Czech
Hydrometeorological
Institute

Informative Inventory Report

Czechia

2022

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

Reported inventories 1990–2020

Prague

March 2022

Subtitle

Emission inventories from the base year of the protocols to year 2020

Authors

Ilona Dvořáková, Monika Filipenská, Alfiya Kassymova, Pavel Machálek, Maroš Petrík, (CHMI)

Martin Dědina (VUZT), Jiří Dufek (MOTRAN Research), Hana Geiplová (SVÚOM), Zuzana Kačmárová (CDV), Vladimír Neužil (KONEKO marketing), Leoš Pelikán (CDV), Radek Srněnský (IDEA-ENVI)

Editing completed

15/03/2022

This report describes methodologies of emission inventories compiling used in Czechia. The report is compiled under the UNECE Convention on Long range Transboundary Air Pollution, as well as the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NEC Directive), in accordance with the EMEP/EEA air pollutant emission inventory guidebook

Report was completed under corporate design

I. Contents

Executive Summary

Czechia 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 [1]. These facts make the obligation to report annual emission data. The report includes description of determination of the emissions.

Since 2019, a part of documentation for emission inventory processing is electronic (e-ANNEX) inclusive EEA Emission Review Tool (EMRT) summary, placed on Czech Hydrometeorological Institute (CHMI) web sites. See e-ANNEX.

As a part to the UNECE/CLRTAP and under the NEC Directive Czechia annually presents reported data of air pollutants (AP) [1, 2]. Report consist of following pollutants, see ANNEX I:

- main pollutants: nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC), sulphur oxides (SO_X, as SO2), ammonia (NH_3);
- particular matter: particulate matter (PMs) with diameters approx.10 micrometres PM_{10} and fine particular matter $PM_{2.5}$, which are smaller than 2.5 micrometres, total suspended particulate (TSP), black carbon (BC);
- carbon monoxide (CO);
- priority heavy metals (HMs): Lead (Pb), Cadmium (Cd) and Mercury (Hg);
- additional heavy metals (HMs): Arsenic (As), Chromium (Cr), Copper (Cu), Nickel (Ni), Selenium (Se), Zinc (Zn)
- persistent organic pollutants (POPs): polychlorinated dibenzodioxins/dibenzofurans (PCDD/F), hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). PAHs consist of benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene.

Emissions are reported under structure given in EMEP/EEA air pollutant emission inventory guidebook. Emission factors (EFs) were use according EMEP/EEA EIG [3].

Main updates presented in IIR 2022

The Czech IIR 2022 submission presents results of emission inventory 1990–2020, including most of recalculations recommended in EMRT Review 2021. The most significant update is related with emissions from agricultural activities (Nomenclature for Reporting (NFR) 3B and 3D) which were recalculated (NO_X, NMVOC and NH_3 emissions) using N-flow concept. Time series for road transport were recalculated due to obtaining new background for précising activity data for COPERT. Emissions of HCB from Aluminium production (NFR 2C3) were newly calculated using the EFs from EMEP/EEA EIG in the years 1990–2020 [3]. These updates are described in more detail in chapters for relevant NFR categories.

Significant emission trends in Czechia

Considering the above mentioned emission recalculations, updated emission trends are presented for period 1990–2020. Long-term emission trends in Czechia as well as last annual changes show a permanently descending trend almost at all pollutants.

Despite a slight increase of degree days in 2020 heating season compared to 2019 (approx. by 1,3 %), the model calculation of emissions reflected mainly the modernization of local heating equipment composition due to legislation measures documented in Ministry of Industry and Trade (MIT) statistics, and improving parameters of burnt wood (lower humidity).

Significant year-on-year declines have occurred in many economic indicators due to the COVID pandemic. The total electricity consumption decreased by about 5%. As a result of total shares increasing, especially in renewable sources, the share of fossil fuels decreased in electricity production. A significant reduction in the consumption of the brown coal for electricity production (by about 20%) was reflected in a reduction in emissions, especially in NFR 1A1a. Industrial production decrease by 8% in 2020 compared to the previous year, which was the strongest year-on-year decline since the global economic crisis in 2009.

Emissions of SO_X had the most significant decrease against 2019 (16.6 %) among main pollutants. Emissions of NO_X decreased by 10.3 %. Total decrease of emissions is: $PM_{2.5}$ by 8.3 %, PM_{10} by 8.1 %, TSP by 8.6 % and CO by 3.8 %. Emissions of NMVOC decrease against 2019 by 9.3 %, as a result of reduced consumption of products containing organic solvents Emissions of HMs and POPs are also decreased, except cadmium Cd, where emissions increased by 0,2 %. Decreases against 2019 are: lead (Pb) by 14.5 %, mercury (Hg) by 11.8 %, PCDD/F by 5.1 %, PAHs by 7.1 %, HCB by 26.6 % and PCBs by 7.8 %.

Share of categories in Czechia in 2020

The sector of residential heating (NFR 1A4bi) still contributes significantly to air pollution, specifically $PM_{2.5}$ emissions 71 %, PM_{10} emissions 55 %, CO emissions 66.9 % and Benzo[a]pyrene 96.2 %. The decisive share of the public sector energy (NFR 1A1a) prevailed in emissions of SO_x 39.4 % and Hg 43.3 %. 26.9 % of Pb emission was emitted by the NFR 2G.

The public electricity (18.6 %), passenger cars (15.0 %), road freight transport sector over 3.5 tonnes NFR 1A3biii (9.6 %), off-road machinery (8.9 %) and Inorganic N fertilizers (8.2 %) and created more than 60 % of NO_X emissions. The most significant sources of emissions of NMVOC are found in the NFR 1A4bi household heating with share 36.6 %. The main source of ammonia emissions is agriculture (NFR 3D + 3B), whose share of total emissions is 88.2 %. In figures below are presented trends of the main pollutant emissions in the period 1990–2020.

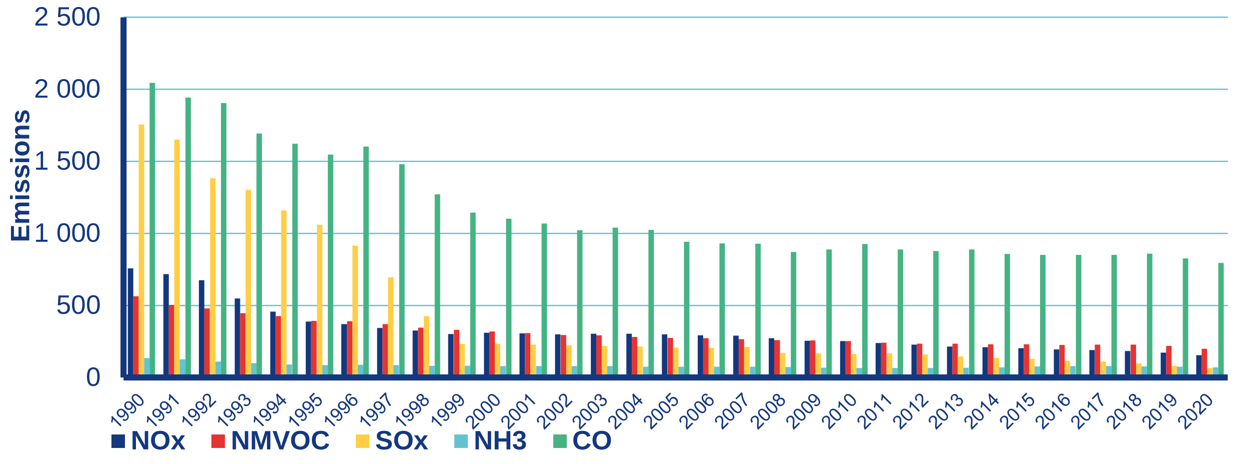

Fig. 0. 1 Total emissions of main pollutants, 1990–2020

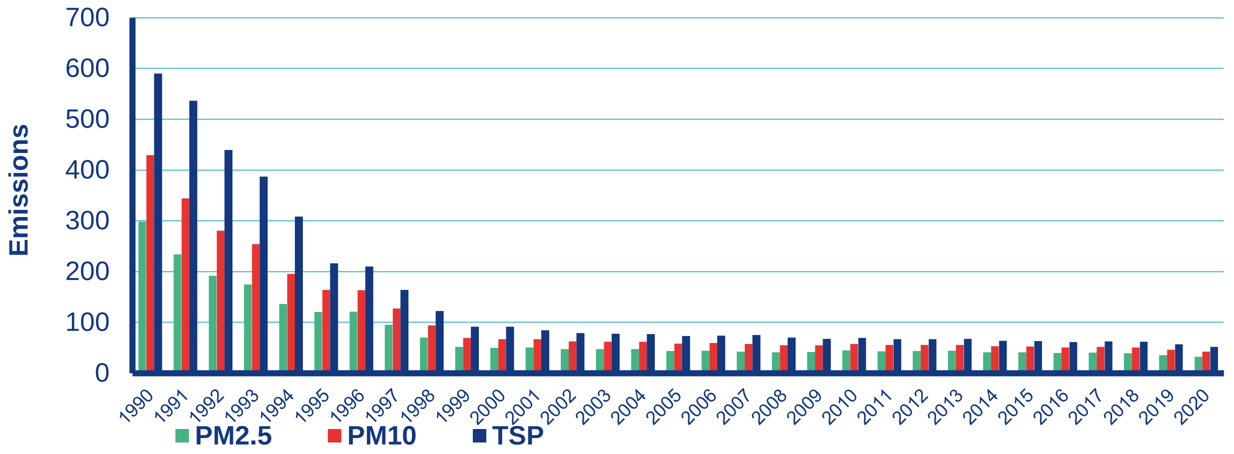

Fig. 0. 2 Emissions of particular matter, 1990–2020

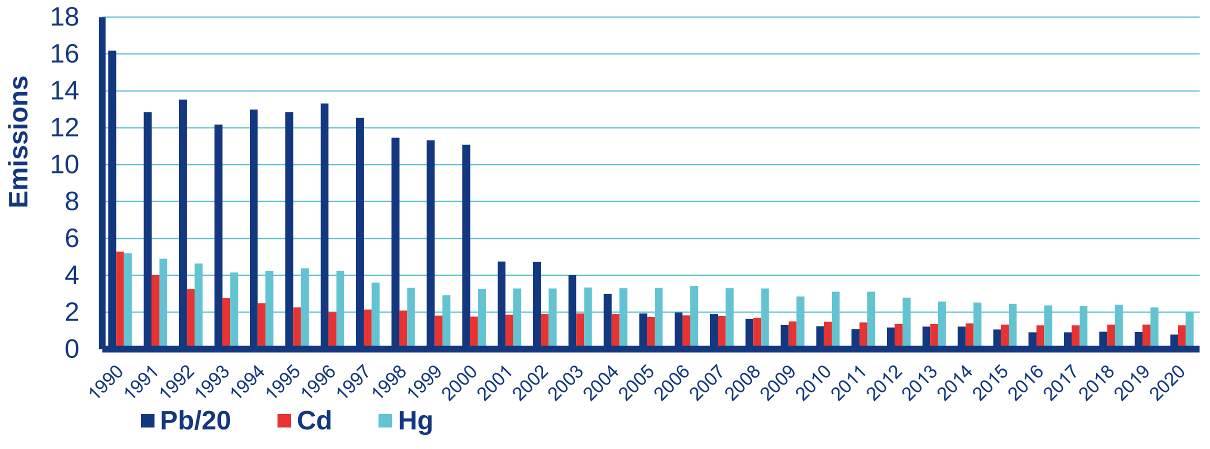

Fig. 0. 3 Emissions of heavy metals, 1990–2020

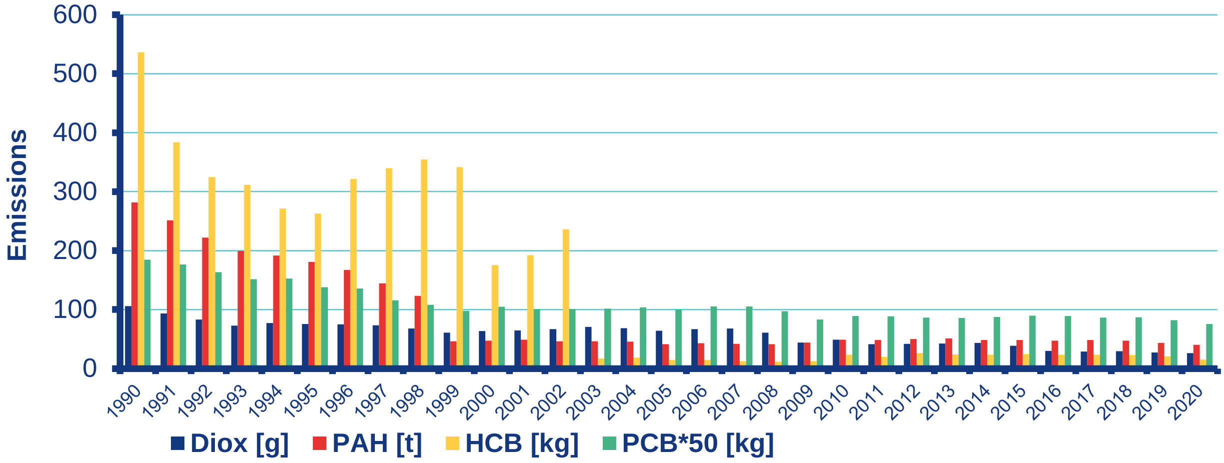

Fig. 0. 4 POPs emissions, 1990–2020

I. Introduction

The date of the last edit of the chapter: 15/03/2022

I.1 National Inventory Background

UNECE/CLRTAP was negotiated in 1979 and belongs to the important instruments of prevention of the long-range transfer of air pollution [1]. 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. Czechia 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.

I.2 Institutional arrangements

The 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 [4].

The information is stored in the Register of Emissions and Stationary Sources (REZZO), which is maintained by the Ministry of the Environment (MoE) of Czechia. 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 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 (Tab. I.1).

Tab. I.1 The categorization of pollution sources

Category	Type of source	Origin of emissions	Category
REZZO 1	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.)	Reported emission data	Individually monitored sources – reported emissions
REZZO 2	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 or facilities for transporting and storing petrol fuel	Calculated emissions from reported activity data (consumption and calorific capacity of fuels, gasoline distribution) and emission factors	Individually monitored sources – emissions calculated from the reported data and emission factor
REZZO 3	Combustion of fuels with a total thermal input lower 0.3 MW, non-specified technological processes (domestic solvent use, building and agricultural activities)	Calculated emissions from activity data obtained e.g. from the Census, production and energy statistical surveys and emission factors	Sources monitored collectively
REZZO 4	Road, railway, water and air transport of persons and EMEP/EEA EIG, tyre and brake wear, road abrasion and evaporation from fuel systems of vehicles using petrol, non-road vehicles and machines used in maintenance of green spaces in parks and forests etc.	Calculated emissions from activity data obtained e.g. from road traffic census, the register of vehicles etc. and emission factors	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 NFR 1A (except mobile sources and 1A4bi), NFR 1B (except 1B1a and 1B2av), furthermore in most of categories NFR 2A (except 2A5b), 2B and 2C. Data reported for sector Solvent use are only being used for NMVOC emission estimate. The whole inventory for NFR 2D (except 2D3b and 2D3c) is being performed by model calculation. Emissions from waste combustion and cremations (NFR 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 (NFR 1A4bi), all categories of mobile sources NFR 1A3 (except gas transport 1A3ei), NFR 1B partly, NFR 2A5b, agricultural machinery (NFR 3).

I.3 Inventory preparation process

CHMI under the supervision of the MoE , is designated as the coordinating and managing organization responsible for the compilation of the national inventory and reporting its results.

Inventory was prepared by sectorial experts, see Tab. I.2.

Inventories were prepared by external help of:

- Transport Research Centre (CDV), Brno, is responsible for compilation of the inventory in NFR 1A3 Energy and Road and non-road Transport.
- Research Institute of Agricultural Technology (VUZT), Prague, is responsible for compilation of the inventory in NFR 3 Agriculture and NFR 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 NFR 2D Solvent Use

Tab. I.2 Institution arrangement

Sector	Author	Institution	E-mail
Energy	Ilona Dvořáková Pavel Machálek Maroš Petrík	CHMI	ilona.dvorakova@chmi.cz pavel.machalek@chmi.cz maros.petrik@chmi.cz
Transport	Leoš Pelikán Zuzana Kačmárová	CDV	leos.pelikan@cdv.cz zuzana.kacmarova@cdv.cz
Industrial processes	Ilona Dvořáková Pavel Machálek	CHMI CHMI	ilona.dvorakova@chmi.cz pavel.machalek@chmi.cz
Agriculture	Martin Dědina Maroš Petrík	VUZT CHMI	martin.dedina@vuzt.cz maros.petrik@chmi.cz
Waste	Ilona Dvořáková	CHMI	ilona.dvorakova@chmi.cz
HMs, POPs emissions	Pavel Machálek	CHMI	pavel.machalek@chmi.cz
NMVOC emissions from Industry	Hana Geiplová	SVUOM	geiplova@svuom.cz
GRIDDED emissions	Pavel Machálek Radek Srněnský	CHMI IDEA-ENVI	pavel.machalek@chmi.cz ras@idea-envi.cz
LPS	Ilona Dvořáková	CHMI	ilona.dvorakova@chmi.cz
Projections	Alfiya Kassymova Jiří Dufek Martin Dědina	CHMI CDV VÚZT	alfiya.kassymova@chmi.cz jiri.dufek@motran.info martin.dedina@vuzt.cz
QA/QC	-	-	-
Coordinator	Alfiya Kassymova	CHMI	alfiya.kassymova@chmi.cz

I.4 Methods and data sources

The emission inventory of air pollutants in Czechia is prepared to fulfil reporting requirements. Calculations are based on a combined methodology. In addition to reported primary emission data from operators of sources, other information (fuel consumption, production, etc.) are also used to estimate emissions in certain sectors. A significant part of emissions is estimated on the basis of statistically monitored and reported information, and available emission factors.

In 2015 there was the Stage III in depth review of the Czech emission inventory and IIR. 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.

The 2022 submission presents:

- Submission (1990–2020) of emissions in all categories
- Notation keys for both, emissions and activity data were thoroughly revised and updated in NFR tables.
- Comment to EMRT findings was adopted in chapter 12 and for details please refer to e-ANNEX.
- New emissions previously reported as NE were reported, see e-ANNEX
- Next updates are described in more detail in chapters for relevant NFR categories and in e-ANNEX.

I.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 the 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.

The use of emissions reported by source operators does not in some cases correspond EMEP/EEA EIG [3]. Namely in categories where operated stationary sources do not reach set threshold 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, 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 1 or 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 PMs 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 [5].

Monitored, or based on the activity data calculated emissions of individually monitored sources are used namely for following main categories – NFR 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 NFR 1A3ei and also for NFR 2D3c (Asphalt Roofing). Detailed information on some categories is given in e-ANNEX (**REZZO-NFR_code.xlsx**). 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 III and Executive Summary). 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 NFR 2D3d to 2D3i). There are more than 3600 sources (painting and degreasing plants, printing plants etc.) that produce more than 7,7 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 NFR 2D category (see chapter IV.4).

The sources in NFR 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 NFR 5A being carried out according to Tier 1 methodology (see chapter VI).

I.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 calculations, emission factors from EMEP/EEA EIG [3] are used (newly e.g. for some NFR categories 2C). For further information see following chapters. Newly, emission factors for NFR 2H2 were supplied. Detailed information on some categories is given in e-ANNEX.

I.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 NFR 2A, 2B, 2C, 2H and partly

NFR 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.

I.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 Czech Statistical Office (CZSO) and boiler structure from census 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 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. Sets of emission data on mobile sources in agriculture and forestry are processed by 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 CDV in 2018. For non-road transport (NFR 1A4cii) the tractor and non-road machinery fleet composition as well as related emissions were thoroughly revised in 2018.

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

I.4.2.1 Emission Factors used

Emissions of collectively monitored sources are being calculated using emission factors. In last period there had been implemented EMEP/EEA EIG emission factors for calculation of most of key sources [6]. In some cases, national emission factors based on emission measurements of large group of sources (namely in NFR 1A4bi) are being preferred. For NMVOC emission estimate in category Solvent use, EMEP/EEA EIG 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 [6]. Detailed information on some categories is given in e-ANNEX.

I.4.2.2 Activity Data used

Emissions of collectively monitored sources are being calculated using activity data prevailing of public accessible web pages of 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.

I.4.3 The condensable component of PM_{10} and $PM_{2.5}$ (emission factors)

In general, emissions from individually monitored sources do not contain a condensable component, because of 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 (NFR 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), they contain a condensable component.

I.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 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 NFR 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 CZSO, MIT (fuel data, production facilities data), Ministry of Agriculture (MoA) (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 to English.

I.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 (see Tab. I.3)

NFR 1A4bi Residential: Stationary was among the most significant sources of emissions in Czechia in 2020. This sector was a key source of the largest number of pollutants and predominantly contributed to the presented national total of $PM_{2.5}$, PM_{10}, TSP, CO, PAHs and HCB, including others emissions (BC, As). NFR 1A1a Public electricity and heat production was a key source for 9 out of 26 pollutants monitored. This sector contributes to total emissions of NO_X (as NO_2), SO_X, Hg (presented) and Cr, Ni and Se. The production of iron and steel, which is comprised in NFR 1A2a and 2C1 represented a key source of CO, persistent organic pollutants and heavy metals.

Tab. I.3 Key categories of air pollutants in Czechia in 2020

	Key categories (Sorted from high to low from left to right)										Total [%]
SO_X	1A1a (39.4%)	1A4bi (21.6%)	1A2a (8.9%)	1B2c (5.0%)	2B10a (4.6%)	1A2f (4.6%)					84.1
NO_X	1A1a (18.6%)	1A3bi (15.0%)	1A3biii (9.6%)	1A4cii (8.9%)	3Da1 (8.2%)	1A4bi (7.8%)	1A2f (5.0%)	1A3bii (4.8%)	1A4ai (3.3%)		81.1
NH_3	3Da1 (30.4%)	3Da2a (19.4%)	3B1b (13.4%)	3B1a (11.8%)	1A4bi (8.0%)						83.1
NMVOC	1A4bi (36.6%)	2D3d (10.4%)	3B1b (7.9%)	3B1a (6.7%)	2D3a (6.5%)	2D3g (3.3%)	2D3h (2.9%)	1A3bi (2.5%)	1A3bv (2.0%)	1A1a (2.0%)	80.8
CO	1A4bi (66.9%)	1A2a (11.1%)	1A3bi (6.7%)								84.8
TSP	1A4bi (48.7%)	3Dc (8.6%)	1B1a (5.4%)	1A3bvi (3.9%)	2A5a (3.3%)	1A3bvii (3.1%)	1A1a (3.0%)	3B4gi (2.9%)	1A4cii (2.4%)		81.3
PM_{10}	1A4bi (55.3%)	3Dc (10.5%)	1A3bvi (3.6%)	1B1a (3.1%)	1A1a (3.1%)	1A4cii (2.9%)	2G (2.6%)				81.2
$PM_{2.5}$	1A4bi (71.0%)	1A4cii (3.6%)	1A1a (2.9%)	2G (2.6%)							80.2
Pb	2G (26.9%)	2C1 (20.6%)	1A3bvi (13.2%)	1A4bi (9.0%)	1A1a (7.6%)	1A3aii(i) (6.7%)					84.0
Hg	1A1a (43.3%)	1A4bi (14.3%)	1A2a (9.3%)	5C1bv (8.2%)	2C1 (4.3%)	1A2f (3.6%)					83.0
Cd	1A4bi (52.0%)	2C1 (9.2%)	2G (9.1%)	1A1a (8.3%)	2C6 (4.3%)						83.0
DIOX	1A4bi (27.9%)	1A2a (20.9%)	5E (15.7%)	2C1 (10.9%)	5C2 (5.4%)						80.8
PAHs	1A4bi (98.1%)										98.1
HCB	1A4bi (74.9%)	1A1a (15.7%)									90.6

I.6 QA/QC and Verification methods

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

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in preparation of emission inventory.

The process of air pollutant emission inventory is a part of the Air Quality System and Management in Czechia. According § 7 of the Air Quality Act 201/2012 coll, on basis of collected data, MoE performs the emission inventory comprising the total amount of air pollutants that had been emitted into the atmosphere in the previous year, and emission projections with estimates for coming years. CHMI had been authorized to monitor the air quality in Czechia. 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).

I.6.1 QC procedures

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

New approach having been applied since 2018 reflecting Stage 3 recommendations and EMRT review includes changes in choice of methodology for sectorial 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 [3]. 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 Residential 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, several errors were appeared in previous reporting periods. Errors were caused by incorrect positioning of emission data in certain rows that were hidden while further processing, or were not checked or wrongly linked to the file with summary annual data and 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.

In IIR single tables are being created that incorporate summary or concrete values of emission reporting. Considering large scale of the document, correct values setting could not be performed in all tables and charts.

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 (CHMI) 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.

I.6.2 QA procedures

Due to insufficient capacity of experts, review procedures on national level have not been established yet. Emission inventory team uses recommendations and results of international reviews.

I.7 General uncertainty evaluation

The date of the last edit of the chapter: 15/03/2022

In the process of emission inventories in Czechia there are mainly used the data provided by the operators of stationary sources of air pollution, the statistical data of the CZSO (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 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) [3].

I.8 General assessment of completeness

I.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 [3].

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

I.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 s	Longname	Reason for IE
1A4aii	Commercial/institutional: Mobile	1990–1997 included in 1A3b
1A4bii	Residential: Household and gardening (mobile)	1990–1997 included in 1A3b
1A4ci	Agriculture/Forestry/Fishing: Stationary	NH_3 1990–2014 included in 1A4ai
1A5a	Other stationary (including military)	1990–2015 included in 1A4ai
1B2c	Venting and flaring (oil, gas, combined oil and gas)	1990–1999 included in 1B2aiv
2A2	Lime production	PMs 1990–1999 included in 1A2f
2A3	Glass production	Main, PMs 1990–1999 included in 1A2f
2A6	Other mineral products	Main, PMs 1990–1999 included in 1A2f
2B6	Titanium dioxide production	Main, PMs 1990–1999 included in 1A2c
2C1	Iron and steel production	HCB included in 1A2a; Main, PMs 1990–1999 in 1A2a
2C3	Aluminium production	PMs, PAHs 1990–1999 included in 1A2a
2C4	Magnesium production	PMs 1990–2001 included in 1A2a
2C5	Lead production	PMs 1990–1999 included in 1A2a
2D3c	Asphalt roofing	CO included in 1A2f; 1990–1999 included in 1A2f
2H1	Pulp and paper industry	1990–1999 included in 1A2d
3B4h	Manure management - Other animals	NH_3 included in 3Da2a
5C1bi – 5C1biv	Waste incineration	included in 1A1a

II. Key trends

The date of the last edit of the chapter: 15/03/2021

Economic indicators show overall trend of economic growth. GDP (CZSO) indicator against 2020 decrease by 1.7 % in 2020.Of the listed REZZO 1-2 sources, emissions decreased the most concerning SO_X by 12 kt, NO_X by 8.2 kt and CO by 6 kt. In the case of collectively monitored stationary REZZO 3 sources, the decrease in SP emissions (by 2.1 kt) is mainly due to domestic heating and then other stationary sources, including coal mining which decreased by 21 % year-on-year for lignite coal and by almost 37.5 % for hard coal. The results of the model evaluation of domestic heating include the available information on the ongoing replacement of boilers for domestic heating. The results show that despite a slight increase in the number of degree-days in the heating period in 2020 compared to 2019 (by about 1.3 %), the estimation of emissions mainly affected the modernization of the composition of combustion equipment in households due to legislative measures documented in the MIT statistics. 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 Fig. 0. 1 and Fig. 0. 2. The level of air pollution in 2020 changed in comparison with the year 2020 as follows: NO_X (as NO2) decreased by 10.3%, NMVOC by 9.3 %, SO_X (as SO2) by 16.6 %, NH_3 by 5.0 % and $PM_{2.5}$ 8.3 %. PM_{10} decreased by 8.1 %, TSP by 8.6 %, BC by 6.3 % and CO by 3.8 %.

Changes in HMs are as follows: emissions of Pb decreased by 14.5 %, Cd 3.7 %, Hg 11,8 %, As 9.1 %, Cr 9.8 %, Cu 8.8 %, Ni 6.7 %, Se 16.4 % and Zn emission by 6.8 %.

Changes in POPs are as follows: emissions of PCDD/F decreased by 5.1 %, PAHs 7.1 %, HCB 26.6 % and PCBs emission 7.8 %.

II.1 Emissions of regulated pollutants

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 1990–2020 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.

II.1.1 Nitrogen oxides (NO_X (as NO_2))

Emissions of nitrogen oxides of 757.8 kt in 1990 dropped significantly mainly due to decrease of economic activity in heavy industry and shut down of obsolete facilities and technologies. The total emission of nitrogen oxides in 2005 amounted 299.9 kt (-60.4 % compared to 1990). The further decline was relatively slight to 153.8 kt in 2020. The total emission of nitrogen oxides decreased year-on-year by 10.3 % (171.4 kt in 2019). 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 NFR 1A1a (18.6 %), 1A3bi (15.0 %), 1A3biii (9.6 %), 1A4cii (8.9 %) and 1A4bi (7.8 %).

II.1.2 Volatile organic compounds (NMVOC)

NMVOC emissions in 1990 reached 566.1 kt and lowered to 274.1 kt in 2005 (-51.6 %). In general the reduction trend remained and the total emission in 2020 amounted 198.9 kt. The total emission of

NMVOC decreased by 9.3 % in 2020 compared to 2019 (219.2 kt). There are two sectors with the highest share of total emission: NFR 1A4bi (36.6 %) and 2D3d (10.4 %).

II.1.3 Sulphur dioxide (SO_X (as 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 208.5 kt in 2005 (88.1 %) and slowly declined due to further improvements to 66.6 kt in 2020 (68.0 % compared to 2005). The achievements in sulphur dioxide abatement in 1990–1999 and later belong to the most significant in Czech emission inventory (-96.2 %, year 2020 compared to 1990). The year-on-year emission of sulphur dioxide lowered by 16.6 % (79.9 kt in 2019). The most emission is being contributed by NFR 1A1a (39.4 %) and 1A4bi (21.6 %).

II.1.4 Ammonia (NH_3)

Emissions of ammonia in 1990 was 149.8 kt and declined in 2005 to 77.1 kt (-48.6%) and lowered further to 68.4 kt in 2020. On the year-on-year basis there was -5.0 % most of the total ammonia emission (72.0 kt in 2019). Main contributing sectors to the final emission are in agriculture NFR 3Da1 (30.4 %), 3Da2a (19.4 %), 3B1b (13.4 %), 3B1a (11.8 %) and 1A4bi (8.0 %).

II.1.5 Particulate matter ($PM_{2.5}$)

The $PM_{2.5}$ emission in 1990 amounted 298.5 kt. It dropped to 43.5 kt in 2005 (-85.4 %) and was 32.4 kt in 2020, which is -89.2 % compared to 1990. The year-on-year change 2019–2020 makes -8.3 % (35.3 kt in 2019) mostly due to warm heating season in 2020. The highest share of total emission comes from NFR 1A4bi (71.0 %), other sectors are below 10 %.

II.1.6 Emissions in the period 1990–2005

The overview of emissions from 1990 to 2020 is in the graphs in 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 Czechia 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.

II.1.7 Emissions in the period 2005–2020

The level of air pollution in 2020 decreased in comparison with the year 2005 as follows: NO_X by 48.7 %, NMVOC by 27.4 %, SO_X by 68.0 %, NH_3 by 11.2% and $PM_{2.5}$ emissions by 25.6 %.

II.1.8 Last year's development

The largest year-on-year decrease of NO_X emission occurred in the case of NFR 1A1a by 6.8 kt (19.2 % of 1A1a NO_X 2019 emissions) followed by NFR 1A3biii by 3.58 kt (19.6 % of 1A3biii NO_X 2019 emissions). The largest year-on-year decrease of NMVOC emission took place in NFR 2D3d by 6.07 kt (22.3 % of 2D3d NMVOC 2019 emissions). The largest year-on-year decrease of SO_x emission took place for NFR 1A1a by 11.50 kt (30.5 % of 1A1a SO_X 2019 emissions), followed by NFR 1A4bi by 2.99 kt (17.2 % of 1A4bi SO_X 2019 emissions). The largest year-on-year decrease of NH_3 emission occurred for NFR 3Da1 by 2.79 kt (11.8 % of 3Da1 NH3 2019 emissions). The largest year-on-year decrease of $PM_{2.5}$ emission took place for NFR 1A4bi by 2.13 kt (8.5 % of 1A4bi $PM_{2.5}$ 2019 emissions).

II.2 PM_{10}, TSP, BC, CO, PAHs, HCB & Dioxins

II.2.1 Particulate matter (PM_{10})

The PM_{10} emission in 1990 amounted 429.7 kt. It dropped to 58.1 kt in 2005 (-86.5 %) and was 42.4 kt in 2020, which is -90.1 % compared to 1990. The year-on-year change 2019–2020 makes -8.1 % (46.2 kt in 2019). The highest share of total emission comes from NFR 1A4bi (55.3 %), 3Dc (10.5%), other sectors are below 10 %.

II.2.2 Total suspended particles (TSP)

The TSP emission of 589.9 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 72.9 kt in 2005 (87.6 %) and slowly decreased to 51.8 kt in 2020 (91.2 % 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 8.6 % (56.6 kt in 2019). The most contributing sector is NFR 1A4bi (48.7 %), other sectors are below 10 %.

II.2.3 Black carbon (BC)

The total BC emission in 1990 was 18.8 kt. It decreased to 6.3 kt in 2005 (66.3 %) and 4.1 kt in 2020, which is -78.2 % compared to 1990. The BC emission in 2020 remained close to 4.4 kt in 2019 (-6.3 %).

II.2.4 Carbon monoxide (CO)

The total emission of carbon monoxide 2,044.6 kt in 1990 was lowered to 941.9 kt in 2005 (-53.9 %). The decline of this emission was gradual and continued until 2020 with 795.6 kt (-61.1 % compared to 1990). The year-on-year change (827.0 kt in 2019) was -3.8 %. Despite these achievements the total emission of CO is the highest in the emission inventory of Czechia. The most important contribution to the total emission comes from NFR 1A4bi (66.9 %). The second important value belongs to NFR 1A2a (11.1 %) followed by NFR 1A3bi (6.7 %).

II.2.5 Polyaromatic Hydrocarbons (PAHs)

The total emission of polyaromatic hydrocarbons (PAHs) 280.1 t in 1990 was lowered to approximately 39.7 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 (PAHs) in 2020 was 38.6 t (-86.2 % compared to 1990). There is a year-on-year decrease in amount of emission which was 41.6 t in 2019 (8.1 %).

II.2.6 Hexachlorobenzene (HCB)

The total emission of hexachlorobenzene (HCB) was 536.5 kg in 1990 lowered to approximately 14.7 t in 2005 (-97.3 %). Main source of emission were NFR 2C3 Aluminium production till 2002. Since 2002 precursor of HCB were prohibited, therefore HCB emission dropped. There was a certain increase of this emission after 2005 which was 15.1 kg in 2020. The total emission of hexachlorobenzene (HCB) in 2019 was 20.5 kg and that makes year-on year decrease by 26.6 %. The sector NFR 1A4bi dominantly contributes to the total emission by 74.9 %.

II.2.7 Dioxins – Polychlorinated dibenzodioxines and furans (PCDD/F)

Total emission of polychlorinated dibenzo-p-dioxines and furans (PCDD/F) in 1990 was 106.0 g I-TEQ. The same emission in 2005 was 64.0 g I-TEQ (-39.6% compared to 1990). The total emission polychlorinated dibenzo-p-dioxines and furans (PCDD/F) in 2020 was 26.0 g I-TEQ (- 75.5 %). The emission of polychlorinated dibenzo-p-dioxines and furans (PCDD/F) reported in 2019 was 27.4 g I-TEQ, which is year-on-year change -5.1 %. These four sectors contribute to 80.8 % of total emission: NFR 1A4bi (27.9 %), 1A2a (20.9 %), 5E (15.7 %), 2C1 (10.9 %) and 5C2 (5.4%).

II.3 Emissions of priority heavy metals

II.3.1 Lead (Pb)

Total emission of lead in 1990 was 323.6 t. The same emission in 2005 was 38.8 t (-88.0 % 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 2020 lowered to 16.0 t (-95.1 % compared to 1990). The emission of lead in 2019 was 18.7 t, which is year-on-year decrease by 14.5 %. The most contributing to the total emission are NFR 2G (26.9 %), 2C1 (20.6 %), 1A3bvi (13.2 %), 1A4bi (9.0 %), 1A1a (7.6 %) and 1A3aii (6.7%) that make 84.0 % together.

II.3.2 Cadmium (Cd)

Total emission of cadmium in 1990 was 5.3 t. The same emission in 2005 was 1.8 t (-66.8 % compared to 1990). The emission of cadmium in 2020 was 1.3 t (-75.6 % compared to 1990). The emission of cadmium in 2019 was 1.3 t, which is year-on-year change -3.7 %. The most contributing sectors to the total emission are: NFR 1A4bi (52.0 %), 2C1 (9.2 %), 2G (9.1 %), 1A1a (8.3 %) and 2C6 (4,3 %) that make 83.0 % together.

II.3.3 Mercury (Hg)

Total emission of mercury in 1990 was 5.2 t. The same emission in 2005 was 3.3 t (-35.9% compared to 1990). The emission of mercury in 2020 was 2.0 t (-61.7 % compared to 1990). The emission of mercury in 2019 was 2.3 t, which is year-on-year change -11,8 %. The most important is the sector NFR 1A1a (43.3 %), followed by 1A4bi (14.3 %) and 1A2a (9.3 %), other sectors are below 10 %.

III. Energy (NFR 1)

The date of the last edit of the chapter: 15/03/2022

This sector includes all combustion emissions (stationary and mobile). Furthermore, it includes fugitive emissions from the energy sector. The emission data from this sector are based on operator-reported emissions or on calculations.

Stationary sources operators listed in Annex 2 of Act 201/2012 Coll. are obliged not to exceed the emission limits set and fulfil 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_X, NO_X, TSP and CO and depend on rated thermal input and type of fuel used (Tier 3). The PM_{10} and $PM_{2.5}$ emissions are determined on base of information on abatement equipment and type of fuel. The ammonia emissions are calculated using emission factors (equipment below 5 MW input) and at some sources with $DeNO_X$ technology reported by source operator. 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 are calculated using the emissions reported in the nearest year and activity data (own emission factors). Emissions of pollutants that are not reported are calculated from activity data (total annual amount of energy input in TJ) and emission factor in mg/GJ. The total annual amount of energy input is calculated from fuel consumption and net calorific values; they are also reported by operators in summary operating records. Czech emission factors are predominantly based on either own measurements, and partly taken from the EMEP/EEA EIG, (Tier 2) [3].

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 and activity data of national statistics [3].

The sectors are the most important sources in key category for emissions of: SO_X (NFR 1A1a – 39.4 %, NFR 1A4bi – 21.6 %), NO_X (NFR 1A1a – 18.5 %, NFR 1A3bi – 14.9 %), NMVOC (NFR 1A4bi – 36.6 %), CO (NFR 1A4bi –66.9 %), TSP (NFR 1A4bi – 48.7 %), PM_{10} (NFR 1A4bi – 55.3 %), $PM_{2.5}$ (NFR 1A4bi – 71 %), Hg (NFR 1A1a – 43.3 %), Cd (NFR 1A4bi – 52 %), PCDD/F (NFR 1A4bi – 27.9 %, 1A2a – 20.9 %), PAHs (NFR 1A4bi – 98.1 %) and HCB (NFR 1A4bi – 74.9 %).

III.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 for production and processing of metals, raw materials, chemicals etc.

Information about combustion processes in sector of services (NFR 1A4ai), agriculture (NFR 1A4ci), military (NFR 1A5i) and household (NFR 1A4bi) are given in chapter III.2.

The criterion for source allocation to NFR 1A1a there is the nominal thermal input and classification NACE. NFR 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 plants (61 in 2020).

Emissions from facilities for waste incineration with heat recovery are allocated also in this sector according to good practice (EMEP/EEA EIG, see chapter VI.4.1) [3].

NFR 1A1b includes fuel combustion in boilers and process furnaces on the production unit. NFR1A1c covers fuel combustion in boilers and coal heat treatment (namely coke ovens, briquetting plants, and drying). NFR 1A3e includes only emission from gas transport.

Distribution of the combustion sources into NFR 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. These are than in a specific way divided among NFR categories of sources where processing combustion – processing heating etc. take place. In the e-ANNEX is placed link between NFR category and classification pursuant Czech legislation (technological sources with combustion of fuel only significant changes in allocation emissions of NO_X, CO (or other emissions from fuel combustion) were newly made in connection of controls performed by TERT. These emissions were in the most cases transferred from NFR categories 2A and 2C to 1A2f, 1A2a or 1A2b. This also applies to NO_X and CO emissions from electric furnaces (especially in the production of glass, cast iron and non-ferrous metals). NFR 1A2f includes HCB emissions from sintering belts (NFR 2C1 Iron and steel production). Another emissions from sintering belts (also for NO_X, SO_X, TSP, Hg and PCDD/F) are reported by source operators, other reported emissions are calculated. In the calculation system, all emissions are classified in NFR 1A2a, because their distribution according to the NFR categories would be technically demanding in the Czech point sources inventory system and could lead to errors. For further detail please see e-ANNEX.

Development of fuel base for stationary sources divided into aggregated sectors (GNFR) in period 1990–2019 is illustrated below in Fig. III.1 to Fig. III.3.

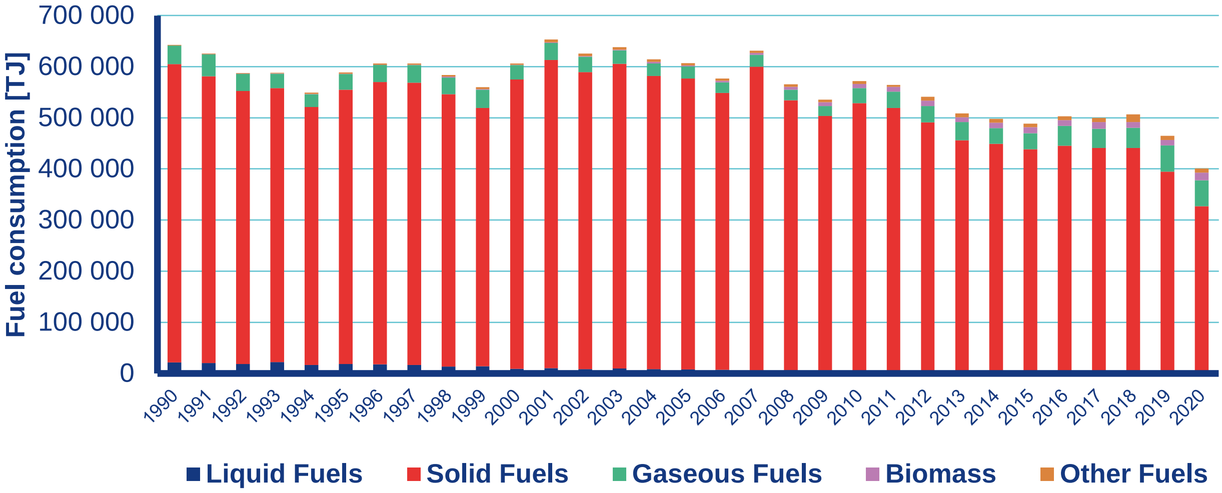

Fig. III.1 Fuel consumption for GNFR sector A_PublicPower, 1990–2020

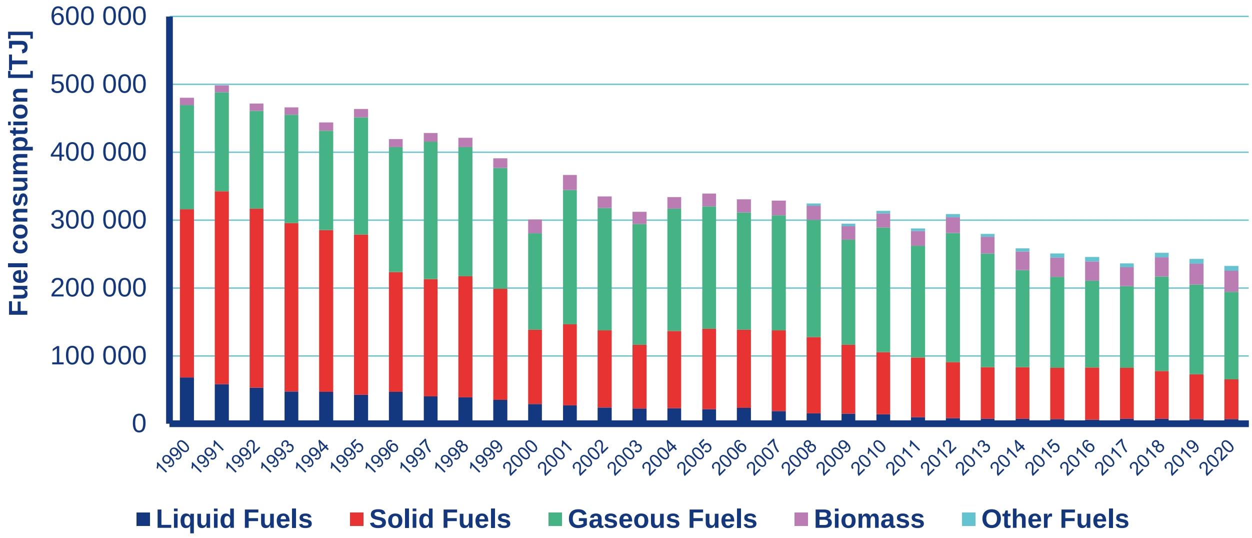

Fig. III.2 Fuel consumption for GNFR sector B_Industry, 1990–2020

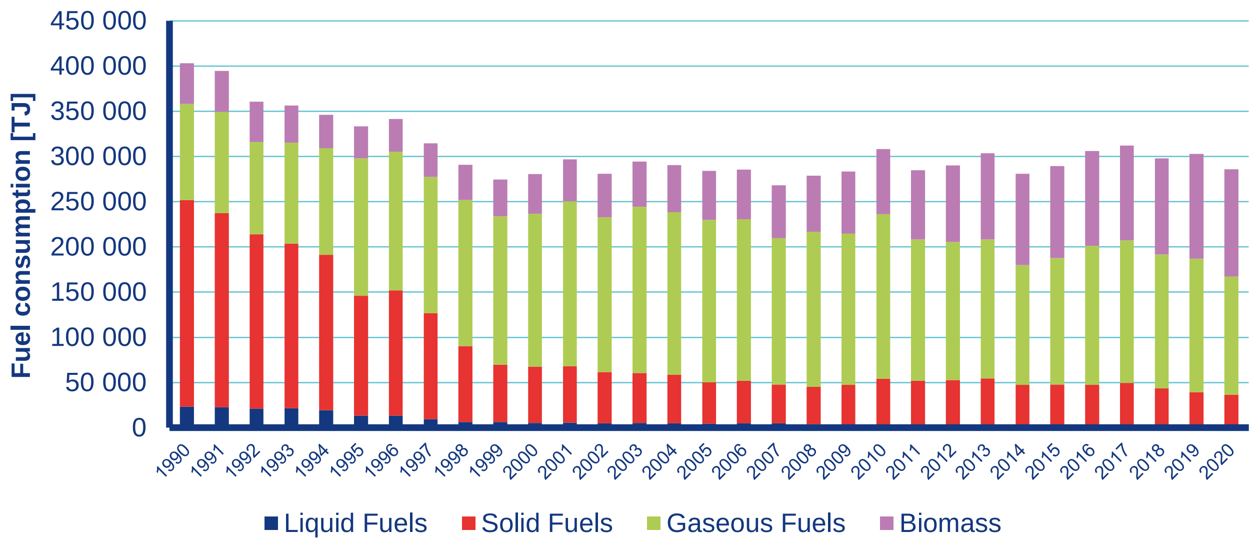

Fig. III.3 Fuel consumption for GNFR sector C_OtherStationaryComb, 1990–2020

Since the 1990s Czech refineries underwent rapid development due to increasing production capacities as well as the need to meet ever more restrictive requirements of environmental legislature. The development of crude oil consumption is presented in the chart below (Fig. III.4).

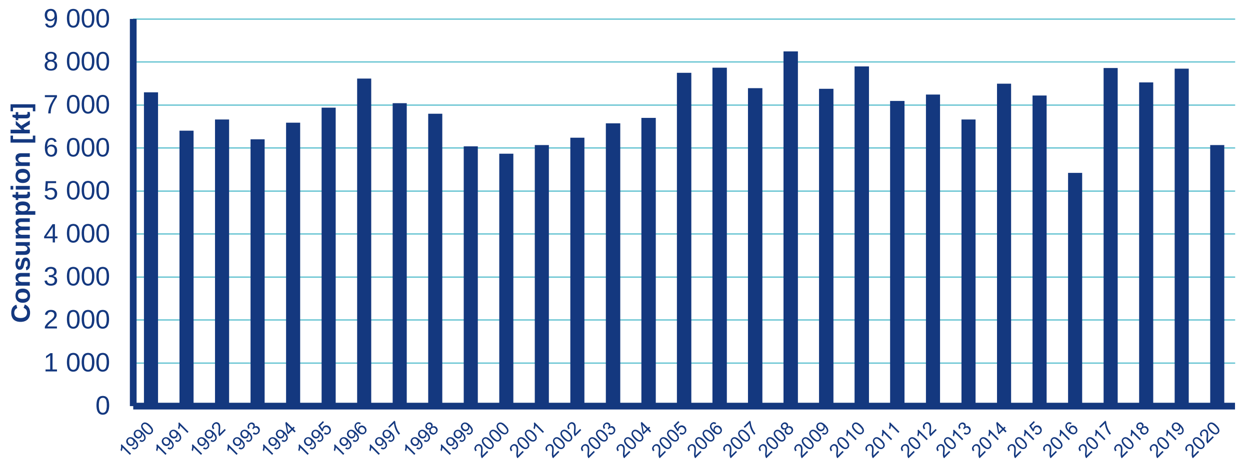

Fig. III.4 Crude oil consumption, 1990–2020

Crude oil refining is essential to the economy of Czechia, 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. Distribution of emissions from processes operated in refinery Litvínov and follow-up emissions from petrochemical processing of petroleum products was revised and transfers of SO_X, NO_X and NMVOC emissions were made in some years between NFR1A1b, 1A2c, 1B2aiv, 1B2c and 2B10a. For further detail please see e-ANNEX.

There is only one technology for coal gasification in Czechia in former town gas facility Sokolovská uhelná near a lignite mine. Generator gas after purification is combusted for power generation. In Ostrava region there are three coke plants in operation, producing mainly metallurgy coke.

Sources for district heating with rated thermal input from 0.3 MW and less 50 MW are included in NFR 1A4ai (Commercial/institutional: Stationary) and 1A4ci (Agriculture/Forestry/Fishing: Stationary).

III.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 (app. 70 %) and pulverized hard coal (app. 10 %), 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 e-ANNEX). 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 installation 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 NFR 1A2a the TSP and PMs emissions lowered significantly since 2016 due to installation of modern bag filters. In the e-ANNEX there are placed EFs for calculation of HMs, POPs and NH_3 emissions.

Specific calculation is performed for emissions of NFR 1A1c. Based on the TERT recommendation, emissions of PAHs from coke production (heating of coke oven batteries and other combustion sources related to the of solid fuels transformation) originally reported by operators were newly recalculated. The procedure of calculation recommended in research report (KONEKO marketing, spol. s r.o., Ing. Neužil) is described in e-ANNEX.

III.1.2 Uncertainties and QA/QC procedures

According to national legislation, emissions for large stationary sources belonging to NFR 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 I.7 General uncertainty evaluation

QA/QC for NFR 1A1a is the same as in case of other stationary point sources, see also chapter I.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_X, NO_X 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_X (as SO_2), NO_X (as NO_2) and TSP emission outlier test:
- significant difference in reported and expected SO_X (as SO_2), NO_X (as NO_2) and TSP emissions,
- consistency with emission trend at national level

III.1.3 Planned improvements

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

III.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 - self-employment, 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. Military combustion sources are allocated in NFR 1A5a. The methodology for NFR 1A4ai and 1A4ci is the same as in the case of NFR 1A1a (see chapter III.1). Natural gas consumption in NFR 1A4ai with thermal input below 0.3 MW is calculated as subtraction of natural gas consumption of all individually and collectively monitored sources from total natural gas consumption in Czechia (data obtained from the CZSO).

Residential sources in NFR 1A4bi belong among collectively monitored sources and they are described in the next part of chapter. NFR 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 (Fig. III.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 [7]. 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[8]. 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 (e-ANNEX), structure of combustion equipment in households, share of wet wood combustion and other parameters had been discovered by statistic census ENERGO 2015. The overview of combustion equipment structure in period 1990–2020 was prepared by combination these results with other statistics (SLDB, ENERGO 2004, sales of boilers).

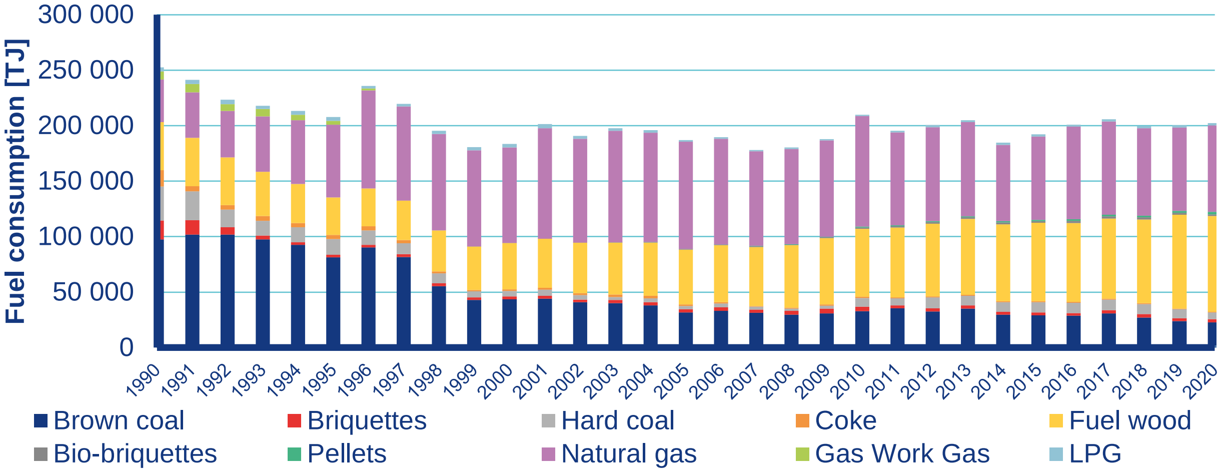

Fig. III.5 Fuel consumption in sector local heating of households, 1990–2020

Tab. III.1 Distribution of solid fuel consumption according type of heating equipment in 2020

Installation type / fuel type	Year	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves/fireplaces
				[%]		
Brown coal	2019	23	31	32	8	5
	2020	23	31	33	9	5
Briquettes	2019	53	22	6	4	14
	2020	53	22	6	5	14
Hard coal	2019	53	15	22	6	5
	2020	52	15	23	6	5
Coke	2019	88	9	1	0	2
	2020	88	9	1	0	2
Wood - dry	2019	31	18	4	18	29
	2020	31	17	4	19	29
Wood - wet	2019	32	14	3	12	38
	2020	32	14	3	13	38
Bio-briquettes	2019	17	9	5	10	59
	2020	17	9	5	11	59
Pellets	2019	1	1	55	0	44
	2020	0	1	56	0	43

III.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). Based on the EMRT review, the EFs of Hg for solid fuels were newly taken over from EMEP/EEA EIG and the emissions were recalculated for all years[3].

Emission factors for other fuels were taken over from EMEP/EEA EIG 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.

Significant recalculation was performed for NMVOC emissions from residential heating. The preceding emission factor stated only for emissions of organic compounds expressed as TOC including also CH_4 emissions, was recalculated. For further detail please see e-ANNEX.

III.2.2 The condensable component of PMs emissions

Detailed description in chapter I.4.3. The table of the condensable component is given in e-ANNEX.

III.2.3 Uncertainties and QA/QC procedures

The chapter will supplied later.

III.2.4 Planned improvements

The proportion of wood moisture enters the calculated emissions of PM_{10}, $PM_{2.5}$ and TSP. This share was changed for 2019, 2020 and projections for the following decade. As there is a presumption that the long-term education regarding wood storage and the use of heating equipment has been relatively successful. As the subsequent use of heating equipment was more efficient, it caused lower wood consumption, higher calorific value, and therefore more heat supplied, but also lower emissions.

Based on this assumption as specified in Tab. III.2 the moisture ratio for wood heating has changed and for 2020 the ratio for dry wood is 75% and for wet wood is 25%.

Tab. III.2 Wood ratio

Wood	2020	2025	2030	2035	2040
[%]					
Dry	75	70	75	80	85
Wet	25	30	25	20	15

Emission changes - decline

In 2020, we can observe a decrease in emissions, which was also caused by the replacement of heating equipment. Compared to 2019, the consumption of solid fuels also decreased, by approximately 9%. In 2020, gaseous fuels were used to a greater extent, 3.5% more than in 2019.

III.3 Transport (NFR 1A3)

III.3.1 Road transport emissions (NFR 1A3b)

The chapters III.3.1, III.3.2, III.3.3 and most of III.3.5 were prepared by CDV. VUZT prepared chapter III.3.4 (Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery). Criteria of sorting means of transport are the type of transport, the fuel used and the emission standard that a particular vehicle must meet (in road transport). Categories of vehicles are not so detailed for non-road transport and mobile sources.

Activity data and main emission factors for all subsectors are displayed in the figures below. National EF is noted as country specific (CS).

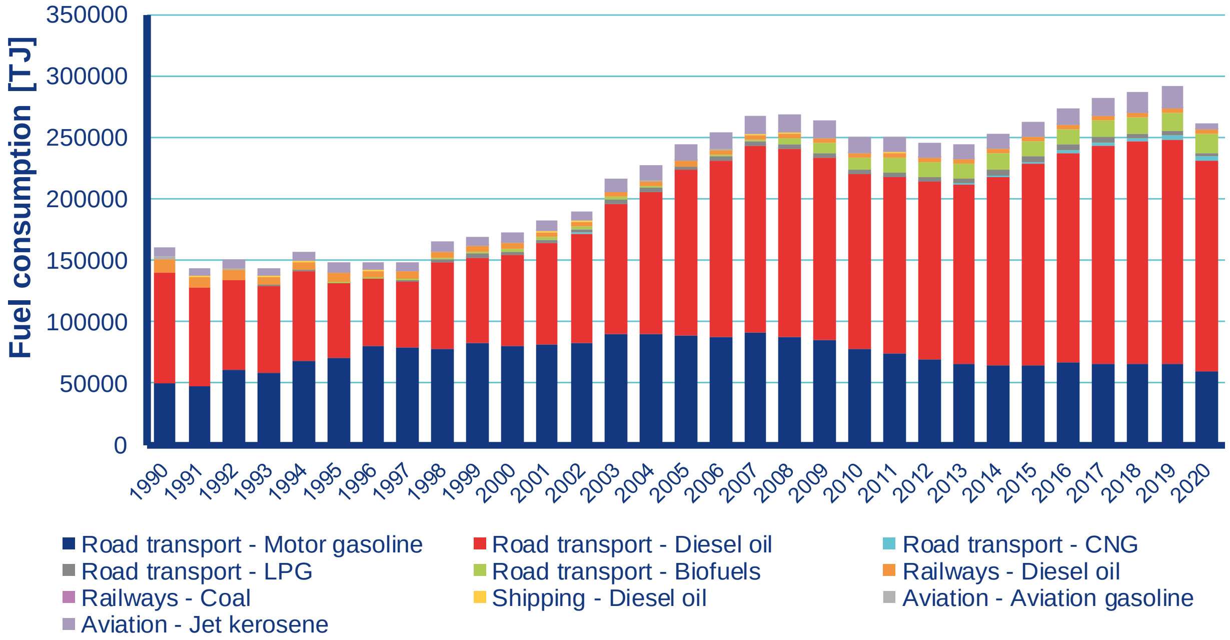

Fig. III.6 Annual fuel consumption by all modes of transport, 1990–2020

The chapter III.3.1 presents the most significant category: emissions from road transport in Czechia. Estimations were made for the following vehicle categories: passenger cars (PCs), light duty vehicles (LDVs), heavy duty vehicles (HDVs), buses and motorcycles (MCs). For calculation purposes, the vehicle categories were broken down by the type of fuel and EURO norms according to COPERT 5 categories.

Since 2005, emissions of NO_X (as NO_2), NMVOC, $PM_{2.5}$ and others from road transport have sharply decreased 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 sharply lowered especially because of the introduction of the EURO 3 standard in 2000.

In 2020, there was a significant reduction in transport emissions as a result of the COVID-19 pandemic. The drop in emissions was caused by the substantial decrease in activity for all modes of transport, and particularly affected aviation. Consumption of jet kerosene in aviation was almost 73 % lower than in 2019, consumption of aviation gasoline dropped by 33 % in 2020. Decrease of fuel consumption in road transport was the highest for LPG (by 16 %) and motor gasoline (by 9 %) in 2020. On the contrary, the consumption of biofuels in road transport increased by almost 10 %, CNG consumption slightly rose as well (by 2 %).

Overall view and basic information about subcategories in road transport are given in the chapter below. More detailed information about particular subcategories is given in the respective 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 to assign a relevant emission factor. NFR 1A3b Road Transport is split into seven subsectors:

- 1A3bi Passenger Cars
- 1A3bii Light Duty Vehicles
- 1A3biii Heavy Duty Vehicles
- 1A3biv Mopeds & Motorcycles
- 1A3bv Gasoline Evaporation (see chapter III.3.2)
- 1A3bvi Automobile tyre and brake wear (see chapter III.3.2)
- 1A3bvii Automobile road abrasion (see chapter III.3.2)

III.3.1.1 Methodology and results

Methodology for the calculation of emissions from road transport is based on COPERT 5 model on Tier 3 level. The basis of 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 only a brief summary. Full description of COPERT 5 program is to be found here: https://www.emisia.com/utilities/copert/documentation/. COPERT 5 is based on EMEP/EEA EIG [3]. Full methodology of application of COPERT 5 in CZ is described in Pelikán, Brich 2017 and Pelikán, Brich 2018 [9].

Activity data

AD for the COPERT program are gained from two large databases - Czech Car Registry (CCR) and 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 annually define traffic performance for a particular car. By combining these two databases it is possible to obtain number of vehicles, average annual mileage and average total mileage for all 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 it is necessary to recalculate those four years backward repeatedly. For recent submission it was 2016 – 2019. This calculation procedure was developed by Brich in 2014, and this methodology was certified by MoT [10]. COPERT uses these AD to calculate fuel consumption in all categories. Fuel consumption in categories is normalized with the help of total fuel consumption provided by CZSO.

Changes in input COPERT data are mentioned in III.1.2, which is mainly focused on the following topics:

- Description of changes in newly used COPERT 5.5 version (emissions were calculated in 5.3 version previously)
- Changes due to analyses of Czech Car Registry and Database of Technical Control Stations
- Changes due to updated activity data from CZSO

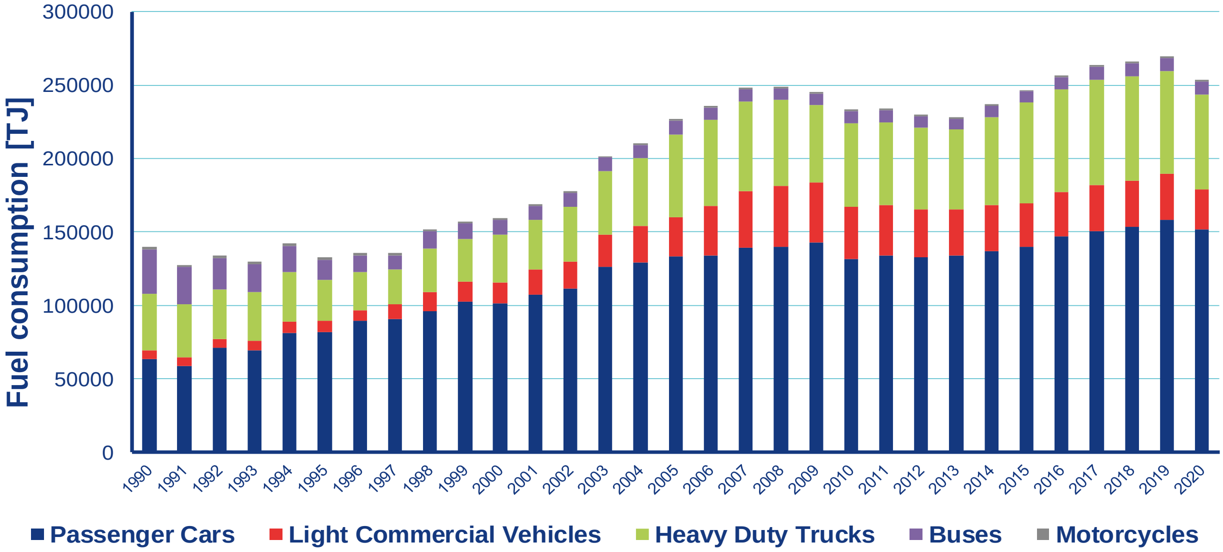

Fig. III.7 Annual fuel consumption by road transport, 1990–2020

Fig. III.7 shows trends in fuel consumption 1990–2020 by particular vehicle categories. General rising trend of fuel consumption by PCs and LDVs is in line with general trend in the whole Europe. There is an obvious influence of the economic crisis between 2008 and 2013 on 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 2003 to 2009, but it started to significantly decline since 2010. It even reached a value 64 650 TJ in 2014. This decline was especially caused by the downward trend in average fuel consumption of modern passenger cars. Since then, gasoline fuel consumption has been fluctuating around 66 000 TJ. Exception is year 2020 influenced by COVID situation, when gasoline consumption was 59 807 TJ.

Fuel consumption of diesel was steadily growing from 2000 until 2008. Steep increase began after 2013 and was related to economic growth and growing popularity of diesel PCs. The year 2020 was influenced by COVID situation and diesel consumption was 171 355 TJ.

Till 2008, bioethanol was almost not used in Czechia and biodiesel was only used 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. 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. Both values are going to remain unchanged in the coming years. Share of biofuels in fossil fuels was increasing too (6.8 % in 2010 and 8.5 % in 2015). After 2015, you can see an increase in consumption of biodiesel. Lower taxes for blends with high percentage of biodiesel were implemented in 2015, but customers slowly accepted this change. Biodiesel fuel consumption was steadily increasing even in 2020 (12 839 TJ). Bioethanol shows no specific long-term trend. The highest consumption of bioethanol was before COVID in 2019 (3 051 TJ). It decreased to 2 754 TJ in 2020. However, the total consumption of biofuels (15 593 TJ) was almost 10 % higher in 2020 than in the previous year.

CNG buses have been used in Czechia from 1994. Use of CNG PCs started after the year 2000. The steep increase of the CNG consumption from 2012 has been caused by subsidies from public resources in order to encourage the use of CNG buses especially. Other subsidies have been determined to CNG LDVs and PCs which have been used by local authorities. CNG consumption continued to increase in 2020 (3 171 TJ). Consumption of LPG was continuously growing until 2016. After 2016, there has been a slight decrease most likely caused by low prices of diesel and gasoline and less subsidies for LPG vehicles in CZ. LPG consumption reached 3 400 TJ in 2020.

Emission factors

Emission factors are based on COPERT 5 model on Tier 3 level. COPERT methodology is in line with EMEP/EEA EIG [3].Generally, EFs are composed of 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 which are final EFs composed of (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
- Tyre, brake and road abrasion – PMs, heavy metals
- Emission factors from lubricant consumption – relevant for SO_X and heavy metals
- Additional influence of A/C – relevant for SO_X and heavy metals
- Mileage degradation – relevant for NO_X (as NO_2), CO and NMVOC

Emissions

Emissions were calculated on the basis of the total consumption in all COPERT vehicle categories which are relevant in CZ. COPERT separately calculates emissions from hot engines, cold engines, emissions originated 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 Czechia became evident during the ‘90s and this trend continued until 2007. Individual road and freight transport made 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_X 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 PMs emissions from fuel combustion is decreasing because of technical development. In brake, tyre and road abrasion, technical development is not so progressive and emission production is more dependent on vehicle activity. Pb is strongly dependent on fuel consumption and its content in fuel. General overview of the emission trends, emissions of NO_X, NMVOC, PMs and CO for the road transport are presented in the figures below for the entire period 1990–2020.

NO_X (as NO_2) emissions were decreasing until 2002 (see Fig. III.8). The increase of emissions after this year was related to economic growth and shift from gasoline to diesel passenger cars and light duty vehicles and increase of 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 improvement of NO_X (as NO_2) reduction technologies stopped increase of NO_X (as NO_2) emissions especially in PCs subcategory. From 2005, overall NO_X (as NO_2) emissions were decreasing because of a less intense increase of traffic performance in all modes of transport except for diesel passenger cars. In 2016, steep decrease of NO_X (as NO_2) emissions was stopped because of economic growth and lower prices of fuels compared to previous years. After 2018, we can see decrease in NO_X (as NO_2) emissions caused by decrease of traffic performance by LDVs, HDVs and buses. Generally, the main emitters of NO_X (as NO_2) emissions are diesel passenger cars and heavy duty vehicles.

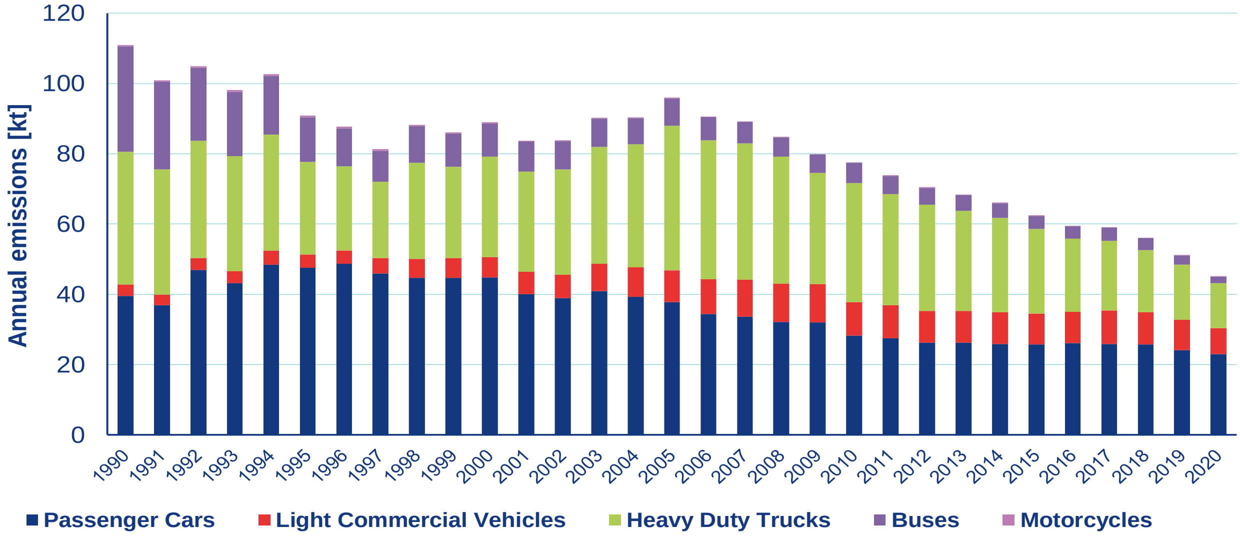

Fig. III.8 Annual emissions of NO_X by road transport, 1990–2020

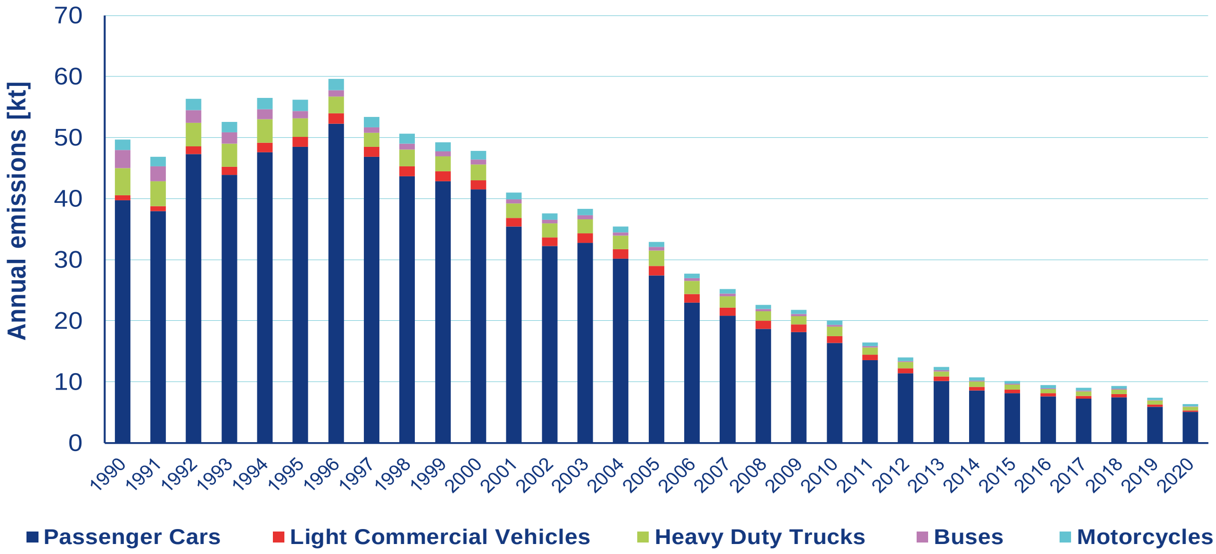

Fig. III.9 Annual emissions of NMVOC by road transport, 1990–2020

Fig. III.9 shows constantly decreasing trend in NMVOC exhaust emissions after 1996 mainly related to decrease of traffic performance of gasoline fuelled cars and enhancement of 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. Especially 2-stroke 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 motorcycle fleet in CZ was quite old especially in the ‘90s. The main cause of more significant decrease of NMVOC exhaust emissions after 2018 is a decrease of traffic performance of the largest emitters – petrol fuelled vehicles in general. NMVOC exhaust emissions continued to decrease in 2020.

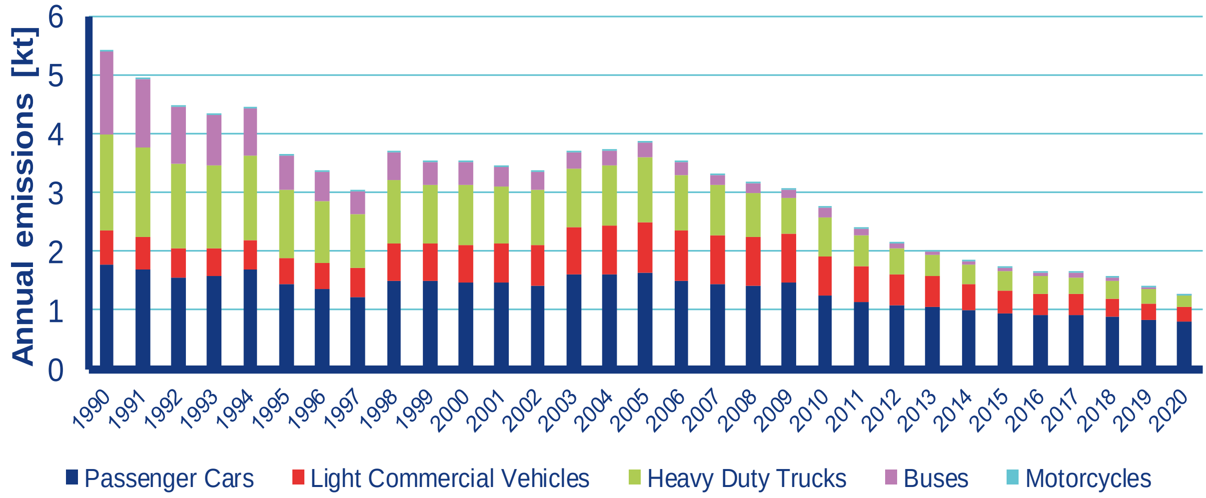

Fig. III.10 Annual emissions of $PM_{2.5}$, PM_{10} and TSP by road transport – exhaust emissions, 1990–2020

Fig. III.10 represents exhaust emissions of particulate matter. In road transportation, all PMs emissions are considered as $PM_{2.5}$ because of the technology of combustion which mostly emits this type of PMs. PMs 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 PMs. At present, the main emitters of PMs are passenger cars. In '90s, passenger cars, light duty vehicles, heavy duty vehicles and buses were approximately on the same level. Due to enhancement of particulate filters technologies and lower pressure of exhaust gases in HDVs, buses and partly in LDVs engines, the share of PMs emissions from these categories has been significantly decreasing especially after 2010. In case of buses, low PMs production has been influenced by significant subsidies from public resources to encourage the use of CNG buses after 2012. In 2020, we can see decrease in PMs exhaust emissions caused by the continual modernization of car fleet as well as by the decrease of traffic performance for all categories, but especially for HDVs, buses and motorcycles due to COVID situation.

Fig. III.11 shows a steady downward trend in CO emissions for all categories since 1997. Trend in emission production before this year is unsteady – dependent on changing traffic performance, economic and political situation. Lowering emission production is mostly related to the modernization of the car fleet in CZ and removing old passenger cars (Pre-Euro). Another factor is decrease of traffic performance of gasoline cars which are the main emitters of CO. Combustion in 2-stroke engines produces extremely high emissions of CO and motorcycles doesn't have such advanced emission control technologies which cause a relatively big share of CO production compared to traffic performance. The next reason is that motorcycle fleet in CZ was quite old especially in '90s. 4-stroke motorcycles have much lower emission production and their growing share in motorcycle fleet has improved emission behaviour of motorcycle category in the last years.

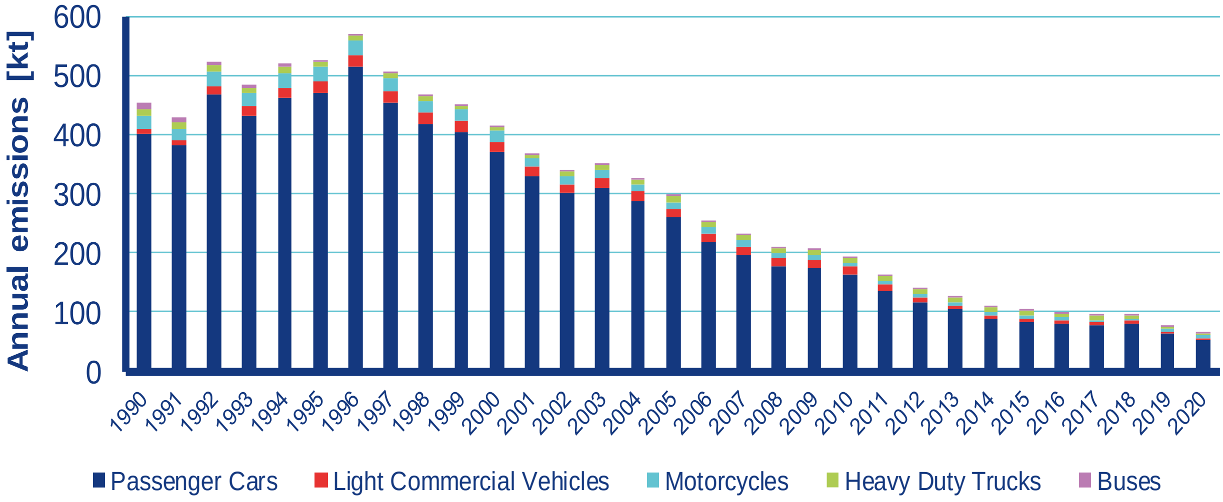

Fig. III.11 Annual emission of CO by road transport, 1990–2020

III.3.1.2 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)

Activity data

General rising trend of fuel consumption by PCs is in line with general trend in the whole Europe (see Fig. III.12). In 2007, the economic crisis started in Czechia and influenced overall fuel consumption. The decrease of fuel consumption stopped in 2012. With a renewal of economic growth, it started to increase again. In 2014, the overall fuel consumption reached the same level as it had been usual in years before the crisis. Decrease in gasoline consumption was the most significant. Decrease of gasoline consumption stopped in 2015. The following years it fluctuated around 65 000 TJ until 2020 when it dropped just under 60 000 TJ. Diesel oil consumption wasn’t so much influenced by the economic crisis, nor by COVID situation in 2020. It has been steadily increasing since 1997 and reached almost 87 000 TJ in 2019 and 2020. Fig. III.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 the lower price of diesel oil (especially in the warm part of the year) compared to petrol cars.

From 2008, biofuels started to be used on a larger scale in Czechia. Till then, there was almost no bioethanol used here and biodiesel was only used in a very small share. The consumption of biofuels by passenger cars has been steadily increasing since 2008. It exceeded a value 8 000 TJ in 2020. CNG started to be used in Czechia from 2002 but a rise in the use of this fuel dates back to 2008. There has been a significant increase of CNG share from 2012. Still, the share of CNG on fuel consumption is really small (1 463 TJ in 2020).

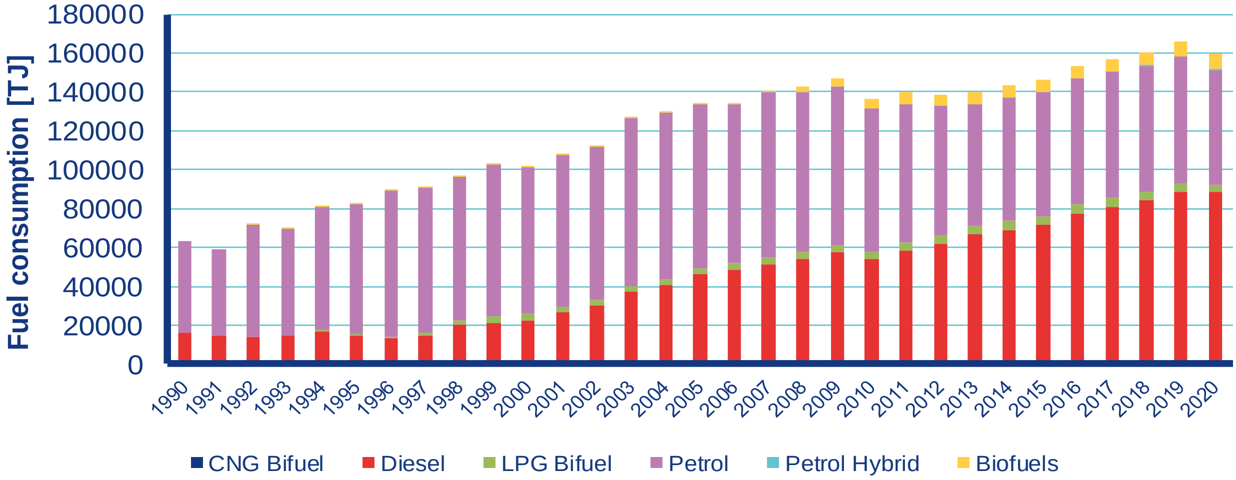

Fig. III.12 Annual fuel consumption by passenger cars, 1990–2020

Emission factors

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

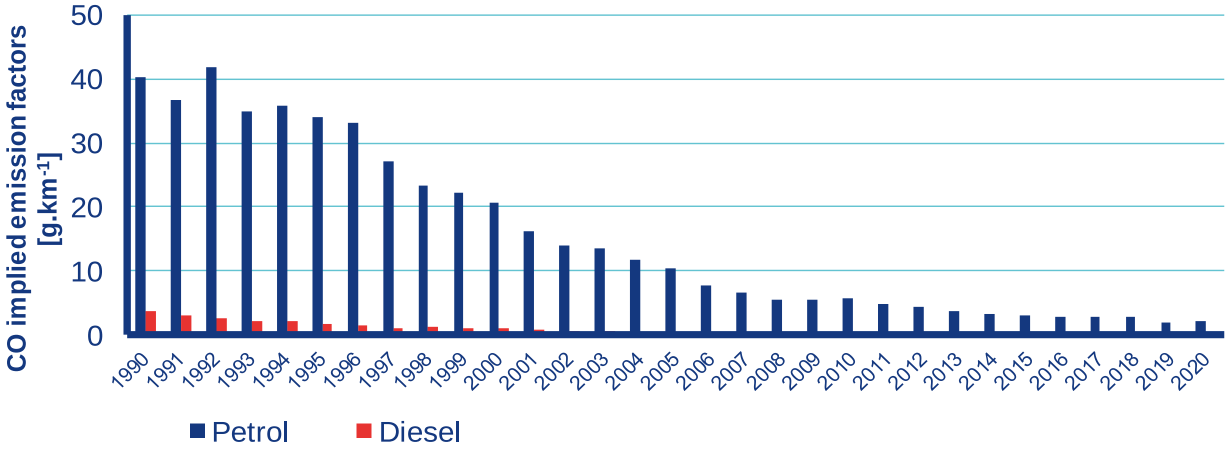

Fig. III.13 Implied emission factors of passenger cars for CO, 1990–2020

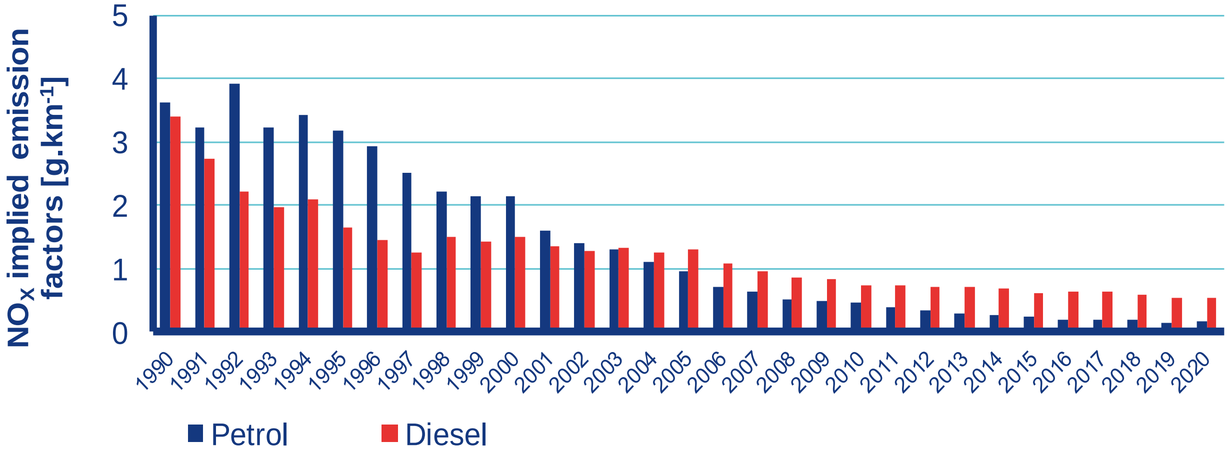

Fig. III.14 Implied emission factors of passenger cars for NO_X (as NO_2), 1990–2020

Emissions

Emissions values of all pollutants can be easily found in national inventory files (NFR) available at EMEP Centre on Emission Inventories and Projections website. Brief description of emissions of pollutants in road transport is stated in chapter III.3.1.1 (Emissions).

III.3.1.3 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 and overall fuel consumption are briefly described in the chapter III.3.1.1 (Activity Data). The most important fuel is diesel oil which share is more than 90 % in the whole time series 1990–2020.

LDVs emissions of all pollutants can be easily found in national inventory files (NFR). Brief description of NO_X, NMVOC and PMs from LDVs subcategory is stated in the chapter III.3.1.3.

Implied EFs of NO_X (as NO_2), for which subcategory of LDVs is a key category, are displayed in the III.1.3. Emission factors are based on the COPERT model on Tier 3 level. Implied EFs for the most important fuels were extracted from COPERT program.

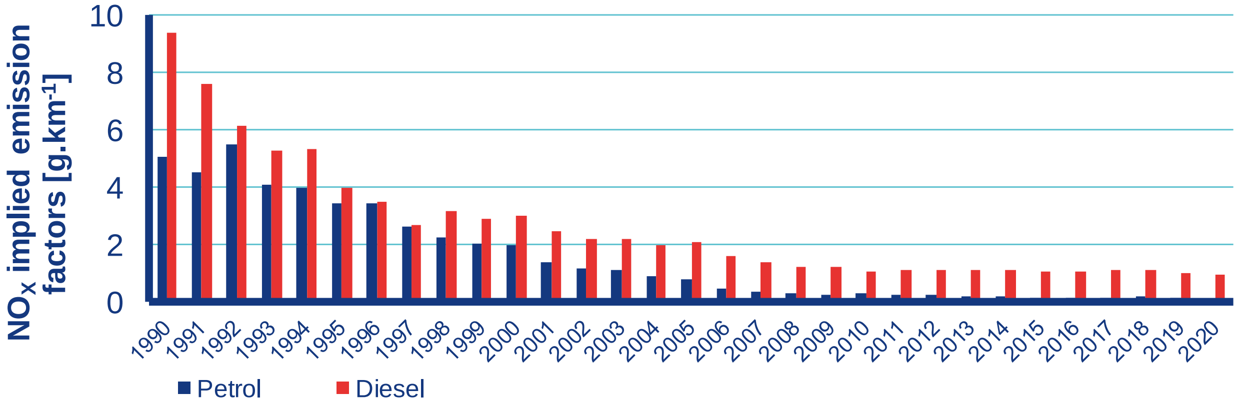

Fig. III.15 Implied emission factors of light duty vehicles for NO_X (as NO_2), 1990–2020

III.3.1.4 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 and overall fuel consumption are briefly described in the chapter III.3.1 (Activity Data) . The most important fuel is diesel oil which share is more than 99 % in the whole time series 1990–2020.

HDVs emissions of all pollutants can be easily found in national inventory files (NFR). Brief description of NO_X, NMVOC and PMs from HDVs subcategory is stated in the chapter III.3.1.1 (Emissions) .

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

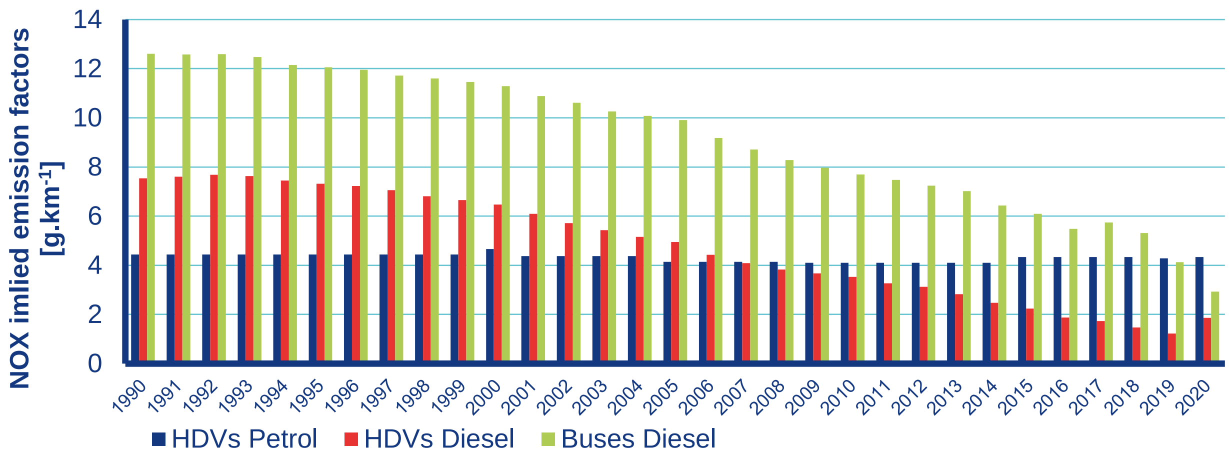

Fig. III.16 Implied emission factors of heavy duty vehicles and buses for NO_X (as NO_2), 1990–2020

III.3.1.5 Mopeds and Motorcycles (1A3biv)

Activity data of motorcycles subcategory and overall fuel consumption are briefly described in the chapter III.3.1.1. The only fuel used 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 PMs from L-subcategory is stated in the chapter III.3.1 (Emissions). Motorcycles are not stated as a key category for any pollutant, therefore there is no detailed description of implied emission factors in this chapter.

III.3.2 Gasoline evaporation and abrasion (NFR 1A3bv, 1A3bvi and 1A3bvii)

NMVOC emissions in the subcategory 1A3bv of road transport were estimated by the model COPERT in Tier 3 mode. Gasoline evaporation was taken into consideration. To estimate these emissions, statistical data regarding the number of vehicles with or without emission control were taken 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.

For the calculation of emissions from tyre, brake and road abrasion model COPERT 5 was used. Tier 2 methodology was applied because no Tier 3 method has been developed yet.

III.3.2.1 **Emission factors and calculations**

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

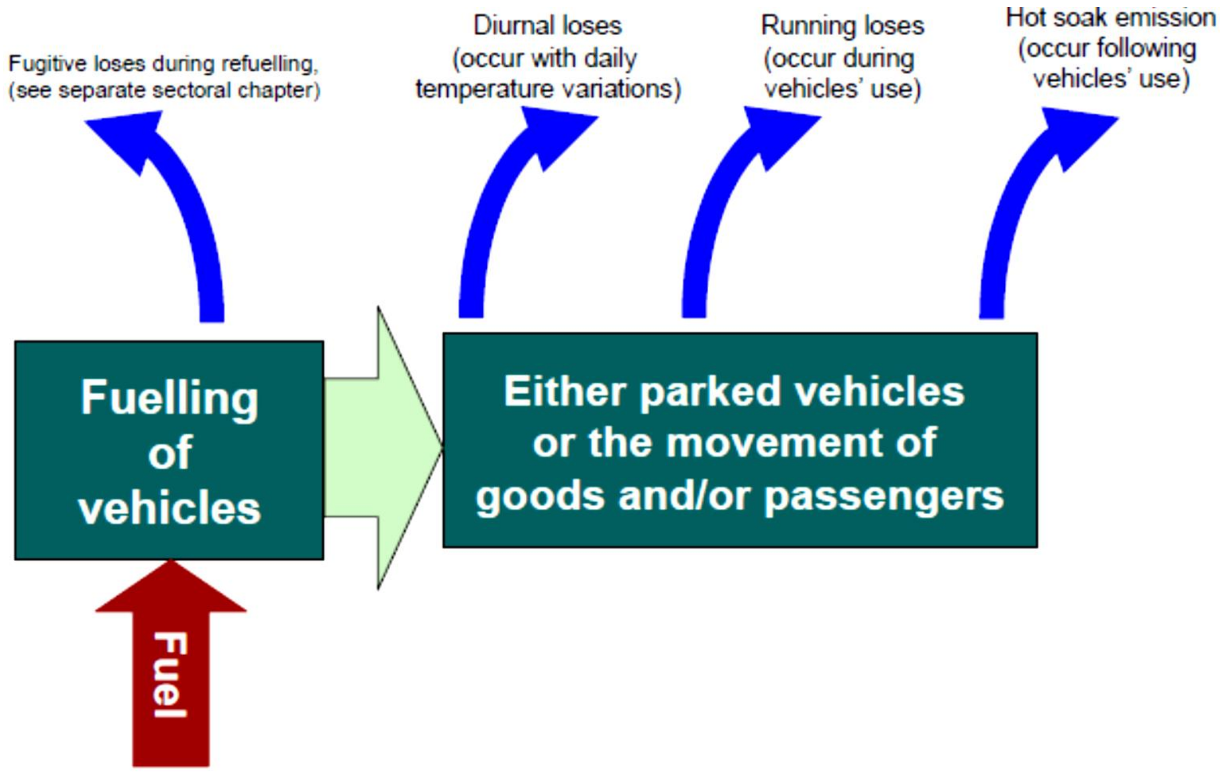

Fig. III.17 Processes resulting in evaporative emissions of NMVOC (source: EMEP/EEA EIG 2019)

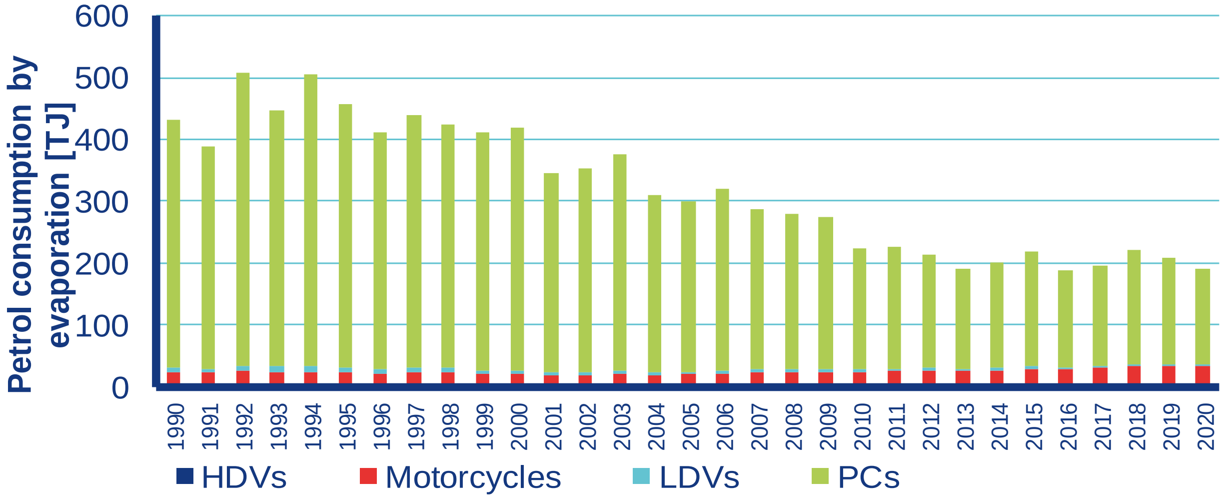

Fig. III.18 Annual petrol consumption by evaporation in relevant subcategories, 1990–2020

Key activity data for abrasion are only traffic performance of car fleet in Czechia (see Fig. III.19). The development of traffic performance after 1990 and its decrease due to the economic crisis is clearly seen in the graph below. After 2013, traffic performance started to increase in a steep way again. The increase stopped in 2020 because of COVID situation.

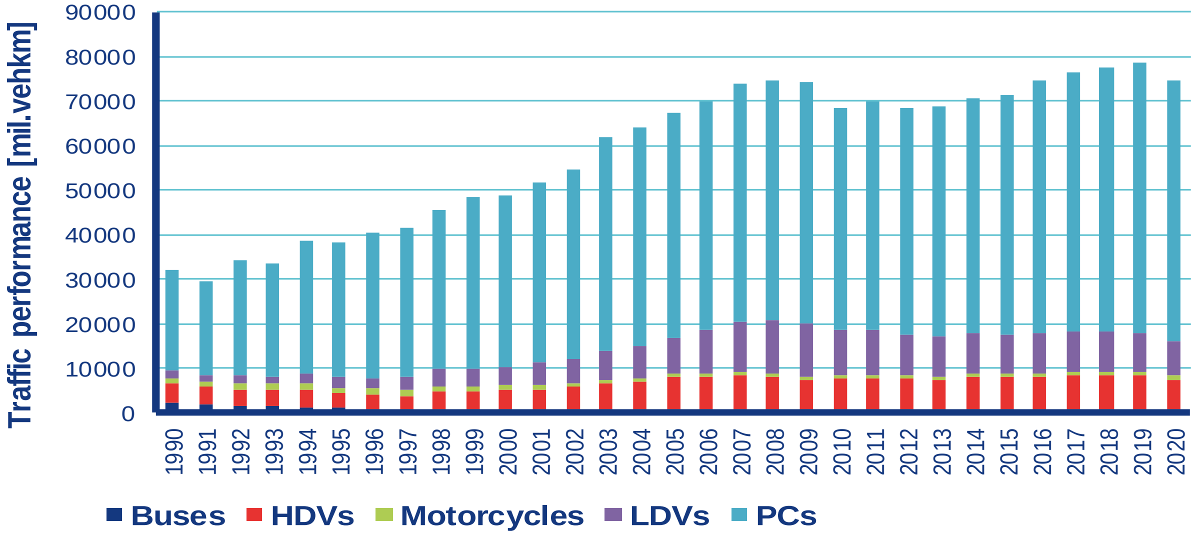

Fig. III.19 Annual traffic performance in relevant subcategories, 1990–2020

Implied EFs of pollutants from tyre, brake and road abrasion (PM_{10} and Pb), are presented in this chapter. Emission factors are based on the COPERT model on Tier 2 level. Implied EFs for all vehicle categories were extracted from COPERT program (see Fig. III.20 and Fig. III.21).

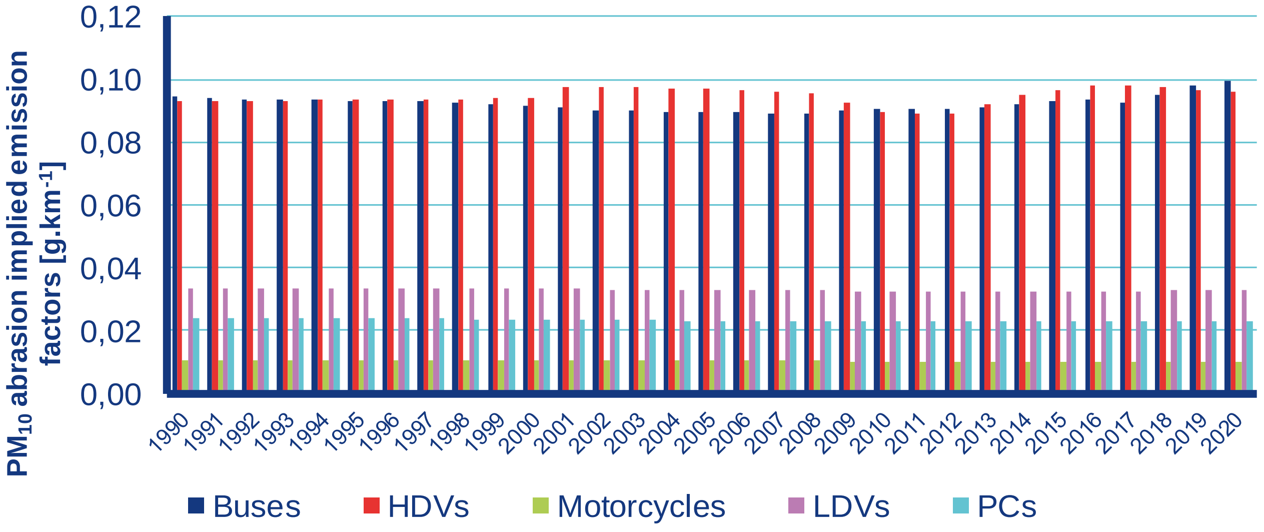

Fig. III.20 Implied emission factors from tyre, brake and road abrasion for PM_{10}, 1990–2020

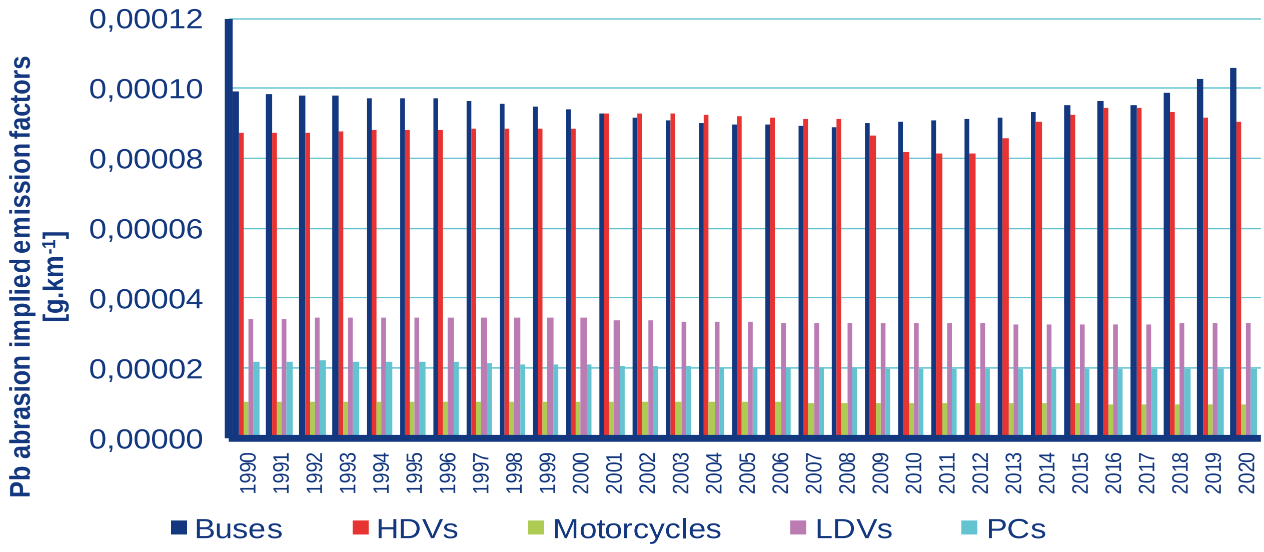

Fig. III.21 Implied emission factors from tyre, brake and road abrasion for Pb, 1990–2020

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

III.3.2.2 **Planned improvements**

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

III.3.3 Non-road transport (NFR 1A3a, 1D1a, 1A3c, 1A3d)

This chapter contains information about emissions from aviation, railway and inland navigation. Emissions from pipeline transport (NFR 1A3e) are listed in chapter III.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 altitude and horizontally with air masses. In NFR 1A3a and 1D1a, emissions of both national (domestic) and international civil aviation are reported with the 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 and helicopters used for public and private purposes are also included in this category.

The Czech railway sector is undergoing a long-term modernization process. The aim is to make electricity the main energy source for rail transport. 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 navigation includes goods transport on navigable parts of rivers (Vltava, Labe) and leisure boats on rivers, channels and reservoirs.

III.3.3.1 Emission factors and calculations

Civil aviation

For IFR flights in time series 2005 to present year, bottom-up data from EUROCONTROL were used. Time series 1990–2005 was estimated by extrapolation of EUROCONTROL fuel consumption with the help of fuel consumption from CzechOil questionnaire provided by CZSO. Emissions were calculated with EUROCONTROL implied emission factors.

For VFR flights, ratio between LTO a CRUISE was obtained from ÚCL as their expert judgement because there is no database in CZ for VFR flight characteristics. These ratios and EFs were applied on fuel consumption obtained from CZSO. Fuel consumption for helicopters was obtained from CZSO. Ratio between LTO and Cruise from ÚCL. EFs according to table 3.10. in EMEP/EEA EIG were applied on fuel consumption VFR flights [3]. Helicopters' fuel consumption has been approximately 1 kt of kerosene (based on CZSO estimation) from 2007 until present. EFs according to table 3.11. in EMEP/EEA EIG were applied on fuel consumption of helicopters. In addition, army air force emissions are included in aviation subsector. Activity data for military flights are based on CZSO estimate. Fuel consumption of jet kerosene used by military flights is reported from 2002. It has been fluctuating around 11 kt since 2015. EFs according to table 3.11. in EMEP/EEA EIG were applied on fuel consumption for army air force [3].

In order to ensure comparability of statistics, fuel consumption for aviation was fuel balanced on fuel consumption stated in CZSO for jet kerosene and aviation gasoline.

Tab. III.3 Ratio of fuel usage between LTO and Cruise flight mode

Subsector	Flight mode	Ratio
1A3a (IFR)	LTO	0.28
	CRUISE	0.72
1A3a (VFR, Helicopters)	LTO	0.90
	Cruise	0.10
1A3a (Army flights)	LTO	0.25
	Cruise	0.75
1D1a	LTO	0.12
	CRUISE	0.88

Activity data were gained from CZSO and EUROCONTROL. Data were divided between LTO and Cruise flight mode according to ratio which is stated in the Tab. III.3. Data for civil aviation and international aviation were gained from EUROCONTROL (IFR flights) and CZSO (VFR flights, helicopters and army flights).

Method for VFR flights, helicopters and army air force is on Tier 1 level. Main pollutants for IFR flights based on EUROCONTROL are on Tier 3 level. Other pollutants are still on Tier 1 level, even though the emission factors have been actualized according to the newest version of EMEP/EEA EIG [3]. Method of EFs for the most significant pollutants and their values are stated in Tab. III.4.

Tab. III.4 EF method used and EFs for the most significant pollutants for IFR domestic and international flights in the current year ($g.kg^{-1}$)

Subsector	Method CO	Method NO_X (as NO_2)	Method NMVOC	EF CO	EF NO_X (as NO_2)	EF NMVOC
Domestic Jet Kerosene LTO	Tier 3	Tier 3	Tier 3	0.00	11.41	3.78
Domestic Jet Kerosene Cruise	Tier 3	Tier 3	Tier 3	0.00	12.25	0.79
Domestic Aviation Gasoline LTO	Tier 3	Tier 3	Tier 3	927.25	5.07	22.51
Domestic Aviation Gasoline Cruise	Tier 3	Tier 3	Tier 3	1092.76	6.03	16.26
International Jet Kerosene LTO	Tier 3	Tier 3	Tier 3	9.29	14.25	1.72
International Jet Kerosene Cruise	Tier 3	Tier 3	Tier 3	2.66	14.73	0.39
International Aviation Gasoline LTO	Tier 3	Tier 3	Tier 3	967.15	3.50	16.02
International Aviation Gasoline Cruise	Tier 3	Tier 3	Tier 3	1181.87	4.25	21.03

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 (NFR 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 approximately 3 700 TJ per year because of the economic crisis and replacement of diesel-powered locomotives by electric ones. In 2020, diesel consumption was 3 136 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. From 2014 to 2018, there was used some lignite too (1 kt every year). Total coal consumption reached 8 TJ in 2020. These small fluctuations mean big percentual difference in emissions from solid fuels because of relative change ± 100 % of fuel consumption.

Emission factors have unit $g.kg^{-1}$ of fuel. Coal EFs are used according to the EMEP/EEA EIG for railways, which recommends using EFs from the chapter 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. Some emission factors (benzo[k]fluoranthene and indeno[1,2,3-cd]pyrene) are not stated in a corresponding EMEP/EEA EIG. According to the recommendation from the EMEP/EEA EIG, Tier 1 EFs for HDVs are used for railway purposes in case of missing EFs. For PM_{10} and $PM_{2.5}$, Tier 1 EFs are used according to EMEP/EEA EIG. 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. In Tab. III.5 there are presented EFs for the most significant pollutants produced by railways and their calculation methods. [3].

Tab. III.5 EF method used and EFs for the most significant pollutants for railways in the 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 $g.GJ^{-1}$

Navigation

Fuel consumption by national navigation is very low. The CZSO only provides data regarding diesel oil consumption within the recreational fleet, which basically represents most of the fuel consumption by national navigation in Czechia. 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. Tier 1 EFs for HDVs 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, EFs for the most significant pollutants produced by navigation and their calculation methods are presented in Tab. III.6. PM_{10} EF is CS. $PM_{2.5}$ EF was derived with the help of ratio between $PM_{2.5}$ and PM_{10} EF (90.3 %) as stated in EMEP/EEA EIG (Tier 1 – marine diesel oil/marine gas oil) [3].

Tab. III.6 EF method used and EFs for the most significant pollutants for inland navigation in the 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	Tier 1	Tier 1	19.7	33.9

III.3.3.2 Planned improvements

In 2023 submission, improvements are planned in method for NFR 1A3c. The calculation of emissions from railway transport for the current year and recalculation until 1990 is going to be performed based on the new methodology and activity data gained.

III.3.4 Other non-road mobile sources & machinery (NFR 1A2gvii, 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 areas, gardening), agriculture and forest machines and consumption of 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), TSP occurring from agricultural non-road machinery operation were recalculated. Emissions of NH_3, SO_X, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs were newly calculated. All produced emissions were recalculated in the whole time series since 1990 until 2020. The key step for emission data revision was opening of the non-road vehicles database running together with the road vehicles database by the Czech Ministry of Transport. Data included were 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 NFR 1A4aii diesel oil and jet kerosene. In 1A4cii, there is consumed diesel oil and gasoline, in 1A4bii gasoline only. The operation of agricultural machinery (NFR 1A4cii) covers a major part of fuel consumption of small combustion, others are negligible. There are no other AD regarding other fuels potentially used in Czechia.

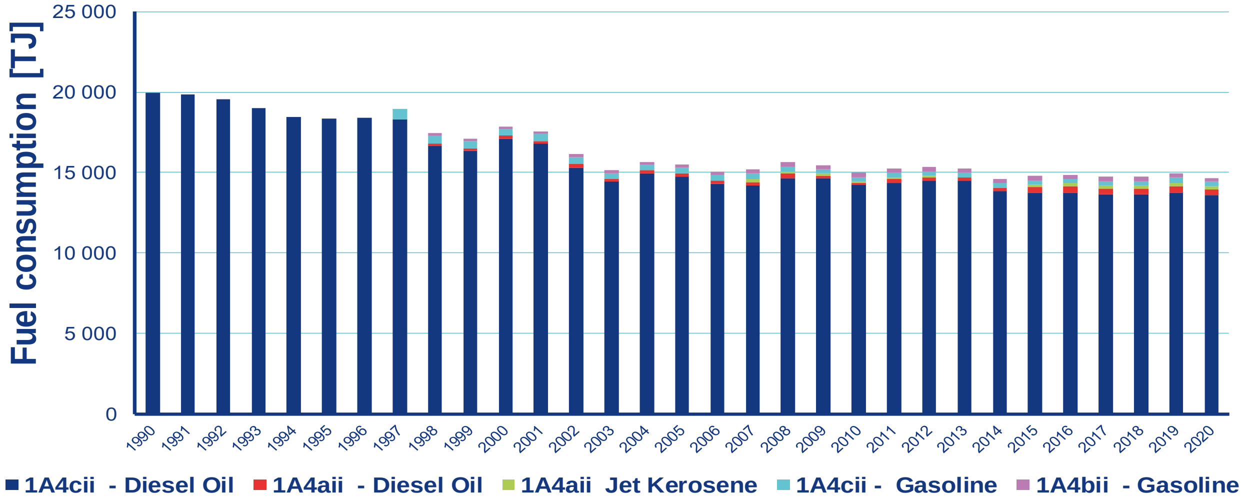

Fig. III.22 Annual fuel consumption by non-road mobile machinery, 1990–2020

III.3.4.1 Emission factors and calculations

Activity data for each category are prepared on the basis of statistical census of CZSO. For NFR 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 for main pollutants are Tier 2 and they are used from the EMEP/EEA EIG [3].Exceptions are emissions of SO_X and 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.

Mobile combustion in manufacturing industries and construction

Emission factors are mainly used from the EMEP/EEA EIG. The exceptions are SO_X and Pb emissions based on country-specific contents of pollutants in fuels. Tab. III.7 shows the method for EF used. Those EFs which are Tier 1 according to EMEP/EEA EIG are not changing in the time, therefore they are not stated in the table. There are stated only CS EFs and Tier 2 EFs which are changing in time [3].

Tab. III.7 EF method used and EFs for the most significant pollutants for non-road mobile machinery in the construction and other industries in the current year ($g.kg^{-1}$)

Subsector	Fuel type	Method CO	Method NO_X (as NO_2)	EF CO	EF NO_X (as NO_2)
1A2gvii	Diesel Oil	Tier 2	Tier 2	6.019	1.570

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 chapter III.3.4.1 Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery).

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 are in the subcategory 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).

Emission factors for main pollutants are Tier 2 EMEP/EEA EIG [3].Exceptions are emissions of SO_X and Pb. Those are country-specific and based on the content of pollutants in fuels. Heavy metals and PAHs are calculated on Tier 1 level. 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 and $PM_{2.5}$. In Tab. III.8 are presented EFs for these pollutants and also for CO, which is another significant pollutant produced by non-road mobile machinery, and their calculation methods.

Tab. III.8 EF method used and EFs for the most significant pollutants for non-road mobile machinery in the 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
1A4aii	Diesel Oil	Tier 2	Tier 2	Tier 2	6.019	1.570	0.536
	Jet Kerosene	Tier 2	Tier 2	Tier 2	6.024	1.587	0.530
1A4bii	Gasoline	Tier 2	Tier 2	Tier 2	736.576	3.922	62.372
1A4cii	Gasoline	Tier 2	Tier 2	Tier 2	736.576	3.922	62.372

Military

Basically, all military ground transport fuelled by diesel oil is included in this category. There is no military navigation (1A5biii) in Czechia, so this is not reported.

Activity data used for the Czech Military are gathered by the CZSO. The trend of diesel oil consumption was decreasing since 1999. From 2006 to 2012, it was slightly increasing. In 2013, it dropped to 345 TJ, and it has been steady since then.

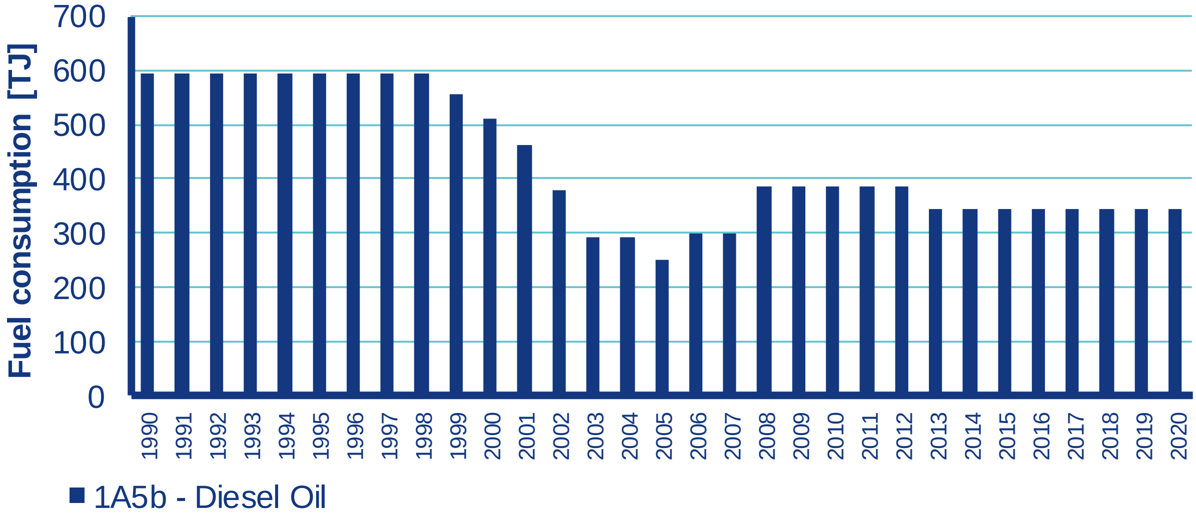

Fig. III.23 Annual fuel consumption by other mobile sources, 1990–2020

Emission factors for main pollutants are Tier 2 and they are used from the EMEP/EEA EIG [3].Exceptions are emissions of SO_X and 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, EFs for the most significant pollutants produced by other mobile sources and their calculation methods are presented in Tab. III.9.

Tab. III.9 EF method used and EFs for the most significant pollutants for other mobile sources in the current year ($g.kg^{-1}$)

Subsector	Fuel type	Method CO	Method NO_X (as NO_2)	EF CO	EF NO_X (as NO_2)
1A5b	Diesel Oil	Tier 2	Tier 2	6.024	1.587

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 Czechia) 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 Fig. III.24 the share of tractors produced in 1987–2017 is presented. From the total number of tractors putted into operation in Czechia 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 Fig. III.25 the 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 TSP. For national estimation of mentioned emissions produced by agricultural machinery in Czechia the Tier 2 approach is used according to the 1A4 Non road mobile machinery 2016 EMEP/EEA EIG – Update May 2017 (Table 5 of the EMEP/EEA EIG[3]). 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.

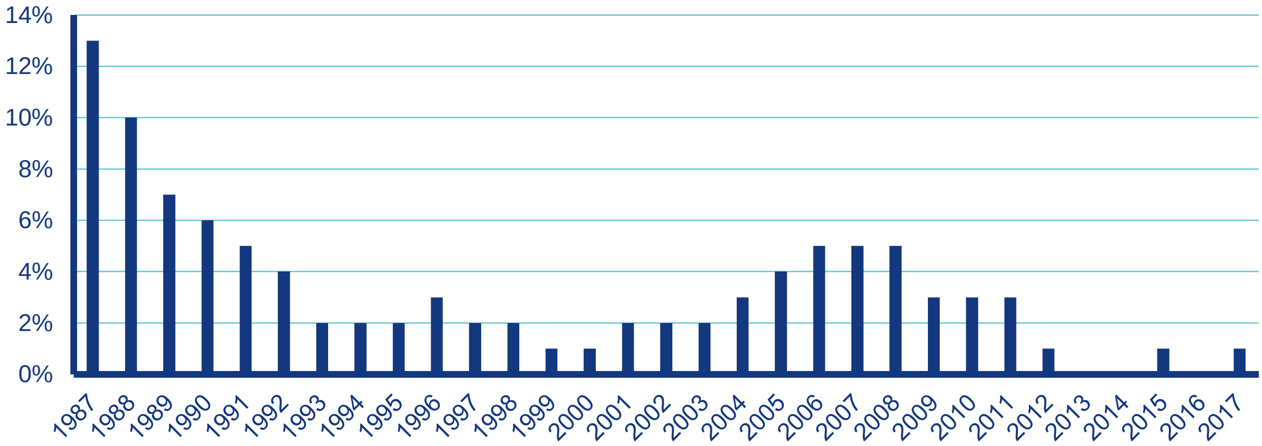

Fig. III.24 Share of tractors by year of production

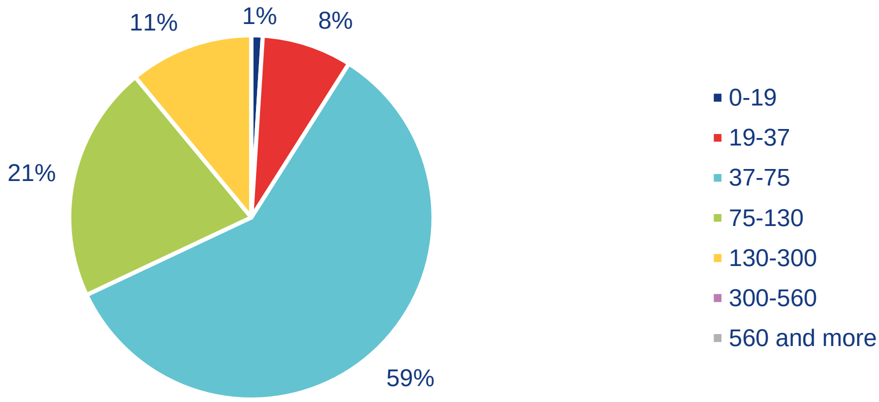

Fig. III.25 Share of tractors [%] according to rated power [kW]

III.3.4.2 Planned improvements

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

III.3.5 Uncertainties for Transport sector

Uncertainties were calculated according to chapter A.5 EMEP/EEA EIG [3]. The uncertainties given here were evaluated for all of time series (1990–2020) and for all reported categories. Uncertainties of national emissions within transport sector for particular pollutants are given in Tab. III.10.

Tab. III.10 Uncertainty data for Transport sector (NFR 1A3) from uncertainty analysis

Gas	Base Year Emissions (2000)	Year Emissions (2020)	Combined Uncertainty as % of Total National Emissions in Year 2020
	[kt]	[kt]	[%]
NO_X	97.72	48.32	28.43
NMVOC	50.41	7.61	40.66
SO_X	3.48	0.23	22.96
NH_3	1.11	0.76	130.90
TSP	6.28	5.05	28.83
BC	2.36	1.16	31.77
CO	432.63	78.07	41.79
HMs	0.21	0.03	140.09
POPs	3,84E-09	3,43E-09	117.43
PAHs	2,42E-04	4,32E-04	125.73

III.4 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 NFR 1B1 deals with fugitive emissions from coal mining and handling, transformation and other sources. In Czechia, 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 for coal gasification Sokolovská uhelná. The trend of lignite and bituminous coal mining is apparent in Fig. III.26.

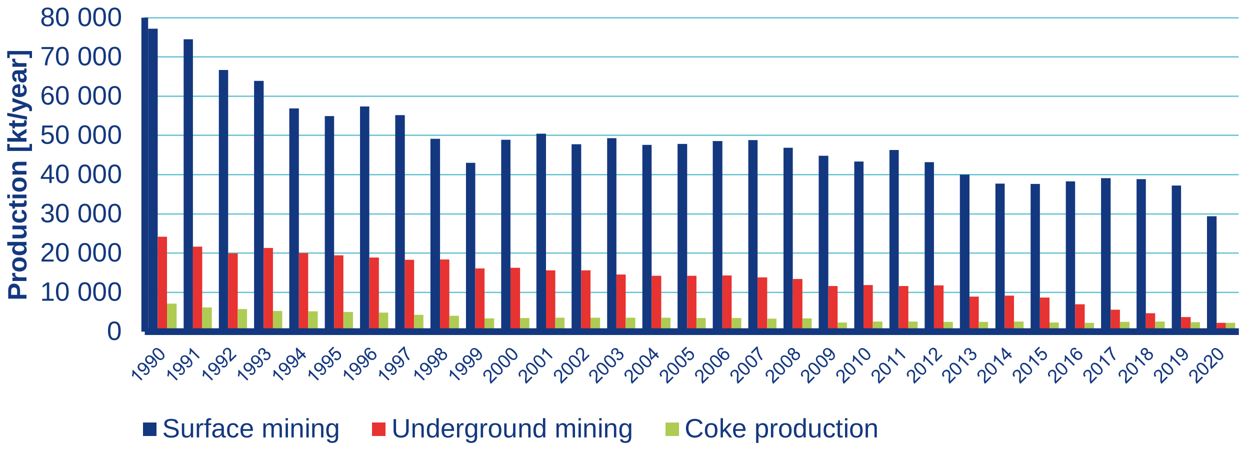

Fig. III.26 Surface and underground mining (COAL) and coke production (kt.year^{-1})

This NFR 1B1c includes emission of coal sorting and drying mainly in sorting plants producing coal for household consumption, coke plants and 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 Czechia located in Southern Moravia and so the fossil fuels´ import plays an important role in the foreign trade. Oil processing to fuels takes place in two refineries (Litvínov and Kralupy nad Vltavou) with consequent petrochemical facilities.

Distribution network of fuels includes 4000 public petrol stations and further approx. 2500 stations not accessible 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. Emissions from accompanying oil gas and carbon gas from bituminous coal are 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_X) and refinery flaring (emission of NO_X and SO_X). Emissions from consequent petrochemical processing of oil products and flaring are allocated in NFR 2B10a.

III.4.1 Emission factors and calculations

This chapter deals with fugitive emissions from coal mining and handling. In the EMEP/EEA EIG there are listed EF for NMVOC and particulates, but currently does not address the emission of Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, BC [3].

In Czechia, 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 [3]. 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 underground mining is partly being combusted in cogeneration units.

For NFR 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).

Emissions for coal sorting plants NFR 1B1c 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.

NFR 1B2 presents reported emissions excluding only emissions from oil fuels distribution that are calculated on the basis of total diesel oil and petrol consumption of CZSO and emission factors. Refinery emissions may fluctuate depending on the product´s demand, sulphur content and the current operating conditions of each facility. Higher emissions in 2016 were caused mainly by shut down of some parts of petrochemical production due to accident of ethylene unit in August 2015.

Emission factors are used for calculation of emissions in NFR 1B2av. For emission from diesel oil distribution emission factor 16.8 $g.t^{-1}$ diesel oil was used for the whole time series. For petrol distribution in 1990–1992 emission factor 1022 $g.t^{-1}$ was used without regeneration. Until 1998, according law, we assume successive installation of stage 1 and 2 regeneration and 1999 onwards emission factor 70 g/t was 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_X and NO_X reported according E-PRTR regulation, these were used for completion of reported emissions (NFR 1B2c and partly 2B10a too).

Distribution of emissions from processes operated in refinery Litvínov (mainly tail gas disposal) and follow-up emissions from petrochemical processing of petroleum products was revised and transfers of SO_X, NO_X and NMVOC emissions were made in some years between NFR categories 1A1b, 1A2c, 1B2aiv, 1B2c and 2B10a. NMVOC emissions for NFR 1B2aiv for 1990 and 1991 were calculated using implied emission factor from 1992 (app. 3 kt NMVOC).

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).

III.4.2 Uncertainties and QA/QC procedures

The chapter will supplied later.

III.4.3 Planned improvements

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

IV. Industrial processes (NFR 2)

The date of the last edit of the chapter: 15/03/2022

For emission estimates from industrial processes in Czechia combined system described in chapter I.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 (NFR 2B1 Ammonia production) or are ascertained only for more important sources (NMVOC emissions in NFR 2H2 Food processing), the inventory performed using EMEP/EEA EIG 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 with exception of solvent use emissions (mainly NFR 2D3a), where EMEP/EEA EIG methodology was used. Emissions in NFR 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 sources not underlying Annex 2 contribute to majority of total emission. Emissions are determined based on a material balance in statistics of production and imports, data from the largest producers and users, etc. A number of industrial processes belong to key categories. Some facilities in sector industrial processes may be part of LPS reporting [3].

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 Czechia. Activity data of the most important production facilities are based on REZZO database in cooperation with CZSO, Lime and Clinker Producers´ Association.

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

The sources belong to key categories (NFR) for NMVOC – 2D3d, 2D3a, 2D3g and 2D3h (23.1 %), SO_X – 2B10a (4.6 %), $PM_{2,5}$ – 2G (2.6 %), PM_{10} – 2G (2.6 %), TSP - 2A5a (3.3 %), Pb – 2G Fireworks (28.7 %) and 2C1 (21.9 %), Cd – 2C1 (9.2 %) and 2G Tobacco (9.1 %), Hg – 2C1 (4.3 %), As – 2C5 (9.4 %) and 2A3 (4.8 %), Cr – 2C1 (4.9 %), Cu – 2G (11 %), Ni – 2C1 (5.3 %) and 2G (4.9 %), Zn – 2C1 (19.4 %) and 2G (3.8 %), PCDD/F – 2C1 (10.9 %).

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

IV.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 1A2f, processing emissions are divided among NFR 2A1–2A6. NFR 2A5a Mining of raw materials (coal excluded) belonged in 2020 to key sources of TSP (3.3 %) 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 lime and cement production please refer to information in section individually monitored sources. To determine HMs emissions from glass production until 1995, national emission factors, see Tab. IV.1 based on measurements performed in glassworks in Czechia are used. In the following years, the reported emissions by individual establishments were used to determine emissions. The description is in the chapter individually monitored sources.

Tab. IV.1 Emission factors for determination of emissions from the production of glass

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se
	g.t^{-1} glass							
1990–1995*	9,034	0,191	0,004	0,597	0,567	0,010	0,676	2,14
from 1996**	1,700	0,130	0,003	0,190	0,230	0,007	0,490	0,800

* country specific EFs
** EMEP/EEA EIG [3]

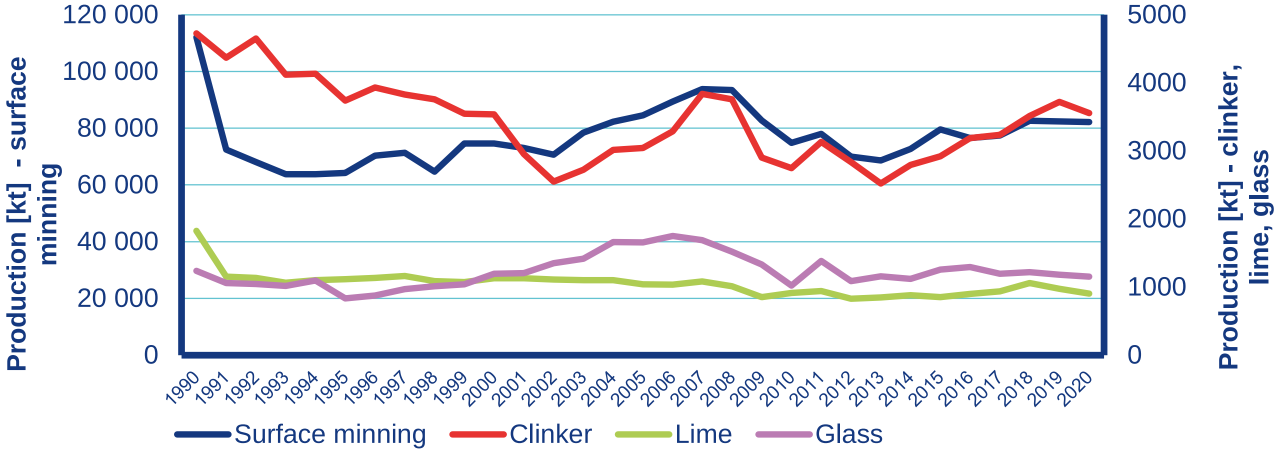

Fig. IV.1 Surface mining (non - fuels) clinker, lime and glass production, 1990–2020

NFR 2A do not belong to key categories. The methodology of emission monitoring is long term constant for all sectors and is based, with exception of NFR 2A5b Construction and demolition, on reported source emissions underlying annual reporting duty. Annual measured emission concentrations show large (sometimes orders of magnitude) differences, leading to irregular emissions reported by operators. A part of operation permit for all rotary clinker 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 NFR 1A2a. Should emissions of raw material and product handling be exhausted by managed exhaust they are based than on one-time measurements in prescribed intervals. For raw material mining in NFR 2A5a and recycling lines of construction wastes (allocated in NFR 2A6) emissions are mainly ascertained by calculation using emission factors.

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 Czechia. Since 2004 their number in both fields had dropped to five. All cement factories produced cement clinker in rotary furnaces using a dry process with preheating. 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 emissions caused by oxidation of combustion air and vaporization of compounds contained in raw materials present in molten glass mixtures. In Czechia 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. However, electricity is widely used also for melting, which is a certain speciality of

Czechia. Emissions TSP, SO_X, NO_X (as NO_2), CO, VOC a NH_3 from processes involved in melting (incl. electric furnaces) and from combustion during the processing and refinement of glass, being ascertained by one-time or continuous measurement, were assigned to NFR 1A2f. Emissions of PMs, TSP and HMs from the preparation of molten glass mixtures and other processes were comprised under 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 NFR 1A2f. Emissions from the preparation and mixing of materials were comprised under NFR 2A6. Similarly, emission from non-combustion processes by other processing of minerals incl. glass fibres and other isolants are included in NFR 2A6 Pursuant to recommended procedures, only ascertained emissions TSP, PMs, BC and HMs are allocated in categories 2A2 to 2A5b. Because other pollutants (NO_X, NMVOC, SO_X, NH_3 and CO) are emitted at many sources related to mining, production, processing and treatment of mineral materials, emissions of them are reported in NFR 2A6. Their relatively higher amount since about 2014 corresponds to changes in legislation and conditions for emission ascertaining during operation of sources.

The most significant emissions are generated from the mining sector (excluding fuels). Mining in Czechia 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, emissions from the NFR 2A5a were not ascertained and the raw material extraction estimate was not carried out. Since 1995 these emissions have been ascertained and mineral resource extraction also comes from toll-priced sources. Until 2002, all mining sites were included among the listed sites. Since 2002, emissions have 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 technology (ie Tier 2 level). The emission factors are published by MoE in the Bulletin.

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 centres, schools, etc.). The emission inventory does not comprise emissions from the construction of transport infrastructure and industrial objects. The statistics do not provide information about demolitions. In Czechia 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 NFR 2A5b, calculated from statistic data, are reported only since 2005. The trend of cement production was used to estimate emissions in 1990-2004.

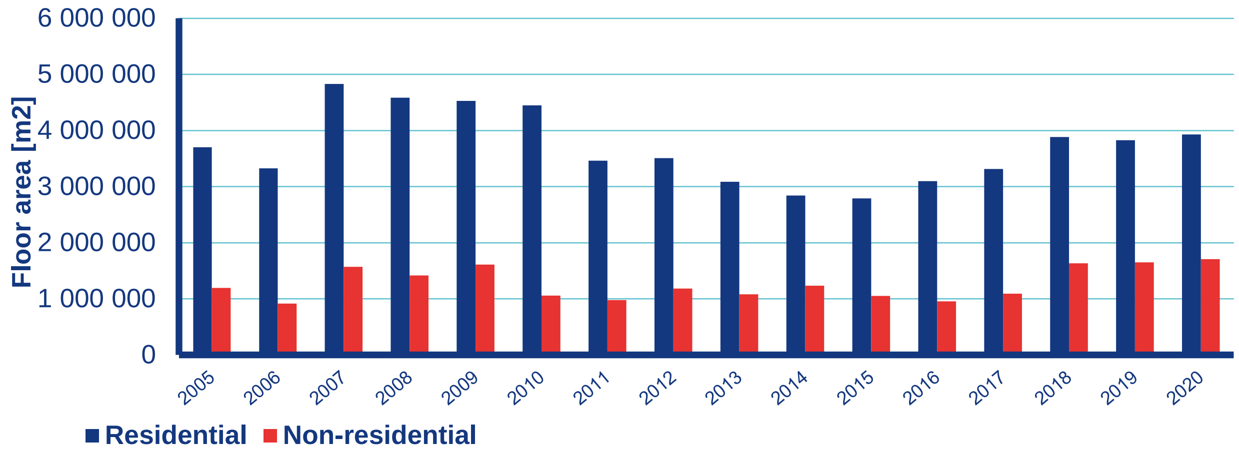

Fig. IV.2 Building floor area, 2005–2020

IV.1.1 Emission factors and calculations

Calculation based on emission factors is used only to estimate emissions in NFR 2A5b. To calculate these emissions, emission factors from the CEPMEIP database were used.

Tab. IV.2 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.

IV.1.2 Uncertainties and QA/QC procedures

The general principles of uncertainty evaluation and QA/QC are described in chapter I.7 and chapter I.6. The detailed information will supplied later.

IV.1.3 Planned improvements

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

IV.2 Chemical industry (NFR 2B)

The chemical industry represents one of the largest industrial branches in Czechia with production of a wide range of organic and inorganic substances. Chemical industry can be divided into: fundamental chemistry, crude oil processing, pharmaceuticals, 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 1A2c. Process emissions for named sorts of production include NFR 2B1, 2B2 and 2B6. Titanium dioxide is produced by sulphate process (PRECHEZA, a.s.). Process emissions for production and processing of other inorganic substances, the whole production and processing of organic substances are included in NFR

2B10a, where the largest emissions (mainly SO_X and NMVOC) are reported. There are no production facilities in Czechia in NFR 2B3, 2B5 and 2B7. There is no information about any sources allocation in NFR 2B10b Storage, handling and transport of chemical products and we assume that these activities take place in areas of above mentioned production facilities and are included in reported emissions. Activity data of main productions are based on REZZO database and CZSO data (Fig. IV.3).

NFR 2B do not belong to key categories. The mythology of emission monitoring is long term constant for all sectors and with exception of the NFR 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 sulphur from crude oil (the Claus process) are reported under NFR 1B2aiv. The Claus process is also used in the production of sulphur for tar processing. Emissions from these processes are comprised under 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 dichloromethane and vinyl chloride. Emissions of PAHs occur in production and processing of tar.

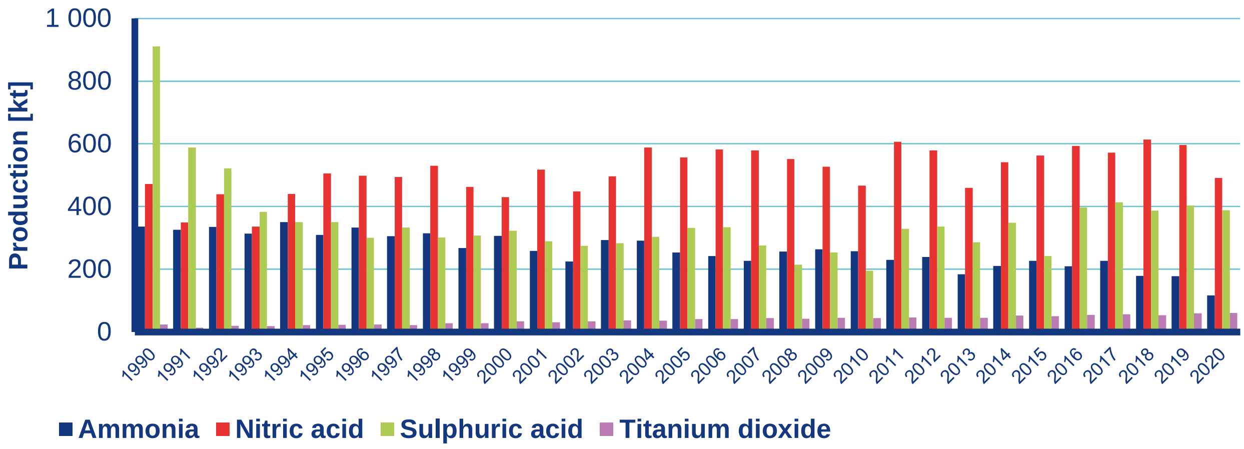

Fig. IV.3 Ammonia, sulphuric acid, nitric acid and titanium dioxide production, 1990–2020

IV.2.1 Emission factors and calculations

Emission factors are used only for calculation of emissions in NFR 2B1. To calculate the emissions, emission factors were taken from the EMEP/EEA EIG [3].

IV.2.2 Uncertainties and QA/QC procedures

The chapter will supplied later.

IV.2.3 Planned improvements

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

IV.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 Czechia. According to the recommended practice, emissions from production technology processes using fuels (production of iron and steel) are reported in NFR 2C1. Other processes namely direct process heating of mean-products and products, air, gas and raw material heaters are allocated in NFR1A2a. There is no information available for sources allocated in NFR 2C7d Storage, handling and transport of metal products and we assume that these activities take place in areas of above mentioned production facilities and are included in reported emissions.

IV.3.1 Iron and steel production (NFR 2C1)

In NFR 2C1 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 NFR 2C1 Iron and steel production, on reported emissions of sources underlying annual reporting obligation. Emissions NO_X, SO_X, PMs and CO (sinter plant, pig iron) are being namely assessed by one-time measurement in prescribed intervals. Annual measured emission concentrations show large (sometimes orders of magnitude) differences, leading to irregular emissions reported by operators. For further detail please see e-ANNEX.

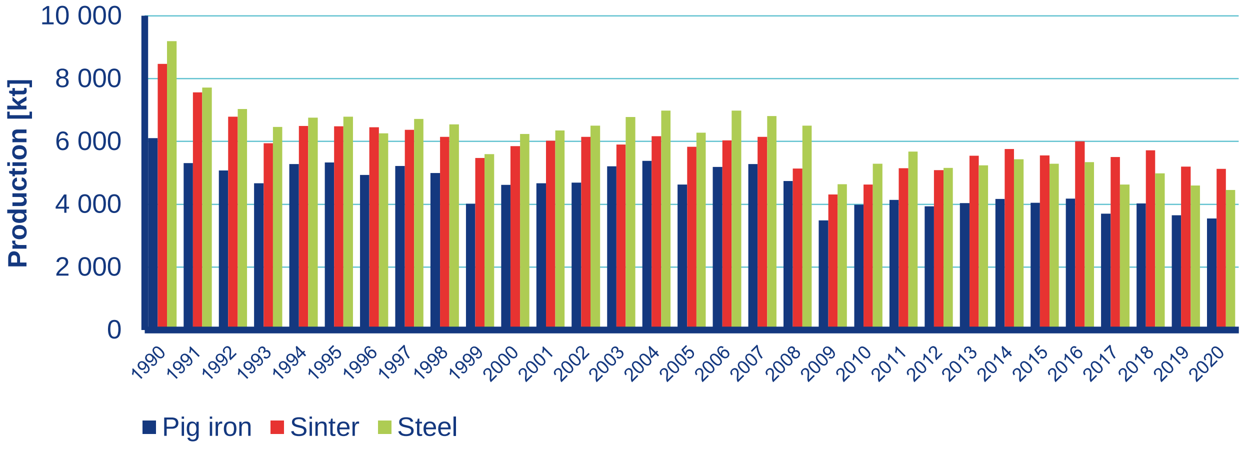

Fig. IV.4 Pig iron, steel and sinter production, 1990–2020

Emissions of CO from open hearth furnace steel plant are since y. 2014 calculated on basis of steel production and emission factor assessed by source operator as several-year-measurement. NMVOC emissions are calculated using EFs from EMEP/EEA EIG [3]. Emissions of HMs and POPs are calculated on basis of emission factors set from Fig. IV.2 to Fig. IV.5. Activity data were collected on the REZZO database and sectorial statistics HŽ a.s.

HCB emissions from sintering belts are reported as a part of NFR1A2f and therefore uses 'IE' symbol for HCB emissions in NFR 2C1. Emissions from sintering belts (also for NO_X, SO_X, TSP, Hg and PCDD/F) are reported by source operators, other reported emissions are calculated. In the calculation system, all emissions are classified in NFR 1A2a, because their distribution according to the NFR categories would be technically demanding in the Czech point sources inventory system and could lead to errors.

In Czechia 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 factories are starting with the production of steel in electric arc furnaces.

IV.3.1.1 Non-ferrous metal (2C2-7)

In Czechia non-ferrous metals (namely copper, lead, magnesium, aluminium and zinc) are made only by recasting secondary raw materials. 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 is presented in Tab. IV.3. Emission inventory in this sector is being performed on the basis of one-time measurements in prescribed intervals Pursuant to recommended procedures, only ascertained emissions TSP, PMs, BC, HMs and some POPs are allocated in categories NFR 2C2 to 2C7a. Because other pollutants (NO_X, NMVOC, SO_X, NH_3 and CO) are emitted at many sources related to production, processing and treatment of metals, emissions of them are reported in NFR 2C7c.

Tab. IV.3 Mapping of NFR 2C3-2C7c sources categories to Annex 2 source categories

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

*processes without fuel

IV.3.1.2 Ferroalloys production (2C2)

Ferroalloys are alloys that contain less than 50% iron and one or more elements. They are used mainly for steel production. In Czechia, only one production plant falls into this category, whose obligation is to report emissions of basic pollutants. Information on HMs and POPs emissions is not available. The EMEP/EEA EIG also does not offer EF for HMs and POPs, so we do not estimate these emissions.

IV.3.1.3 Aluminium production (2C3)

Emissions from aluminium foundries are determined from the reported activity data. HCB emissions are calculated using recommended EF 5. Since 2002 HCB emissions are not expected due to prohibition of HCB precursor (hexachloroethane) to degas the aluminium melt.

IV.3.1.4 Magnesium production (2C4)

The plant engaged in the recycling and production of magnesium in Czechia is only the company Crown Metals CZ s.r.o. (previously Magnesium Elektron CZ s.r.o.). Emissions are determined from the emissions reported by the operator.

IV.3.1.5 Lead production (2C5)

Emissions are determined from the emissions reported by the operators.

IV.3.1.6 Zinc Production (2C6)

Only one company in Czechia is engaged in the secondary processing of zinc. It is Ekozink Praha, s.r.o. It was founded with the aim of ecological processing of zinc waste from hot dip galvanizing. Emissions of the main pollutants are classified in NFR1A2b. The reporting obligation only applies to Zn emissions. Other HMs and POPs emission are calculated from EF in EMEP/EEA EIG [3].

IV.3.1.7 Copper production (2C7a)

Only one company in Czechia is engaged in the secondary processing of zinc. It is Měď Povrly a.s. Emissions from copper production were newly determined only for this operated plant. Emissions from other productions (crucible furnaces), which are part of plants with other non-ferrous metal productions, were transferred to NFR 2C7c. As, Ni, PCDD/F and PCBs emissions were calculated using emission factors from EMEP/EEA EIG[3]. For emissions of the other pollutants, reported data registered in the emission database (REZZO) were used.

IV.3.1.8 Nickel production (2C7b)

At present, nickel is not processed in Czechia.

IV.3.1.9 Other metal production (2C7c)

This category includes emissions from copper and copper alloy plating, galvanic nickel plating, chromium plating, zinc plating and zinc alloy plating, etc. These processes tend to emit heavy metals and other pollutants. 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. More detail information including selected emission and activity data, emission factors and calculation for NMVOC are presented in the e-ANNEX. Technological processes that precede surface treatment are mechanical pre-cleaning of surfaces and degreasing. Mechanical pre-treatment 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 included under NFR 2L (see Tab. IV.4). Some processes of degreasing use solvents, and emissions from them are reported under sector 2D3e.

Storage, handling and transport of metal product (2C7d)

There is no information available for sources allocated in this category and we assume that these activities take place in areas of above mentioned production facilities and are included in reported emissions.

Tab. IV.4 Mapping of NFR 2C7c sources categories to Annex 2 source categories

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

2C7c	4.16. Spraying of protective coatings made of molten metals with a projected output of greater 1 t of coated steel per hour
2C7c	4.17. Hot zinc coating

*processes without fuel

**processes without plating bath

IV.3.2 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.

Tab. IV.5 Casting (blast furnace) – emission factors

Abatement	Pb	Cd	Hg	As	Zn	BaP	BbF	BkF	InP	PAHs	PCDD/F
	[mg.t^{-1}]										[µg I-TEQ.t^{-1}]
Dry ESP	52.00	6.00	48.00	4.50	1729.00	0.09	0.53	0.25	0.11	1.00	0.01
Bag filter	11.10	1.29	0.66	1.50	79.66	0.03	0.18	0.08	0.04	0.33	0.01

Emissions of TSP, SO_X and NO_X in tandem furnaces and oxygen converters are being measured once a year. Fluctuation of SO_X emission is related with use of different amounts of heavy fuel oil in the process of iron production (carbon content balancing). NMVOC emissions are calculated using emission factors for sinter, iron and steel production stated in EMEP/EEA EIG – Tier 2. 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, PAHs and PCBs are being based on national emission factors (Fig. IV.3 and Fig. IV.4). Emissions of other pollutants reported under UN CLRTAP are being estimated based on emission factors according EMEP/EEA EIG – Tier 2 [3].

Tab. IV.6 Tandem furnaces – emission factors

Pb	Cd	Hg	As	BaP	BbF	BkF	InP	PAHs	PCBs	PCDD/F
[mg.t^{-1}]									[µg.t^{-1}]	[µg I-TEQ.t^{-1}]
854.15	34.39	24.54	5.98	0.03	0.18	0.07	0.04	0.31	30.00	1.43

Tab. IV.7 Oxygen converters – emission factors

Pb	Cd	Hg	As	BaP	BbF	BkF	InP	PAHs	PCBs	PCDD/F

[mg.t^{-1}]									**[µg.t^{-1}]**	**[µg I-TEQ.t^{-1}]**
549.75	9.46	7.65	1.94	0.47	5.84	1.98	0.25	8.53	30.00	0.08

Emissions of TSP, NO_X (as NO_2) 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 PCBs 2,2 µg.t^{-1}. Emissions of other pollutants according UN CLRTAP are being based on EMEP/EEA EIG – Tier 2 emission factors [3].

Siemens-Martin furnaces used to be operated in Czechia until 2001. The resulting emissions depend namely on the sort of the input (pig iron or metal scrap), the sort of the fuel used and production intensification by oxygen. One-time measurement of TSP, SO_x, 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 – Tier 2. The emission factor for Pb according EMEP/EEA EIG 300 g. t^{-1} of steel was adapted to more real value 30 g. t^{-1}of steel [3].

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

Tab. IV.8 Cupola furnaces – emission factors

Pb	Cd	Hg	As	BaP	BbF	BkF	InP	PAHs	PCBs	PCDD/F
[mg.t^{-1}]									**µg.t^{-1}**	**µg I-TEQ.t^{-1}**
149.80	5.00	7.00	12.00	0.50	2.67	1.21	0.18	4.55	1023.02	0.48

For copper production the emissions of As, Ni, PCDD/F and PCBs were calculated using emission factors from EMEP/EEA EIG. For emissions of the other pollutants, reported data registered in the emission database (REZZO) were used. For further detail please see e-ANNEX.

IV.3.3 Uncertainties and QA/QC procedures

The chapter will supplied later.

IV.3.4 Planned improvements

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

IV.4 Solvent use (NFR 2D)

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 (NMVOC) into the atmosphere (NFR 2D3a, 2D3d-i). Although the EMEP/EEA EIG methodology recommends verifying Hg emissions from the use of fluorescent tubes, there is currently no data to quantify Hg emissions.

Emissions of NMVOC from production and use of Hot Mix Asphalt and emulsified asphalt are included in NFR 2D3b according to EMEP/EEA EIG guideline. Emissions from all types of asphalt production are reported annually by source operators in Summary Operation Records. The asphalt production processes also cover combustion sources. Therefore, emissions from combustion are regarded in NFR 1A2f. Only NMVOC emissions from emulsified asphalt applications are included in NFR 2A3b.

Reported emissions in NFR 2D3c (NMVOC and PMs) specially come only from annual reports in Summary Operation Records. Technological heating emissions from this process are reported in NFR 1A2f.

Based on the investigation at asphalt producers, it was found that at used technologies are applied technological procedures that prevent the emission of PAHs from the asphalt blowing. Therefore, symbol NE was used as in the case of the other emissions (NFR 2D3g).

Except for NMVOC emissions, there is no necessary data for other emissions calculations in NFR 2D3i. Consequently, there is used notation key NE for another emission.

The solvent and other product use sector belongs to one of the largest pollution source of NMVOC emissions in Czech and it accounted for over 25 % of total NMVOC emissions. The largest share (2020) was for decorative coating application at 38.8 %, domestic solvent use 24.1 %, chemical products 12.3 % and printing 10.9 %.

The main activities leading to air pollutant emissions in the Solvent Use sector in Czechia 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 NMVOC 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.

Tab. IV.9 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 26.5 %. 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 equipment 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, as well as for individual pollutants. The modelling of solvents emission is done by estimating the amount of used solvents consumed, knowledge of production volume, export and import product with solvent content. All relevant solvents must 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 Czechia. 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 Czechia and SOR Libchavy are focused on the production of buses. There are also many major suppliers in Czechia for the domestic and foreign automotive industry. Škoda Transportation produces trams, locomotives and train sets.

The printing industry in Czechia 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 polygraph´s 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. On the other hand, the demand for printing colors is reflected in the consumption of print colors.

Paints and coatings protect materials and significantly increase the durability of many objects. Regarding vehicles, coatings serve as corrosion protection. Paint application for industrial goods is decisively affected by the economic situation of individual countries. Architectural paints 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 transportation segment. 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 external 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 EIG, national emission factors, based on data reported by individually monitored sources, were used for some categories [3].

IV.4.1 Emission factors and calculations

Emissions are estimated using a combination of top-down data (from National statistical office, the MIT of Czechia, National Associations, data collected from REZZO) and with bottom-up data from inquires in solvent consumption and expert technical estimations.

Emissions from point sources are gathered from the web-based air emissions data system for point sources (ISPOP) and the emissions for diffuse sources are calculated from the data received from Czech Statistical Office using international emission factors and expert opinions. The statistic statement of Customs Administration of Czechia is significant source of date and information. For emissions in NFR 2D3a we newly use recommended emission factor 1.2 kg/capita/year according EMEP/EEA EIG Tier 1 [3].

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

Emissions are estimated using a combination of top-down data (from National statistical office, the MIT of Czechia, National Associations, data collected from REZZO) and with bottom-up data from inquires in solvent consumption and expert technical estimations. For NMVOC pollutant or product a mass balance is formulated: Consumption equals (production + import) – (export + destruction/disposal).

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 Czechia. The publication is elaborated by the MIT in close cooperation with the Czech Statistical Office and the Confederation of Industry of Czechia. The aim of this yearbook is to provide expert advice on the development and achievements of the manufacturing industry as well as present the results of industrial companies operating in Czechia. They are also a solid basis for the monitoring of production with the possibility to predict further developments. Import and export figures are available on National Statistical 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.

Emission factors are based on the values in the EMEP/EEA EIG and adjusted on a country specific basis according to the assessment of some individual sectors [3]. 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 (Czech series of acts, mainly

Act. No201/2012 Co. and Regulation No 415/2012 Co.). 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.

Unfortunately, due to confidentiality no activity data are available in some branches. In these cases are used expert estimation, often based on the earlier data.

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

IV.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 Czechia in the various applications, a bottom-up and a top-down approach were combined. A 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 EIG, to range from 50 to 200 % [3].

IV.4.3 Planned improvements

Emissions of NFR 2D3a will be recalculated under Tier 2 during further following years. Updates in other categories of solvent use (NFR 2D3d-2D3i) are either planned.

IV.5 Other product use (NFR 2G)

NFR 2G in Czechia 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 Czechia was in recent years very popular. Started 2020, their consumption started to decline, mainly due to a ban of fireworks in some public spaces and also due to the covid-19 pandemic. (see Fig. IV.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, combined nomenclature KN (8) and commodity code 36041000 (Fireworks) was selected. Data are available from 1999.

Tobacco consumption shows moderate decrease (see Fig. IV.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 (main aggregates) – https://www.czso.cz/csu/czso/food-consumption, 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 [3.]).

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

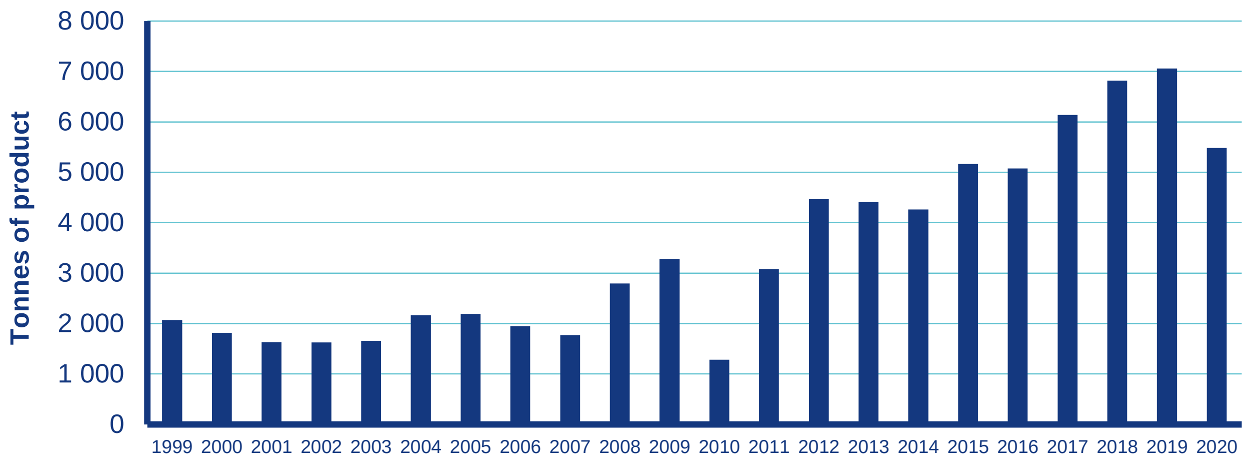

Fig. IV.5 The fireworks import, 1999–2020

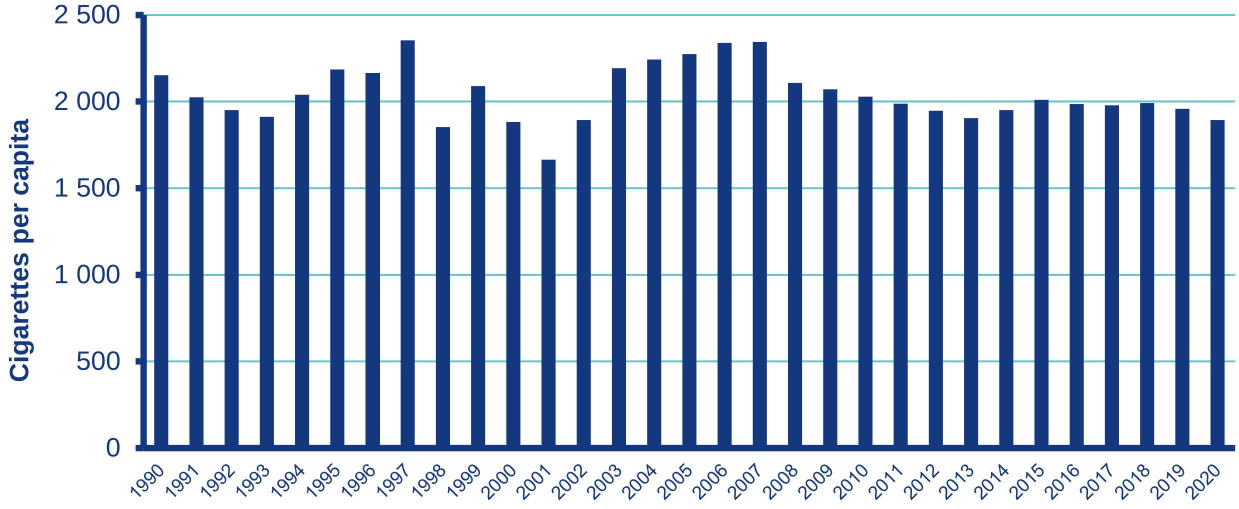

Fig. IV.6 Tobacco smoking, 1990–2020

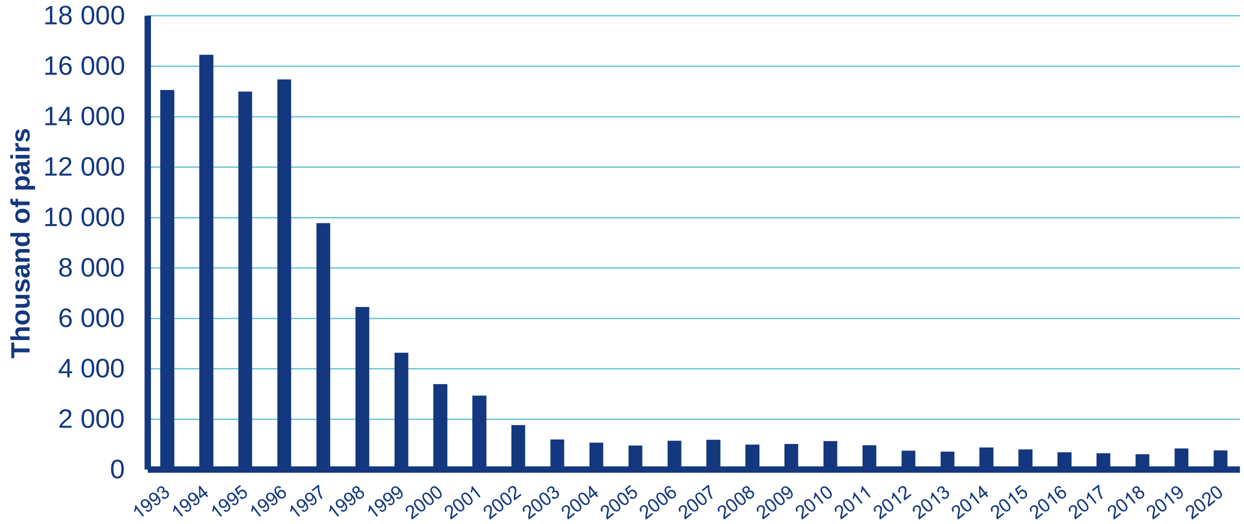

Fig. IV.7 Shoes production, 1993–2020

IV.5.1 Emission factors and calculations

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

IV.5.2 Uncertainties and QA/QC procedures

Emissions for NFR 2G are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter I.7 General uncertainty evaluation.

QA/QC for NFR 2G is the same as in case of other collectively monitored sources, see also chapter I.6 QA/QC and Verification methods.

IV.5.3 Planned improvements

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

IV.6 Other industry production and wood processing (NFR 2H; 2I)

The consumer industry has a long-standing tradition in Czechia. 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 1990–2020 is shown in Fig. IV.8.

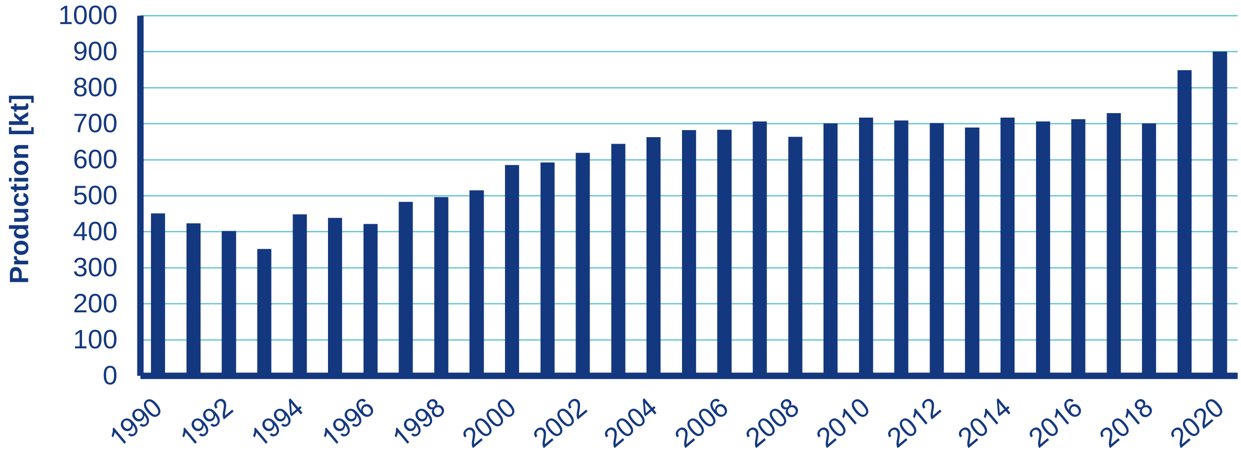

Fig. IV.8 Pulp production, 1990–2020

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 fibres. 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.

IV.6.1 Emission factors and calculations

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

IV.6.2 Uncertainties and QA/QC procedures

The chapter will supplied later.

IV.6.3 Planned improvements

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

IV.7 Other (NFR 2J and 2K; 2L)

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

The system of emission inventory in Czechia enables allocation of most individually monitored sources into specific NFR categories. Emissions of sources that could not be allocated to other NFR categories are allocated in NFR 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).

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

IV.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 (PCBs), DDT, Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF)) nor PAHs are produced in Czechia

IV.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 (PCBs), DDT, Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF)) are consumed/on sale in Czechia.

IV.7.1.3 Other production, consumption, storage, transportation or handling of bulk products (2L)

The emission specification according EMEP/EEA EIG includes emissions from other production, consumption, storage, transport or handling of bulk products. Emission reported in NFR 2L can be allocated as “Other production” and come from Emission database [3]. NFR 2L includes all emissions in processes without fuel combustion that are not allocated in previous categories.

This paragraph includes emissions specified in EMEP/EEA EIG as other production, consumption, storage, transport or handling of bulk products[3].

Emissions reported in NFR 2L belong to sources specified as “Other production” and come from the reported emissions of Summary operation evidence (SOE). NFR 2L includes all emissions from processes without fuel combustion not allocated to any of previous categories, namely: Production or processing of synthetic polymers and composites, surface treatment of metals, plastics and other non metallic 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 areas, 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 unavailable appropriate activity data.

IV.7.2 Uncertainties and QA/QC procedures

The chapter will supplied later.

IV.7.3 Planned improvements

Emissions of sources classified under NFR 2L will be inspected in more detail and, if not covered by EMEP/EEA EIG, will be reclassified [3].

V. Agriculture (NFR 3)

The date of the last edit of the chapter: 15/03/2022

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
- 3Da2b Sewage sludge applied to soils
- 3Da2c Other organic fertilisers applied to soils (including compost)
- 3Da3 Urine and dung deposited by grazing animals
- 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products
- 3De Cultivated crops
- 3F Field burning of agricultural residues

An overview of main pollutants occurring in agriculture is shown in Tab. V.1.

Tab. V.1 Overview of main pollutants occurring in NFR 3b and 3D

NFR Code	NO_X (as NO_2)	NMVOC	SO_X (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC
3B	x	x		x	x	x	x	
3Da1	x			x				
3Da2a	x			x				
3Da2b	x			x				
3Da2c	x			x				
3Da3	x			x				
3Dc					x	x	x	
3De		x						

In Czechia NFR 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.

All emissions of monitored pollutants have decreased between 1990 and 2020 as the result of animal population significant reduction, especially in case of 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. In future it is expected a slight increase of pig production in Czechia.

The agricultural sector is responsible for more than 91 % of NH3 emissions in Czechia. The main sources of ammonia emissions in Czechia represent manure management (cat. 3.B) by 39 % share in total ammonia emission followed by inorganic N fertilizers application (cat. 3Da1) by 34 % share and animal manure application to soils (cat. 3Da2a including cat. 3Da3) by 25 % of share. Other non-agricultural sources are biological treatment of waste – composting (cat. 5B1), municipal and industrial waste incineration (cat. 5C1A and 5C1bi), residential: Stationary (cat. 1A4bi), chemical industry, transport and so on. These non-agricultural sources represent approximately 9 % share in total ammonia emissions.

Fig. V.1 shows the distribution of sources of NH_3 emission from the agricultural sector for 2020 in Czechia.

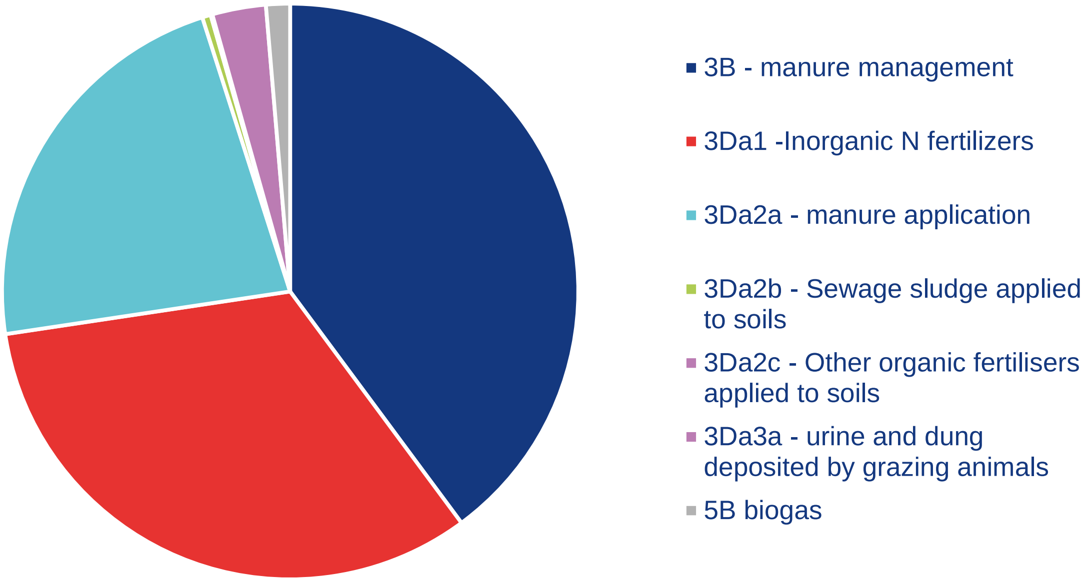

Fig. V.1 NH_3 emissions from the agricultural sector, 2020

Except for NH_3 agriculture in Czechia also contributes to other main pollutants as NO_X, NMVOC, PMs and TSP. Tab. V.2 shows the agricultural contribution of total national emissions of mentioned pollutants.

Tab. V.2 Agricultural contribution to total emissions of NO_X, NMVOC, NH_3, PMs and TSP (year 2020)

	Emissions					
	NO_X (as NO_2)	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
National total [kt]	153,77	198,89	68,43	32.36	42.44	51.75
Agriculture [kt]	17,85	37,75	60,36	0,63	5,60	8,30
Agricultural share [%]	11,6	19,0	88,2	1.9	13.2	16.0

The most significant agricultural contributor to total NO_X emissions is related to the mineral and organic manure application (approx. 11 %). The remaining 1 % is related to emissions from livestock breeding. The agricultural share of NMVOC emissions accounts for 19 %, which cattle breeding (NFR 3B1a and 3B1b) contributes to the total NMVOC emissions by approx..15 %. In case of PM_{10} and TSP NFR 3Dd - Farm-level agricultural operations including storage, handling and transport of agricultural products represents the most significant sources of emissions from agriculture.

The Czech agriculture is characteristic by extra-large cattle, pigs and poultry farms. In the e-ANNEX **NFR-3B-1** share of animals bred on farms (agricultural holdings) by size group of cattle, pigs and poultry is shown (data from 2016). Tab. V.3 shows number of dairy cattle farms and share of dairy cattle by size of groups [11].

Tab. V.3 Number of dairy cattle farms, share of breed dairy cattle by size groups (ČMSCH, a.s. 2019)

Cattle farms			
Amount of dairy cattle (heads)	**number**	**%**	**% of cattle**
1–10	1 888	56.6	1,1
11–50	419	12.6	2.8
51–200	395	11.8	11.9
201–500	405	12.1	36.7
501–1000	191	5.7	34.5
More than 1000	37	1.2	13.0
Total	3 335	100	100

In Czechia dairy cattle were breed in total on 3 335 farms in 2019. However, only 28 % of cattle farms (633 farms) have kept approx. 84 % of total dairy cattle amount in Czechia. The following chapters describe the method of calculation for subsectors.

V.1 Livestock breeding - Manure management (NFR 3B), Animal manure applied to soil (NFR 3Da2a), urine and dung deposited by grazing animals (NFR 3Da3)

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
- 3B4giv Other poultry
- 3B4h Other animals

Animals in NFR 3B4a (buffalo), 3B4f (mules and asses) are not kept as livestock in Czechia it means these subcategories are not estimated.

Number of animals is a key activity data for emissions inventories calculation relating to manure management (NFR 3B), animal manure applied to soil (NFR 3Da2a), urine and dung deposited by grazing animals (NFR 3Da3). Number of animals was taken from annual agricultural census coming from the official statistics (CZSO). The number of animals is considered as an average annual production. In Tab. V.4 trends of the livestock population are presented in the period 1990-2020.

Tab. V.4 Livestock population, 1990-2020 (thousands of heads)

	1990	1995	2000	2005	2010	2015	2017	2018	2019	2020
Cattle	3 506	2 030	1 574	1 392	1 349	1 407	1 421	1 416	1 418	1 404
Swine	4 790	3 867	3 688	2 877	1 909	1 560	1 491	1 557	1 544	1 499
Sheep	430	165	84	140	197	232	217	219	213	204
Poultry	31 981	26 688	30 784	25 372	24 838	22 508	21 494	23 573	22 979	24 247
Horses	27	18	24	21	30	33	35	35	37	38
Goats	41	45	32	13	22	27	28	30	29	29

Trends in the livestock populations in the key categories (cattle, swine) are determining for emissions trends in agricultural sector. The cattle population in 2020 corresponded to only 40% of the population in 1990 and the swine population in 2020 corresponded to even less - only 31% of the initial population.

V.1.1 Emission factors and calculations

The Czech team accepted remarks from the international Technical expert review team (TERT) and prepared a new concept for calculation of NH_3, NO_X and NMVOC emissions originating from livestock. This concept was based on the following decisions:

- for national estimation of NH_3, NO_X and NMVOC emissions from animal breeding the Tier 2 approach according to the 3B Manure management EMEP/EEA EIG was used[3].
- for fulfilment of above-mentioned requirement, the Manure management N-flow tool developed by the Aether Ltd 2019 under contract to the EEA was used [12].
- all used activity data for NH3, NOx and NMVOC emissions inventories are in accord with the latest data used for greenhouse gas (GHG) inventories (submission 2022) and with the Gross nitrogen balance per hectare of utilised agriculture area for the Czech Republic as a result of activities focusing on unification of national data used for calculation of all inventories (GHG, NH3, NOx, NMVOC and Gross nitrogen balance).

V.1.1.1 Activity data

Number of livestock

Tier2 uses a mass-flow approach based on the concept of a flow of TAN through the manure management system. According to 3.B Manure management EMEP/EEA EIG the first step is to define the livestock subcategories that are homogeneous with respect to feeding, excretion and age/weight range [3]. In the e-ANNEX NFR-3B-2 Number of animals allocated on relevant subcategories used for inventories calculation is shown. Source of these data is the Czech Statistical Office. This allocation is used for all-time series since 1990 to 2020. It includes 43 different livestock categories divided on weight and age. These data are used for definition of relevant NFR categories and are used as input data for the Manure management N-flow tool.

Values of N-excretion (Nex)

The emission of NH3 and NOx from manure management is calculated on the basis on nitrogen excreted from livestock. The country specific values of Nex were derived from the national legislation Decree No. 377/2013 Coll. on the storage and use of fertilizers. Since 2021, these values are also used for calculation of GHG emissions and Gross nitrogen Balance. In the e-ANNEX NFR-3B-6 all revised Nex used for calculation of NH3 and NOx inventories are presented.

V.1.1.2 Agricultural Waste Management System (AWMS)

There are four main Manure Management systems defined in Czechia according to Table 10.18 (IPCC 2019) [6].

1. Anaerobic digesters
2. Liquid
3. Solid storage
4. Pasture/Range/Paddock

The use of manure in anaerobic digesters is relevant for cattle, swine and poultry manure. Operation of anaerobic digesters began in 2001. Currently, 397 biogas power stations are operated in the Czech agriculture. The significant accruement of biogas power stations occurred between years 2008 – 2013.

The specific structure of Czech animal breeding (mostly in factory farming) made it possible to build anaerobic digesters close to farms to consume daily manure production very efficiently without need to store the manure. The number and capacity of anaerobic digesters has remained at its maximum value since 2014. Animal waste management systems (AWMS) is used for N2O, CH4, NH3 and NOx emission estimations by the same way. Based on a statistical survey of amount and types of biomasses used for anaerobic digestion carried out in 2018 the AWMS for cattle, swine and poultry categories has been updated. The overview of used AWMS per individual animal categories is provided in the e-ANNEX **NFR-3B-3**.

Values of feed intake and values of excreted volatile solids

Emissions of NMVOC occur from silage, manure in livestock housing, outside manure stores, field application of manure and from grazing animals. Feeding of cattle with silage has been identified as the largest source of NMVOC occurring in agriculture. Values of feed intake in MJ (average gross energy intake) are basic activity data for calculation of NMVOC originating from dairy and non-dairy cattle. As a source of these data values presented in NIR for GHG inventory are used. These data are available in the e-ANNEX **NFR_3B_4** likewise values of excreted volatile solids used for calculation of NMVOC originating from all livestock categories other than cattle. Moreover, calculation of NMVOC is also depended on ammonia emissions originating from animal housing, manure storage, manure application and livestock grazing. These ammonia emissions are downloaded from the Manure management N-flow tool for all livestock category.

V.1.1.3 Ammonia emissions factors

Housing

In 2012 the study on implementation of Best available techniques (BAT) in the installation falling in Czechia under the Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) was carried out. There was found that approx. 44 % of rearing pigs housed on intensive pig farms were housed in the system with partly slated floor with reduced slurry channel, 32 % in the system with partly slatted flor with vacuum system and 22 % in the system with partly slatted floor with scraper [13]. According to relevant Best Available Reference Document for Intensive Livestock Farming (ILF BREF since 2017

IRPP BREF) all these systems were considered as BAT with different potential on ammonia emissions reduction. However, for calculation of ammonia emissions national inventory with the assistance of the Manure management N-flow tool default EF presented in the Table 3.9. 3B EMEP/EEA EIG have been used [3]. Reason for this approach has been lack of detailed information for implementation of abatement measures resulting from BATs application into inventories calculated according to Tier 2.

Manure storage

Livestock manure is collected either as solid manure or as slurry depending on housing type. This share is used as a basic input data to the Manure management N-flow. According to the Czech low 201/2012 on the air protection all slurry tanks have to be covered by a fixed or floating cover or by natural floating cover to reduce ammonia emissions to the air.

Manure application

A significant subsidy program focused on introduction of low ammonia application techniques started in 2011 in Czechia. This effort resulting in faster incorporation of manure into soil. This trend was confirmed by the Czech statistical office based on data published in April of 2018 in the "Farm Structure Survey – 2016" and in September 2021 in the "Integrated farm survey - 2020" [14]. In Tab. V.5 share of low ammonia application techniques is presented.

Tab. V.5 Manure consumption by application technique (CZSO 2021)

Manure application techniques	Manure applied (tons)	Share (%)
Broadcast		
No incorporation	2 994 173	15.4
Incorporation within 4 hours	2 174 620	11.2
Incorporation between 4 and 24 hours	10 826 971	55.5
Band-spread		
Trailing hose	2 394 88	12.0
Trailing shoe	336 783	1.7
Injection		
Shallow / open-slot	537 289	2.8
Deep / closed-slot	282 397	1.4

Presented values show that 85 % of manure were applied by low ammonia emissions techniques defined in the Options for Ammonia Abatement: Guidance from the UNECE Task Force on Reactive Nitrogen [15]. Approximately 15 % of manure were applied and incorporated into soil immediately by injection or within 4 hours, where ammonia abatement effect is on the level of 80 - 90 in case of injection and on the level of 45 - 65 % in case of incorporation of manure into soil within 4 hours. Share of manure incorporation within 24 hours represents 56 % of total amount of applied manure with ammonia abatement effect on the level of 30 % similarly like utilization of band spreading with share of 14 %. Based on these facts it is possible declare that 85 % of all manure has been applied by technique with abatement effects on ammonia emissions at least 30 %.

Ammonia emissions originating from manure application are registered under NFR code 3Da2a and from grazing animals under NFR code 3Da3.

Abatement measures

Ammonia abatement effects according to the Options for Ammonia Abatement: Guidance from the UNECE Task Force on Reactive Nitrogen were incorporated into inventory. Abatement effects refer to slurry storage, slurry and manure application. Penetration rates of used measures and relating comments are available in the e-ANNEX **NFR-3B-5.**

NO_X emission factors

For calculation of NO_X (as NO_2) emissions inventory with the assistance of the Manure management N-flow tool default EF presented in the Table 3.10. 3B EMEP/EEA EIG have been used[3].

NMVOC emission factors

Since 2020 emissions of NMVOC are calculated by using the Tier 2 approach. For calculation of NMVOC emissions inventory default EFs presented in the Table 3.11 for dairy cattle and other cattle and in table 3.12 for livestock categories other than cattle of 3B EMEP/EEA EIG have been used [3].

PMs emission factors

The estimation of PMs emissions is based on the Tier 1 approach according to the 3B EMEP/EEA EIG [3]. For calculation of $PM_{2.5}$, PM_{10} and TSP emissions inventories default EFs presented in the Table 3.5 of the EMEP/EEA EIG have been used. These emissions include primary particles in the form of dust from housings. The inventory includes PMs emissions from cattle, swine, poultry, horses, sheep and goats. The number of grazing days is taken into account. Each category of animals has been multiplied by default specific emission factor.

Ammonia, NO_X and NMVOC emissions

Trends in ammonia, NO_X and NMVOC emissions originating from manure management are presented in Fig. V.2 and from manure application and animal grazing in Fig. V.3.

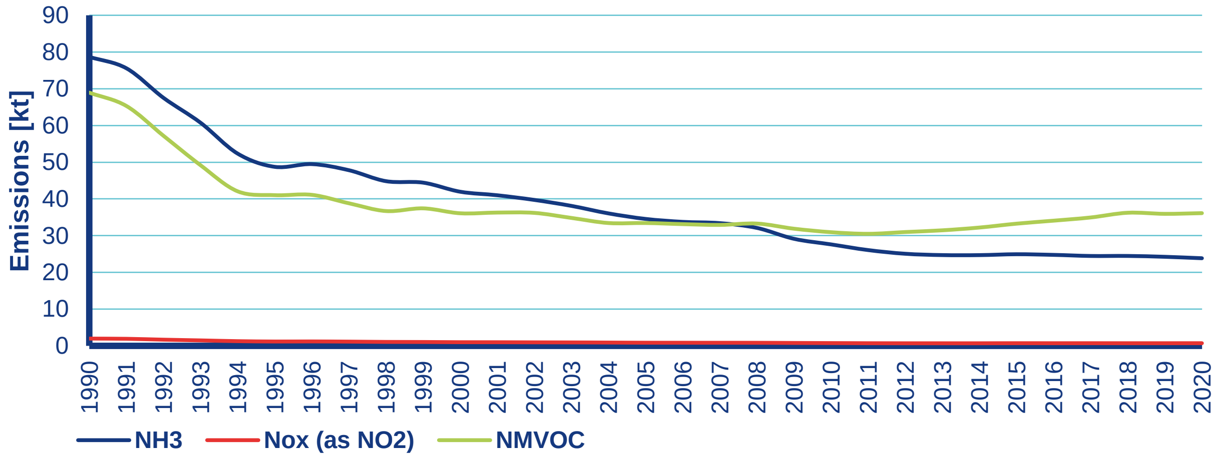

Fig. V.2 NH_3, NO_X and NMVOC emissions originating from manure management, 1990–2020

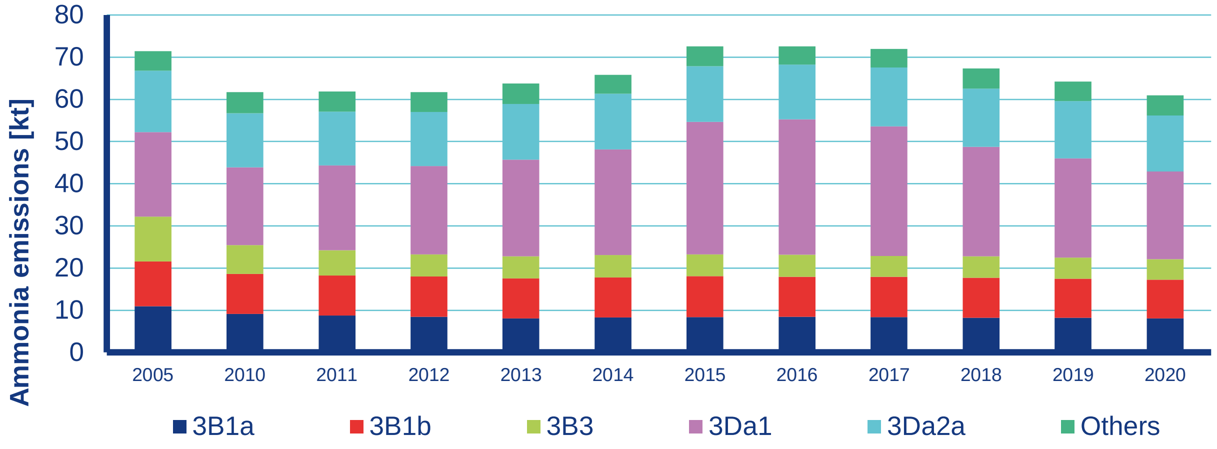

Fig. V.3 NH_3 and NO_X originating from manure application, urine and dung deposited by grazing animals, 1990–2020

V.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.

V.1.3 Planned improvements

There are planned following issues:

- Verification of harmony of input data used for NH_3, GHG emissions inventories and Gros nitrogen balance inventory with the expert group for greenhouse gases and nitrogen balance calculation.
- Incorporation of ammonia abatement techniques following from BATs utilisation in housing of pigs and poultry into inventory calculation.
- Verification of animal feed properties.
- Verification of Nex values for cattle

V.2 Crop production and agricultural soils - Inorganic N fertilizers (NFR 3Da1)

For the sector Inorganic N-fertiliser (includes also urea application) (NFR 3Da1) emissions of NH_3 and NO_X are estimated. As seen in fig. 5.1 emissions of NH_3 from inorganic fertilisers contribute with 26 % of the total ammonia emissions from the agricultural sector and emissions of NO_X contribute with 68 % of the total NO_X emissions from the agricultural sector in 2020. Trends in inorganic fertilisers' consumption are presented in Tab. V.6. Source of these data is CZSO [16].

Tab. V.6 Consumption of inorganic fertilisers (CZSO)

Agricultural production year	Consumption (tonnes of nutrients)			
	Fertilizers, total	Nitrogenous (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
1994/95	333 456	229 334	61 172	42 950

1999/00	279 238	212 988	39 834	26 416
2004/05	279 918	206 576	43 083	31 097
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
2018/19	365 071	274 305	52 595	38 171
2019/20	360 414	267 676	55 656	37 083

The highest consumption of inorganic N-fertilisers was in agricultural production year 2015/2016. Since the year consumption of this fertiliser has decreased.

V.2.1 Emission factors and calculations

For national estimation of NH_3 emissions from consumption and application of inorganic N-fertiliser the Tier 2 approach according to the 3.D Crop production and agricultural soils has been used [3]. For estimation of NO_X Tier 2 is not available, it means the Tier 1 approach has been used.

V.2.1.1 Activity data

Based on the TERT review and recommendations concerning methods of ammonia emissions calculation originating from inorganic N-fertilizers application (3.D.a.1) the IFASTAT database as a key source of basic activity data regarding to amount of inorganic N-fertilisers consumption has been used. In this context is very important to underline that these data express the amount of fertilizers sold which are assumed to equal the amounts that are applied. Since the 2022 submission, storage effects are approximated by applying a moving average to the sales data (moving cantered three-year average, for the last year a two-year average). It results in smoothing of extreme values and redistribution of emissions between neighbouring years.

In the e-ANNEX NFR-3D-1 consumption of different inorganic N-fertilisers is presented. According to this database a total consumption of inorganic N-fertilisers mentioned in the Tab. V.6 is divided into consumption of Ammonium nitrate (AN), Ammonium phosphates (AP), Ammonium sulphate (AS), Calcium ammonium nitrate (CAN), NK Mixtures, NPK Mixtures, NP Mixtures, N solutions, Other straight N compounds and Urea. Some differences in data of total consumption of inorganic N-fertilizers between IFASTAT database and data presented by the Czech Statistical Office (CZSO) and FAOSTAT is probably caused by differences in methodological approach of data collection.

NH_3 emissions factors

For calculation of ammonia emissions originating from inorganic N-fertilizers default EF presented in the Table 3.2 of the 3D EMEP/EEA EIG for each above mentioned group of inorganic N-fertilizers have been used [3]. Czechia is classified into region with cool climate zone which the soil pH is below 7.0.

NO_X emissions factors

For calculation of NO_X emissions originating from inorganic N-fertilizers default EF presented in the Table 3.1 of the 3D EMEP/EEA EIG for all inorganic N-fertilizers have been used [3].

Ammonia and NO_X emissions

In the e-ANNEX NFR-3D-2 share of different types of inorganic N-fertilisers on total ammonia emissions originating from inorganic N-fertilisers consumption in 2020 is presented. In 2020 ammonia emissions originating from Urea and N solutions based mainly on urea reached proportion of the total ammonia emissions from inorganic N-fertilisers consumption on the level of 25 % and 19 % respectively. In the e-ANNEX **NFR-3D-1** are also presented trends in ammonia emissions originating from different types of inorganic N-fertilisers. Ammonia emissions originating from consumption of urea and urea-based fertilisers are decreasing. Trends in NH_3 and NO_X emissions originating from inorganic N-fertilisers consumption in period 1990-2020 (in kt) are presented in Fig. V.4.

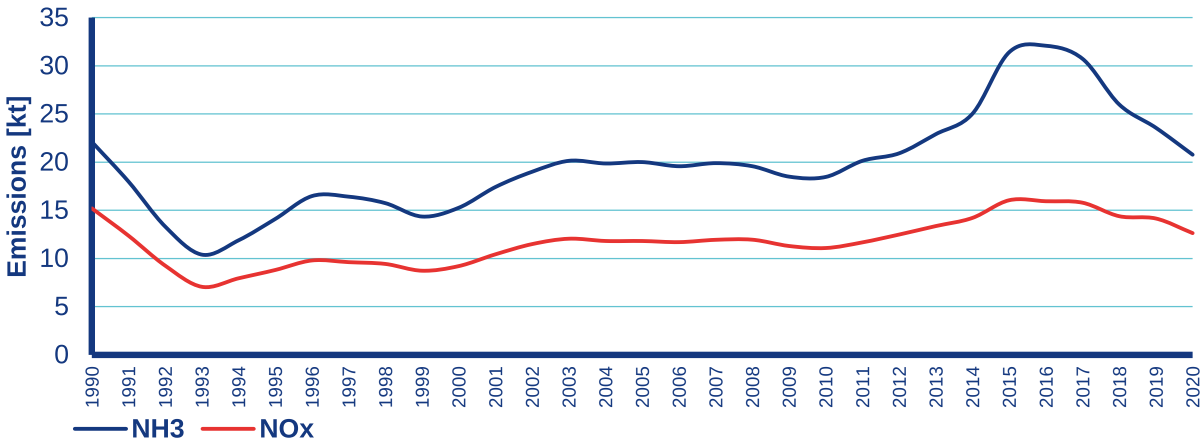

Fig. V.4 NH_3 and NO_X emissions originating from inorganic N-fertilisers consumption, 1990–2020
Uncertainties and QA/QC procedures

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

V.2.2 Planned improvements

In Czechia, since 1.7.2022 there is planned an implementation of low ammonia emissions option focused on urea-based fertilizers according to principles set down in the Options for Ammonia Mitigation Guidance from the UNECE Task Force on Reactive Nitrogen. It is planned banning of surface application of urea based inorganic N-fertilisers without a rapid incorporation into soil or application of urea based inorganic N-fertilisers untreated by urease inhibitor. This measure could lead to ammonia emissions abatement from urea application by 70 %. The specific default EF for urea would be decreased.

V.3 Crop production and agricultural soils - Sewage sludge applied to soils (NFR 3Da2b) and Other organic fertilisers applied to soils (including compost) (NFR 3Da2c)

For the sectors Sewage sludge applied to soils (NFR 3Da2b) and Other organic fertilisers applied to soils (including compost) (NFR 3Da2c) emissions of NH_3 and NO_X are estimated. Emissions of NH_3 from both sectors contribute less than 1 % of the total ammonia emissions from the agricultural sector equally emissions of NO_X contribute less than 1 % of the total NO_X emissions from the agricultural sector in 2020.

V.3.1 Emission factors and calculations

For national estimation of NH_3 emissions from Sewage sludge applied to soils (NFR 3Da2b) and Other organic fertilisers applied to soils (including compost) (NFR 3Da2c) the Tier 1 approach according to the 3.D Crop production and agricultural soils has been used [3].

V.3.1.1 Activity data

According to the Tier 1 methodology emissions of NH_3 and NO_X are calculated as a multiplication of amount of N applied into soil and default emission factor. Source of activity data regarding to sludge application and composts production is the Czech Statistical Office. Except composts another organic fertilisers are not estimated. In the e-ANNEX NFR-3D-6 trends of utilisation of sewage sludge are shown. Average N-content in sewage sludge is assumed to be 3.66 kg N per kg dry matter [17] and 0.55 N per kg dry matter in composts in Czechia [18]. In Tab. V.7 and in Tab. V.8 from composts applied on soil are presented.

Tab. V.7 Activity data used to estimate NH_3 and NO_X from sewage sludge, 1990–2020

	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020
Amount of sludge applied on soil (tons of DM)	6 841	28 615	34 467	60 639	63 061	62 551	75 451	88 883	90 663	63 064
N-content (%)	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66
N applied on soil (tons of N)	253	1 058	1 275	2 243	2 333	2 314	2 791	3 288	3 354	2 333

Tab. V.8 Activity data used to estimate NH_3 and NO_X from composts, 1990–2020

	2005	2010	2015	2016	2017	2018	2019	2020
Amount of applied composts (tons of DM)	47 260	70 333	87 275	124 502	130 013	128 619	143 736	145 599
N-content (%)	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
N applied on soil (tons of N)	259	386	480	684	715	707	790	801

Ammonia emissions factors

For calculation of ammonia emissions originating from sewage sludge applied to soils and from other organic fertilizers applied to soils (including compost) default EFs presented in the tab. 3.1 of the 3D EMEP/EEA EIG have been used [3].

NO_X emissions factors

For calculation of NO_X originating from sewage sludge applied to soils and from other organic fertilizers applied to soils (including compost) default EFs presented in the tab. 3.1 of the 3D EMEP/EEA EIG have been used [3].

Ammonia and NO_X emissions

Trends in NH_3 and NO_X emissions originating from sewage sludge applied to soils and from other organic fertilizers applied to soils (including compost) in period 2005–2020 (in kt) are presented in the

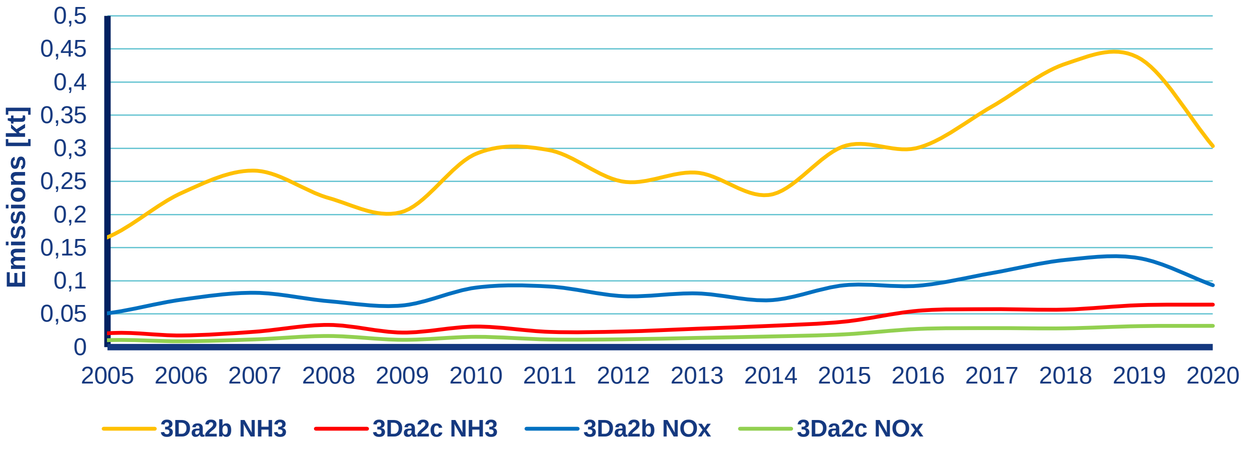

Fig. V.5 NH_3 and NO_X emissions originating from sewage sludge applied to soils and from other organic fertilizers applied to soils (including compost), 2005–2020

V.3.2 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.

V.3.3 Planned improvements

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

V.4 Crop production and agricultural soils – farm-level agricultural operations including storage, handling and transport of agricultural product (NFR 3Dc)

NFR 3Dc comprises fugitive emissions of $PM_{2.5}$ and PM_{10} 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.

Emissions of $PM_{2.5}$ and PM_{10} from Farm-level agricultural operations including storage, handling and transport of agricultural products contribute with 1 % and 9 % respectively of the total $PM_{2.5}$ and PM_{10} emissions production in Czechia in 2020.

Cropped areas of individual crops divided at the level of Nomenclature of Territorial Units for Statistics (NUTS 3) have been obtained from the annual report of the Czech Statistical Office. The main focus has been on areas of monitored cereals as wheat, rye, barley and oats, which are grown on approximately 55 % of arable land. The area taken up by cereal crops has been 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.

V.4.1 Emission factors and calculations

For national estimation of $PM_{2.5}$ and PM_{10} emissions from Farm-level agricultural operations including storage, handling and transport of agricultural products the Tier 2 approach according to the 3.D Crop production and agricultural soils has been used.

V.4.1.1 Activity data

According to the Tier 2 methodology 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. Source of activity data regarding to sowing area of crops is the Czech Statistical Office. In the e-ANNEX NFR-3D3 trends of utilisation of agricultural area and areas under crops (as at 31 May of relevant year) are shown.

$PM_{2.5}$ and PM_{10} emissions factors

For calculation of $PM_{2.5}$ and PM_{10} emissions inventories default EFs presented in the Table 3.5 and 3.7 of the 3D EMEP/EEA EIG, for the region with wet climatic conditions [3]. For rape default EF as for crop cultivation utilisation of different tillage practices (conventional tillage - mouldboard plough or disc ploughland, conservation tillage - low tillage) have been taking into consideration to obtain a more precise calculation of PMs emissions from the agricultural operation. Share of zero tillage (direct seeding) is only 1.5 % in Czechia and was not considered into calculation. 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 PMs for individual operations and individual crops. In the e-ANNEX NFR-3D-4 share of used tillage methods are presented for years 2010 and 2016. In Tab. V.9 frequency of farming operations during the course of the year for individual types of crops is presented.

Tab. V.9 Frequency of farming operations during the course of the year for individual types of crops

Crop	Soil cultivation		Harvesting	Cleaning	Drying
	Conventional tillage	Conservation tillage			
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

$PM_{2.5}$ and PM_{10} emissions

Trends in $PM_{2.5}$ and PM_{10} emissions originating from farm-level agricultural operations including storage, handling and transport of agricultural products in period 1990-2020 (in kt) are presented in the Fig. VI.6.

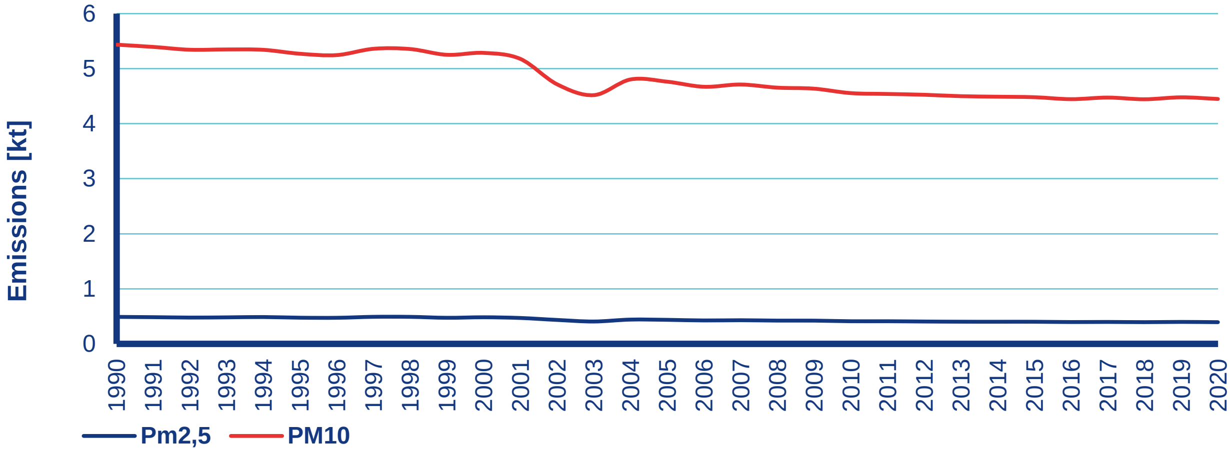

Fig. V.6 $PM_{2.5}$ and PM_{10} emissions originating from farm-level agricultural operations including storage, handling and transport of agricultural products, 1990-2020

V.4.2 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.

V.4.3 Planned improvements

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

V.5 Crop production and agricultural soils – cultivated crops (NFR 3DE)

For NFR 3De cultivated crops NMVOC emissions are estimated. Emissions of NMVOC from Cultivated crops contribute less than 1 % of the total NMVOC emissions production in Czechia in 2020.

V.5.1 Emission factors and calculations

For national estimation of MNVOC emissions from 3De cultivated crops the Tier 2 approach according to the 3.D Crop production and agricultural soils has been used for selected crops (wheat, rye, barley, oats, rape, grain maize, perennial fodder crops – pasture and grass) [3]. For the other crops the Tier 1 has been used. The calculation of the NMVOC emission is based on emission factors recommended in the Table 3.3 of the 3D EMEP/EEA EIG. Since 2022, the AgrEE tool – Agricultural Emission Estimation tool has been used for calculation of NMVOC inventory. This tool was developed by the Air and Climate Unit (C.5) at Joint Research Centre under the Administrative Arrangement between Directorate-General for Environment - Clean Air (ENV.C.3)/JRC-C.5 [19].

Activity data

According to the Tier 2 methodology emissions of NMVOC are calculated as the multiplication of yield of harvested crops and relevant emission factors. Source of activity data regarding to harvested crops and per hectare yields of harvested crops is the Czech Statistical Office. In the e-ANNEX NFR-3D-5 trends of yields of harvested crops are shown.

NMVOC emissions factors

In Tab. V.10 NMVOC emissions factors used for calculation of NMVOC originating from cultivated crops in 2020 are shown. In the e-ANNEX **NFR-3D-7** all activity data used for calculation are presented in all-time series.

Tab. V.10 Emissions factors for selected cultivated crops

Crop	EEA / EMEP EF	Year fraction emitting
	kg NMVOC / kg DM / hour	
Wheat	2.60×10^{-8}	0.3
Rye	1.41×10^{-7}	0.3
Barley	2.60×10^{-8}	0.3
Oats	2.60×10^{-8}	0.3
Rape	2.02×10^{-7}	0.3
Grain maize – other grain	2.60×10^{-8}	0.3
Perennial fodder crops - pasture	1.03×10^{-8}	0.5
Grass land 15°C	1.03×10^{-8}	0.5

NMVOC emissions

Trends in NMVOC emissions originating from cultivated crops in period 1990-2020 (in kt) are presented in Fig. V.7.

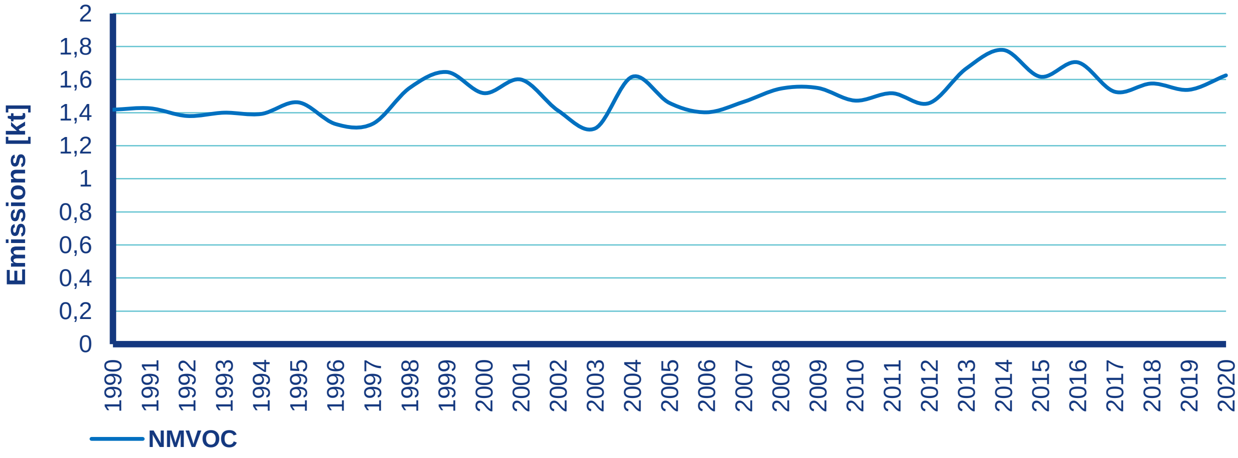

Fig. V.7 NMVOC emissions originating from cultivated crops, 1990–2020

V.5.2 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.

V.5.3 Planned improvements

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

V.6 Other (NFR 3DF, 3F and 3I)

In Czechia NFR 3F 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 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 Czechia in scale specified in Annex III of the Regulation.

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

V.6.1 Emission factors and calculations

For national estimation of HCB emissions from 3Df use of pesticides Tier 1 approach according to the 3.D.f-3.I Use of pesticides and limestone 2019 has been used [20].

Activity data

According to the Tier 1 methodology emissions of HCB are calculated as the multiplication used pesticides and relevant emission factors. Source of activity data regarding to use of pesticides is Central Institute for Supervising and Testing in Agriculture (UKZUZ) available at website of UKZUZ [21]: In the e-ANNEX **NFR-3Df** all activity data used for calculation of HCB are presented in all-time series since 1999.

HCB emissions factors

In Tab. V.11 HCB emissions factors used for calculation of HCB originating from use of pesticides are shown.

Tab. V.11 Emissions factors for selected pesticides

Active Substances	1990	1995	2000	2005	2010	2015
	mg.kg^{-1}	mg.kg^{-1}	mg.kg^{-1}	mg.kg^{-1}	mg.kg^{-1}	mg.kg^{-1}
Altrazine	2,5	1	1	1	not used	not used
Clopyralid	2,5	2,5	2,5	2,5	2,5	2,5
Chlorothalonil	300	300	40	10	40	40
DCPA, Dacthal, Chlorthaldimethyl	1000	1000	40	40	not used	not used
Endosulfan	0,1	0,1	0,1	0,1	not used	not used
Lindane	100	50	50	50	not used	not used
Pentachloronitrobenzene (PCNB), Quintozene	500	500	500	not used	not used	not used
Picloram	50	50	50	50	50	50
Propazine	1	1	1	not used	not used	not used
Simazine	1	1	1	not used	not used	not used
Pentachlorphenol (PCP)	50	50	50	not used	not used	not used

HCB emissions

Trends in HCB emissions originating from use of pesticides in period 1999–2020 (in kt) are presented in Fig. V.8.

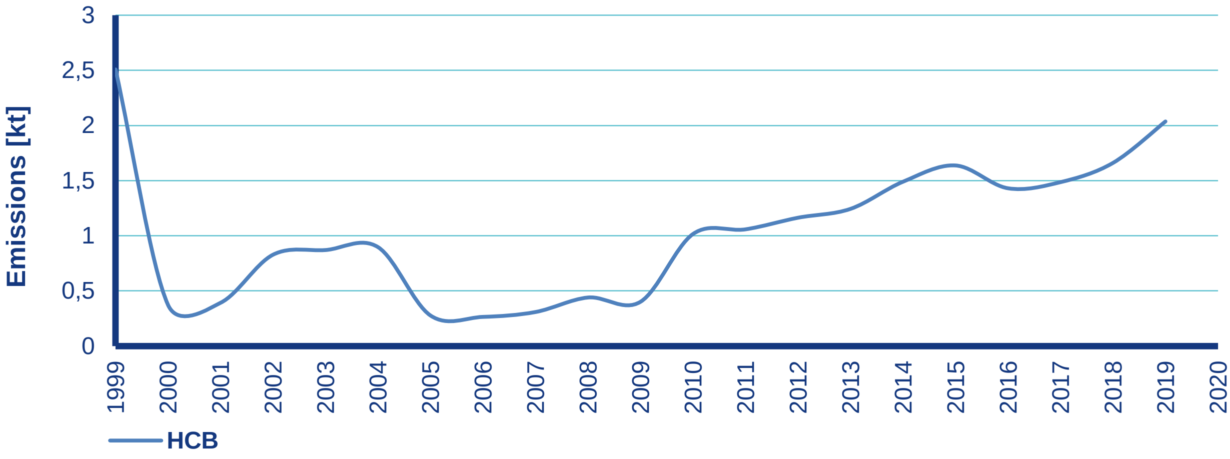

Fig. V.8 HCB emissions originating from used of pesticides, 1999–2020

V.6.2 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.

V.6.3 Planned improvements

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

VI. Waste (NFR 5)

The date of the last edit of the chapter: 15/03/2022

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

Tab. VI.1 NFR categories and Czech classification for NFR 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 – NFR 5C1bv (8.2 %) and PCDD/F – NFR 5E Car and building fires (15.7 %) and NFR 5C2 (5.4 %). Increase of Hg emission from cremations in 2021 was caused by high mortality due to the covid-19 pandemic.

According to Report on the Environment of Czechia 2020 (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 (95.4% in 2020) is held by the generation of non-hazardous waste, rose since 2009 to 38,503.7 kt in 2020. Municipal waste generation also increased in the reporting period by 7.6 % to 5,729.9 kt.

Every year since 2009, the generation of packaging waste has risen to 1,328.7 kt in 2020. A declining trend has long been observed in the generation of hazardous waste (in the period 2009–2020 it dropped to a total of 1,781.8 kt).

The total waste treatment is dominated by waste recovery, particularly material, the proportion of which has long been increasing (see Fig. V.1). Between 2009 and 2020, the share of waste used for material recovery grew from 72.5 % to 86.2 % and the share of waste used for energy recovery from 2.2 % to 3.6 %. The share of waste disposed of by landfilling is reducing (to 9.8 % in 2020) in favour of material and energy recovery.

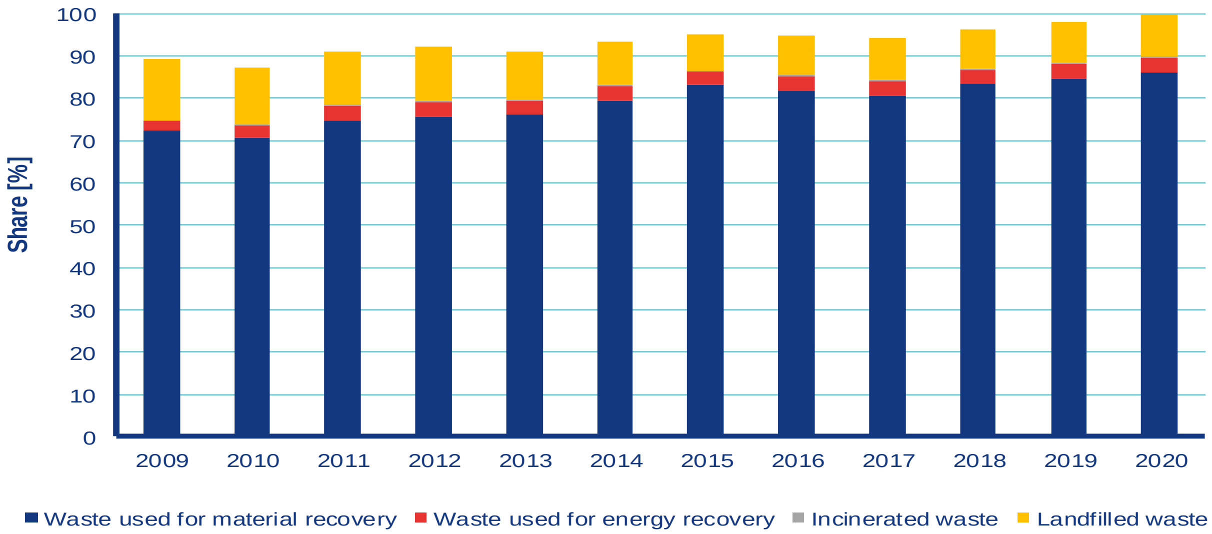

Fig. VI.1 Proportion of selected waste treatment methods in the total waste generation, 2009–2020

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

VI.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 Czechia 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 MoE 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.

Fig. VI.2 Comparison of the amount of deposited and incinerated municipal waste, 1990–2020

Fig. VI.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 – NFR 5C1a). Pursuant to State Energy Policy and Decree 352/2014 Coll. (see e-ANNEX), on the Waste Management Plan of Czechia 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.

VI.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 TSP, PM_{10} and $PM_{2.5}$ were taken from the EMEP/EEA EIG (Tier 1 approach) [3]. On the recommendation of the Technical Expert Review Team (TERT) emissions were calculated 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 Czechia gets extracted and burned in co-generation units with energy recovery for different sectors according to NACE classification. It predominantly takes place in NFR 1A4ai and 1A2gviii. There are no estimates available on the emission factors for the other pollutants.

Emissions for historical period 1990–1999 were calculated using activity data estimated based on National Greenhouse Gas Inventory Report of Czechia submitted 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.

NMVOC emissions for all years were recalculated using methodology recommended by TERT. This methodology was developed to estimate a NMVOC EF for on the basis of CH_4 emissions reported in the framework of the UNFCCC reporting. To do so, CH_4 emission ratio per tonne of disposed waste (based on Czech UNFCCC 2020 reporting) was used, converted it into a volume of CH_4 per tonne of disposed waste (using the molecular volume of CH_4) and then into a volume of biogas per tonne of disposed waste (applying the fraction of CH_4 in biogas F = 50 %) and then the fraction of NMVOC in biogas (5.65 g/m^3 of landfill gas), presented in the note at the bottom of table 3-1, chapter 5A of the EMEP/EEA EIG was applied [3].

VI.1.2 Uncertainties and QA/QC procedures

Emissions for NFR 5A are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter I.7 General uncertainty evaluation

QA/QC for NFR 5A is the same as in case of other collectively monitored sources, see also chapter I.6 QA/QC and Verification methods

VI.1.3 Planned improvements

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

VI.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 VI.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.

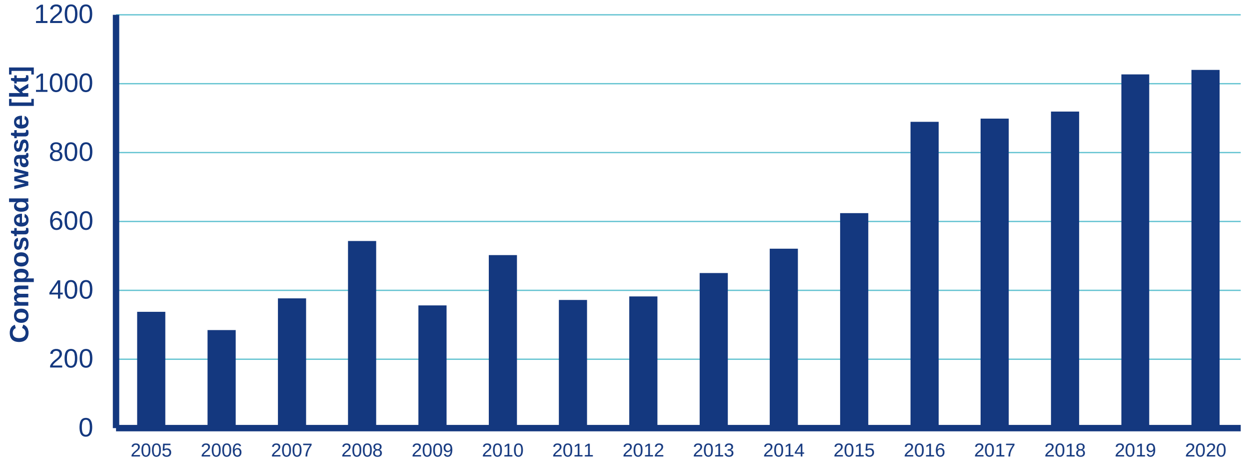

Fig. VI.3 The trend in the waste composting, 2005–2020

As is shown in Fig. V.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 2020, 339 biogas stations in operation were registered in REZZO database.

Czech national legislation does not specify emission limit values or technical conditions of operation for this category. Due to the hermetisation the biogas plant are not expected any releases of air emissions. The small amounts of emissions of NO_X, NMVOC, SO_X, 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 1A4ai.

Data for NFR 5B2 were supplied by VUZT. Activity data were obtained from websites of association CZBA (https://www.czba.cz/en.html). Here is freely accessible map of biogas plants (BP), which contains information about starting date of operation and power (heat and electric). They are divides into agricultural BP (397), BP in landfills (58), industrial BP (21) and BP in water treatment plants (98). Based on these data was found the gradual commissioning of agricultural BP. Table VI.2 illustrates year of commissioning, number of BP and cumulative installed electric power for agricultural BP.

Tab. VI.2 Commissioning of agricultural biogas plants

Year of commissioning	Number of agricultural BP	Cumulative installed electric power [MW]
2001	2	1.760
2002	7	5.452
2003	0	5.452
2004	0	5.452
2005	1	6.550
2006	5	10.149

2007	7	15.887
2008	32	39.250
2009	43	76.442
2010	42	11.3057
2011	72	17.5393
2012	127	284.297
2013	59	319.264
2014	0	319.264
2015	0	319.264
2016	0	319.264
2017	0	319.264
2018	0	319.264
2019	0	319.264
2020	0	319.264

It is apparent that the highest increase of BP number was achieved in the period 2008–2013. Since 2013, their number remained constant. This fact is also shown in Figure VI.4 below.

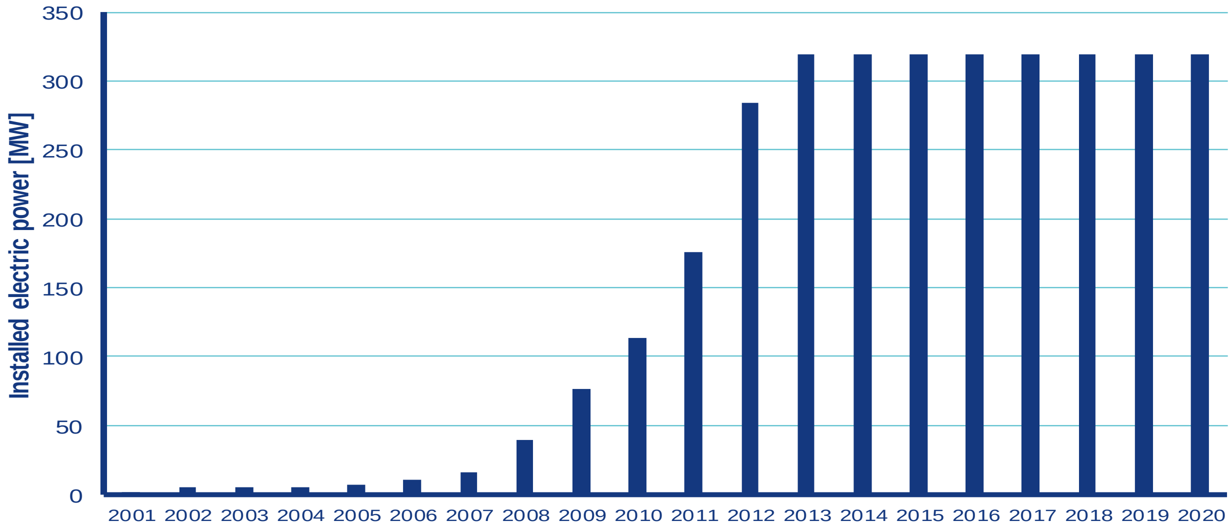

Fig. VI.4 Installed electric power of agriculture biogas plants, 2001–2020

VI.2.1 Emission factors and calculations

Emissions of NH_3 for NFR 5B1 Composting were calculated using emission factor from EMEP/EEA EIG (Tier 2) [3].

Emissions of NH_3 for NFR 5B2 Anaerobic digestion at biogas facilities were calculated only for agricultural biogas plants and were calculated using Manure management N-flow tool, used to calculate NH_3 emissions for the NFR 3B Manure management.

VI.2.2 Uncertainties and QA/QC procedures

Emissions of NH_3 for NFR 5B are calculated based on official statistics and default emission factor, uncertainty is therefore estimated from 50 up to 200 % , see also chapter I.7 General uncertainty evaluation.

QA/QC for NFR 5B is the same as in case of other collectively monitored sources, see also chapter I.6 QA/QC and Verification methods

VI.2.3 Planned improvements

In 2019, a MEMORESP project (https://www.cenia.cz/projekty/aktualni-projekty/memoresp/) was launched, it will be completed in 2022. This project deals, inter alia, with the development of methodology for estimation of household composting Research was initiated to obtain data about composting before 2005, too. Data will be available probably in reporting year 2023.

TERT recommends a first approach a rough estimation could be done using the number of plants in the time series as a proxy indicator. However, the number of facilities is also not available (their evidence in the REZZO database is restricted by capacity). It is not even possible to perform a simple extrapolation of data, because on the website of the association CZ Biom (https://biom.cz) was found that after 1990, after the restructuring of agriculture, interest in composting fell sharply at the expense of landfilling and incineration of biodegradable waste, it has increased again after 1998 (see expert article https://biom.cz/cz/odborne-clanky/kompostovani-biodegradabilnich-odpadu-v-ceske-republice).

VI.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 NFR 5C1bii (Hazardous waste incineration) is not considered separately; incineration of hazardous waste is included in NFR categories 5C1bi and 5C1biii. NFR 5C1biv is at present represented by a single facility for incineration of waste sludge, which was out of operation in years 2014–2020, 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 Czechia (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) 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 Czechia 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 NFR1A2f 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 Czechia. 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 1990–2020. 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 1990–2020 is illustrated Fig. VI.5 and Fig. VI.6.

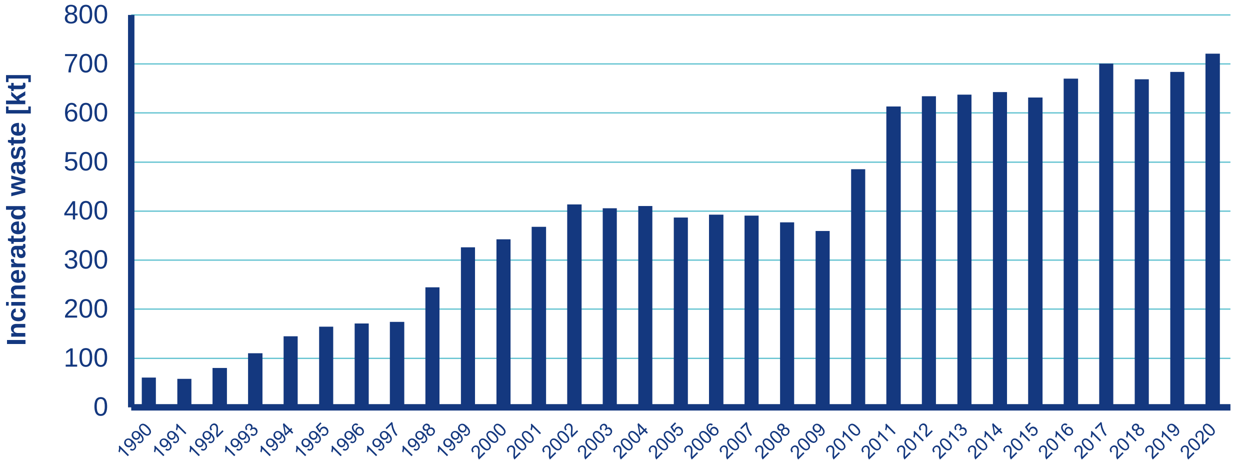

Fig. VI.5 Municipal waste incinerated, 1990–2020

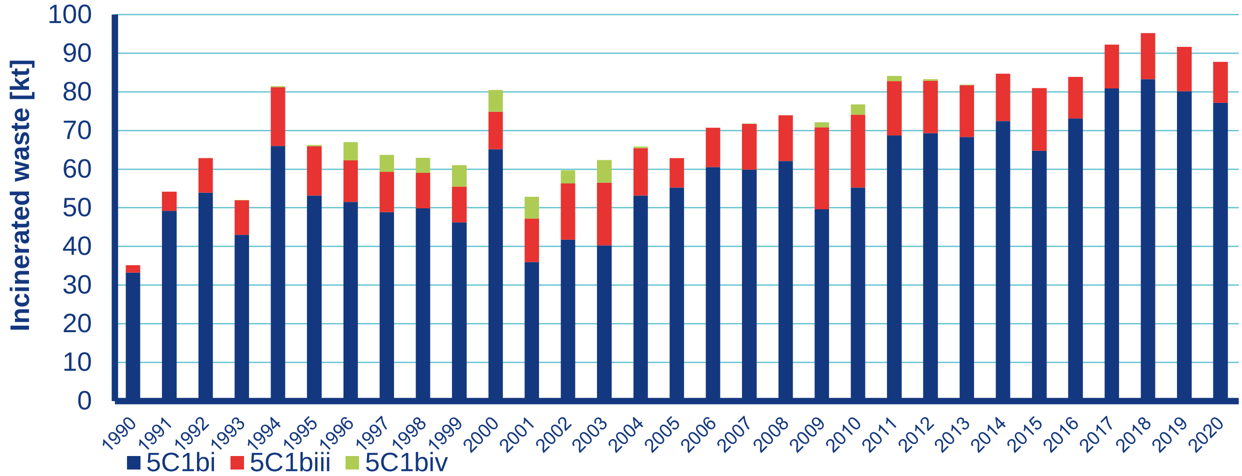

Fig. VI.6 Other waste incinerated, 1990–2020

It is clear from Fig. VI.5 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 2002–2020 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 were reduced again, noticeable decrease is apparent in inventorying starting 2018.

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 Fig. VI.6 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 NFR 5C1. This fact is also reflected in the variable amount of emissions of all pollutants.

In the period 2002–2020, 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.

VI.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 2000–2020 and 1990–1999 was different and is therefore described for each period separately.

I.1.1.1 Methodology for period 2000–2020

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, NMVOC, SO_X, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni and PCDD/F. In addition, NH_3 emissions are reported in the case of its use in the selective non-catalytic reduction of nitrogen oxides, therefore it has an emission limit set in order to reduce its emissions. 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 EIG, 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 [3].

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

Tab. VI.3 Emission factors of heavy metals and POPs not reported used for categories 5c1a–5c1biv

NFR	Zn	Se	B(a)P	B(b)F	B(k)F	I(1,2,3-cd)P	HCB	PCBs
[$mg.t^{-1}$]								

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

I.1.1.2 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 and found comparable order of magnitude [3]. 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 2000–2020.

Specific emission factors set for purposes of emission inventory for the categories 5C1a–5C1biv in 1990–1999 are presented below in Tab. VI.4 and Tab. VI.5.

Tab. VI.4 Emission factors of basic pollutants for categories 5C1a–5C1biv, 1990–1999

NFR	TSP	SO_X	NO_X	CO	TOC
	[kg.t^{-1}]				
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

Tab. VI.5 Emission factors of reported heavy metals and PCDD/F for categories 5C1a–5C1biv, 1990–1999

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	PCDD/F
	[mg.t^{-1}]							
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.

Most of facilities in CR 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. For this reason, emissions and activity data for all plants in categories 5C1a–5C1biv were allocated under 1A1a (see also chapter 3.1). All sources in NFR 5C1a are facilities for energetic utilisation of waste (see also chapter 6.3.), symbol "NO" was therefore used in the entire time series. In the case of other categories utilization of heat is not so clear, symbol "IE" was used.

VI.3.2 Uncertainties and QA/QC procedures

According to national legislation, emissions for stationary sources belonging to NFR 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 I.7 General uncertainty evaluation.

QA/QC for categories 5C1a–5C1biv is the same as in case of other stationary point sources, see also chapter I.6 QA/QC and Verification methods.

VI.3.3 Planned improvements

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

VI.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 Czechia. 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 Fig. VI.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 Fig. VI.7.

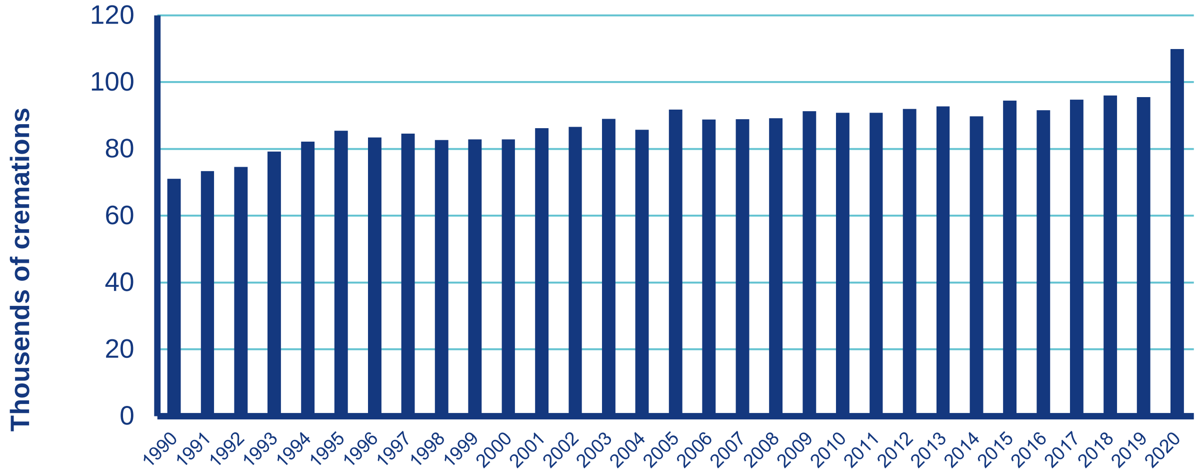

Fig. VI.7 The cremation, 1990–2020

VI.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_X, 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 Tab. VI.6.

Tab. VI.6 Emission factors for basic pollutants in NFR 5c1v, 1990–1994

Pollutant	Value	Unit
TSP	0.031	kg/body
SO_X	0.022	kg/body
NO_X	0.321	kg/body
CO	0.059	kg/body
NMVOC	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 .

National emission factors for heavy metals including Hg were determinated based on study "Emission factors setting and imission contribution of stationary source for the purpose of subsidy application of Operation programme the Environment" (see e-ANNEX), performed by the company Technical services for air protection Prague, a.s. in 2014. This study is focused on setting of emission factors for various technologies, cremation is one of them. Emission factors were stated by combination of research of literary resources and measurements provided on plants in CR. In the case of crematoriums, measurements were provided on eleven representative plants equipped with typical abatement technologies (usually gas combustion in the flame). The proposed emission factors are identical with those stated in the EMEP/EEA EIG [3].

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 CZSO. Incineration of animal tissues was not included in the balance of heavy metals, which also applies to activity data.

Tab. VI.7 Shares of cremations in the total number of funerals

Year	Share of cremations [%]
1920	0.37
1925	2.09
1930	3.32
1935	4.04
1940	5.01
1945	8.11
1950	11.60
1955	19.63
1960	24.26
1966	45.54
1970	39.00
1975	45.00
1980	64.40
1986	53.54
1990	55.22
1995	72.50
2000	75.94
2005	84.66
2008	84.72

VI.4.2 Uncertainties and QA/QC procedures

According to national legislation, emissions of TSP, NO_X, CO and NMVOC and SO_X for stationary sources belonging to NFR 5C1bv 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 I.7 General uncertainty evaluation.

QA/QC for category 5C1bv is the same as in case of other stationary point sources, see also chapter I.6 QA/QC and Verification methods.

VI.4.3 Planned improvements

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

VI.5 Other waste incineration and Open burning of waste (NFR 5C1BVI and NFR 5C2)

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

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.

Activity data (types of utilised land) were obtained from website of the CSO, Catalogue of Products *https://www.czso.cz/csu/czso/ceska-republika-od-roku-1989-v-cislech-aktualizovano-1452021)* Table. 02.02 – Lands by species. The trend in types of utilised land in the period 1990–2020 is illustrated below inFig. VI.8. Here are shown all types of utilised land, for calculation of emissions only selected types were used (see VI.5.1).

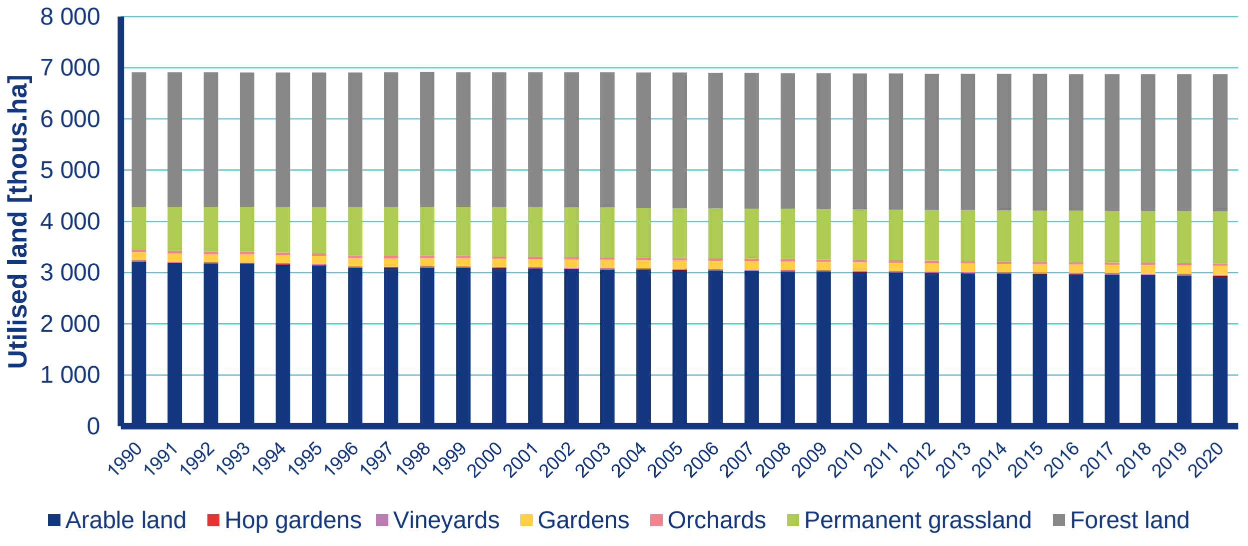

Fig. VI.8 Utilised land, 1990–2020

VI.5.1 Emission factors and calculations

Emissions for 5C2 were calculated pursuant to EMEP/EEA EIG [5], (Tier 1). Areas in forestry, orchard and arable farming were taken into account, assuming that amount of burned waste is 25 kg per hectare.

VI.5.2 Uncertainties and QA/QC procedures

Emissions for NFR 5C2 are calculated based on official statistics and default emission factor, uncertainty is therefore estimated from 50 up to 200 % , see also chapter I.7 General uncertainty evaluation.

QA/QC procedures for NFR 5C2 is the same as in case of other collectively monitored sources, see also chapter I.6 QA/QC and Verification methods.

VI.5.3 Planned improvements

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

VI.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 1990–2020 is illustrated below.

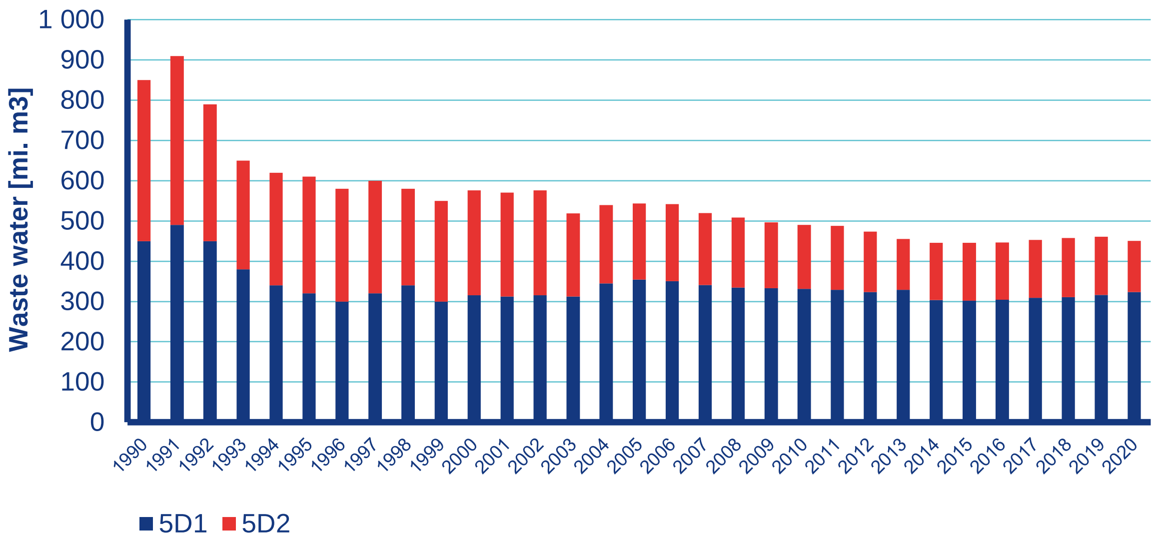

Fig. VI.9 Wastewater handling, 1990–2020

VI.6.1 Emission factors and calculations

In the Summary operation records are reported emissions NO_X, NMVOC, SO_X, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO originating from flares. These emissions were removed from NFR 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 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 average ratio between subcategories 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 EIG (Tier 1) [3]. Activity data for sector 5D3 are not available.

VI.6.2 Uncertainties and QA/QC procedures

Emissions of NMVOC for NFR 5D are calculated based on official statistics and default emission factor, uncertainty is therefore estimated from 50 up to 200 % , see also chapter I.7 General uncertainty evaluation.

QA/QC for NFR 5D is the same as in case of other collectively monitored sources, see also chapter I.6 QA/QC and Verification methods.

VI.6.3 Planned improvements

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

VI.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 EIG, accidental fires of car and buildings are included in this category [3]. 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 Czechia (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. Activity data for remaining year 1990 were supplemented according to 1991.

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

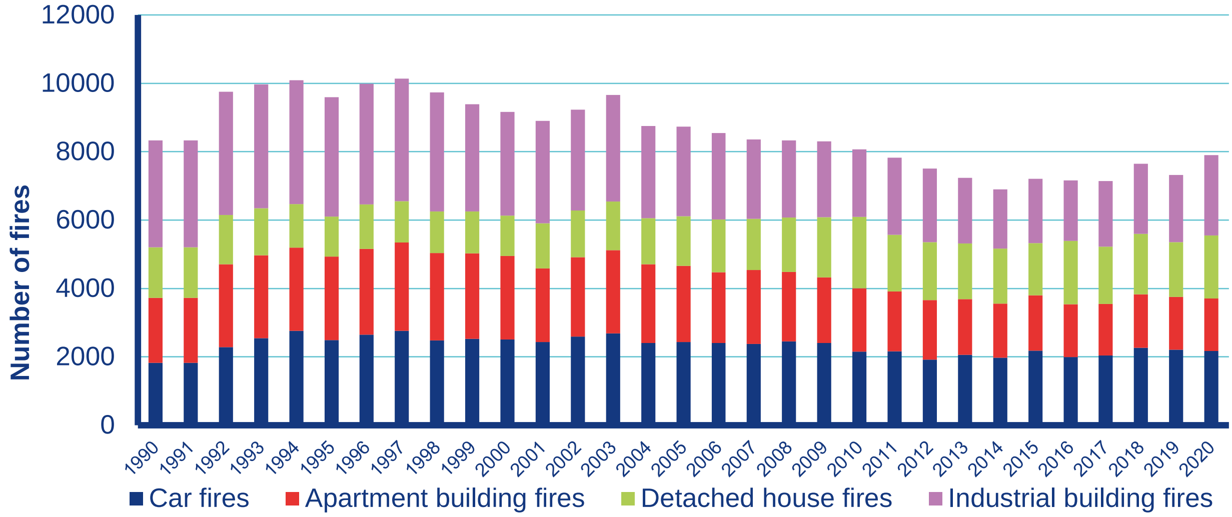

Fig. VI.10 Fires, 1991–2020

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.

VI.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 EIG, in division into EFs for fires of cars, apartment buildings, detached houses and industrial buildings were used (Tier 2) [3]. Overview of used emission factors is presented below.

Tab. VI.8 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

VI.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 I.7 General uncertainty evaluation.

QA/QC for NFR 5E is the same as in case of other sources (divided into individually and collectively monitored), see also chapter I.6 QA/QC and Verification methods.

VI.7.3 Planned improvements

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

VII. Other and natural emissions

The date of the last edit of the chapter: 15/03/2022

There is no active volcano on the territory of Czechia, 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, NH_3, SO_X and particulates are produced.

VII.1 Forest fires (NFR 11B)

Activity data (hectares of burned area) were obtained from Statistical Yearbooks of Fire Rescue Service of Czechia (FRS CR). They are available since 1996 and are accessible to the public on https://www.hzscr.cz/hasicien/article/statistical-yearbooks.aspx . Fig. VII.1 illustrates development of forest areas affected by fire in 1996–2020.

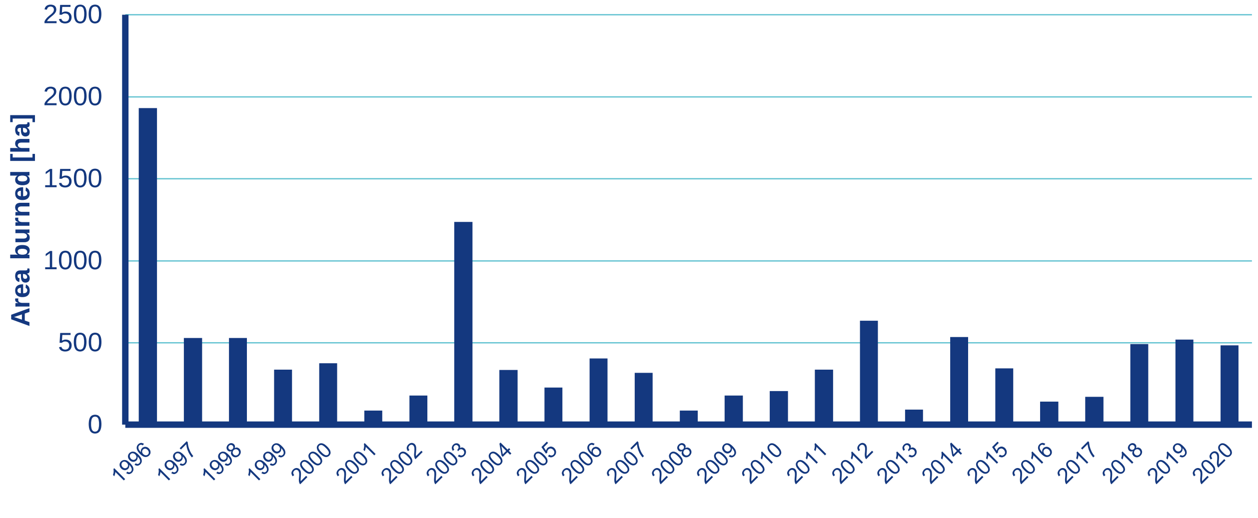

Fig. VII.1 Forest fires, 1996–2020

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).

VII.1.1 Emission factors and calculations

For emission inventorying emission factors from the EMEP/EEA EIG, version 2016, were used (Tier 2) [3]. In the case of Czechia, EFs for temperate forests were chosen.

For the period 1996–2020 emissions of NO_X, CO, NMVOC, SO_X and 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.

VII.1.2 Uncertainties and QA/QC procedures

Emissions for NFR 11B are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200 % , see also chapter I.7 General uncertainty evaluation.

QA/QC for NFR 5D is the same as in case of other collectively monitored sources, see also chapter I.6 QA/QC and Verification methods.

VII.1.3 Planned improvements

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

VIII. Recalculations and improvements

The date of the last edit of the chapter: 15/03/2022

VIII.1 General recalculations in 2022

The full set of data for period 1990–2020 in NFR format 2020 is reported in 2022. Several corrections of reported data were performed including particularly:

- Recalculation (2000) of NO_X emissions in NFR 2A3 (one significant plant was added)
- Recalculation (1990–2004) in NFR 2A5b according a trend of clinker production
- Recalculation (2014–2019) of CO emissions in NFR 2C1 due to mistake
- Recalculation (1990–2019) of Hg emissions in NFR 2C1 due to mistake
- Recalculation (1990–2019) of HCB emissions in NFR 2C3 using the recommended EF
- Recalculation (1990–2020) NMVOC emissions in NFR 3De
- Recalculation (1997–2020) HCB emissions in NFR 3Df
- Recalculation (2000–2020) NH_3 emissions in NFR 5B2
- Recalculation (1990–2020) NH_3 emissions in NFR 3B
- Recalculation (1990–2020) NH_3 emissions in NFR 3Da1
- Recalculation (1990–2020) NH_3 emissions in NFR 3Da3
- Recalculation (1990–2020) NO_X emissions in NFR 3B
- Recalculation (1990–2020) NO_X emissions in NFR 3Da1
- Recalculation (1990–2020) NO_X emissions in NFR 3Da3
- Recalculation (1990–2020) NMVOC emissions in NFR 3B
- Several minor corrections – detailed in e-Annex

VIII.2 Recalculations and Improvements in Transport

VIII.2.1 Recalculations

VIII.2.1.1 Aviation

CZ obtained more accurate data on jet kerosene consumption for domestic aviation, by obtaining either bottom-up data from EUROCONTROL in time series 2005 – 2020 for IFR flights. Time series 1990 – 2005 was estimated by extrapolation of EUROCONTROL fuel consumption with help of fuel consumption from CzechOIL questionnaire provided by CZSO. Emissions were calculated with EUROCONTROL implied emission factors.

For VFR flights ratio between LTO a CRUISE was obtained from ÚCL as their expert judgement because there is no database in n CZ for VFR flight characteristics. These ratios and EFs were applied on fuel consumption obtained from CZSO. Fuel consumption for helicopters was obtained from CZSO. Ratio between LTO and Cruise from ÚCL. EFs according table 3.10. in EMEP/EEA EIG 2019 was applied on fuel consumption VFR flights. Also 1 kt (based on CZSO estimation) of kerosene from 2007 until present year was subtracted from 1A4aii and added to 1A3a ((represented helicopters fuel consumption). EFs according table 3.11. in EMEP/EEA EIG 2019 was applied on fuel consumption of helicopters. Reason is that helicopters was originally reported under 1A4aii, which was considered to be unprecise. In addition army air force emissions are newly calculated in aviation subsector. Due to this change there was significant shift of 90 % kerosene fuel consumption from 1A5b to 1A3a from 2002 until present. EFs according table 3.11. in EMEP/EEA EIG 2019 was applied on fuel consumption for army air force.

Fuel consumption for Aviation was fuel balanced on fuel consumption stated in CZSO for jet kerosene and aviation gasoline, to ensure comparability of statistics.

Method for VFR flights, helicopters and army air force in general is on Tier 1 level. Main pollutants from EUROCONTROL are on Tier 3 level. Other pollutants are still on Tier 1 Level even though the emission factors have been actualized according the newest version of EMEP/EEA EIG.

In general, there was a mistake in activity data for Aviation gasoline. The data for national and international aviation was switched. Now they are in line with data in CzechOil questionnaire reported by CZSO to EUROSTAT.

VIII.2.1.2 **NFR 1A3b Transport**

Every year is necessary to make recalculation four years backwards, because of methodology of obtaining transport performance data. Transport performance is calculated from national database of technical controls. Due to Czech law, all vehicles are checked by technical controls in four year cycle (especially new cars, older cars in one or two years). In this submission the time series for road transport 2016 – 2019 was recalculated due to this methodological issue.

This year inventory for road transport was made in new version of COPERT 5.5. Last year inventory was made in version 3.3 which means these changes:

- Updated Diesel PC and LDV (N1-I) Euro 5 emission factors for NO_X, VOC and CO, new category added (with software update)
- Updated Euro 6 updated emission factors
- New vehicle categories added
    - Petrol PHEV
    - Diesel PHEV
    - Busses Hybrid
- PMs exhaust for petrol hybrid passenger cars added
- Correction in the calculation of NH_3 emissions for PC LPG & CNG and Urban Buses CNG.
- Correction in the calculation of HMs emissions.
- Correction of NO_X emission factors for PC Diesel PHEV (Euro 6d-temp and 6d).
- Correction of hot emission factors for Quad & ATVs and Micro-cars.
- Updated PMs exhaust emission factors. Affected vehicle categories:
    - PCs (Euro 5, Euro 6 a/b/c, Euro 6 d-temp, and Euro 6d)
    - LCVs (Euro 5, Euro 6 a/b/c, Euro 6 d-temp, and Euro 6d)
    - HDVs and Busses (Euro V, Euro VI A/B/C and Euro VI D/E)
    - L-category vehicles (Euro 4 and Euro 5)
- Corrected PMs exhaust emission factors for PC LPG Bifuel ~ LPG and CNG Bifuel ~ CNG for Euro 6 a/b/c, Euro 6 d-temp, and Euro 6d
- New calculation of BC from road abrasion

<u>Changes due to analyses of Czech Car Registry and database of Technical Control:</u>

- New activity data for motorcycles and updated data of other categories in road transport.

These two main changes described above led to changes in trends for all pollutants in all categories between submissions 2021 and 2022. Here are described only changes of NO_X time series 2005 – 2019 (see graphs below). Changes for all pollutants in whole time series you can find in e-ANNEX.

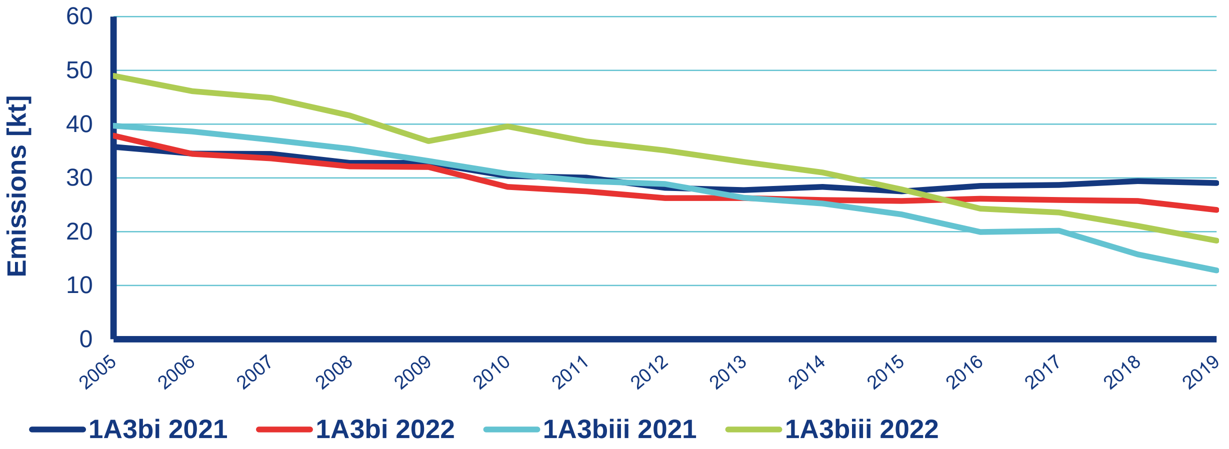

Fig. VIII.1 NO_X emissions for PCs and HDVs, Buses (2005–2019)

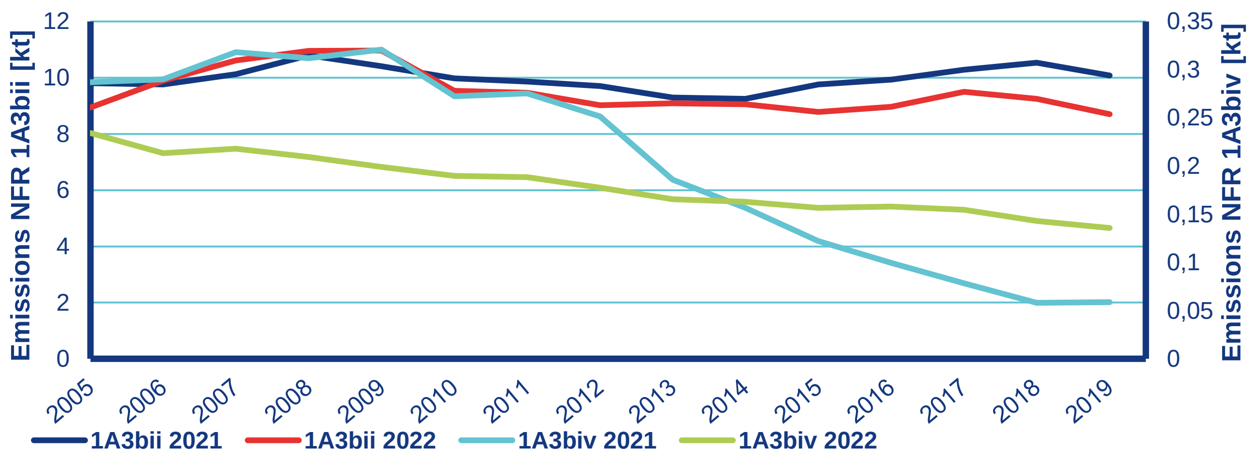

Fig. VIII.2 NO_X emissions for LDVs and Motorcycles (2005–2019)

Changes due to updated activity data from CZSO:

- Bioethanol FC change in 2019 (from 113 kt to 114 kt)
- 1A4aii kerosene – changes due to new methodology for calculating emissions from aviation. 1 kt (based on CZSO estimation) of kerosene from 2007 until present year was subtracted from 1A4aii and added to 1A3a.Reason is that helicopters was originally reported under 1A4aii, which was considered to be unprecise.
- 1A4bi gasoline - change in 2019 (from 6 kt to 5 kt)
- 1A5b diesel – changes in 2017 and 2015
- 1A5b jet kerosene - updated values in 2011, 2014, 2019. In addition, due to change of methodology and newly calculating army air force emissions in aviation subsector there was significant shift of 90 % kerosene fuel consumption from 1A5b to 1A3a from 2002 until present year

VIII.2.1.3 Other sectors

Recalculations due to error in calculating spreadsheet:

- it was necessary to actualize EF for BC in 1A4bii between 2007 – 2019. EF in model had linear change towards zero, which was incorrect.

- EF for 1A3d for B(k)F was actualized in whole time series because every year raised, by mistake by 1.
- EF for 1A5b for SO_2, jet kerosene was, by mistake, based on sulphur content in diesel. Now the EF values are in line with sulphur content in kerosene

VIII.2.2 Improvements

Methodology according chapter A.5 of EMEP/EEA EIG 2019 for uncertainties was involved this year. Newly uncertainties are calculated according pollutants for the whole transport sector. I the last It was all pollutants in one subsector and uncertainties was evaluated by subsectors.

New methodology for Aviation described in chapter VIII.2.1.1

VIII.3 Recalculations and improvements in Agriculture

Compared with the previous NH_3, NO_X and NMVOC emissions inventory (submission 2021), some changes and updates have been made, see Tab. VIII.1. These changes cause an decrease in the total NH_3 emissions for all years (1990-2019), an increase for NO_X emission for years 1990–1995 and an decrease for years 2000-2019 and increase in NMVOC emissions for years 1990-2019 except around year 2000.

Tab. VIII.1 NH_3, NO_X and NMVOC emissions inventory submissions

NH_3 emissions [kt]	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**
- **2021 submission**	159.6	109.2	100.8	94.2	85.5	100.6	83.5	79.6	79.5	77.7
- **2022 submission**	138.9	86.8	77.4	71.2	61.8	72.7	73.0	72.4	67.6	64.8
Difference [%]	-13	-21	-23	-24	-28	-28	-13	-9	-15	-17
NO_X emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- **2021 submission**	20.4	16.1	17.6	17.7	17.6	23.4	20.2	21.5	19.9	19.7
- **2022 submission**	27.5	16.5	15.7	17.5	16.3	21.2	21.2	21.0	19.7	19.4
Difference [%]	26	2	-11	-2	-7	-9	-4	-2	-1	-1
NMVOC emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- **2021 submission**	70.5	42.5	38.4	34.5	32.2	33.6	31.5	31.2	32.4	31.8
- **2022 submission**	70.4	42.5	37.6	38.9	32.4	34.9	35.8	36.5	37.8	37.5
Difference [%]	0.2	0	-2	1	1	4	12	15	14	15

VIII.3.1 NH_3 and NO_X emissions

A range of changes has been made for NH3 and NOx emissions. Ammonia emissions have decreased in range from 9 to 28% for the years 1990 – 2019, NOx emissions have decreased in range from 1 to 11% for years 2000 - 2016 compared to submission 2021. Recalculations for the subcategories are mentioned below.

VIII.3.1.1 *NFR 3B Manure management*

Emissions of NH_3 and NOx from manure management has been recalculated due to unification of input data used for GHG, NH3, NOx inventories and the gross nitrogen balance per hectare of utilised agriculture area for the Czech Republic.

Till submission 2021of GHG emissions inventory, the Tier 2 procedures for estimation of nitrogen excretion rates for dairy cattle and other cattle have been used. The rates were calculated from typical animal mass data and estimated nitrogen excretion. The nitrogen excretion rate for dairy cattle and other cattle was compared with the default Nex rate factors available for the Western Europe region in IPCC 2006 Gl. (Table 10.19). These rates were evaluated as overestimated.

Dairy cattle, Nex rate (kg N/1000 kg animal mass/day):

Default value (T.10.19 IPCC GL) = 0.48,

- country specific value (GHG Submission 2020) = 0.8
- country specific value (GHG Submission 2022) = 0.46

Non-dairy cattle, Nex rate:

Default value= 0.33,

- country specific value (GHG Submission 2020) = 0.45
- country specific value (GHG Submission 2022) = 0.40

The calculation of the Nex rate for individual categories of livestock was newly derived by means of coefficients (excretion kg N/head/year) specified in the Czech Decree No. 377/2013 Coll. on the storage and use of fertilizers. This Decree contains values of the average annual nitrogen production, calculated per unit of livestock (1 Livestock Unit = 500 kg live weight of animals). These values were used as coefficients for the Nex rate calculating. The reported coefficients were obtained based on the study by the Ministry of Agriculture of the Czech Republic (research project No. QH82283 “Study on interaction between water, soil and environment from the point of view of manure management in sustainable agriculture”, 2008 - 2012). The aim of this study was to analyse manure production in different systems of animal housing used in the Czech Republic. The research was based on a detailed survey of the annual manure production per one livestock unit (LU), considering the technological systems of animal housing, the production of various types of manure and species and categories of animals.

Since 2019 these Nex rates have been used for recalculation of the Gross nitrogen balance on agricultural land for the Czech Republic and for recalculation of GHG inventory (submission 2021). Since 2022 these Nex rates have been used for calculation of NH_3 and NO_X. New Nex rates were used for all-time series (1990 – 2020).

Furthermore, the animal waste management system (AWMS) was updated based on a long-term statistical survey of agricultural farms in the Czech Republic. This investigation, which has been ongoing since 2005, evaluates crop production and livestock production of the farms. From the point of view of AWMS, data of livestock housing systems are processed every year. A further complementary basis for the uniform calculation of the AWMS was the statistical study of the IAEI (Institute of Agricultural Economics and Information), which surveyed farms for manure transferred annually to biogas stations. Newly, emissions of NH_3 regarding biogas production were implemented in inventory in all time series (since 2000). This change influenced animal waste management system (AWMS). In the e-ANNEX **NFR 3B_3** all newly used AWMS are presented.

Finally, recalculation of NH3 and NOx emissions from manure management and animal manure applied to soils have been made due to implementation of some low-emissions storage and manure application techniques into inventory. In the e-ANNEX **NFR 3B_5** details are presented. This recalculation was carried out for all years 1990-2019. Tab. VIII.2 shows the effects of recalculations on NH_3 and NO_X between submission 2021 and 2022.

Tab. VIII.2 Comparison of NH_3 and NO_X emissions from manure management of the submissions 2021 and 2022

NH_3 emissions [kt]	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**
- **2021 submission**	88.9	58.0	51.3	45.5	38.4	37.5	32.4	32.0	33.3	32.5
- **2022 submission**	78.7	48.7	42.0	34.5	27.6	24.9	24.8	24.5	24.5	24.2
Difference [%]	-11	-16	-18	-24	-28	-33	-23	-24	-27	-25
NO_X emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- **2021 submission**	1.73	1.10	1.02	0.81	0.74	0.72	0.83	0.82	0.86	0.75
- **2022 submission**	1.96	1.16	0.97	0.83	0.73	0.70	0.69	0.70	0.69	0.70
Difference [%]	12	5	-5	2	-1	-3	-17	-15	-20	-7

The emissions of NH_3 decreased by 21–35 % and emissions of NO_X decreased by 2–10% in the years 1990–2010 and increased by 13–32% compared to submission 2021.

VIII.3.1.2 *NFR 3Da1 Inorganic N-fertilisers*

The Czech Republic has followed the way of NH_3 and NO_X emissions calculation from 3Da1 Inorganic N-fertilisers as Germany. The Czech statistics similarly to German statistics report the amounts of fertilizers sold which are assumed to equal the amounts that are applied. These data are handing over to IFASTAT via Fertilisers Europe, where are presented as “fertilisers consumption.” In order to approximate storage effects that have not yet been taken into account in the inventory, from the present 2022 submission onwards, the mineral fertilizer data will be averaged over the years (moving cantered three-year mean for 1990 to 2019; for 2020 a mean from 2019 and 2020). The time averaging leads to a smoothing of extreme values and redistribution of emissions between neighbouring years. Tab. VIII.3 shows the effects of recalculations on NH_3 and NO_X between submission 2021 and 2022.

Tab. VIII.3 Comparison of NH_3 and NO_X emissions from mineral N fertilisers of the submissions 2021 and 2022

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
2021 submission	19.8	16.7	17.1	19.2	16.0	37.5	29.2	25.6	23.2	21.9
2022 submission	22.1	14.1	15.3	20.0	18.5	31.4	32.1	30.7	26.0	23.6
Difference [%]	10	-18	-12	4	14	-19	9	16	11	7
NO_X emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
2021 submission	8.1	8.1	10.5	11.6	11.8	17.8	14.1	15.4	13.6	13.6
2022 submission	15.2	8.8	9.2	11.8	11.1	16.0	15.9	15.8	14.4	14.1
Difference [%]	47	9	-12	2	-6	-10	12	2	6	4

On Fig. VIII.3 effects of time averaging on smoothing of extreme values and redistribution of NH_3 emissions between neighbouring years is shown.

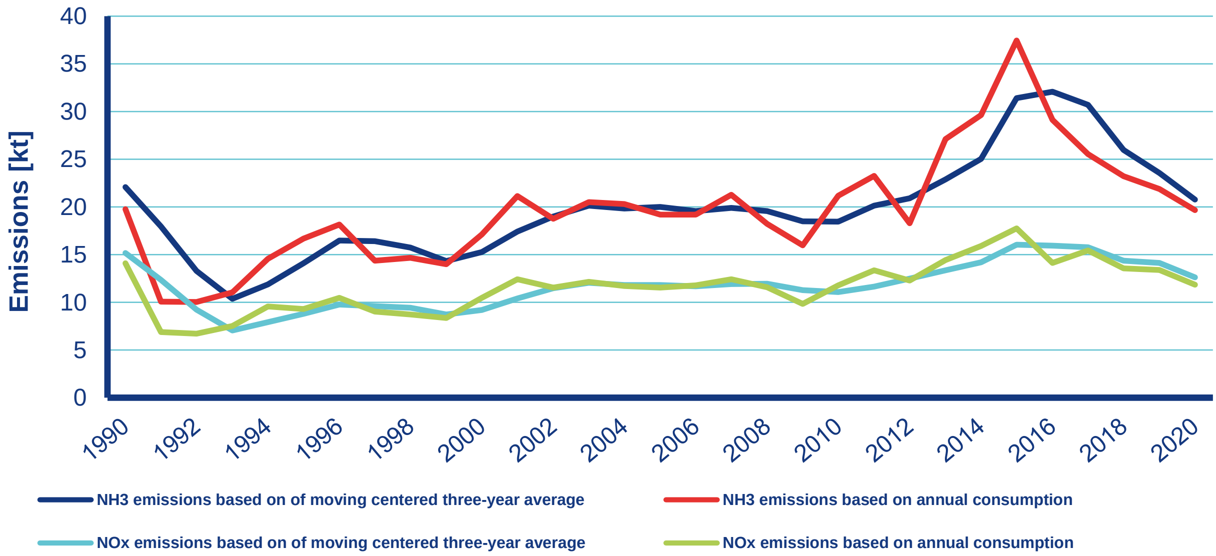

Fig. VIII.3 Ammonia and NO_X emissions from N mineral fertilisers after recalculation

VIII.3.1.3 NFR 3Da2a Animal manure applied to soils

A recalculation of NH_3 and NO_X emissions from animal manure applied to soil has been made for all years 1990-2019 due to implementation of use of low-emission manure spreading techniques for the application of manure and slurry into inventory. Tab. VIII.4 shows the effects of recalculations on NH_3 and NO_X between submission 2021 and 2022.

Tab. VIII.4 Comparison of NH_3 and NO_X emissions from animal manure applied to soils of the submissions 2021 and 2022

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019

- **2021 submission**	53.9	34.7	30.2	27.2	23.0	22.7	19.2	19.1	19.8	19.2
- **2022 submission**	36.6	21.6	18.1	14.6	12.9	13.2	13.0	13.9	13.8	13.5
Difference [%]	-34	-38	-40	-46	-44	-42	-32	-27	-30	-32
NO_X emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- **2021 submission**	9.4	6.0	5.2	4.5	3.9	3.9	4.3	4.2	4.4	4.4
- **2022 submission**	9.3	5.6	4.8	4.1	3.6	3.6	3.7	3.6	3.7	3.6
Difference [%]	-1	-5	-9	-10	-9	-6	-14	-14	-17	-17

NH3 emissions decreased by 27-46 % and NOx emissions decreased by 1-17% in the years 1990-2019 compared to submission 2021.

VIII.3.1.4 *NFR 3Da2b Sewage sludge applied to soils*

No recalculations

VIII.3.1.5 *3Da2c Other organic fertilisers applied to soils*

No recalculations

NFR 3Da3 Urine and dung deposited by grazing animal

Changes in calculation of NFR 3B and 3Da2a have effects also on calculation of NFR 3Da3. Tab. VIII.5 shows the effects of recalculations on NH_3 and NO_X between submission 2021 and 2022.

Tab. VIII.5 Comparison of NH_3 emissions from animal manure applied to soils of the submissions 2021 and 2022

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- 2021 submission	2.8	2.4	2.1	2.0	2.4	2.4	2.3	2.3	2.5	2.4
- 2022 submission	2.6	2.2	1.9	1.8	2.2	2.0	2.0	2.1	2.1	2.1
Difference [%]	-9	-9	-11	-9	-9	-19	-12	-10	-15	-14
NO_X emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- 2021 submission	1.14	0.96	0.80	0.76	0.93	0.94	0.87	0.88	0.94	0.78
- 2022 submission	1.01	0.87	0.73	0.70	0.83	0.76	0.76	0.78	0.78	0.80
Difference [%]	-12	-9	-9	-9	-11	-19	-14	-12	-16	-2

NH3 emissions decreased by 9-19 % and NOx emissions decreased by 2-19% in the years 1990-2019 compared to submission 2021.

VIII.3.2 NMVOC emissions

VIII.3.2.1 *NFR 3B Manure management*

Emissions of MNVOC from manure management has been recalculated as an inference of changes in ammonia emissions. Ammonia emissions are part of NMVOC calculation. Tab. VIII.6 shows the effects of recalculations on NMVOC between submission 2021 and 2022.

Tab. VIII.6 Comparison of NMVOC emissions from manure management of the submissions 2021 and 2022

NMVOC emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- 2021 submission	69.5	41.4	37.3	33.5	31.1	32.2	30.0	29.9	31.1	30.6
- 2022 submission	68.9	41.0	36.1	33.4	30.9	33.3	34.1	34.9	36.2	35.9
Difference [%]	-1	-1	-3	-0.1	-0.4	3	12	14	14	15

NMVOC emissions decreased by 0-3 % in the years 1990-2010 and increased by 3-15% in the years 2015-2019 compared to submission 2021.

VIII.3.2.2 *NFR 3De Cultivated crops*

Emissions of MNVOC from cultivated crops were underestimated in 2021 submissions. Part of grown crops was not included in inventory. These crops were supplemented in 2022 submission. Tab. VIII.7 shows the effects of recalculations on NMVOC between submission 2021 and 2022.

Tab. VIII.7 Comparison of NMVOC emissions from cultivated crops of the submissions 2021 and 2022

NMVOC emissions [kt]	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
- 2021 submission	0.99	1.07	1.01	1.03	1.13	1.33	1.41	1.23	1.31	1.24
- 2022 submission	1.42	1.46	1.52	1.46	1.47	1.61	1.70	1.53	1.58	1.54
Difference [%]	31	27	34	29	23	18	17	20	17	19

The NMVOC emissions increased by 17–29% in the years 1990–2019 compared to submission 2021.

IX. Projections

The date of the last edit of the chapter: 20/12/2021

Disclaimer. Projections of main pollutants were last published on March 2021, where the base year 2019 was used. The current 2022 submission contains recommendations given in 2021 review process. However, calculations or methodologies were not changed, only missing information has been added to the IIR submission. Some inconsistences have been either eliminated

Projections were based on principles and calculations, which were described in EMEP/EEA air pollutant emission inventory guidebook, 2019 (EMEP/EEA EIG) [3]. The emissions of NO_X (as NO_2), NMVOC, SO_X (as SO_2) and $PM_{2.5}$ were projected to year 2030. Projections for some significant categories were made by external partial experts´ assessment. Detailed description is shown in appropriate subchapters.

Main pollutants projections are published every two years. The 2022 submission based on 2021 projections, which were built on the base year 2018. Data were taken from the inventory published in 2021 "2021_Czech_Republic_1990-2019_Resubmissions2" (see Annex I of Czech emission inventory released 29.03.2021).

Projections are reported under the structure given in EMEP/EEA EIG. Two scenarios, with existing measures (WEM/WM) and with additional measures (WAM) were prepared. Emissions projections were compiled to the appropriate Annex IV. Emissions of main pollutants in 2018-2030 are shown in Fig. IX.1 Emissions are expressed in kilotons.

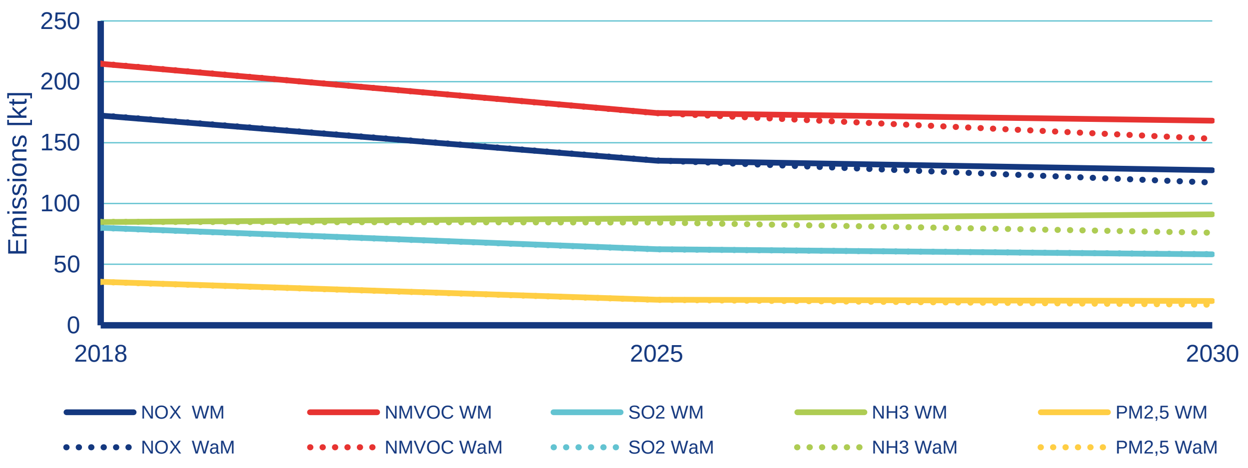

Fig. IX.1 Main pollutants emissions, 2018-2030

Czechia has an obligation to fulfil commitments given in NEC Directive 2016/2284/EU. The commitments of Czechia is shown in tables A and B, Annex II [2].Total commitments of Czechia are shown in Tab. IX.1

Tab. IX.1 Commitments under NEC Directive 2016/2284/EU

		NO_X (NO_2)	NMVOC	SO_X (as SO_2)	NH_3	$PM_{2.5}$
Reduction from 2005 level [%]		[%]				
	2020 to 2029	35	18	45	7	17
	from 2030	64	50	66	22	60
Reduction from 2005 level [kt]		[kt]				
	2020 to 2029	95.31	42.31	93.80	6.95	7.35
	from 2030	174.29	117.52	137.57	21.85	25.95
Ceilings		[kt]				
	2005	272.32	235.05	208.44	99.34	43.24
	2020	177.01	192.74	114.64	92.39	35.89
	2030	98.04	117.52	70.87	77.48	17.30

The conditions defined in NEC Directive 2016/2284/EU Article 4 to limit annual anthropogenic emissions was used to compile national emissions ceilings. Ceilings of main pollutants were compiled without NO_X and NMVOC emissions in NFR 3B and 3D, as described in paragraph 3 point d) *emissions of nitrogen oxides and non-methane volatile organic compounds from activities falling under the 2014 Nomenclature for Reporting (NFR) as provided by the LRTAP Convention categories 3B (manure management) and 3D (agricultural soils)* [2].

Czech ceilings commitments are shown in Fig. IX.2 and Fig. IX.3.

Ceilings 2020

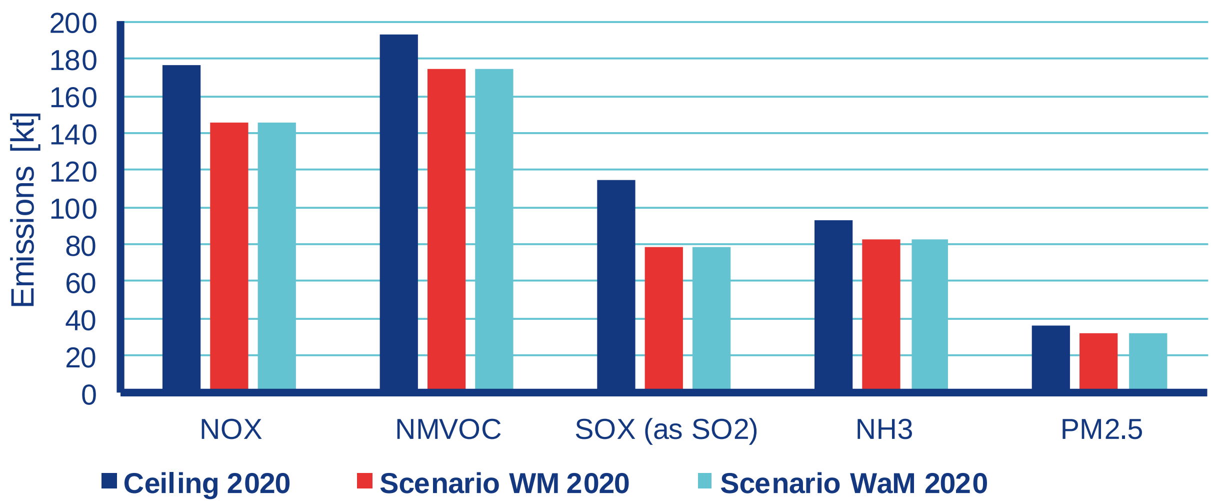

Fig. IX.2 Czech commitments 2020

Ceilings in 2020 are not exceeded under both scenarios.

Ceilings 2030

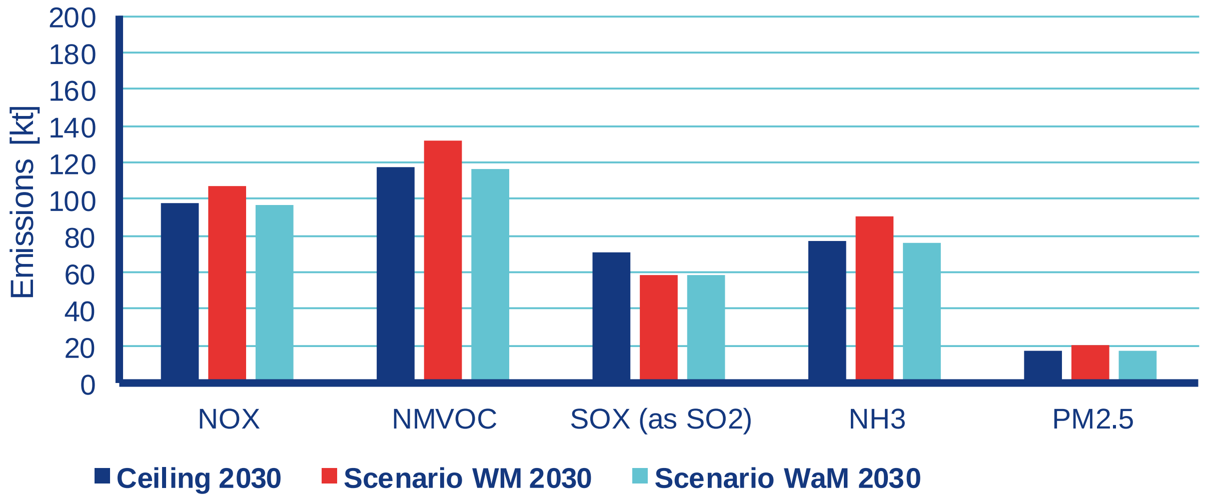

Fig. IX.3 Czech commitments 2030

We presuppose (except SO_2) an exceeding of ceilings in 2030 under scenario WM. Therefore, there is an effort to implement additional politics and measures (PaMs) (see chapter IX.10) to fulfil commitments in 2030. As was mentioned above, scenario WM is not sufficient for fulfilling emission ceilings, in particular in 2030. Ceilings are not exceeded under scenario WaM, what indicates the necessity of additional politics and measures implementation.

Ceilings 2025

Ceilings of 2025 were either counted as a mean between 2020 and 2030, see Fig. IX.4.

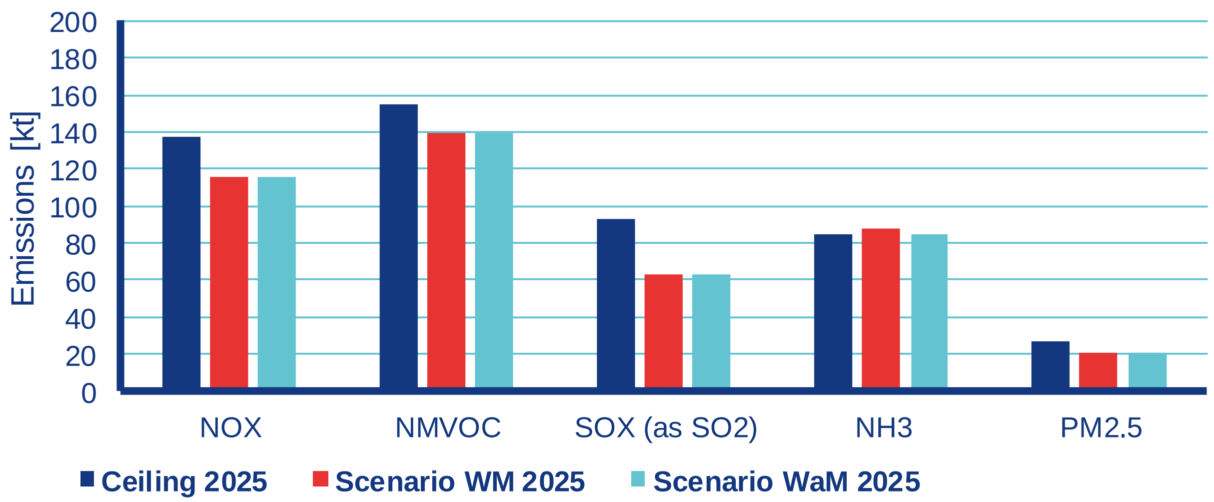

Fig. IX.4 Czech commitments 2025

Ceilings in 2025 are not exceeded under scenario WM. excepting NH_3, where the value of exceeding is 2.6 kt. Commitments are fulfilled under WaM scenario.

IX.1.1 Methodology

Emission categories were divided by 5 groups, and then were calculated separately. Different organisations were participated in the report preparation. Overview of projection arrangement is shown in Tab. IX.2.

Tab. IX.2 Sectors and participants of Czech projections

Sector	Organisation prepared projection	Organisation provided input data
Energy	CHMI	CHMI, MIT. CZSO
Residential	CHMI	CHMI, MIT, CZSO
Industry	CHMI	CHMI, MIT, CZSO
Transport	Motran s.r.o.	CDV, MoT, MIT, CZSO
Agriculture	VUZT	MoA, CZSO
Waste	CHMI	CHMI, MZP, CZSO

Each of described sector was prepared separately. Final emissions´ projections were taken from organisations and compiled to Annex IV template. Then total emissions were calculated.

Shares of each sector to total emissions are shown below in the following figures.

NO_X (as NO_2)

Energy and Transport contribute to total emissions more than 30% of each. Around 20% of emissions are emitted from Residential sector. Agriculture contribute around 12% to total NO_X emissions. Under WaM scenario, the amount of NO_X will decrease in transport sector in 2030. Shares of NO_X emissions are shown in Fig. IX.5.

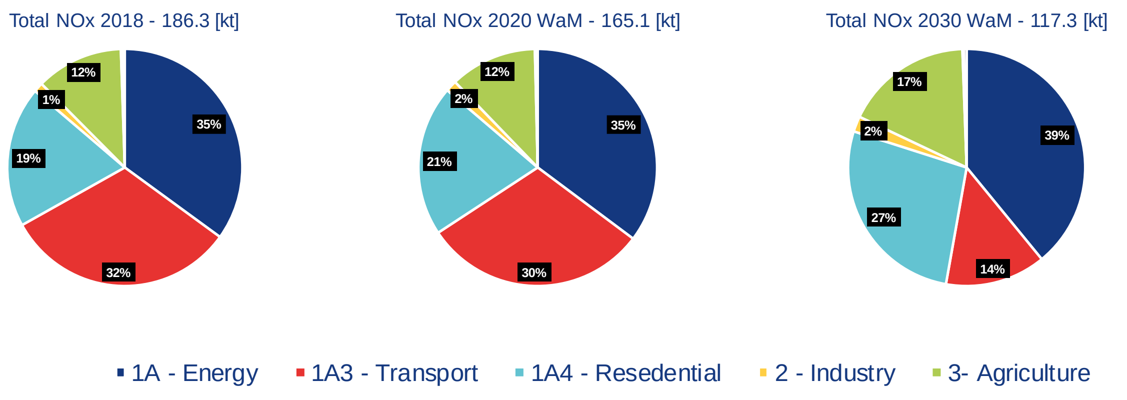

Fig. IX.5 NO_X shares

NMVOC

Great share of NMVOC emission is emitted from Industry (around 40 %). More than 30% are originated from Residential and around 15% emissions are from Agriculture. Total shares of NMVOC are shown in Fig. IX.6.

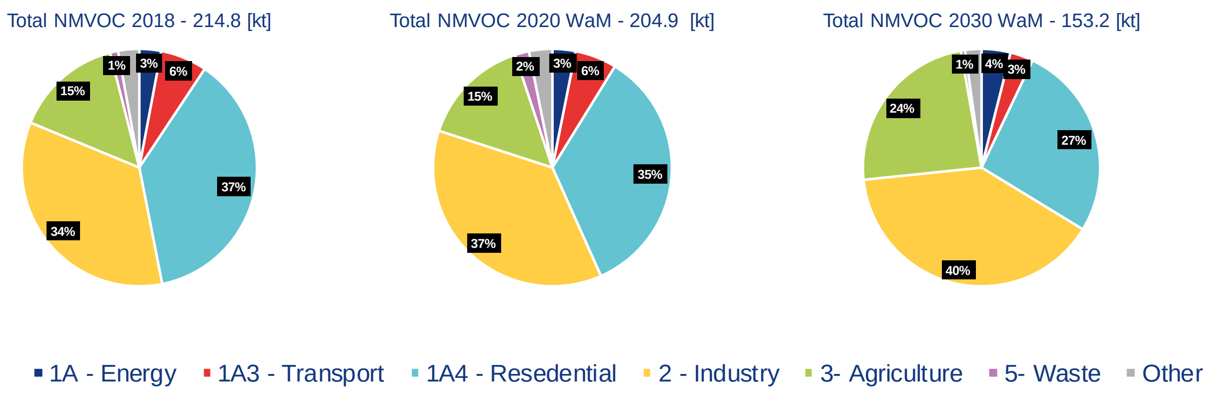

Fig. IX.6 NMVOC shares

SO_X (as SO_2)

The bigger part of SO_X emitted emission are arisen in Energy (around 70 %), 20 % are emitted from Residential. Total shares of SO_X emissions are shown in Fig. IX.7.

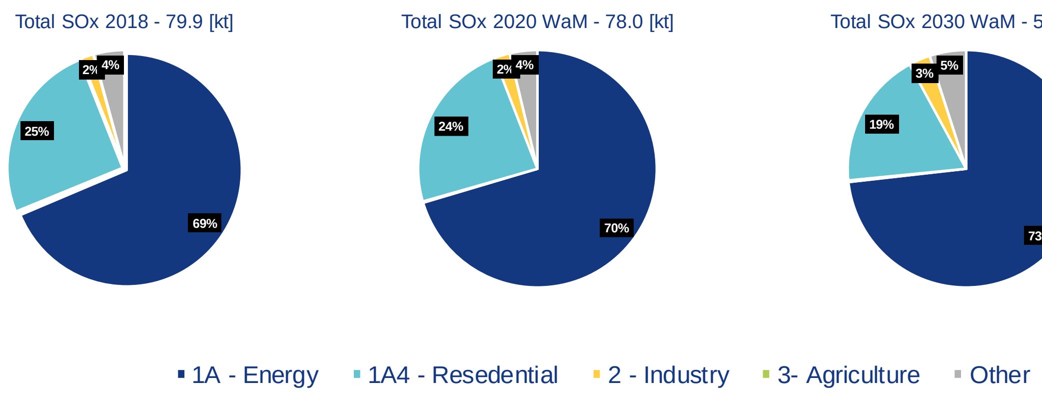

Fig. IX.7 SO_X (SO_2) shares

NH_3

Apart from the fact that more than 90 % of NH_3 emissions are emitted from Agriculture, there is a big share of Residential (around 7 %). Total shares of NH_3 are shown in Fig. IX.8.

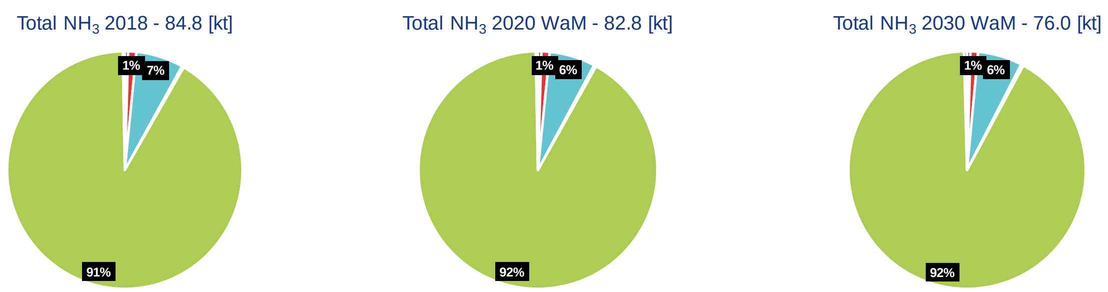

Fig. IX.8 NH_3 shares

$PM_{2.5}$

Around 75 % of $PM_{2.5}$ emissions (this share is changed in 2030 under WaM scenario) are emitted from Residential. Transport, Industry and Energy also shared in total $PM_{2.5}$ emissions. Total shares of $PM_{2.5}$ emissions are shown in Fig. IX.9.

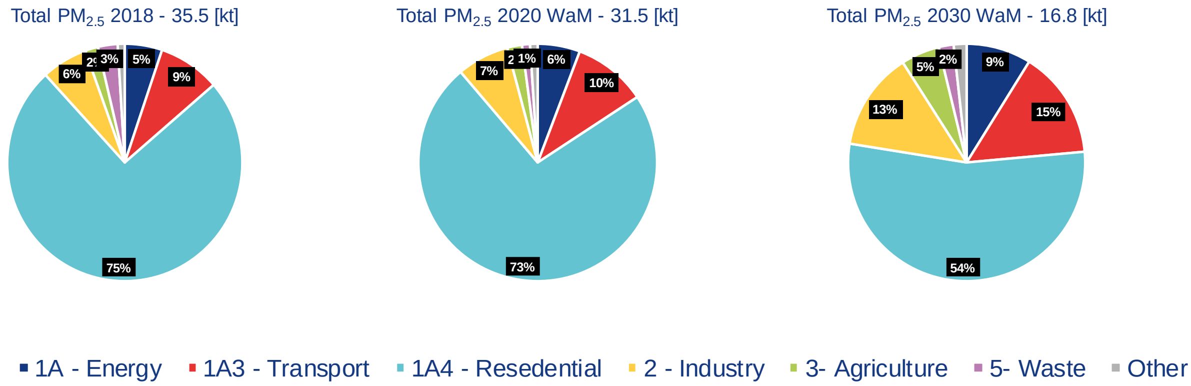

Fig. IX.9 $PM_{2.5}$ shares

IX.1.2 Black Carbon

Czechia do not dispose enough data of BC emissions to evaluate further projections at any categories. Especially a lack of information about trends of IEF in 2025 - 2050. Therefore, emissions of BC were not estimated.

IX.1.3 Uncertainties

Uncertainties are arisen mainly with PaMs implementations.

IX.1.4 Planned Improvements

Next projections of Energy will be prepared by extrernal help. Emission projections for Energy will be prepared in TIMES-CZ model.

IX.2 Energy (NFR 1A1 and 1A2)

IX.2.1.1 Input data

Input data were providing under Czech Air Protection Act n.201/2012 Coll. combustion sources divides to 3 main groups [4]:

- Combustion sources with a total rated thermal input exceeding 50 MW. which fall under the Industrial Emissions Directive (LCP- Large Combustion Plants 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.

Detailed description is explained in IIR Chapter III (Large combustion plants) [22].

Projections were based under energy balance forecast provided by the Department of Strategy and International Cooperation in Energy of the MIT (MIT).

IX.2.1.2 Methodology

Projections of Energy sector were calculated in MS Excel. Input data were collected to excel sheet, where all combustion plants with a total rated thermal input exceeding 50MW, were divided under the category to NFR 1A1 or 1A2. Current fuel mix of each plant, current consumption, amounts of heat, the efficiency and other parameters were added to excel sheet. The amount of emission emitted from 1 GJ of heat was calculated. Each plants had a different amount because of different fuel mix, the efficiency, fuel supply and other parameters.

Amount of emissions emitted from 1 GJ [t/GJ] were multiplied by activity data rate, given in forecasts provided by MIT. These forecasts consist future fuel mix of each plant, domestic supply, final consumption in different sectors, heat supply, energy supply, etc.

Emissions were calculated under the equation

$$E = EF \cdot AR \qquad 1.1$$

Where.

E	calculated emissions	[kt]
EF	amount of emissions emitted from 1 GJ	$[kt.GJ^{-1}]$
AR	data given in forecast	[GJ]

The calculation scheme also responds to changes that occur till 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.

Emissions with a total rated thermal input less 50MW were calculated according forecasts of further production (eg. in Industry) given by MIT. In addition, data obtained from CZSO, as further consumption, GDP, population, etc., were used.

Calculated emission were summarised and added to template Annex IV.

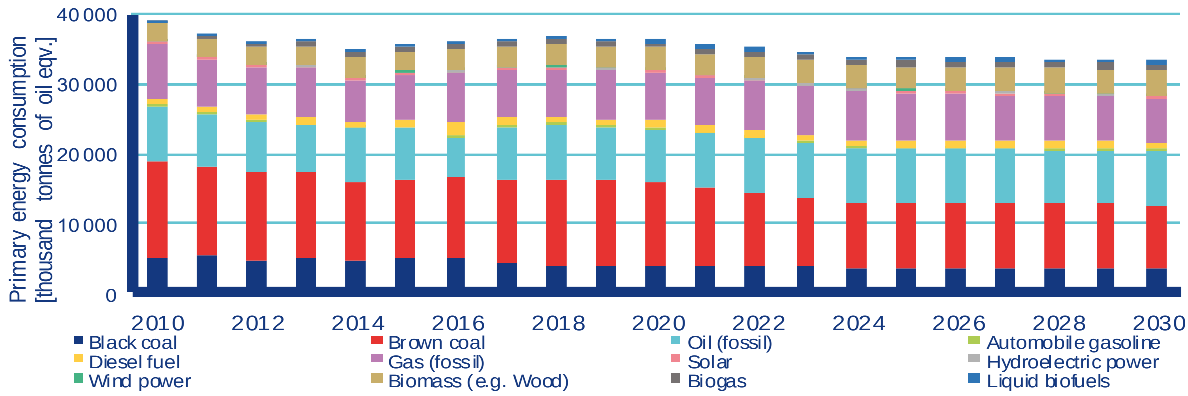

Fig. IX.10 Primary energy consumption. 2010-2030

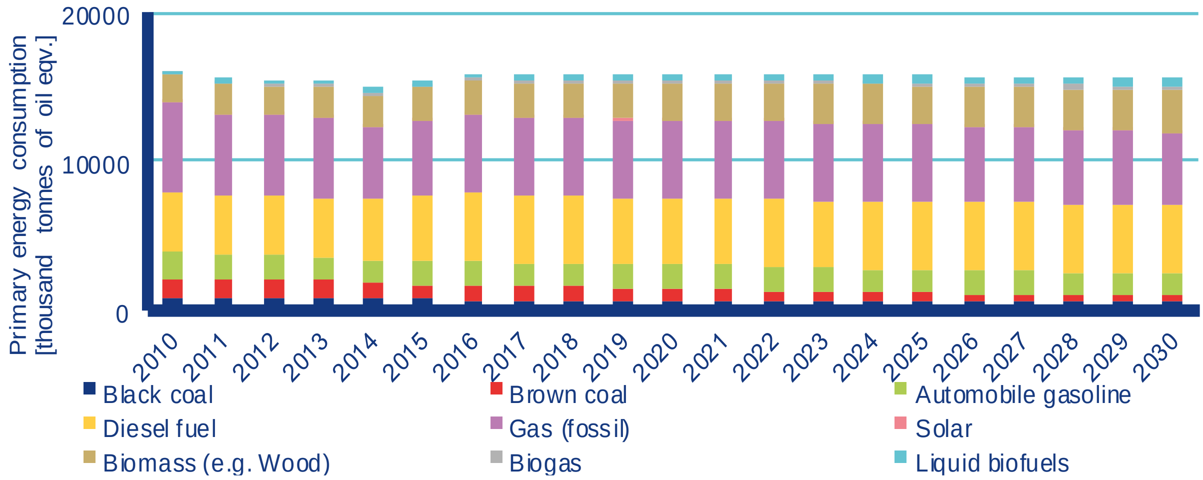

Fig. IX.11 Final energy consumption, 2010-2030

IX.3 Transport (NFR 1A3)

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 approach for emission reduction calculations was updated. This update is related to the reduction of greenhouse gas emission. In 2019, new Regulation (EU) 2019/631 of the European Parliament and of the Council f 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles was adopted. By this Regulation, the CO2 emissions from new cars should decrease on 15 % in 2025 and 37.5 % in 2030 compared to 2021 year. The CO2 emissions from new vans should decrease on 15 % in 2025 and 31 % in 2030 compared to 2021 year.

These standards are defined for new car fleet of every car manufacturers (with some exceptions). It will influence emissions of "traditional" pollutants like NO_X, CO, NMVOC and others as well. Future vehicle fleet and kilometres composition was modelled in order to meet these standards. Resulted vehicle composition contains more zero emission vehicles that in the WM scenario. The percentage of zero emission vehicles in the fleet is set to get weighted average to values of above mentioned percent. These modifications in WAM scenario resulted in new calculated emission reductions.

Further emission reduction was calculated by impact of other 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.

IX.3.1.1 Road and non-road transport (1A3a-d)

Emission projections from Transport sector were made by expert from MOTRAN Research. s.r.o. The results of the projection were elaborated in the R-project. The Department of Strategy and International Cooperation in Energy (MIT) provided activity data including expected changes in the share of consumption of individual transport fuels.

The emission projection comes from the official Czech transport forecast defined in Transport Sectoral Strategy and issued by Ministry of Transport. Transport Sectoral Strategy was implemented with the help of national transport model. It comes from the prediction of demography and economy as well as export and import of freight. Forecasts of energy consumption split to individual fuels, done by MIT. is another important input for the model of emissions projections in transport.

Transport and energy forecasts are a base for the calculation of more detailed activity data for emissions projection. These data are further disaggregated to more detailed vehicle categories by fuel used and Euro Standards emission limits. Emission projections model has now 91 transport categories, which differ each other in transport mode, fuel used and emission limits, which a vehicle must meet (by a year of manufacture).

Up to now, emissions datasets 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. CDV Brno (Transport Research Centre, Brno) provided the evaluation of the dynamic trends.

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. These data were aggregated in emissions projection model to less detailed vehicle categories.

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.

Tab. IX.3 COPERT appropriative NFR names

COPERT names	NFR Code	Long name
Aircrafts_freight	1A3a.c.d.e	Off-road transport
Aircrafts_passenger	1A3a.c.d.e	Off-road transport
Boats_freight	1A3a.c.d.e	Off-road transport
Boats_passenger	1A3a.c.d.e	Off-road transport
Buses	1A3biii	R.T.. Heavy duty vehicles
Heavy_Duty_Trucks	1A3biii	R.T.. Heavy duty vehicles
L_Category	1A3biv	R.T.. Mopeds & Motorcycles
Light_Commercial_Vehicles	1A3bii	R.T.. Light duty vehicles
Passenger_Cars	1A3bi	R.T.. Passenger cars
Trains__freight	1A3a.c.d.e	Off-road transport
Trains_passenger	1A3a.c.d.e	Off-road transport

Tab. IX.4 COPERT results

Transport mode	Vehicles					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	15823	13092	13570	15093	18176	20375
Heavy_Duty_Trucks	139855	125061	120586	132986	170547	214289
L_Category	1147200	899572	681842	417272	433433	671622
Light_Commercial_Vehicles	578176	543646	530239	555797	628065	698320
- gasoline	84515	81157	78383	72048	49421	22740
- diesel	493661	452934	387523	352497	291586	220553
- other	0	9555	64333	131252	287058	455027
Passenger_Cars	5889714	5530582	4851861	4847390	5721905	7483050
- gasoline	3466557	3132046	2421351	2072781	1664973	1347622
- diesel	2285218	2212567	1939306	1858071	1848944	1821257
- other	137939	185969	491204	916538	2207988	4314171
Total	7770768	7111953	6198098	5968538	6972126	9087656

Tab. IX.5 COPERT results

Transport mode	th.vkm					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	715444	732475	817628	902780	981476	968562
Heavy_Duty_Trucks	8231218	8398826	9236994	10075237	11088849	11439552
L_Category	390344	392597	403864	415130	437953	461064
Light_Commercial_Vehicles	9966415	10169405	11184355	12199306	13426533	13851088
- gasoline	670163	666670	638941	594103	427542	207578
- diesel	9296252	9319284	9334854	9184442	7912630	5897652
- other	0	183451	1210560	2420761	5086361	7745858
Passenger_Cars	70745064	71153450	73195382	75237313	79373532	83562109
- gasoline	25723438	25560954	24694990	23739782	21575872	19062358
- diesel	42641366	42140130	39505260	36655907	30333762	23157197
- other	2380260	3452366	8995132	14841624	27463898	41342554
Total	90048485	90846753	94838223	98829766	1.05E+08	110282375

Tab. IX.6 COPERT results

Transport mode	NO_X[kt]					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	2.75	2.62	1.65	1.22	0.77	0.43
Heavy_Duty_Trucks	10.04	10.04	5.91	4.39	2.93	1.92
L_Category	0.06	0.05	0.04	0.02	0.02	0.02
Light_Commercial_Vehicles	10.08	8.98	5.48	3.15	1.84	0.93
- gasoline	0.12	0.09	0.04	0.03	0.02	0.01
- diesel	9.96	8.89	5.42	3.10	1.77	0.85
- other	0.00	0.00	0.01	0.02	0.05	0.07
Passenger_Cars	29.05	25.63	15.32	9.79	5.94	3.66
- gasoline	4.11	3.38	1.71	1.23	0.96	0.83
- diesel	24.74	22.06	13.43	8.36	4.70	2.46
- other	0.20	0.19	0.18	0.20	0.28	0.37
Total	51.98	47.33	28.39	18.57	11.49	6.96

Tab. IX.7 COPERT results

Transport mode	NMVOC[kt]					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	0.09	0.09	0.06	0.05	0.04	0.03
Heavy_Duty_Trucks	0.39	0.29	0.21	0.19	0.20	0.21
L_Category	0.89	0.30	0.25	0.21	0.17	0.18
Light_Commercial_Vehicles	0.55	0.46	0.25	0.17	0.11	0.09
- gasoline	0.21	0.19	0.11	0.08	0.05	0.02
- diesel	0.34	0.27	0.14	0.07	0.02	0.01
- other	0.00	0.00	0.01	0.02	0.04	0.05
Passenger_Cars	11.15	9.43	5.54	4.20	3.31	2.88
- gasoline	10.28	8.69	5.13	3.92	3.10	2.64
- diesel	0.57	0.45	0.23	0.13	0.06	0.03
- other	0.30	0.30	0.18	0.15	0.16	0.20
Total	13.07	10.57	6.30	4.81	3.83	3.39

IX.4 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.

Projections assume that if a device already meets specific emission limits in 2018, 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 2018.

However, if specific limits covered to the device by 2025 are not fulfilled, reported emissions from 2018 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.

IX.4.1 Residential

IX.4.1.1 Input Data

Projections of emissions in Residential are based on State energy concept [23]. The Department of Strategy and International Co-operation, MIP provided forecasts of fuel consumption. Emissions inventory in households, trends of combustion plants and emission factors were provided by CHMI. More detailed Chapter III.2 Czech IIR [22].

IX.4.1.2 Methodology

The total mix of boilers was calculated. Mix was based on:

- The prohibition on sales of 1st and 2nd 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 (projections are 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.

A fuel consumption forecast indicates that the consumption of brown coal will be reduced and partially replaced by natural gas and renewable sources, primarily by biomass. However, the consumption of the black coal will not be significantly changed.

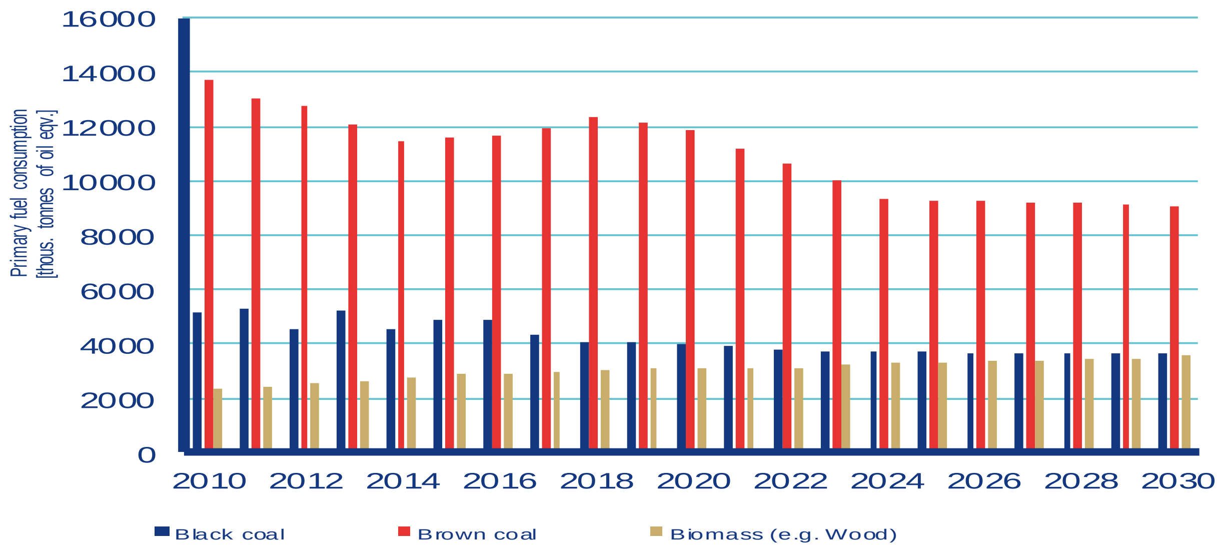

Fig. IX.12 Fuel consumption. 2010-2030

Another group of sources is 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. Therefore, 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/EEA EIG [3].

IX.5 Other (NFR 1A5)

Emissions from the operation of military vehicles and aircraft are included in the NFR 1A5 and they are very low. A fuel consumption trend was used as activity data, which have been taken from CZSO and reported by Ministry of Defence and Armed Forces. A trend of this consumption is manifested as, for example, emergency aid during floods. Therefore is difficult to project the development in the future. Therefore, “NE” symbols were stated for some main pollutants projections.

IX.6 Fugitive emissions from fuels (NFR 1B)

Projection of Fugitive emissions were calculated as 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/EEA EIG or were calculated [3].

Input data for NFR 1B1a. 1B1b. 1B1c and 1B2b were provided by Department of Strategy and International Co-operation in Energy, MIT. Input data were contained a forecast about future fuel consumption and physicochemical properties of fuels. Input data for sectors NFR 1B2ai. 1B2aiv. 1B2av were provided by Czech Association of Petroleum Industry and Trade. Input data were contained data about current consumption. These data were analyzed by linear regression in MS Excel, where calculated emission factors were multiplied by population growth factor. For sector 1B2c emission´s calculation was based on historical data. After analyzing the historical data trend, the future trend was established by multiplying with population growth factor.

IX.7 Industrial Processes and Product Use (NFR 2)

Projections of Industry were calculated with a big margin of uncertainties, because of diversity of organic compounds, their using and absence appropriate measures. Several researches were made in a specific type of emission sources recently. However, there still exist a margin of inaccuracy.

IX.7.1.1 Input data

Projections of Industry were calculated under forecast of further industrial production. Forecasts were provided by MIP. Emissions of base year were taken from Czech emissions inventory, more detailed in Chapter IV Czech IIR [22].

Calculations were made in MS Excel. Projections concerned activities with a major contribution to emissions. Other emissions and activities with a minor contribution were derived on the basis of general economic based growth factors in manufacturing industry. General economic based growth factors, as a recent population estimation and gross domestic product were provided by CZSO. Emission factors were used according EMEP/EEA EIG [3].

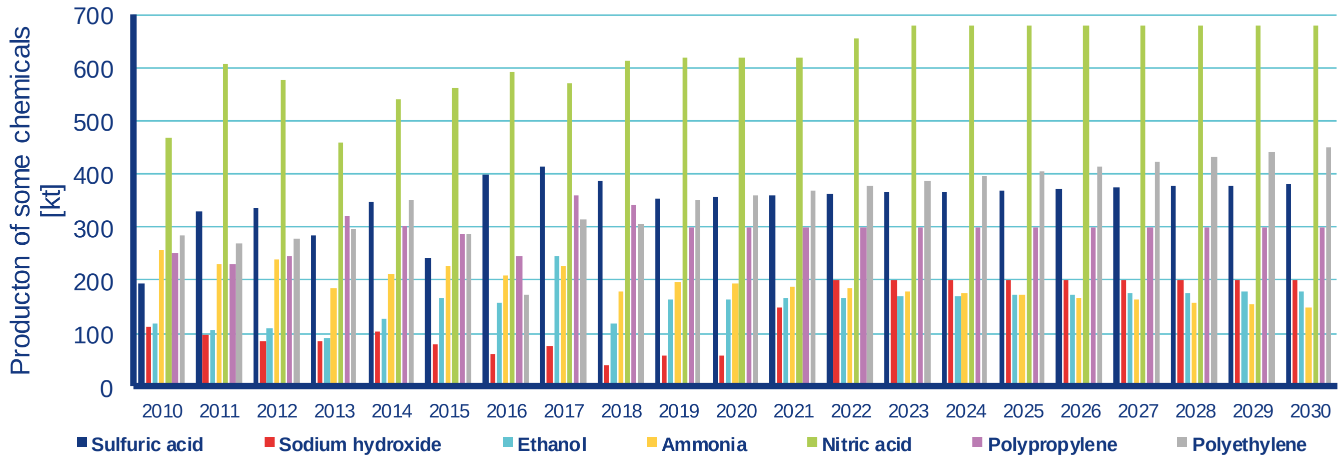

Fig. IX.13 Production of chemicals, 2010-2030

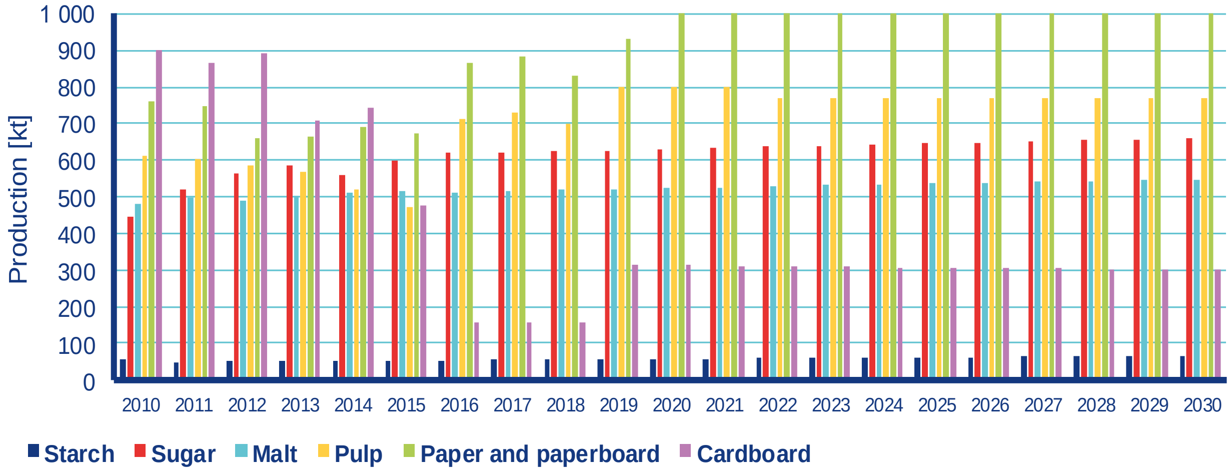

Fig. IX.14 Production of food, 2010-2030

IX.8 Agriculture (NFR 3)

The study of emission projection from agriculture sector was built on the data and information published in Czech IIR 2019 submitted by CHMI under the UNECE Convention on Long-range Transboundary Air Pollution in May 2021 [22].

Projections were strictly based on the methodology used in inventory of main pollutants in the Agriculture. Trends of activity data and emission factors used for emission estimates were derived from two official documents of the Ministry of Agriculture. These were confirmed by experts of the agricultural policy and rural development.

The Agricultural sector is responsible for more than 89 % of NH_3 emissions in Czechia. 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 Czechia, cattle are the biggest key source of NH_3, followed by application of organic and mineral fertilisers. 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 future development of ammonia and $PM_{2.5}$ emissions definitely depends on number of livestock breeding in Czechia. The sector development strategy was published by the Ministry of Agriculture in 2016. In 2020 this strategy was revised.

IX.8.1 Emission projection of ammonia and $PM_{2.5}$ from manure management (NFR 3B)

For the national estimation of ammonia and $PM_{2.5}$ emissions from manure management the Tier 2 (in case of ammonia) and the Tier 1 (in case of $PM_{2.5}$) approach is used according to the 3B Manure management EMEP/EEA EIG 2019. Currently, each category of animals (population data) is multiplied by default EF presented in the EMEP/EEA EIG [3].

IX.8.2 Emission projection of ammonia and $PM_{2.5}$ from category crop production and soils (NFR 3D)

For the national estimation of ammonia emissions from manure applied to soils (3Da2a) in Czechia, the Tier 2 approach is used according to the 3B Manure management EMEP/EEA EIG 2019. The total nitrogen in manure was assessed and integrated into the Czech regulation no 377/2013 on manure storage and utilization.

Each category of animals is multiplied by the country specific emission factors. Compared to 2015 reporting, reducing effects on ammonia emissions resulting from manure 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 adaption period 2009–2016.

Ammonia emissions from mineral N fertilizer application (3Da1) are calculated according to the 3D Crop production EMEP/EEA EIG 2019. The Tier 2 approach is used.

Activity data on N fertilizers consumption and application are provided by the FAO database with adjustments according to IFASTAT.

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 CZSO. 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 the 3D Crop production EMEP/EEA EIG 2019 for the region with humid climate. During dry weather period, the operations (performed several times per year) may produce emissions of particle matters. For crop cultivation two different tillage practices (conventional and minimizing tillage) have been taking into consideration.

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.

IX.9 Waste (NFR 5)

Waste sector (IPCC guidelines sector no. 5) in Czechia can be separated in to 4 distinctive source categories. First, so far dominant category is NFR5A, 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 NFR 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 NFR 1A – Energy or in NFR 2B Fugitive emissions, depending which kind of pollutant is in question. Third source category is NFR 5C – waste incineration. This category should be also accounted in energy sector should waste incineration produce useable energy, in NFR 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 NFR 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.

Compared to last projections, emissions of this sector were partly reallocated to 1A. The highest share to total emissions (NFR 5) in this sector is from an open burning of waste. We assume a reduction of the share of open burning of waste and slight increase of emission from crematoria for 2025 and following years. We expect that the ratio of cremation and burial to the ground will change.

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 EIG [3].

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 and 2030 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 EMEP/EEA EIG emission factor database. Emission factors for SO_X and NH_3 was added from EMEP/EEA EIG 2016. It was removed CO from NFR 5B and kept NH_3 only.

In NFR 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.

IX.10 National air pollution control programmes

Under Article 6 of NEC Directive 2016/2284 Member States shall draw up, adopt and implement their respective national air pollution control programmes.

Czech NAPCP submitted in Czech national emission reduction programme [24]. Last NAPCP was published in 2019.

A summary of measures that can contribute to reducing emissions and improving air quality is given in Tab. IX.8.

The measures, under the reduction programme, are marked as "priority". "supportive" and "cross-cutting". The priority measures form the basis of the scenario WaM and help to reduce emissions of main pollutants, which will ensure that the reduction targets are met. They have been quantified for additional emission reduction potential and their contribution to reducing emissions and / or improving quality is either directly quantifiable or unquestionably significant. All other measures will also lead to a reduction in emissions and a reduction in the air pollution load. However, their effect cannot be quantified in most cases for objective reasons, so they are identified as supportive and cross-cutting measures.

The measures are marked with a unique code that follows the requirements of reporting obligations. The code consists of two letters and a number. The first letter indicates the sector concerned, the second letter indicates the type of measure, and the number indicates the order of measures in the group.

Groups of measures (sectors) listed in the Catalogue:

A Reducing the impact of road transport on air pollution levels

B Reducing the impact of stationary sources on the level of air pollution

C Reducing the impact of agricultural production on the level of air pollution

D Reducing the impact of stationary sources operated in households on the level of air pollution

E Reducing the impact of other sources on air pollution levels.

Types of measures listed in the Catalogue:

A Economic

B Technical / technical-organizational

C Educational / information

D Other (e.g. administrative)

Tab. IX.8 The list of priority measures

Code	Name of measure
BB12	Additional reduction of emissions by 2030 from the public energy and heat production sector
DA1	Replacement of heat sources in households
DB11	Improving the quality of wood used in stationary sources with a rated heat input up to 300 kW
AB26	Additional emission reductions by 2030 from the transport sector
CB8	Obligations for storage and application of fertilizers
CA2	Grazing supporting

The implementation of priority measures will reduce the amount of pollutant emissions to / below the level of national commitment.

X. Reporting of gridded emissions and LPS

The date of the last edit of the chapter: 15/03/2022

According to the UNECE Convention on Long-Range Transboundary Air Pollution as well as under the NEC Directive parties are obligated to report gridded emissions and large point sources (LPS). Being in line with the revised 2014 CLRTAP Reporting Guidelines (ECE/EB.AIR.125) both datasets shall be reported every four years from 2017 onwards for the year x-2.

Last submission (data for reporting year 2019) was provided 30. 4. 2021. In accordance with the requirements the more detailed description of basic information on the methodology used for LPS & gridded data in Czechia was prepared and submitted. Next submission will be carried out in 2025 (data for reporting year 2023).

X.1 Emission gridding in GNFR structure for EMEP grid

Remark: Gridded data comply summary data reported in 2017.

The preparation of gridded emissions for the year 2019 required extension of expert team for the sphere of GIS applications (IDEA ENVI, Ltd.). The data have been adjusted to the new “EMEP grid” referring to a 0.1° × 0.1° latitude-longitude projection. 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. The mandatory reporting of gridded emissions includes the following pollutants: SO_X, NO_X, NH_3, NMVOC, CO, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, PCDD/F, PAHs, HCB and PCBs. The following chapter describes the GIS based method and the proxy data, which was used for the allocation of national emissions to the EMEP Grid.

Czechia coverage site “new EMEP grid” is shown in Fig. X.1. Presentation of selected emission data in GRID structure is a part of e-ANNEX.

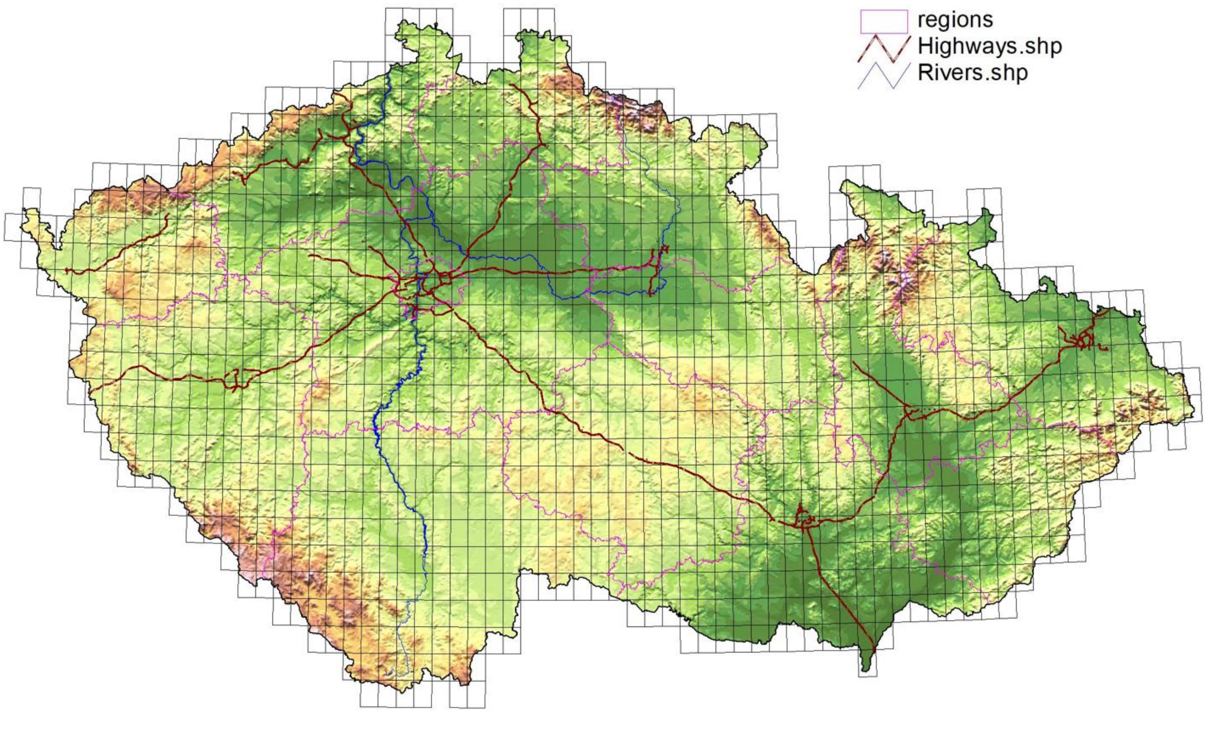

Fig. X.1 EMEP Grid Czechia – allocation of regions, highways network and rivers

X.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.

X.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.

X.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 Fig. X.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.

X.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 from solid 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)

X.2 LPS data

X.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_X, NO_X, CO, NMVOC, 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.

X.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.

In comparison with previous years, in 2021 reporting (data 2019), emissions registered in REZZO are strictly compared with those in IPR. If some difference was ascertained, total emissions from IPR were used. Source coordinates (latitude and longitude) and LPS names are also taken over from IPR. LPS emissions are used directly in the emission inventory.

X.2.3 LPS in Czechia

For 2019, Czechia reported emissions from 512 IPR facilities divided into 614 LPS. The largest share is livestock production (39 %), followed by industry (31 %).

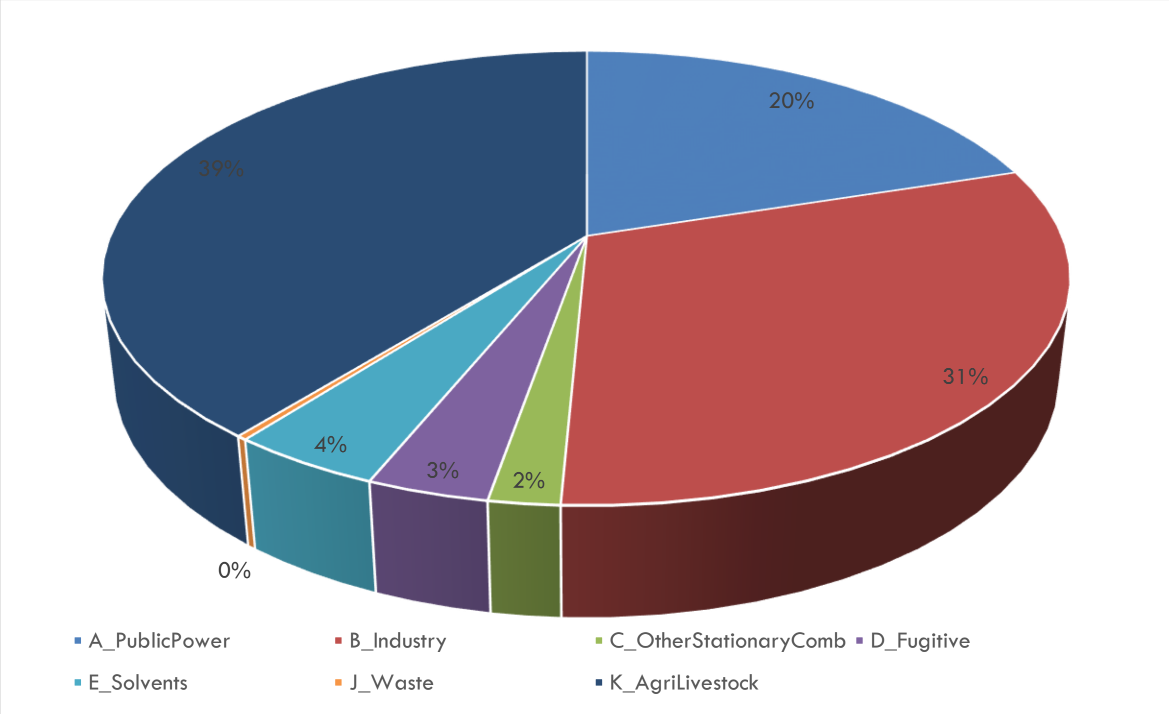

Fig. X.2 Share of GNFRs in the total LPS number in 2019

The shares of national emissions covered by LPS emission in sorting from the highest are listed below in Tab. X.1

Tab. X.1 Shares of LPS emissions in national totals

Pollutant	Share [%]
Hg	60.02
SO_X (as SO_2)	35.26
Pb	16.22
NO_X (as NO_2)	15.88
PCDD/F	10.80
Cd	9.95
CO	8.55
NH_3	5.47
PCBs	3.38
PM_{10}	1.84
$PM_{2.5}$	1.63

NMVOC	1.04

It is apparent that the highest shares in national totals have Hg and SO_X emissions which originate predominantly from public electricity and heat production, as do emissions of Pb, NO_X, PCDD/F, Cd, PCBs, PM_{10} and $PM_{2.5}$. The main source of CO emission are industrial processes, in the case NH_3 emission is it livestock production, NMVOC emissions come mainly from solvent use. There were no PAHs and HCB emissions for LPS sources in 2019.

XI. Adjustments

The date of the last edit of the chapter: 15/03/2022

Application of emissions adjustments or request for emissions adjustments have not been planned in Czechia in 2022.

XII. EMRT 2017–2021

In reporting year 2021, 34 observation for Czechia were sent by Technical expert review team (TERT). Most of given recommendations were accepted. Most of the findings were solved and an appropriate comments are to be find at individual chapters.

Numbers of TERT observations in the classification by GNFR categories were as follows:

A_PublicPower	3
B_Industry	13
C_OtherStationaryComb	1
E_Solvents	1
I_Offroad	2
J_Waste	3
K_AgriLivestock	2
L_AgriOther	4

The complete overview of observations with assessments and recommendations of TERT and reactions of Czechia is presented in the file **Recommendations** (see e-ANNEX)

List of Figures

List of Tables

Abbreviations

AAP	Annual Average Population
AD	Activity Data
BP	Biogas Plant
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
CS	Country Specific
CZ Biom	Czech Biomass Association
CZBA	Czech Biogas Association
CZSO	Czech Statistical Office
EFs	Emission Factors
EIA	Environmental Impact Assessment
EMEP/EEA EIG	EMEP/EEA air pollutant emission inventory guidebook 2019
EMRT	EEA Emission Review Tool
FRS CR	Fire Rescue Service of the Czech Republic
GDP	Gross domestic product
IEA	International Energy Agency
IPR	Integrated Pollution Register of the Environment
ISOH	Waste Management Information System
ISPOP	Integrated System for Fulfilment of Reporting Duties
LCP	Large Combustion Plants
LPS	Large Point Sources
MIT	MIT
MoA	Ministry of Agriculture
MoE	Ministry of the Environment
MoT	Ministry of Transport
MSW	Municipal Solid Waste
NACE	Statistical Classification of Economic Activities
NR	Not Reported
PaMs	Politics and Measures
REZZO	Register of Emissions and Stationary Sources of air pollution
SOE	Summary Operation Evidence
STK	Technical Control Station/Technical Inspection Station
SVUOM	National Research Institute for the Protection of Materials
SWDS	Solid Waste Disposal Sites
TERT	Technical Expert Review Team
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

References

[1] UNECE, "Convention on Long-range Transboundary Air Pollution," 1979. [Online]. Available: https://unece.org/sites/default/files/2021-05/1979%20CLRTAP.e.pdf

[2] European Parliament, *Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (Text with EEA relevance)*. 2016. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.344.01.0001.01.ENG

[3] C. Dore, M. Adams, and K. Saarinen, "EMEP/EEA air pollutant emission inventory guidebook 2019," 2019. [Online]. Available: https://www.eea.europa.eu/themes/air/air-pollution-sources-1/emep-eea-air-pollutant-emission-inventory-guidebook

[4] Sbírka zákonů, *Zákon č. 201/2012 Sb. o ochraně ovzduší*. Czech Republic, 2012. [Online]. Available: https://www.zakonyprolidi.cz/cs/2012-201

[5] H. Hnilicová, "Optimalizace metodiky výpočtu podílu velikostních frakcí PM10 a PM2.5 na emisích tuhých znečišťujících látek. Výzkumná zpráva. ." ČHMÚ, Praha, 2012.

[6] O. Gavrilova *et al.*, "Emissions from Livestock and Manure management (Chapter 10)," 2006.

[7] Bureš et al., "Stanovení emisních faktorů a imisních příspěvků stacionárních zdrojů pro účely zjednodušení přípravy a vyhodnocení žádostí o podporu z OPŽP ," 2014.

[8] M. Dědina, "Emise ze zemědělských strojů v období 1990-2016 s využitím údajů STK." VÚZT Praha , 2018.

[9] L. Pelikán, "Introducing of COPERT 5 for calculating emissions from road transport in Czech Republic," *Brich, Milan*. CDV, Brno, 2018.

[10] Brich et al., "Methodology of calculation of traffic performance using database of Technical Inspection data." CDV, Brno, 2014.

[11] P. Bucek, J. Kučera, J. Syrůček, and et al., "Českomoravská společnost chovatelů, a," Praha, 2021. [Online]. Available: https://www.cmsch.cz/plemenarska-prace/ku-kontrola-uzitkovosti/chovatelske-rocenky/rocenky-chovu-skotu/

[12] European Environment Agency - European Union, "Manure Management N-flow tool," 2020. https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/manure-management-n-flow-tool/view

[13] M. Dědina, A. Jelínek, R. Mašatová, and Z. Abrham, "Evaluační studie aplikace BAT u zařízení v kategorii průmyslových činností č. 6.6 dle zákona o Integrované prevenci," Praha, 2012. [Online]. Available: https://docplayer.cz/68528873-Evaluacni-studie-aplikace-bat-u-zarizeni-v-kategorii-prumyslovych-cinnosti-c-6-6-dle-zakona-o-integrovane-prevenci.html

[14] ČSÚ, "Farm Structure Survey – Manure consumption by application technique," 2016. [Online]. Available: https://www.czso.cz/documents/10180/46015056/27015117021.pdf/050bb28a-1a6c-47e0-9dc7-b5ad29673b38?version=1.0

[15] S. Bittman, M. Dedina, C. M. (Clare) Howard, O. Oenema, and M. A. Sutton, *Options for ammonia mitigation : guidance from the UNECE Task Force on Reactive Nitrogen*. Centre for

Ecology & Hydrology, on behalf of Task Force on Reactive Nitrogen, of the UNECE Convention on Long Range transboundary Air Pollution, 2014.

[16] ČSÚ, “Statistical Yearbook of the Czech Republic – Consumption of mineral fertilisers,” 2020. [Online]. Available: https://www.czso.cz/documents/10180/148556675/320198201329.xlsx/8ce934f7-dbe5-4a75-b6a6-32e86024009f?version=1.1

[17] J. Černý, M. Balík, M. Kulhánek, K. Čásová, and V. Nedvěd, “Mineral and organic fertilization efficiency in long-term stationary experiments,” *PLANT SOIL ENVIRON*, pp. 28–36, 2010, [Online]. Available: https://www.agriculturejournals.cz/web/pse.htm?volume=56&firstPage=28&type=publishedArticle

[18] Sbírka Zákonů, *Regulation No. 377/2013 Coll. on storage and methods of manure utilisation*. 2017. [Online]. Available: https://ec.europa.eu/growth/tools-databases/tris/en/search/?trisaction=search.detail&year=2017&num=118

[19] M. Banja, M. Crippa, F. Pagani, E. Pisoni, and E. Vignati, “Agricultural Emission Estimation (AgrEE) tool-Improving national emission inventories for the agricultural sector in Europe,” 2021.

[20] B. Musil, “Usage of active substances of PPP (kg) on agricultural land,” 2021. [Online]. Available: https://eagri.cz/public/web/file/680565/Celek_2020_EN_oprava_29_6_2021.pdf

[21] ÚZKÚZ, “Statistika uvádění účinných látek obsažených v přípravcích na ochranu rostlin na trh.” 2020. [Online]. Available: https://eagri.cz/public/web/ukzuz/portal/pripravky-na-or/ucinne-latky-v-por-statistika-spotreba/statistika-uvadeni-ul-por-na-trh/

[22] Czech Hydrometeorological Institute, “Informative Inventory Report,” 2019.

[23] Ministry of Industry and Trade of the Czech Republic, *Státní energetická koncepce*. 2015. [Online]. Available: https://www.mpo.cz/dokument158059.html

[24] Ministry of the Environment of the Czech Republic, “Aktualizace Národního programu snižování emisí České republiky,” 2019. [Online]. Available: https://www.mzp.cz/cz/strategicke_dokumenty