II. AIR POLLUTION

The CHMI evaluates the level of air pollution under authorisation by the Ministry of the Environment for primary pollutants of anthropogenic origin. The basic background material for this evaluation consists of the "emission inventory", which combines the direct collection of data reported by operators of sources with model calculations of data reported by operators of sources or determined in the context of statistical studies performed primarily by the Czech Statistical Office. The resulting emission inventories are presented in the form of emission balances in sectoral and territorial classifications (CHMI 2021a). The accompanying documents describing the methodologies for processing emission inventories are also presented on the CHMI website (CHMI 2021b). The current report (CHMI 2021f) presents results of the emission inventory for the period 1990–2019, taking into account recommendations of the team reviewing the inventory methodology of the EU Member States. These relate mainly to the calculations of ammonia emissions from the application of mineral fertilizers, and the inclusion of emissions of the sectors agricultural activities (NMVOCs and NO_x) and food production (NMVOCs). The time series for road transport were recalculated due to an update of the COPERT balance model used and new methodological recommendations for performing calculations by the model.

Emission inventory in the Czech Republic

From the viewpoint of methods for monitoring emissions, air pollution sources are divided into individually monitored sources and collectively monitored sources. Sources listed in Annex No. 2 of the Act No. 201/2012 on the air protection are monitored individually. Pursuant to Article 17(3)(c), the operators of these sources are obliged to keep operating records of permanent and variable data on stationary sources, describing the source and its operation, and also data on inputs and outputs from these sources. They are also obliged to annually report information on the summary operating records (SPE) through an integrated system of fulfilling reporting obligations (ISPOP in Czech). ISPOP data are then collected in the REZZO 1 and REZZO 2 databases. Data collection for the previous year takes place from January to the end of March.

Collectively monitored sources registered in REZZO 3 include emissions from unspecified combustion sources, construction and agricultural activities, the surface use of organic solvents, filling stations, coal mining, car and building fires, waste and waste-water treatment, the use of fireworks, etc. Emissions from these sources are determined using data collected by national statistical surveys and emission factors.

Data from mobile sources are also monitored collectively (REZZO 4) and include emissions from roads (including NMVOC emissions from vehicle fuel system petrol evaporation and emissions from brake, tyre and road abrasion), rail, water and air transport, and the operation of off-road machinery and equipment (agricultural, forest and construction machinery, military vehicles, greenery maintenance, etc.). Emissions from resuspension, i.e. dust swir-

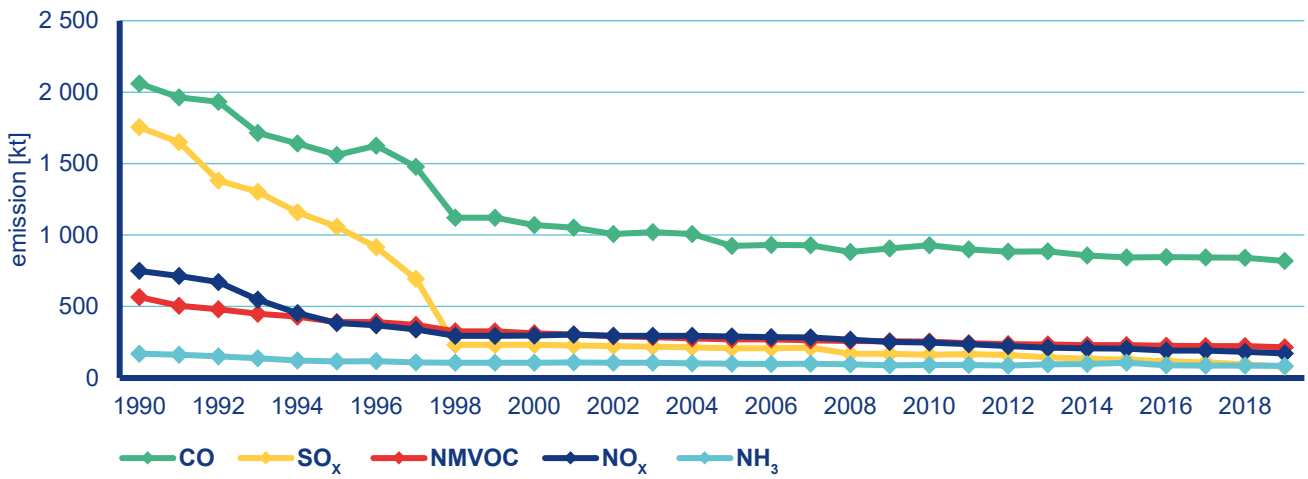

Fig. II.1 Main pollutants total emissions, 1990–2019

ling during vehicle operation, are not part of the emission inventory.

For the model assessment of pollution levels, to determine emissions from domestic heating, emissions factors are applied that represent estimated conditions when boilers are operated for part of the time at reduced output, meaning imperfect combustion and increased emissions (EU 2015).

Emission trends

Trends in air pollution levels are closely connected with economic and social-political conditions, as well as with the development of knowledge about the environment, permitting more complete and accurate emission inventories. A time series of the 1990–2019 period separated for the main gaseous pollutants, particulate matter, heavy metals and POPs is presented in Figs. II.1 to II.4. During this period, the main pollutant emissions have been decreased by tens of percents. After an initial decrease in the period up to 2008, benzo[*a*]pyrene emissions again started to increase, and by 2012 approached the level in 2001. Due to a higher rate of black coal consumption in households after 2010, HCB emissions were also increased. In 2012, they reached levels 35% higher than in 2000. Emissions from stationary sources in REZZO 1 and REZZO 2 decreased substantially as a result of the introduction of an air quality control system that uses a number of instruments (normative, economic, information, etc.) at various levels. The impacts of these instruments appeared to the greatest degree at the end of the 1990s, i.e. at a time when emission limits introduced by the then new legislation came into force. Significant reductions emissions from the most important sources had a positive affect on air quality, especially in industrial areas of Northern Bohemia and Moravia,

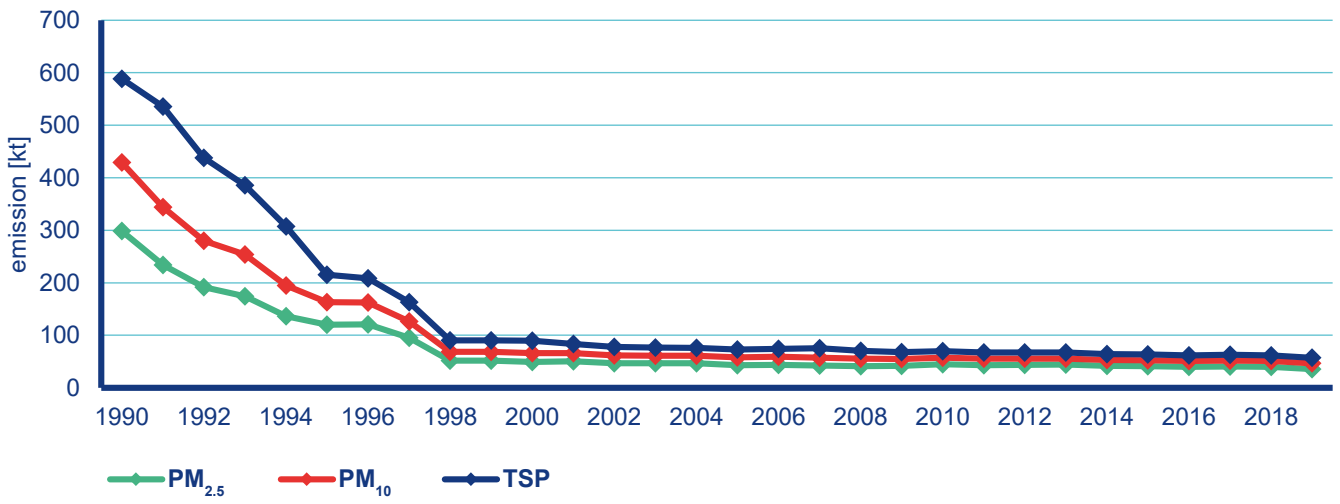

Fig. II.2 Particulate matter total emissions, 1990–2019

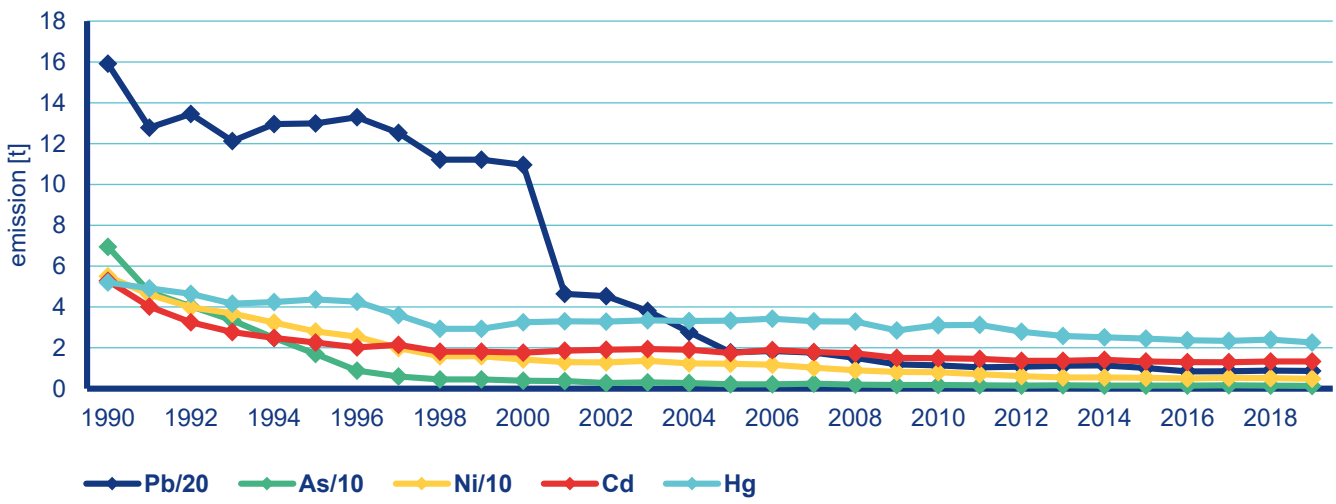

Fig. II.3 Heavy metals total emissions, 1990–2019

and there was also a significant reduction in the long-distance transport of pollutants. Despite significant reductions in emissions from energy and industrial sources, compliance problems with air quality requirements persist in many places, which is why attention has been focused in recent years on REZZO 3 and REZZO 4 categories. Although there has been a significant reduction in emissions, especially from road transport, the impact of these sources on air quality is significant mainly in municipalities, and no effective country-wide measures have yet been applied to regulate them. For these reasons, among others, revision of the Göteborg Protocol and Directive of the European Parliament and Council (EU) 2016/2284 imposes the obligation on the CR to reduce emissions by 2020 for $PM_{2.5}$ by 17%, SO_x by 45%, NO_x by 35%, NMVOCs by 18% and NH_3 by 7% and by 2030 for $PM_{2.5}$ by 60%, SO_x by 66%, NO_x by 64%, NMVOCs by 50% and NH_3 by 22%, compared to 2005.

In 1991, Act No. 309/1991 Coll., on air protection, came into force, supplemented by Act No. 389/1991 Coll., on state administration in air protection and fees for pollution thereof, which introduced emission limits with validity from 1998 for the first time in the history of the CR, with validity from 1998. As a result of the restructuring of the economy and the modernization of resources, there has been a significant decline in production in a number of sectors since 1990 (Fig. II.5). For combustion sources with lower heat output (heating plants/boiler rooms), solid and liquid fossil fuels were gradually replaced by natural gas (Fig. II.6).

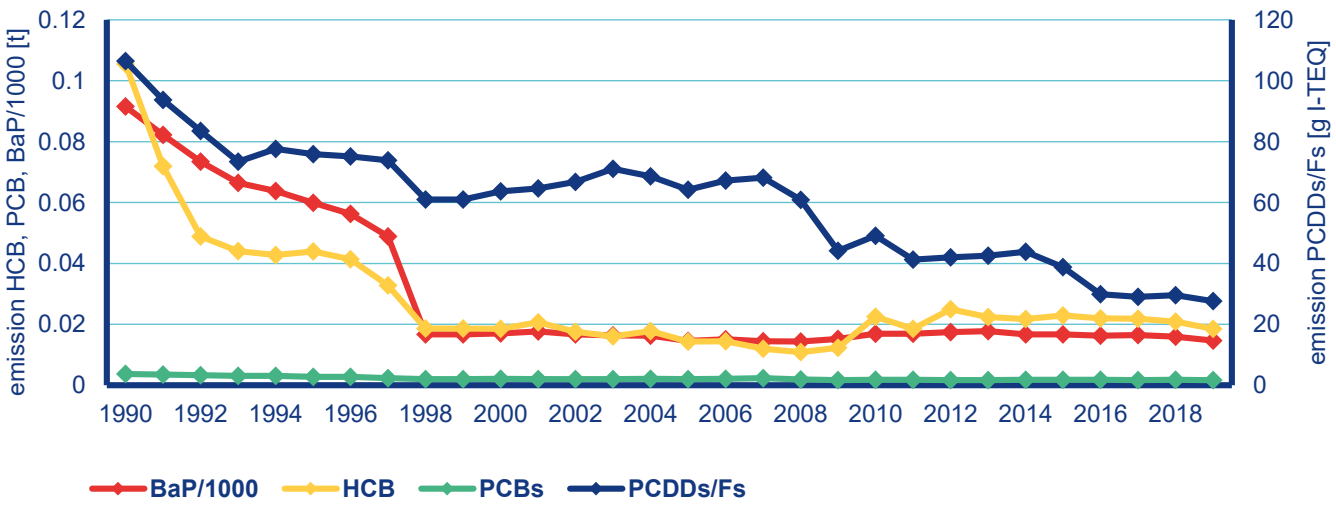

Fig. II.4 POP emissions, 1990–2019

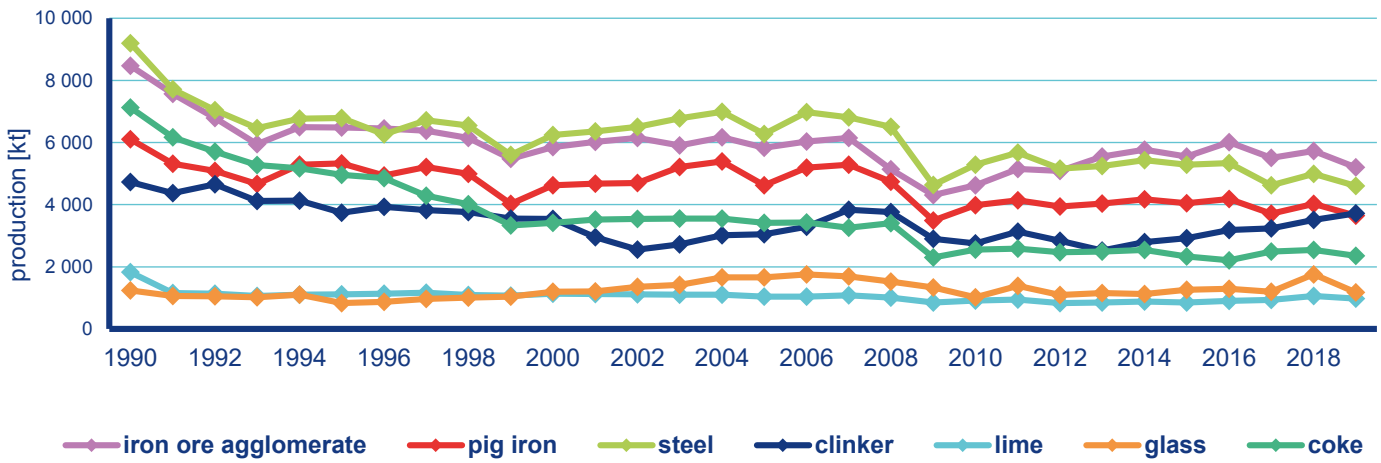

Fig. II.5 The output of basic industrial products, 1990–2019

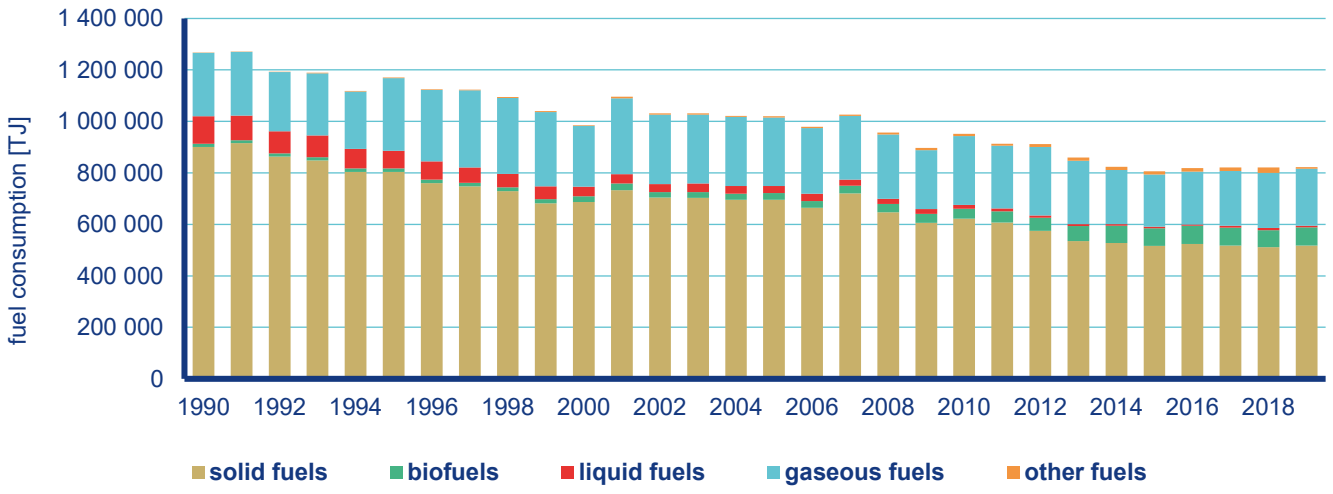

Fig. II.6 Fuel consumption in REZZO 1 and REZZO 2 sources, 1990–2019

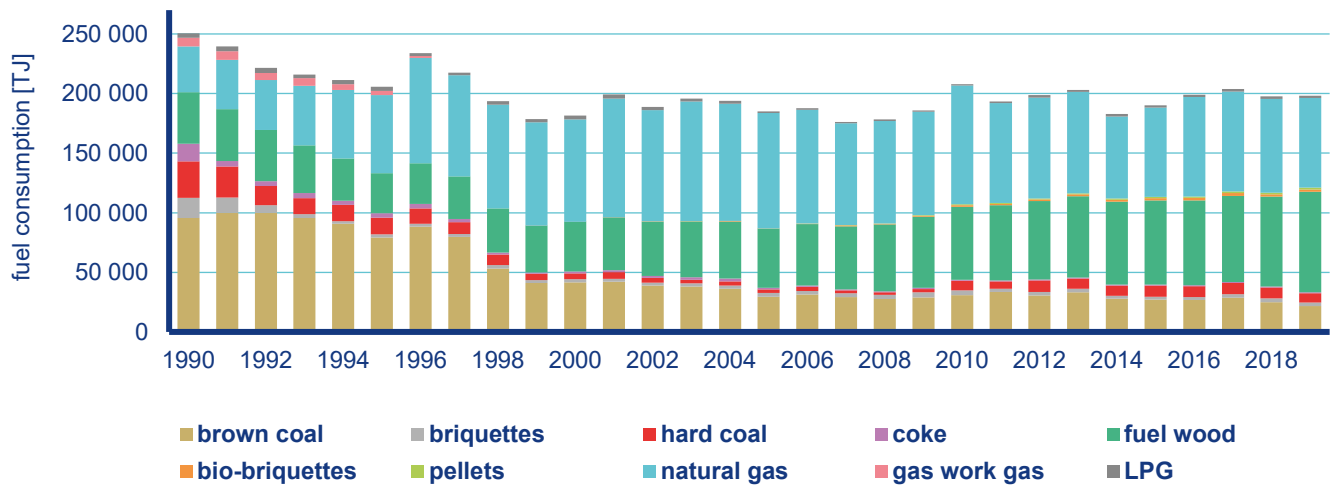

Fig. II.7 Fuel consumption in REZZO 3 sources (households), 1990–2019

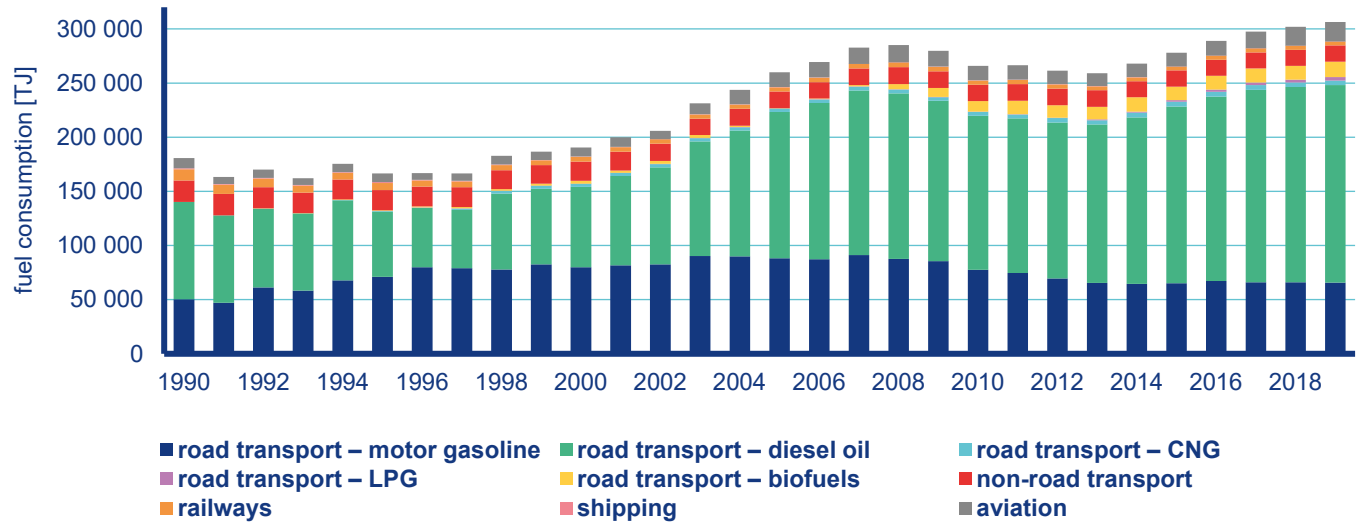

Fig. II.8 Fuel consumption in REZZO 4 sources, 1990–2019

Emissions from local household heating decreased most in the 1993–1997 period as a result of conversion to gas heating in municipalities and state support for heating with electricity. The consumption of household fossil fuels in 2001 was 67% lower than in 1990 (Fig. II.7). Emissions of the main pollutants from REZZO 4 sources decreased due to regular vehicle fleet renewal. Termination of the sale of leaded petrol in 2001 led to a substantial decrease of Pb emissions into the air (Fig. II.3).

The favourable trend in reducing consumption of fossil fuels in the local household heating sector did not continue after 2001, mainly because of the increasing prices of natural gas and electricity. In the 2002–2008 period, the consumption of coal slightly decreased and was replaced by increasingly popular heating with wood. After 2009 the consumption of solid fuels in households, particularly firewood, again started to increase (Fig. II.7). In 2009–2012, the Green Light for Savings programme helped in insulating buildings and environmentally unsound heating being replaced by low-emission sources. Emissions of the main pollutants from REZZO 4 sources decreased due to introduction of stricter emission standards for new vehicles brought to market. The impact of increased intensity of transport and consumption of diesel fuel led to an increase in emissions of heavy metals and POPs (Fig. II.8).

In 2012, the Act No. 201/2012 Coll. on air protection came into force, introducing stricter emission limits for combustion sources pursuant to Directive 2010/75/EU on industrial emissions. The most important technical measures to reduce emissions in the 2013–2020 period included the installation of sulphur-removal and nitrogen-removal equipment from combustion products (most power plants and larger heating plants) or the installation of fabric filters on existing electrostatic separators (e.g. at metallurgical plants in the Moravian-Silesia region).

The new legislation it also focused on reducing emissions from the local household heating sector by introducing minimum emission parameter values for combustion sources with overall rated thermal input of up to 300 kW for equipment brought to market since 2014 and 2018. From 1 September 2022, for these sources will only be possible to operate boilers complying with emission class 3, which should lead to the removal of old types of boilers and their replacement by more modern equipment with lower emissions. The replacement of boilers takes place gradually, and together with reducing building energy demands, are supported by subsidy policies at national and regional levels.

Results of the emission inventory for the presented period 1990–2019 were recalculated on the basis of recommendations following regularly performed inspections and comparisons of the CR and EU countries national inventory methodologies (CHMI 2021f). A more significant change was made in the NMVOC emissions inventory of the sector Residential: Heating, water heating, cooking (1A4bi), where NMVOC emissions were reduced through recalculating previously used emission factors. The emission inventory of the agricultural sector was prepared using completely new permanently developed procedures, according to which better methodologies called Tier 2 (CHMI 2021b) were used for the first time. The most significant methodological adjustments ranging approximately between 10 and 30 kt per year were reflected in NH_3 and NMVOC emissions mainly in connection with changes in technologies used to reduce emissions produced from livestock and fluctuations in the consumption of mineral fertilizers.

The preliminary emission assessment for 2020 (Tab. II.1) shows further reductions for all major pollutants. Of the listed REZZO 1–2 sources, emissions decreased the most concerning SO_x by 12 kt and NO_x by 8.2 kt. The reduction of SP emissions by 1 880 t represents a decrease of more than 26% compared to 2019. For some energy sources (power plants and heating plants) there was a reduction in production or even permanent termination of operation (ČEZ, a.s. — Prunéřov I power plant as of 30 June 2020, ČEZ Energetické služby, s.r.o. — Vítkovice heating plant, Sokolovská uhelná, legal successor, a.s. — Processing part PPC plant). In the sector of mining and processing of mineral resources, there was a decrease in mining by about 5%, but the amount of SP emissions reported at sources listed in category

Tab. II.1 The comparasion of emissions of main pollutants, 2019–2020 (preliminary data)

Emission source category	TSP		SO_x		NO_x		CO		VOC		NH_3	
	kt.year^{-1}											
Year	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
REZZO 1–2	7.0	5.1	62.3	50.3	68.2	60.0	159.8	153.8	20.8	18.8	0.6	0.7
REZZO 3	43.0	40.9	17.4	16.0	34.6	34.5	556.1	549.6	177.3	173.8	83.2	82.5
TOTAL stationary sources	**50.0**	**46.0**	**79.7**	**66.3**	**102.8**	**94.5**	**715.9**	**703.4**	**198.1**	**192.6**	**83.8**	**83.2**
REZZO 4	7.1	6.5	0.2	0.1	69.6	66.5	102.7	94.2	16.8	13.8	1.0	0.8
TOTAL	**57.1**	**52.5**	**79.9**	**66.4**	**172.4**	**161.0**	**818.6**	**797.6**	**214.9**	**206.4**	**84.8**	**84.0**

5.11 according to Annex No. 2 of the Air Protection Act decreased by almost half.

Reductions in reported emissions reflect a change in the methodology for calculating emissions for individual mining processes and operations, particularly for quarries. In the case of collectively monitored stationary REZZO 3 sources, the decrease in SP emissions (by 2.1 kt) is particularly due to reductions in domestic heating and also in other stationary sources, including coal mining which decreased year-on-year by 4.4% for lignite coal and by almost 25% for black coal. Although the number of degree-days in the heating period of 2020 compared to 2019 slightly increased (by about 1.3%), model calculations of emissions reflected positively replacements of boilers in households, following legislative measures. However, the Ministry of Industry and Trade statistical data (e.g. MIT 2021) show that the trend of purchasing new solid fuel boilers has slowed significantly in the last three years and in 2020, the lowest sales were recorded in the history of statistics since 1970. The decrease in fuel consumption in relation to the pandemic situation (petrol by approx. 9% and diesel by approx. 5%) was significantly reflected in the reduction of calculated emissions of REZZO 4 category sources. A more detailed assessment of emissions in the period 2010–2019 can be found in Chapter IV.

Projections of emissions

Within the framework of reporting concerning the Czech Republic's international obligations (CLRTAP) and Directive 2016/2284/EU, the CHMI provides projections based on emission inventories, trends of socio-economic indicators, legislation valid for the projected time horizon and further emission reduction measures.

Emissions projection for the period 2020–2030 (Fig. II.9) were prepared according to the WM (without additional measures) and WaM (with additional measures) scenarios for the purpose of updating the National Emission Reduction Programme (MŽP 2019). This projection was updated as part of the preparation of reporting under international obligations in March 2021. The projections for NO_X, NMVOCs, SO_X, NH_3, and $PM_{2.5}$ particles are based primarily on expert evaluations of future emissions and activity data for significant source categories such as energy, transport, agriculture, solvent use and waste management.

By 2030, it is anticipated that emissions of all pollutants will be reduced, resulting from the replacement of heating facilities in the local household heating sector, vehicle fleet renewal including support for low-emission and zero-emission vehicles, greater support for renewable energy, tightening of obligations for the storage and application of fertilizers, and other measures.

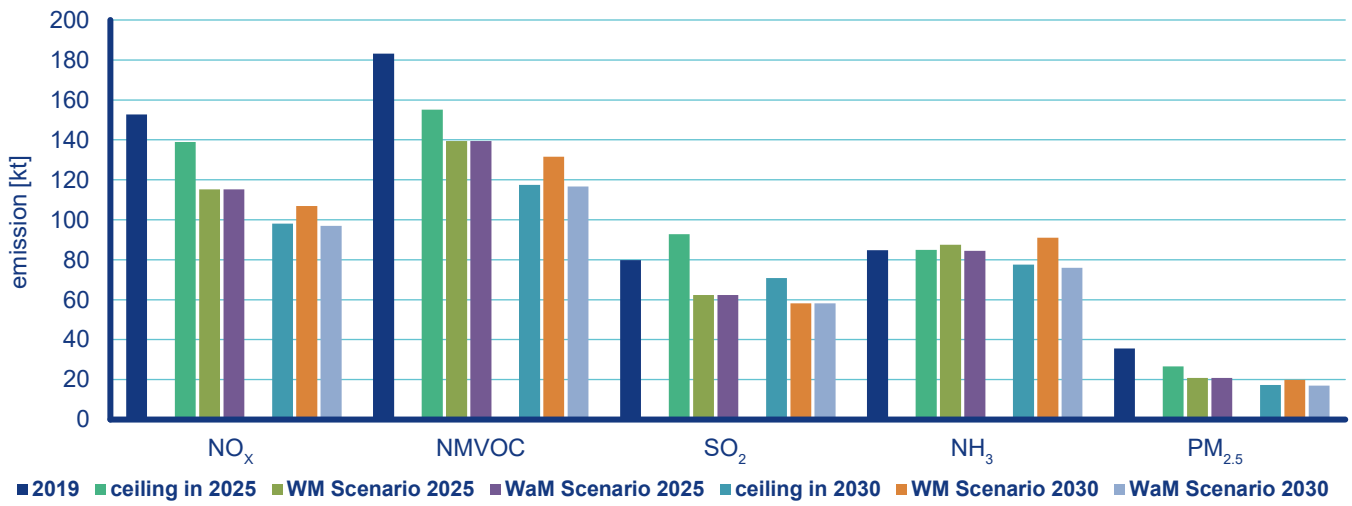

Fig. II.9 Comparison of emission ceilings and emission projection scenarios of basic air pollutants