Czech Hydrometeorological Institute

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Czechia

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Reported inventories 1990–2022

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Subtitle

Emission inventories from the base year of the protocols to the year 2022

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This report describes methodologies of emission inventory 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), by the EMEP/EEA air pollutant emission inventory guidebook.

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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 a description of the determination of the emissions.

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

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

- main pollutants: nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC), sulphur oxides (SO_X, as SO_2), 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/PCDF), hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). PAHs consist of benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, and Indeno (1,2,3-cd) pyrene.

Emissions are reported under the EMEP/EEA air pollutant emission inventory guidebook structure. Emission factors (EFs) were used according to EMEP/EEA EIG 2023 [3].

Main updates presented in IIR 2024

The Czech IIR 2024 submission presents the results of the emission inventory 1990–2022, including most of the recalculations recommended in EMRT Review 2023. In 2023 there was a complete recalculation in category 1A4bi for a whole time series since 1990. A base for the recalculation was new ratios of boiler types according to results of ENERGO 2008, 2015 and 2021 surveys, historical production data (1970–1990) and official sale stats from MIT 2010-2022. Moreover, based on the TERT recommendation combined emission factors were used for emission calculation. Combined emission factors regard the operation of boilers at reduced output, originating from measurements carried out in the Czechia in 2008–2012. New results of the emission inventory of category 1A4bi affect significantly emissions of TSP, PM, VOC and CO and were presented in the form of a special resubmission on 23.08.2023 together with a new projection for aggregated sector 1A4.

Also, on the TERT recommendation, NMVOC emissions from using disinfectants against COVID-19 (2020–2022) were moved from the category 2D3i into 2D3a. All categories calculated with emission factors from EMEP/EEA EIG 2019 are now used values according to the new EMEP/EEA EIG 2023. Also, according to TERT recommendation emissions from highway construction are now in category 2A5b which caused differences in emissions of TSP and PM. A small correction based on the TERT recommendation in emission calculations was done in 2H2. These updates are described in more detail in chapters for relevant NFR categories.

Significant emission trends in Czechia

The evaluation of emissions for 2022 (see the following Figure 0.I.1 – Figure 0.I.4) shows a year-on-year decrease in most emissions. The number of degree-days in the heating period of 2022 compared to 2021 significantly decreased (by about 10%) which is also visible in the decrease in total fuel consumption in the sector 1A4bi. Model calculations of emissions reflected positive replacements of boilers in households following law measures. In some sectors, emissions are partly reflected in the legislative measures of the government of the Czech Republic and other influences in connection with the war in Ukraine. Above all, there was an increase in the number of inhabitants after the acceptance of refugees in the number of approximately 370 000, with impacts on some production sectors, as well as the adoption of temporary measures for sources of electricity and heat production, leading to a partial change in the fuel base and a slight increase in emissions

All pollutants except SO_X, NH_3 and metals (except Cd and Hg) emission levels have decreased. The increase in SO_X, Cd and Hg emissions is mainly related to higher coal consumption in sector 1A1a (by approx. 8%). The increase in NH_3 emissions is related to higher consumption of mixed mineral fertilizers. For other pollutants, there is no significant decrease or increase in emissions in 2022 compared to 2021.

Share of categories in Czechia in 2022

The sector of residential heating (NFR 1A4bi) contributes significantly to air pollution, specifically $PM_{2.5}$ emissions (83.1%), PM_{10} emissions (67.3%), CO emissions (71.5%) and benzo[*a*]pyrene (97.3%). The decisive share of the public sector energy (NFR 1A1a) prevailed in emissions of SO_X (40.2%) and Hg (49.7%).

The Public electricity - 1A1a (19.8%), Passenger cars - 1A3bi (15.5%), Heavy duty vehicles and buses - 1A3biii (8.7%), Off-road vehicles and other machinery - 1A4cii (8.1%) and other sources belong to Transport, Stationary combustion sources or Agriculture created more than 60% of total NO_X emissions. Agriculture (NFR 3D and 3B) is the main source of ammonia emissions, whose share of total emissions is more than 80.8%.

The figures below present trends of the main pollutant emissions from 1990–2022.

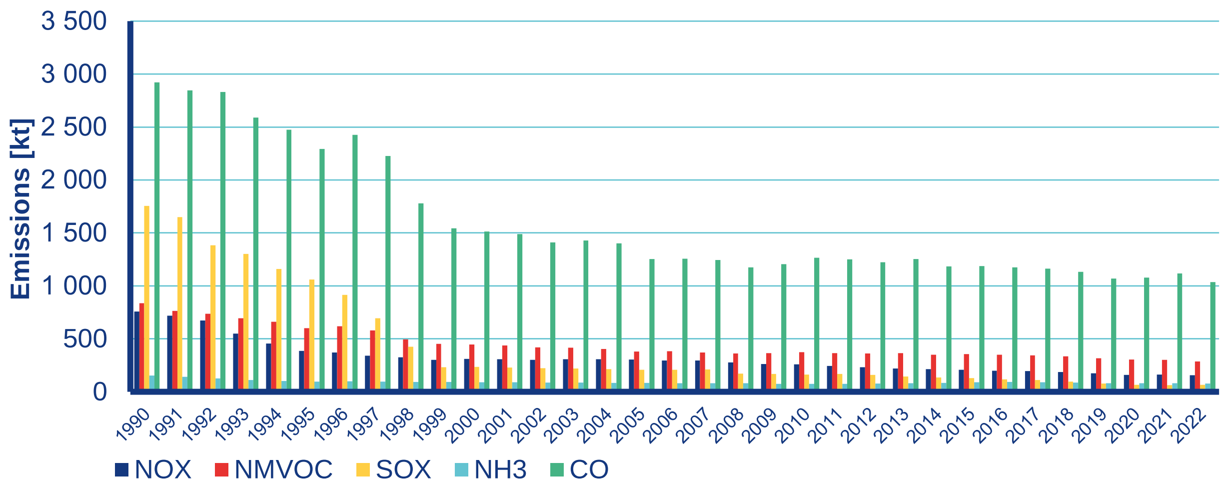

Figure 0.I.1: Total emissions of main pollutants, 1990–2022

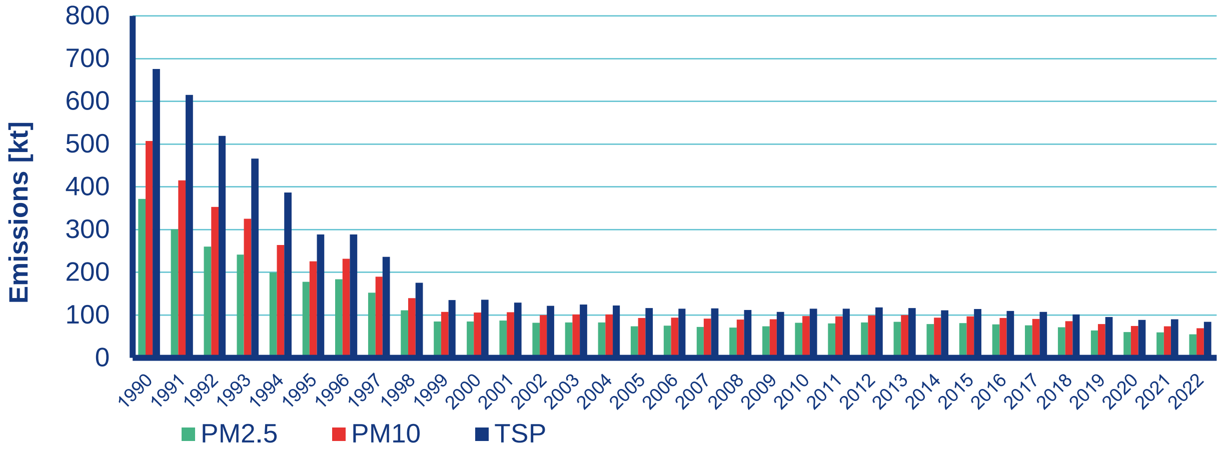

Figure 0.I.2 Emissions of particular matter, 1990–2022

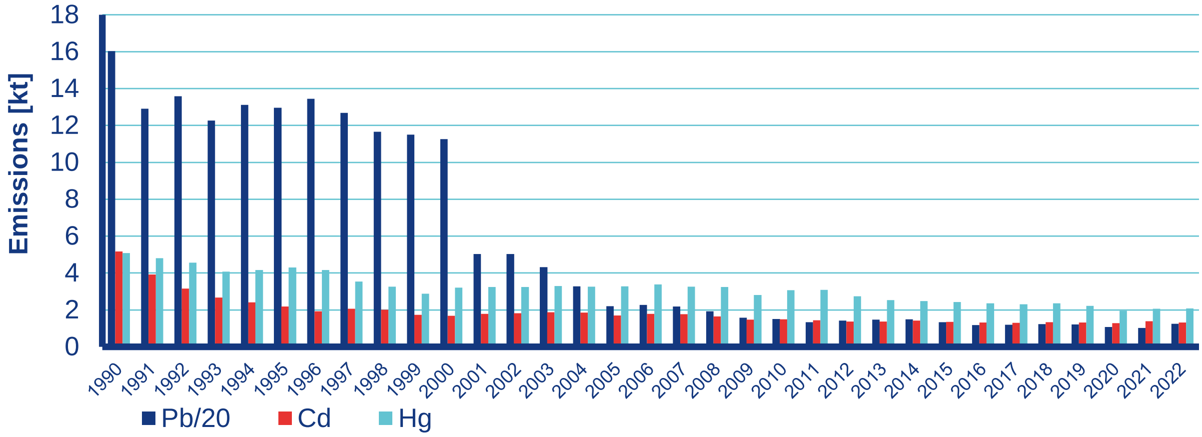

Figure 0.I.3 Emissions of heavy metals, 1990–2022

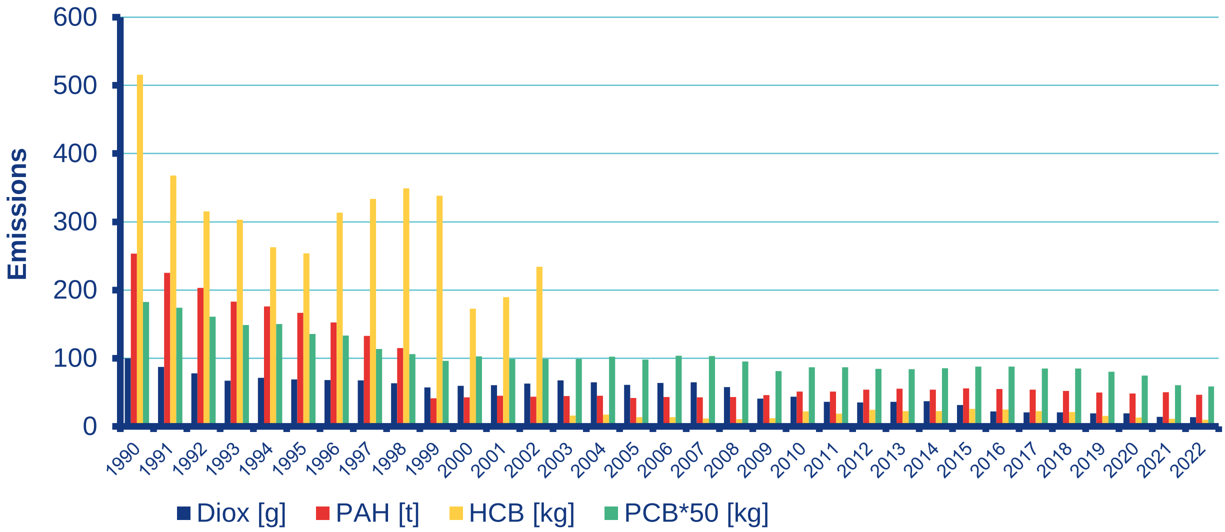

Figure 0.I.4 POPs emissions, 1990–2022

I. Introduction

The date of the last edit of the chapter: 15/03/2024

I.1 National Inventory Background

UNECE/CLRTAP was negotiated in 1979 and is an important instrument for preventing the long-range transfer of air pollution [1]. The Convention has a framework character: the contractual reduction of air pollution is realised through protocols adopted by the Convention. Eight protocols have been adopted yet. Czechia acceded to the Convention on 1st January 1993 and is a party to all eight 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 upon in 1984 and came into force on 28th January 1988.
- Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30%. It was agreed upon in 1985 and came into force on 2nd September 1988.
- Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes. It was agreed in Sofia in 1988 and entered into force on 14th February 1991.
- Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes. It was adopted in 1991 and entered into force on 29th September 1997.
- Protocol on Further Reduction of Sulphur Emissions. It was agreed upon in Aarhus in 1994 and came into force on 5th August 1998.
- Protocol on Heavy Metals. It was adopted in 1998 and entered into force on 29 December 2003. The protocol framework has been developed for 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, it entered into force on 23rd December 2003.
- Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. It was adopted on 30th November 1999 and entered into force on 17th May 2005.

The current CLRTAP development strategy is focusing, above all, on the increase in ratifications and on the revision of the last three 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 strengthening the implementation of the Protocols and 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 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 by the National Law for the Prevention of Air Pollution and Reduction of Air Pollution from 2012. There are Act 201/2012 Coll. on Air Protection Act and Regulation 415 /2012 Coll. on the Permitted Level of Pollution and its ascertainment and on implementing some further provisions of the Act on Air Protection [4].

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

Since 2013, regarding the change in the categorisation of sources according to Annex 2 of the Air Protection Act, REZZO sources have been newly circumscribed (Table I.1).

Table I.1 The categorisation of pollution sources

Category	Type of source	Origin of emissions	Category
REZZO 1	Stationary plants for the combustion of fuels with a nominal heat input power of 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 of 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 than 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 statistical energy 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 the 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 the categories NFR 2A (except 2A5b), 2B and 2C. Data reported for sector Solvent use are only used for NMVOC emission estimates. 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 calculated 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, and agricultural machinery (NFR 3).

I.3 Inventory preparation process

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

Sectorial experts prepared inventory; see Table I.2.

Inventories and projections were prepared with the external help of:

- Transport Research Centre (CDV), Brno and MOTRAN, compile the inventory and projection in NFR 1A3 Energy and Road and non-road Transport.
- Research Institute of Agricultural Technology (VUZT), Prague, compiles the inventory and projection 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, compiles the NFR 2D Solvent Use inventory.
- Charles University Environment Centre, Prague, compiles the projection in NFR 1A1.

Table I.2 Institution arrangement

Sector	Author	Institution	E-mail
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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.) is also used to estimate emissions in certain sectors. A significant part of emissions is estimated based on 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, significant improvements were made in reported emissions and the presented report. The improvements are being implemented successively, with full implementation in 2020 reporting.

The 2024 submission presents:

- Submission (1990–2022) of emissions in all categories
- Notation keys for emissions and activity data were thoroughly revised and updated in NFR tables.
- Comment on EMRT findings was adopted in Chapter XII, 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.

Some changes in the use of notification symbols; see e-ANNEX

I.4.1 Emissions from individually monitored sources - stationary sources

Under 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 summarising the operational records using 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. Annex 11 to Regulation 415/2012 Coll. states the requirements for summary operating records.

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 an operating permit issued by regional authorities. The manner and frequency of measuring or calculating pollution levels and the scope, manner and conditions for recording, verifying, evaluating and storing results of the ascertainment of pollution are set in Regulation 415/2012 Coll. Part Two (Ascertainment of the Pollution Level and Evaluation of the Fulfilment of Emission Limits). According to the Tier 3 approach, reported emissions by the operators of their sources are preferred.

The use of emissions reported by source operators does not, in some cases, correspond to EMEP/EEA EIG [3], namely in categories where operated stationary sources do not reach the set threshold of named sources. Only for natural gas consumption are sufficient data 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 the methodology of reported data in categories with named sources. These emissions mostly come from annual one-time measurements to prove meeting emission limits when pollutant concentrations may depend on current equipment conditions, fuel burned, material inputs or abatement efficiency.

Emission of the pollutants, for which operators are not required to ascertain pollution levels, is calculated for each source in the emission database based on reported activity data and emission factors (Tier 1 or 2). Emission factors for stationary combustion sources are divided according to the type of fireplace and nominal thermal output. As activity data, fuel consumption is expressed in $t \cdot year^{-1}$, $thousand \cdot m^{-3} \cdot year^{-1}$, or the calorific capacity of fuel in $GJ \cdot year^{-1}$ 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 a percentage of PM fraction in total emissions of solid pollutants (TSP) are used. If a source is equipped with abatement technology, the share of particles depends on the separation principle of this technology. In combustion sources without any abatement, the shares of particles are determined according to the fuel type. 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 the 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, 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**). Two exceptions in emissions of heavy metals and POPs 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 product 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 the one-time measurement of suction devices. Wood coal production emissions are being measured while putting the facility in operation, and for annual reporting, specific production emissions are being used.

Besides the categories mentioned above, the REZZO register also contains solvent emissions using sources (NFR 2D3d to 2D3i). More than 3900 sources (painting and degreasing plants, printing plants etc.) produce more than 7.6 kt of NMVOC emissions. These data are not used directly, but considering a high number of non-monitored facilities and the area character of emissions in the 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 similarly. The permits of sources underlying permission mostly include the obligation to ascertain the TSP emissions. These sources are currently not used for emission inventory in NFR 5A according to Tier 1 methodology (see Chapter VI).

I.4.1.1 Emission Factors used

As stated above, the emission of the most important point sources is reported in Summary Operational Evidence (SOE). However, part of emissions is being calculated using national emission factors. Namely, NMVOC combustion emissions (boilers, piston engines and other sources) are included. Furthermore, $PM_{2.5}$ and PM_{10} are calculated as a portion of TSP-reported emissions. There is a similar situation concerning emissions of heavy metals and POPs. In further calculations are used emission factors from EMEP/EEA EIG [3]. For further information, see the following chapters. 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 the 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. Correctly estimating relevant activity data for sources using organic solvents is very problematic. The completion here is assumed for reporting in the coming years. Activity data for NFR 5 are partly being taken over from reported data (waste combustion) and statistical 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 emissions from local household heating, fugitive TSP emissions from construction, emissions from coal, oil and natural gas mining, food production and agricultural activity, ammonia emissions from farm animals' breeding, and mineral fertiliser application. VOC emissions from fuel distribution and VOC emissions from organic solvents are also included here.

Besides household heating emissions, other sources are calculated solely using data obtained within the national statistical monitoring. Potential year-to-year changes are usually related to the development of the relevant indicators. By contrast, year-to-year changes in the amount of emissions from local household heating depend primarily on the character of the heating season, expressed by the number of degree days, and on the changes in 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). During 2023, a complete recalculation of emissions was carried out for the entire period since 1990. The basis was the newly compiled shares of individual types of boilers according to the linked outputs of the ENERGO survey 2008, 2015 and 2021 and sales statistics from 1970.

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, and non-road vehicles (machines used in agriculture, forestry and building industry, military vehicles etc.). The database also includes emissions from tyres and brakes, road abrasion and evaporation calculated from data on transport performance. Since 1996 CDV complied the emission balance from mobile, based on data on the sale of fuels submitted by the Czech Association of Petroleum Industry and Trade (ČAPPO), since 2000 on the data from CZSO, and own emission factors. VÚZT processes sets of emission data on mobile sources in agriculture and forestry. The consistent time series of emissions in the traffic sector from 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 and related emissions were thoroughly revised in 2018.

Emissions of area monitored sources are being represented in main NFR 1A3 except for 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 the last period, EMEP/EEA EIG emission factors were implemented to calculate most key sources [6]. In some cases, national emission factors based on emission measurements of large sources (namely in NFR 1A4bi) are preferred. For NMVOC emission estimate in the category of Solvent use, EMEP/EEA EIG emission factors (use in households) and 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

Collectively monitored sources' emissions are calculated using activity data prevailing on publicly accessible web pages of CZSO (metal production and raw materials, agricultural production data, census ENERGO 2021, data from technical inspection of operated cars, waste data ISOH etc.). CZSO officers are preparing some data for emission inventory (fuels sold), or other statistical data are being used (customs statistics for emission estimate in solvent use). More detailed information is provided in the 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)

Generally, emissions from individually monitored sources do not contain a condensable component because of Czech legislation. TSP is determined by a heated apparatus, where a temperature is higher than the dew point of the exhaust gas (usually 70–160°C). These are mainly NFR 1A1 and NFR 1A2 sources.

Regarding collectively monitored sources, national emission factors from household heating (NFR 1A4bi) are determined based on sampling performed in the dilution tunnel. The sampling temperature was about 40°C. The EFs were thus determined to contain a high proportion of the condensable component. COPERT emission model calculates emissions from transport. EF is also determined by dilution methods (including dilution tunnels or systems using dilution after sampling); they contain a condensable component.

I.4.4 Inventory preparation timetable

Table I.3 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									

Collecting individually monitored sources is related to the deadline set by law for reporting of SOE 31st March. By the end of April, the first data in XML format will be available in the central storage ISPOP. During May, the announcements are checked, and in June, correction notifications are sent in case of unfilled or incorrect data. Complete download of the announced data, including additional or correction reports, is being done in September. 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 groups of sources are being announced as a sum (for example, a cascade of gas boilers) and emissions or fuel consumptions are being represented by approx. 40 000 records a year.

The processing of this data set in December and January includes mainly the check of the correctness of the NFR and the appropriate composition of emissions. If some emissions are reported in a category where are not expected, these are shifted into an appropriate category (for example, NO_X 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 is the sum of category emissions, 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 occur from May–December. Emission calculations for each category take place in January.

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

I.5 Key categories

The Key category analysis of the Czech Republic inventory is carried out according to the Tier 1 method described in the EMEP/EEA Guidebook. According to these guidelines, the key category is an emission category that significantly influences a country's inventory in terms of the absolute level of emissions. Key categories add up to over 80% of the total emissions, summed together in descending order of magnitude.

National emissions have been disaggregated into the categories reported in the National Format Report; details varied according to different pollutants to reflect specific national circumstances in 2022. The trend analysis has also been applied considering 1990, 2005 and 2022. Results are reported in the following Chapter II Key trends.

The main source of pollution in 2022 was NFR category 1A4bi (Residential stationary). The NFR category 1A4bi was top in nine emissions (NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO, PAH, HCB, PCDD/PCDF, Cd). The second most frequent NFR category was 1A1a (Public electricity and heat production). The 1A1a was top in measurements of three emissions (NO_X, SO_X, Hg) and occurring in others. In 2022, there was no important event.

I.5.1 QA/QC and Verification methods

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

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 the emission inventory preparation.

The process of air pollutant emission inventory is a part of the Air Quality System and Management in Czechia. According to § 7 of the Air Quality Act 201/2012 Coll., based on 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 authorised 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.5.2 QC procedures

The basic principle of emission inventory processing in Czechia consists of a dual system, including processing reported data of individual facilities (emissions or activity data enabling emissions calculations) and emission calculations based on national statistics. Despite significant differences between these approaches, quality control procedures are similar to a 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.

A new approach that has been applied since 2018 reflecting Stage 3 recommendations and EMRT review includes changes in methodology for sectorial emission inventory where full completeness of individually collected data needs to be secured. Still, activity data precise enough are available to enable the calculation of emissions relevant for the whole sector. These results replace individually reported data initially chosen for emission inventory compilation by calculating national statistics data and emission factors recommended by EMEP/EEA EIG [3]. The key sector with emission inventory solely based on individually reported emission data will, in the following periods, undergo detailed 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 are 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 the 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 needs to be corrected by the source operator, sent again and consequently imported into the national database EDA. The list of imported facilities is compared with the list of reporting by the ISPOP operator. Random checks of data transfer correctness into the EDA database are being performed.

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

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

Collectively monitored sources are processed 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 occurs before finalising the reporting or in the form of a resubmission.

The conversion of emission data, either reported or calculated, is done directly in the MS Excel application. Via linking of files, errors can be eliminated while filling in files for reporting. However, several errors appeared in previous reporting periods. Errors were caused by incorrect positioning of emission data in specific rows hidden while further processing or were not checked or wrongly linked to the file with annual summary data and incorrect reporting period. To eliminate these events test version of interlinked files with accessible data for a better check was prepared. This test version was in the following processing locked for adjustment of linking formulas.

In IIR, single tables are created that incorporate summary or concrete values of emission reporting. Considering the large scale of the document, correct value setting could only be performed in some tables and charts.

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

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

I.5.3 QA procedures

Due to the insufficient capacity of experts, review procedures on a national level have yet to be established. The emission inventory team uses recommendations and results of international reviews.

I.5.4 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 based on measurements are determined with less uncertainty than the emissions calculated based on statistical data. The uncertainty of emissions from point sources is below 5% (e.g. emissions from large combustion sources), and the uncertainty of emission data based on a model (e.g. emissions from household heating and exhaust emissions from transport) ranges between 25–30%. 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 to 200% (in this way, the emissions from the use of solvents, animal production and non-combustion emissions from transport are estimated) [3].

I.5.5 General assessment of completeness

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 applying the notation key ´NE´, we mostly accept recommendations in EFs tables of EMEP/EEA EIG [3].

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

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.

Table I.4 Sources included elsewhere

NFR s	Long name	Reason for IE
1A3aii(i)	Domestic aviation LTO (civil)	1990–1995 included in 1A3ai(i)
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	PMs 1990–1999 included in 1A2f
2A6	Other mineral products	NO_X, SO_X 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, BC 1990–1999 included in 1A2a
2C4	Magnesium production	PMs 1990–2001 included in 1A2a
2C5	Lead production	PMs 1990–1999 included in 1A2b; SO_X included in 1A2b
2C6	Zinc production	PMs included in 1A2b
2D3c	Asphalt roofing	CO included in 1A2f; all 1990–1999 included in 1A2f
2H1	Pulp and paper industry	1990–1999 included in 1A2d; NO_X, CO included in 1A2d
5C1bi–5C1biv	Waste incineration	included in 1A1a

II. Key trends

The date of the last edit of the chapter: 15/03/2024

The main monitored pollutants in the Czech Republic and the European Union are NO_X, NMVOC, SO_X, NH_3, and $PM_{2.5}$. Other pollutants covered in the chapter are TSP, PM_{10}, $PM_{2.5}$, BC, CO, POPs (PAHs, HCB, PCDD/PCDF) and heavy metals (Pb, Cd, Hg). Emissions are also regulated by law, and their combustion production is partly monetized (TSP, SO_X, NO_X and NMVOC).

In the Key trends chapter are summarized distributions in 2022 and sorted by trend NFR categories.

II.1 Emissions of most observed pollutants (NO_X, NMVOC, SO_X, NH_3, $PM_{2.5}$)

Air pollution is related to the economic and socio-political situation, environmental knowledge, and development of technology. Emissions levels mostly depend on static sources, especially from categories REZZO 1 and 2. REZZO 1 and 2 sources have been major polluters in the past. However, in the 21st century, people invented and started applying several measuring devices, filtering tools and other abatements to diminish the pollution from the combustion gases. The Czech Republic and European Union also strictly control emissions sources. Strict conditions for REZZO 1 and 2 reduce emissions which can be transported by the atmosphere for a long range.

Although REZZO1 and 2 undergo emissions limits, the required air quality still needs to be achieved. Stricter monitoring should be applied to REZZO 3 and 4 for better air quality results.

Nitrogen oxides (NO_X as NO_2)

NO_X emissions have decreased since 1990 because of heavy industry's lower activity and technological evolution. In 1990 the emission was 756.40, and in 2022 the emission was 156.15. In total, emissions decreased between 1990 and 2022 by 600.25 kt. In 2005, the Czechia recorded 305.42 kt.

Most emissions in 2022 come from NFR 1A1a 31.55 kt (20.2%). The category is sensitive to the population's future expansion and energy demands. Therefore, the EU increases renewable energy sources and creates sustainable development.

Another important source of NO_X pollution is NFR 1A3bi. The NFR 1A3bi category is also influenced by population, EU legislation and law. In 2022 NFR 1A3bi produced 24.75 kt (15.9%) of the total NO_X emissions. There are two main reasons why the pollution from passenger cars is so high: First, the passenger cars in the Czech Republic are one of the oldest in the EU. Second, In Czechia, there are numerous internal combustion vehicles. The remaining NO_X emissions come from NFR 1A3biii at 13.82 kt (8.9%), 1A4cii at 12.95 kt (8.3%), 3Da1 at 11.42 kt (7.3%) and others.

Volatile organic compounds (NMVOC)

The emission of NMVOC has a decreasing trend over time. The emissions of NMVOC decreased between 1990 and 2022 by 549.04 kt. Emissions were 834.97 kt in 1990, 308.76 kt in 2005 and 285.92 kt in 2022. The most NMVOC comes from the NFR 1A4bi 157.77 kt in 2022 (55.2% of total NMVOC emissions). NFR 1A4bi sources are small and pointed but numerous. NFR 2D3d is the second most significant source of NMVOC emissions. The category produced 19.8 kt (6.9%) in 2022.

The remaining emissions come from various parts of Agriculture (NFR 3) and the Solvent and produce use (NFR 2D).

Sulphur dioxide (SO_X as SO_2)

The total SO_X emission of 1753.81 in 1990 was the second-highest measured emission. And the highest in the database history of SO_X. Due to the shutdown of old power stations, shift to low SO_X content fuels, applying desulphurization and combustion adaptation in power generation. These steps dramatically changed the situation. The emission of SO_X has a decreasing trend over time. Emissions were 208.47 kt in 2005 and 64.64 kt in 2022. In 2022 the most SO_X emission was contributed by the NFR 1A1a. In NFR 1A1a, is indicated 25.97 kt (40.2%). In NFR 1A4bi 17.42 kt (27%). Other important sources of SO_X pollution are categories from the industrial segment.

Ammonia (NH_3)

NH_3 emissions have a decreasing trend over time. NH_3 emissions were 152.8 kt in 1990 and 83.01 kt in 2005. In 2022, total emissions were 78.08 kt and the major contributors to ammonia emissions were NFR categories 3Da1 26.53 kt (34%), 3Da2a 13.31 kt (17.1%), 3B1b 9.48 kt (12.2%), 3B1a 8.87 kt (11.4%) and other categories belonging to agriculture.

Particulate matter ($PM_{2.5}$)

The emissions measured in 1990 were high, 298.98 kt, because of the production of factory combustions. The emission of $PM_{2.5}$ has a decreasing trend over time. Between 1990 and 1998 we observe a sharp decline in $PM_{2.5}$ emissions due to the desulphurisation of factories. Emission was 73.84 kt in 2005 and 55.08 kt in 2022. The future changes in $PM_{2.5}$ emissions depend on the winter season and the expansion of the population because 45.75 kt (83.1%) of emission from NFR 1A4bi also the planned replacement of boilers due to age and the change of heating method following the closure of the coal mines. A change in the calculation methodology has also contributed to the change in emission levels. The changes are presented in Chapter III.2.

II.2 Emissions of TSP, PM_{10}, BC, CO

Total suspended particles (TSP)

The TSP emission in 1990 was 675.88 kt and in 2022 was measured at only 83.96 kt. TSP is still on a declining trend due to the shutdown of old power plants, intensive desulphurisation and the development of new methods to capture emissions

The achievements in TSP abatement belong to the second most significant in Czech emission inventory considering the percentage ratio. Because TSP refers to the entire range of ambient air matter that can be collected, from the sub-micron level up to 100 µm in aerodynamic diameter (d_{ae}). Particles with a diameter larger than 100 µm will not remain suspended in the atmosphere for a significant time. Compared to PM_{10} and $PM_{2.5}$, TSP remains in the air for shorter periods and is generally not carried over long distances. PM_{10} and $PM_{2.5}$ are parts of the TSP.

The NFR 1A4bi was the most contributing sector at 50.08 kt (59.6%), and NFR 3Dc was the second at 6.69 kt (8.0%).

Particulate matter (PM_{10})

The emissions measured in 1990 were extremely high, in total 507.6 kt, because of the production of combustions from factories. The emission of PM_{10} has a decreasing trend over time. In 2022 emission was 69.47 kt.

Nowadays, the production of PM_{10} mainly depends on the heating season and the number of boiler types installed. Therefore, most of the emission comes from NFR 1A4bi 46.78 kt (67.3%), second-highest emission comes from NFR 3Dc, 6.69 kt (9.6%).

Black carbon (BC)

The total emissions of BC depend on $PM_{2.5}$ emissions (EMEP/EEA 2016 guide to estimate BC emission factors). The BC has a decreasing trend. In 1990 was measured at 23.77 kt. In 2022 emission was 5.81 kt. Most of the emission comes from NFR 1A4bi 3.93 kt (68.7%)

Carbon monoxide (CO)

The CO emissions have a stable decreasing trend with slight fluctuation. The total CO emissions of 2920.43 kt in 1990 were the highest emission, the highest emission in the Czech Republic database history. Through time, the CO emissions come especially from NFR 1A4bi. In 2022 emission was 1034.59 kt.

Most of the emissions come from NFR 1A4bi, 739.86 kt (71.5%). Followed by the emission of NFR 1A2a, 78.54 kt (7.6%), and NFR 2C1, 77.94 kt (7.5%).

II.3 Emissions of POPs

Polyaromatic Hydrocarbons (PAHs)

The emission of PAHs has a decreasing trend over time. In 1990 emission of PAHs was 282.01 t. The decline was due to the reduced coke industry, and heavy industry is slowly disappearing. In 2022 it was 46.37 t and the only source of emission was NFR 1A4bi 43.83 t (94.5%).

Hexachlorobenzene (HCB)

The emission of HCB has a decreasing trend over time. In 1990 emission of HCB was 536.5 kg. In 2002 the primary sources of emission NFR 2C3 were limited, and precursors of HCB were prohibited. In 2022 the emission of HCB was 9.93 kg. The most HCB emission was contributed by the NFR 1A4bi, 6.41 kg (64.5%), and NFR 1A1a, 2.86 kg (18.8%).

Polychlorinated dibenzo-p-dioxins and furans (PCDD/PCDF)

PCDD/PCDF emissions have a decreasing trend over time. The emission of PCDD/PCDF in 1990 was 106.01 g I-TEQ. The total emission of PCDD/PCDF in 2022 was 13.67 g I-TEQ. The remaining amount of PCDD/PCDF emission is covered by NFR 5E, 4.28 g I-TEQ (31.3%) followed by NFR 2C1, 2.72 g I-TEQ (19.9%), NFR 5C2, 1.41 g I-TEQ (10.3%), and others.

II.4 Emissions of heavy metals

Lead (Pb)

The emission in 1990 was high, 316.59 t. In the year 2001, emissions dropped due to the end of the use of leaded petrol in transport activities. Since 2001 the Pb pollutant has had a slightly fluctuating trend. In 2022 emission was 24.84 t.

The biggest producer of Pb emission was NFR 1A3bvi by 8.11 t (32.7%), followed by NFR 2G, 6.87 t (27.7%) and NFR 2C1, 3.17 t (12.8%). Other important sources of Pb emission are NFR 1A4bi and 1A1a.

Cadmium (Cd)

The emission of Cd has a decreasing trend through time. In 1990 emission of Cd was 5.28 t and in 2022 emission was 1.32 t. The main contributors of Cd emission are NFR 1A4bi at 0.68 t (51.7%), 2G at 0.13 t (9.5%), 1A1a at 0.12 t (9.3%) and other categories belonging to the Industry.

Mercury (Hg)

The emission trend of Hg is decreasing. In 1990 emission of Hg was 5.2 t and in 2022 was 2.08 t. From NFR 1A1a comes the majority of emissions 1.03 t (49.7%). The following sources of emission are also in connection with combustion from small stationeries. The NFR 1A4bi produced 0.27 t (12.9%) of Hg. And the NFR 1A2a produced 0.18 t (8.6%).

II.5 II.5. The overview of emissions

II.5.1 The history of regulated pollutants from 1990 to 2005

In 1991 Act No. 309/1991 Coll. on Air Protection supplemented by Act No. 389/1991 Coll. on State Administration in Air Protection and charges for Air Pollution came into force for the first time in Czechoslovakia (later Czech Republic) history. After Czechoslovakia fell apart in 1993, the Czech Republic took over international commitments CRLTAP (Convention of Long-range Transboundary Air Pollution). As the same as another eight international protocols (such as the Protocol of Further Reduction of Sulphur Emissions and Protocol on Heavy Metals). Therefore, Czechia implemented the emission limits and fees per ton for SO_2, NO_X, and $PM_{2.5}$, starting to be effective in 1998. This program should prepare the sources for the new operating conditions. The national economy was restructured, the factories were modernised, and many closed or reduced their operation. For example, the iron and steel sector decreased production significantly between 1992 and 1994. Old boilers were shut down or modernised in the electricity and heat production sector. During 1993–1998, the coal-burning power stations were desulphurised. The combustion sources with lower heat consumption (heating plants/boiler houses) gradually replaced solid and liquid fossil fuels with natural gas. More pollutants were charged with fees, and the fee rates for emission release rose. As a result, emissions of all pollutants of REZZO 1 and 2 categories decreased. In 2002 law 309/1991 Coll. on Air Protection was replaced by new law Act No. 86/2002 Coll. on Air Protection (and completed by Act No. 86/2002 Coll. Air Quality and Act No. 76/2002 Coll. Integrated Prevention (IPPC) in connection with the best available technique (BAT) and Integrated Pollution Register (IPR). Since 2004 Czechia has been a part of the European Union, and new international laws came into force: Aarhus Convention on Access to Information, the European Environmental Agency which controls and summarises data on EIONET, the European Release and Transfer Register and many more.

II.5.2 Emissions of regulated pollutants from 2005 until the present

Before 2005 Czechia was one of the biggest air polluters in Europe. Since 2005, the air quality conditions have been much better.

New laws and amendments have come into force. In Czechia the law 86/2002 Coll. on Air Protection was replaced by Act No. 201/2012 Coll. on Air Protection and two years later was amended by Act No. 64/2017 Coll. which changed some parts of low on Air Protection, due to connection with the adoption of the control condition. Act No. 25/2008 Coll. on Integrated Pollution Register, also Integrated Environmental Reporting System (IERS) are one of the most effective and has a long-term effect on improving air quality. In 2016 the Integrated Environmental Reporting System was modified. Moreover, EU E-PRTR also came into effect in 2019.

The emissions of regulated pollutants are on the same value level with a slight deviation. Due to regulations and applied abatements, the pollution level is less sensitive to growth in industry, agriculture, population, and other connected activities. Compared to the previous year, monitored emissions decreased or stayed at the same level, except for SO_X, NO_X, CO and Hg in 2022. The SO_X emissions are higher by 1.87 kt, although a moderate increase from all NFR categories. The NO_X emissions are higher by 3.07 kt mainly because of emissions from NFR 1A1a (Public electricity and heat production). The CO emission increased by 1.46 kt in 2022. The most significant increase is in NFR categories 1A4bi and 1A2a. The rise of Hg levels is moderate, only 0.08 t.

II.6 Summary

NFR 1A4bi (Residential stationary) was the most significant emissions source, contributing enormously to eight emission pollutants (NMVOC, $PM_{2.5}$, TSP, PM_{10}, CO, PAH, HCB, and Cd) in 2022. The second most significant source was NFR 1A1a (Public electricity and heat production), contributing enormously to three emissions components (NO_X, SO_X, Hg) and occurring in others. Data for every emissions component are in the table down below. The rest of the NFR categories have increased values only in its most significant pollutants (ex., Ammonia was most represented by agriculture).

SO_X, NH_3, Pb, As, Cr, Cu, Ni, Se and Zn emissions increased year to year due to higher coal consumption in sector 1A1a.

Table II.1 Key categories of air pollutants in Czech Republic in 2022

Component	Key Category										Total 2022
NO_X	1A1a	1A3bi	1A3biii	1A4cii	3Da1	1A4bi	1A3bii	1A2f	1A4ai	other	
%	20.2	15.9	8.9	8.3	7.3	6.9	5.7	5	4.1	21.8	
[kt]	31.55	24.75	13.82	12.95	11.42	10.72	8.87	7.79	6.33	34.28	156.15
NMVOC	1A4bi	2D3d	2D3a	3Da2a	3B1b	3B1a	2D3g	other			
%	55.2	6.9	5.6	4	3.9	3.5	2.1	18.8			
[kt]	157.15	19.8	15.93	11.51	11.25	9.95	6.15	54.18			285.92
SO_X	1A1a	1A4bi	1A2a	1A2f	1B2c	other					
%	40.2	27	6.9	5.1	3.9	16.9					
[kt]	25.97	17.42	4.47	3.29	2.54	10.95					64.64
NH_3	3Da1	3Da2a	3B1b	3B1a	3Da4	other					
%	34	17.1	12.2	11.4	6.3	19					
[kt]	26.53	13.31	9.48	8.87	4.93	14.83					77.95
$PM_{2.5}$	1A4bi	other									
%	83.1	16.9									
[kt]	45.75	9.33									55.08
TSP	1A4bi	3Dc	2A5b	1B1a	1A3bvi	1A3bvii	other				
%	59.6	8	4	4	3	2.2	19.2				
[kt]	50.08	6.69	3.38	3.38	2.56	1.81	16.06				83.96
PM_{10}	1A4bi	3Dc	1A3bvi	1B1a	other						
%	67.3	9.6	2.9	2.2	18						
[kt]	46.78	6.69	2.03	1.56	12.41						69.47
CO	1A4bi	1A2a	2C1	other							
%	71.5	7.6	7.5	13.4							
[kt]	739.86	78.54	77.94	138.25							1034.59
PAH	1A4bi	other									
%	94.5	5.5									
[t]	43.83	2.54									46.37
HCB	1A4bi	1A1a	other								
%	64.5	28.8	6.7								
[kg]	6.41	2.86	0.66								9.93
PCDD/PCDF	5E	2C1	5C2	1A3bi	1A1a	2C7a	other				
%	31.3	19.9	10.3	8.4	7.9	7.2	15				
[g I-TEQ]	0.64	0.99	1.08	1.15	1.41	2.72	5.68				13.67
Pb	1A3bvi	2G	2C1	1A4bi	1A1a	other					
%	32.7	27.7	12.8	6.1	5.9	14.8					
[t]	8.11	6.87	3.17	1.52	1.47	3.7					24.84

Hg	1A1a	1A4bi	1A2a	5C1bv	1A2f	other	
%	49.7	12.9	8.6	7.3	4.3	17.2	
[t]	1.03	0.27	0.18	0.15	0.09	0.36	2.08
Cd	1A4bi	2G	1A1a	2C1	2C6	other	
%	51.7	9.5	9.3	8.6	4	16.9	
[t]	0.68	0.13	0.12	0.11	0.05	0.23	1.32

III. Energy (NFR 1)

The date of the last edit of the chapter: 15/03/2024

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 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 operating permit conditions. For stationary combustion sources, these obligations are obligatory for all combustion sources exceeding the rated thermal input of 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 based on information on abatement equipment and fuel type. The ammonia emissions are calculated using emission factors (equipment below 5 MW input) and at some sources with $DeNO_X$ technology reported by the source operator. For inventorying of HMs and POPs, please refer below.

Operators of specific sources must also measure some of the other pollutants by law (Annex 4 to Act. 201/2012 Coll.)

Furthermore, limits for 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 $mg \cdot GJ^{-1}$. The total annual amount of energy input is calculated from fuel consumption and net calorific values; operators also report them in summary operating records. Czech emission factors are predominantly based on either own measurements and partly taken from the EMEP/EEA EIG, version 2023 (Tier 2) [3].

Emissions of road-mobile sources are estimated according to recommendations in the 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 categories 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/PCDF (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 technological combustion processes in the industry, like solid fuels transformation or for production and processing of metals, raw materials, chemicals etc.

Information about combustion processes in the sector of services (NFR 1A4ai), agriculture (NFR 1A4ci), military (NFR 1A5i) and household (NFR 1A4bi) are given in Chapter III.1.2.

The criterion for source allocation to NFR 1A1a is the nominal thermal input and classification NACE. Combustion plants represent NFR 1A1a for producing public electricity and heat with total rated thermal input equal to or greater than 50 MW (according to aggregation rules according to article 29 of the Directive 2010/75/EU on Industrial Emissions – IED), regardless of the type of the used fuel.

These sources are classified according to IED as Large Combustion Plants – LCP. This sector is characterised by a relatively small number of operation units (60 in 2022).

Emissions from facilities for waste incineration with heat recovery are also allocated 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 coal heat treatment (coke ovens, briquetting plants and drying). NFR 1A3e includes only emissions 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 categorised according to NACE classification in the 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 the processing industry (for instance, 13–16, 22, 25–33) in NFR 1A2gviii. These are specifically divided among NFR categories of sources where processing combustion – processing heating etc., take place. In the e-ANNEX is placed a link between the NFR category and classification according to Czech laws: in connection of controls performed by TERT technological sources with the combustion of fuel were significantly changed in allocation emissions of NO_X and CO (or other emissions from fuel combustion). These emissions were, in 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 producing glass, cast iron and non-ferrous metals). NFR 1A2a includes HCB emissions from sintering belts (NFR 2C1 Iron and steel production). Other emissions from sintering belts (also for NO_X, SO_X, TSP, Hg and PCDD/PCDF) are reported by source operators, and other reported emissions are calculated. All emissions are classified in NFR 1A2a in the calculation system 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 details, please see e-ANNEX.

The development of fuel bases for stationary sources divided into aggregated sectors (GNFR) in 1990–2022 is illustrated below in Figure III.1 to Figure III.3.

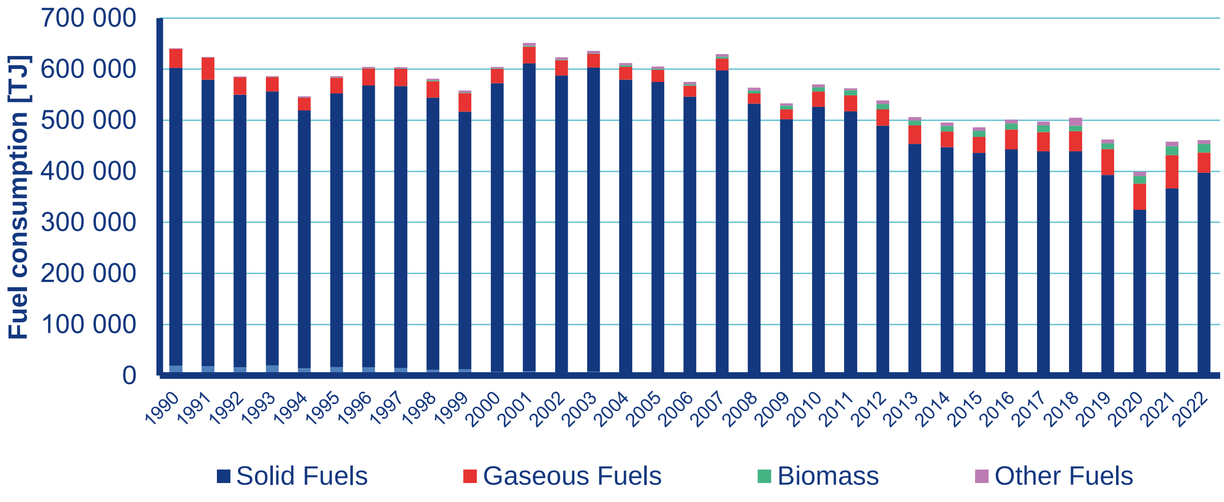

Figure III.1 Fuel consumption for GNFR sector A_PublicPower, 1990–2022

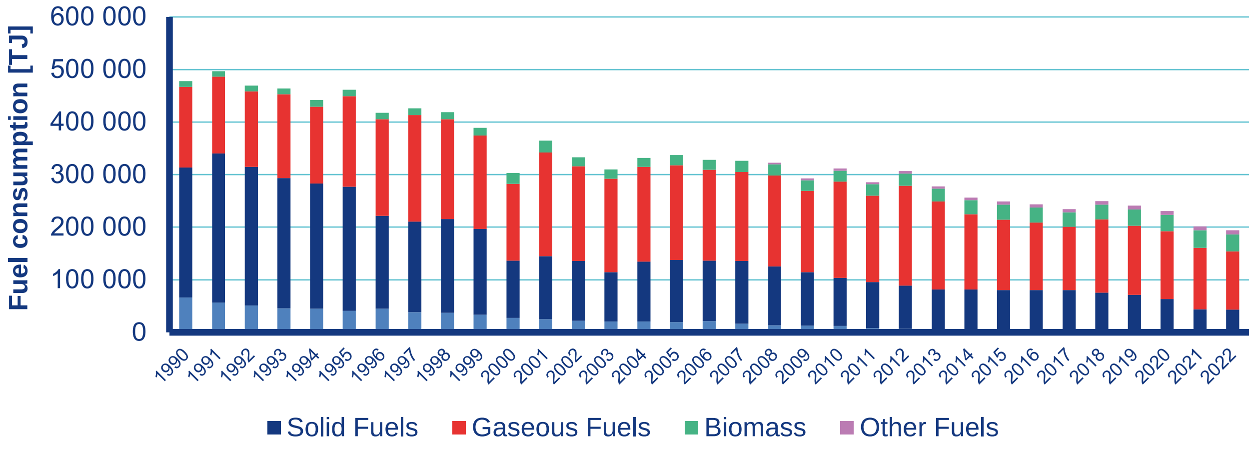

Figure III.2 Fuel consumption for GNFR sector B_Industry, 1990–2022

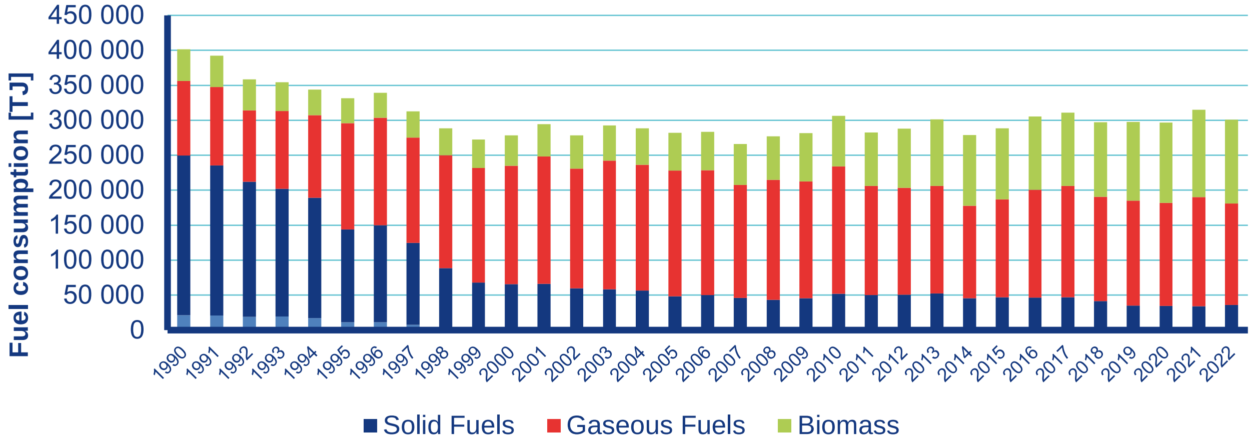

Figure III.3 Fuel consumption for GNFR sector C_OtherStationaryComb, 1990–2022

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

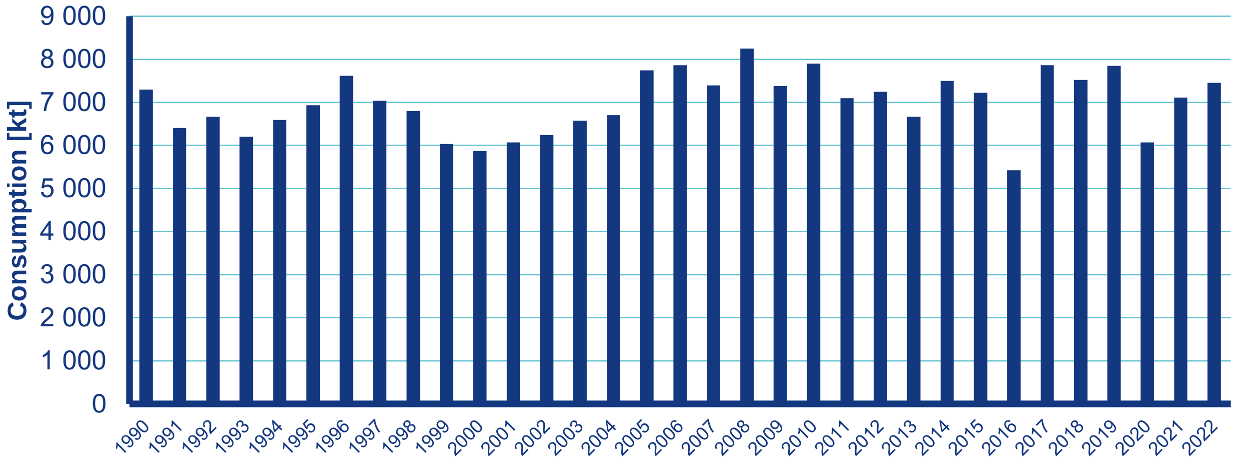

Figure III.4 Crude oil consumption, 1990–2022

Crude oil refining is essential to the economy of Czechia, not only due to the production volumes reached but also to its broader significance (ensuring energy safety and the close connection with the third most important manufacturing sector: the chemical industry). Operational accidents in both refineries Litvínov and Kralupy caused a strong decrease in 2016. 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 details, please, see e-ANNEX.

There was only one technology for coal gasification in Czechia in the former town gas facility Sokolovská uhelná near a lignite mine. After purification, the generated gas was combusted to power production. The facility terminated gas generation in 2020. Three coke plants operate in the Ostrava region, producing mainly metallurgy coke.

Sources for district heating with rated thermal input from 0.3 MW and less than 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 and fluidised bed boilers. Solid fuels are represented mainly by pulverised brown coal (approx. 70%) and pulverised hard coal (approx. 10%), followed by various types of biomass (wood and other biomass). In addition to solid-fuel boilers in this category, oil-fired and gas-fired boilers, burning mainly natural gas, are represented. Natural gas and fuel oils are also stabilising in solid-fuel boilers.

These plants' specific emission limit values 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 according to Act 76/2002 Coll. on 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 $mg \cdot GJ^{-1}$ (see e-ANNEX). The methodology is the same for all stationary sources in categories 1A1, 1A2, 1A3ei, 1A4ai and 1A4ci. 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 PM emissions have lowered significantly since 2016 due to the installation of modern bag filters. In the e-ANNEX are placed EFs for calculating HMs, POPs and NH_3 emissions. The average national emission factor (8 $g \cdot GJ^{-1}$, determined using the declared emissions) was used to calculate NH_3 emissions for categories in which biomass is burned in boilers with an input of up to 5 MW.

The specific calculation is performed for emissions of NFR 1A1c. The procedure of calculation recommended in a 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 laws, emissions for large stationary sources of NFR 1A are determined based on continuous or periodic measurements that comply with European laws (IED, MPCD and previous directives). The uncertainty of the sum of emissions from those sources is below 5%; see also Chapter I.5.4 General uncertainty evaluation.

QA/QC for NFR 1A1a is the same as in the case of other stationary point sources; see also I.5.1QA/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 according to valid European laws. 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 EIONET (European Environment Information and Observation Network) system, which is subjected to further checks. Since 2013, data have been inserted via a web form with an implemented control mechanism, specifically focusing on filling 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 occurs, but the inserted data are to be checked.

The 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 must 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:
- a significant difference in reported and expected SO_X (as SO_2), NO_X (as NO_2) and TSP emissions
- consistency with emission trends at the national level.

III.1.3 Planned improvements

No improvements are planned, and 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 to 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 the chapter. NFR 1A4bi includes emissions from local household heating, cooking and water warming. The emission inventory is prepared at the Tier 2 approach.

Fuel consumption is being ascertained by CZSO which hands over the data via international questionnaires to EUROSTAT and other institutions. These data represent basic input for emission inventory (Figure III.5). The consumption of individual coal fuels is being taken over directly from the international questionnaire CZECH_COAL in natural units. The caloric values, stated summary in this questionnaire under the item “For other uses”, do not correspond to real calorific values of coal fuels distributed to households. The recalculation of energy units was therefore done using caloric values annually ascertained by statistical census among fuel producers in the 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 the CZECH_REN questionnaire, there was according to the statistical 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 $MJ \cdot kg^{-1}$ was used. Data about the consumption of gaseous fuels for emission inventory are taken over directly from the energy balance of EUROSTAT.

Data about the distribution of total fuel consumption according to combustion equipment type (e-ANNEX), the structure of combustion equipment in households, share of wet wood combustion and other parameters had been discovered by statistic census ENERGO 2021. The overview of combustion equipment structure in the period 1990–2021 was prepared by combining these results with other statistics (SLDB, ENERGO 2021, sales of boilers). The significant change in the heating equipment ratio is in Table III.1, where the data from ENERGO 2015 and ENERGO 2021 are compared.

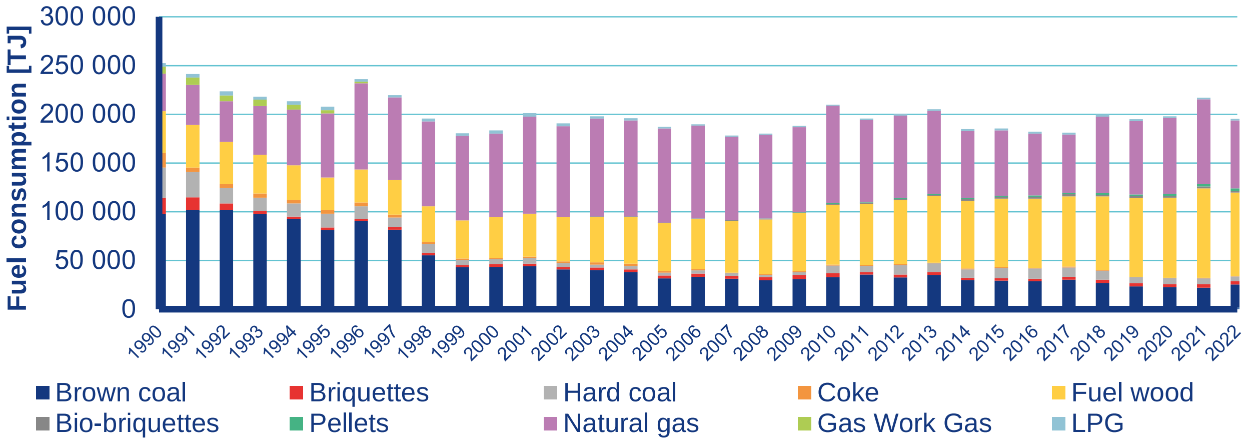

Figure III.5 Fuel consumption in sector local heating of households, 1990–2021

Table III.1 Distribution of solid fuel consumption according to the type of heating equipment in 2021 - change of heating equipment ratio

Installation type/fuel type	ENERGO	Over-fire boilers	Under-fire boilers	Automatic boilers	Gasification boilers	Stoves/fireplaces
			[%]			
Brown coal	2015	23	31	33	9	5
	2021	6	45	36	9	4
Briquettes	2015	53	22	6	5	14
	2021	35	37	6	12	10
Hard coal	2015	53	15	23	6	5
	2021	23	35	31	8	3
Coke	2015	88	9	1	0	2
	2021	77	8	13	0	2
Wood - dry	2015	31	17	4	19	29
	2021	34	14	4	22	26
Wood - wet	2015	32	14	3	13	38
	2021	30	14	9	8	39

Bio-briquettes	2015	17	9	5	11	59
	2021	24	9	3	11	53
Pellets	2015	0	1	56	0	44
	2021	6	1	40	3	50

III.2.1 Emission factors and calculations

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). The methodology modified in 2023 uses a combined emission factor for the operation of boilers and heating plants in reduced and nominal output mode, based on the Stage III recommendations from 2022. Representation of emission factors for reduced performance in the entire period incl. assumption until 2030 is shown in Table III.2.

Table III.2 Distribution of solid fuel consumption according to the type of heating equipment in 2021 - change of heating equipment ratio

Parameters for calculation / Year		**1990**	**2000**	**2005**	**2020**	**2025**	**2030**
The volume of dry wood		until 2016 = 85%			since 2020 = 92%		
Share of reduced output for boilers, stoves and fireplaces	**Over–fire boilers**	98%	98%	97%	95%	NO*	NO*
	Under–fire boilers	98%	98%	97%	95%	8%	3%
	Automatic - boilers	100%	90%	90%	87%	85%	82%
	Gasification boilers	100%	86%	73%	48%	36%	23%
	Stoves and fireplaces	100%	100%	96%	90%	87.5%	85%
Share of heaters without Eco-design		100%	100%	100%	100%	80%	60%

NO*: not occurring

These adjustments significantly affected the entire emission inventory of the Residential: Stationary sector. More detailed information is provided in the e-ANNEX.

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 the household heating sector and more information about combustion measurements of VEC VŠB are available in e-ANNEX.

Ammonia emissions from combustion in equipment below 5 MW until 2014 are 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. The emission factor for biomass and boilers with an input of up to 5 MW was calculated as an average from the emission factors of the European countries which do not use Guidebook emission factor values. The average value of the NH_3 emission factor is 5.2 $g \cdot GJ^{-1}$.

Based on the ENERGO 2021 survey results and other surveys, the proportion of burned dry wood was determined. The ratio 85% for dried (dry) wood and 8% for non-dried (wet) wood is used for the period

1990–2015. The ratio of 92% for dried (dry) wood and 8% for non-dried (wet) wood is used for the entire period 2020–2022 and the emission projection. Between 2016 and 2019 a smooth change of ratios is applied.

From the first measurement results of newly sold boilers [47], the NMVOC emission factor for newly sold filling boilers was determined. For further details, please see e-ANNEX.

The condensable component of PM emissions

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

III.2.2 Uncertainties and QA/QC procedures

The chapter will supplied later.

III.2.3 Planned improvements

Currently, an extensive verification of the emission factors of older boilers is conducted. The measurements of newly sold boilers and stoves are in progress at the same time. The results will be processed for reporting in 2025 or 2027.

III.3 Transport (NFR 1A3)

The Chapters 0, III.3.2, III.3.3, III.3.5 and most of III.3.4 were prepared by CDV. Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery in Chapter III.3.4 was prepared by VUZT. The sorting criteria of 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).

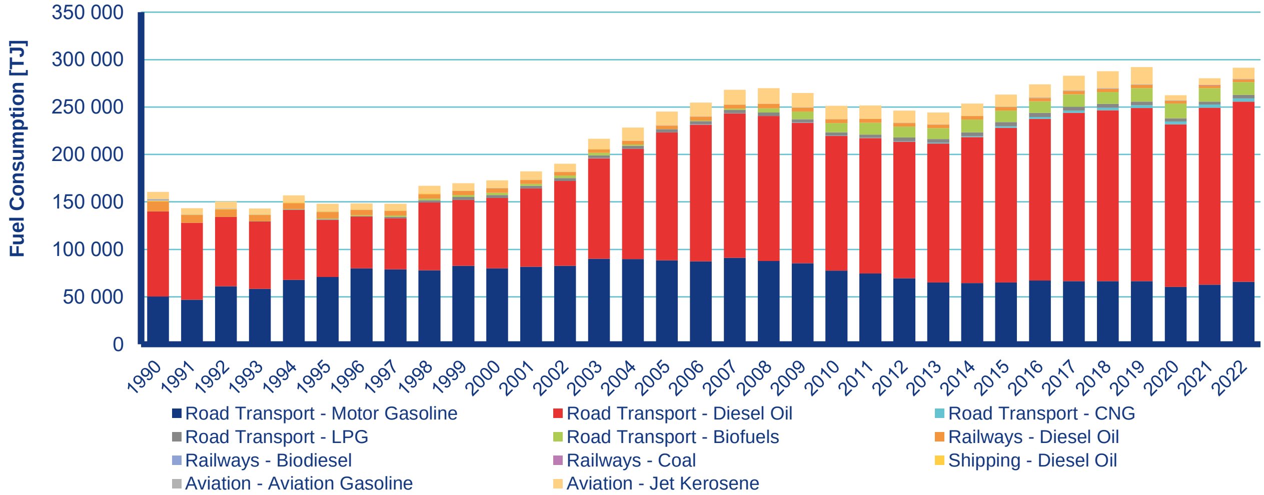

Figure III.6 Annual fuel consumption by all modes of transport, 1990–2022

Chapter 0 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 L-category. 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, NMVOC, $PM_{2.5}$ and others from road transport have sharply decreased due to the 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 and 2021, there was a significant reduction in transport emissions as a result of the COVID-19 pandemic. The drop in emissions was caused by a substantial decrease in activity for all modes of transport, and particularly affected aviation. In 2022, the total fuel consumption in the transport sector jumped back to values similar to before the pandemic. Fuel consumption increased or stayed the same for most of the transport modes except for shipping and biofuels in road transport in comparison with the year 2021.

III.3.1 Road transport emissions (NFR 1A3b)

In this chapter, an overall view and basic information about subcategories in road transport are given. More detailed information about particular subcategories is given in the respective subchapters. The content and structure of these subchapters are not uniform as every subcategory has important information to point out.

The appropriate distribution is necessary to assign a relevant emission factor. NFR 1A3b Road Transport is split into seven subcategories:

- 1A3bi Passenger Cars
- 1A3bii Light Duty Vehicles
- 1A3biii Heavy-Duty Vehicles
- 1A3biv Mopeds & Motorcycles (L-Category)
- 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

The methodology for the calculation of emissions from road transport is based on the COPERT 5.7 model on the Tier 3 level. The basis of emission calculations in COPERT 5.7 are number 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, etc.),
- fuel quality and composition of fuel,
- calorific value of fuels (from CZSO).

This is only a brief summary. A full description of the COPERT 5.7 program is to be found in COPERT documentation. COPERT 5 is based on 2023 EMEP/EEA EIG [3]. The full methodology of application of COPERT 5 in Czechia 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 a number of vehicles and technical details of vehicles registered in particular categories in CZ. TCS defines the annual traffic performance for a particular car. By combining these two databases it is possible to obtain a 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 the actual reported year. The reason is that new private cars in CZ have to undertake technical control four years after signing in CCR. To have precise emissions estimates it is necessary to recalculate those four years retrospectively. For the recent submission, it was 2018–2021. This calculation procedure was developed by Brich in 2014, and the 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 described in Chapter VIII.3, which is focused on the following topics:

- Changes due to update to a new version of COPERT program

- Changes due to analyses of the Czech Car Registry and Database of Technical Control Stations
- Changes due to updated activity data from CZSO

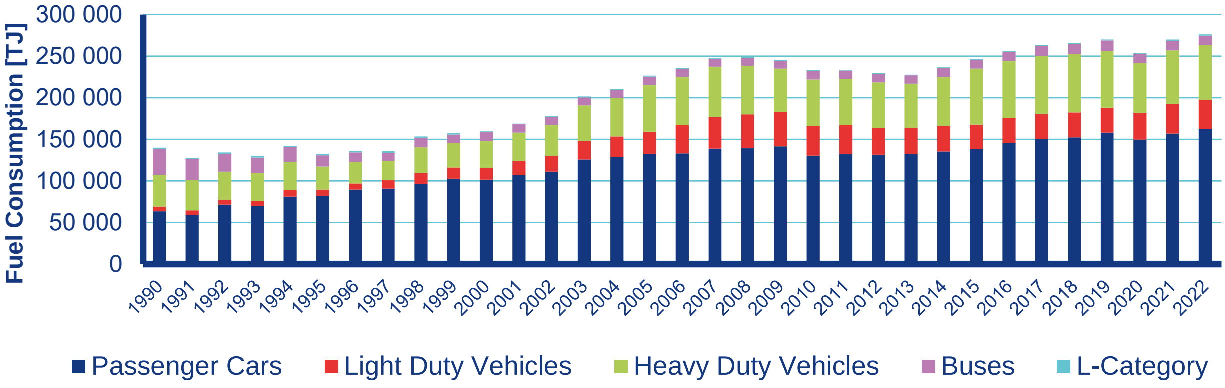

Figure III.7 Annual fuel consumption by road transport, 1990–2022

Figure III.7 shows trends in fuel consumption 1990–2022 by particular vehicle categories. A general rising trend of fuel consumption by PCs and LDVs is in line with a general trend across Europe. There is an obvious influence of the economic crisis between 2008 and 2013 on fossil fuel consumption. Since 2014, there has been a significant increase in main fossil fuel consumption. In 2016, almost 10% lower prices of diesel and gasoline influenced the increase in fossil fuel consumption with a one-off break in 2020 due to the COVID-19 pandemic.

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 of 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. The exceptions are the years 2020 and 2021 influenced by the COVID-19 situation when gasoline consumption was lower.

Fuel consumption of diesel was steadily growing from 2000 to 2008. In the following years, it was oscillating around 14 000 TJ due to the economic crisis. Another steep increase started in 2014 and was related to economic growth and the growing popularity of diesel PCs. The year 2020 was influenced by the COVID-19 situation when diesel consumption dropped to 171 416 TJ. In 2021, it already increased by 2% in comparison with 2019 and in 2022 it was 4% higher than before COVID-19.

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 of 4.1% in 2010 and the share of fatty acid methyl esters (FAME) as a renewable resource in diesel oil reached a value of 6% in 2010. The share of biofuels in fossil fuels was increasing too (6.8% in 2010 and 8.5% in 2015). After 2015, biodiesel consumption started increasing. Lower taxes for blends with a high percentage of biodiesel were implemented in 2015, but customers slowly accepted this change. Biodiesel consumption was steadily increasing and it reached more than 12 600 TJ in 2020, then it began to decrease. Bioethanol shows no specific long-term trend. The highest consumption of bioethanol was before COVID-19 in 2019 (3 078 TJ). It reached 2 646 TJ in 2022.

CNG buses have been used in Czechia since 1994. The use of CNG PCs started after the year 2000. The steep increase in CNG consumption from 2012 was caused by subsidies from public resources to encourage the use of CNG buses especially. Other subsidies were determined for CNG LDVs and PCs used by local authorities. CNG consumption continued to increase also in 2022 (3 353 TJ).

Consumption of LPG was continuously growing until 2016. After 2016, there was a slight decrease most likely caused by low prices of diesel and gasoline and fewer subsidies for LPG vehicles in CZ. LPG consumption reached 3 723 TJ in 2022.

Emission factors

Emission factors are based on the COPERT 5.7 model on the Tier 3 level. COPERT methodology is in line with EMEP/EEA EIG [3]. Generally, EFs are composed of hot EFs and cold EFs and they are additionally dependent on vehicle category and driving mode (share of urban, rural, and 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 – PM, 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, CO and NMVOC

Emissions

Emissions were calculated based on the total consumption in all COPERT vehicle categories which are relevant in CZ. COPERT calculates emissions from hot engines and 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.

Downward trends in emissions of NO_X, NMVOC, and CO depend on different EU regulations which came into force and on ongoing technical development (engines, catalysts, etc.). SO_X shows a strong dependence on the increasing quality of fuels (sulphur content) bringing a significant downward trend which is slightly influenced by increases in fuel consumption. The share of PM 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. A general overview of trends in emissions of NO_X, NMVOC, PM and CO for road transport are presented in the figures below for the entire period 1990–2022.

NO_X emissions were decreasing until 2002 (see Figure III.8). An increase in emissions after this year was related to economic growth, a shift from gasoline to diesel passenger cars and light-duty vehicles and an increase in traffic performance, especially by heavy-duty vehicles. There was a significant increase in traffic performance by passenger cars and light-duty vehicles after 2001, however, improvement of NO_X reduction technologies stopped the increase of NO_X emissions, especially in the PCs subcategory. From 2006, overall NO_X emissions were decreasing because of a less intense increase in traffic performance in all modes of transport except for diesel passenger cars. In 2016, a steep decrease in NO_X emissions slowed down because of economic growth and lower prices of fuels compared to previous years. From 2018, we can see a decrease in NO_X emissions caused by a decrease in traffic performance by LDVs, HDVs and buses. Generally, the main emitters of NO_X emissions are diesel passenger cars and heavy-duty vehicles. In 2021, NO_X emissions slightly increased due to an increase in traffic performance after the COVID-19 pandemic.

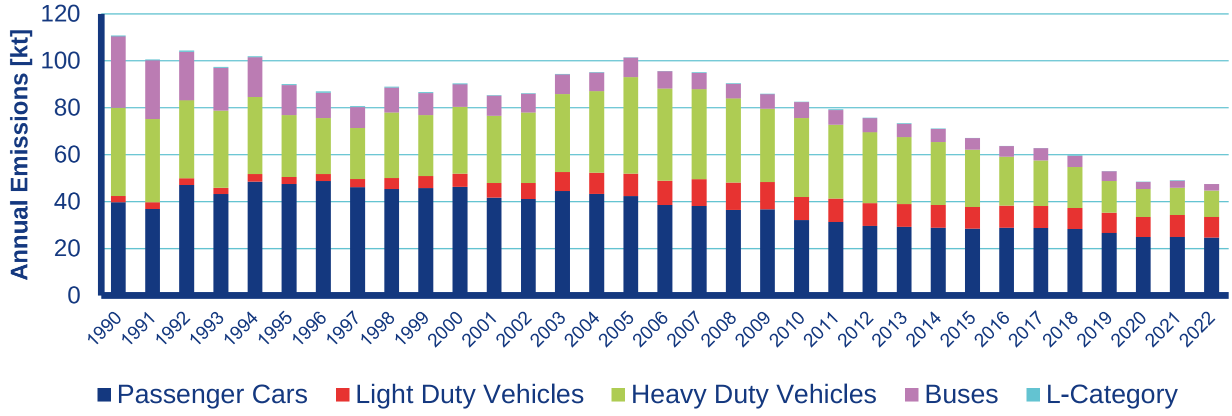

Figure III.8 Annual emissions of NOX from road transport, 1990–2022

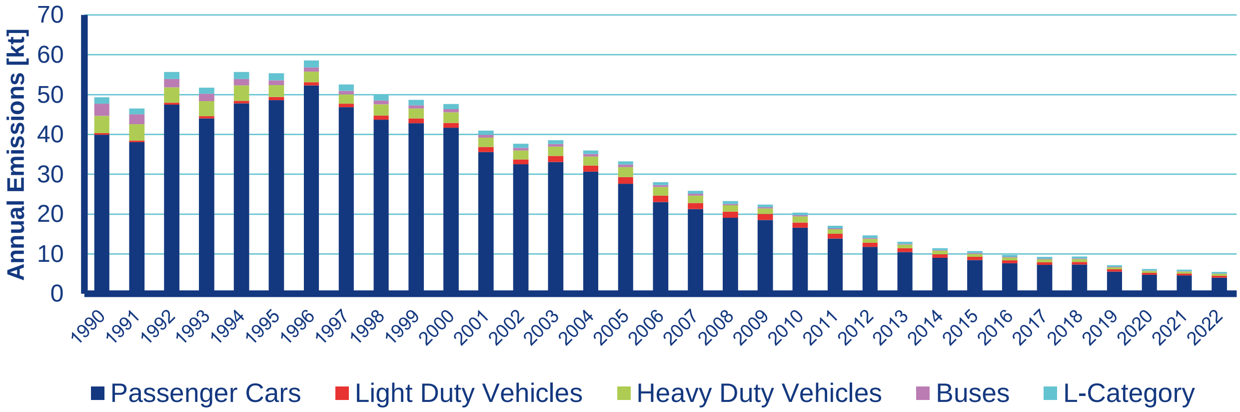

Figure III.9 Annual emissions of NMVOC from road transport, 1990–2022

Figure III.9 shows a constantly decreasing trend in NMVOC exhaust emissions after 1996 related mainly to the decrease in traffic performance of gasoline-fuelled cars and the enhancement of emission control technologies. Between 2015 and 2017, a steep decrease in NMVOC emissions was stopped because of economic growth and lower prices of gasoline compared to previous years. Especially 2-stroke motorcycles do 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 the motorcycle fleet in CZ was quite old, especially in the ‘90s. The main cause of a more significant decrease in NMVOC exhaust emissions after 2018 is a decrease in traffic performance of the largest emitters – petrol-fuelled vehicles in general. NMVOC exhaust emissions continued to decrease also in 2022.

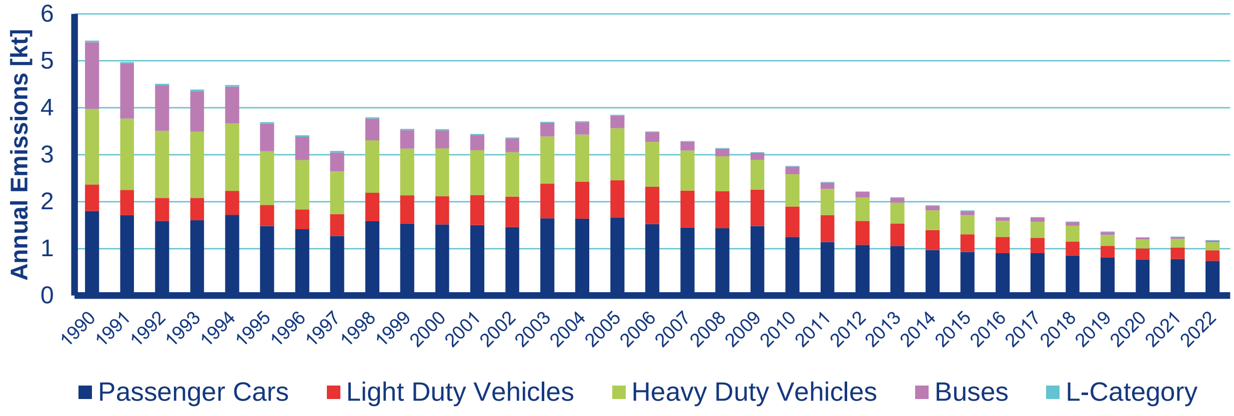

Figure III.10 Annual emissions of $PM_{2.5}$, PM_{10} and TSP from road transport – exhaust emissions, 1990–2022

Figure III.10 represents exhaust emissions of particulate matter (PM). In road transport, all PM emissions are considered as $PM_{2.5}$ because of the combustion technology which mostly emits this type of PM. Emission factors contain both filterable and condensable components as the measurement procedure regulated for vehicle exhaust PM mass characterisation requires that samples are taken at a temperature lower than 52 ˚C (at this temperature, PM contains a large fraction of condensable species). PM emissions were decreasing until 1997. The trend in emission production by road transport after this year is unsteady – dependent on changing traffic performance and economic situation. A continual decrease came in 2006 after involving the Euro 4 (IV) standard with a significantly lower limit for PM. At present, the main emitters of PM are passenger cars. In the ‘90s, passenger cars, light-duty vehicles, heavy-duty vehicles and buses were approximately on the same level. Due to the enhancement of particulate filter technologies and lower pressure of exhaust gases in HDVs, buses' and partly in LDVs engines, the share of PM emissions from these categories has been significantly decreasing especially after 2010. In the case of buses, low PM production has been influenced by significant subsidies from public resources to encourage the use of CNG buses after 2012. In 2022, we can see a slight decrease in PM exhaust emissions for most of the subcategories in comparison with the previous year. The only exception is emissions from the L-category which increased by 4% due to the increase in traffic performance in this subcategory.

Figure III.11 shows a steady downward trend in CO emissions for all categories since 1997. The trend in emission production before this year is unsteady – dependent on changing traffic performance, and economic and political situation. Decreasing emission production is mostly related to the modernization of the car fleet in CZ and removing old passenger cars (Pre-Euro). Another factor is a decrease in 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 don'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 the motorcycle fleet in CZ was quite old, especially in the ‘90s. 4-stroke motorcycles have much lower emission production and their growing share in motorcycle fleets has improved the emission behaviour of the motorcycle category in the last years. In 2022, CO emissions slightly decreased in most of the subcategories except for the L-category (increase of traffic performance in this subcategory).

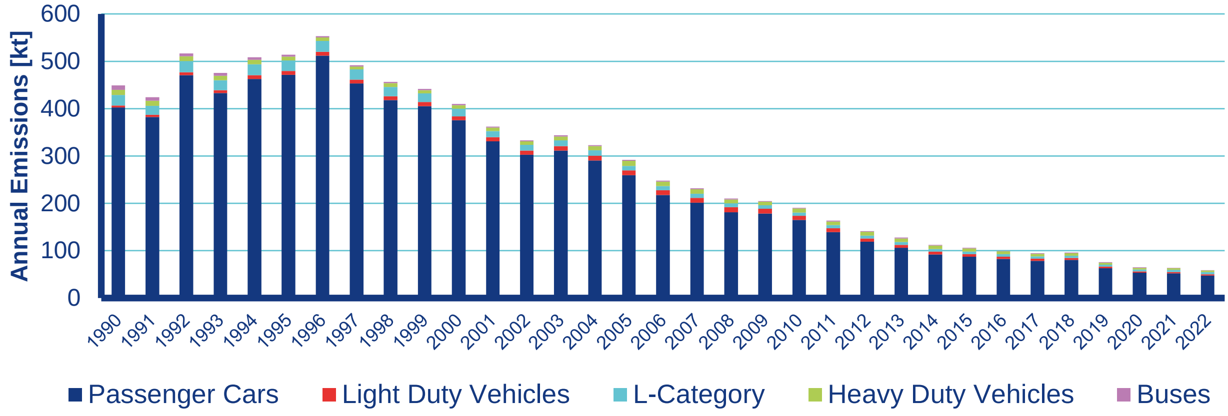

Figure III.11 Annual emissions of CO from road transport, 1990–2022

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)
- passenger battery electric cars

Activity data

The general rising trend of fuel consumption by PCs is in line with a general trend across Europe (see Figure III.12). In 2007, the economic crisis started in Czechia and influenced overall fuel consumption. The fuel consumption dropped significantly in 2010, but it increased already the following year. Due to a renewal of economic growth, the overall fuel consumption reached in 2014 a similar level as it was in years before the crisis. The most significant decrease was noted in gasoline consumption during the crisis period. After 2015, it fluctuated around 65 000 TJ except for the pandemic years 2020 and 2021 when it was lower. Diesel oil consumption wasn’t influenced by the economic crisis, nor by the COVID-19 situation so much. It has been steadily increasing since 1997 and reached more than 86 000 TJ in 2019. It slightly dropped the next year, but jumped to 90 000 TJ in 2021 and was still growing in 2022. Figure III.12 shows a growing share of diesel oil compared to gasoline. The reason is the 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 gasoline cars.

From 2008, biofuels started to be used on a larger scale in Czechia. Till then, there was almost no bioethanol used 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 of 8 000 TJ in 2020. CNG started to be used in Czechia in 1994 but a rise in the use of this fuel dates back to 2008. There has been a significant increase in CNG consumption from 2012. Still, the share of CNG in total PCs fuel consumption is very small (1.1% in 2022).

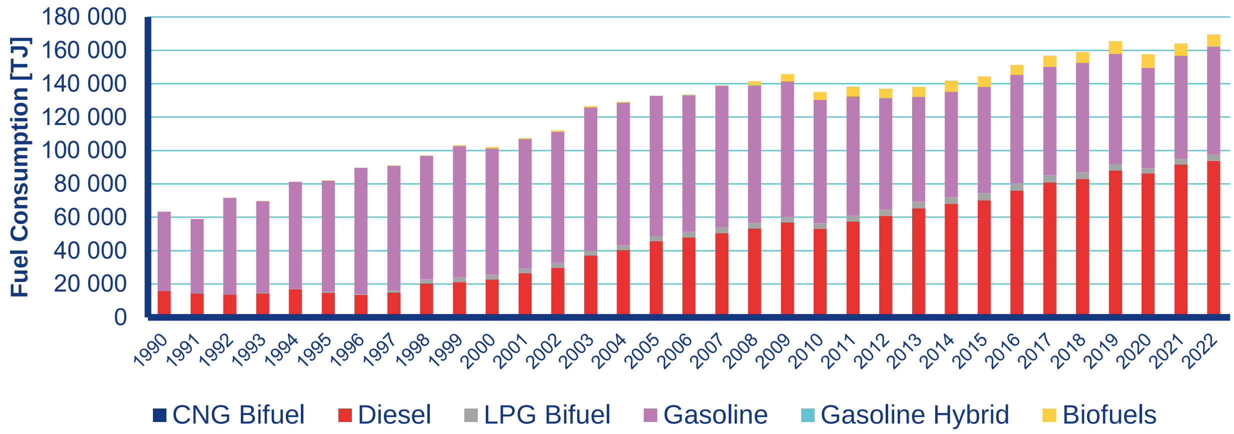

Figure III.12 Annual fuel consumption by passenger cars, 1990–2022

Emission factors

Implied EFs of selected pollutants, for which the PCs subcategory is a key category (CO and NO_X), are presented in this chapter. Emission factors are based on the COPERT 5.7 model on the Tier 3 level. Implied EFs for the most important fuels were extracted from the COPERT program (see Figure III.13 and Figure III.14).

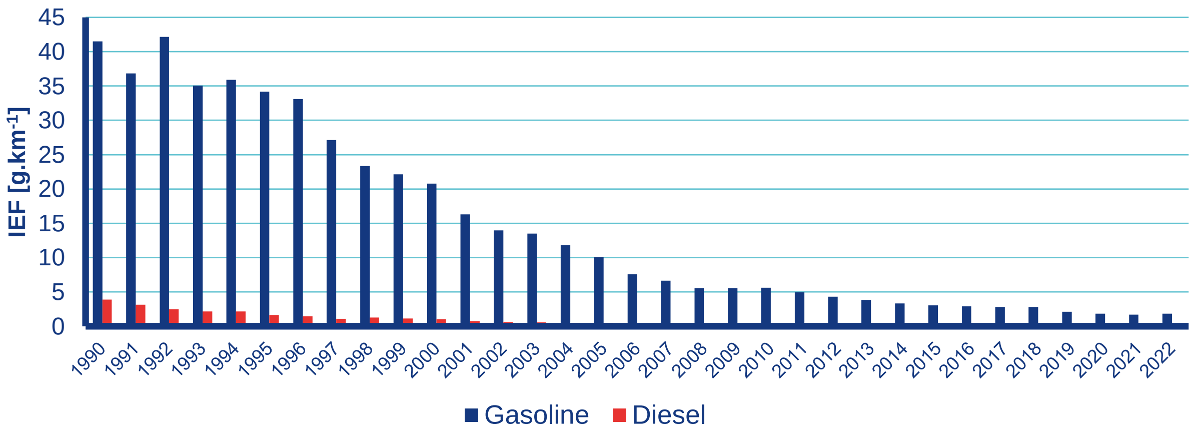

Figure III.13 CO implied emission factors for passenger cars, 1990–2022

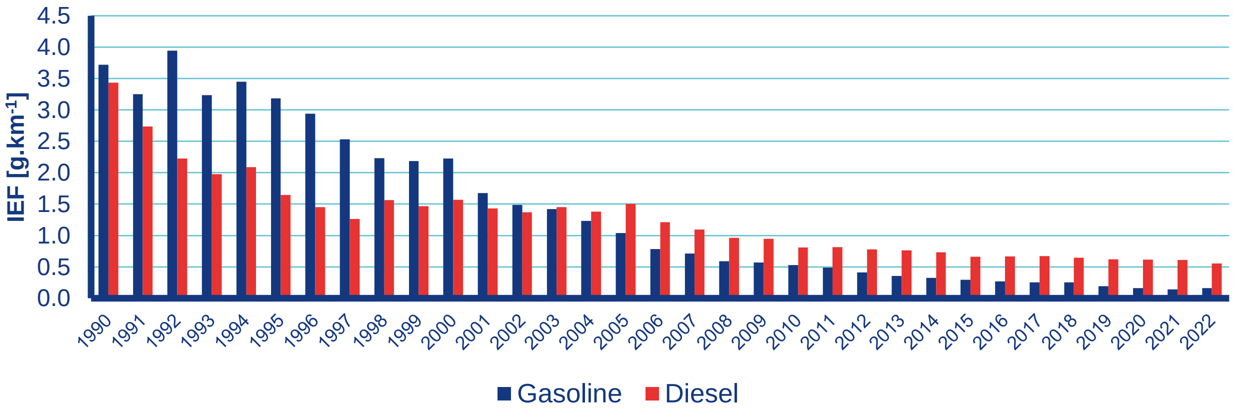

Figure III.14 NO_X implied emission factors for passenger cars, 1990–2022

Emissions

Emission values of all pollutants are to be found in national inventory files (NFR) available at EMEP Centre on Emission Inventories and Projections website. A brief description of emissions 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 Chapter III.3.1.1 (Activity Data). The most important fuel is diesel oil whose share has been around 90% in most of the years 1990–2022.

LDVs emissions of all pollutants are to be found in national inventory files (NFR).

NO_X implied EFs, for which the LDVs subcategory is a key category, are displayed in Figure III.15. Emission factors are based on the COPERT 5.7 model on the Tier 3 level. Implied EFs for the most important fuels were extracted from the COPERT program.

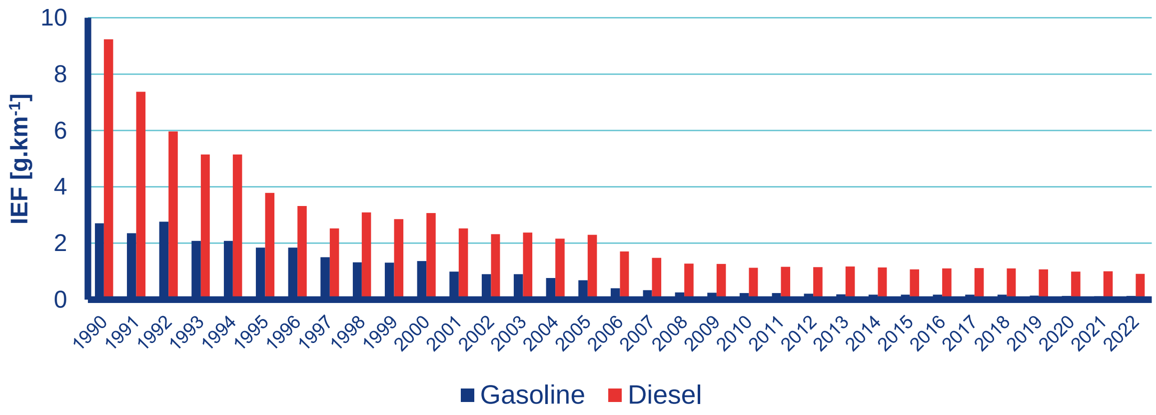

Figure III.15 NO_X implied emission factors for light duty vehicles, 1990–2022

III.3.1.4 Heavy-Duty Vehicles and Buses (1A3biii)

- heavy-duty petrol vehicles, conventional
- 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 Chapter III.3.1.1 (Activity Data). The most important fuel is diesel oil which share is more than 99% in the whole time series 1990–2022.

HDVs emissions of all pollutants are to be found in national inventory files (NFR). A brief description of NO_X, NMVOC and PM emissions from the HDVs subcategory is stated in Chapter III.3.1.1 (Emissions).

NO_X implied EFs, for which the HDVs and buses subcategory is a key category, are displayed in Figure III.16. Emission factors are based on the COPERT 5.7 model on the Tier 3 level. Implied EFs for the most important fuels were extracted from the COPERT program.

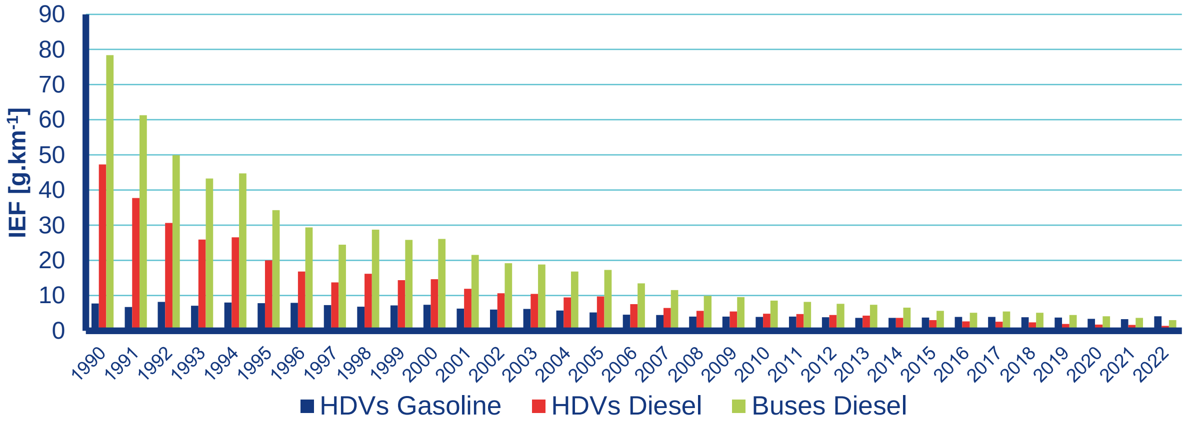

Figure III.16 NO_X implied emission factors for heavy-duty vehicles and buses, 1990–2022

III.3.1.5 Mopeds and Motorcycles (1A3biv)

Activity data of motorcycles subcategory and overall fuel consumption are briefly described in Chapter III.3.1.1. The main fuel used in CZ is gasoline whose share is more than 99% in all years. Emission values of all pollutants produced by motorcycles are to be found in national inventory files (NFR). A brief description of NO_X, NMVOC and PM emissions from the L-category is stated in Chapter III.3.1.1 (Emissions). Motorcycles are not a key category for any pollutant, therefore no detailed description of implied emission factors was provided in this chapter.

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

NMVOC emissions in the subcategory 1A3bv from road transport were estimated by the model COPERT 5.7 on the Tier 3 level. 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 5.7 was used. Tier 2 method was applied as no Tier 3 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 Figure III.17. Activity data for relevant subcategories are displayed in Figure III.18. The main sources of evaporative NMVOC emissions are gasoline passenger cars and motorcycles.

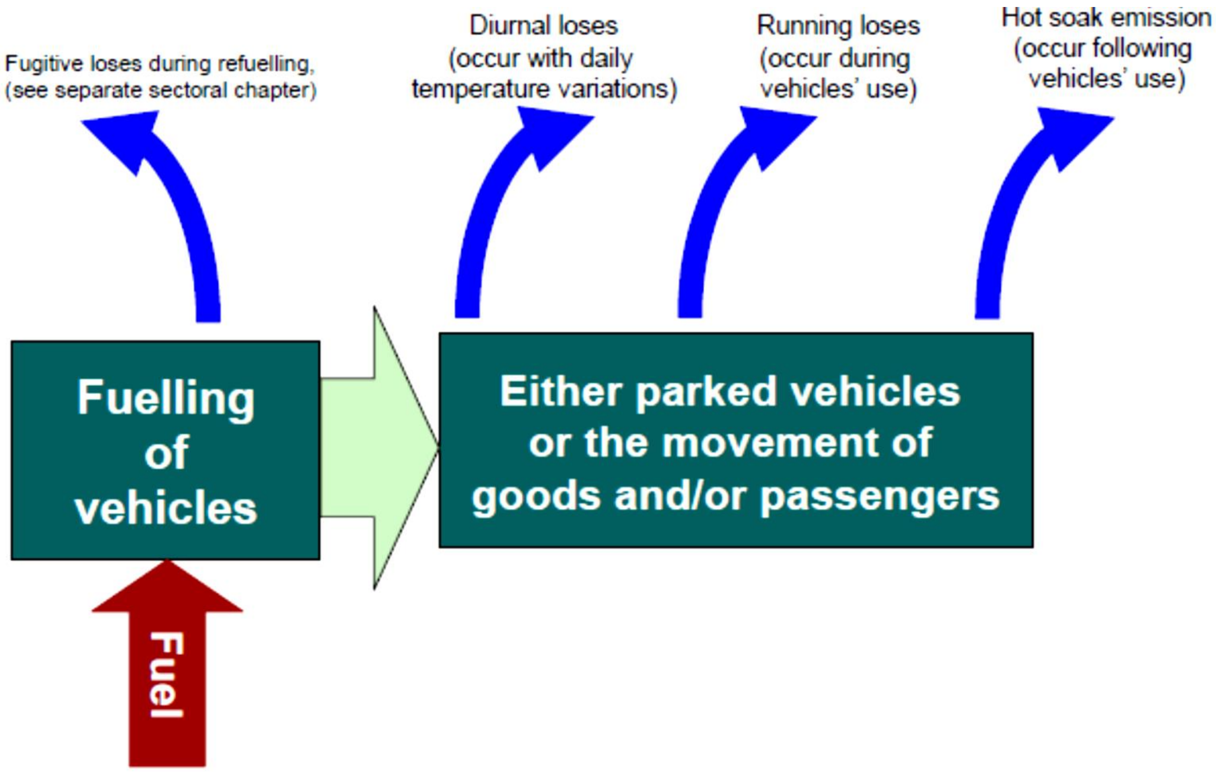

Figure III.17 Processes resulting in evaporative emissions of NMVOC (source: EMEP/EEA EIG 2023)

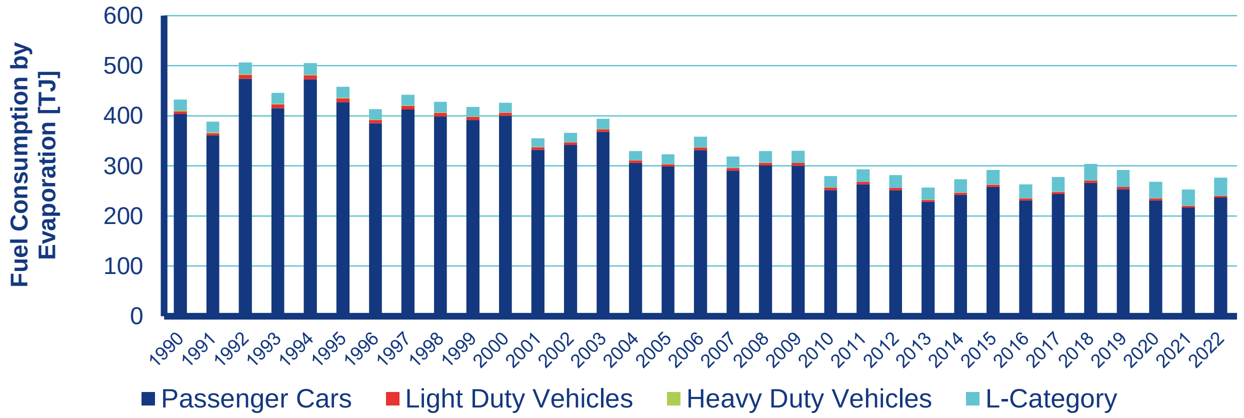

Figure III.18 Annual fuel consumption by evaporation in relevant subcategories, 1990–2022

Key activity data for abrasion is the traffic performance of the car fleet in Czechia (see Figure III.19). The development of traffic performance after 1990 and its decrease due to the economic crisis in 2008–2013 is clearly seen in the graph below. From 2014, traffic performance started to increase steeply again. The increase stopped in 2020 and 2021 because of the COVID-19 situation but in 2022 it approached the numbers from 2019.

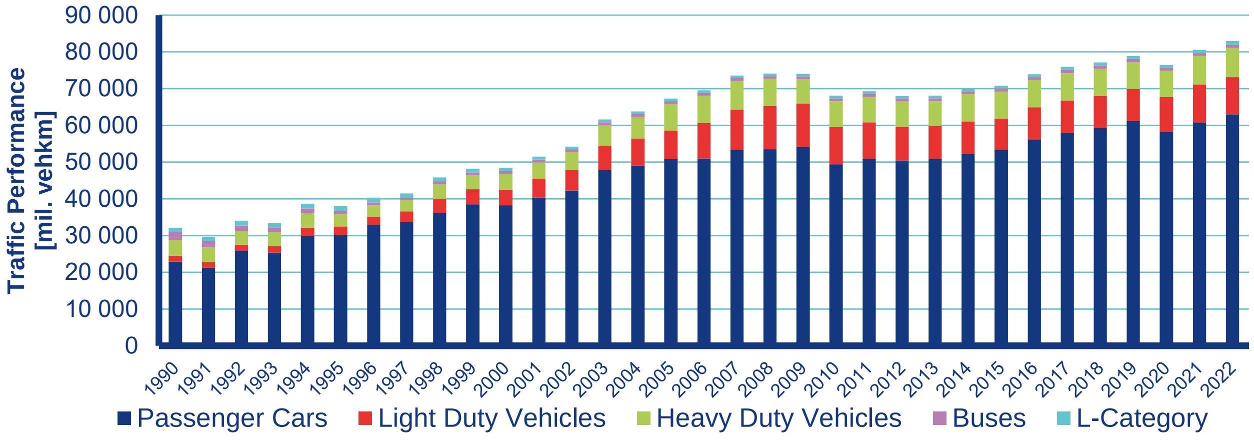

Figure III.19 Annual traffic performance in relevant subcategories, 1990–2022

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 5.7 model on the Tier 2 level. Implied EFs for all vehicle categories were extracted from the COPERT program (see Figure III.20 and Figure III.21).

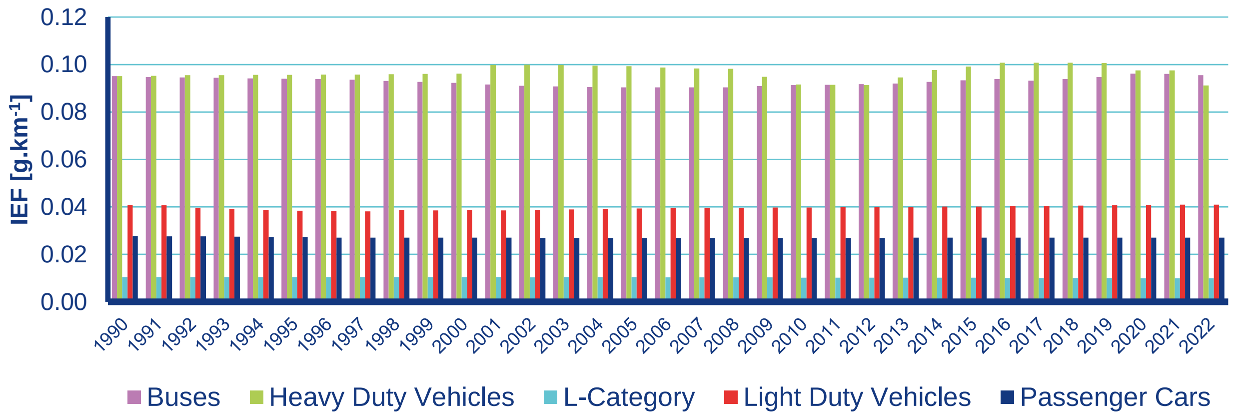

Figure III.20 PM_{10} implied emission factors from tyre, brake and road abrasion, 1990–2022

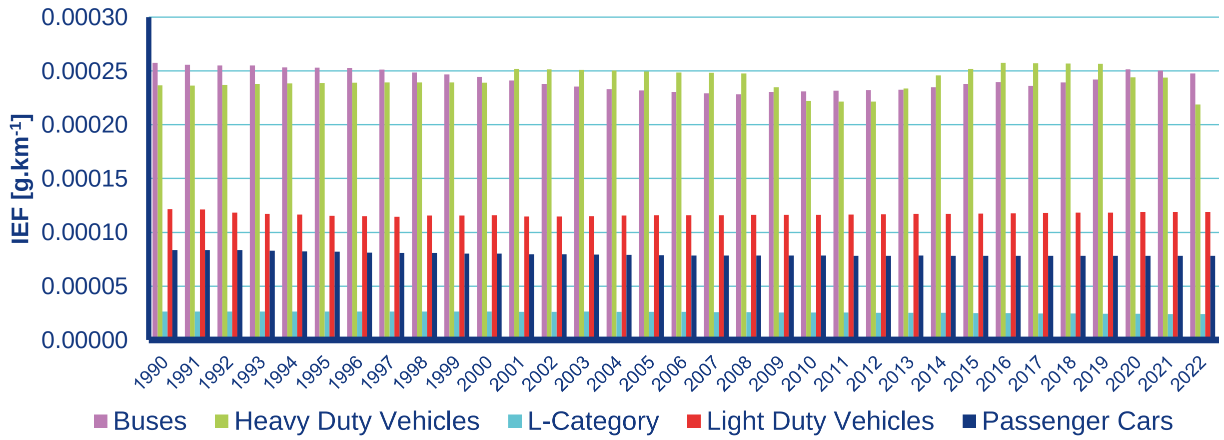

Figure III.21 Pb implied emission factors from tyre, brake and road abrasion, 1990–2022

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

III.3.2.2 Planned improvements

No improvements are planned.

III.3.3 Non-road transport (NFR 1A3a, 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 change vertically with altitude and horizontally with air masses. In NFR 1A3a, emissions of both national (domestic) and international civil aviation are reported with respect to distinctive flight phases: the LTO (Landing/Take-off: 0–3 000 feet) and the Cruise (above 3 000 feet). Emissions from military aircraft 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. The 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 the present year, bottom-up data from EUROCONTROL were used. These data were updated in time series 2015–2022 based on the latest EUROCONTROL data. The time series 1990–2004 was estimated by extrapolation of EUROCONTROL fuel consumption with the help of fuel consumption from the Czech Oil questionnaire provided by CZSO. Emissions were calculated with EUROCONTROL implied emission factors. LTO/Cruise ratios were calculated from EUROCONTROL.

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

To ensure comparability of statistics, fuel consumption for aviation was fuel balanced on fuel consumption stated in the Czech Oil questionnaire for jet kerosene and aviation gasoline on a national level.

Table III.3 Ratio of fuel usage between LTO and Cruise flight mode in 2022

Subsector	Flight mode	Ratio
1A3a (IFR, domestic)	LTO	0.26
	CRUISE	0.76
1A3a (IFR, international)	LTO	0.13
	Cruise	0.87
1A3a (VFR, Helicopters)	LTO	0.90
	Cruise	0.10
1A3a (Army flights)	LTO	0.25
	CRUISE	0.75

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 Table III.3. Data for domestic aviation and international aviation were gained from EUROCONTROL (IFR flights) and CZSO (VFR flights, helicopters and army flights).

The method for VFR flights, helicopters and the army air force is on the Tier 1 level. The main pollutants for IFR flights based on EUROCONTROL are on the Tier 3 level. Other pollutants are still on the Tier 1 level, but the emission factors have been actualized according to the newest version of EMEP/EEA EIG [3]. EF method for the most significant pollutants and EFs are stated in Table III.4.

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

Subsector	Method CO	Method NO_X	Method NMVOC	EF CO	EF NO_X	EF NMVOC
Domestic Jet Kerosene LTO	Tier 3	Tier 3	Tier 3	16.76	12.28	6.35
Domestic Jet Kerosene Cruise	Tier 3	Tier 3	Tier 3	6.51	12.26	1.24
Domestic Gasoline LTO	Tier 3	Tier 3	Tier 3	795.66	7.76	26.22
Domestic Gasoline Cruise	Tier 3	Tier 3	Tier 3	795.75	12.43	16.58
International Jet Kerosene LTO	Tier 3	Tier 3	Tier 3	8.36	14.67	1.37
International Jet Kerosene Cruise	Tier 3	Tier 3	Tier 3	2.83	13.73	0.37
International Gasoline LTO	Tier 3	Tier 3	Tier 3	850.51	6.44	22.39
International Gasoline Cruise	Tier 3	Tier 3	Tier 3	902.09	10.73	16.94

Railways

At present, the energy consumption share of locomotives powered by electricity is 54% in Czechia. The 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 the 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 and their contribution to emissions is very small.

In general, diesel fuel consumption by railways has a slightly decreasing trend from 2000. The only exception is the period 2005–2008 when it was increasing. After this, diesel fuel consumption oscillated around 4 000 TJ per year because of the economic crisis and the replacement of diesel-powered locomotives with electric ones. In 2022, diesel consumption was 3 109 TJ. CZSO provides data about coal consumption since 2005 (lignite for purposes of historical rides). In the previous submission, coal consumption was estimated also for the years 1990–2004. Whereas it is not possible to verify those data, the values were marked as 'NE'. From 2005 to 2017, 1 kt of lignite was burnt every year. Since 2014, bituminous coal has been used as well. Total coal consumption has been decreasing since 2018 with a bigger drop during pandemic years 2020 and 2021. This decrease has been caused by no consumption of lignite from 2018. The small fluctuations in fuel consumption mean a big proportional difference in emissions from solid fuels because of relative change ± 100% of fuel consumption.

In the 2023 submission, a new methodology for the calculation of railway emissions from diesel oil was introduced which increased the detail and accuracy of calculation from Tier 1 to Tier 2 level as per EMEP/EEA EIG [3] for most of the pollutants. Based on the new activity data obtained from the Czech Railway Administration (Správa železnic), České dráhy (ČD) and CZSO, national diesel fuel consumption statistics were broken down by locomotive type to apply three different sets of emission factors. There are three diesel locomotive categories:

- line-haul locomotives,
- shunting locomotives,
- rail-cars.

Calculation of railway emissions from diesel consists of three main steps:

1) Rail traffic performance calculation – Average traffic performance of line-haul locomotives and rail-cars is calculated based on the data from Správa železnic for profile weeks in 2019. In each category, five of the most frequent locomotives and their share of rail traffic performance in brtkm was defined. The final value is the weighted traffic performance of these locomotives. Shunting locomotive traffic performance is based on the study by Perůtka et al., 2020.
2) Calculation of traction diesel consumption – Specific traction diesel consumption is calculated for each locomotive category. Final traction diesel consumption is a product of activity data and specific traction diesel consumption. Based on this value, the share of each locomotive category on the total rail diesel fuel consumption given by CZSO is set.
3) EFs application – Tier 2 or Tier 1 EFs according to EMEP/EEA EIG are applied on final diesel consumption calculated for each category.

Emission factors

Railway transport is not a key category for any pollutant. Emission factors for diesel oil are Tier 2 for the following pollutants: NO_X, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, and CO. EFs for the rest of the pollutants are on Tier 1 level. EFs for coal are on the Tier 1 level according to EMEP/EEA EIG which recommends using EFs for 1A2 Combustion in manufacturing industries and construction. Some emission factors (Hg, As, benzo(a)pyrene, benzo(b)fluoranthene) are not stated in a corresponding chapter in EMEP/EEA EIG. According to the recommendation from the guidebook, Tier 1 EFs for HDVs were applied in case of missing EFs. In Table III.5, there are presented EFs for the most significant pollutants produced by railways and their calculation methods [3].

Table III.5 EF method used and EFs for the most significant pollutants for railways in the current year

Locomotive type	Fuel type	Method CO	Method NO_X	EF CO	EF NO_X
Line-haul	Diesel Oil	Tier 2	Tier 2	18.0 $g \cdot kg^{-1}$	63.0 $g \cdot kg^{-1}$
Shunting	Diesel Oil	Tier 2	Tier 2	10.8 $g \cdot kg^{-1}$	54.4 $g \cdot kg^{-1}$
Rail-cars	Diesel Oil	Tier 2	Tier 2	10.8 $g \cdot kg^{-1}$	39.9 $g \cdot kg^{-1}$
Steam	Coal	Tier 1	Tier 1	931.0 $g.GJ^{-1}$	173.0 $g \cdot GJ^{-1}$

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. There is no Czech merchant fleet. Activity data (diesel oil consumption in TJ) are to be found in national inventory files (NFR).

Navigation is not a key category for any pollutant. EFs are only applied to diesel oil due to a lack of data. Emission factors for heavy metals and PAHs are not stated in the EMEP/EEA EIG. Tier 1 EFs for HDVs were used for inland navigation. PM_{10} EF is country-specific, and $PM_{2.5}$ EF was derived with the help of the 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]. EFs for the most significant pollutants produced by navigation and their calculation methods are presented in Table III.6.

Table III.6 EF method used and EFs for the most significant pollutants for inland navigation in the current year ($g \cdot kg^{-1}$)

Fuel type	Method CO	Method NO_X	EF CO	EF NO_X
Diesel Oil	Tier 1	Tier 1	19.7	33.9

III.3.3.2 Planned improvements

In the 2025 submission, improvements are planned in the subsector NFR 1A3d. Recalculation of emissions from navigation is going to be performed in the entire time series 1990–2022 based on the new methodology and activity data to be gained.

III.3.4 Other non-road mobile sources & machinery (NFR 1A2gvii, 1A4, 1A5)

This chapter contains information about emissions from the 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 gasoline and diesel oil in further sectors (services, integrated rescue system and military).

The biggest contribution to emissions comes from the operation of agricultural machinery (1A4cii), mainly represented by tractors. The key step for emission data revision in 2020 was the opening of the non-road vehicles database running together with the road vehicles database by the Czech Ministry of Transport. Data 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 were calculated for diesel oil and jet kerosene in NFR 1A4aii. In 1A4cii, diesel oil and gasoline are consumed, in 1A4bii gasoline only. The operation of agricultural machinery (NFR 1A4cii) covers a major part of fuel consumption of small combustion, other subcategories are negligible. AD regarding other fuels potentially used in Czechia are not available.

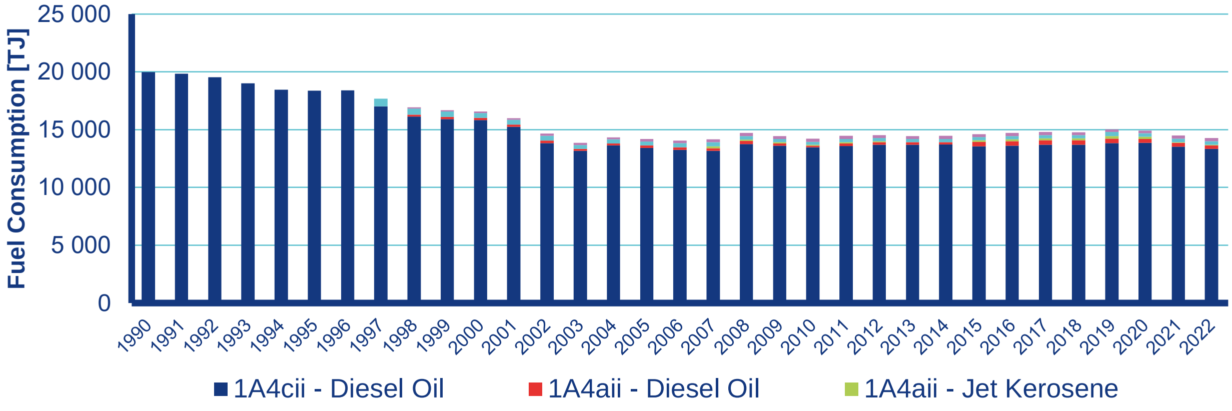

Figure III.22 Annual fuel consumption by non-road mobile machinery, 1990–2022

III.3.4.1 Emission factors and calculations

Activity data for each category were prepared based on the CZSO statistical census. For NFR 1A4cii, total diesel fuel consumption was gained and allocated to each machine category according to year of production and performance-related parameters.

Mobile combustion in manufacturing industries and construction

Emission factors for main pollutants are Tier 2 and they are used according to EMEP/EEA EIG [3]. The 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 were calculated on the Tier 1 level. Mobile combustion in manufacturing industries and construction is not a key category for any pollutant. Table III.7 shows the EFs and EF method used. Tier 1 EFs are constant in time, therefore they are not stated in the table. There are only stated CS EFs and Tier 2 EFs which are changing in time.

Table 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 ($g \cdot kg^{-1}$)

Subsector	Fuel type	Method CO	Method NO_X	EF CO	EF NO_X
1A2gvii	Diesel Oil	Tier 2	Tier 2	6.02	1.57

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

Gasoline-driven lawnmowers 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, more attention is paid 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 the Tier 1 level. Emission factors of diesel agriculture and forest machines are based on emission measurements done in the past years for each type of vehicle for various performance parameters. Non-road machinery is a key category for NO_X and $PM_{2.5}$. In Table III.8, there 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.

Table III.8 EF method used and EFs for the most significant pollutants for non-road mobile machinery in the current year ($g \cdot kg^{-1}$)

Subsector	Fuel type	Method CO	Method NO_X	Method NMVOC	EF CO	EF NO_X	EF NMVOC
1A4aii	Diesel Oil	Tier 2	Tier 2	Tier 2	6.02	1.57	0.54
	Jet Kerosene	Tier 2	Tier 2	Tier 2	6.02	1.59	0.53
1A4bii	Gasoline	Tier 2	Tier 2	Tier 2	736.58	3.92	62.37
1A4cii	Gasoline	Tier 2	Tier 2	Tier 2	736.58	3.92	62.37

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 NFR 1A5b are gained from CZSO. Diesel oil consumption was decreasing from 1999 to 2005. In the following years, it was increasing and reached around 390 TJ in 2008. Since then it has been quite steady with a drop to 344 TJ in 2013 and it maintained the same level until 2021 when it jumped to more than 400 TJ.

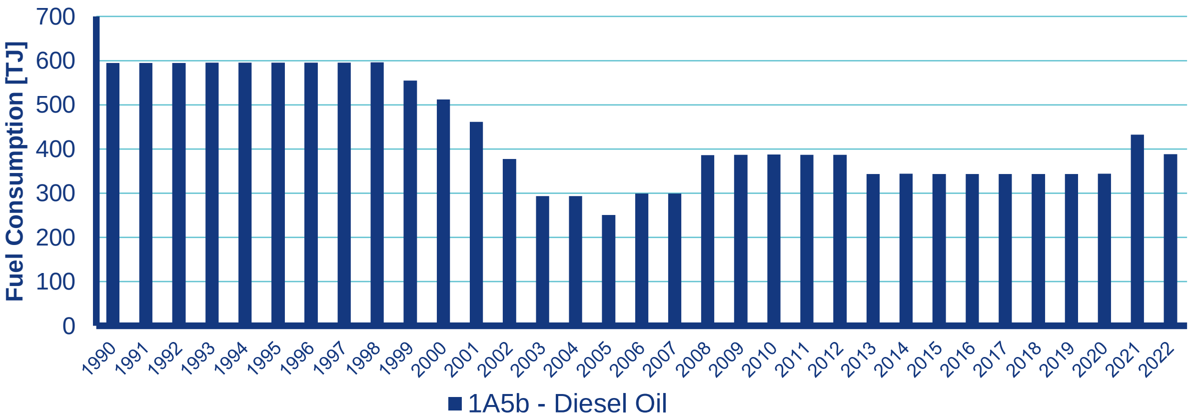

Figure III.23 Annual fuel consumption by other mobile sources, 1990–2022

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 the Tier 1 level. Other mobile sources are not a key category for any pollutant. EFs for the most significant pollutants produced by other mobile sources and their calculation methods are presented in Table III.9.

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

Subsector	Fuel type	Method CO	Method NO_X	EF CO	EF NO_X
1A5b	Diesel Oil	Tier 2	Tier 2	6.02	1.59

Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery

In past, calculated relevant emissions occurring during the 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, and activity data and for updating this section (June 2018). Emission data for wood processing tools (wood cutting) are available from 1997 onwards.

The key step for activity data revision was the opening of the road and non-road vehicles database run by the Czech Ministry of Transport. The included data have been sorted according to age and engine power into groups of tractors according to relevant efficiency for categorization into Stages I - V.

For the calculation of emissions tractors less than 15 years old are taken into consideration. The reason for this approach is an assumption that intensive land farming (estimated to share 75% of crop farming in Czechia) requires new tractors with higher-rated power for aggregation of some field operations into just one. From the economical point of view tractors older than 15 years are not used for most significant field operations. This 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 the air. Currently, older tractors with lower rated power are successively being used in stock farming for moving raw and other materials, at small farms and municipalities. This will reduce the number of machines included in emission calculations to approx. 20 thousand tractors.

In Figure III.24, the share of tractors produced in 1987–2017 is presented. From the total number of tractors put 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 put into operation within the last 30 years.

In Figure III.25, the share of tractors structured according to rated power is shown. Only tractors put into operation within the last 30 years have been taken into account. The most significant categories of agricultural machinery comprise tractors with efficiency of 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 the 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 dependent on the type, age and engine output of tractors/harvesters.

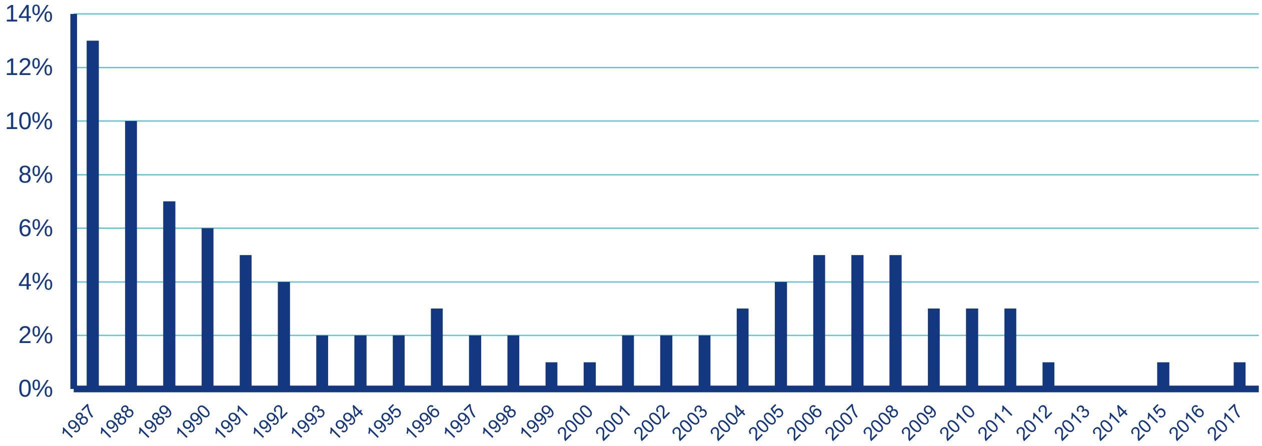

Figure III.24 Share of tractors by year of production

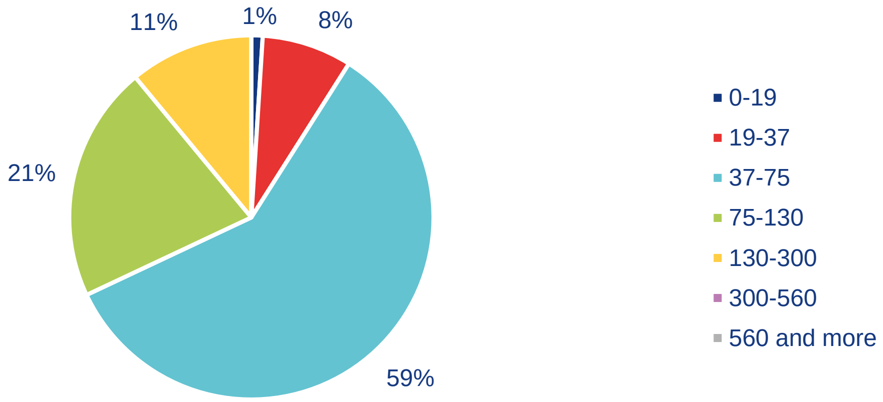

Figure III.25 Share of tractors [%] according to rated power [kW]

Planned improvements

No improvements are planned.

III.3.5 Uncertainties for Transport sector

Uncertainties were calculated according to chapter A.5 of EMEP/EEA EIG [3] and evaluated for the entire time series (1990–2022) for all reported categories. Uncertainties of national emissions within the transport sector for particular pollutants are given in Table III.10.

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

Gas	Base Year Emissions (2000)	Year Emissions (2022)	Combined Uncertainty as% of Total National Emissions in Year 2022
	[kt]	[kt]	[%]
NO_X	100.56	55.40	24.22
NMVOC	50.25	6.90	36.37
SO_X	3.48	0.37	28.61
NH_3	1.17	0.80	126.76
TSP	6.45	5.77	30.05

BC	2.38	1.23	29.35
CO	425.16	72.80	39.96
HMs	0.25	0.10	144.81
POPs	3.83E-09	3.23E-09	117.62
PAHs	2.56E-04	4.88E-04	116.47

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 the 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, handling, transformation and other sources. In Czechia, there are mined bituminous coal and lignite. Lignite is mined in open-cast mining, and bituminous coal is from underground mining. Since the 1990s, coal mining has significantly lowered, and coal imports have grown. Lignite is mainly mined in North-West Bohemia, and bituminous coal is mined in Silesia (northeast of Czechia), as part of the Silesian basin. An important input for metallurgical production is the coke production located near bituminous coal mining in Ostrava and Třinec. The only facility for coal gasification (Sokolovská uhelná) ended its activity in 2020 and switched to standard coal combustion. The trend of lignite and bituminous coal mining is apparent in Figure III.26.

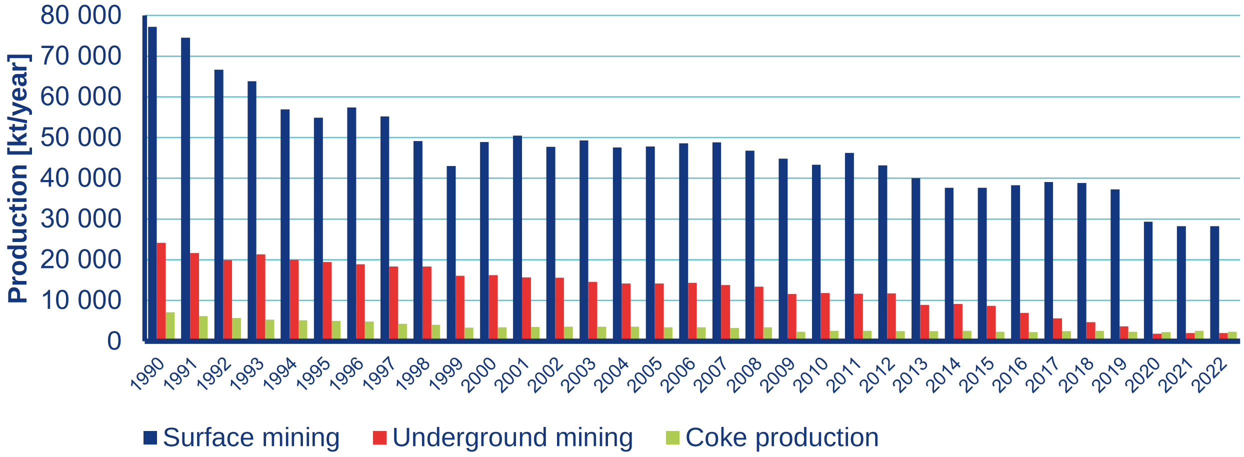

Figure III.26 Surface and underground mining (COAL) and coke production (kt·year^{-1})

NFR 1B1c includes coal sorting and drying emissions, mainly in sorting plants producing coal for household consumption, coke plants and wood coal production emissions.

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, so the fossil fuels import plays an important role in foreign trade. Oil processing to fuels takes place in two refineries (Litvínov and Kralupy nad Vltavou) with consequent petrochemical facilities.

The distribution network of fuels includes 4000 public petrol stations and approximately 2500 stations not accessible to the 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 fuel distribution (mainly CNG) grows.

NMVOC emissions from oil drilling come from oil storage and filling railway transport tanks. Due to low amounts, emissions from accompanying oil gas and carbon gas from bituminous coal are omitted. The most significant emission comes from refinery oil processing. It includes oil as well as oil product storage (NMVOC emissions), catalytic converters 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

In Czechia, there are mined bituminous (underground) and lignite coal. Lignite is mined mainly in open-cast mining and bituminous coal in underground mining. Emission factors for quantifying particulate emissions from lignite mining are taken from EMEP/EEA EIG, Tier 2, Table 3-3 Open cast mining [3]. The necessary activity data (hole drilled) are not available to calculate emissions from deep mining, however, negligible emissions are assumed.

Emission factors for primal manipulation with mined lignite (import and export) come from EMEP/EEA EIG, Tier 2, Table 3-7 [3]. Emission estimation from bituminous coal mining regards only manipulation with coal and through import and export. Detailed calculation is given in e-ANNEX.

For determining the EF of NMVOC from underground coal mining, the composition of mine gas and the emission factor for methane used in the GHG inventory were considered. The EF for methane ranged from 17.7 kg·Mg^{-1} (1970) to 8.75 kg·Mg^{-1} (2017). Information on the percentage composition of individual components of mine gas can be found here: http://www.okd.cz/cs/tezime-uhli/uhli-tradicni-zdroj-energie/dulni-plyny-a-metan or here: http://energetika.tzb-info.cz/kogenerace/5644-

dulni-plyn-jako-druhotny-zdroj-energie-pro-kombinovanou-vyrobu-elektriny-a-tepla. Based on the obtained data and consultation with experts, the EF for NMVOC was estimated at 0.56 $kg \cdot Mg^{-1}$.

NMVOC emissions from surface coal mining are not tied to a specific air stream, making monitoring the amount of escaping gas into the air significantly more complex. Therefore, an expert estimate is used for calculating NMVOC emissions from surface mining, due to geological conditions, the gas content in the North Bohemian coal basin is low. The EF for NMVOC was estimated at 0.075 $kg \cdot Mg^{-1}$.

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 the one-off measurement of suction devices. Wood coal production emissions are being measured while putting the facility in operation, and specific production emissions are being used for annual reporting.

NFR 1B2 presents reported emissions excluding only emissions from oil fuels distribution calculated based on 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 shutting down some parts of petrochemical production due to an accident in the ethylene unit in August 2015.

Followed emission factors are used for calculating emissions in NFR 1B2av: Emissions from diesel oil are using EF 16.8 $g \cdot t^{-1}$ for the whole time series. For petrol distribution in 1990–1992, was used EF 1022 $g \cdot t^{-1}$ (without regeneration). Until 1998, according to law, we assumed successive installation of stage 1 and 2 regeneration, and from 1999 onwards, EF 70 $g \cdot t^{-1}$ was used.

Due to changes in integrated permits in refineries (Claus plants and flares) and petrochemical processes, there were changes in 2014 to 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 were reported according to E-PRTR regulation. These were used to complete reported emissions (NFR 1B2c and partly 2B10a).

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 the implied emission factor from 1992 (approx. 3 kt NMVOC). Detailed information on some categories is given in e-ANNEX.

The inventory of fugitive NMVOC emissions in the gas industry includes a 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. National emission factors by IPCC balance and NMVOC emission were calculated as a long-term share of higher hydrocarbons in natural gas at 4.02% (w).

III.4.2 Uncertainties and QA/QC procedures

The chapter will supplied later.

III.4.3 Planned improvements

The TERT 2023 report includes suggestions to correct the calculation of emissions from the handling and storage of mined coal. The recommendations will be included in the IIR in 2025.

IV. Industrial processes (NFR 2)

The date of the last edit of the chapter: 15/03/2024

For emission estimates from industrial processes in Czechia, a 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 is 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 except for solvent use emissions (mainly NFR 2D3a), where EMEP/EEA EIG methodology was used. Emissions in NFR 2D Solvent use are estimated in a 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 a majority of total emissions. Emissions are determined based on a material balance in statistics of production and imports, data from the largest producers and users, etc. Many industrial processes belong to key categories. Some facilities in sector industrial processes may be part of LPS reporting [3].

Annual emissions closely depend on the main industrial indicators of production (steel, clinker, etc.) as well as economic (GDP) that correlate industrial indicators like passenger car production linked to other production sectors in Czechia. Activity data of the most important production facilities are based on the REZZO database in cooperation with CZSO, Lime and Clinker Producers´ Association. In 2024, the reported activity data was unified with GHG reporting.

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, 2D3i and 2D3g (25.9%), SO_X – 2B10a (12.3%), $PM_{2,5}$ – 2G (2.9%), PM_{10} – 2A5a (2.9%), TSP - 2A5a (3.9%) and 2A5b (2.3%), Pb –2C1 (24.2%) and 2G Fireworks (27.7%), Cd – 2C1 (10.1%), 2G Tobacco (9.5%) and 2C6 (4.8%), Hg – 2C1 (4.4%), As – 2C5 (10.2%) and 2A3 (4.9%), Cr – 2C1 (5.4%), Cu – 2G (6%), Ni – 2C1 (5.9%) and 2G (3.3%), Zn – 2C1 (20.1%) and 2G (3.3%), PCDD/PCDF – 2C1 (13.7%).

The following chapters describe the method of calculation for sub-sectors. In 2022, the methodologies for classifying NO_X, NMVOC, SO_X and CO emissions in processing mineral raw materials and the production and processing of metals were adjusted. Until 2020, emissions of NO_X, NMVOC, SO_X and CO were reported for processes of processing mineral raw materials and production and processing of metals, which are not directly related to melting furnaces (glass vats, smelting in the production of non-ferrous metals), were reported as part of the categories NFR 2A6 and NFR 2C7c. For 2021, these emissions were reported for the first time in NFR 1A2f (emissions from combustion processes related to glass NFR 2A3) and NFR 1A2b (emissions from the combustion processes of processing non-ferrous metals 2C2 to 2C7a). The conversion of emissions from NFR 2C7c and NFR 2A6 in historical reports will only be carried out in the next reporting period. More detailed information is provided in the e-Annex.

IV.1 Mineral products (NFR 2A)

Industrial processing of mineral raw materials represents 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 2021 to key sources of TSP (4.1%) and PM_{10} (2.9%). Activity data of the most important production facilities are based on the REZZO database in cooperation with CZSO, Czech Lime Association and Czech Cement Association.

For more details on lime and cement production please refer to the information in the section on individually monitored sources. To determine HMs emissions from glass production until 1995, national emission factors, see Table 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.

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

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se
	$g \cdot t^{-1}$ 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]

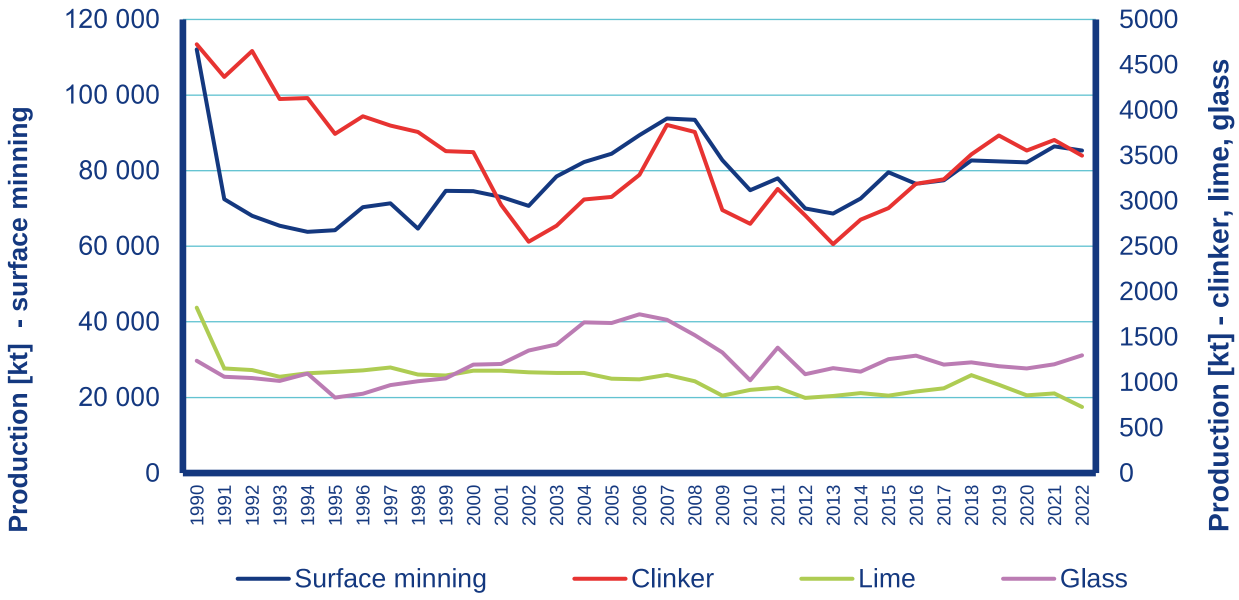

Figure IV.1 Surface mining (non-fuels) clinker, lime and glass production, 1990–2022

The methodology of emission monitoring is long-term constant for all sectors and is based, except for 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. As part of the 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 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 the 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 has 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. There are approx. 60 operational glass works that melt glass in Czechia at present. 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 through 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, emissions from non-combustion processes by other processing of minerals incl. glass fibres and other isolants are included in NFR 2A6 according 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 or 1A2f if fuel consumption is reported. Their relatively higher amount since about 2014 corresponds to changes in legislation and conditions for emission ascertaining during the operation of sources.

Table IV.2 Mapping of NFR 2A1-2A6 sources categories to main Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.*
2A1	5.1.1. Handling raw materials and products
2A1	5.1.2. Production of cement clinkers in rotary furnaces; 5.1.3 Other technological equipment for cement production
2A2	5.1.4. Lime production in rotary furnaces; 5.1.5. Lime production in shaft furnaces and other furnaces
2A5a	5.11. Quarrying and stone processing, refined stone production, mining, treatment, and processing of gravel (natural and artificial) with a projected output of over 25 $m^3 \cdot day^{-1}$
2A6	5.9. Production of composite glass fibres with the use of organic binders
2A6	5.5. Production of glass, fibre, glass products, enamel, and sintered glass for glazing and glass for jewellery processing

*processes without fuel

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 many 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 carried out using the construction production index back to 1990. 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 $m^3 \cdot day^{-1}$, 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 (i.e. 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, non-residential buildings (e.g. hotels, shopping centres, schools, etc.) and highways (IIR 2024). 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 statistical data, have been reported only since 2005. The trend of cement production was used to estimate emissions in 1990–2004. Data on the length of completed sections of highways in individual years were taken from the information system of the ŘSD.

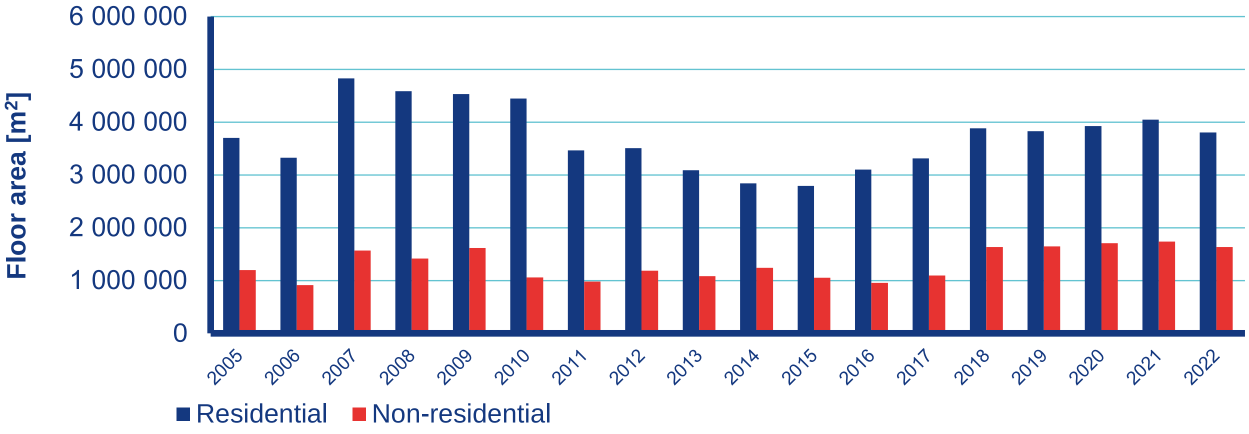

Figure IV.2 Building floor area, 2005–2022

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 CEIP/EMEP database were used.

Table IV.3 Emission factors for building construction

Poll.	Residential buildings	Non-residential buildings	Unit
TSP	0.21515	0.12268	$kg \cdot m^{-2}$
PM_{10}	0.10757	0.06134	$kg \cdot m^{-2}$
$PM_{2.5}$	0.01075	0.00613	$kg \cdot m^{-2}$

The method of calculating emissions from highway construction is given in the e-ANNEX. For some categories, source operators use their calculation and annual emission reporting using emission factors stated in the Bulletin of the 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.5 and Chapter 0. The detailed information will be supplied later.

IV.1.3 Planned improvements

The methodology for estimating the share of particle emissions from the declared TSP emissions will be updated in 2025.

IV.2 Chemical industry (NFR 2B)

The chemical industry represents one of the largest industrial branches in Czechia with a production of a wide range of organic and inorganic substances. The chemical industry can be divided into fundamental chemistry, crude oil processing, pharmaceuticals, rubber industry and plastics processing as well as paper production. Products of the 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 the sulphate process (PRECHEZA, a.s.). Process emissions for the 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 for 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 the above-mentioned production facilities and are included in reported emissions. Activity data of main productions are based on the REZZO database and CZSO data (Figure IV.3).

NFR 2B does not belong to key categories, except for SO_X (2B10 – 12.3%). The methodology of emission monitoring is long-term constant for all sectors except for the NFR 2B1 Ammonia production and 2B2 Nitric acid production, based on reported emissions of sources with annual reporting obligation. Emissions of these sources are being determined based on one-time measurements of the source 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 the production of phosphoric acid by thermic method, in the production of accumulator fillings or agents for galvanic plating and metallurgy. Emissions of PCDD/PCDF are being monitored in the production of dichloromethane and vinyl chloride. Emissions of PAHs occur in the production and processing of tar.

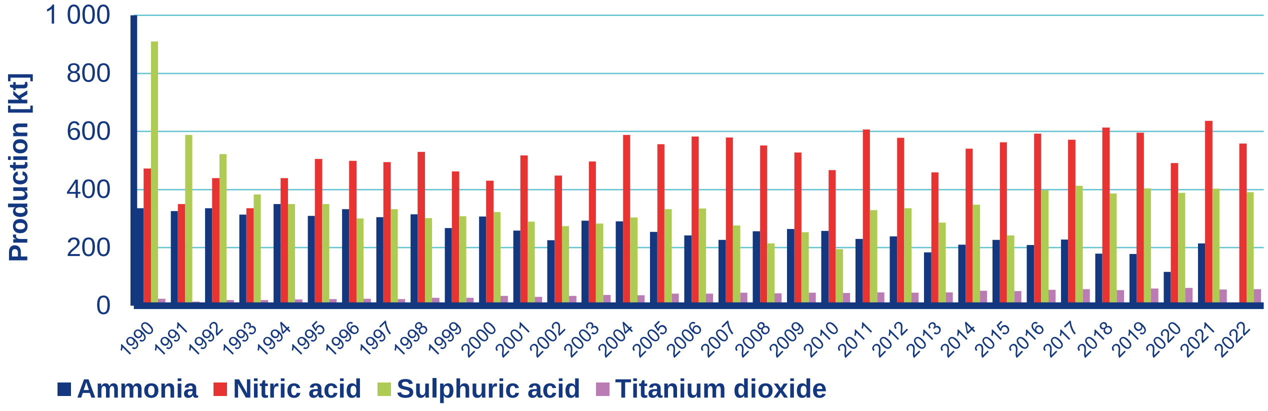

Figure IV.3 Ammonia, sulphuric acid, nitric acid and titanium dioxide production, 1990–2022

IV.2.1 Emission factors and calculations

Emission factors are used only for the calculation of emissions in NFR 2B1 and 2B2. To calculate the emissions, emission factors were taken from the EMEP/EEA EIG [3]. Detailed information on some categories is given in e-ANNEX.

IV.2.2 Uncertainties and QA/QC procedures

The chapter will be supplied later.

IV.2.3 Planned improvements

No improvements are planned, and 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 the above-mentioned production facilities and are included in reported emissions.

IV.3.1.1 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, except for CO emissions in NFR 2C1 Iron and steel production, on reported emissions of sources underlying annual reporting obligation. Emissions of NO_X, SO_X, PMs and CO (sinter plant, pig iron) are being namely assessed by one-time measurement in prescribed intervals. Annually measured emission concentrations show large (sometimes orders of magnitude) differences, leading to irregular emissions reported by operators. For further detail please see e-ANNEX.

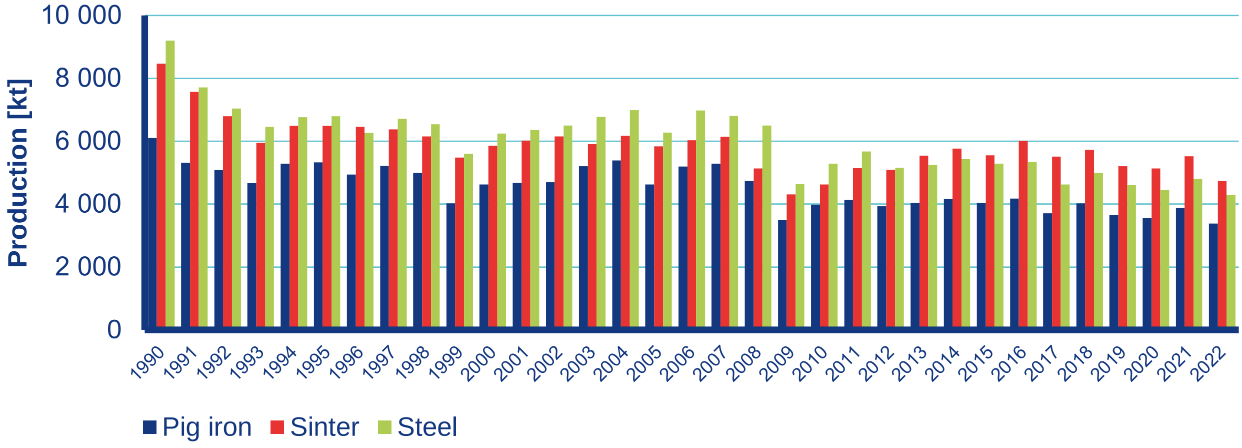

Figure IV.4 Pig iron, steel and sinter production, 1990–2022

Emissions of CO from open hearth furnace steel plants have been calculated from 2014 based on steel production and emission factors assessed by source operators as several-year measurements. NMVOC emissions are calculated using EFs from EMEP/EEA EIG [3]. Emissions of HMs and POPs are calculated based on emission factors set from Table IV.6 to Table IV.9. **Chyba! Nenalezen zdroj odkazů.**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 use the 'IE' symbol for HCB emissions in NFR 2C1. Emissions from sintering belts (also for NO_X, SO_X, TSP, Hg and PCDD/PCDF) are reported by source operators, and 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. Since the production facility of VÍTKOVICE, a.s. was close to a housing estate and high abatement technology costs, the production ended in 1998. Other factories started with the production of steel in electric arc furnaces.

IV.3.1.2 Non-ferrous metal (2C2-2C7c)

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 Table IV.4. Emission inventory in this sector is being performed based on one-time measurements in prescribed intervals according 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 the production, processing and treatment of metals, emissions of them are reported in NFR 2C7c or 1A2f if fuel consumption is reported.

Table IV.4 Mapping of NFR 2C2-2C7a sources categories to main Annex 2 source categories

NFR code	Classification pursuant Annex 2 to No. 201/2012 Coll.*
Metallurgy of nonferrous metals	
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
2C3–2C7c	4.10. Smelting and casting of nonferrous metals and alloys thereof
2C7c	4.11. Aluminium processing with rolling mill

*processes without fuel

IV.3.1.3 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.3.1.4 Aluminium production (2C3)

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

IV.3.1.5 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.3.1.6 Lead production (2C5)

Emissions are determined from the emissions reported by the operators.

IV.3.1.7 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 emissions are calculated from EF in EMEP/EEA EIG [3].

IV.3.1.8 Copper production (2C7a)

Only one company in Czechia is engaged in the secondary processing of zinc. It is Měď Povrly a.s. 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/PCDF and PCB 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.3.1.9 Nickel production (2C7b)

At present, nickel is not processed in Czechia.

IV.3.1.10 Other metal production (2C7c)

This category includes emissions from copper and copper alloy plating, galvanic nickel plating, chromium plating, zinc plating, 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 detailed information including selected emission and activity data, emission factors and calculations 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 Table IV.5). Some processes of degreasing use solvents, and emissions from them are reported under sector 2D3e.

IV.3.1.11 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 the above-mentioned production facilities and are included in reported emissions.

Table IV.5 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.

Table IV.6 Casting (blast furnace) – emission factors

Abatement	Pb	Cd	Hg	As	Zn	BaP	BbF	BkF	InP	PAHs	PCDD/PCDF
	[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. The fluctuation of SO_X emission is related to the 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 an emission factor of 7043 g·t^{-1} of produced steel while CO emissions of oxygen converters are being balance estimated based on operating measurement. For emission inventory Pb, Cd, Hg, As, PCDD/PCDF, PAHs and PCBs are being based on national emission factors (see Table IV.7 and Table IV.8). Emissions of other pollutants reported under UN CLRTAP are being estimated based on emission factors according to EMEP/EEA EIG – Tier 2 [3].

Table IV.7 Tandem furnaces – emission factors

Pb	Cd	Hg	As	BaP	BbF	BkF	InP	PAHs	PCBs	PCDD/PCDF
[mg·t^{-1}]									[μ g·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

Table IV.8 Oxygen converters – emission factors

Pb	Cd	Hg	As	BaP	BbF	BkF	InP	PAHs	PCBs	PCDD/PCDF
[mg·t^{-1}]									[μ g·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/PCDDF had been set at 0.144 μg I-TEQ·t^{-1} and for emissions of PCBs 2.2 μg·t^{-1}. Emissions of other pollutants according to UN CLRTAP are 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 input (pig iron or metal scrap), the sort of fuel used and production intensification by oxygen. One-time measurement of TSP, SO_X, NO_X and CO emissions for this type of furnace used to take place once a year. For an inventory of other pollutants required by UN CLRTAP emission factors according to EMEP/EEA EIG – Tier 2. The emission factor for Pb according to EMEP/EEA EIG 300 g·t^{-1} of steel was adapted to a more real value of 30 g·t^{-1} of steel [3].

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

Table IV.9 Cupola furnaces – emission factors

Pb	Cd	Hg	As	BaP	BbF	BkF	InP	PAHs	PCBs	PCDD/PCDF
[mg·t^{-1}]									[μ g·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/PCDF 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 be supplied later.

IV.3.4 Planned improvements

The distribution of emissions from production processes between NFR 1A and NFR 2C will be revised.

IV.4 Solvent use (NFR 2D)

This chapter describes solvents and other product use. Using 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 fluorescent tubes, there is currently no data to quantify Hg emissions.

Emissions of NMVOC, PM and TSP from the production and use of Hot Mix Asphalt and emulsified asphalt are included in NFR 2D3b according to EMEP/EEA EIG [3]. All types of asphalt production emissions are reported annually by source operators in Summary Operation Records. The asphalt production processes also cover combustion sources. Therefore, all emissions from hot processes are regarded in NFR 1A2f.

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

The investigation of asphalt producers shows that applied technological procedures prevent the PAHs emission from the asphalt blowing. Therefore, the symbol NE was used as in the case of the other emissions (NFR 2D3g).

The solvent and other product use sector belongs to one of the largest pollution sources of NMVOC emissions in Czechia, accounting for app. 30% of total NMVOC emissions. The largest share (2021) was for decorative coating application at 35.3%, domestic solvent use 22.7%, other solvent use (including using disinfectants against COVID-19) 17.3% and chemical products 12.2%.

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 from the manufacturing and use of paints in the pharmaceutical, plastic, leather and textile industries, wood preservation, glass fibre production, use of household and solvent-containing detergents and extraction of fats and oils. The range of monitored categories is shown in the table below.

Table IV.10 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 applications.
	3. Other coating application	Emissions in this sector include car components production, containers, tins and barrels, aircraft, coating of plastics etc. This sector includes painting on-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; The amount of emissions for 2020 and 2021 also includes estimated emissions related to using disinfectants against COVID-19
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, other solvent use, and emissions PM and TSP from oil extraction.

* In the next period, the methodology is expected to be improved using the TNO study.

Category Solvent use belongs to the key sources of NMVOC emissions with a share of 26.5%. It covers various technological activities from all the monitored categories. The Solvent application registers the most numerous technological equipment among point-monitored sources (almost 4000 installations, including one or more equipment such as paint boxes, degreasing baths, printing machines, and others.). Unlike the EU Directive, the lower limits for including these resources among the individually monitored sources are significantly lower. These limits often 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 households also produce a significant part of the emissions.

Emission inventories for solvents are based on model estimates, as direct and continuous emissions are only measured from limited 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, and individual pollutants. Solvents emission modelling is based on estimating the amount of used solvents, knowledge of production volume, and solvent-containing products trade. All relevant solvents must be estimated or at least represent more than 90% of the total pollutant emission.

The motor industry, one of the essential industries in Czechia, applies a significant proportion of paints and solvents. 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 which mainly manufactures truck 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%. Like in Europe, digital print and electronic media cause a drop in demand for some types of ink (such as printing labels, books, and printed matters). 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, and it is forecasted that about 58% of all paints and coatings will be utilized in construction. Another important application is the transportation segment. Besides the division by various application areas, the paints and coatings are mainly based on acrylics, vinyl, alkyd, epoxy, polyurethane (PUR), and polyester.

The smallest share of emissions includes producing asphalt roofing materials and road paving with cutback asphalt and asphalt emulsions.

In 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 were used for some categories based on data reported by individually monitored sources [3].

IV.4.1 Emission factors and calculations

Emissions are estimated using top-down data (from the National Statistical Office, the MIT of Czechia, National Associations, and data collected from REZZO) and bottom-up data from inquiries 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). Emissions for diffuse sources are calculated from the data received from the Czech Statistical Office using international emission factors and expert opinions. The statistical statement of the Customs Administration of Czechia is a significant source of data and information. For emissions in NFR 2D3a is used recommended emission factor of 1.2 kg/capita/year according to EMEP/EEA EIG Tier 1 [3]. It was not yet possible to implement the recommended ESIG data into the calculation methodology.

Emissions from the application of paints produced by companies which are members of the Association of Paint Manufacturers of Czechia are estimated by an expert, who 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 products and surfaces to be painted, such as “waterborne decorative indoor paints” or “solvent-borne decorative indoor paints”. For each of these subgroups, the expert estimated the average NMVOC content and average density.

For NMVOC pollutants or products, a mass balance is formulated: Consumption equals (production + import) – (export + destruction/disposal).

The National Statistical Office collects data on the production, import and export amounts of solvents and solvent-containing products. Many data and trends in the production of many branches are gained from publishing Panorama of the Manufacturing Industry of Czechia. MIT elaborates on the publication by cooperating with the Czech Statistical Office and the Confederation of Industry of Czechia. This yearbook aims to provide expert advice on the development and achievements of the manufacturing industry and present the results of industrial companies operating in Czechia. They are also a solid basis for monitoring production and predicting further developments. Import and export figures are available on the 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 are 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 aggregated factors from industrial branches or sectors. In some sectors, corresponds emission factor with the VOC Solvents Directive (Czech series of acts, mainly Act. No201/2012 Co. and Regulation No 415/2012 Co.). Furthermore, emission factors may be characteristic of certain products' use patterns.

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

Unfortunately, confidentiality creates a lack of activity data in some branches. In these cases, Czechia used expert estimation, often based on earlier data.

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

Emissions from asphalt production are reported by operators. These emissions are related to hot processes, so they are listed in NFR 1A2f. TSP and PM emissions for NFR 2D3b only include asphalt use activities. These emissions were determined proportionally according to NMVOC emissions. The emission factors in the EIG correspond to the production and use processes together. Therefore the ratio of TSP/NMVOC and PM/NMVOC emissions cannot be used to avoid overestimation. Thus, for the estimation of TSP and PM emissions, the average ratios of PM/NMVOC and TSP/PM emissions were chosen according to the reporting of countries that do not use EF according to the Guidebook - see e-ANNEX.

TZL emissions from oil extraction, which are part of the reported SPE data, were reported in NFR 2B10a in previous years. Based on the recommendation, these emissions were moved to NFR 2D3i. It concerns the period from 2000. In previous years, data on TZL emissions were not reported and the amount of processed oils is not available either. Emissions have been replaced by the NO symbol for this reason. PM emissions were added according to the proportion recommended in the Guidebook.

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 number of solvents used and the solvent emissions were calculated. To determine the number 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 uncontrolled fugitive emissions entering the atmosphere. The resulting total combined uncertainty concerning the estimate of fugitive emissions, using the formula presented above, amounts to 13%. All the calculations tend to give results closer to the lower bound of the given range, and the real uncertainty can be somewhat higher. However, it follows from the nature and the principle of calculating fugitive emissions of NMVOC that this ascertainment is based on the balance method, which generally provides relatively accurate results. The total uncertainty should not exceed the threshold of 15%, provided that the input data correspond to reality.

The basic approach to emission inventories, the top-down balance method, utilizes results from emissions reported to the REZZO database, especially to ascertain the rate of capture and destruction of VOC contained in the products used. Suppose 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. In that case, the total 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 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 EMEP/EEA EIG methodology, 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 the following activities: use of fireworks, use of tobacco and use of shoes. All activity data was obtained from the national statistics of the Czech Statistical Office.

The 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, in 2022, on the contrary, consumption increased strongly (see Figure 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 the External Trade Database in the cross-border concept (https://apl.czso.cz/pll/stazo/STAZO.STAZO?jazyk=EN&prvni=N). 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 a moderate decrease (see Figure IV.6) mainly caused by a complete ban on smoking in public areas (including restaurants, cafes, pubs and bars) and the rise in 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-2022, 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, version 2023 [3]).

On the other hand, production of shoes decreased significantly compared to the 1990s, most of the shoes are imported at present (see Figure 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.

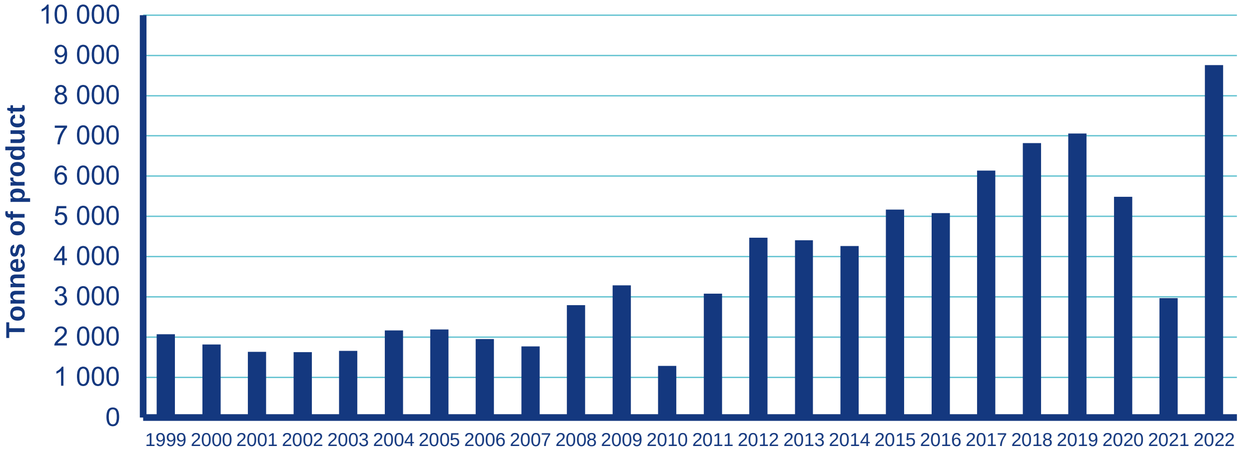

Figure IV.5 The fireworks import, 1999–2022

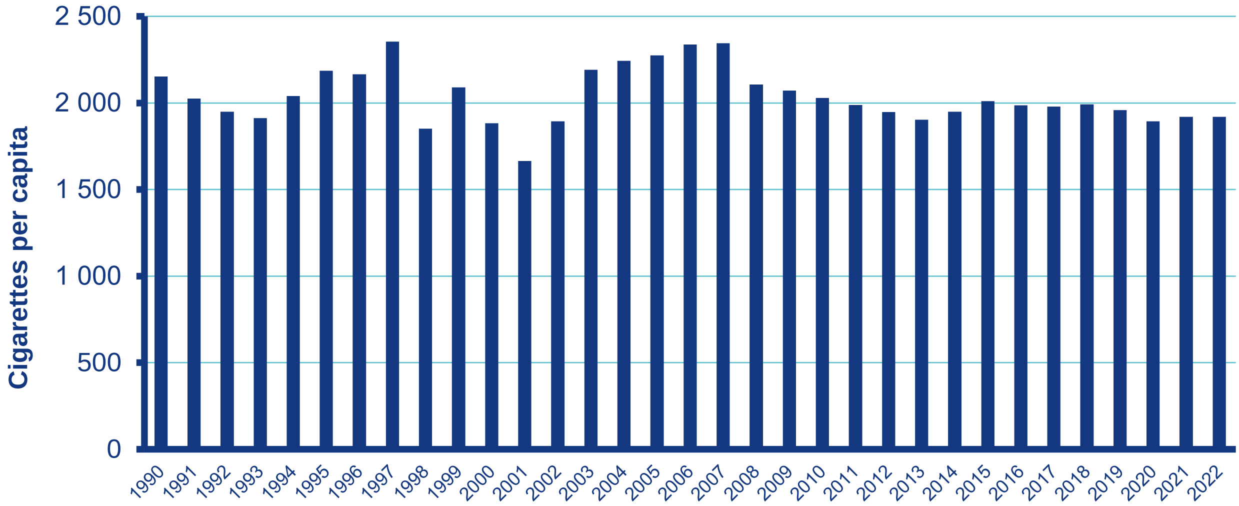

Figure IV.6 Tobacco smoking, 1990–2022

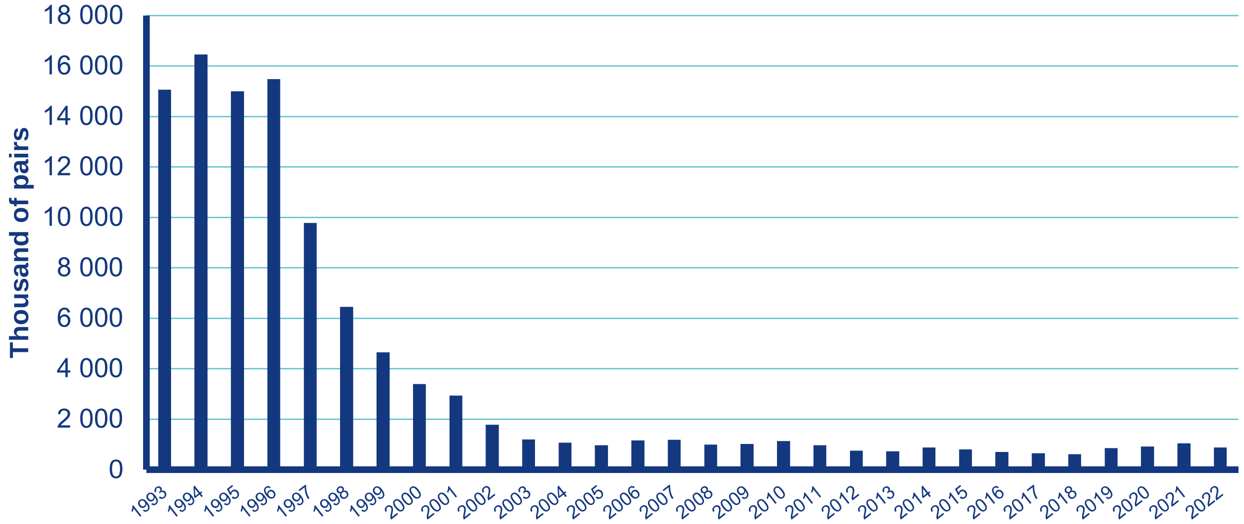

Figure IV.7 Shoes production, 1993–2022

IV.5.1 Emission factors and calculations

For all groups of processes, emission factors from EMEP/EEA EIG, version 2023, were used [3]. They are listed in tables 3-13 to 3-15. In all cases, it is a Tier 2 approach.

IV.5.1 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.5.4.

QA/QC for NFR 2G is the same as in the case of other collectively monitored sources, see also chapter 0 The main source of pollution in 2022 was NFR category 1A4bi (Residential stationary). The NFR category 1A4bi was top in nine emissions (NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO, PAH, HCB, PCDD/PCDF, Cd). The second most frequent NFR category was 1A1a (Public electricity and heat production). The 1A1a was top in measurements of three emissions (NO_X, SO_X, Hg) and occurring in others. In 2022, there was no important event.

QA/QC and Verification methods.

IV.5.2 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 the privatization in 1990, a certain number of enterprises' production was reduced or completely stopped. At present, in the 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. The trend of pulp production is shown in Figure IV.8.

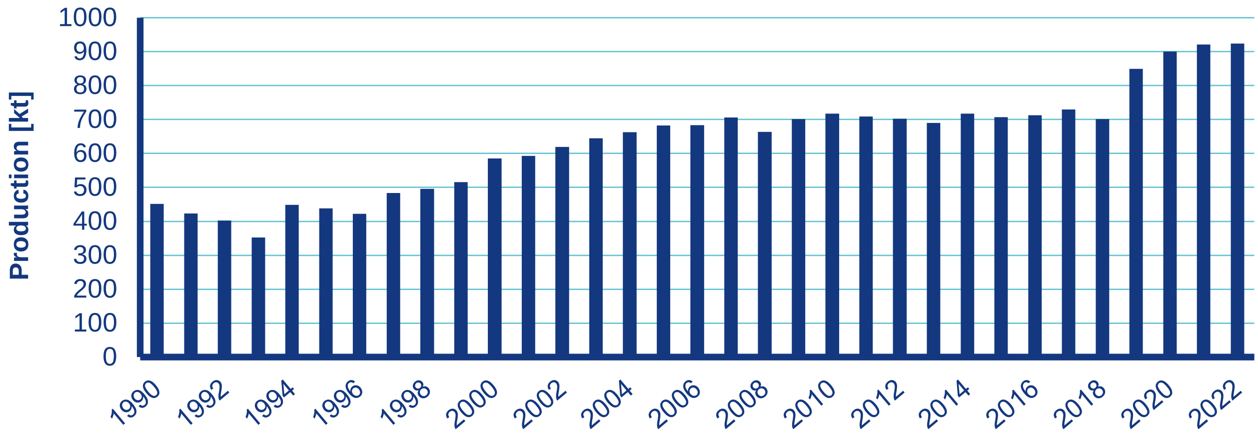

Figure IV.8 Pulp production, 1990–2021

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 Lenzig 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 the 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. By the recommended practice, emissions from combustion processes are reported in categories 1A2d, 1A2e or 1A2gviii.

IV.6.1 Emission factors and calculations

EMEP/EEA EIG, emission factors for NFR 2H2 were used [3]. 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 the Party of the Stockholm Convention and fulfils its obligations. While acceding to the Convention there were ascertained data about emissions and use of POPs (NFR 2J and 2K).

The system of emission inventory in Czechia enables the 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 though 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 to 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 comes from the 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 the 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 the 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 to 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: 15/03/2024

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
- 3Da4 Crop residues applied to soils
- 3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products
- 3De Cultivated crops
- 3Df Use of pesticides
- 3F Field burning of agricultural residues

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

Table 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				
3Da4				x				
3Dc					x	x	x	
3De		x						

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

In NFR 3B and 3Da2a, all emissions of monitored pollutants decreased between 1990 and 2022 due to significant animal population reduction, especially in cattle breeding. While milk production per head has increased, animal numbers decreased. In the case of pig production amount of rearing pigs and sows also decreased rapidly in the last decade. In future, a slight increase in pig production in Czechia is expected.

In NFR code 3Da1, ammonia and NO_X emissions have slightly decreased between 1990 and 2022 (approx. 13%). This situation was mainly caused by a significant increase in the consumption of mineral fertilizers between 2014 and 2018.

The agricultural sector is responsible for more than 97% of NH_3 emissions in Czechia. The main sources of ammonia emissions in Czechia represent manure management (category 3B) with a 39% share in total ammonia emissions, followed by inorganic N fertilizers application (category 3Da1) with a 34% share and animal manure application to soils (category 3Da2a including 3Da3) by 25% of share. Other non-agricultural sources are a biological treatment of waste – composting (category 5B1), municipal and industrial waste incineration (category 5C1a and 5C1bi), residential: Stationary (category 1A4bi), chemical industry, transport and others. These non-agricultural sources represent approximately 9% share of total ammonia emissions.

Figure V.1 shows the distribution of sources of NH_3 emission from the agricultural sector for 2022 in Czechia.

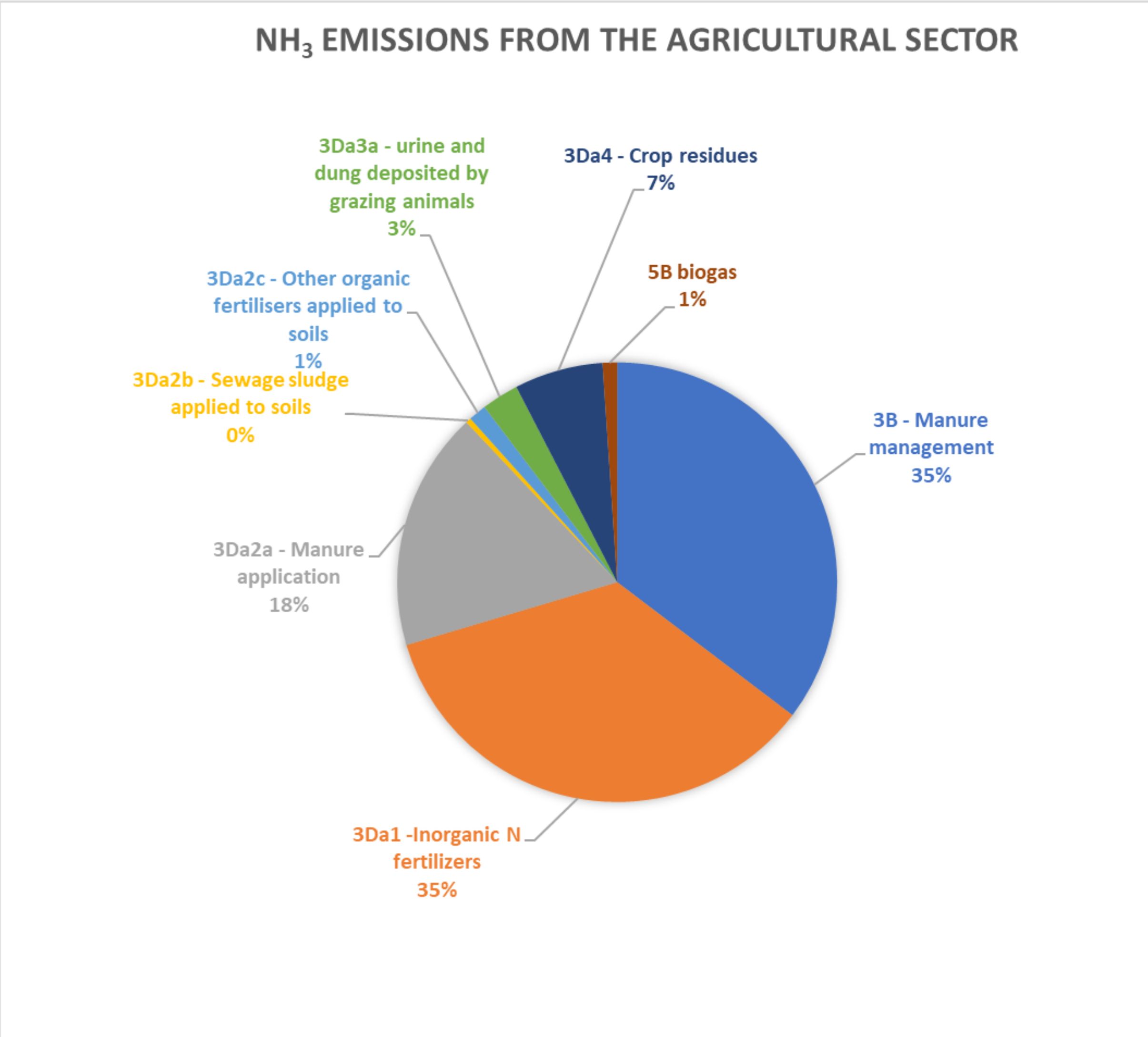

Figure V.1 NH3 emissions from the agricultural sector, 2022

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

Table V.2 Agricultural contribution to total emissions of NO_X, NMVOC, NH_3, PMs and TSP (year 2022)

	Emissions					
	NO_X (as NO_2)	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
National total [kt]	159.56	285.69	78.09	55.08	69.47	83.96
Agriculture [kt]	20.82	36.17	75.02	0.81	8.14	11.49
Agricultural share [%]	13.05	12.66	96.07	0.01	11.72	13.69

The mineral and organic manure application is the most significant agricultural contributor to total NO_X emissions (approximately 12%). The remaining 1% of NO_X is related to emissions from livestock breeding. The agricultural share of NMVOC emissions accounts for 13%, and cattle breeding (categories 3B1a and 3B1b) contributes to the total NMVOC emissions by approximately 7%. PM_{10} and TSP from category 3Dd Farm-level agricultural operations, including storage, handling and transport of agricultural products, represent the most significant sources of emissions from agriculture.

Extra-large cattle, pigs and poultry farms characterise Czech agriculture. The e-ANNEX **NFR-3B-1** shows the share of animals bred on farms (agricultural holdings) by size group of cattle, pigs and poultry (data from 2016 and 2020). Table V.3 shows the number of dairy cattle farms and the share of dairy cattle by the size of groups [11].

Table 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 bred on 3 335 farms in 2019. However, only 28% of cattle farms (633) have kept approximately 84% of the 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) and 3B4f (mules and asses) are not kept as livestock in Czechia. Therefore these subcategories are not estimated.

The number of animals is a key activity data for emissions inventory calculation relating to manure management (NFR 3B), animal manure applied to soil (NFR 3Da2a), urine, and dung deposited by grazing animals (NFR 3Da3). The number of animals was taken from an annual agricultural census from the official statistics (CZSO). The number of animals is considered as an average annual production. Table V.4 shows trends of the livestock population in the period 1990–2022.

Table V.4 Livestock population, 1990–2022 (thousands of heads)

	1990	1995	2000	2005	2010	2015	2020	2021	2022
Cattle	3 506	2 030	1 574	1 392	1 349	1 407	1404	1 406	1 421
Swine	4 790	3 867	3 688	2 877	1 909	1 560	1 499	1 518	1 513
Sheep	430	165	84	140	197	232	204	183	174
Poultry	31 981	26 688	30 784	25 372	24 838	22 508	24247	23 809	23 026
Horses	27	18	24	21	30	33	38	33	37
Goats	41	45	32	13	22	27	29	25	24

Trends in the livestock populations in the key categories (cattle, swine) determine emissions trends in the agricultural sector. The cattle population in 2022 corresponded to only 40% of the population in 1990, and the swine population in 2022 corresponded to even less - only 31% of the initial population.

V.1.1 Emission factors and calculations

All used activity data for NH_3, NO_X and NMVOC emissions inventories are in accord with the latest data used for greenhouse gas (GHG) inventories (submission 2024) and with the Gross nitrogen balance per hectare of utilised agriculture area for the Czech Republic (Eurostat) as a result of activities focusing on unification of national data used for calculation of all inventories (GHG, NH_3, NO_X, NMVOC and Gross nitrogen balance).

To estimate NH_3, NO_X and NMVOC emissions from animal breeding, the Tier 2 approach according to the 3B Manure management EMEP/EEA EIG has been used since 2020 (first submission 2021) [3].

To calculate ammonia and NO_X emissions according to Tier 2, the Manure management N-flow tool developed by Aether Ltd. 2019 under contract to the EEA was used [12].

V.1.1.1 Activity data

The number of livestock

Tier 2 uses a mass-flow approach based on the concept of a flow of TAN through the manure management system. According to 3B Manure management EMEP/EEA EIG, the first step is to define the homogeneous livestock subcategories concerning feeding, excretion and age/weight range [3]. The e-ANNEX NFR-3B-2 shows a number of animals allocated on relevant subcategories used for inventory calculation. The source of these data is the Czech Statistical Office. This allocation has been used for the all-time series from 1990 to 2022. It includes 43 different livestock categories divided on weight and age. These data are used for defining relevant NFR categories and as input data for the Manure management N-flow tool.

Values of N-excretion (Nex)

The emission of NH_3 and NO_X from manure management is calculated based on nitrogen excreted from livestock. Nex value in all animal categories, except dairy cattle, had been based on the national data for typical animal mass (TAM), Eq. 10.30 IPCC 2006 Gl. and the default excretion rate (Table 10.19, IPCC 2006 Gl. In dairy cattle's case, the excreted nitrogen calculation depends on milk production, which has been increasing in the Czech Republic since 1990. Therefore Nex rate value for the entire time series was taken new from OECD reporting (the documentation provided by the Crop Research Institute team). The country-specific values of Nex were derived from the national legislation Decree No. 377/2013 Coll. on the storage and use of fertilizers. The use of the updated coefficients was supported mainly by the need to synchronize input data used to evaluate the nitrogen flows in agriculture to increase the methodological level of reporting the nitrogen balance, greenhouse gas emissions and pollutants for the Czech Republic in terms of the requirements of international organizations.) Since 2021, these values are also jointly used for calculating GHG emissions and Gross nitrogen Balance (for Eurostat). The e-ANNEX NFR-3B-3 presents all revised Nex used for calculating NH_3 and NO_X inventories.

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) [14].

1. Anaerobic digester

2. Liquid system

3. Solid storage

4. Pasture/Range/Paddock

The use of manure in anaerobic digesters is relevant for cattle, swine and poultry manure. The 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 2008 and 2013.

The specific structure of Czech animal breeding (mostly in factory farming) allows building anaerobic digesters close to farms to consume daily manure production efficiently without manure storage. The number and capacity of anaerobic digesters have remained at their maximum value since 2014. In the same way, animal waste management systems (AWMS) are used for N_2O, CH_4, NH_3 and NO_X emission estimations. Based on a statistical survey of the amount and types of biomasses used for anaerobic digestion in 2018, the AWMS for cattle, swine and poultry categories have been updated. The overview of used AWMS per individual animal categories is provided in the e-ANNEX **NFR-3B-4**.

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 grazing animals. Feeding cattle with silage has been identified as the largest source of NMVOC in agriculture. Values of feed intake in MJ (average gross energy intake) are basic activity data for calculating NMVOC originating from dairy and non-dairy cattle. These data values presented in NIR for GHG inventory are used as a source. These data are available in the e-ANNEX **NFR_3B_5**; likewise, values of excreted volatile solids are used to calculate NMVOC originating from all livestock categories other than cattle. Moreover, the calculation of NMVOC is also dependent 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 categories.

V.1.1.3 Ammonia emissions factors

Housing

In 2012 the study on the implementation of Best Available Techniques (BAT) in the installation in Czechia under 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. It was found that approx. 44% of rearing pigs on intensive pig farms were housed in the system with a partly slated floor with a reduced slurry channel, 32% in the system with a partly slatted floor with a vacuum system and 22% in the system with a partly slatted floor with scraper [13]. According to the relevant Best Available Reference Document for Intensive Livestock Farming (ILF BREF since 2017 IRPP BREF), all these systems were considered BAT with different potentials for ammonia emissions reduction. However, for calculating ammonia emissions national inventory with the assistance of the Manure management N-flow tool default EF presented in Table 3.9. 3B EMEP/EEA EIG have been used [3]. The reason for this approach has been the need for more detailed information for implementing abatement measures resulting from BAT's application into inventories calculated according to Tier 2.

Manure storage

Depending on the housing type, livestock manure is collected solid or slurry. This share is primary input data to the Manure management N-flow. According to Czech law 201/2012 on air protection, all slurry tanks must be covered by a fixed or floating cover or a natural floating cover to reduce ammonia emissions into the air.

Manure application

A significant subsidy program focused on introducing low ammonia application techniques started in 2011 in Czechia. This effort resulted in faster incorporation of manure into the soil. The Czech Statistical Office confirmed these trends based on data published in April 2018 in the “Farm Structure Survey – 2016” and in September 2021 in the “Integrated Farm Survey - 2020” [15]. Table V.5 presents a share of low ammonia application techniques.

Table V.5 Manure consumption by application technique (CZSO 2022)

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 was applied by low ammonia emissions techniques defined in the Options for Ammonia Abatement: Guidance from the UNECE Task Force on Reactive Nitrogen [16]. Approximately 15% of manure was applied and incorporated into the 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 the soil within 4 hours. Share of manure incorporation within 24 hours represents 56% of the total amount of applied manure with ammonia abatement effect at 30%, similar to utilization of band spreading with a share of 14%. Based on these facts, possibly 85% of all manure has been applied by technique with abatement effects on ammonia emissions of at least 30%.

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

Abatement measures

According to the Options for Ammonia Abatement: Guidance from the UNECE Task Force on Reactive Nitrogen, ammonia abatement effects were incorporated into the inventory. Mitigation measures were included directly in the N-flow tool calculation program as an extension of the original program. The extension of the original program was created as a result of the specific contract No 070201/2020/831771/SFRA/ENV.C.3 - Capacity building for Member States regarding the development of national emission inventories led by the Ricardo Energy & Environment, a trading name of Ricardo Nederland BV, under contract to the European Commission dated 28 May 2018. Reducing measures regarding manure storage and its application to the soil was considered for the Czech Republic. Penetration rates of used abatement measures and related comments are available in the e-ANNEX **NFR-3B-6.**

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 Table 3.10. 3B EMEP/EEA EIG have been used [3].

NMVOC emission factors

Since 2020 emissions of NMVOC have been calculated using the Tier 2 approach. For calculating NMVOC emissions inventory, default EFs presented in Table 3.11 for dairy cattle, and other cattle and 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 calculating $PM_{2.5}$, PM_{10} and TSP emissions inventories, default EFs presented in 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 Figure V.2 and from manure application and animal grazing in Figure V.3.

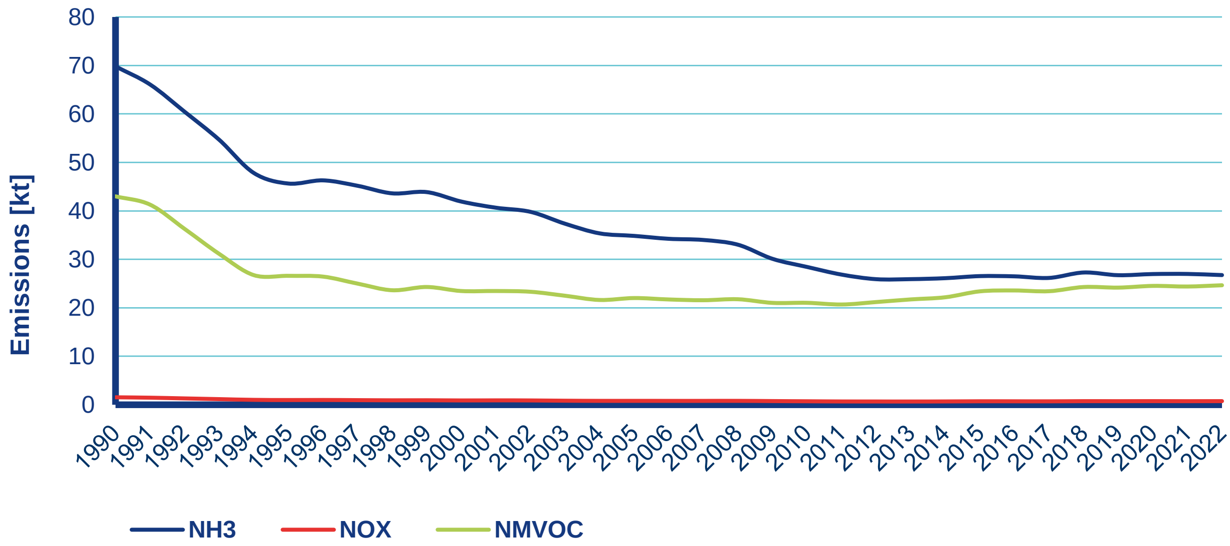

Figure V.2 NH_3, NO_X and NMVOC emissions originating from manure management, 1990–2022

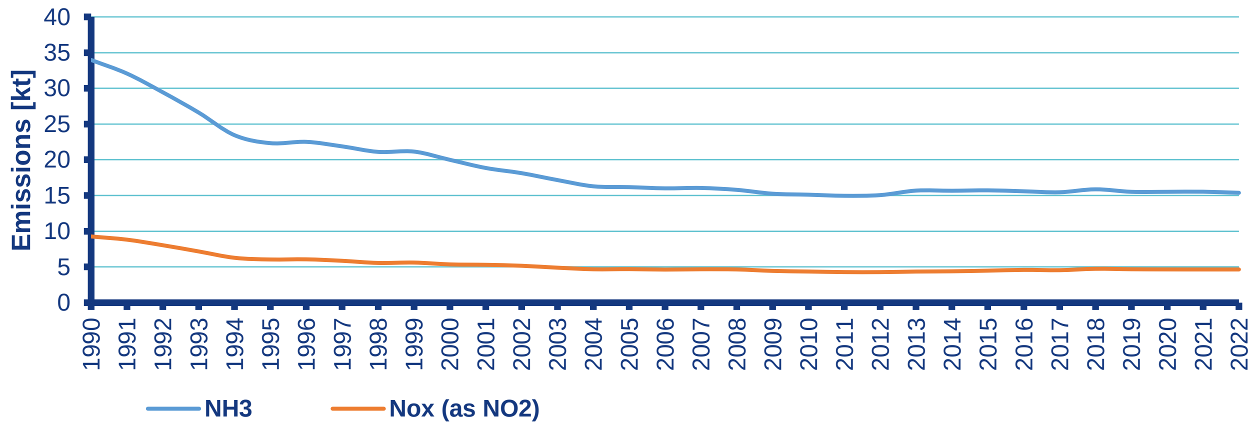

Figure V.3 NH_3 and NO_X originating from manure application, urine and dung deposited by grazing animals, 1990–2022

V.1.2 Uncertainties and QA/QC procedures

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

V.1.3 Planned improvements

There are planned following issues:

- Regular verification of the compliance of the input data used for the inventory of NH_3, GHG emissions and the inventory of the gross nitrogen balance with the expert group for greenhouse gases and the calculation of the nitrogen balance.
- Incorporate ammonia abatement techniques following BATs utilization in housing pigs and poultry into inventory calculation.
- Verification of animal feed properties.

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

For the Inorganic N-fertiliser (also includes urea application) sector (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 26% of the total ammonia emissions from the agricultural sector, and emissions of NO_X contribute 68% of the total NO_X emissions from the agricultural sector in 2022. Trends in inorganic fertilisers' consumption are presented in Table V.6. Source of these data is CZSO [17].

Table 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	279 238	212 988	39 834	26 416
1999/00	279 918	206 576	43 083	31 097
2004/05	301 864	223 684	47 083	31 097
2006/07	320 042	237 875	49 034	33 133
2007/08	278 198	221 667	35 218	21 313
2008/09	281 484	225 982	35 078	20 424
2009/10	303 927	238 554	39 991	25 382
2010/11	318 225	248 024	43 001	27 199
2011/12	337 764	261 216	47 053	29 495
2012/13	353 989	268 892	50 847	34 250
2013/14	357 668	270 023	52 005	35 641
2014/15	385 739	292 750	54 401	38 589
2015/16	380 659	285 739	56 194	38 725
2016/17	374 995	281 271	54 969	38 755
2017/18	365 071	274 305	52 595	38 171
2018/19	360 414	267 676	55 656	37 083
2019/20	343 049	256 521	51 617	34 911
2021/22	299 452	228 661	40 617	29 957
2022/23	295 303	231 198	38 787	25 630

The highest consumption of inorganic N-fertilisers was in the agricultural production year 2014/2015. Since 2016/2017, consumption of these fertilisers has decreased.

V.2.1 Emission factors and calculations

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

V.2.1.1 Activity data

The IFASTAT database has been used as a key source of basic activity data regarding the amount of inorganic N-fertiliser consumption. In this context is very important to underline that these data express the amount of fertilizers sold, which are assumed to equal the amounts applied. Since the 2022 submission, storage effects have been 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 the smoothing of extreme values and redistribution of emissions between neighbouring years.

In the e-ANNEX NFR-3D-1a consumption of different inorganic N-fertilisers is presented. According to this database, the total consumption of inorganic N-fertilisers is mentioned in the Table V.6 is divided into the 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. Differences in the methodological approach of data collection cause differences in total consumption data on inorganic N-fertilizers between the IFASTAT database, the EUROSTAT database, the Czech Statistical Office (CZSO) and FAOSTAT. The IFASTAT database expresses the consumption of mineral fertilizers used in the economic year (e.g. 2021/2022), while the data in the FAOSTAT and EUROSTAT databases are in the calendar year (2022).

NH_3 emissions factors

Until the 2022 submission, ammonia emissions from inorganic N fertilizers were calculated using the default EF in Table 3.2 of the 3D EMEP/EEA EIG 2019 for each group of inorganic N fertilizers above. [3]. The Czech Republic is included in a cold climate zone with a soil pH below 7.0.

Since the 2023 submission, the emission factors are listed in the tab. 3.2 of the 3D EMEP/EEA EIG 2023 were used for individual groups of mineral fertilizers. A 'normal' pH of 7.0 or below was taken into account. REF _Ref129801343 \n \h * MERGEFORMAT [https://www.eea.europa.eu/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/3-agriculture/3-d-agricultural-soils-2023/view].

The emission factors listed in the EMEP/EEA EIG 2023 are significantly higher for some mineral fertilizers compared to the 3D EMEP/EEA EIG 2019, which caused a significant increase in the production of ammonia emissions in the year-on-year calculations.

NO_X emissions factors

NO_X emissions from inorganic N-fertilizers are calculated by default EF in Table 3.1 of the 3D EMEP/EEA EIG for all inorganic N-fertilisers [3].

Ammonia and NOX emissions

The e-ANNEX **NFR-3D-2** presents a share of different types of inorganic N-fertilisers on total ammonia emissions from inorganic N-fertilisers consumption in 2022 is presented. In 2022 ammonia emissions from Urea and N solutions based mainly on urea reached a proportion of the total ammonia emissions from inorganic N-fertilisers consumption at 27% and 16%, respectively. In the e-ANNEX **NFR-3D-1a** are also presented trends in ammonia emissions originating from different types of inorganic N-fertilisers. Ammonia emissions from the consumption of urea and urea-based fertilisers are decreasing. Trends in NH_3 and NO_X emissions originating from inorganic N-fertiliser consumption (in kt) are presented in Figure V.4.

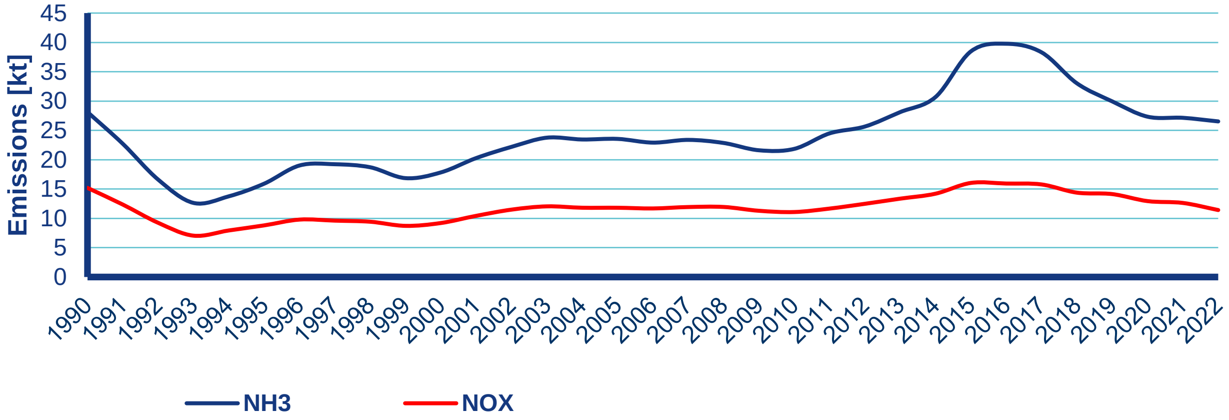

Figure V.4 NH_3 and NO_X emissions originating from inorganic N-fertilisers consumption, 1990–2022

V.2.2 Uncertainties and QA/QC procedures

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

V.2.3 Planned improvements

A new law has imposed measures for the low-emission urea application since July 1 2022. According to the Options for Ammonia Mitigation Guidance principles from the UNECE Task Force on Reactive Nitrogen, the measure represents a low ammonia emissions option focused on urea-based fertilisers. The law does not allow surface application of urea-based inorganic N-fertilisers without rapid incorporation into soil or application of urea-based inorganic N-fertilisers untreated by urease inhibitor. Consequently, ammonia emissions from urea application could decrease by 70%. Then, the specific default EF for urea can be reduced. This measure will be included in the national ammonia emission inventory in 2024.

V.3 Crop production and agricultural soils - Sewage sludge applied to soils (NFR 3Da2b), Other organic fertilisers applied to soils (including compost) (NFR 3Da2c) and Crop residues applied to soils (NFR 3Da4)

For the sectors, Sewage sludge applied to soils (NFR 3Da2b), Other organic fertilisers applied to soils (including compost) (NFR 3Da2c) and Crop residues applied to soils (NFR 3Da4) emissions of NH_3 and NO_X are estimated. NH_3 from these sectors contribute approx. by 9% of the total ammonia emissions from the agricultural sector. Emissions of NO_X contributed 19% of the total NO_X emissions from the agricultural sector in 2022.

V.3.1 Emission factors and calculations

The Tier 1 approach has been used for national estimation of NH_3 emissions from Sewage sludge applied to soils (NFR 3Da2b), Other organic fertilisers applied to soils (including compost) (NFR 3Da2c) and Crop residues applied to soils (NFR 3Da4), according to the 3.D Crop production and agricultural soils [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 the amount of N applied into the soil and the default emission factor. The source of activity data regarding sludge application and compost production is the Czech Statistical Office. The average N-content in sewage sludge is assumed to be 3.66 kg N per kg dry matter [18] and 0.55 N per kg dry matter in composts in Czechia [19]. In Table V.7 and in Table V.8 amount of N from sludge, composts and plant share of digestate applied on soil is presented.

Table V.7 Activity data used to estimate NH3 and NOX from sewage sludge, 1990–2022

	1990	2000	2005	2010	2015	2020	2021	2022
Amount of sludge applied on soil (tons of DM)	6 841	28 615	34 467	60 639	63 061	63 064	66 082	63 260
N-content (%)	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	2 333	2 445	2 340

Table V.8 Activity data used to estimate NH3 and NOX from composts and plant share of digestate, 1990–2022

	2005	2010	2015	2020	2021	2022
Amount of applied composts (tons of DM)	47 260	70 333	87 275	145 599	145 710	140 980
N-content (%)	0.55	0.55	0.55	0.55	0.55	0.55
N applied on soil (tons of N)	259	386	480	801	801	775
N applied on soil from plant share of digestate (tons of N)	940	5 920	12 530	11 710	11 850	11 620

The calculation of ammonia emissions from plant residues was performed for the first time in the entire time series 1990 - 2022 for submission in 2023. All activity data used for the calculation are listed in the e-ANNEX NFR-3D_3Da4_NH3_FCR - IPCC.

Ammonia emissions factors

For calculating ammonia emissions originating from sewage sludge applied to soils and other organic fertilizers applied to soils (including compost), default EFs are presented in the tab. 3.1 of the 3D EMEP/EEA EIG has been used [3]. For calculating of ammonia emissions originating from crop residues left in fields default EFs presented also in the 3D EMEP/EEA EIG have been used [3]

NO_X emissions factors

Ammonia emissions from sewage sludge applied to soils and other organic fertilizers applied to soils (including compost) are calculated by default EFs from Tab. 3.1 in the 3D EMEP/EEA EIG [3].

Ammonia and NO_X emissions

Figure V.5 presents trends in NH_3 and NO_X emissions originating from sewage sludge applied to soils and other organic fertilizers applied to soils (including compost) and emissions from crop residues in 1990–2022 (in kt).

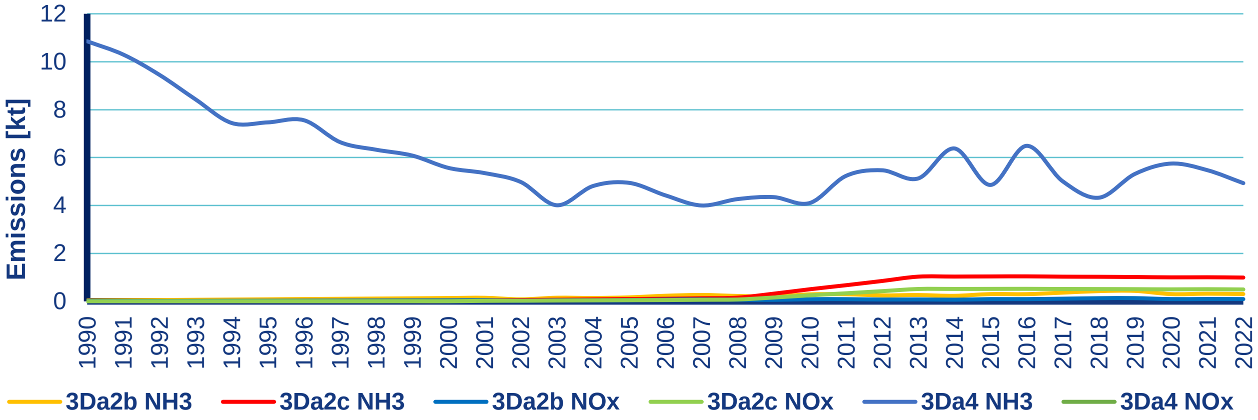

Figure V.5 NH_3 and NO_X emissions from sewage sludge applied to soils and other organic fertilizers applied to soils (including compost) and crop residues left on fields, 1990–2022

V.3.2 Uncertainties and QA/QC procedures

There needed to be more 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, and 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 crop, soil type, soil cultivation method, and climatic conditions before and during farming operations. NFR 3Dc contributed 0.01% and 9% of the total $PM_{2.5}$ and PM_{10} emissions in 2022. Cropped areas of individual crops divided at the 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 such 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 gives the area of arable land on which root crops, vegetables, oilseeds, fodder plants, etc., are grown.

V.4.1 Emission factors and calculations

Activity data

The Tier 2 approach has been used for the NFR 3.Dc soils to estimate $PM_{2.5}$ and PM_{10} emissions. According to the Tier 2 methodology, PM_{10} and $PM_{2.5}$ are calculated as the product of cropped areas of individual crops and emission factors of individual field operations emitting dust particles. The source of activity data regarding the sowing area of crops is the Czech Statistical Office. The e-

ANNEX NFR-3D3 shows trends in the utilisation of agricultural areas and areas under crops (as of 31st May of the relevant year).

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

Tables 3.5 and 3.7 in 3D EMEP/EEA EIG for the region with wet climatic conditions present default EFs for calculating $PM_{2.5}$ and PM_{10} emissions inventories [3]. For rape default, EF for crop cultivation utilisation of different tillage practices (conventional tillage - mouldboard plough or disc ploughland, conservation tillage - low tillage) has been considered to obtain a more precise calculation of PMs emissions from the agricultural operation. The share of zero tillage (direct seeding) is only 1.5% in Czechia and was omitted in the calculation. Soil cultivation, the area taken up by cereal crops in each region, was divided into thirds. For one-third 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 lands. In the case of permanent grasslands, the emission factor for the operation Harvesting was factored in twice. The 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 crops. The e-ANNEX NFR-3D-4 shows the share of used tillage methods in 2010 and 2016. In Table V.9 frequency of farming operations during the year for individual types of crops is presented.

Table V.9 Frequency of farming operations during 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

Figure V.6 shows trends in $PM_{2.5}$ and PM_{10} emissions from farm-level agricultural operations, including storage, handling and transport of agricultural products (in kt).In the time series of the production of PM emissions, a significant decrease can be seen in 2003. This decrease was caused by lower cereal production in 2003. Cereal production, especially wheat, was lower by approx. 15% compared to 2002 and approx. 35% lower than in 2004. According to EMEP GB, the production of cereals is most closely related to the production of PM emissions. The e-ANNEX NFR-3D-5 Crop yield shows the yields of individual crops in the entire time series.

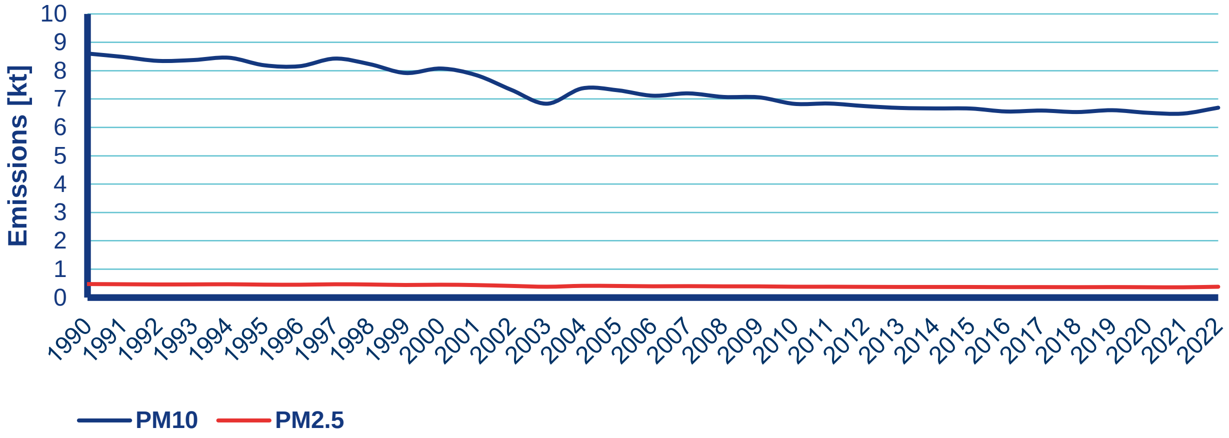

Figure V.6 $PM_{2.5}$ and PM_{10} emissions originating from farm-level agricultural operations including storage, handling and transport of agricultural products, 1990-2022

V.4.2 Uncertainties and QA/QC procedures

There needed to be more 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, and 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. For NFR 3De cultivated crops, NMVOC emissions are estimated. NFR 3De contributed less than 1% of the total NMVOC emissions production in 2022

V.5.1 Emission factors and calculations

Czechia uses emission factors from 3D EMEP/EEA EIG. The Tier 2 method is used for MNVOC emissions of selected crops (wheat, rye, barley, oats, rape, grain maize, perennial fodder crops – pasture and grass). Tier 1 values from Table 3.3 have been used for the other crops [3].

Activity data

According to the Tier 2 methodology, emissions of NMVOC are calculated as the harvest crop yield multiplication and relevant emission factors. The Czech Statistical Office provides activity data regarding harvested crops and per-hectare crop yields. Trends of yields of harvested crops are in the e-ANNEX NFR-3D-5. All activity data used for calculating the all-time series are in the e-ANNEX **NFR-3D-6**.

NMVOC emissions factors

In Table V.10 NMVOC are emissions factors used for the calculation of NMVOC from cultivated crops in 2021.

Table 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

The trend in NMVOC emissions originating from cultivated crops (in kt) is presented in Figure V.7.

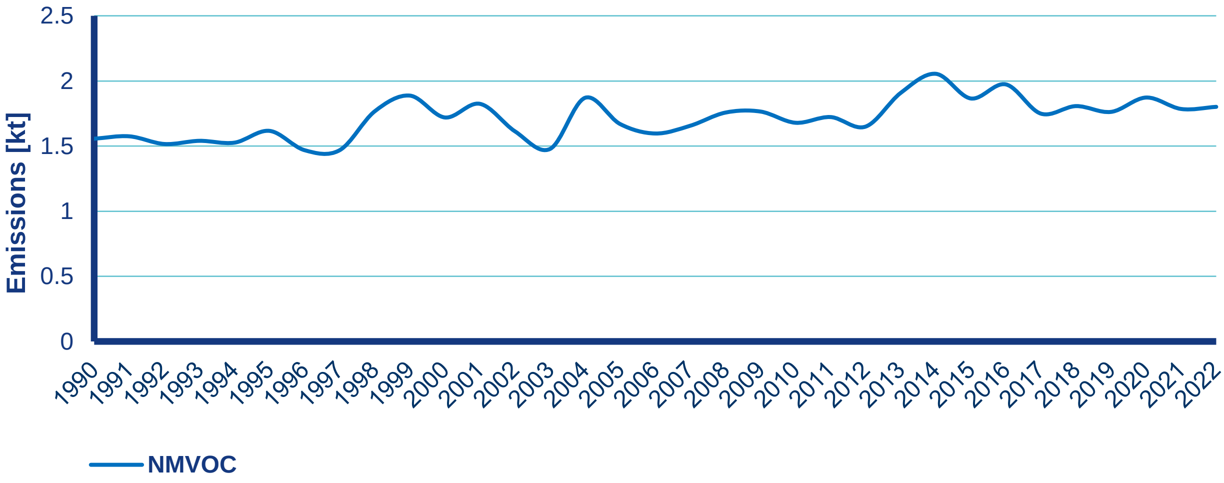

Figure V.7 NMVOC emissions originating from cultivated crops, 1990–2022

V.5.2 Uncertainties and QA/QC procedures

There needs to be more 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, and 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 not allowed. Thus emissions occurring from this category are not considered in the IIR.

The CZSO, in cooperation with the Central Institute for Supervising and Testing in Agriculture (UKZUZ), monitor pesticide consumption following Regulation (EC) No 1185/2009 of the European Parliament and the Council of 25 November 2009 concerning statistics on pesticides. The monitoring scale is 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. Therefore, emissions of NH_3 from the NFR 3I are omitted in the IIR.

V.6.1 Emission factors and calculations

The Tier 1 approach is used to estimate HCB emissions from 3Df use of pesticides according to the 3.D.f-3.I Use of pesticides and limestone 2023 [3].

Activity data

HCB is calculated as the multiplication of used pesticides and relevant emission factors. The source of activity data regarding pesticide use is the Central Institute for Supervising and Testing in Agriculture (UKZUZ), available at the website of UKZUZ [22]: e-ANNEX **NFR-3Df** shows all activity data used for calculation of HCB in all-time series since 1999.

HCB emissions factors

Table V.11 shows HCB emissions factors used for the calculation of HCB originating from the use of pesticides.

Table V.11 Emissions factors for selected pesticides

Active Substances	1990	1995	2000	2005	2010	2015
	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$	$mg \cdot kg^{-1}$
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
Pentachlorophenol (PCP)	50	50	50	not used	not used	not used

HCB emissions

Figure V.8 presents trends in HCB emissions from the use of pesticides (in kt).

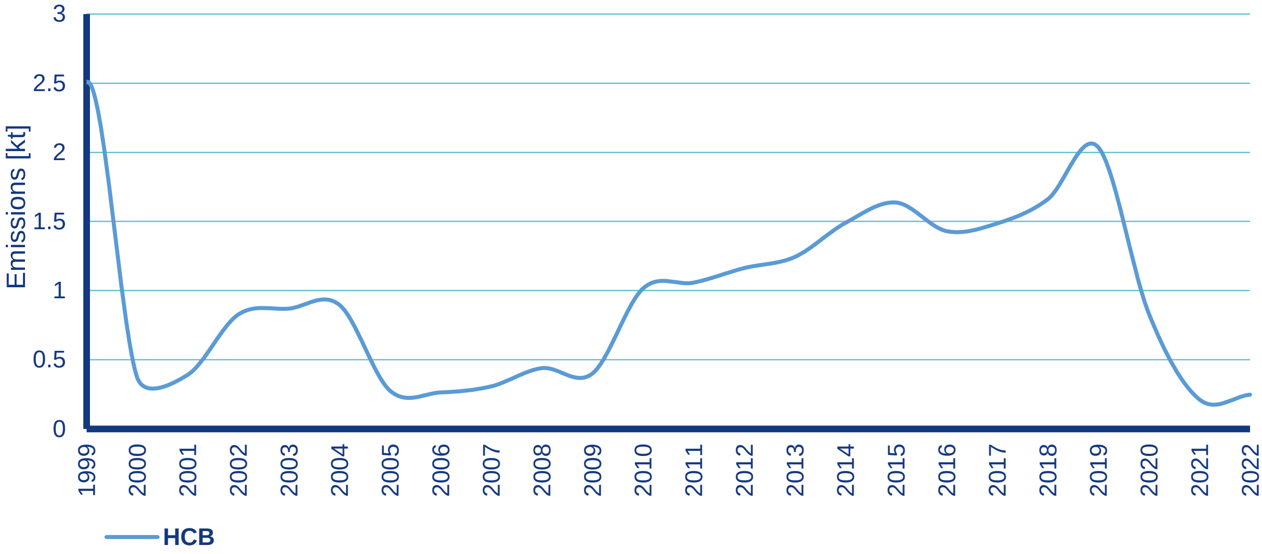

Figure V.8 HCB emissions originating from used of pesticides, 1999–2022

V.6.2 Uncertainties and QA/QC procedures

There needed to be more 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, and the chapter is considered to be final.

VI. Waste (NFR 5)

The date of the last edit of the chapter: 15/03/2024

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, 5C2, 5D1–5D2, 5E – Car and buildings fires). Links between the NFR category and classification according to Czech law are listed in Table VI.1 below.

Table 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 (7.3%) PCDD/PCDF – NFR 5E Car and building fires (31.3%) and NFR 5C2 (10.3%). The increase in Hg emission from cremations in 2020 and 2021 was caused by high mortality due to the COVID-19 pandemic.

According to statistics of CZSO (https://www.czso.cz/csu/czso/cesko-v-roce-2022-vyprodukovalo-39-mil-tun-odpadu) and Catalogue of Products (https://www.czso.cz/csu/czso/generation-recovery-and-disposal-of-waste-2022), 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 landfilling.

Total waste generation, in which the largest share (96% in 2022) is held by the generation of non-hazardous waste, reached 39.2 million tons in 2022, which represents a year-on-year decrease of roughly 0.3%. Municipal waste generation increased in the period 2021–2022 by 1.3% to 5.4 million tons.

A declining trend has long been observed in the generation of hazardous waste (in the period 2021–2022 it dropped by 10% to a total of 1.56 million tons).

According to statistics from the Czech Environmental Information Agency (CENIA), total waste treatment is dominated by waste recovery, particularly material, the proportion of which has long been increasing (see Figure VI.1). The 2022 data is not yet available due to the transition to the new database ISOH 2. For the same reason, 2022 data for sectors 5A and 5B1 is preliminary (based on CZSO statistics).

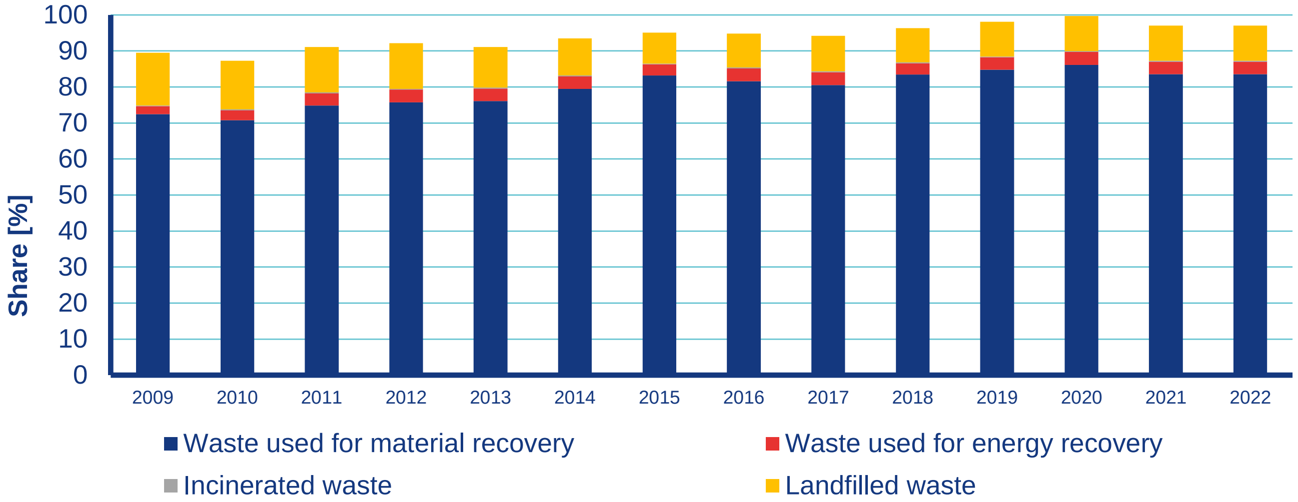

Figure VI.1 Proportion of selected waste treatment methods in the total waste generation, 2009–2021

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 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 waste 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 were the Centre for Waste Management (CeHO). Since 2007 the operator of the ISOH database is CENIA**.** The basic source for aggregated information on waste production and treatment is data on annual reports from originators and authorized persons sent to the ISPOP. This database can be queried by year, area, treatment method and waste catalogue number. The whole republic and all types of waste were chosen in this case.

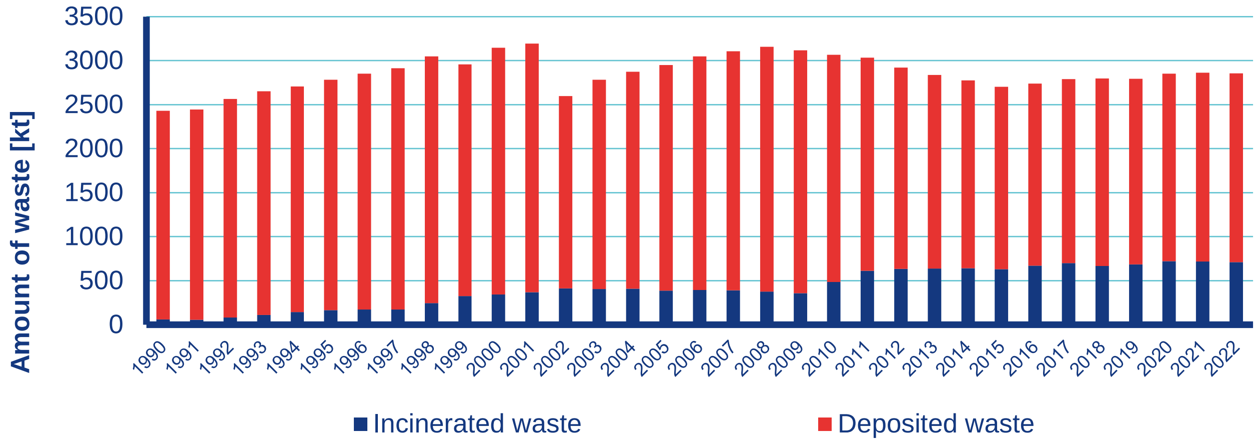

Figure VI.2 Comparison of the amount of deposited and incinerated municipal waste, 1990–2022

Figure 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. 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). According to State Energy Policy and Decree 352/2014 Coll. (see e-ANNEX), on the Waste Management Plan of Czechia for the period 2015–2024, the amount of deposited municipal waste will continue to decrease together with the 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, version 2023, (Tier 1 approach) [3]. On the recommendation of the Technical Expert Review Team (TERT) in 2018, emissions are calculated using default emission factors. Initially, the lower level of EFs was used because of used technology. All large landfills (with capacity restriction according to Annex 1, point 5.4. of Act No. 76/2002 Coll. On the integrated prevention) comply with the emission limitation principles following 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 the historical period 1990–1999 were calculated using activity data estimated based on the National Greenhouse Gas Inventory Report of Czechia submitted in 2017 (http://portal.chmi.cz/files/portal/docs/uoco/oez/nis/nis_do_cz.html). In this report, only the amount of deposited municipal solid waste (MSW) is given. In the year 2002 (the first year with data available in ISOH), the ratio between 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 the methodology recommended by TERT. This methodology was developed to estimate an NMVOC EF based on CH_4 emissions reported in the framework of the UNFCCC reporting. To do so, the CH_4 emission ratio per tonne of disposed waste (based on Czech UNFCCC 2020 reporting) was used, converted 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, version 2023, 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 to 200%, see also Chapter I.5.

VI.1.3 Planned improvements

No improvements are planned, and 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.

According to Annex 8 to Regulation No 415 /2012 Coll., point 1.1. (Composting plants and equipment for biological modification of waste with a 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 no emission limit is set, 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 the 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 the 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 ISOH. For detailed information about this country-wide database, see Chapter VI.1. Activity data have been available since 2005. Historical activity data for 1990−2004 were estimated using various information sources – expert article by association CZ Biom ((https://biom.cz/cz/odborne-clanky/kompostovani-biodegradabilnich-odpadu-v-ceske-republice), publication of CENIA (https://www.cenia.cz/publikace/monografie/hospodarstvi-a-zivotni-prostredi-v-ceske-republice-po-roce-1989/), statistical yearbooks of CZSO and CENIA. Calculated NH_3 emissions are below the threshold of significance. Emissions of the other pollutants, reported by operators, were removed.

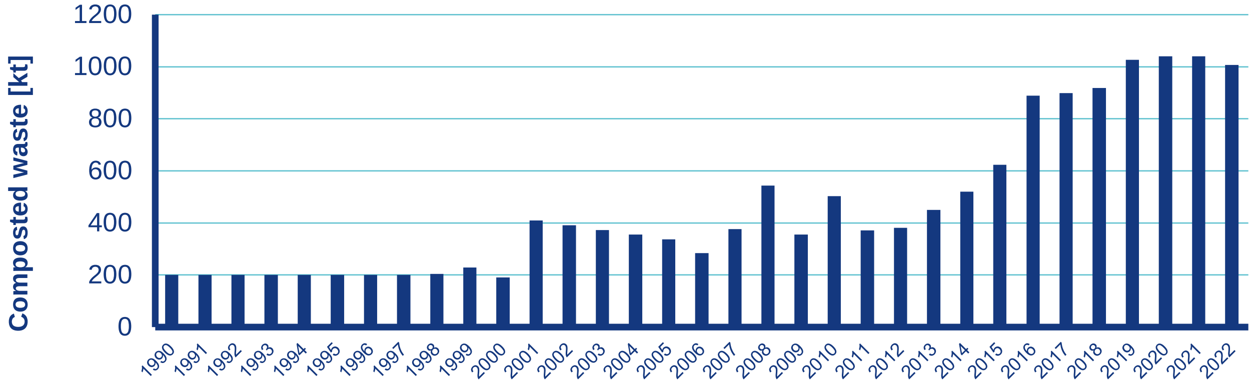

Figure VI.3 The trend in the waste composting, 1990–2022

As is shown in Figure VI.3 it is evident, that its amount has increased significantly recently due to mainly rising interest in the minimization of waste and its ecological utilization. Emissions of NH_3 depend exclusively on activity data because the 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 of 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 2022, 352 biogas stations in operation were registered in the 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 plants are not expected any release 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 the websites of the association CZBA (https://www.czba.cz/en.html). Here is a freely accessible map of biogas plants (BP), which contains information about starting date of operation and power (heat and electric). They are divided into agricultural BP (397), BP in landfills (58), industrial BP (21) and BP in water treatment plants (98). Based on these data, the gradual commissioning of agricultural BP. Table VI.2 illustrates the year of commissioning, number of BP and cumulative installed electric power for agricultural BP.

Table 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
2021	0	319.264
2022	0	319.264

The highest increase in 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.

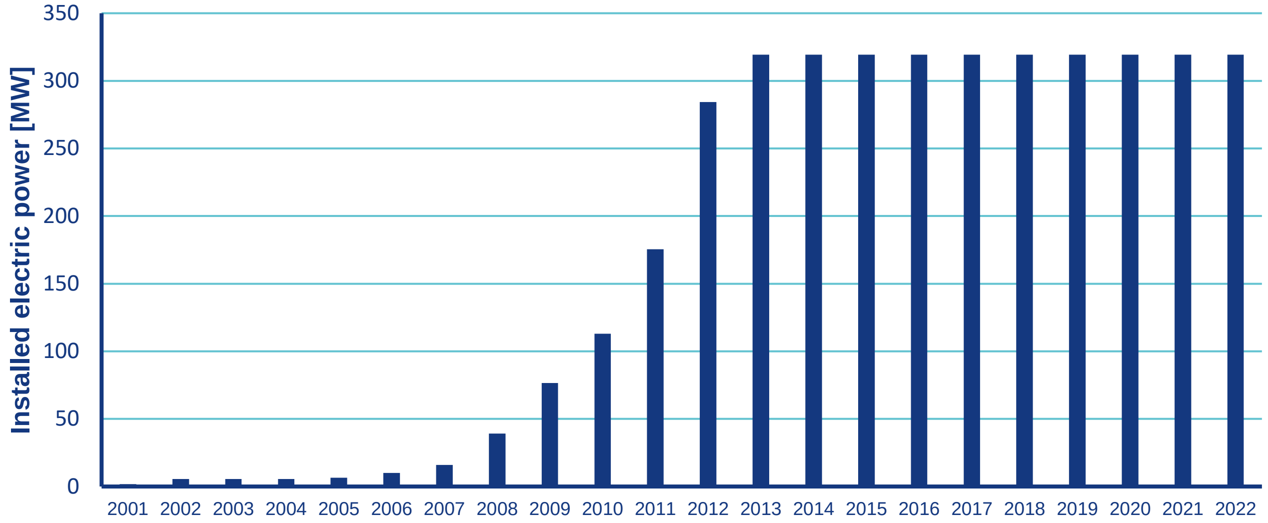

Figure VI.4 Installed electric power of agricultural biogas plants, 2001–2022

Activity data of non-agricultural biogas plants in Czechia are not available. Considering that the number of different types of biogas stations listed in the IIR (p. 89) shows that agricultural ones are predominant, NH_3 emissions from other types can be considered negligible. On the recommendation of TERT, Czechia will make efforts to obtain data on the input materials to non-agricultural biogas plants in the next years (e.g. with cooperation with CENIA).

VI.2.1 Emission factors and calculations

Emissions of NH_3 for NFR 5B1 Composting were calculated using emission factor from EMEP/EEA EIG, version 2023 (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 the 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.5.

VI.2.3 Planned improvements

For category 5B2, Czechia will make efforts to obtain data on the input materials to non-agricultural biogas plants in the next years (e.g. with cooperation with CENIA).

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 the incineration of waste sludge, which was out of operation in the years 2014–2022, therefore symbol “NA” was used.

Most 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 working on the principle of the cogeneration cycle, which provides heat and electricity production.

The database of installations for the thermal treatment of waste in Czechia (Register of waste incinerators and co-incinerators) has been maintained since 2002 by 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 is obtained from the 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 the amount of incinerated waste) is obtained from summary operating records. They are made public in the form of synoptic tables which contain following data: identification data (region, name of operator, name of facility, identification number (IČ), identification number of the operating unit (IČP), address of operator, address of facility) 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 from regional authorities, which have been issuing permits since 1. 1. 2003.

The types of permits are the following:

Permits according to § 17 paragraphs 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 the Register of waste incinerators are utilized in emission inventory. Co-incineration plants which are in Czechia only cement kilns cannot be included in emission inventory because the largest share of emissions does not come from waste incineration but from the production of cement clinker. The amount of waste incinerated in rotary furnaces for the production of cement clinkers is included in the 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 the 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 1990–2022. 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 as facilities for energetic utilisation of waste.

The trend showing amounts of municipal and other waste incineration in the years 1990–2022 is illustrated in Figure VI.5 and Figure VI.6.

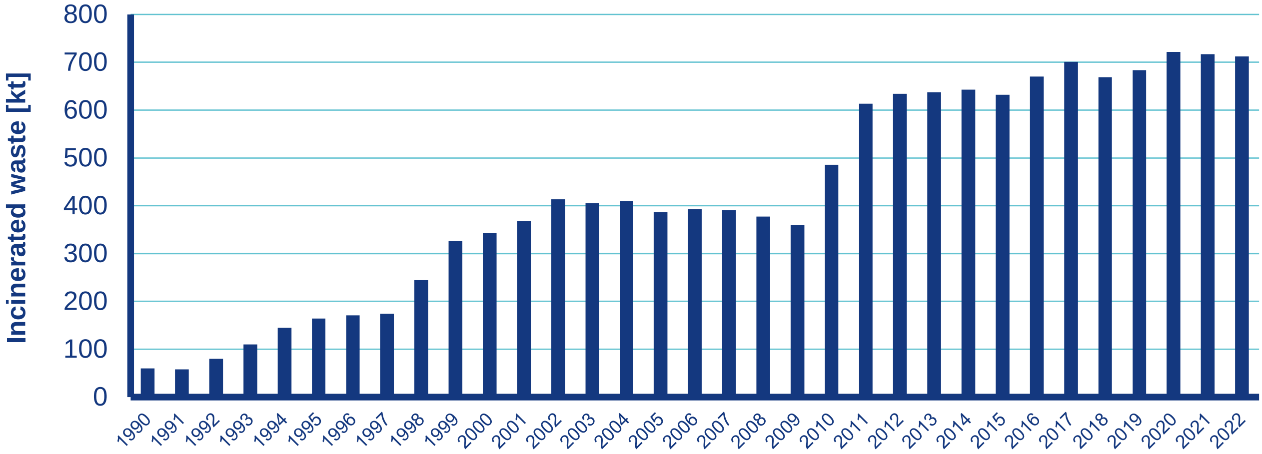

Figure VI.5 Municipal waste incinerated, 1990–2022

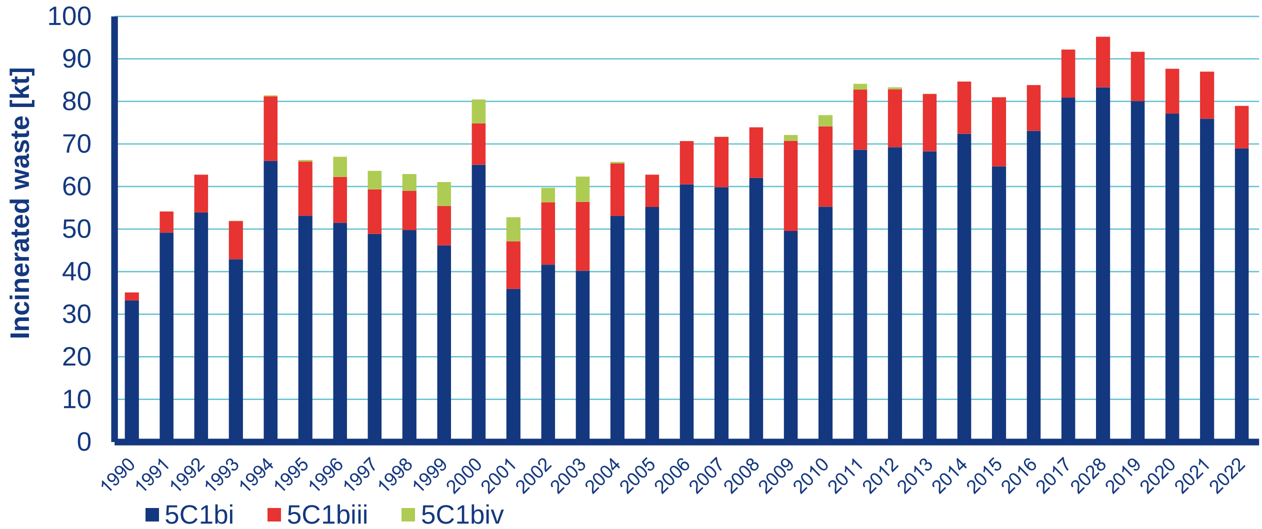

Figure VI.6 Other waste incinerated, 1990–2022

It is clear from Figure VI.5 that the amount of incinerated municipal waste has significantly increased in the last few years. The reason is the 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. One 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%. 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 the decrease in waste amount in 2009 when the plant was shut down

Emissions of all pollutants in the period 2002–2022 show high consistency and mainly depend on the amount of waste. In the summer of 2016, a 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/PCDF. 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 in 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 cleaners and residential heating. Moreover, the obligation to have a permit for waste incineration, which sets emission limits and operating conditions, including requirements for measurement and equipment to reduce emissions entered into force only after the legislation in 2002.

It is apparent from Figure VI.6 that the predominant type in the whole reporting period is industrial waste. The 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 hospitals had their 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 the same as in NFR 5C1. This fact is also reflected in the variable amount of emissions of all pollutants.

In the period 2002–2022, following the adoption of the new legislation, the slightly increasing trend in the amount of incinerated waste was stabilized. A relatively large decrease in 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

The methodology for particular reported categories is the same. According 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 2000–2022 and 1990–1999 was different and is therefore described for each period separately.

I.1.1.1 Methodology for the period 2000–2022

For 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 Regulation 415/2012 Coll., which sets specific emission limit values according 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/PCDF. 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 to reduce its emissions. Emissions of obligatory pollutants for concrete sources unavailable in some years, 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 their measurements (POPs), partly they were taken from the EMEP/EEA EIG, version 2023, 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.

Table 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	NE	NE	0.6923	3.03845	3.03845	0.10666	0.139	4.150757
5C1biii	NE	NE	0.6923	3.03845	3.03845	0.10666	0.04559	1.726015
5C1biv	NE	NE	0.6923	3.03845	3.03845	0.10666	0.139	4.150757

I.1.1.2 Methodology for the period 1990–1999

Fundamental for the inventorying was 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 II.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, the emission consistency of each pollutant for a 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 the 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 in 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 2000–2021.

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

Table 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

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

NFR	Pb	Cd	Hg	As	Cr	Cu	Ni	PCDD/PCDF
	[$mg \cdot t^{-1}$]							
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 the facilities in Czechia 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 working on the principle of the 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 III.1). All sources in NFR 5C1a are facilities for energetic utilisation of waste (see also Chapter VI.3), symbol "NO" was therefore used in the entire time series. In the case of other categories utilization of heat is not so clear, the 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 based on continuous or periodic measurements that comply with European legislation (IED and previous directives). The uncertainty of the sum of emissions from those sources is below 5%, see also Chapter I.5.4.

VI.3.3 Planned improvements

No improvements are planned, and 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 a 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 except for 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.

The share of cremations has increased rapidly in the monitored period, it has stabilized since 2005. Moreover, cremations of pets were started only in 2003. This increasing trend is illustrated also in Figure VI.7. A sharp increase in cremations in 2020 and 2021 was caused by high mortality due to the COVID-19 pandemic.

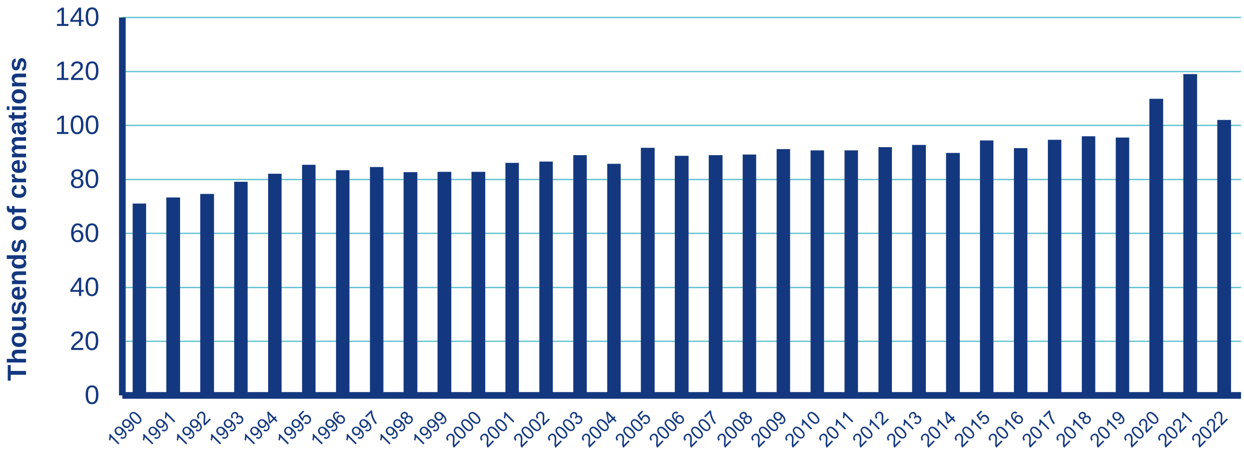

Figure VI.7 The cremation, 1990–2022

VI.4.1 Emission factors and calculations

Emission limits for cremation are set by Annex 8 to 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 intervals once every three calendar years. Because emissions in category REZZO 2 have been available since 1995, for additional calculation of earlier years there had been calculated emission factors for the above-specified pollutants which had been calculated additionally based on activity data. An overview of emission factors is presented in the following Table VI.6.

Table 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 by the 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/PCDF, 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 determined based on the study “Emission factors setting and imission contribution of a stationary source for 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 emission factors for various technologies, cremation is one of them. Emission factors were stated by a 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 to those stated in the EMEP/EEA EIG, version 2023 [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 the Study of the Institute of Sociology of the Czech Academy of Science (see e-ANNEX), and are presented below. 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.

Table 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, NMVOC and SO_X for stationary sources belonging to NFR 5C1bv are determined based on 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 to 200%, see also Chapter I.5

VI.4.3 Planned improvements

No improvements are planned, and 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. According 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 its disposal or place a ban on its burning.

According to § 19 of Regulation 415/2012 Coll. dry vegetable waste is not classified as waste but as biomass. On recommendation and for better comparability of total national inventories, emissions were calculated using the area of utilized land and EFs corresponding to Tier 1 of EIG.

However, we would like to point out that this procedure does not correspond to the real way of processing plant residues because open burning occurs only rarely (e.g. in orchards). According to Forests of the Czech Republic (owner of 86 % area of all state forests), the burning of forest residues is not allowed. They are used for wood chip production or sold for energy use (e. g. publication https://lesycr.cz/casopis-clanek/vyuziti-klestu-pro-vyrobu-energie/). Agricultural residues from arable land are principally ploughed in as fertilizer on site. Annual information on the real amount of incinerated material is not registered.

Czechia considers the current calculated emissions to be overestimated and proposes to use the symbol "NE", i.e. emissions of very little importance.

Activity data (types of utilised land) were obtained from the website of the CSO, Catalogue of Products (*https://www.czso.cz/csu/czso/ceska-republika-od-roku-1989-v-cislech-aktualizovano-2482023)* Table. 02.02 – Lands by species. The trend in types of utilised land in the period 1990–2022 is illustrated below in Figure VI.8. Here are shown all types of utilised land, for calculation of emissions only selected types were used (see Chapter VI.5.1).

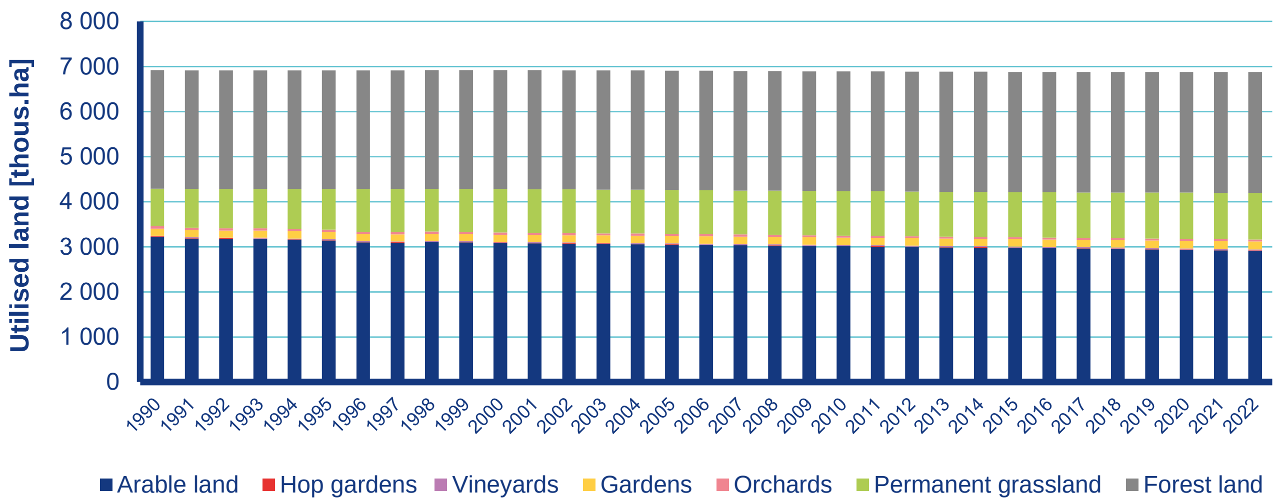

Figure VI.8 Utilised land, 1990–2022

VI.5.1 Emission factors and calculations

Emissions for 5C2 were calculated according to EMEP/EEA EIG, version 2023 [3], (Tier 1). Areas in forestry, orchard and arable farming (excluding agricultural residues after harvesting classified as NFR 3F) were taken into account, assuming that the amount of burned waste is 25 kg per hectare. A relevant table containing detailed activity data and calculations is given in e-ANNEX (file NFR-5C2).

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.5.

VI.5.3 Planned improvements

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

VI.6 Wastewater handling (NFR 5D1–5D3)

Wastewater treatment is the process of removing contaminants from wastewater, both municipal and industrial. Wastewater treatment plants are only an insignificant source of NMVOC. They are divided mainly by the type of purification process: mechanical, biochemical and chemical. Large plants generally combine more purification processes. Further cleaning takes place in so-called recipient, i. e. natural watercourse. Discharge of wastewater into recipients is governed by Act 254/2001 Coll. (Water Act) and by its implementing regulations.

For wastewater treatment plants (both domestic and industrial), only the technical condition of operation is set in Annex 8 to Regulation 415/2012 Coll., points 1.4. and 1.5. This technical condition is the same for both categories and reads as follows:

To reduce 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 wastewater. The trend in the amount of discharged wastewater is illustrated below.

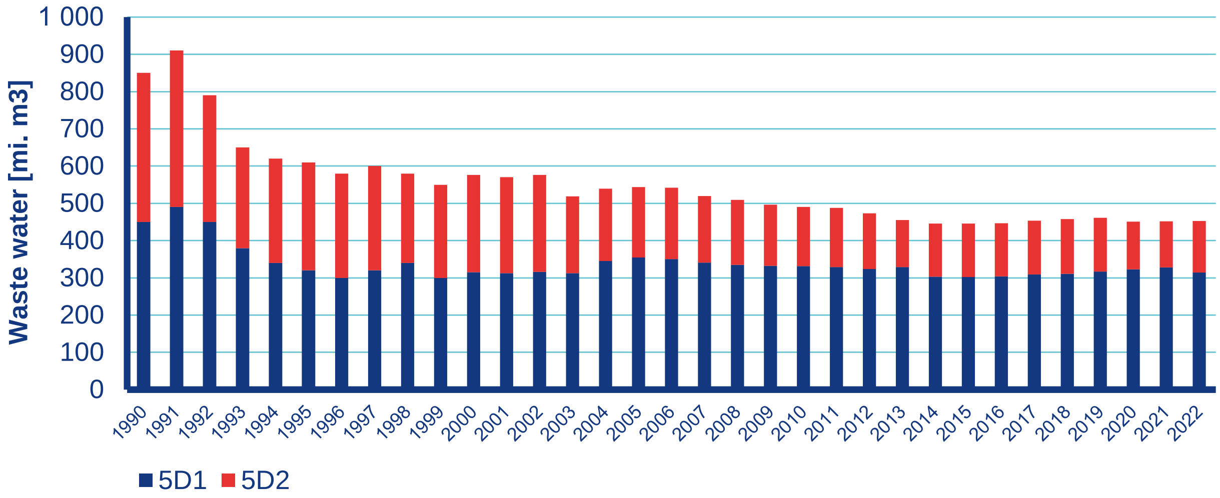

Figure VI.9 Wastewater handling, 1990–2022

NH_3 emissions from dry toilet use were included in the category 5D1 in the whole time series. The trend in the amount of population using dry toilets is shown in the figure below.

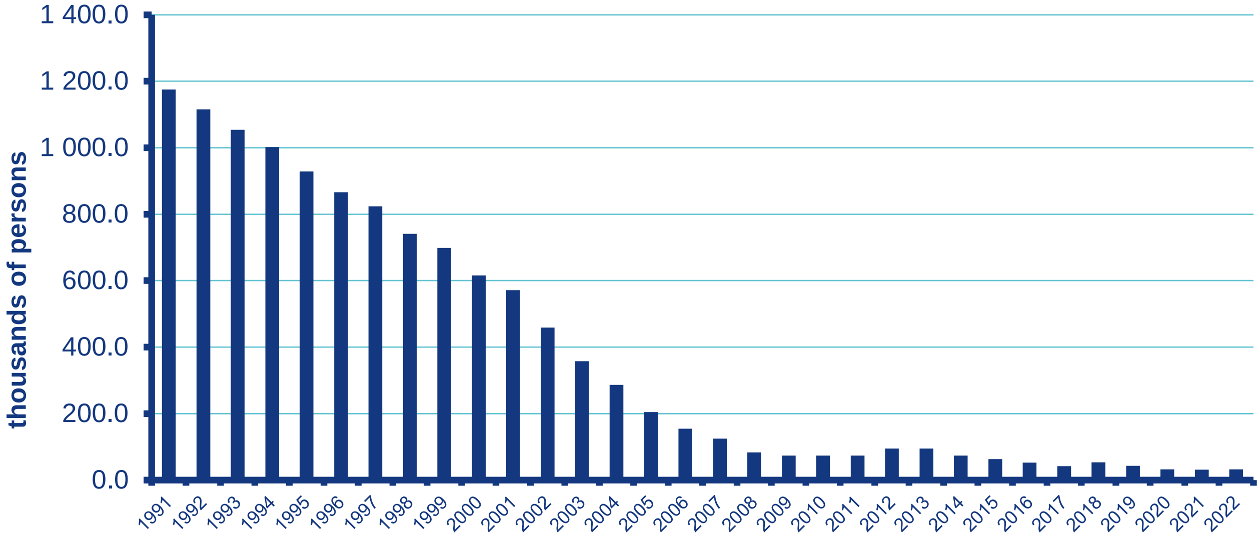

Figure VI.10 Dry toilettes, 1990–2022

VI.6.1 Emission factors and calculations

In the Summary operation records are reported emissions of 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 for NMVOC emissions, i.e. the amount of wastewater discharged into the sewerage system, were obtained from the public database of CZSO. Data are available in the division mentioned above since 2003, only the total amount in the years 2000–2002 is known. Activity data for the historical period 1990–1999 were estimated based on a document of CZSO (Wastewater discharged into public sewers), see e-ANNEX. Data 2000–2002 were specified using the average ratio between subcategories 5D2 and the total amount of discharged wastewater in 1990–1999.

Activity data for NH_3 emissions (percentage of the population using dry toilets) were obtained from CZSO statistics (https://www.czso.cz/csu/stoletistatistiky/splachovaci-zachod-neni-samozrejmosti-ani-v-eu) and related links (EUROSTAT, Population census 2011).

Emission factors for NMVOC and NH_3 were adopted from EMEP/EEA EIG, version 2023 (Tier 1) [3]. Activity data for sector 5D3 are not available.

A relevant table containing detailed activity data and calculations is given in e-ANNEX (file NFR-5D).

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.5.

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 the technical condition of operation is set in Annex 8 to 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 reduction of 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 the 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.

By EMEP/EEA EIG, accidental fires of cars and buildings are included in this category [3]. Emissions of particulates, some heavy metals and PCDD/PCDF are predominantly emitted.

Activity data (number of fires) were obtained from the Statistical Yearbooks of the Fire Rescue Service of Czechia (FRS CR). They have been available since 1991 and are accessible to the public at http://www.hzscr.cz/clanek/statisticke-rocenky-hasicskeho-zachranneho-sboru-cr.aspx. Data since 2004 are available also in English at http://www.hzscr.cz/hasicien/article/statistical-yearbooks.aspx. Activity data for the remaining year 1990 were supplemented according to 1991.

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

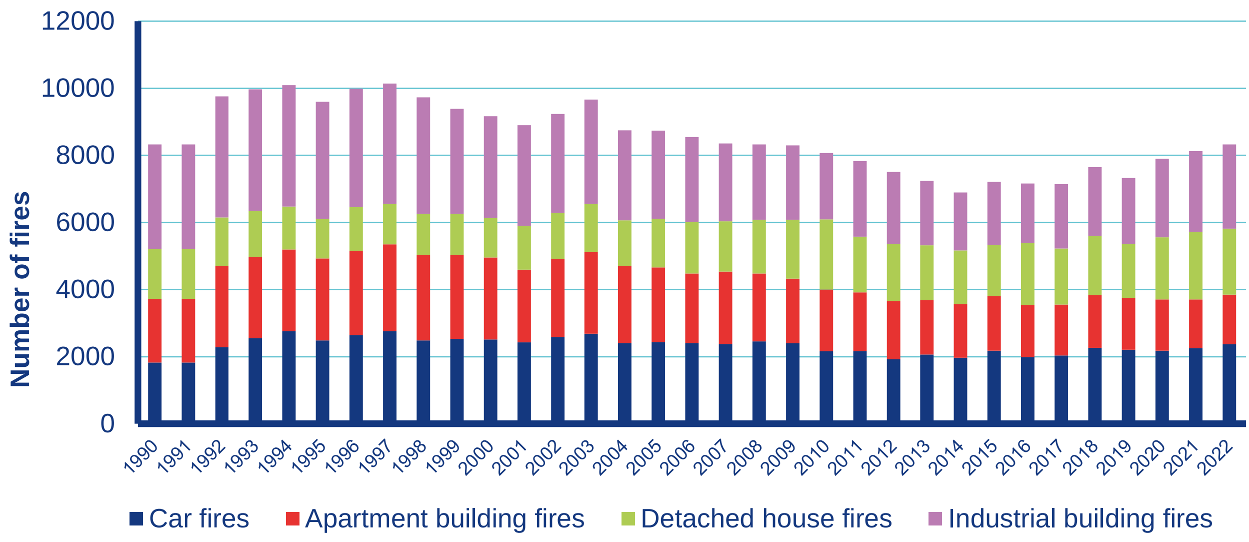

Figure VI.11 Fires, 1991–2022

Accidental fires of cars 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 the category biodegradation and solidification facilities and sanitation facilities, only a small amount of emissions of 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 the base of the type of technology.

For emission inventorying emission factors from EMEP/EEA EIG, version 2023, in division into EFs for fires of cars, apartment buildings, detached houses and industrial buildings were used (Tier 2) [3]. An overview of used emission factors is presented below.

Table 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/PCDF	mg/fire	0.048	0.44	1.44	0.27

A relevant table containing detailed activity data and calculations is given in e-ANNEX (file NFR-5E_car and building fires).

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 building fires are calculated based on official statistics and default emission factors, uncertainty is therefore estimated from 50 up to 200%, see also Chapter I.5.4

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: 15/03/2024

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 lesser 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 the Statistical Yearbooks of Fire Rescue Service of Czechia (FRS CR). They have been available since 1996 and are accessible to the public at https://www.hzscr.cz/hasicien/article/statistical-yearbooks.aspx. Figure VII.1 illustrates the development of forest areas affected by fire in 1996–2022.

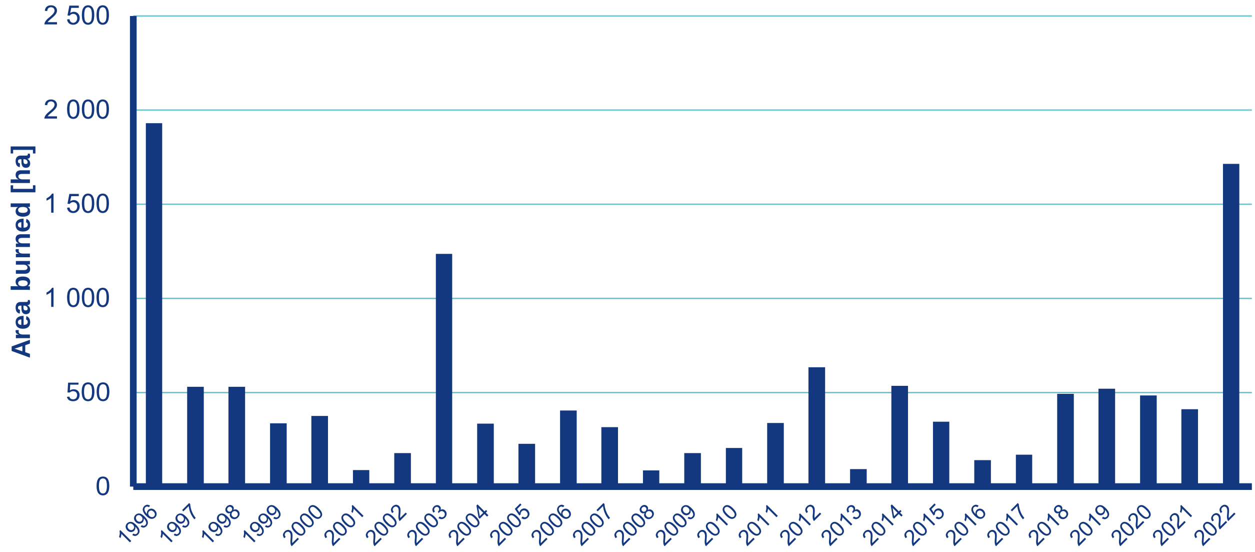

Figure VII.1 Forest fires, 1996–2022

The size of forest areas affected by fire depends mainly on atmospheric conditions (drought, hot weather, precipitation, direction and speed of the wind, etc.). Forest fires can be caused either by natural origin (lightning strikes, self-ignition) or by negligence (smoking, setting fire in the wild). The great increase in burned area in 2022 is caused by forest fire in Bohemian Switzerland National Park in the period 23. 7.–12. 8. 2022.

VII.1.1 Emission factors and calculations

For emission inventorying emission factors from the EMEP/EEA EIG, version 2023, were used (Tier 2) [3]. In the case of Czechia, EFs for temperate forests were chosen.

For the period 1996–2022, 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 $g \cdot kg^{-1}$ 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.5.4.

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: 15/03/2024

VIII.1 General recalculations in 2024

The full set of data for the period 1990–2022 in NFR format 2020 is reported in 2024. Several other corrections of reported data were performed, see Table VIII.1.

Table VIII.1General recalculations in 2024

Period	NFR	Emissions	Detail
1990-2021	1B2aiv	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF	New EF from Guidebook 2023
1990-2021	3Da1	NH_3,	New EF from Guidebook 2023
1990-2021	3Da4	NH_3,	Added emissions from Crop residues applied to soils (see Chapter V)
1990-2021	2A5b	PM, TSP	Added emissions from highway construction
2020-2021	2D3a; 2D3i	NMVOC	Transfer of part of the emission from NFR 2D3i to 2D3a
1990-2021	2H2	NMVOC, PM, PAHs	Recalculation
1990-2014	1A2e	NH_3	Added emissions from biomass burning
2019-2021	1A5a	all emissions	Correction of the calculation (error in the consumption of ZP used for the additional calculation of emissions)
2003	1Acii	HMs, POPs	Correction of erroneously inserted emissions
1990-2021	3B4giv	NH_3	Correction of the calculation (error in units of Nex values for poultry)
1990-2021	3De	NMVOC	Correction in activity data
2001-2021	3Da2c	NH_3	Correction of activity data regarding the amount of N applied in plant share of digestate
2009-2021	3Da3	NH_3	Correction of activity data caused by changes in activity data in other NFR categories
2020-2021	3B, 3D	NO_X, NMVOC, NH_3	Correction of activity data caused by changes in activity data in other NFR categories

Several minor corrections caused by EMRT – detailed in e-ANNEX.

VIII.2 Recalculations and Improvements in 1A4bi Residential: Stationary

In August 2023, an extraordinary resubmission of the reporting from March 2023 was inserted into the CDR, which contained a complete recalculation of the emissions of sector 1A4bi – Residential: Stationary. Detailed information on the conversion is given in Chapter III.2. For reporting 2024, the emissions from natural gas combustion were recalculated for the 2015–2021 emissions using the new ratio distribution of condensing and conventional boilers.

VIII.3 Recalculations and improvements in 1A3 Transport

Aviation (NFR 1A3a)

EUROCONTROL provided updated data for the years 2015–2022. Time series 1990–2014 were updated based on the interpolation of these latest data. Emissions were recalculated with the updated IEFs in the entire time series 1990–2022.

Update of jet kerosene consumption for international aviation in the year 2021 based on the latest IEA data.

Road Transport (NFR 1A3b)

The new version of the COPERT programme (update from version 5.5.1 to 5.7.2) was used to calculate emissions from road transport. Due to this update, the entire time series 1990–2022 were recalculated. The following changes were made in the new version:

- Revision of degradation methodology
- Revision and update of non-exhaust emission factors
- Updated emission factors of CO, NO_X, and VOC for Euro 6 LPG passenger cars
- Updated cold parameters of CO, NO_X, and VOC for Euro 6 PCs and LDVs
- Introduction of cold emissions of CO, NO_X and VOC for Euro V and VI diesel HDVs and buses
- Updated emission factors of Euro 6 CNG passenger cars
- Updated emission factors of Euro VI diesel buses
- Updated emission factors of Euro VI diesel hybrid buses
- New vehicle category and emission factors added
    - Battery electric passenger cars
- Corrected calculation for cold emissions of CO, NO_X, and VOC for petrol and diesel PCs and LDVs
- Corrected cold start ratio of diesel Euro 6 cars for NO_X & CO
- Corrected cold start ratio of petrol-fuelled cars and vans for VOC & CO
- Corrected PM hot emission factors of HDVs and buses
- Corrected PM hot emission factors of PHEV petrol passenger cars
- Corrected calculation for cold PM emissions of Euro 6 PCs and LDVs
- Corrected hot emission factors for LDVs N1-I
- Corrected ratios of TSP of brake and tyre non-exhaust heavy metal emissions
- Corrected cold EC emissions for small petrol hybrid PCs
- Trip length and duration per vehicle category

Activity data for the last four years were updated and the years 2018–2021 were recalculated which is given by the methodology of obtaining traffic performance data (for more details, please see Chapter III.3.1). Due to this fact, the data for 2019–2022 are preliminary.

Recalculation of emissions in time series 2016–2022 due to an update of biodiesel consumption based on the latest IEA data.

Update of petrol net calorific value in 2021 based on the latest IEA data.

Railways (1A3c)

Separation of non-bio and biodiesel consumption. Activity data were recalculated in time series 2016–2022.

Update of diesel net calorific values in years 2016–2022 based on the latest IEA data – separation of non-bio and biodiesel.

Update of specific consumption of traction diesel in years 2020 and 2021 for personal line-haul locomotives and rail cars based on the latest data from Czech railway operator České dráhy.

VIII.4 Agriculture

Compared with the previous NH_3, NO_X and NMVOC emissions inventory (submission 2023), some changes and updates have been made, see Table VIII.2. These changes cause an increase in the total NH_3 emissions for the years 1990-2021. Both NO_X and NMVOC emissions remained at the same values as in the 2023 submission.

Table VIII.2 The comparison of submissions 2023 and 2024 for NH_3, NO_X and NMVOC

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	125.8	82	77.2	71.3	63.8	75.3	64.0	63.6
2024 submission	142.8	91.4	85.5	79.8	70.3	85.9	76.9	76.5
Difference [%]	+13.5	+11.5	+10.8	+11.9	+10.2	+14.1	+20.2	+12.9
NO_X emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	26.0	15.9	15.5	17.4	16.5	22.1	19.2	18.4
2024 submission	26.0	15.9	15.5	17.4	16.5	21.9	18.9	18.6
Difference [%]	0	0	0	0	0	-0.2	-0.3	+0.2
NMVOC emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	67.7	42.8	38.0	35.7	33.8	36.5	38.0	37.5
2024 submission	67.7	42.8	38.1	35.7	33.8	36.5	38	37.6
Difference [%]	0	0	0	0	0	0	0	+0.3

VIII.4.1 NH_3 and NO_x emissions

A range of changes has been made for NH_3 and NO_x emissions. Ammonia emissions have increased in range from 10 to 17% for years 1990 – 2021 compared to submission 2023. The main reason for this increase was the recalculation of ammonia emissions from the application of mineral fertilizers and the new inclusion of ammonia emissions from crop residues left on soil residues in the national emission inventory. NMVOC emissions remained at the same values as in the 2023 submission.

3B Manure management

Emissions of NH_3 and NO_x from manure management have been recalculated due to unification and harmonisation of input data used for GHG, NH_3, NO_x inventories and the Gross nitrogen balance for the Czech Republic. To this end, a significant revision of the AWMS values and a revision of the Nex values were carried out in 2023. The details are given in the IIR from 2023. Based on the review procedure within TERT and our control processes, minor errors in the calculations of ammonia were detected. However, the correction of these errors had a negligible effect on the calculations of total national emissions of ammonia.

During the preparation of the emission inventory, errors were detected in the NFR categories related to other poultry. By comparing the national Nex values for poultry with default values from Tab. 10.19 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, confusion in the units used was found. A confusion of values was found between the values expressed in kg N (1000 kg of animal mass)$^{-1}$·day^{-1} and the values expressed in kg N piece^{-1}·year^{-1}.

Table VIII.3 shows the effects of recalculations on NH_3 between submission 2023 and 2024 after correction of the above-mentioned errors in category 3B4giv – Manure management – Other poultry.

Table VIII.3 Comparison of NH_3 emissions from manure management 3B4giv of the submissions 2023 and 2024

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	0.003	0.003	0.003	0.002	0.002	0.003	0.003	0.002
2024 submission	0.145	0.128	0.105	0.056	0.047	0.066	0.068	0.052
Difference [%]	+4733.3	+4166.7	+3400	+2700	+2250	+2100	+2166.7	+2500

NH_3 emissions in the years 1990-2021 increased in the range of 2.3-4.0 times compared to the submission in 2022. However, this is not a key emission category, so this change was not significantly reflected in the total ammonia emissions.

3Da1 Inorganic N-fertilisers

In 2023, the EMEP/EEA air pollutant emission inventory guidebook, chapter 3.D Crop production and agricultural soils was updated. This update brought about a change in emission factors for individual types of mineral fertilizers listed in the tab. 3.2. used to calculate ammonia emissions from the application of mineral fertilizers. Based on the change in emission factors, ammonia emissions were recalculated for the NFR 3Da1 category in the entire time series. This change in emission factors led to a very significant change in reported emissions with a negative impact on the fulfilment of the strategic goals of the Czech Republic in the area of reducing emissions and the fulfilment of the emission ceilings set out in Directive No. 2016/2284 on the reduction of national emissions of certain atmospheric pollutants.

Table VIII.4 shows the effects of recalculations on NH_3 between submission 2023 and 2024.

Table VIII.4 Comparison of NH_3 emissions from mineral N fertilisers of the submissions 2023 and 2024

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	22.12	14.11	15.26	20.00	18.46	31.41	19.87	19.22
2024 submission	18.12	15.91	17.83	23.54	21.85	38.47	27.33	27.14
Difference [%]	-18.1	+12.8	+16.8	+17.7	+18.4	+22.5	+37.5	+41.2

The change in emission factors after the update of the EMEP manual led to an increase in reported ammonia emissions between 1990 and 2021 by 27–41%, even though the consumption of mineral nitrogen fertilizers in the Czech Republic is constantly decreasing.

3Da2a Animal manure applied to soils

The change in activity data during the recalculation of ammonia emissions from NFR category 3B4giv is directly linked to the calculation of ammonia emissions from NFR category 3Da2a. For this reason, a recalculation of ammonia emissions in the entire time series 1990-2021 was also carried out for category 3Da2a.

Table VIII.5 Comparison of NH_3 emissions from animal manure applied to soils of the submissions 2023 and 2024

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	31.72	20.37	18.25	14.47	13.01	13.78	13.44	13.53
2024 submission	31.72	20.37	18.25	14.47	13.02	13.74	13.46	13.49
Difference [%]	0	0	0	0	+0.1	-0.3	+0.1	-0.3

The change in ammonia emission values is negligible after recalculation.

3Da2b Sewage sludge applied to soils

No recalculations

3Da2c Other organic fertilisers applied to soils

In the submission of data from 2023, ammonia and NO_X emissions from the application of digestate, respectively its plant share, were included in the inventory for the first time. The share of digestate originating from manure has already been included in the inventory in category 3Da2a.

The use of manure in anaerobic digesters is relevant for cattle, swine and poultry manure. The operation of anaerobic digesters began in 2001 when 2 biogas stations started to work. 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 the need to store the manure. The number and capacity of anaerobic digesters remained at their maximum number from 2013. The animal waste management system (AWMS) has been updated every year based on a long-term statistical survey of agricultural farms in the Czech Republic. Based on these data, nitrogen production in farmyard manure (Nex rate) was divided according to the percentage of individual housing systems for each category of livestock, where part of this nitrogen enters the biogas production process. Energy crops are also used as an input material in the production of biogas. In 2023, a revision of the amount of input materials for biogas production and subsequently the number of materials (digestate) coming out of the biogas production process was carried out. Ammonia and NO_X emissions produced from the application of digestate to soils are divided into an animal part, calculated and included in the inventory in category 3Da2a, and a plant part, calculated and included in the NFR 3Da2c category.

In 2023, based on the revision of AWMS values, the amount of produced digestate from agricultural biogas digesters was refined in the time series from 2001-2021. This refinement also affected the amount of N applied to the soil from the plant part of the digestate, which is active data for calculating ammonia and NO_X emissions.

Table VIII.6 shows the effects of recalculations on NH_3 and NO_X between submissions in 2023 and 2024.

Table VIII.6 Comparison of NH_3 and NO_X between submissions in 2023 and 2024.

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	0.01	0.01	0.01	0.03	0.05	0.56	1.51	1.54
2024 submission	0.01	0.01	0.01	0.04	0.10	0.50	1.04	1.00
Difference [%]	0	0	0	+33.3	+100	-10.7	-31.1	-35.1
NOx emissions [kt]	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**
2023 submission	0.006	0.006	0.006	0.018	0.024	0.278	0.754	0.769
2024 submission	0.006	0.006	0.006	0.020	0.048	0.252	0.519	0.501
Difference [%]	0	0	0	+11.1	+100	-9.4	-31.2	-34.9

The increase in ammonia and NO_X emissions by 100% for the year 2005 reported in the submission in 2024 compared to the submission in 2023 was caused by a more detailed accounting of the produced amount of digestate since 2001 when the number of operating biogas stations in the Czech Republic was increasing.

3Da3 Urine and dung deposited by grazing animal

Changes in the calculation of NFR 3B and 3Da2a have effects also on the calculation of NFR 3Da3. Table VIII.7 shows the effects of recalculations on NH_3 between submission 2023 and 2024.

Table VIII.7 Comparison of NH_3 emissions from animal manure applied to soils of the submissions 2023 and 2024

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	2.24	1.96	1.75	1.69	2.09	1.98	2.05	2.03
2024 submission	2.24	1.96	1.75	1.69	2.1	1.87	2.07	2.03
Difference [%]	0	0	0	0	+0.5	-5.6	+1	0

The change in ammonia emission values is negligible after recalculation

3Da4 Crop residues left to soil

Ammonia emissions originating from crop residues left on the field were calculated for the first time in 2024.

VIII.4.2 NMVOC emissions

3B Manure management

No recalculations

Although NMVOC emissions from manure management are directly dependent on category 3B ammonia emissions calculations, recalculation has not been performed. The reason was the fact that the recalculations in category 3B related to categories that do not have a significant impact on the production of NMVOC.

3Da2a Animal manure applied to soil

No recalculations

3Da3 Urine and dung deposited by grazing animals

No recalculations

3De Cultivated crops

This agricultural land was supplemented in the 2023 submission, however minor deficiencies were detected. The reason for the recalculation was the inclusion of the remaining cultivated agricultural areas, which were not included in the previous calculations. These were insignificant areas of crops whose NMVOC emissions are calculated according to TIER 1. Furthermore, the areas that are calculated using TIER 2 were refined. In 2023, the entire time series was recalculated.

Table VIII.8 Comparison of NMVOC emissions from cultivated crops of the submissions 2023 and 2024

NH_3 emissions [kt]	1990	1995	2000	2005	2010	2015	2020	2021
2023 submission	1.53	1.57	1.65	1.63	1.66	1.86	1.88	1.79
2024 submission	1.55	1.62	1.72	1.67	1.68	1.86	1.87	1.78
Difference [%]	+1.3	+3.2	+4.2	+2.5	+1.2	0	-0.5	-0.6

The NMVOC emissions increased by 0.2-3.9% in the years 1990-2021 compared to submission 2023.

IX. Projections

The date of the last edit of the chapter: 20/01/2024

The year 2020 was used as the Base year for the emission projections processed in 2023. However, for most categories, the same methodologies were used for the projection announced in 2021. The new laws and the current political and economic situation seriously changed the dates predicted for 2025, 2030, 2040 and 2050. Obligations that apply from 2020 are included in projections.

The projection report provides updated emissions of NO_X, SO_X, NMVOC, NH_3 and $PM_{2.5}$. In sectors of Energy (NFR 1A1 and 1A2), Transport (NFR 1A3), Combustion sources (NFR 1A4) and Other combustion sources (NFR 1A5). Following Fugitive emissions from fuels (NFR 1B), Agriculture (NFR 3) and Waste (NFR 5). Projections were based on principles and calculations described in the EMEP/EEA air pollutant emission inventory guidebook, 2019 (EMEP/EEA EIG) [3]. The projections are usually modelled by two scenarios WM (with existing measures) and WAM (with additional measures). However, projections in 2025, 2030, 2040 and 2050 are processed just in the WM scenario because the Czech Republic should fill the Emission Ceilings each year. The WAM scenario is not required. The projections were compiled in the appropriate Annex IV used in past years. The new format will only be applied from 2025.

The Czech Republic must fulfil NEC Directive 2016/2284/EU commitment to the Reduction of emissions of air pollutants. This directive on national emission ceilings sets stricter national limits from 2020 to 2029 and from 2030 onwards. The national emission limits set for each pollutant from 2020 to 2029 are identical to the limits to which Member States have already committed themselves under the revised Gothenburg Protocol (2012 revision of the Gothenburg Protocol [2]). The commitments are available in tables A and B, Annex II [2]. The total commitments of the Czech Republic are shown in Table IX.1.

The conditions defined in NEC Directive 2016/2284/EU Article 4 to limit annual anthropogenic emissions were used to compile national emissions ceilings. Ceilings of primary pollutants were compiled without NO_X and NMVOC emissions in NFR 3B and 3D, as described in paragraph; 3.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].

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

		NO_X (NO_2)	NMVOC	SO_X (SO_2)	NH_3	$PM_{2.5}$
Emission [kt]	2005	282.6	342.8	208.5	74.4	73.6
	2020	135.2	262.7	66.6	67.1	59.8
Projection [kt]	2030	84.5	150.8	36.2	58.0	26.3
Percentage reduction from 2005 to 2030 [%]	2020	35	18	45	7	17
	2030	64	50	66	22	60
Emission reduction from 2005 to 2030 [kt]	2020	98.9	61.7	93.8	5.2	12.5
	2030	180.9	171.4	137.6	16.4	44.2
Ceiling [kt]	2020	183.7	281.1	114.7	69.2	61.1
	2030	101.7	171.4	70.9	58.1	29.4

IX.1 Methodology Introduction

Emission categories were divided into five groups. The emissions from each category were calculated separately. Different organisations participated in the report preparation. Each described sector was prepared separately and used methods available in the following chapters. Final emissions projections were taken from organisation authors and compiled into the Annex IV template. The formation of total emissions, according to the WM projection, is shown in Table IX.2.

Table IX.2 Sectors and participants of Czech projections

Sector	Organisation prepared projection	The organisation provided input data
Energy	CUEC, CHMI	CHMI, MIT, CZSO, MZP
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

IX.2 Summary of projection in the context of commitments

Ceilings 2020

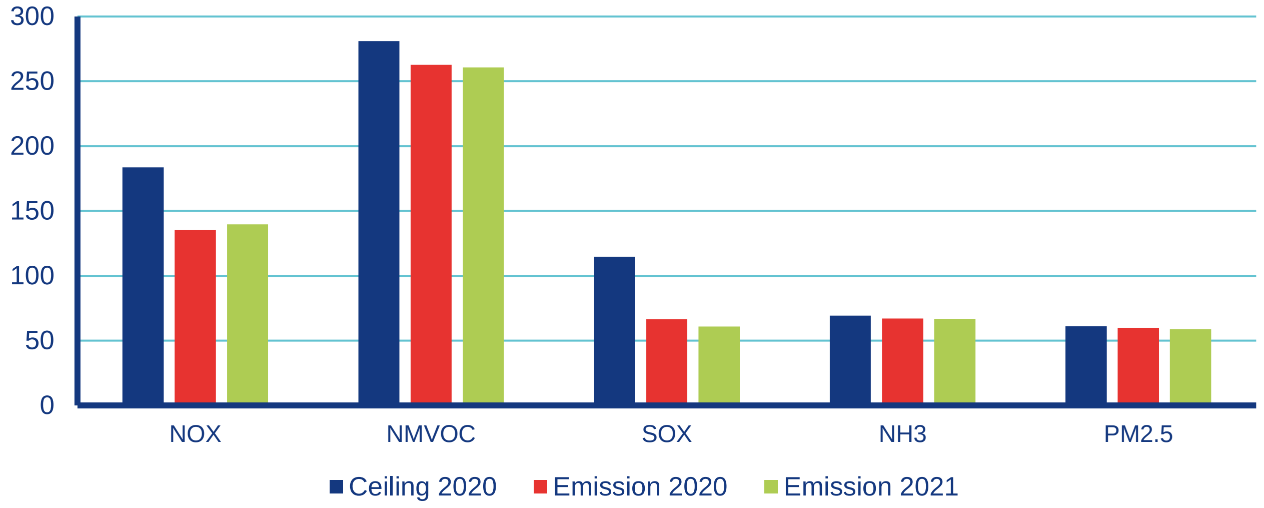

Figure IX.1 Czech Commitments 2020

In 2020 and 2021, emission ceiling limits were achieved for all Emissions pollutants.

Ceilings 2030

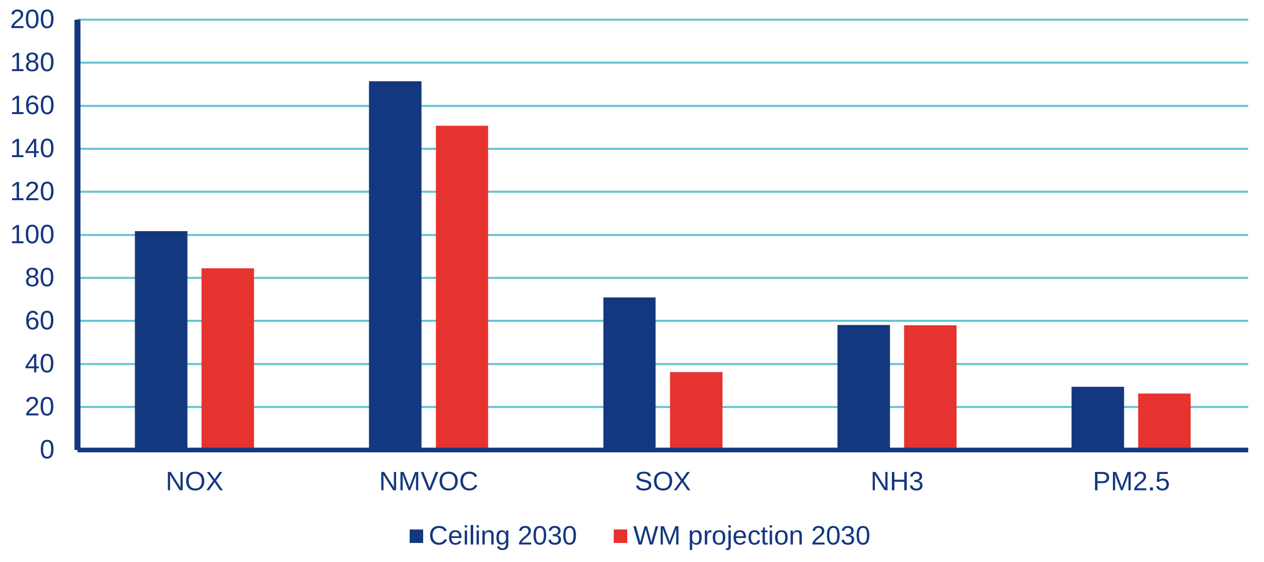

Figure IX.2 Czech Commitments 2030

In 2030, Czechia will achieve the emission ceilings for all pollutants under the WM scenario.

Ceilings 2050

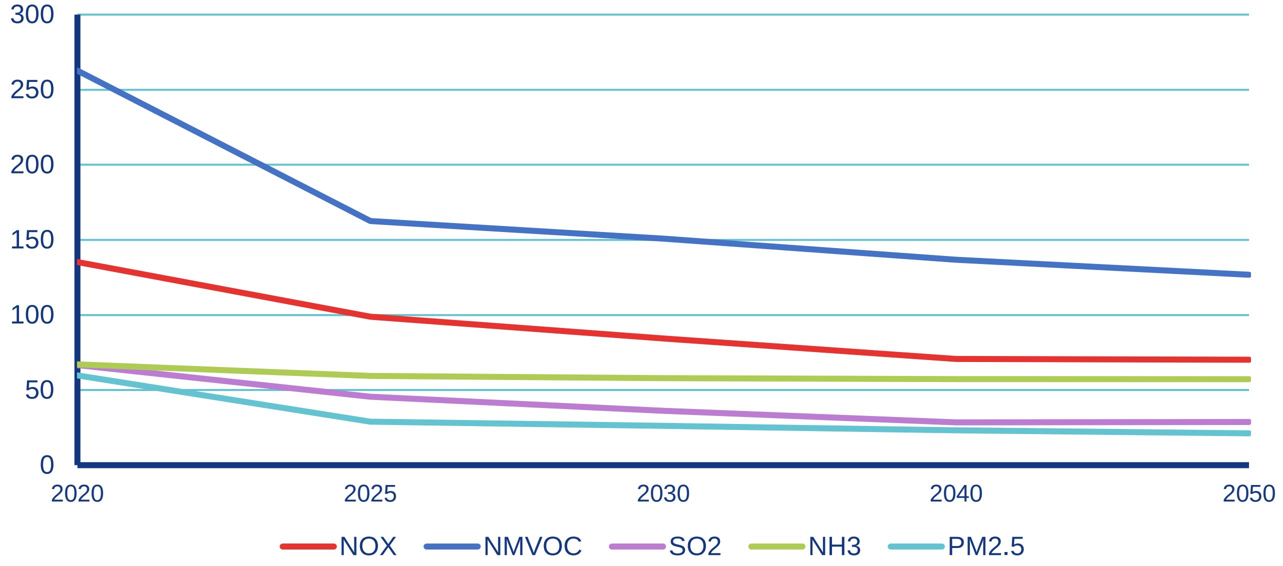

Figure IX.3 Czech Emissions by WM Scenario

In 2050, Czechia will achieve the emission ceilings for all pollutants under the WM scenario.

Because the projected values of emissions slightly decrease or stagnate. However, additional policies and precautionsis needed.

IX.2.1 Share of Emissions in 2030

The WM scenario shows the distribution of emissions in NFR categories recorded in 2020, and data in 2030 by WM projection. The data are from Annex IV.

NO_X (as NO_2)

The total emission of NO_X (as NO_2) will decrease from 135.2 kt in 2020 to 84.46 kt in 2030.

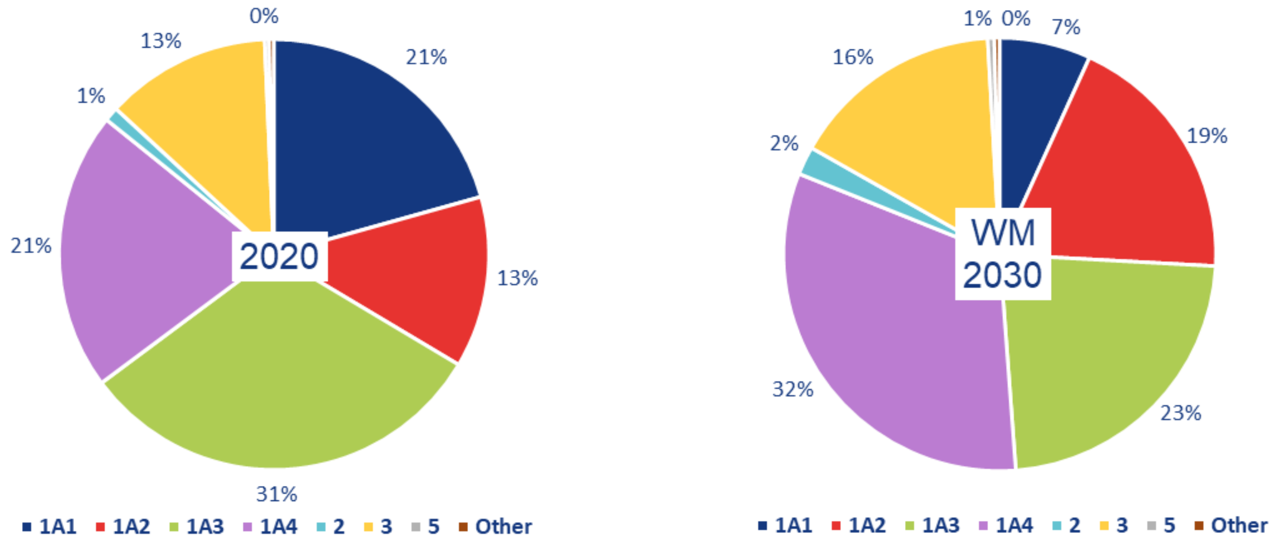

Figure IX.4 NO_X share

NMVOC

The total emission of NMVOC will decrease from 262.7 kt in 2020 to 150.76 kt in 2030.

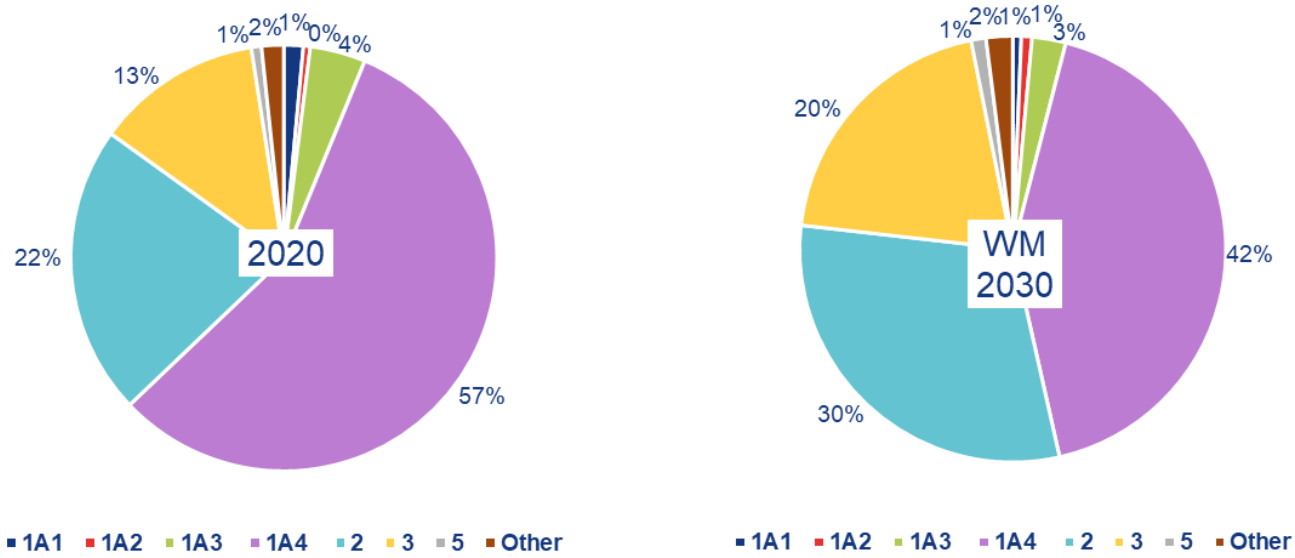

Figure IX.5 NMVOC share

SO_X (as SO_2)

The total emission of SO_X (as SO_2) will decrease from 66.6 kt in 2020 to 36.2 kt in 2030.

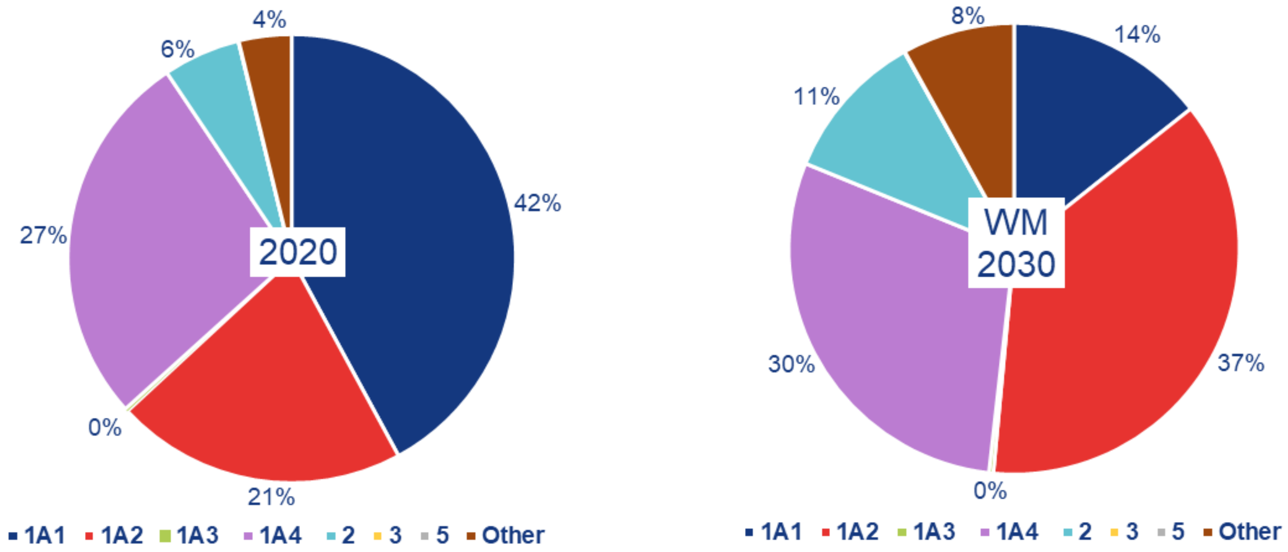

Figure IX.6 SO_X share

NH_3

The total emission of NH_3 will decrease from 67.1 kt in 2020 to 58 kt in 2030.

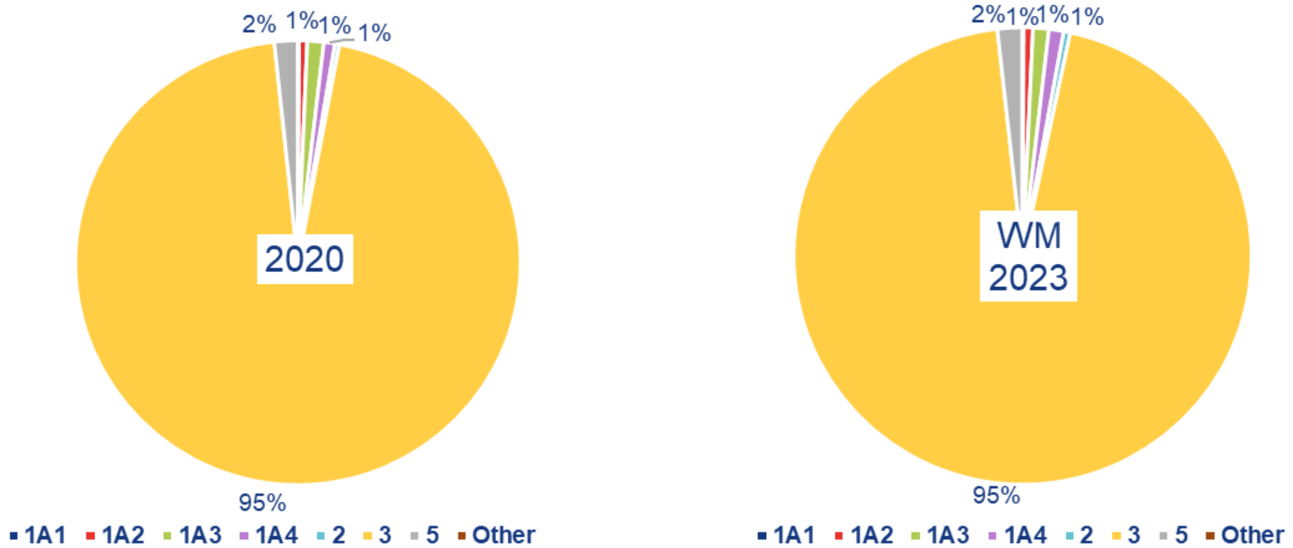

Figure IX.7 NH_3 share

$PM_{2.5}$

The total emission of $PM_{2.5}$ will decrease from 59.78 kt in 2020 to 26.3 kt in 2030.

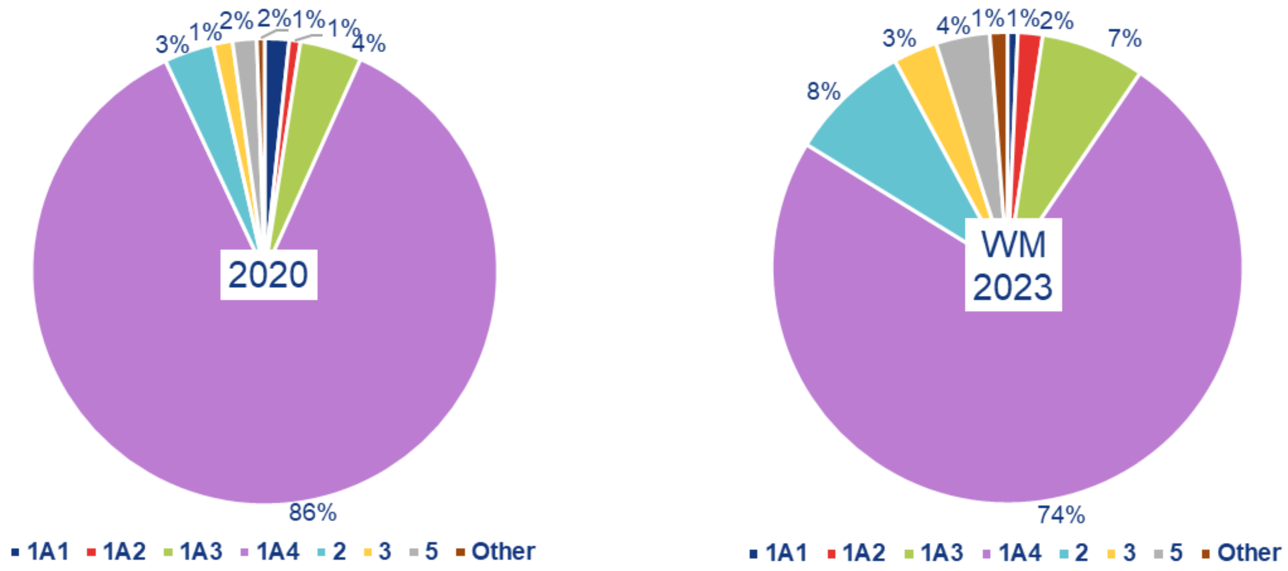

Figure IX.8 $PM_{2.5}$ share

IX.3 Projections by individual sectors

IX.3.1 Energy – NFR 1A1, 1A2

Input data were provided under Act No. 201/2012 Coll. Air Protection, combustion sources are divided into 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 the Act No. 201/2012 Coll. Air Protection.
- Combustion sources not underlying Annex 2 to the Act on Households and other sources (natural gas combustion only).

The primary 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
- Household fuel consumption data contained in IEA (International Energy Agency questionnaires)
- Data on natural gas consumption is calculated as the difference between the total consumption of natural gas and the partial consumption of listed sources and households.

The detailed description is explained in IIR Chapter III.1 (Large combustion plants) [23]. Projections of 1A1 are based on the TIMES-CZ model.

Projections of 1A2 were based on the energy balance forecast the Department of Strategy and International Cooperation in Energy of MIT (Ministry of Industry and Trade) provided.

Energy - NFR 1A1

The projections preparation in the 1. Energy sector in the current submission reflects a transition to complete preparation of projection by TIMES-CZ model [37][38].

TIMES-CZ is a technology-rich, bottom-up, cost-optimizing integrated assessment model built within the generic and flexible TIMES (The Integrated MARKAL-EFOM System) model generator's General Algebraic Modelling System (GAMS) code. TIMES has been developed and maintained within the Energy Technology System Analyses Program (ETSAP) by the International Energy Agency (IEA) [33]. TIMES searches for an optimal solution for an overall energy mix that will satisfy exogenously given energy service demand with the least total discounted costs in a given timeframe with a perfect foresight principle [34].

TIMES-CZ is based on the Czech region of the Pan-European TIMES PanEu model developed by the Institute of Energy Economics and Rational Energy Use at the University of Stuttgart [29]. Also it is regionalized into 14 regions of Czechia, its base year is updated to 2019 and the model structure is modified by individual data of EU ETS facilities. The year 2019 was selected as the base year of the model to avoid bias by the pandemic year 2020. The modelling horizon spans from 2019 to 2050, split into two 2 and six 5 year-time steps. A year is divided into 12 time slices, 4-seasonal and 3-day levels (day, peak and night). GHG emissions (CO_2, CH_4 and NO_2) and other pollutants (SO_2, NO_X, NMVOC and PM) are included in the model.

Assumption of WM scenario

The final energy service demand is based on the National Energy Climate Plan (NECP) [35]. Nuclear power development is an exogenous assumption according to NECP: Temelín nuclear power plant remains in operation for the whole period (2020–2050), and the operation of the current 4 units of the Dukovany nuclear power plant will be decommissioned gradually in the period 2040–2042. New nuclear units will be introduced after 2036 with a temporary overlap with the Dukovany nuclear power plant.

The electricity export balance is assumed according to NECP (Table 2-9). The maximum renewable energy source (RES) potential for electricity generation corresponds to the Progressive Scenario of the Resource Adequacy Assessment of the Electrical Grid of the Czech Republic until 2040 (MAF CZ) [30].

Assumptions of fuel prices are taken from Recommended parameters for reporting on GHG projections in 2023 [31].

The stock of residential boilers and appliances is based on ENERGO 2015 (the most recent one was published too late to be included in the model).

The heating plant and the ICGT plant Sokolovská uhelná - Vřesová are included in category 1A1c only until 2020. Then coal gasification ends and both sources move to the 1A1a category and the ICGT source consumes natural gas instead of gas. All new electricity generating (or CHP) sources are reclassified from sector 1A4a to sector 1A1a.

The reflection of the current energy crisis and war is limited to the updated price assumptions based on Recommended parameters for reporting on GHG projections in 2023 [31]. No restriction on natural gas use is assumed. The model has time steps in 2020 and then 2025. As a result, the model does not reflect the current extremely high prices of energies and the current induced boost in energy efficiency is not reflected in the current submission.

Table IX.3 Assumed net electricity export (TWh)

	2019	2020	2025	2030	2035	2040	2045	2050
TWh	17.6807	10.1528	7.7535	6.3591	4.7675	1.2330	1.1373	0.3608

Emission allowance prices are taken from the WEM scenario from Recommended parameters for reporting on GHG projections in 2023 [13]. The electricity consumption in road transport is in line with the medium scenario of the National Clean Mobility Action Plan [36].

Table IX.4 Applied EUA prices

	2020	2025	2030	2035	2040	2045	2050
EUR $_{2020}$	24	80	80	82	85	130	160

Scenario results – activity data

The results of the modelling reflect the given assumptions. As a result of decreasing electricity net export and the high price of EUA, the input of hard coal and lignite for heat and power generation decreases sharply. Renewable energy sources and natural gas are the main substitutes for hard coal and lignite in heat and power generation. Consumption of lignite decreases slower in sector 1A2 (autoproducers) than in sector 1A1a.

In 1A1a Public electricity and heat production, the total energy input decreases until 2030 because of lower electricity export. Then the total energy input increases again up to 704 PJ in 2050. The most significant changes occur in lignite, hard coal, natural gas, solar and wind. Lignite and hard coal continue to decrease up to zero in 2050 – lignite approximately by 110 PJ within 5 years in the first two periods until 2030 (decrease between 2019 and 2020 was 59 PJ). The decrease in hard coal and lignite is substituted partly by an increase in the use of natural gas (up to 139 PJ in 2050) and renewable energy sources (mainly solar and wind). The decrease in consumption of lignite in 1A1a Public electricity and heat production is faster than in auto producers.

Table IX.5 Fuel input for heat and power generation in 1A1a – WM scenario

PJ	2020	2025	2030	2035	2040	2045	2050
Hardcoal	33.3	18.8	7.1	2.1	1.9	0.2	0
Lignite	299	190.6	81.3	23.9	17.5	6	0
Natural	62.6	30.4	51.4	68.9	68.7	82.7	139.1
Other	5.4	8	3.7	2.7	0.3	0.3	0.3
Biogas	2.5	1.3	0.2	0.1	0.3	6.8	7
Biomass	19.9	19	17	16	14	14	16
Liquid	0.2	0.2	0.1	0.1	0.1	0	0.1
Nuclear	312.7	323.9	324.1	373	422.7	409.1	409.4
Hydro	7.7	7.9	7.9	8.1	8	7.9	8.2
Solar	17.7	23.8	32.4	34.5	41.1	51.8	56.8
Wind	2.1	5.1	10.1	14.7	17.1	19.6	22
Waste	4.2	15.7	15.8	15.4	15	22.3	22.3
Total	767.3	644.7	551.1	559.5	606.7	620.7	681.2

Energy - NFR 1A2

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

The number of emissions emitted from 1 GJ [t/GJ] was multiplied by the 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, energy supply, and other parameters.

Emissions were calculated by the equation down below in the table:

$$E = EF \cdot AR$$

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

The calculation scheme also responds to changes that occur until 2030. There are significant changes in the fuel base of individual sources, reconstruction and replacement of boilers and related changes in the total rated thermal input, termination of the source operation, and putting new sources into operation.

The use of coal in the energy sector will be minor due to the end of mining. Moreover, more energy from usable sources will be used.

Emissions with a total thermal input of less than 50 MW were calculated according to forecasts of further production (ex., in Industry) given by MIT (Ministry of Industry and Trade). Data obtained from CZSO (Czech Statistical Office), as further consumption, GDP, population, and other parameters were used.

Calculated emissions were summarised and added to template Annex IV.

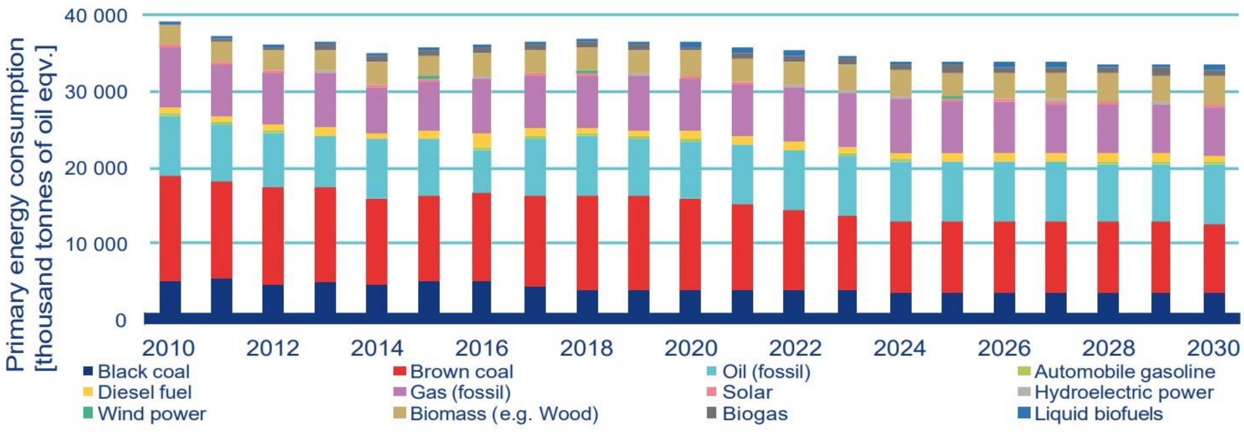

Figure IX.9 Primary energy consumption, 2010–2030

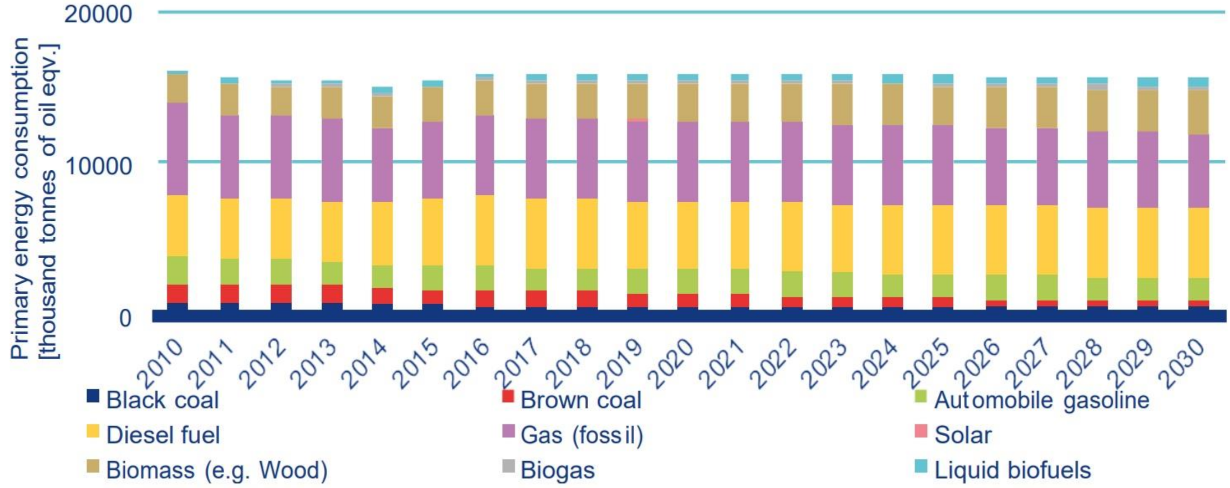

Figure IX.10 Final energy consumption, 2010–2030

IX.3.2 Transport - NFR 1A3

The basic approach was to obtain the time series of activity data (vehicle fleet, fuel 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 the 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 scenario: with existing measures (WM) and with additional measures (WAM). The WAM scenario is not required.

The approach for emission reduction calculations was updated. This update is related to the reduction of greenhouse gas emissions. In 2019, new Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles was adopted. By this Regulation, the CO_2 emissions from new cars should decrease by 15% in 2025 and 37.5% in 2030 compared to 2021 year. The CO_2 emissions from new vans should decrease by 15% in 2025 and 31% in 2030 compared to the 2021 year.

These standards are defined for the new car fleet of every car manufacturer (with some exceptions). It will influence emissions of "traditional" pollutants like NO_X, CO, NMVOC and others as well. Future vehicle fleets and kilometres composition were modelled to meet these standards. Resulted vehicle composition contains more zero-emission vehicles than in the WM scenario. The percentage of zero-emission vehicles in the fleet is set to get a weighted average to values of the above-mentioned percentage.

Further emission reduction was calculated by the impact of other measures. For example, new vehicles with purer emission standards, and demand–influencing measures (investment in railway and combined transport infrastructure, road toll and others) influence harmful emission production as well.

Road and non-road transport - NFR 1A3a-d

Emission projections from the Transport sector were made by experts 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 the analytical parts of the Transport policy of the Czech Republic for the period 2021–2027 with a view to 2050. For analytical parts of Transport Policy the national Czech transport model was used. It comes from the prediction of demography and economy as well as the export and import of freight. Forecasts of energy consumption split to individual fuels, done by MIT. It 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 into more detailed vehicle categories by fuel used and Euro Standards emission limits. The emission projections model has now 112 transport categories, which differ from 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 have been processed in a model COPERT. Detailed inputs for the 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 including vehicle allocation and modal split, development and operation of new environment-friendly vehicles.

Activity data and emission factors have been structured according to the COPERT 5 model. Results from model COPERT recently contain 432 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 an emissions projection model to less detailed vehicle categories.

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

Table IX.6 COPERT appropriative NFR names

COPERT names	NFR Code	**Long name**
Aircraft's freight	1A3a.c.d.e	Off-road transport
Aircraft's passenger	1A3a.c.d.e	Off-road transport
Boat freight	1A3a.c.d.e	Off-road transport
Boat 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

Table IX.7 COPERT results (from 2025 these are results of the emission projection model)

Transport mode	Vehicles					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	15823	13092	16782	17957	19116	19448
Heavy duty trucks	139855	125061	155949	182885	206228	230760
L - category	1147200	899572	1270866	1295240	1338054	1350957
Light commercial vehicles	578176	543646	584370	685344	772818	864758
- **gasoline**	84515	81157	63133	50999	30661	23610
- **diesel**	493661	452934	478372	521137	380460	321100
- **other**	0	9555	42865	113208	361697	520048
Passenger cars	5889714	5530582	6455317	6579119	6796591	6862131
- **gasoline**	3466557	3132046	3860000	3546287	2528876	1952305
- **diesel**	2285218	2212567	2271129	2115264	1517303	1183314
- **other**	137939	185969	324188	917568	2750412	3726512
Total	7770768	7111953	8483284	8760545	9132807	9328054

Table IX.8 COPERT results (from 2025 these are results of the emission projection model)

Transport mode	NO_X[kt]					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	2.75	2.62	1.27	1.08	0.83	0.77
Heavy duty trucks	10.04	10.04	7.57	5.63	3.48	2.52
L - category	0.06	0.05	0.07	0.04	0.02	0.03
Light commercial vehicles	10.08	8.98	5.89	4.45	2.66	1.75
- **gasoline**	0.12	0.09	0.02	0.02	0.01	0.01
- **diesel**	9.96	8.89	5.84	4.39	2.59	1.67
- **other**	0.00	0.00	0.03	0.05	0.05	0.06
Passenger cars	29.05	25.63	13.66	9.7	4.77	2.83
- **gasoline**	4.11	3.38	1.87	1.37	0.89	0.7
- **diesel**	24.74	22.06	11.62	8.11	3.64	1.86
- **other**	0.20	0.19	0.16	0.22	0.24	0.27
Total	51.98	47.33	28.46	20.9	11.76	7.9

Table IX.9 COPERT results (from 2025 these are results of the emission projection model)

Transport mode	NMVOC[kt]					
Year	**2019**	**2020**	**2025**	**2030**	**2040**	**2050**
Buses	0.09	0.09	0.04	0.04	0.04	0.04
Heavy duty trucks	0.39	0.29	0.2	0.17	0.17	0.18
L - category	0.89	0.30	0.49	0.36	0.31	0.3
Light commercial vehicles	0.55	0.46	0.19	0.15	0.09	0.08
- **gasoline**	0.21	0.19	0.06	0.05	0.04	0.03
- **diesel**	0.34	0.27	0.12	0.06	0.02	0.01
- **other**	0.00	0.00	0.01	0.03	0.04	0.05
Passenger cars	11.15	9.43	5.83	4.48	2.96	2.33
- **gasoline**	10.28	8.69	5.44	4.19	2.76	2.15
- **diesel**	0.57	0.45	0.23	0.13	0.04	0.03
- **other**	0.30	0.30	0.16	0.16	0.15	0.16
Total	13.07	10.57	6.75	5.2	3.57	2.93

IX.3.3 Combustion sources - NFR 1A4

Combustion of fuels in households for heating, hot water preparation and cooking are generally combustion sources with a nominal heat input of up to 300 kW known as unlisted sources. According to Act No. 201/2012 Coll. on air protection, unlisted sources are monitored collectively based on statistical data for inventorying emissions. Register of Emissions and Stationary Sources (REZZO) classifies unlisted sources in the category REZZO 3. The methodology for inventorying emissions from these sources based on the results of the Census of Population, Houses and Dwellings has been developed by the Czech Hydrometeorological Institute (CHMI) since the 1990s and was used in an updated form until 2017 [40]. A revision of emission inventories in 2017 [41] according to the Directive of the European Parliament and the Council (EU) 2016/2284 and the results of the statistical survey ENERGO 2015 [42] led to a new methodology for inventorying emissions from combustion in households [43]. The revision required improving the completeness of the data and the unification of reporting data according to the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the United Nations Framework Convention on Climate Change (UNFCCC). The model was based on the original methodology of the CHMI modified according to the results of the ENERGO 2015 survey, which for the first time mapped fuel stocks and fuel equipment in households in the Czech Republic in detail. Model using national emission factors determined at the nominal thermal output of the boilers. Only in the air quality modelling were national emission factors determined in the case of reduced thermal output of boilers applied in isolated cases.

In the current methodology compiled in 2023, the calculation procedures from the previous methodology completed in 2018 were largely adopted [43]. Significant changes have been made to some key parameters affecting the overall emissions calculation. Mainly changes were in the representation of individual types of boilers in the time series since 1990, which is partially reflected in the assumption of the future composition of boilers until 2025 and the following years. These adjustments and the newly determined proportion of dried wood were carried out based on the evaluation of data from the new ENERGO 2021 survey [44].

Another change in the methodological approach is related to the comments of the team of emission experts [45][46], who checks of the reported data. Based on the CEIP request, there were changes in the emission factors used. In previous years, emission factors were determined at the nominal thermal output of boilers and heaters were used as a basic set. The new methodology uses primarily emission factors corresponding to operation at reduced output. Therefore, only combustion sources with an adequate storage tank have emission factors with the nominal heat output for the entire period of operation. The representation of boilers with storage tanks was based on the evaluation of the reported data of the Report on the Technical Condition and Operation Control (RTCOC) forms.

Input Data

Projections of emissions in Residential are based on State energy concept and The National Energy and Climate Plan of the Czech Republic [25][26]. The Department of Strategy and International Co-operation, MIP provided forecasts of fuel consumption. Emissions inventory in households and trends of combustion plants were provided by MOI and trends of emission factors were provided by CHMI. More detailed Chapter III.2 Czech IIR [23].

Methodology

The total mix of boilers was calculated. The 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 2024)
- The prohibition of operation of 1st and 2nd class boilers after the year 2022 (projections are based on the ideal state of fulfilment of the legislative requirement to prohibit the operation of 1st and 2nd class boilers after 2024 was considered)

If the source operator replaced an older solid-fuel combustion plant, with a modern solid-fuel system, the same fuel type should be used. Also in a case of biomass combustion. The old Energy sources which use coal, must be gradually replaced by biomass fuels. Especially in the case of gas boiler installations. Especially in areas lacking gas pipelines or heat distribution from heating plants, old boilers will have to be replaced with new ones due to the closing of coal mines.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 stay similar.

Projection of emissions following the new emission balance of fuel combustion in households

The above-mentioned adjustments to the methodology for calculating emissions from fuel combustion in households are also reflected in the results of the emissions projection until 2030 and subsequent years. The change in the boiler stock affects the most significantly the projections of emissions from fuel combustion in households. The current boiler change in Czech households is mainly a result of the legislatively mandated termination of the operation of non-ecological boilers (Act No. 201/2012 Coll. § 17). The projection therefore includes a requirement that from September 1, 2024, only boilers that meet the conditions listed in Annex No. 11 of the Air Protection Act will be able to be operated. Another important factor influencing the emission projection is the assumption of the development of fuel consumption: the reduction and gradual termination of coal consumption and increasing the share of biomass and non-emission heating methods.

IX.3.4 Other combustion sources - NFR 1A5

Emissions from the operation of military vehicles and aircraft are included in the NFR 1A5. The Emissions are low. A fuel consumption trend was used as activity data, which was taken from CZSO and reported by the 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. For Projections the data registered in 2020 were used.

IX.3.5 Fugitive emissions from fuels - NFR 1B

Projection of Fugitive emissions were calculated as individual amounts of emissions from appropriate activity data and emission factors. It was chosen as 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 [1].

Department of Strategy and International Co-operation in Energy, MIT, provided input data for NFR 1B1a, 1B1b, 1B1c and 1B2b. Input data contained a forecast about future fuel consumption and physicochemical properties of fuels. The Czech Association of Petroleum Industry and Trade provided input data for sectors NFR 1B2ai, 1B2aiv and 1B2av. Input data contained data about current consumption. These data were analysed by linear regression in MS Excel, where calculated emission factors were multiplied by the 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 it with the population growth factor.

IX.3.6 Industrial Processes and Product Use - NFR 2

Projections of Industry, especially for category 2D, were calculated with a big margin of uncertainties, because of the diversity of organic compounds, their use and the absence of appropriate measures. Several researches were conducted on specific types of emission sources recently. However, there still exists a margin of inaccuracy.

Input data

Projections of Industry were calculated under the forecast of further industrial production. Forecasts were provided by MIP. Emissions of the base year were taken from the Czech emissions inventory, more detailed in Chapter IV Czech IIR [23].

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 based on general economic growth factors in the manufacturing industry. General economic-based growth factors, such as a recent population estimation and gross domestic product were provided by CZSO. Emission factors were used according to EMEP/EEA EIG [3].

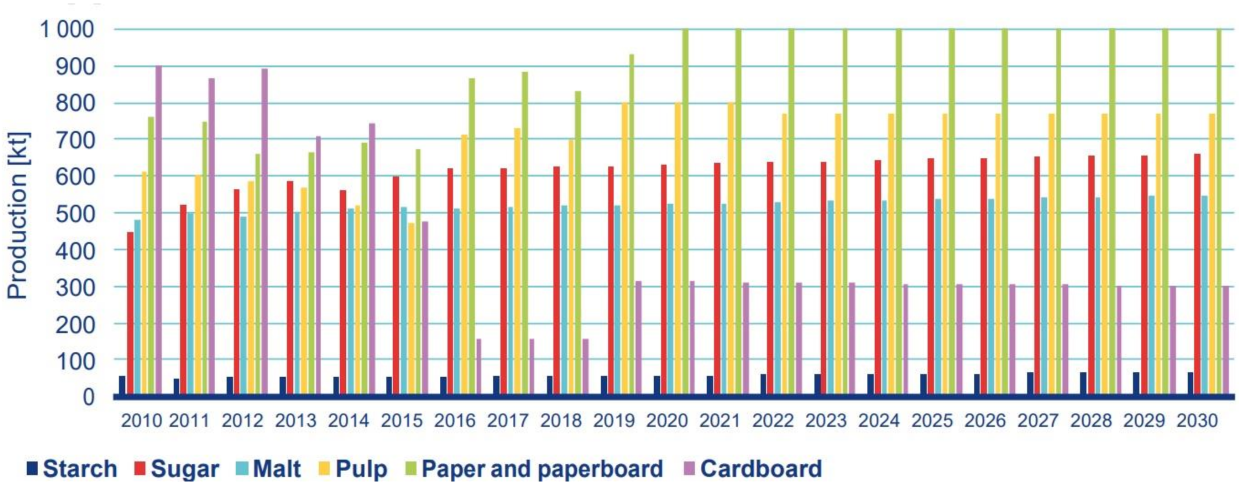

Figure IX.11 Production of food and paper, 2010–2030

IX.3.7 Agriculture - NFR 3

The projection on emissions of air pollutants originating from agriculture is regularly updated in line with new knowledge as a consequence of new emission sources, changes in emission factors or changes in the agricultural production conditions, e.g. changes regarding the legislation and regulation. Past TERT recommendations prompted changes in the methodological procedure for calculating pollutant emissions.

Many of these changes have led to revisions and recalculations of historical emissions inventories in the past few years (especially from 2020). These changes were reflected in the deviations in the values compared to the projections published in previous reports. Some changes can also lead to a revision in the historical emission inventory; therefore, some deviations are apparent compared to the projection scenarios published in previous reports.

The current projection of pollutant emissions from agriculture is based on the most recent values in the 2023 data submission. It fully reflects recalculations in the historic emissions reported in this report.

IX.3.7.1 Manure management (NFR 3B), Animal manure applied to soil (NFR 3Da2a), urine and dung deposited by grazing animals (NFR 3Da3)

The number of animals is a key activity data for emissions inventory calculation relating to manure management (NFR 3B), animal manure applied to soil (NFR 3Da2a), urine, and dung deposited by grazing animals (NFR 3Da3). The historical number of livestock from 2005 to 2021 was taken from an annual agricultural census from the official statistics (CZSO). The e-ANNEX NFR-3B-2 shows several animals allocated on relevant subcategories used for inventory calculation for the all-time series. No other category of livestock is monitored and recorded. The future estimated number of animals is based on the updated values of the number of livestock resulting from the official Strategy of the Ministry of Agriculture until 2030, approved by the government of the Czech Republic. The number of animals is considered as an average annual production. Table IX.10 shows the trends of the livestock population in the period 2005-2040.

Table IX.10 Livestock population, 2005–2040

	2005	2010	2015	2021	2025	2030	2035	2040
Cattle	1 392	1 349	1 407	1 406	1 406	1 410	1 451	1 459
Swine	2 877	1 909	1 560	1 518	1 500	1 500	1 500	1 500
Sheep	140	197	232	183	240	165	165	165
Poultry	25 372	24 838	22 508	23 809	25 325	26 601	26 601	26 601
Horses	21	30	33	33	35	35	35	35
Goats	13	22	27	25	35	25	25	25

An increase in the number of cattle by 4% is expected in 2040 compared to 2021 due to an increase in non-dairy cattle. A slight decrease in the number of dairy cows is expected due to the expected steady increase in milk production per head, but no increase in its consumption or export is expected. Considering the pig breeding market situation, the aim is to maintain at least the current number of pigs. Therefore, no significant change is expected. A slight increase is also expected in the number of poultry of 10% in 2040 compared to 2020, especially in the number of reared laying hens to increase food self-sufficiency in egg production. Numbers of other livestock categories (sheep, horses and goats) have a negligible effect on future emission predictions.

NH_3 reducing technology

According to Options for Ammonia Abatement: Guidance from the UNECE Task Force on Reactive Nitrogen implementation of NH_3 reducing technology in manure storage and application is already used in inventory and is also used in the projection. The technologies included in the inventory and this projection is the tight lid, plastic sheeting and natural crust in case of slurry storage and band spreading - trailing hose, shoe, slurry injection, incorporation immediately by ploughing, incorporation after 4 hours and incorporation within 24 hours in case of application of slurry and manure. Current penetration rates of used abatement measures are available in the e-ANNEX NFR-3B-6. These penetration rates were not changed for the emission prediction calculation.

Emission factors and calculations

To calculate the prediction of ammonia and NO_X emissions, the same Tier 2 calculation methodology based on the mass flow of TAN through the manure management system was used to calculate the emission balance. The Manure Management N-flow tool was used. Default EF is presented in Table 3.9. 3B EMEP/EEA EIG reduced by mitigating measures have been used. Emissions of NMVOC have been calculated using the Tier 2 approach. For calculating NMVOC emissions prediction, default EFs presented in Table 3.11 for dairy cattle, and other cattle and Table 3.12 for livestock categories other than cattle of 3B EMEP/EEA EIG have been used. The estimation of PM emissions is based on the Tier 1 approach according to the 3B EMEP/EEA EIG. For calculating $PM_{2.5}$, PM_{10} and TSP emissions predictions, default EFs presented in Table 3.5 of the EMEP/EEA EIG have been used [1].

Ammonia, NO_X and NMVOC

Trends of prediction in ammonia, NO_X and NMVOC emissions originating from manure management are presented in Figure IX.12 and from manure application and animal grazing in Figure IX.13.

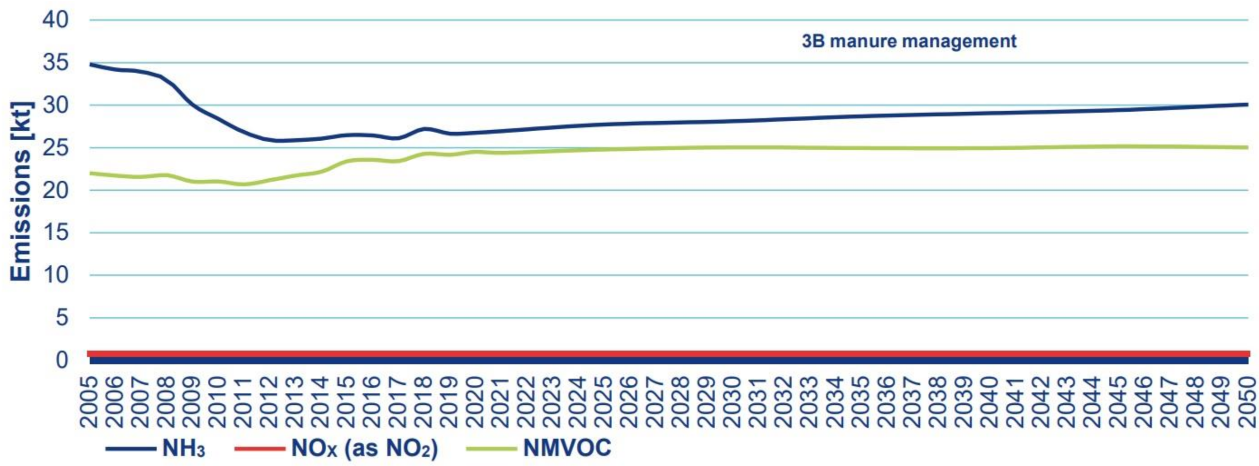

Figure IX.12 NH_3, NO_X and NMVOC emissions originating from manure management, 2005–2040

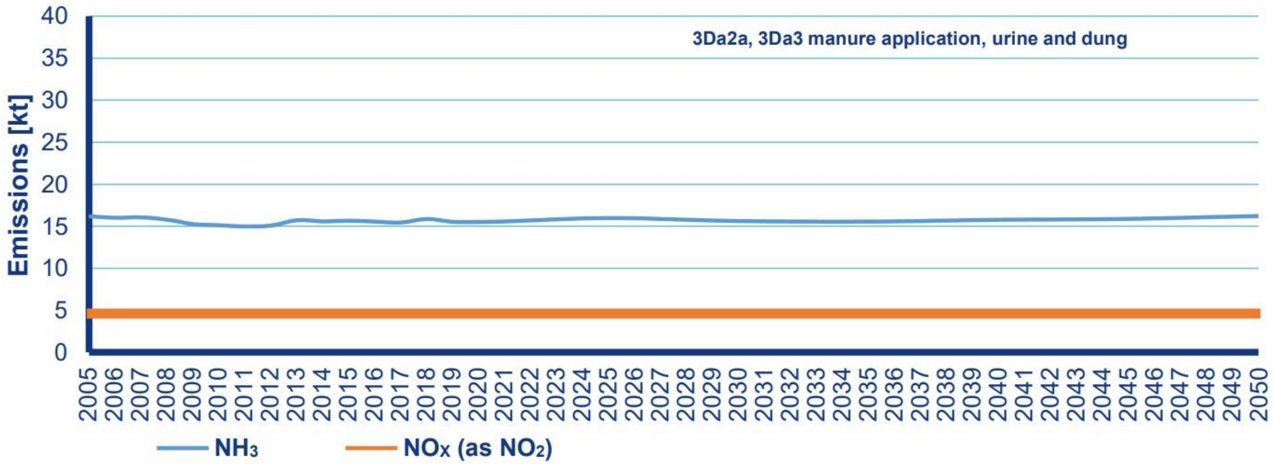

Figure IX.13 NH_3 and NO_X originating from manure application, urine and dung deposited by grazing animals, 2005–2040

The total ammonia emissions related to livestock farming are expected to decrease by approximately 14% by 2030 compared to 2005. A slight increase of approx. 2% in 2030 compared to 2005 is expected for total NO_X emissions related to livestock farming. An increase of approx. 6 % can also be expected for total NMVOC emissions in 2030 compared to 2005.

Crop production and agricultural soils (inorganic N fertilisers application) - NFR 3Da1, sewage sludge applied to soils - NFR 3Da2b, other organic fertilisers applied to soils (including compost) - NFR 3Da2c

Consumption of nitrogen mineral fertilizers is one of the key sources of ammonia and NO_X emissions from agriculture (NFR 3Da1). The increase in their consumption was associated with a significant decrease in the number of farm animals and the production of farmyard manure. The highest consumption of nitrogen mineral fertilizers, especially urea, was recorded in the production year 2015–2016 and has been decreasing since then. The consumption of sludge and compost used for fertilizing agricultural land is not very significant and does not belong to the key sources of emissions. The historical consumption of N inorganic fertilizers from 2005 to 2021 was taken from the IFASTAT database. The future consumption of N inorganic fertilizers is based on a study prepared by the Institute of Agricultural Economics and Information (IAEI), the expert centre for the agricultural economy, food, agricultural advice and information established by the Czech Ministry of Agriculture. Within the framework of the elaborated study, the effects of the current energy crisis, the prices of inorganic

Fertilizers and the international obligations resulting from, for example, the "Farm to Fork" agreement are considered in future consumption of N inorganic fertilizers. Table IX.11 shows the trends of N inorganic fertilizer consumption in 2005–2040.

Table IX.11 N inorganic fertilizers consumption, 2005–2040 (kt of N)

	2005	2010	2015	2021	2025	2030	2035	2040
Ammonium nitrate (AN)	10.0	10.0	5.5	3.2	2.3	2.0	1.8	1.6
Ammonium phosphates (AP)	4.0	5.0	4.5	3.4	5.6	4.9	4.3	3.8
Ammonium sulphate (AS)	19.0	17.0	9.1	1.1	6.0	5.2	4.6	4.0
Calcium ammonium nitrate (CAN)	108.0	90.0	98.5	108.9	97.0	84.3	73.8	65.4
NK Mixtures	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NPK Mixtures	11.5	4.0	14.8	11.2	9.3	8.1	7.07	6.3
NP Mixtures	3.0	7.0	4.0	2.6	0.4	0.3	0.3	0.3
N solutions	84.0	87.0	150.1	57.0	61.8	53.7	47.0	41.6
Other straight N compounds	2.5	15.0	31.6	38.3	41.3	35.9	31.4	27.9
Total	**289.0**	**295.0**	**444.4**	**309.5**	**272.7**	**237.1**	**207.5**	**183.8**

For the year 2040, compared to 2021, the consumption of nitrogenous inorganic fertilizers is expected to decrease by approx. 40%, among other things, due to the fulfilment of obligations arising from the European Green Deal (reduction of mineral consumption by 20%), the introduction of so-called regenerative and carbon agriculture, or a reduction in the consumption of inorganic fertilizers to reduce the carbon footprint of cultivated crops.

NH_3 reducing technology

In 2021, an amendment to Decree No. 377/2013 on the storage and use of fertilizers came into force in the Czech Republic, which imposes an obligation to immediately incorporate urea into the soil or use urea with urease inhibitors only. According to Options for Ammonia Abatement: Guidance from the UNECE Task Force on Reactive Nitrogen, the measure represents a low ammonia emissions option focused on urea-based fertilizers. This ammonia abatement measure could decrease ammonia emissions from urea application by 70%. This measure has been incorporated into prediction since 2025. Penetration rates of used abatement measures are available in the e-ANNEX NFR-3D-7. These penetration rates have not been used for the emission inventory calculation yet.

Emission factors and calculations

For national estimation of NH_3 emissions from consumption and application of inorganic N-fertilizers, the Tier 2 approach according to the 3.D Crop Production and Agricultural Soils Guidebook has been used [3]. Tier 2 is not available, therefore, the Tier 1 approach has been used for the estimate of NO_X. The same methods were used to calculate the prediction of ammonia and NO_X emissions. Default EF is presented in Table 3.2. 3D EMEP/EEA EIG for each inorganic N-fertilizer group has been used. For urea, from 2025, measures leading to the reduction of ammonia emissions were taken into account, thereby reducing the recommended emission factor.

Ammonia and NO_X

Trends of prediction in ammonia and NO_X emissions originating from inorganic N-fertilizers application are presented in Figure IX.14.

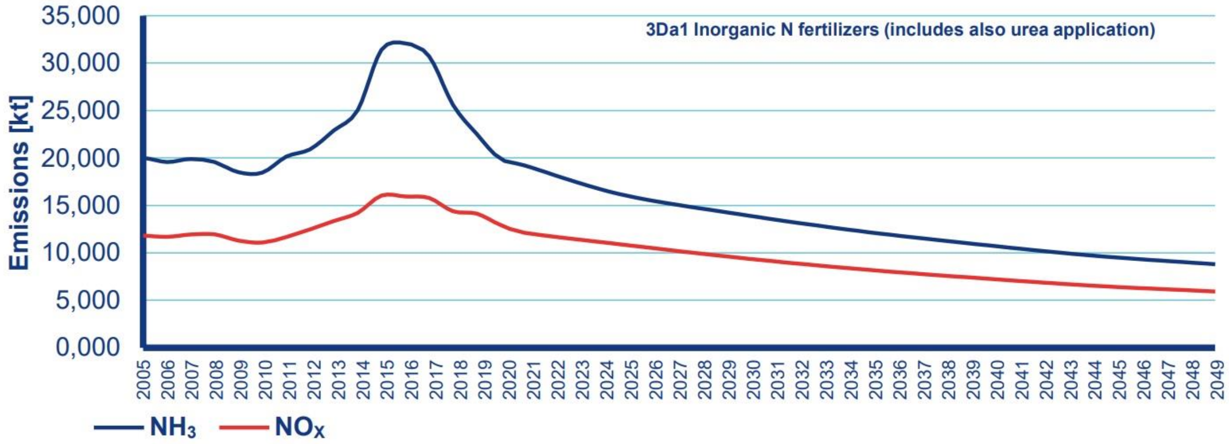

Figure IX.14 NH_3 and NO_X emissions originating from inorganic N-fertilizers application, 2005-2040

Total ammonia emissions related to inorganic N-fertilizers application are expected to decrease by approximately 46% by 2030 compared to 2005. This reduction should be achieved as a result of gradually reducing the consumption of mineral fertilizers and putting reduction measures for urea-based fertilizers into practice. A similar emission reduction of 38% in 2030 compared to 2005 is also expected for NO_X emissions.

No significant change in the total emissions of ammonia and NO_X from the application of sewage sludge (NFR 3Da2b) and other organic fertilizers (compost and digestate NFR 3Da2c) is expected in the future compared to the current state, which would affect the predictions of these emissions.

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

The area of cultivated crops is a key activity data for emissions inventory calculation relating to manure management (NFR 3Dc). The historical data regarding cultivated crop area from 2005 to 2021 was taken from an annual agricultural census from the official statistics (CZSO). The e-ANNEX NFR- 3D-3 shows utilised agricultural areas and areas under crops. The future estimated area of cultivated crops is based on the official Strategy of the Ministry of Agriculture until 2030, approved by the government of the Czech Republic. Table IX.12 shows selected crops' cultivated area trends in 2005–2040.

Table IX.12 Cultivated area of selected crops, 2005-2040 (thousands ha)

	2005	2010	2015	2021	2025	2030	2035	2040
Wheat	820	834	830	785	853	821	834	669
Rye	47	30	22	25	27	26	27	21
Barley	522	389	366	327	355	342	347	278
Oat	52	52	42	58	63	60	61	49

Emission factors and calculations

The Tier 2 approach has been used for the NFR 3Dc soils to predict $PM_{2.5}$ and PM_{10} emissions. Tables

3.5 and 3.7 in 3D EMEP/EEA EIG for the region with wet climatic conditions present default EFs for calculating $PM_{2.5}$ and PM_{10} emissions predictions.

PM

The emission of PM from field operations is calculated by the area of cultivated crops multiplied by the number of operations and emission factor for each crop type and type of operation. Operations are divided into soil cultivation, harvesting, cleaning and drying. The expected trend in changes in the soil cultivation method was considered in the calculations of PM emissions projections. This trend should lead to higher use of no-till technologies than current tillage methods. Table IX.13 shows the trends of the share of the tillage method.

Table IX.13 Trends of share of tillage method, 2020–2040

Share of tillage method in the year	Conventional (deep ploughing or disc ploughing)	Minimization (shallow ploughing)	No-tillage (direct seeding)
2020	67%	32%	1%
2030	58%	32%	10%
2040	33%	32%	35%

Trends of prediction in PM emissions originating from farm-level agricultural operations, including storage, handling and transport of agricultural products, are presented in Figure IX.15.

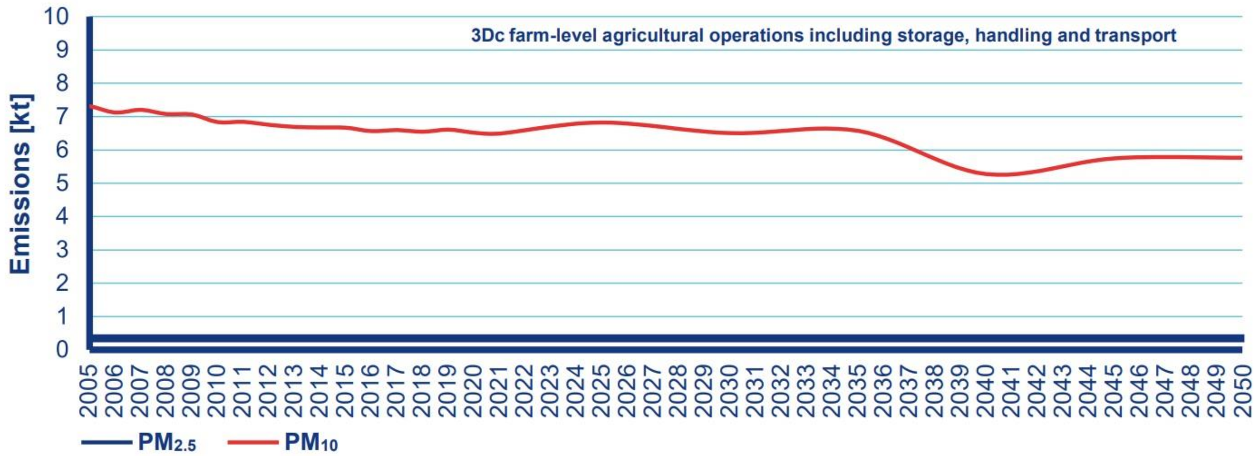

Figure IX.15 PM emissions originating from farm-level agricultural operations including storage, handling and transport of agricultural

The expected change in the tillage method could decrease PM_{10} emissions by approx. 11% in 2030 compared to 2005. A similar reduction can be expected for PM $_{2.5}$ emissions.

IX.3.8 Waste - NFR 5

The waste sector (IPCC guidelines sector No. 5) in the Czech Republic is separated into four distinctive categories. The dominant category is NFR 5A, emissions from solid waste disposal sites. The NFR 5A is a limited source range of emissions (NMVOC, and $PM_{2.5}$).

The second source category is an NFR 5B. This source category consists mainly of composting and up to a small degree of anaerobic digestion of waste. Composting produces a small amount of NH_3. In NFR 5B2 Anaerobic digestion at biogas facilities, NH_3 emissions are estimated.

The third category is NFR 5C. NFR 5C belongs to is accounted for in the Energy sector. Waste incineration produces usable energy. In NFR 5C, only hazardous and industrial waste incineration is accounted for. This category comprises a wide ray of pollutants such as NO_X, NMVOC, SO_X, $PM_{2.5}$ and BC.

The last category is NFR 5D. The category includes public and private wastewater treatment plants and industrial counterparts and is the source of NH_3 and NMVOC.

Main activity data about future activities comes from the WMP (Waste Management Plan) of the Czech Republic. Key assumptions in WMP are: “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 based on these assumptions, due to the diversion of materially recoverable components of municipal material 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“.

These assumptions have yet to materialize fully. Landfill municipal solid waste has slightly increased. Waste treatment options of material recovery, energy recovery, and composting options exceeded their assumptions. However, this positive development was overshadowed by the steady increase in total generated municipal solid waste. Waste projections keep the WMP assumption that, over time, the municipal landfill waste will decrease according to due waste management policies.

NFR 5 have the highest share of total emissions. Emissions are from open waste burning. We assume a reduction of the share of open waste burning and a slight increase in emissions from crematoria for 2025, 2030, 2040, and 2050. We expect the ratio of cremation and burial to the ground will change.

The primary methodological approach to emissions estimation in all categories is an equation multiplying the emission factor by activity data. Any change in methodology is noted explicitly in the specific category. The main source of emission factors is EMEP/EEA EIG [3]. The same spreadsheet with the GHG emissions was used to estimate classical emissions from NFR 5. The values of projected waste emissions for 2025, 2030, 2040 and 2050 are based on extrapolation from emission trends.

In NFR 5C, the previous emission factor is applied, which changes NO_X and NMVOC. It is in connection with emission factors from EMEP/EEA EIG. Emission factors for SO_X and NH_3 were assumed from EMEP/EEA EIG 2016.

In NFR 5D, the latest estimations are based on extrapolation from emission trends. An increase in population is observed, while the emissions from NFR 5D have been decreasing.

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/PCDF, 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 Figure X.1. Presentation of selected emission data in GRID structure is a part of e-ANNEX.

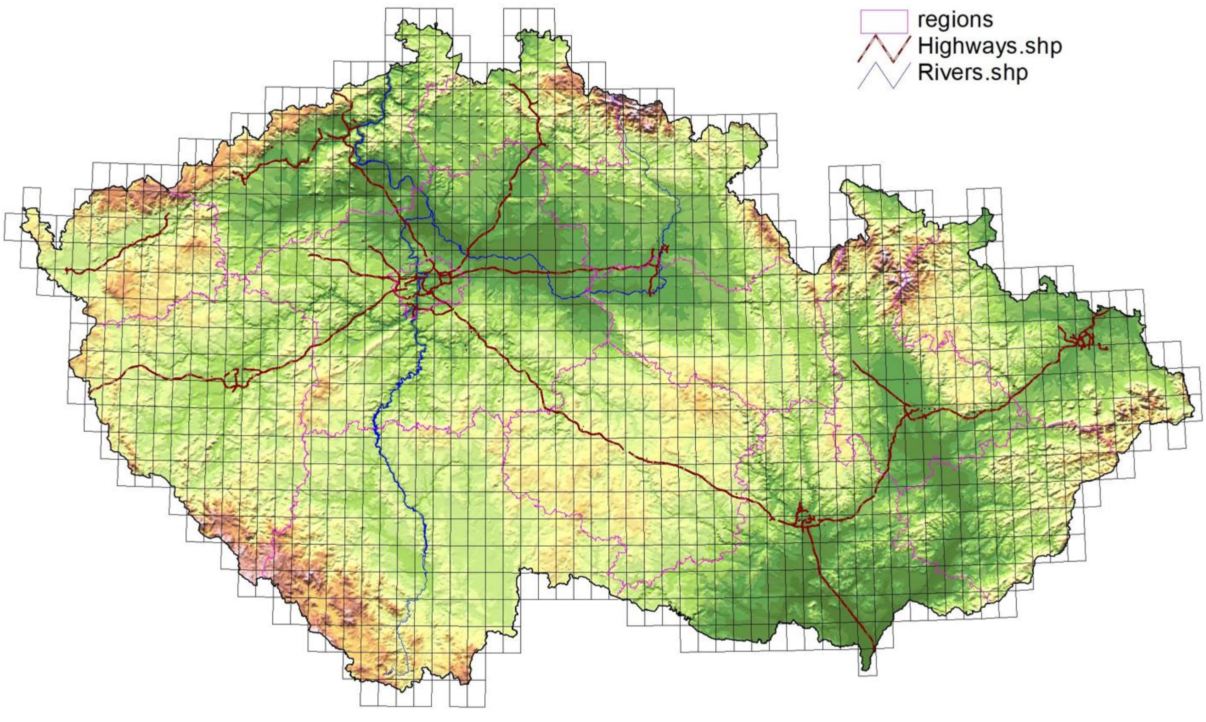

Figure X.1 EMEP Grid Czechia – allocation of regions, highways network and rivers

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 Figure 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/PCDF, 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%).

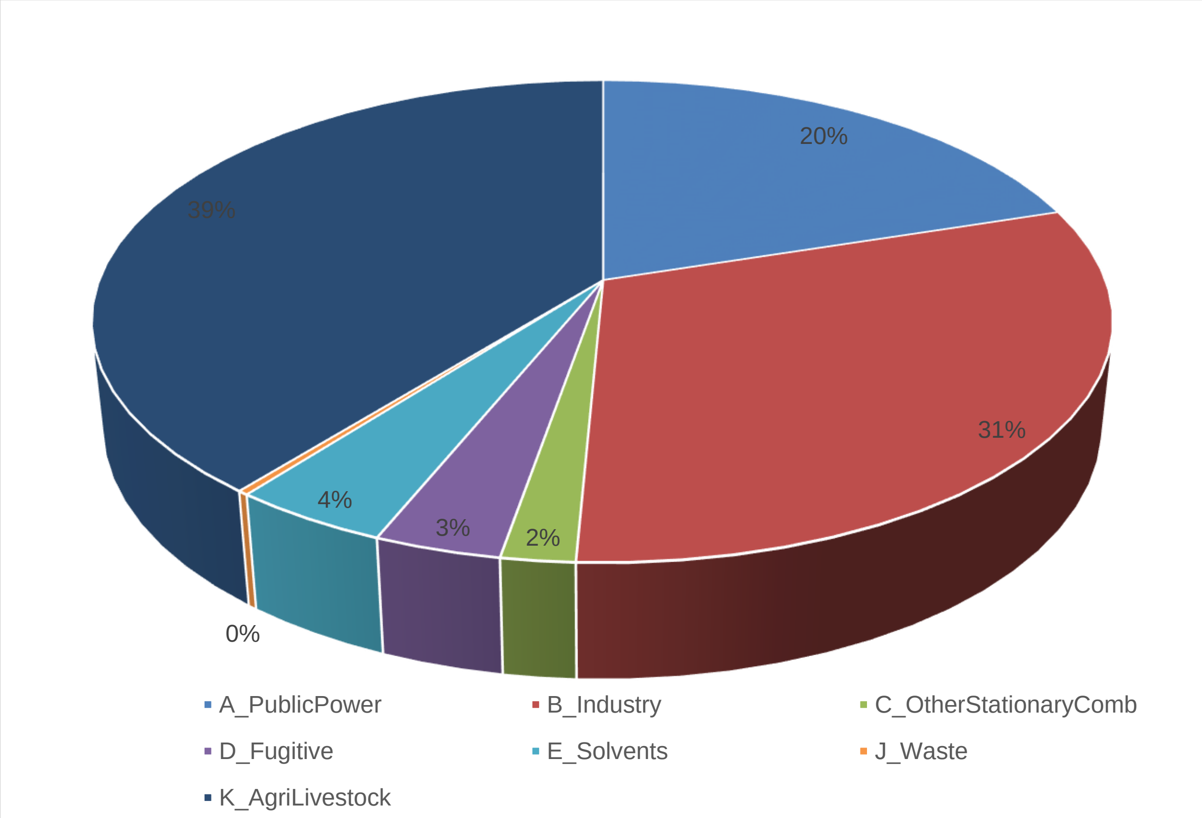

Figure X.2 Share of GNFRs in the total LPS number in 2019

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

Table 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/PCDF	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/PCDF, 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: 15/03/2024

XI.1 Introduction

Czech Republic have national emissions ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_X), non-methane volatile organic compounds (NMVOC) and ammonia (NH_3) under National Emissions Ceilings Directive (2016/2284/EU).

Article 21(2) of Directive (EU) 2016/2284 indicates that Member States may apply Article 5(1) of the Directive in relation to the ceilings in Annex I to Directive 2001/81/EC. Article 5(1) allows Member States to establish adjusted annual national emission inventories where non-compliance with emission ceilings or reduction commitments occur due to applying improved emission inventory methods in accordance with best science. The information provided in this chapter follows the reporting requirements of the adjustment process presented in Article 5 and Part 4 of Annex IV of the Directive (EU) 2016/2284.

XI.2 Meeting the Requirements for an Adjustment

XI.2.1 Significantly Different Emission Factors

Part 4.1.d.ii of Annex IV of Directive (EU) 2016/2284 indicates that where significantly different emission factors (EFs) are used, the following evidence is required:

- The original EF, and information on its origin or derivation.
- Evidence that the original EF was used in determining the emission ceilings when they were set.
- The updated EF, and information on its origin or derivation.
- A comparison of the original and updated EFs, demonstrating that the change contributes to a MS being in exceedance.
- A rationale for deciding whether the changes in EF are significant.

Section 9.3 and 9.4 below present the original and updated EFs and the quantified impact on the emissions estimates of the change. The sources of the EFs are also presented, and the original EFs were all used in the emission inventory in 2021.

All of the changes to emission factors that are presented contribute to moving Czech Republic's national total emissions into compliance. All of changes are therefore considered to be "significant" in the context of attaining compliance with emission ceilings.

In calculating adjustments for revised EFs, it is not necessary to present the current activity data (since this can be derived from the current emission and the current emission factor). In presenting information to quantify the adjustment, the following approach has been used:

$$\text{Adjustment} = (\text{EFOriginal} \times \text{ADCurrent}) - (\text{ECurrent})$$

Given that:

$$\text{ADCurrent} = \text{ECurrent}/\text{EFCurrent}$$

The adjustment can be written:

$$\text{Adjustment} = (\text{EFOriginal}\ \ \text{ECurrent}/\text{EFCurrent}) - \text{ECurrent}$$

The information provided in the tables for each of the adjustments in the following sections should therefore be sufficient to allow a review of the adjustment quantification.

The final adjustment value has been determined and provided at the individual mineral fertilisers of this NFR category level. Where there have been revisions to emission factors for sources within an NFR category, all revisions have been included i.e. both increases and decreases to emission factors have been included. This avoids selectively including only EF revisions which would result in a favourable revision of the national emissions inventory total – a process which is not considered to be appropriate. As a result, the adjustment values that are shown for each mineral fertilisers of this NFR category can be considered “net” adjustment values.

XI.3 NH_3 Adjustment Applications

Justification – Significantly Different EFs - NFR category 3Da1 Inorganic N fertilisers (includes urea)

The first emission factors for calculation of NH3 from inorganic N fertilisers application (includes urea) were included in the EMEP/CORINAIR Emissions Inventory Guidebook – First edition 1996, chapter 10 - Agriculture in 1996. In 1999, when national emission ceilings were set for individual Member States, these emission factors were the same as in 1996. In 1999, when national emission ceilings were set for individual Member States, these emission factors were the same as in 1996 and remained the same until 2007. From 2007 to 2023, they were changed a total of 5 times. The Czech national emission inventory of ammonia from the NFR category 3Da1 Inorganic N fertilisers including all adopted legislative measures aimed at reducing ammonia emissions leading to the fulfillment of EU strategic measures in the area of emission reduction from mineral fertilisers, were based on EF from 2016, which did not change until 2023 and were at the same level.

As part of new scientific findings and revisions of international documents, changes in emission factors of individual fertilisers can be expected. However, such significant and incredible changes as occurred between EMEP 2016(2019) and EMEP 2023 cannot be expected and predicted. In Table XI.1 an evaluation of EF changes between EMEP 2016(2019) and EMEP 2023 is carried out.

Table XI.1 Comparison of emission factors of individual mineral fertilizers between EMEP 2019 and EMEP 2023

	EF - EMEP/EEA GB 2016(2019)	EF - EMEP/EEA GB 2023	increase / decrease
	g NH_3 volatilized per kg of N	g NH_3 volatilized per kg of N	%
Anhydrous ammonia (AH)	19	20	+5
Ammonium nitrate AN	15	24	+60
Ammonium phosphate (AP)	50	84	+68
Ammonium sulphate (AS)	90	84	-7
Calcium ammonia nitrate (CAN)	8	24	+200
NK mixtures	15	52	+246
NPK mixtures	50	84	+68
NP mixtures	50	84	+68
N solutions	98	87	-11
Other straight N compounds	10	84	+740
Urea	155	195	+26

The EF used in the current national emission inventory is higher than this original EF. Czech Republic considers that the current NH_3 EF for this source is significantly different, as defined by the Directive (EU) 2016/2284 and is eligible for an adjustment.

Quantification

The adjustment quantification is explained in the Table XI.2.

The general approach for quantification is presented in Chapter XI.2.1. The original EF for individual mineral fertilisers of NFR category 3Da1 Inorganic N fertilisers is from the EMEP/EEA air pollutant emission inventory guidebook 2019, part 3, chapter 3 D Crop production and agricultural soils 2019, tab. 3.2, page 15.

Since 2024 submission, Czech Republic has used the EF from EMEP/EEA air pollutant emission inventory guidebook 2023, part 3, chapter 3 D 3.D Agricultural soils 2023, tab. 3.2, page 17, which replace the above referenced EF which were published in 2019 (or in 2016). Methodology of emissions calculation remained the same for both inventories.

Table XI.2 Adjustments for emissions from the 3Da1 Inorganic N fertilisers (NH_3)

Current EF (2023)				Current NH3 emissions (kt)					
g NH_3 (kg N applied)$^{-1}$)	Fertiliser Type	Pollutant	Units	2005	2010	2015	2020	2021	2022
24	Ammonium nitrate (AN)	NH3	kt	0,2536	0,144	0,472	0,0672	0,0616	0,0702594
84	Ammonium phosphates (AF	NH3	kt	0,4956	0,224	0,3668	0,532	0,504	0,295218
84	Ammonium sulphate (AS)	NH3	kt	1,7808	1,372	0,7812	0,6132	0,4228	0,19985952
24	Calcium ammonium nitrate	NH3	kt	2,4104	2,168	2,6928	2,812	2,7032	2,67103572
52	NK Mixtures	NH3	kt	0	0	0	0,00173333	0	0
84	NPK Mixtures	NH3	kt	0,9212	1,12	0,9576	0,9604	0,9688	0,85157856
84	N solutions	NH3	kt	7,9344	8,323	9,7121	6,1219	5,7913	4,05631845
87	Other straight N compound	NH3	kt	0,5376	1,008	1,3916	3,6008	3,7744	2,022762
84	NP Mixtures	NH3	kt	0,1932	0,336	0,3836	0,07	0,028	0,08183658
195	Urea	NH3	kt	9,022	7,15	21,71	12,558	12,8895	16,2825
	Total	**NH3**	**kt**	**23,549**	**21,845**	**38,468**	**27,337**	**27,144**	**26,531**
	Percentage as of 2005		**%**		**-7,235**	**63,353**	**16,088**	**15,265**	**12,665**
Original EF (2019)				Original NH3 emissions (kt)					
g NH_3 (kg N applied)$^{-1}$)	Fertiliser Type	Pollutant	Units	2005	2010	2015	2020	2021	2022
15	Ammonium nitrate (AN)	NH3	kt	0,1585	0,09	0,295	0,042	0,0385	0,043912125
50	Ammonium phosphates (AF	NH3	kt	0,295	0,1333333	0,218333333	0,31666667	0,3	0,175725
90	Ammonium sulphate (AS)	NH3	kt	1,908	1,47	0,837	0,657	0,453	0,2141352
8	Calcium ammonium nitrate	NH3	kt	0,8034667	0,7226667	0,8976	0,93733333	0,901066667	0,89034524
15	NK Mixtures	NH3	kt	0	0	0	0,0005	0	0
50	NPK Mixtures	NH3	kt	0,5483333	0,6666667	0,57	0,57166667	0,576666667	0,506892
50	N solutions	NH3	kt	8,9376	9,3753333	10,94006667	6,89593333	6,523533333	4,5691863
98	Other straight N compound	NH3	kt	0,064	0,12	0,165666667	0,42866667	0,449333333	0,240805
10	NP Mixtures	NH3	kt	0,115	0,2	0,228333333	0,04166667	0,016666667	0,04871225
155	Urea	NH3	kt	7,1713333	5,6833333	17,25666667	9,982	10,2455	12,9425
	Total	**NH3**	**kt**	**20,001**	**18,461**	**31,409**	**19,873**	**19,504**	**19,632**
	Percentage as of 2005		**%**		**-7,699**	**57,034**	**-0,639**	**-2,485**	**-1,845**
				Adjustments (kt)					
	Fertiliser Type	Pollutant	Units	2005	2010	2015	2020	2021	2022
	Total	**NH3**	**kt**	**-3,548**	**-3,384**	**-7,059**	**-7,464**	**-7,639**	**-6,899**

Quantification of the differences in the calculations of ammonia emissions originating from individual mineral fertilizers, expressed in kt NH_3, however, do not reflect the effects achieved so far in reducing ammonia emissions. The reason is the fact that the total emission of ammonia from the use of mineral fertilizers is also determined by the structure of the portfolio of fertilizers used. The revision of emission factors and their change in 2023 brought about a paradoxical situation. The total consumption of mineral fertilizers in the Czech Republic has been decreasing since 2016, but the production of NH_3 emissions is increasing. This completely contradicts the idea set out in the Green Deal - by reducing the consumption of mineral fertilizers, emissions will be reduced.

In Table XI.3, the values of ammonia emissions are calculated in such a way that the existing percentage reduction of ammonia emissions achieved in the past years and calculated on the basis of emission factors from 2019, respectively 2016. These values are subject to adjustment.

Table XI.3 Adjustments for to maintain current trends in reducing ammonia emissions to meet emission ceilings

				Adjustments based on original percentage as of 2005 (kt)					
	Fertiliser Type	Pollutant	Units	2005	2010	2015	2020	2021	2022
	Total	**NH3**	**kt**	**27,030**	**24,949**	**42,446**	**26,857**	**26,358**	**26,531**
	Percentage as of 2005		**%**		**-7,699**	**57,034**	**-0,639**	**-2,485**	**-1,845**

The calculation of ammonia emissions in other years before the EF change and after the EF change in the entire time series is shown in the e-ANNEXNFR 3D – 3Da1 and 3D1b.

Article 21(2) of Directive (EU) 2016/2284 indicates that Member States may apply Article 5(1) of the Directive in relation to the ceilings in Annex I to Directive 2001/81/EC. Article 5(1) allows Member States to establish adjusted annual national emission inventories where noncompliance with emission ceilings or reduction commitments occur due to applying improved emission inventory methods in accordance with best science. The information provided in this chapter follows the reporting requirements of the adjustment process presented in Article 5 and Part 4 of Annex IV of the Directive (EU) 2016/2284.

XII. EMRT 2017–2022

In the reporting year 2022, 26 observations for Czechia were sent by the Technical expert review team (TERT). Most of the given recommendations were accepted. Most of the findings were solved, and appropriate comments were added to individual chapters. The complete overview of observations with assessments and recommendations of TERT and reactions of Czechia is presented in the file **Recommendations** (see e-ANNEX).

In Review Report 2023, TERT summarises findings. Also, to improve the quality TERT suggested that Czechia should:

- improve completeness by calculating missing emissions for sources even if the emissions are expected to be small:

Observation	Recommendation	CZ answer
CZ-1A2e-2023-0001	The TERT recommends that Czechia estimate NH3 emissions in 1A2e for all years where biomass consumption occurs, using a default Tier 1 emission factor from Table 3-5 of the 2019 EMEP/EEA Guidebook, or a country/plant-specific emission factor if available. Alternatively, the TERT recommends that Czechia provide evidence for why NH_3 emissions are not applicable from units below 5 MW.	The EIG lists most combustion sources for both NFR 1A2 and 1A1 for NH_3 emissions with the symbol NE. However, some emission factors are relevant for part of the sources included in the Czech Republic in sector 1A2e. These emissions were calculated from 2015 onwards from operational data reported in the SOE for individual combustion sources. The average EF (8 $g\cdot GJ^{-1}$ of burned biomass) evaluated from the data of the period 2015–2022 was used for the additional calculation from 1990.
CZ-1A2d-2023-0001	The TERT recommends that Czechia estimate NH_3 emissions in 1A2d for all years in which biomass consumption occurs, using a default Tier 1 emission factor from Table 3-5 of the 2019 EMEP/EEA Guidebook, or a country/plant-specific emission factor if available. Alternatively, the TERT recommends that Czechia provide evidence that explains why NH3 emissions are not applicable from units below 5 MW.	The EIG lists most combustion sources for both NFR 1A2 and 1A1 for NH_3 emissions with the symbol NE. This designation is used in the 2024 reporting for years when NH_3 emissions were not reported. Reported emissions in the years 2015–2022 were taken directly from the SOE report and were verified to be related to the operation of regeneration boilers of paper mills. It can be assumed that emissions occurred to a small extent in the past. However, the operators did not detect these emissions and it is impossible to determine them retroactively. That is why the NO symbol was used.
CZ-2A5b-2023-0001	The TERT recommends that Czechia include the revised estimate in the next submission.	The revised calculation with added emissions from highway construction was applied for the entire period from 1990.
CZ-2D3i-2022-0001	The TERT reiterates the recommendation that Czechia should estimate PM_{10} and $PM_{2.5}$ emissions for all years from the fat, edible and non-edible oil extraction and include or reallocate these emissions under category 2D3i Other solvent Use in the next NFR and IIR submission.	PM emissions from oil extraction (currently 3 establishments in the Czech Republic) have been reported in NFR 2B10a until now. Based on the recommendation, these emissions were moved to NFR 2D3i. It concerns the period from 2000. In previous years, data on PM emissions were not reported and the amount of processed oils is unavailable.

Observation	Recommendation	CZ answer
CZ-2D3b-2022-0001	The TERT recommends that Czechia include in the next IIR a detailed description of the methodology applied to estimate $PM_{2.5}$, PM_{10}, and TSP emissions associated with category 2D3b Road paving with asphalt, by including the information provided during the review.	The calculation procedure is in the IIR, see Chapter IV.4 and a file with the calculation is inserted into the e-ANNEX.

- move to a Tier 2 for all key categories across all sectors e.g. recommendation:

Observation	Recommendation	CZ answer
CZ-5C2-2023-0001	The TERT recommends Czechia to develop a country-specific estimate in its next submission adapted to national circumstances with careful justification for arable residue, orchard residue and forest residue (e.g. providing detailed reference of the legal framework prohibiting open-burning - including date when entered into force, translated extract) and provides the methodology and the result of the estimates in the IIR of the next submission.	NFR 5C2 includes e .g. open burning of crop residues, wood, leaves, straw or plastics. According 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 its disposal or place a ban on its burning. According to § 19 of Regulation 415/2012 Coll. dry vegetable waste is not classified as waste but as biomass. On recommendation and for better comparability of total national inventories, emissions were calculated using the area of utilized land and EFs corresponding to Tier 1 of EIG. However, we would like to point out that these procedures do not correspond to the real way of processing plant residues, because open burning occurs only rarely (e.g. in orchards). According to Forests of the Czech Republic (owner of 86% area of all state forests), the burning of forest residues is not allowed. They are used for wood chip production or sold for energy use (e. g. publication https://lesycr.cz/casopis-clanek/vyuziti-klestu-pro-vyrobu-energie/). Agricultural residues from arable land are principally ploughed in as fertilizer on site. Annual information on the real amount of incinerated material is not registered. Czechia considers the current calculated emissions to be overestimated and proposes to use the symbol “NE”, i.e. emissions of very little importance.

- further improve the transparency of the IIR by providing detailed information on assumptions, methodologies and recalculations e.g. recommendation:

Observation	Recommendation	CZ answer
CZ-1A4bi-2023-0001	The TERT strongly recommends that Czechia implement their proposed solution to provide consisten;t and accurate emission estimates from 1A4bi Residential: Stationary for 2016-2020 for all pollutants for inclusion in the 2024 submission.	The new methodology, presented in IIR 2024, was applied for the entire period from 1990.
CZ-3B-2023-0001	The TERT recommends that in future submissions, Czechia include quantification and explanations in the IIR for all significant recalculations at the livestock subcategory level, including where this relates to correction of errors.	The values have been corrected in the emissions inventory for 2022.
CZ-3B4h-2023-0001	The TERT recommends that Czechia correct the NFR in the next submission to use the correct notation key ‘NE’ (Not Estimated) or ‘NO’ (Not Occurring) if rabbit farming does not take place in Czechia, and include in the next IIR submission additional text explaining why emissions from rabbit are not estimated (e.g. at the bottom of page 73 alongside the explanation for buffalo and mules and asses), as well as any plans for obtaining suitable activity data in future or a justification for not having such plans.	The symbol NE is used in all years.
CZ-1B1a-2022-0001	The TERT recommends that Czechia revise the methodology for 1B1a Fugitive emission from solid fuels: Coal mining and handling to be in line with the methodology presented in the 2019 EMEP/EEA Guidebook, and to estimate emissions from coal storage using the emission factors in Tables 3-4/3-5/3-7 of the 2019 EMEP/EEA Guidebook depending on abatement measures used, or to provide evidence in the next submission that no emissions from coal storage occur.	In 1991, Czechia laws established the conditions for the operation of coal sorting and processing sources. Most of the coal is burned by LCPs, which have been issued an integrated permit with strict operating conditions since approximately 2008, incl. conditions for coal storage and handling. Relevant law conditions, including measures to reduce emissions, will be added to the IIR 2025.

- implementing previous Technical Corrections and recommendation:

Observation	Recommendation	CZ answer
CZ-2D3a-2017-0001	The TERT strongly recommends that Czechia include a revised emission calculation in the 2024 submission as it is not acceptable to use a Tier 1 methodology for a key source category when there is a Tier 2 methodology available in the latest version of the EMEP/EEA guidebook.	Emissions from the use of disinfectants in the period 2020 - 2022 were moved to sector 2D3a. The Czech Republic is unable to implement further adjustments to the methodology due to limited personnel and financial capacity.
CZ-5B2-2022-0001	The TERT reiterates the recommendation that Czechia include the AD applied for calculation of NH_3 from agricultural plants in	On the recommendation of TERT, Czechia will make an effort to obtain data on the input materials to non-

Observation	Recommendation	CZ answer
	the IIR to increase transparency of reporting, and report on its approach and progress to obtain data for the calculation of NH_3 emissions from other (non-agricultural) biogas plants in its next submission.	agricultural biogas plants in the next years (e.g. with cooperation with CENIA).

- to improve the time series consistency for category 2A5a and pollutants $PM_{2.5}$ and PM_{10} by using the same assumptions and methodology (Tier) throughout:

Observation	Recommendation	CZ answer
CZ-2A5a-2022-0001	The TERT recommends that Czechia include in the forthcoming IIR the results of the expert study concerning the $PM_{2.5}$ and PM_{10} emissions of 2005, and that action is taken to improve the time series consistency of $PM_{2.5}$ and PM_{10} emissions.	The results of the expert study will be processed in 2024 and the recalculated emissions should be presented in 2025.

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Abbreviations

AAP	Annual Average Population
A/C	Air-conditioning
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
CNG	Compressed Natural Gas
COPERT	COmputer Programme to calculate Emissions from Road Transport
CS	Country Specific
CZ	Czech Republic
CZ Biom	Czech Biomass Association
CZBA	Czech Biogas Association
CZSO	Czech Statistical Office
ČD	České dráhy
EFs	Emission Factors
EIA	Environmental Impact Assessment
EMEP/EEA EIG	EMEP/EEA air pollutant emission inventory guidebook 2023
EMRT	EEA Emission Review Tool
FAME	Fatty Acid Methyl Esters
FRS CR	Fire Rescue Service of the Czech Republic
GDP	Gross domestic product
HDV	Heavy Duty Vehicle
IEA	International Energy Agency
IFR	Instrument Flight Rules

IPR	Integrated Pollution Register of the Environment
ISOH	Waste Management Information System
ISPOP	Integrated System for Fulfilment of Reporting Duties
LCP	Large Combustion Plants
LDV	Light Duty Vehicle
LPG	Liquefied Petroleum Gas
LPS	Large Point Sources
LTO	Landing/Take-off
MIT	Ministry of Industry and Trades
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
PC	Passenger Car
REZZO	Register of Emissions and Stationary Sources of air pollution
SCR	Selective Catalytic Reduction
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
TCS	Database of Technical Control Stations
TERT	Technical Expert Review Team
TGM WRI	T. G. Masaryk Water Research Institute
ÚCL	Civil Aviation Authority of the Czech Republic
UKZUZ	Central Institute for Supervising and Testing in Agriculture
VFR	Visual Flight Rules
VUZT	Research Institute of Agricultural Technology

WaM	Scenario with Additional Measurements
WM	Scenario with Measurements
WMP	Waste Management Plan

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