport were recalculated due to changes in COPERT methodology. The main reasons of recalculation were program updates and recommendations resulting from the COPERT workshop in Copenhagen (October 2019).

COPERT 5 software developer issued a new version 5.3 in September 2019. Main changes are:

- New Emission Factors for L-Category Mopeds 4-stroke.
- New Emission Factors for L-Category Motorcycles.
- Fixed bug with Petrol Hybrid vehicles. Cold Emissions now are in line with the corresponding PC Petrol vehicles.

Because of recommendations resulting from the COPERT workshop calculation setting was changed in parameter mileage degradation from „without regular maintenance“ to „with regular maintenance“. The reason is, that in CZ all cars must undergo regular technical inspection and pass otherwise they are not allowed to be operated on the road.

Methodology for calculating vehicles stock and annual mean activity is briefly described in chapter 3.3.1.1. Until 2019 imported vehicles were distributed between emission standards according to records about first registration in CZ. This was obviously inaccurate and led to the effect that approximately 21 % imported vehicles were assigned to the higher euro standard. For 2020 submission, the methodology was updated and vehicles are assigned to euro standards with the help of the records about first registration in the world. During actualization process were fixed sum minor inaccuracies in vehicle distribution between COPERT categories.

Recalculation tables for FC for the whole time series 1990–2017 are given in the table below. Changes in emissions for particular pollutants are in line with COPERT methodology. It should be taken into consideration, those changes are not caused only by changes in activity data methodology, but also caused by the synthetic influence of the following factors:

- Changes in activity data methodology.
- Extensive changes in COPERT made by program developer concerning emission factors.
- 2015–2017 changes in annual mean activity especially for PCs caused by the Czech law. Annual mileage is calculated from data gained during technical inspection. Technical inspection is for new private

PCs obligatory after 4 years of using a car. At first, we have data about company cars which have much higher annual mileage. When we work with data for the year 2018 the final dataset is for time series 1990–2014. 2015–2017 are changed because described effect.

TABLE 8-1 DIFFERENCES IN FC BETWEEN SUBMISSIONS 2019 AND 2020

Year	FC Road transportation (TJ)			FC PCs (TJ)			FC LCVs (TJ)			FC HDTs and Buses (TJ)			FC L-category (TJ)		
	2019	2020	diff.	2019	2020	diff.	2019	2020	diff.	2019	2020	diff.	2019	2020	diff.
1990	140156	140156	0.00%	59531	59517	-0.02%	13281	13279	0.0%	65190	65190	0.0%	2155	2171	0.7%
1991	127739	127739	0.00%	55760	55747	-0.02%	12057	12055	0.0%	57961	57961	0.0%	1962	1976	0.7%
1992	134247	134247	0.00%	68050	68040	-0.01%	12630	12624	0.0%	51086	51086	0.0%	2481	2498	0.7%
1993	129846	129846	0.00%	66676	66627	-0.07%	13547	13565	0.1%	47305	47306	0.0%	2319	2349	1.3%
1994	142445	142445	0.00%	77968	77821	-0.19%	15549	15624	0.5%	46336	46339	0.0%	2592	2661	2.7%
1995	132642	132642	0.00%	79167	79069	-0.12%	14392	14445	0.4%	36475	36476	0.0%	2607	2652	1.7%
1996	136028	136028	0.00%	86949	86674	-0.32%	14826	14979	1.0%	31537	31541	0.0%	2716	2833	4.3%
1997	135600	135599	0.00%	88135	88082	-0.06%	15363	15393	0.2%	29386	29386	0.0%	2716	2739	0.8%
1998	152007	152005	0.00%	94004	93950	-0.06%	19559	19589	0.2%	35885	35885	0.0%	2559	2582	0.9%
1999	157124	157122	0.00%	100697	100603	-0.09%	20148	20179	0.2%	33939	33939	0.0%	2340	2401	2.6%
2000	159705	159702	0.00%	101318	101812	0.49%	20550	21031	2.3%	35679	34628	-2.9%	2158	2232	3.4%
2001	169114	169111	0.00%	106367	106269	-0.09%	20637	22482	8.9%	39944	38133	-4.5%	2165	2227	2.8%
2002	177904	177899	0.00%	111866	112190	0.29%	20066	22784	13.5%	43899	40788	-7.1%	2072	2137	3.1%
2003	201861	201856	0.00%	128254	128840	0.46%	21814	25898	18.7%	49672	44925	-9.6%	2121	2193	3.4%
2004	210529	210524	0.00%	133278	133148	-0.10%	22884	28478	24.4%	52399	46866	-10.6%	1969	2031	3.2%
2005	226694	226688	0.00%	139787	139735	-0.04%	25707	32802	27.6%	59538	52440	-11.9%	1663	1711	2.9%
2006	235662	235653	0.00%	145089	143901	-0.82%	25744	35025	36.1%	63203	55090	-12.8%	1626	1637	0.7%
2007	248120	248114	0.00%	154819	152370	-1.58%	27175	38184	40.5%	64332	55758	-13.3%	1793	1802	0.5%
2008	248856	248848	0.00%	152311	148863	-2.26%	29601	42408	43.3%	65068	55601	-14.6%	1876	1977	5.4%
2009	245384	245375	0.00%	152109	148366	-2.46%	28640	41365	44.4%	62715	53526	-14.7%	1919	2117	10.3%
2010	233256	233242	-0.01%	145050	141295	-2.59%	26658	38728	45.3%	59851	51340	-14.2%	1697	1879	10.7%
2011	233794	233777	-0.01%	145775	142789	-2.05%	25326	37395	47.7%	61000	51713	-15.2%	1693	1880	11.1%
2012	229653	229630	-0.01%	145270	139363	-4.07%	23203	35603	53.4%	59565	52868	-11.2%	1613	1796	11.3%
2013	228087	228064	-0.01%	147348	140086	-4.93%	21782	34127	56.7%	57412	52244	-9.0%	1545	1608	4.1%
2014	236960	236939	-0.01%	152317	144506	-5.13%	21456	33772	57.4%	61657	57381	-6.9%	1531	1280	-16.4%
2015	246778	246762	-0.01%	158909	151503	-4.66%	22463	34130	51.9%	63776	60133	-5.7%	1631	996	-38.9%
2016	256625	256300	-0.13%	168096	158793	-5.53%	24079	35321	46.7%	62692	61380	-2.1%	1758	805	-54.2%
2017	263563	263290	-0.10%	171772	164455	-4.26%	25829	36887	42.8%	63740	61243	-3.9%	2223	705	-68.3%

8.1.2 1A3bvi TYRE, BREAK WEAR AND 1A3bvii ROAD ABRASION

For 1A3bvi were newly introduced EFs in $ug.km^{-1}$ for BC, PAHs (Tier 2, EMEP/EEA EIG [5]). For 1A3bvii were newly introduced EFs in $g.km^{-1}$ for heavy metals according to Winther and Slentø (2010). All EFs are Tier 2 according to EMEP/EEA EIG [5]. The original methodology was based on fuel consumption and EFs in $g.kg^{-1}$ of fuel. These emissions are not included in COPERT 5 and are calculated separately.

8.1.3 OTHER NON-ROAD MOBILE SOURCES & MACHINERY (NFR 1A2gvii; 1A4; 1A5bi)

For the year 2017 there were some smaller changes of fuel consumption made by CZSO. For 1A2gvii it was change from 1 933.7 TJ to 1 890.1 TJ. For 1A4aii it was change from 560.2 TJ to 603.1 TJ.

For 1A2gvii, 1A4aii and 1A5bi was introduced EF (4.10^{-7} $g.kg^{-1}$) for Pb based on Pb content in diesel oil.

8.2 PLANNED IMPROVEMENTS

The layout of IIR chapters was kept and unified as in 2019 according the Annex 2 Recommended Structure for Informative Inventory Report (IIR).

For next submission (of most importance):

- Projection for road transport and agricultural emissions will be updated.
- Open recommendations (mostly 3B) will be solved.
- Historical data for category 5B1will be supplemented in coming years (see also chapter 6.2.3).
- Emission projections are planned to be updated with new emission data.

More detail improvements are stated in sections Planned improvements of several chapters.

9 PROJECTIONS

The date of the last edit of the chapter: 15/03/2019

Remark: Despite the fact that the emission data since 2005 have chnaged, the projection has not been updated yet.

The preparation of projections for the period 2020–2030 requires partial expert assessment of future emissions and activity data for some significant source categories, as for example transport, agriculture or solvent use. Projection for public energy was calculated from the data of expected fuel consumption provided by the Department of Strategy and International Cooperation in Energy of the Ministry of Industry and Trade. Other segments were made by experts with the use model of or with statistical data multiplied by emission factors.

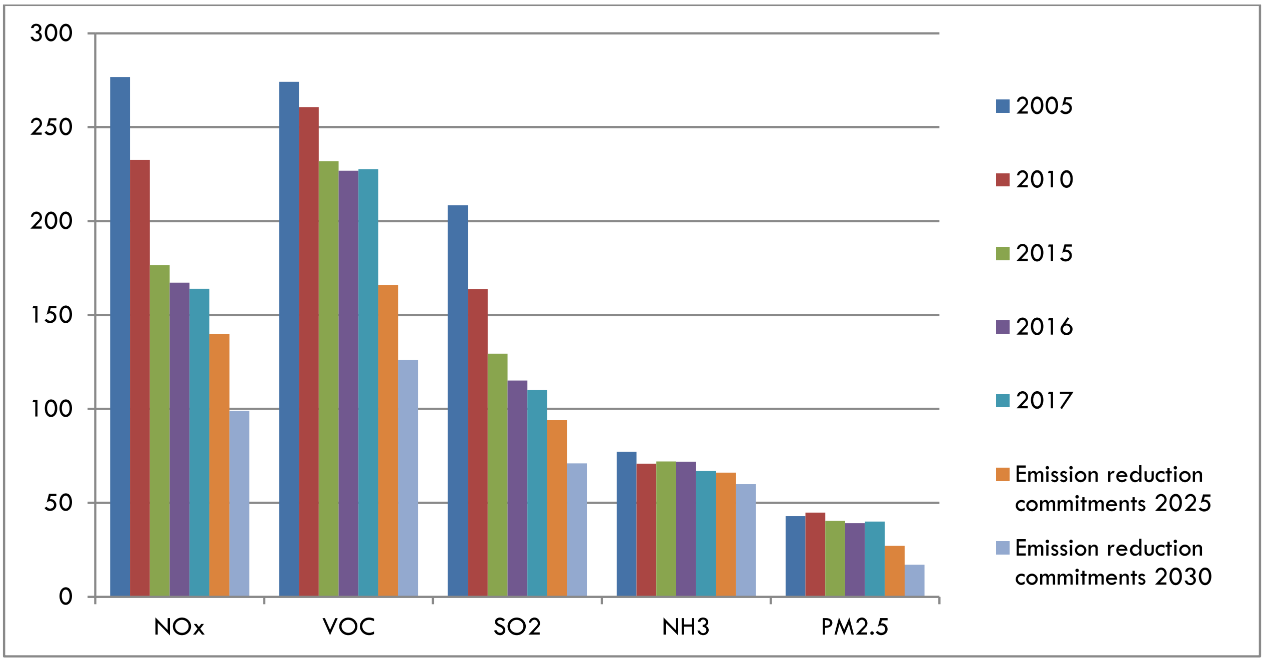

FIGURE 9-1 DEVELOPMENT OF MAIN POLLUTANTS EMISSIONS

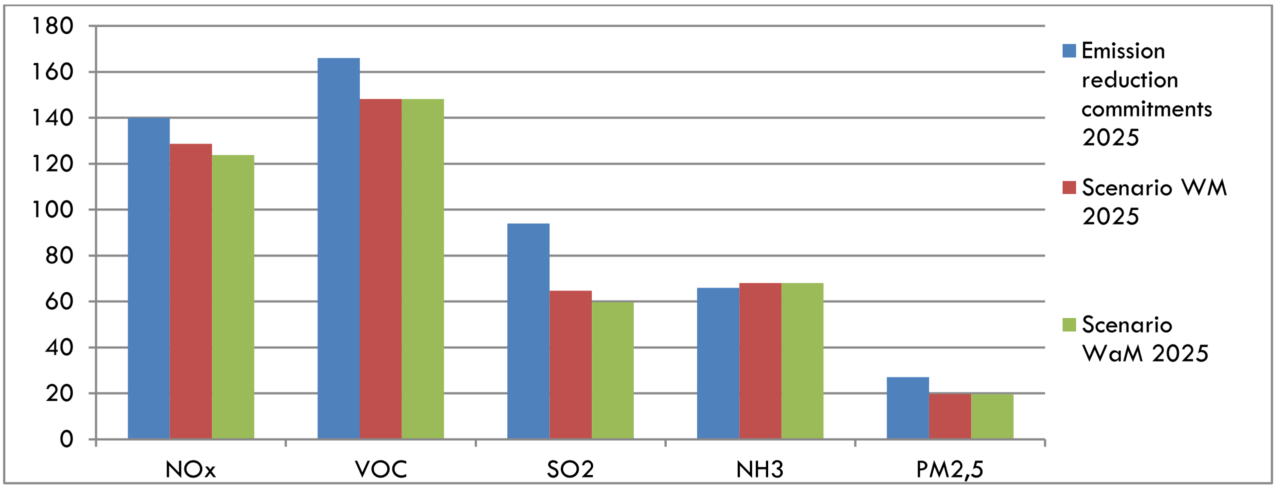

FIGURE 9-2 COMPARATION OF EMISSION REDUCTION COMMITMENTS 2025 AND SCENARIOS WM AND WAM

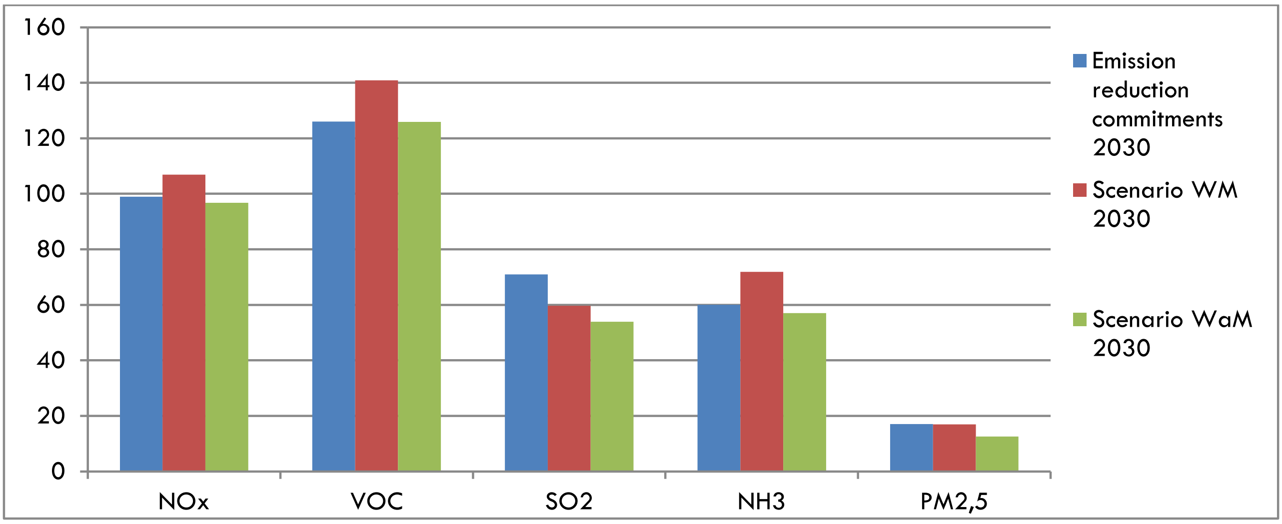

FIGURE 9-3 COMPARATION OF EMISSION REDUCTION COMMITMENTS 2030 AND SCENARIOS WM AND WAM

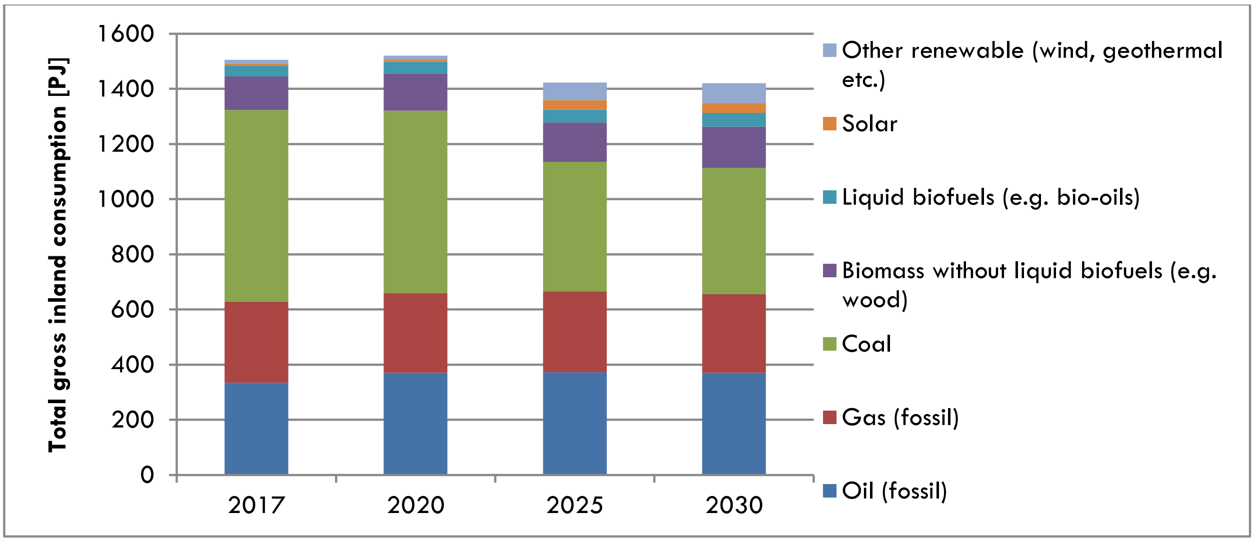

FIGURE 9-4 ACTIVITY DATA FOR WM SCENARIO GROSS INLAND CONSUMPTION

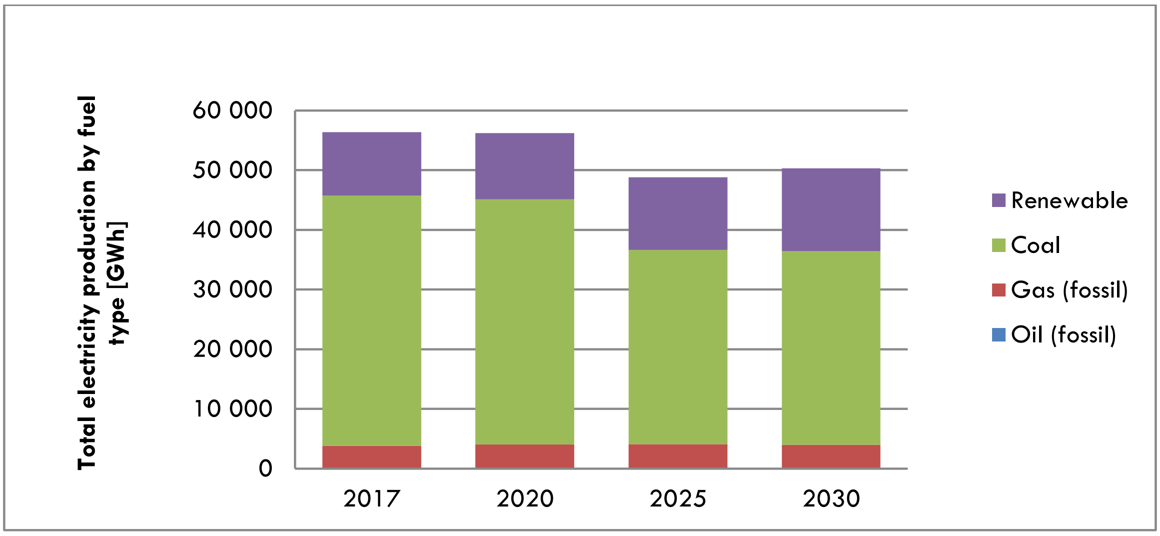

FIGURE 9-5 ACTIVITY DATA FOR WM SCENARIO ELECTRICITY PRODUCTION

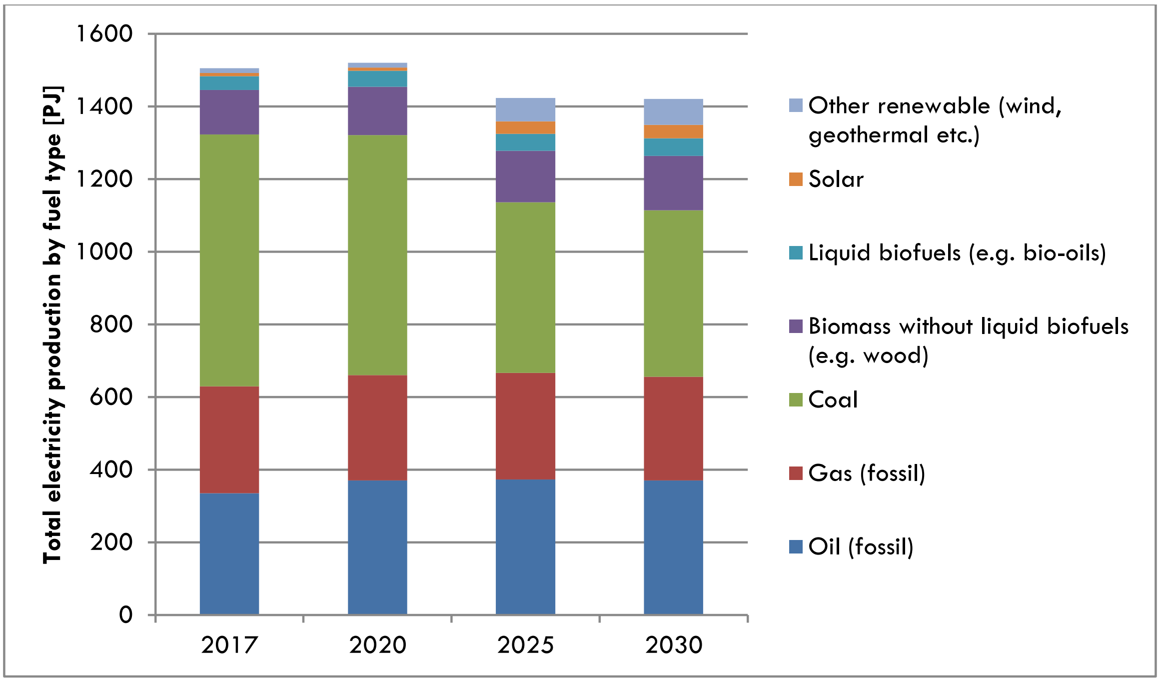

FIGURE 9-6 ACTIVITY DATA FOR WM SCENARIO - GROSS INLAND CONSUMPTION

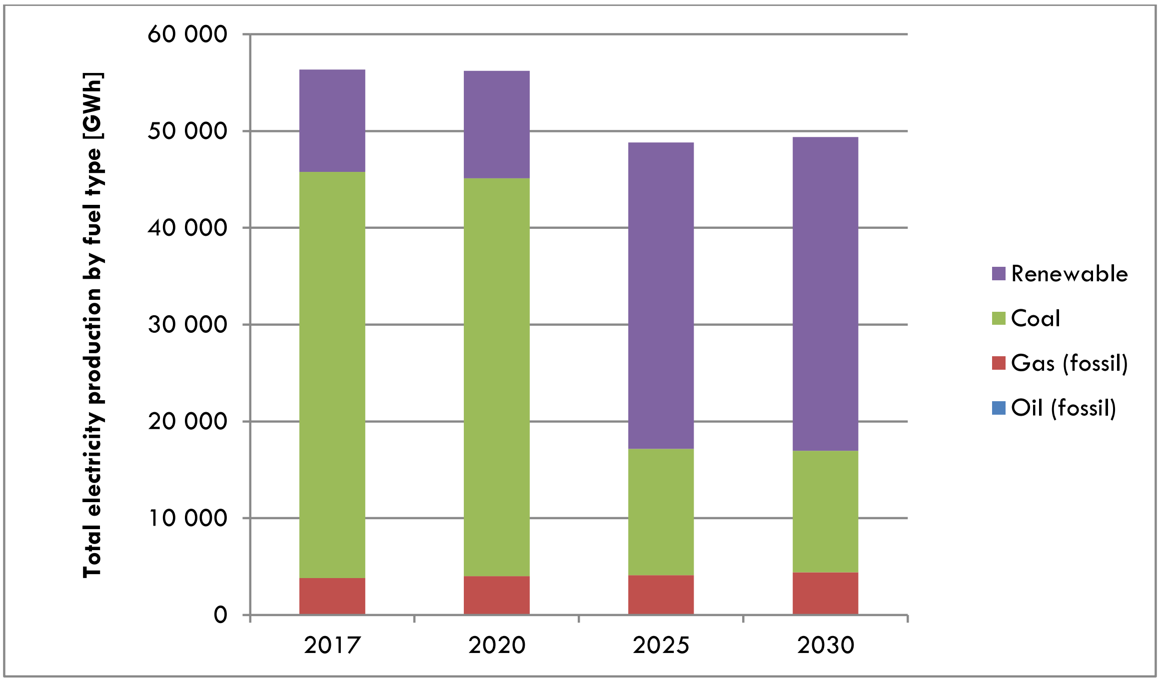

FIGURE 9-7 ACTIVITY DATA FOR WM SCENARIO - ELECTRICITY PRODUCTION BY FUEL TYPE

9.1 ENERGY

9.1.1 STATIONARY COMBUSTION

Projection of energy sector was prepared separately for following groups of sources:

- combustion sources with a total rated thermal input exceeding 50 MW, which fall under the Industrial Emissions Directive
- other combustion sources underlying Annex 2 of Act 201/2012 Coll.
- combustion sources not underlying Annex 2 to the Act on Households and other sources (natural gas combustion only).

The basic background material consisted of such data:

- the REZZO 1 and 2 databases (Register of emissions and sources of air pollution) containing the reported data of sources by operators covered by Annex 2 of the Act
- household fuel consumption data contained in IEA International Energy Agency questionnaires
- data on natural gas consumption calculated as the difference between the total consumption of natural gas and the partial consumption of listed sources and households.

9.1.1.1 PROJECTIONS IN ENERGY AND INDUSTRIAL SECTORS (1A1 AND 1A2)

COMBUSTION SOURCES WITH A TOTAL RATED THERMAL INPUT EXCEEDING 50 MW THAT UNDERLYING THE INDUSTRIAL EMISSIONS DIRECTIVE

Projection of emissions of a group of sources with a total rated thermal input above 50 MW (LCP- Large Combustion Plants under the Industrial Emissions Directive) was based on detailed assumptions about the development of fuel consumption in the period to 2030. The development of consumption and fuels changes were delivered for 105 sources in the form of a change in percentage compared to data reported in 2016.

Data on the assumptions of the development of consumption of individual types of fuels was supplied for the resources listed in the pre-prepared list of the Department of Strategy and International Cooperation in Energy of the Ministry of Industry and Trade. .

LCP sources were split separately in three groups for 2020 according to the current or planned measures by their limits or ceilings. According to underlying Directive 2010/75/EU on industrial emissions (IED), National Transitional Plan (PNP) or for which an exemption under Article 35 of the Directive applies (CZT – Central heat supply).

The calculation scheme also responds to changes that occur during the years 2018-2030. Above all, there are significant changes in the fuel base of individual sources (coal-gas transition etc.), reconstruction and replacement of boilers and related changes in the total rated thermal input, termination of the operation of the sources, putting into operation new sources.

9.1.1.2 OTHER COMBUSTION SOURCES (1A4)

This sector is characterized as a non-Large Combustion Plants (non-LCP). These are stationary combustion sources with a total rated thermal input of 0.2 to 50 MW. Similar to LCP sources, reported data from operators was used for 2017. For the projection of the years 2025 and 2030, the emission limits set out in law including the tightening of the limits in the following years, were used.
Projection assumes that if a device already meets specific emission limits in 2017 adjusted to the 2025 decree, in future it will still operate the same way, i.e. with the same total rated thermal input and the same fuels and emissions as in 2017.

However, if the device covered by the 2025 specific limits are not fulfilled, reported emissions from 2017 were reduced proportionally using the concentrations reported by operators and the specific emission limits in accordance with law, valid for the target years of emission projections.

COMBUSTION SOURCES IN HOUSEHOLDS AND OTHER SOURCES (NATURAL GAS COMBUSTION ONLY - 1A4)

Domestic sector emissions projection was prepared on the basis of the fuel consumption development in this sector, elaborated by the Department of Strategy and International Co-operation in Energy of the Ministry of Industry and Trade, including the projected type of combustion plants in 2035. Emission factors were used for the emissions of individual types of combustion plants by methodology of Czech Hydro-meteorological Institute from 2018.

The projection of this sector is based on following:

- the prohibition on sales of first and second class boilers from 1st January 2014
- the prohibition on sales of 3rd class boilers from 1st January 2018 (part of the burning boilers may meet Class 3 parameters, so they will run also after 2022)
- the prohibition of operation of 1st and 2nd class boilers after the year 2022 (projection is based on the ideal state of fulfillment of the legislative requirement to prohibit the operation of 1st and 2nd class boilers after 2022 was considered)
- if a source operator exchanges an older solid-fuel combustion plant with a more modern solid fuel system, it will use the same type of fuel as before replacing it

Another group of sources are sources with a power 300 kW and lower, burning natural gas. These are, in general, boiler rooms in public buildings and the business sector. Operators of these sources are under no obligation to report emissions and emissions of this category are calculated from the total gas consumption available in the EIA questionnaires. This consumption is multiplied by the emission factor, which is taken from the EMEP/CLRTAP Emission Inventory Guidebook 2016.

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.

9.1.2.1 ROAD TRANSPORT (1A3B)

Emission projection from transport sector was done by expert from MOTRAN Research, s.r.o. The results of the projection were elaborated in the R-project. Activity data including expected changes in the share of consumption of individual transport fuels, were provided by the Department of Strategy and International Cooperation in Energy (Ministry of Instustry and Trade).

The forecast of future transport and transport emissions is divided into three steps:

- prediction of total transport based on the population trends and Gross Domestic Product (GDP)

- prediction of the “division of transport” between different modes of transport (road transport, civil aviation, rail and water transport
- more detailed forecasts of individual modes of transport

Data from road transport were processed in a model COPERT. Detailed inputs for COPERT model were obtained from the data outputs of the Technical Inspection Stations (STK) linked to the Vehicle Register data. The evaluation of the dynamic trends was provided by CDV Brno (Transport Research Center, Brno).

The underlying data for emission projections were time series including fleet composition, mileage and derived fuel consumption, annual number of new and discarded vehicles, total volumes and transport performance. Analysis was based on the possible future development in demand for transport includes vehicle allocation and modal split, development and operation of new environment friendly vehicles.

Activity data and emission factors have been in structure according to COPERT 5 model. Results from model COPERT are 372 categories of road vehicles which are different by type of transport, fuel, engine volume for passenger transport, vehicle weight for freight and EURO emission standards.

By multiplying these activity data emission factors related to the distance travelled, emission projection were calculated. Analysis of the effectiveness of individual current or future policies and measures was carried out to the projections also.

9.1.2.2 OTHER TRANSPORT

Emission projections of other modes of transport were created by easier calculation used mostly prediction of population and GDP evolution. It is mainly aviation, rail and water transport, rescue aircraft technology etc.

For emission projection from agriculture machinery, tractors recovery trends were used, according to the database from Technical Inspection Stations (STK), an estimate of performance categories to be replaced, and emission factors from EMEP/CLRTAP Emisson Inventory Guidebook 2016 following STAGE.

Emissions from category NFR 1A4cii (Agriculture/Forestry/Fishing: Off-road vehicles and other machinery like a tractors mainly come from plant productions and soil are calculated by activity data (total fuel consumption in agriculture which is elaborated from CZSO (Czech Statistical Office) agriculture surveys. These activity data are multiplied by emission factors. This category does not included emissions from the transport of agricultural crops to the processing industry.

A key assumption for the renewal of the fleet after 2020 is Directive 97/68/EC and 2004/26/EC restricting the production and sale of tractors not meeting the required STAGE standards. The emissions inventory for the last year and projections for 2020 is therefore based on the assumption of full representation of STAGE III compliant tractors.

The forecast for diesel consumption in agricultural activities was taken from the background for the projection of greenhouse gas emissions (ENVIROS 2018). All emission calculations were performed using emission factors from EMEP/EEA EIG [5].

9.2 INDUSTRIAL PROCESSES AND PRODUCT USE

9.2.1 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.

9.2.2 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.

9.2.3 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

The study of emission projection from agriculture sector was built on the data and information published in Informative Inventory Report 2016 submitted by CHMI (Czech hydro-meteorological institute) under the UNECE Convention on Long-range Transboundary Air Pollution in May 2018.

The projections are based strictly on the methodology used in inventory of main pollutants in the Agriculture sector. Trends in activity data and emission factors used for the emission estimates were derived from two official documents of the Ministry of Agriculture. These were agreed, confirmed, discussed by (with) experts of the agricultural policy and rural development.

The Agricultural sector is responsible for more than 89 % of NH_3 emissions in the Czech Republic. The role of the agricultural sector in production of particulate matter $PM_{2.5}$ is less important. Only 3 % of the total national $PM_{2.5}$ emissions are produced in Agriculture. In the Czech Republic, cattle are the biggest key source of NH_3, followed by swine and poultry. The similar situation is in production of $PM_{2.5}$ emissions. Emissions from manure management represent 67 % of the total $PM_{2.5}$ emissions. Dairy cows and poultry are the most important producers of these emissions. Farm-level agricultural operations including storage, handling and transport of agricultural products (3Dc) produce 33 % of these emissions.

Number of animals is currently taken from annual agricultural census coming from the official statistics (CZSO, The Czech Statistical Office). The future development of ammonia and $PM_{2.5}$ emissions definitely depends on number of livestock breeding in the Czech Republic. The sector development strategy has been published by the Ministry of Agriculture in 2016.

9.3.1 EMISSION PROJECTION OF AMMONIA AND $PM_{2.5}$ FROM MANURE MANAGEMENT (3B)

For the national estimation of ammonia and $PM_{2.5}$ emissions from manure management the Tier 2 approach is used according to the 3B Manure management EMEP/EEA EIG [5]. Each category of animals (population data) is multiplied by the country specific emission factors. The current national emission factors used for calculation of ammonia emission originating from key animal categories reflected new legislation available in the Czech Republic. By real surveys in hundreds of farms comparing of nitrogen production and nitrogen losses in different types of housing was implemented. For key categories of housed animals was these nitrogen loses appointed as a specific emission factors which takes into account the type of applied management (solid or liquid).

9.3.2 EMISSION PROJECTION OF AMMONIA AND $PM_{2.5}$ FROM CATEGORY CROP PRODUCTION AND SOILS (3D)

For the national estimation of ammonia emissions from manure applied to soils (3Da2a) in the Czech Republic the Tier 2 approach is used (EEA 2016). The total nitrogen in manure was assessed and integrated into the Czech implementation of regulation no 377/2013 on manure storage and its utilization.

Each category of animal is multiplied by the country specific emission factors. Compared to 2015 reporting, 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 adaption period 2009-2016 for farms to get equipped with suitable technology (slurry applicators, plough etc.) enabling to fulfil this duty.

Ammonia emissions from synthetic N fertilizer application (3Da1) are calculated according to the methodology and the emission factors used for GAINS model which is used as part of the standard modeling framework for negotiations under the Convention on Long-range Transboundary Air Pollution and the European Union (The GAINS Model, 2018).

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 (20 %) in the total consumption of the N –inorganic fertilizers was estimated by the Ministry of Agriculture.

The emissions of $PM_{2.5}$ from crop production and soils are calculated as the product of cropped areas of individual crops and the emission factors pertaining to individual field operations emitting dust particles, expressed by the formula:

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

Where: E_{PM} = emissions of $PM_{2.5}$ from the i-crop in kg/year,
I = number of crops grown,
A_i = annual cropped area of the i-crop in ha,
N_{i_k} = number of times the k_{th} operation is performed on the i_{th} crop, in $year^{-1}$,
$EF_{PM\_i\_k}$ = EF for the k-operation of the i-crop, in kg/ha.

Cropped areas of individual crops were obtained from the annual report of the Czech Statistical Office. 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.

The emission factors for $PM_{2.5}$ were adopted from EEA 2016 for the region with humid climatic. During dry weather period, the operations (performed several times per year) may produce emissions of particle matters. For crop cultivation we can use two different technologies, ie conventional, or minimizing the tillage.

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 factors for the operation harvesting were factored in twice.

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 NO_X (as NO_2), NMVOC, SO_X, $PM_{2.5}$ and BC.

The 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 (Waste Management Plan) 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. 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).

For estimation of classical pollutants from category waste, same spreadsheet with the GHG emissions was used. Values of projected waste emissions for years 2020, 2025, 2030, 2035 and 2040 are multiplied by emission factors for classical pollutants. Emission factors are mainly based on the EMEP/EEA Air pollutant Emission Inventory Guidebook 2016.

5C category had significant change in data source values. It was applied previous emission factors but changed NO_X (as NO_2) and NMVOC to better fit emission factors from EEA’s emission factor database. Emission factors for SO_X and NH_3 was added from EEA’s guidebook 2016. It was removed CO from 5B category and kept NH_3 only.

In category 5D the previous NH_3 suggestion was based on population estimates instead of wastewater estimates with the Guidebook emission factors. The recent population estimation to 2050 was used it as it was done the previous projection.

9.5 SCENARIO WaM

WaM scenario is focused on the domestic sector. This scenario is based on the WM 2025, 2030 scenario. It was developed in collaboration with the Ministry of the Environment.

In WaM scenario it is expected that people will exchange 80,000 stoves by other combustion devices until 2030: 30% of stoves will be replaced by gasification boilers (wood), 30% by automatic boilers (pellets), 20% will be replaced by heat pumps and 20% by natural gas. For the purposes of WaM scenario coal-burning stoves were completely replaced (about 14,000 stoves), the rest of replaced stoves was wood-burning (about 66,000).

The WaM scenario 2025 and 2030 for large combustion sources is based on the replacement of 5 million tonnes of brown coal consumption for electricity generation by non-emission renewable resources.

The WaM scenario for NFR 3 includes the application of additional technological and administrative measures to reduce emissions by about 15 kt.

10 REPORTING OF GRIDDED EMISSIONS AND LPS

The date of the last edit of the chapter: 21/05/2017

Remark: Gridded data comply summary data reported in 2017.

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.

10.1.3 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 (see Figure 10-1) 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..

10.1.4 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 disposal on land (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 reporting year 2015) was provided 27. 4. 2017. Next submission will be carried out in 2021 (data for reporting year 2019).

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 (as NO_2), 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 %).

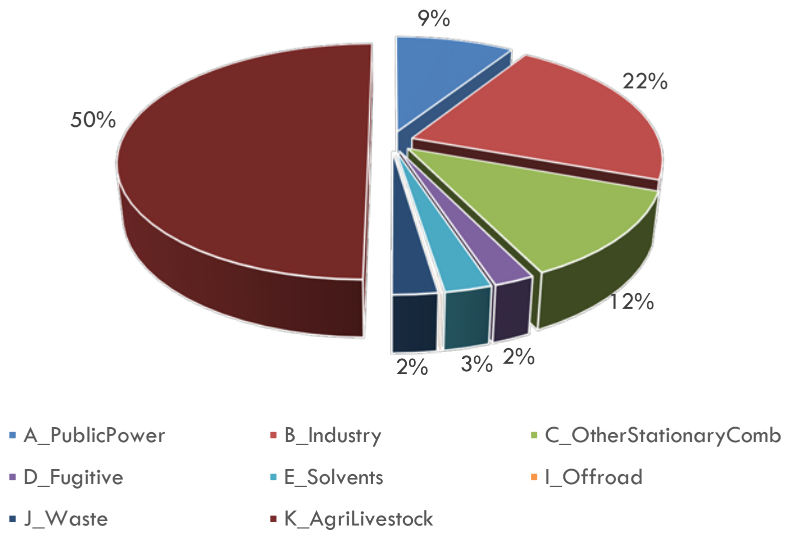

FIGURE 10-1 SHARE OF GNFRs IN THE TOTAL LPS NUMBER

11 ADJUSTMENTS

Country: Czechia

Date of submission: 15th March 2020

Czechia as an EU Member State adopted the National Emission Ceiling Directive (2001/81/EC) in 2001, which was replaced in 2016 by the revised NECD (2016/2284/EU), and signed and ratified the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level ozone (Gothenburg Protocol). With this, Czechia is committed to reduce its emissions of NO_X, SO_2, NMVOC and NH_3 to the agreed national emission ceilings by 2010 and to respect these ceilings from 2010 onwards.

11.1 GENERAL ASSESSMENT

In 2020 Czechia is in non-compliance for NMVOC for all years since 2010 (Table 11.2), due to changes in the emission inventory unforeseen when the emission ceilings were set. For NH_3, NO_X and SO_X the Czechia is in compliance.

TABLE 11-1 NATIONAL TOTALS, ADJUSTMENT OF NO_X EMISSIONS IN NFR CATEGORY 3B AND NATIONAL TOTALS FOR COMPLIANCE IN THE 2020 SUBMISSION

NO_X (kt)	2010	2011	2012	2013	2014	2015	2016	2017	2018
National total	229,9	217,4	205,3	190,4	185,9	179,6	171,4	168,1	161,6
Adjustment 3B	-0,8	-0,8	-0,8	-0,8	-0,8	-0,8	-0,8	-0,7	-0,8
National total for compliance	229,1	216,6	204,5	189,6	185,1	178,8	170,6	167,4	160,8

TABLE 11-2 NATIONAL TOTALS, ADJUSTMENT OF NMVOC EMISSIONS IN NFR CATEGORY 3B AND NATIONAL TOTALS FOR COMPLIANCE IN THE 2020 SUBMISSION

NMVOC (kt)	2010	2011	2012	2013	2014	2015	2016	2017	2018
National total	264,6	252,7	246,9	244,0	238,2	236,8	232,7	233,1	231,0
Adjustment 3B	-19,7	-19,1	-19,0	-19,4	-19,5	-19,9	-20,0	-20,1	-20,4
National total for compliance	244,9	233,6	227,9	224,6	218,7	216,9	212,7	213,0	210,6

11.2 (APPLICATION FOR) ADJUSTMENTS

Decision 2012/3 of the Executive Body (UNECE, 2012) decided that adjustments may be made under specific circumstances to the national emission inventories for the purpose of comparing the inventories with emission reduction commitments.

Under the revised NEC Directive (Directive 2016/2284/EU) Article V specifies flexibilities one of which is the possibility to establish adjusted emission inventories, where non-compliance with the national emission reduction commitments would result from applying improved emission inventory methods updated in accordance with scientific knowledge. The circumstances under which an adjustment may be applied fall into three broad categories where:

- Emission source categories are identified that were not accounted for at the time when emission reduction commitments were set;
- Emission factors used to determine emissions levels for particular source categories for the year in which emissions reduction commitments are to be attained are significantly different than the emission factors applied to these categories when emission reduction commitments were set;
- The methodologies used for determining emissions from specific source categories have undergone significant changes between the time when emission reduction commitments were set and the year they are to be attained.

11.2.1 NO_X ADJUSTMENTS

The EMEP/EEA Guidebook implemented a default methodology and default emission factors for NO_X from animal husbandry and manure management. This resulted into the inclusion of the NO_X emissions from agriculture into the emission inventory implemented in 2020.

The NO_X emissions from agriculture are only small contributor to the national total. With the proposed adjustment in Table 11.1, Czechia will report adjusted total for compliance 2010 onwards.

11.2.2 NMVOC ADJUSTMENTS

The EMEP/EEA Guidebook implemented a default methodology and default emission factors for NMVOC from animal husbandry and manure management. This resulted into the inclusion of the NMVOC emissions from agriculture into the emission inventory implemented in 2020.

The NMVOC emissions from agriculture are a large contributor to the national total, resulting in an exceedance of the emission ceiling 220 kt (2010). With the proposed adjustment in Table 11.2, Czechia will be in compliance again 2014 onwards.

12 EMRT 2017–2019

The STAGE 3 Review Report 2015 and subsequent EMRT Reviews 2017–2019 were considerable contribution to further improvement of Czech emission inventory. The target was to have the 2019 reporting consistent with EMEP/EEA EIG [5] requirements and comparable with other reporting countries. The most significant improvements took place in 2018 and 2019 reporting when model COPERT 5 was introduced at our cooperating institution Transport Research Center (CDV), non-road machinery fleet was thoroughly revised (VÚZT) and significant recalculations for household heating were performed (CHMI).

In e-ANNEX tables please find specific reasons for keeping the items on the list for particular sector and giving the reviewers adequate information where not present in the text of previous chapters (table Recommendations adopted in IIR). Some recommendations remained open (table Recommendations for future IIR).

12.1 KEY CATEGORIES

We find it necessary to mention, that for some key categories we were asked to provide revised emission estimates or implement higher Tier methodology. Our revised estimates (Manure management) were basically comparable to proposed technical corrections.

TABLE 12-1 RECOMMENDATIONS FROM THE NECD REVIEW 2018 FOR NO_X, NMVOC, SO_2, NH3 AND $PM_{2.5}$ THAT HAVE NOT BEEN IMPLEMENTED IN THE INVENTORY SUBMISSION 2019 (TABLE 2 OF FINAL REVIEW REPORT)

Status	Recommendation	Text
Open	CZ-2D3a-2017-0001 KC – Key category	Adopted Tier 1 NMVOC IEF 1.2 kg/capita/year. Difference to total 2D NMVOC emission compensated in sector 2D3d.
Resolved	CZ-2H2-2017-0001	Reported in 2020 submission.
Open	CZ-3B-2017-0006 PTC 2019 – Potential technical correction	The requested data will be reported after clarification, how to implement some ammonia abatement techniques into calculation.
Open	CZ-3Da2a-2017-0001 PTC 2019 – Potential technical correction	Not reported in 2020 submission. Rated as planned improvement.

TABLE 12-2 ADDITIONAL RECOMMENDATIONS MADE DURING THE NECD REVIEW 2019 FOR NO_X, SO_2, NH_3 AND $PM_{2.5}$ (TABLE 3 OF FINAL REVIEW REPORT)

Status	Recommendation	Text
Resolved	CZ-3Da1-2019-0003 TC 2019 – Technical Correction	The emissions were estimated using Tier 2 methodology in 2020 submission.

Higher Tier methodology remains to be a problem. We can request an update of legal background and get more detail data in the future for such sectors, but the input data for years passed will be available no more. This is the difficulty we face and would like to find a common solution.

In particular, we rose the emission factor to 1.2 kg/capita/year at 2D3a in 2020 and compesated the differences to total emission in sector 2D3d, but Tier 2 data as in more other countries are not available for past years of the time series.

12.2 OTHER CATEGORIES

Current 2020 submission focused on assessment of previus recommendations even for less important sectors. Most of the findings were solved and an appropriate comments are to be find in individual chapters or in e-ANNEX.

13 ABBREVIATIONS

AAP	*Annual Average Population*
AD	*Activity Data*
CCR	*Czech Car Registry*
CDV	*Transport Research Centre*
CeHO	*Centre for Waste Management*
CEI	*Czech Environmental Inspectorate*
CENIA	*Czech Environmental Information Agency*
CHMI	*Czech Hydrometeorological Institute*
CME	*Czech Ministry of the Environment*
CS	*Country Specific*
CZSO	*Czech Statistical Office*
EFs	*Emission Factors*
EIG	*EMEP/EEA air pollutant emission inventory guidebook 2019*
FRS CR	*Fire Rescue Service of the Czech Republic*
IPR	*Integrated Pollution Register of the Environment*
ISOH	*Waste Management Information System*
ISPOP	*Integrated System for Fulfilment of Reporting Duties*
LCP	*Large Combustion Plant*
LPS	*Large Point Sources*
MIT	*Ministry of Industry and Trade*
MSW	*Municipal Solid Waste*
MT	*Ministry of Transport*
NACE	*Statistical Classification of Economic Activities*
NR	*Not Reported*
REZZO	*Register of Emissions and Stationary Sources*
SOE	*Summary Operation Evidence*
STC	*Technical Control Station/Technical Inspection Station*
SVUOM	*National Research Institute for the Protection of Materials*
SWDS	*Solid Waste Disposal Sites*
TGM WRI	*T. G. Masaryk Water Research Institute*
UKZUZ	*Central Institute for Supervising and Testing in Agriculture*
VUZT	*Research Institute of Agricultural Technology*
WaM	*Scenario with Additional Measurements*
WM	*Scenario with Measurements*
WMP	*Waste Management Plan*

14 FIGURES

15 TABLES

16 REFERENCES

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