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Emission inventories from the base year of the protocols to the year 2021

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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.

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) [1]. 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 [3]. The total commitments of the Czech Republic are shown in Table 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) [3].

Table 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

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 2.

Table 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

Summary of projection in the context of commitments

Ceilings 2020

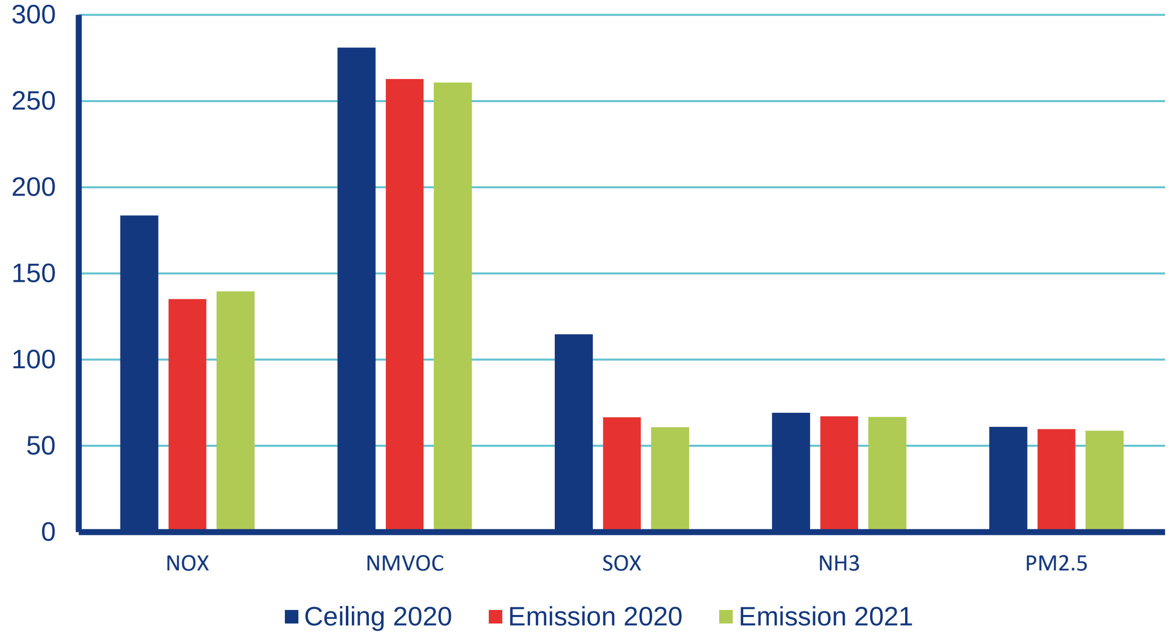


Figure 1- Czech Commitments 2020

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

Ceilings 2030

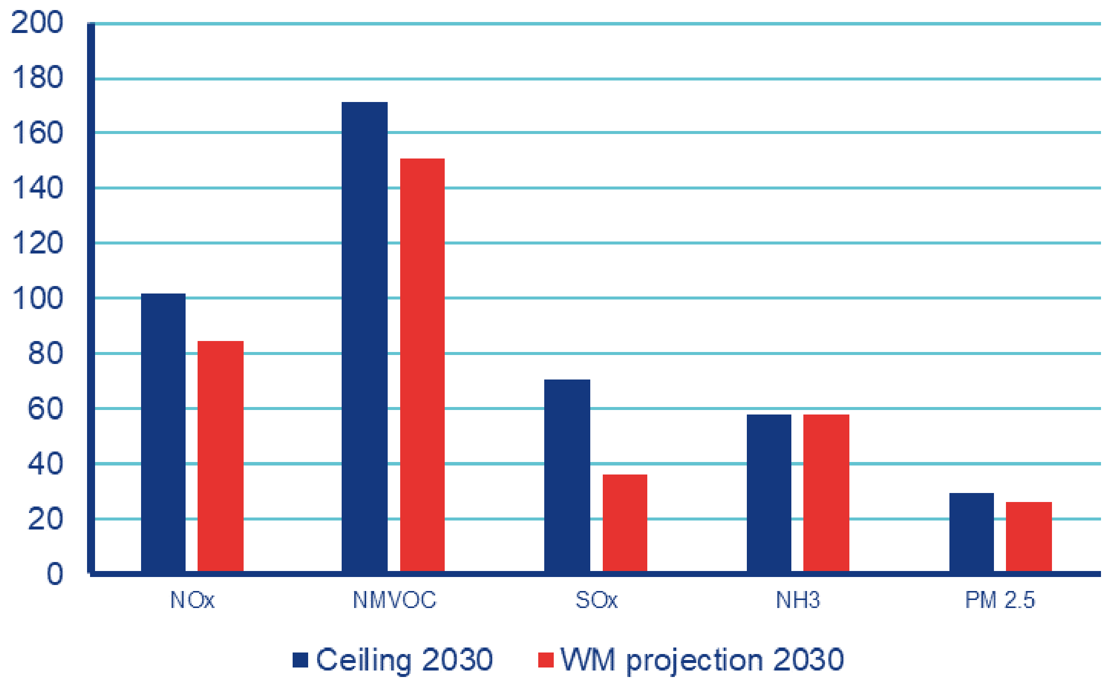


Figure 2 - Czech Commitments 2030

In 2030 will achieve the emission ceiling limits for all Emissions pollutants by the scenario WM.

Ceilings 2050

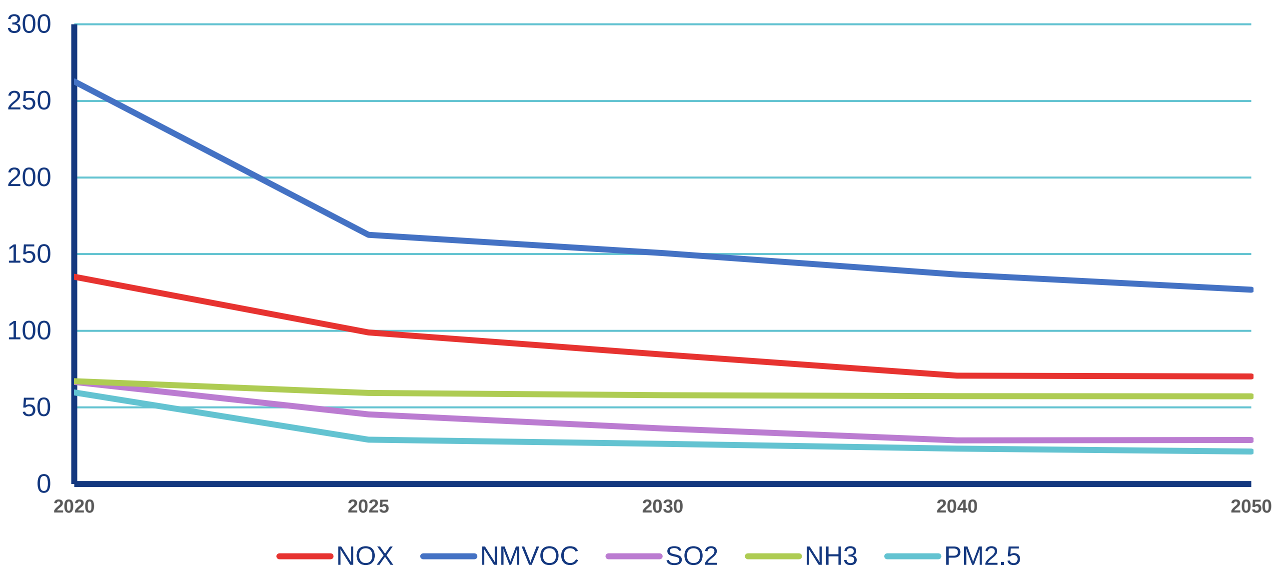


Figure 3 - Czech Emissions by WM Scenario

In 2050 will achieve the emission ceiling limits for all Emissions pollutants by the scenario WM. Because the projected values of emissions slightly decrease or stagnate. However, additional policies and precautions will need to be implemented.

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.

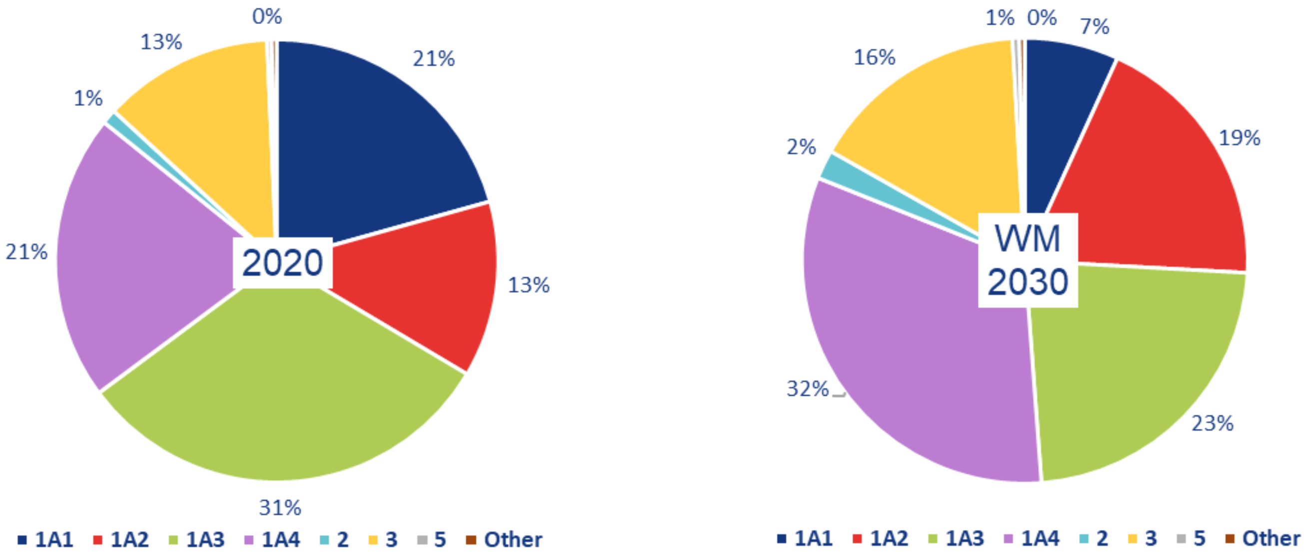


Figure 4 - NO_X share

NMVOC

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

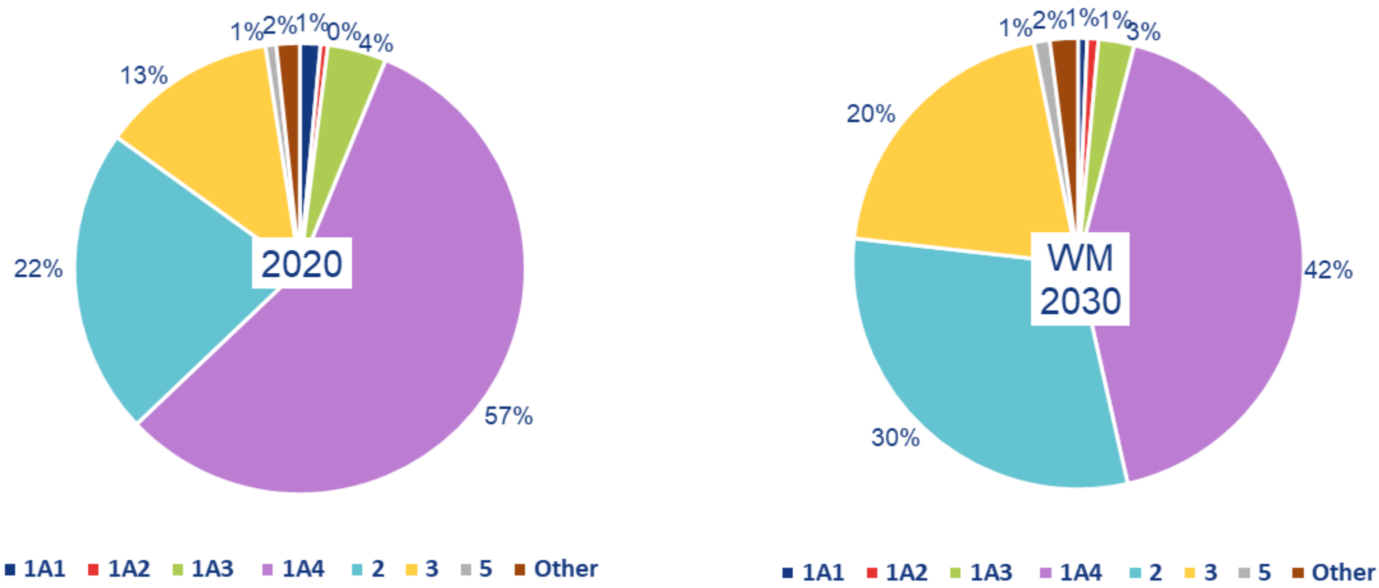


Figure 5 - NMVOC share

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.

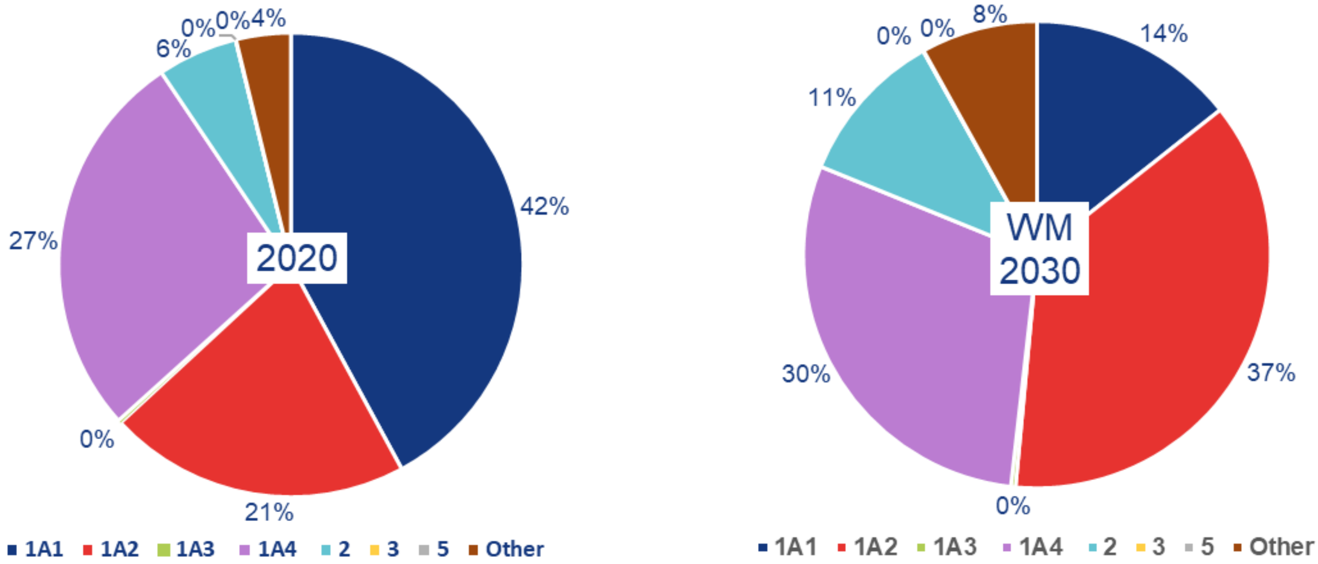


Figure 6 - SO_X share

NH_3

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

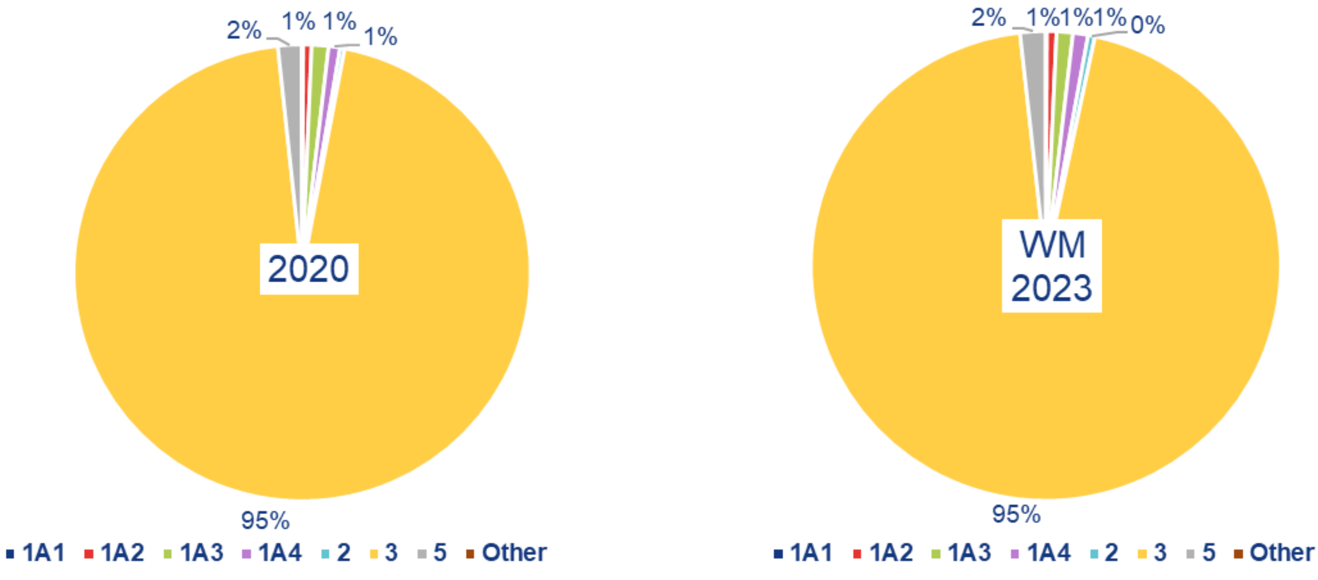
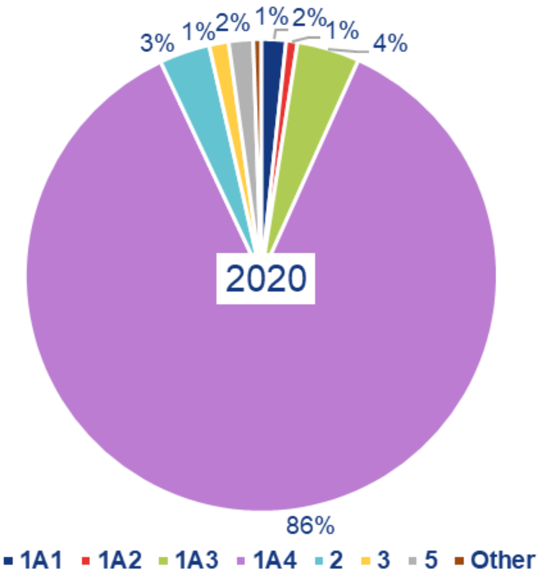


Figure 7 - NH_3 share

$PM_{2.5}$

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



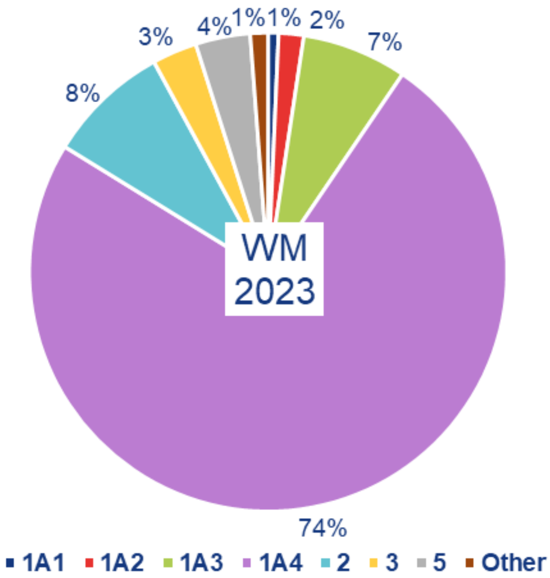


Figure 8 - $PM_{2.5}$ share

Projections by individual sectors

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 (Large combustion plants) [5]. 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 in the 1. Energy sector by TIMES-CZ model [6][7].

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) [8]. 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 [9].

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 [10] but 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, NO_2) and other pollutants (SO_2, NO_X, NMVOC, PM) are included in the model.

Assumption of WM scenario

The final energy service demand is based on the National Energy Climate Plan (NECP) [11]. 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) [12].

Assumptions of fuel prices are taken from Recommended parameters for reporting on GHG projections in 2023 [13].

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 [13]. 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 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 [14].

Table 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 (auto producers) 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 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
Naturalgas	62.6	30.4	51.4	68.9	68.7	82.7	139.1
Othergases	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
Liquidfossil	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.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.

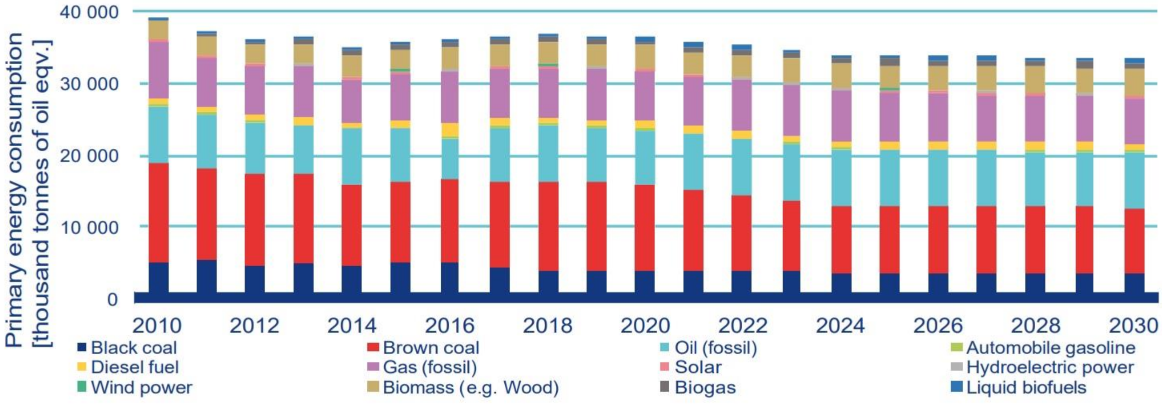


Figure 9 - Primary energy consumption, 2010-2030

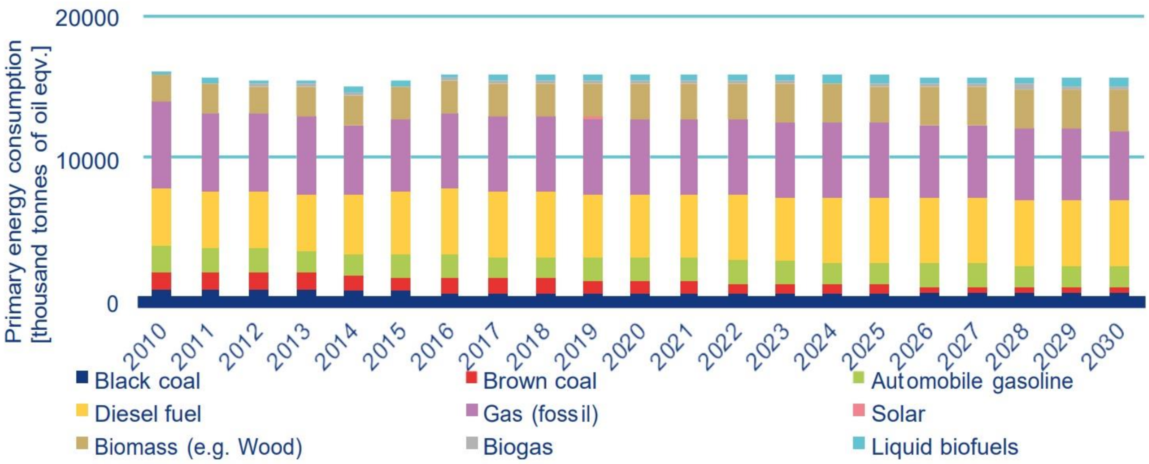


Figure 10 - Final energy consumption, 2010-2030

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 fleet and kilometers 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 percent.

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 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 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 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 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

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 [15]. A revision of emission inventories in 2017 [16] according to the Directive of the European Parliament and the Council (EU) 2016/2284 and the results of the statistical survey ENERGO 2015 [17] led to a new methodology for inventorying emissions from combustion in households [18]. 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 [18]. 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 [19].

Another change in the methodological approach is related to the comments of the team of emission experts [20], who carry out 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.

Methodology for inventorying emissions from fuel combustion in households

Fuel consumption in Czech households for 2021

Fuel consumption in households at the level of the entire Czech Republic is determined by the Czech Statistical Office (CSO), which processes the data in the format of international IEA - EUROSTAT - UNECE questionnaires. The consumption of individual types of coal fuels for emission inventories is from the CZECH_COAL questionnaire in natural units. The conversion of coal fuel consumption into energy units for emission inventory is carried out annually with the calorific value adjusted according to a specific investigation provided by TEKO [21]. The CZECH_REN questionnaire in energy units, according to statistical surveys of the Ministry of Industry and Trade (MIT), provides the consumption of bio-briquettes and pellets is singled out [22]. The calorific value of 45.9 $MJ{\cdot}kg^{-1}$ is used to calculate the consumption of propane-butane listed in the CZECH_OIL questionnaire. The data on the consumption of gaseous fuels from the CZECH_GAS questionnaire in energy units of combustion heat are converted to energy units determined from the calorific value for the emission inventory. The development of household fuel consumption in units of heat contained in the fuel and the scheme of the national calculation methodology is presented in Chapter III.2 Smaller and area stationary sources (NFR 1A4 and 1A5) in the document of IIR 2023.

The ENERGO 2021 survey provides the distribution of total fuel consumption according to the type of combustion equipment (Table 10) as well as the determination of the proportion of stored wood. Based on the stored wood information an expert assessed a new distribution of dry and wet wood consumption. MIT processed the complete outputs of ENERGO 2021, specifically the Department of Analysis and Concept Data Support at the turn of 2022 and 2023. Detailed information is presented by MIT (Modlík, 2024).

One of the most important outputs of ENERGO 2021 was the new determination of the share of individual types of boilers and the share of heaters for all types of monitored fuels. The new distribution of total fuel consumption by type of combustion equipment for the year 2021 and a comparison with similar shares determined by the original methodology according to the ENERGO 2015 outputs are in Table 10. A comparison of the development of the representation of basic types of gas boilers is shown in Table 11.

Table 10 - Shares of fuel consumption by type of combustion equipment, ENERGO 2021 and ENERGO 2015

Fuel type		Combustion boiler type [%]									
Fuel section	**Fuel**	**Over – fire boilers**		**Under – fire boilers**		**Automatic boilers**		**Gasification boilers**		**Stoves and fireplaces**	
		ENERGO 15	ENERGO 21	ENERGO 15	ENERGO 21	ENERGO 15	ENERGO 21	ENERGO 15	ENERGO 21	ENERGO 15	ENERGO 21
Coal	**Brown coal**	28.1	6	42.1	45.4	18.2	35.6	6.4	9.2	5.2	3.8
	Black coal	60.4	23	19.1	35.2	11.9	31.1	4.1	8.2	4.6	2.5
	Briquettes	56	35.3	25.9	36.9	2.9	5.7	3.1	12	12.2	10.1
	Coke	88.1	76.7	10.1	8.3	0.4	12.6	0	0	1.4	2.3
Biomass	**Dry wood**	35.5	31.7	22	13.3	2	3.1	13	19.9	27.6	32
	Wet wood	36.2	27.5	17.9	13	1.5	7.6	8.9	7.6	35.6	44.2
	Bio- briquettes	20.1	23.8	11.9	9.5	2.8	2.8	7.8	11	57.4	53
	Pellets	0.8	5.8	0.9	0.5	41.3	40	0	3.5	57.0	50.3

Table 11 - Share of gas boilers by type

Gas boiler type	2015	2021
Atmospheric boiler	85 %	57 %
Condensing boiler	15 %	43 %

The wood-wet category includes the consumption of wood that households do not store or dry for less than 6 months. Of the outputs of ENERGO 2021, the share of wood–wet was set at 8 % and for the Wood – dry category at 92 %. Wood–dry was at 85 % as a representation of stored wood until 2016.

A new parameter used in the calculations of the amount of emissions is the percentage representation of combustion sources operating in reduced power mode. ENERGO 2021 outputs determined the highest share corresponding to the representation of combustion sources operated without storage tanks (or with an inadequate storage tank) for post-burning boilers, post-burning boilers and local heaters (Table 12).

Table 12 - Proportion of resources operating at reduced and nominal power for 2021

	Combustion test level	
	Cut power	**Full power**
Combustion boiler type	**[%]**	
Over–fire boilers	90.0	10.0
Under–fire boilers	90.0	10.0
Automatic boilers	86.5	13.5
Gasification boilers	45.5	54.5
Stoves and fireplaces	89.5	10.5

Model of emissions inventory and projection of emissions from fuel consumption in households
The model of the emission inventory and projection of emissions from fuel consumption in households is currently processed in a spreadsheet (MS Excel). The dividing of the types of combustion sources and fuels described above (Table 10) used for emission inventory calculations is also used in this model for emission projections. The calculation matrix includes all types of combustion equipment listed in Tables 10 and 11, intended for burning solid or gaseous fuels. Solid fuels are further divided into coal fuels, i.e.

brown and black sorted coal, briquettes (including pellets) and coke, and biomass, represented by wood biomass, wood pellets and bio-briquettes. Liquid fuels are not included in the national emission inventory, as they represent a minority. Therefore, liquid fuels are not monitored by the energy balance of the CZSO for households. Gaseous fuels include burning propane-butane and natural gas. From the point of view of the devices used, natural gas boilers are divided into conventional and condensing boilers. Their ratio is based on long-term sales monitoring and the ENERGO survey. The matrix of the types of boilers and solid fuels used currently includes all combinations between the mentioned fuels, four types of boilers and one general category of heaters, including stoves, fireplaces, and other combustion sources with manual addition (Table 10). The use of heater sales statistics allows future matrix expansion to include detailed types of heaters, e.g. fireplaces, fireplace inserts, stoves, etc.

The calculation scheme for the emission inventory from 1990 and the projection until 2030 (and beyond) is based on three basic variable parameters. The first parameter concerns the development of the number of combustion sources according to the type of fuel. Thus, the second parameter reflects the transition to non-emission methods of heating apartments, especially the use of heat pumps in recent years. The second variable parameter includes changes in the number and hereby the representation of the above-mentioned types of boilers. However, the projection model still omits the replacement of boilers with heaters and vice versa. The third variable parameter is the development of emission factors for reduced and nominal power, derived from the assumption of the development of the number of boilers with storage tanks. Therefore, the last parameter affects significantly the historical emissions as well as their projection. All these three parameters were calculated for the year 1990 and updated for emission inventories in the time series until 2021 and also for projections until 2050. Table 12 shows the basic settings for the year 2021. Table 13 shows the development of percentage representation in the years 1990–2030; the last line shows the assumption of a change in the representation of older types of heaters until 2025 and 2030, based on sales statistics of new heaters that meet the requirements for Ecodesign.

Table 13 - Development of the share of boilers operated at reduced thermal output according to the type of combustion equipment and the share of heaters not meeting Eco-design in the period 1990 – 2030

Parameters for calculation		1990	2000	2005	2020	2025	2030
The volume of dry wood		do r. 2016 = 85 %			od r. 2020 = 92 %		
Share of reduced output for boilers, stoves and fireplaces	Over–fire boilers	98 %	98 %	97 %	95 %	0 %	0 %
	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 %

To set the shares for the year 2021 (Table 12) and for the previous, current and future representation of emission factors for reduced and nominal output (Table 13), come from the RTCOC of stationary combustion sources for solid fuels with a total nominal heat input of 10 - 300 kW (§ 17 paragraph h) of

Act No. 201/2012 Coll.). Data evaluation on the installation of storage tanks depends on the type of boiler and the year of their manufacture.

Model of territorial distribution of fuel consumption for heating apartments.

The methodology for determining fuel consumption at the level of basic territorial units is based on the calculation of the average annual consumption of heat and a specific type of fuel for an average apartment. The main basis for determining fuel consumption is the results from the Census of Population, Houses and Dwellings in 2021 [23], which provides data on the heating method and the size of the floor area of the apartments. Because the ENERGO 2021 statistical survey was processed into the Census of Population, Houses and Dwellings 2021 a new set of data could be used from 2021 for the territorial distribution of fuel consumption: updated numbers of apartments, representation of apartments in family and apartment buildings, shares of fuels in combinations main and secondary methods of heating apartments and other parameters. A new calculation model and a detailed description of its processing have been published by MIT in a study by Modlík (2024) [24].

The update of the model's key parameters for the next period will be carried out using sales statistics of boilers and heaters, information on boiler replacements according to the evaluation of subsidies and updating of technical parameters (calorific value of fuels, etc.). An update of the number of newly completed flats and their heating method can be processed every year from the number of new flats and the method of their heating processed according to the statistics of newly completed flats, also using the documents of fuel and energy distributors. Internal changes in total fuel consumption will be calculated based on the nature of the heating season, which is expressed in the calculation every year by the number of degree days determined for each municipality based on region and altitude.

Comparison of the emission balance from fuel combustion in households according to ENERGO 2015 and ENERGO 2021

The values of most pollutant emissions are higher according to the new methodology for calculating emissions regarding the recommendations of the TERT expert team than according to the previous methodology based on the evaluation of ENERGO 2015 and the emission factors for the combustion mode at nominal output. The highest differences are for TSP (including PM), CO and NMVOC emissions. The increase in emissions of TSP causes higher emissions of heavy metals and POPs, e.g. BaP emissions. On the contrary, NO_X emissions slightly decrease due to lower combustion temperatures at reduced output. The current model reflects the effect of the gradual phasing out of both types of grate boilers with manual loading and the increase in the share of more ecologically friendly boilers (gasification and automatic fuel dosing), operated to a greater extent with connection to storage tanks. Some emissions have decreased since 2015 due to the change in the share of stored wood biomass.

The territorial model of emissions divided by regions or individual municipalities reflects the aforementioned changes as well as other adjustments in the processing of SLDB outputs. These changes in methodology were processed and published by the MPO Modlík (2024) [24].

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.

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.

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.

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 [5].

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 [1].

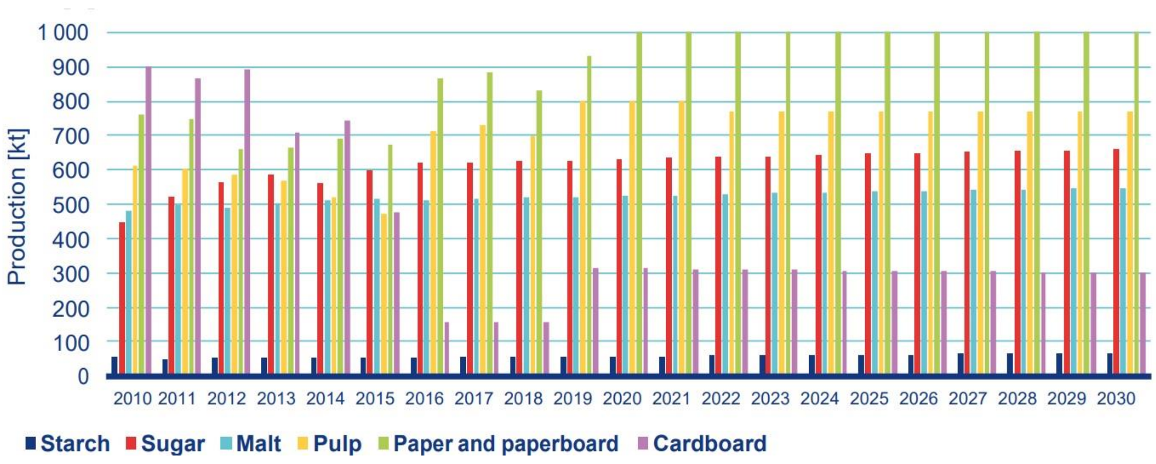


Figure 11 - Production of food and paper, 2010-2030

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.

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 14 shows the trends of the livestock population in the period 2005-2040.

Table 14 - 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 are 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 12 and from manure application and animal grazing in Figure 13.

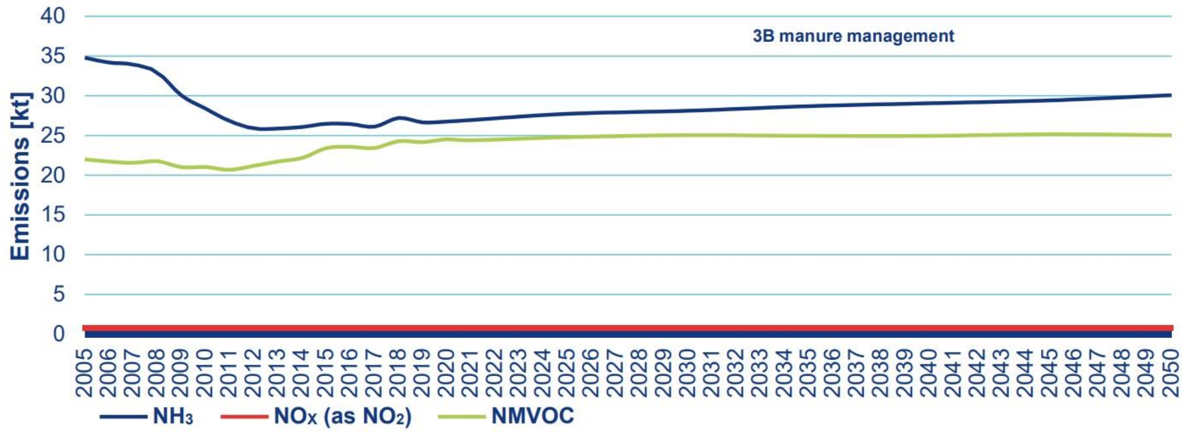


Figure 12 - NH_3, NO_X and NMVOC emissions originating from manure management, 2005-2040

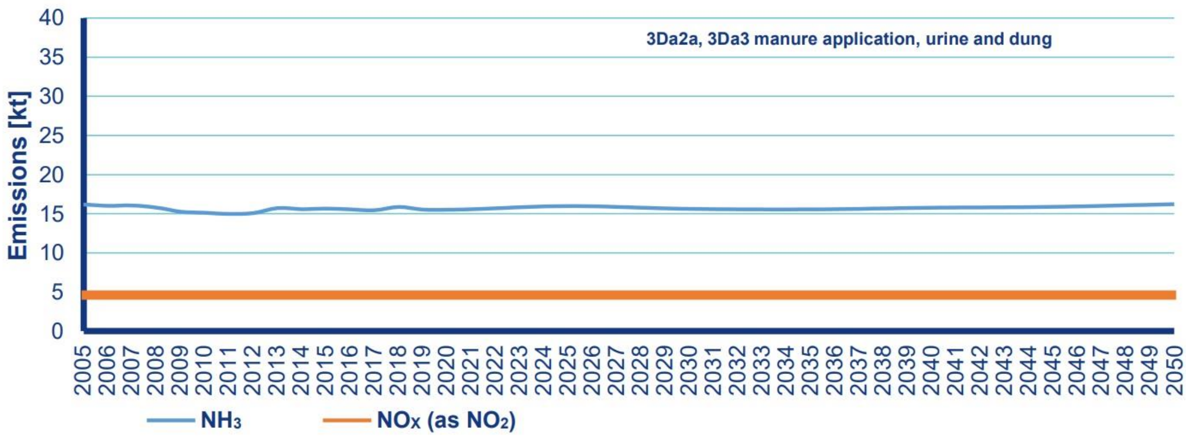


Figure 13 - NH_3 and NO_X originating from manure application, urine and dung deposited by grazing animals, 2005-2040

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 15 shows the trends of N inorganic fertilizer consumption in 2005-2040.

Table 15 - 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 [1]. For the estimation of NO_X, Tier 2 is not available, too, for the estimate of NO_X, which means the Tier 1 approach has been used. 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 14.

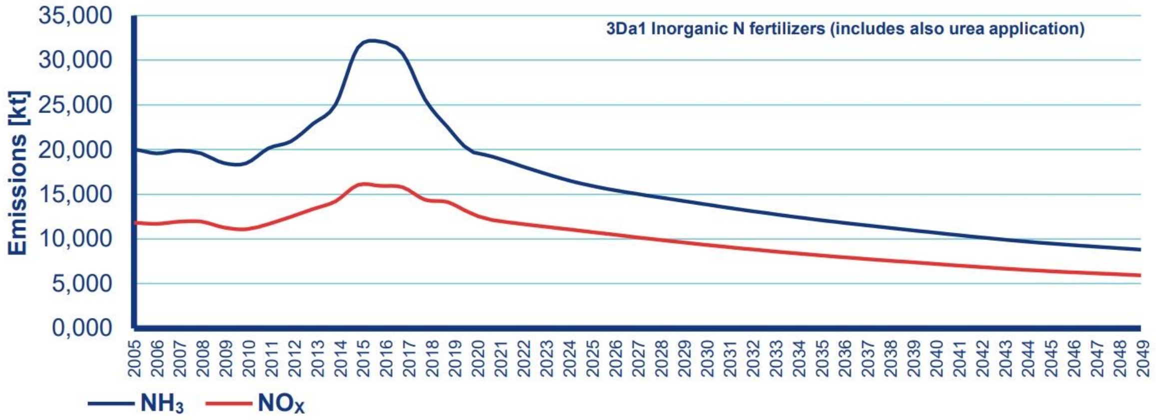


Figure 14 - NH_3 and NO_X emissions originating from inorganic N-fertilizers application, 2005-2040

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 16 shows selected crops' cultivated area trends in 2005- 2040.

Table 16 - 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 17 shows the trends of the share of the tillage method.

Table 17 - Trends of share of tillage method, 2020 - 2040

Share of tillage method in the year	Conventional (deepploughing or disc ploughing)	Minimalisations (shallow ploughing)	No-tillage (directseeding)
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 15.

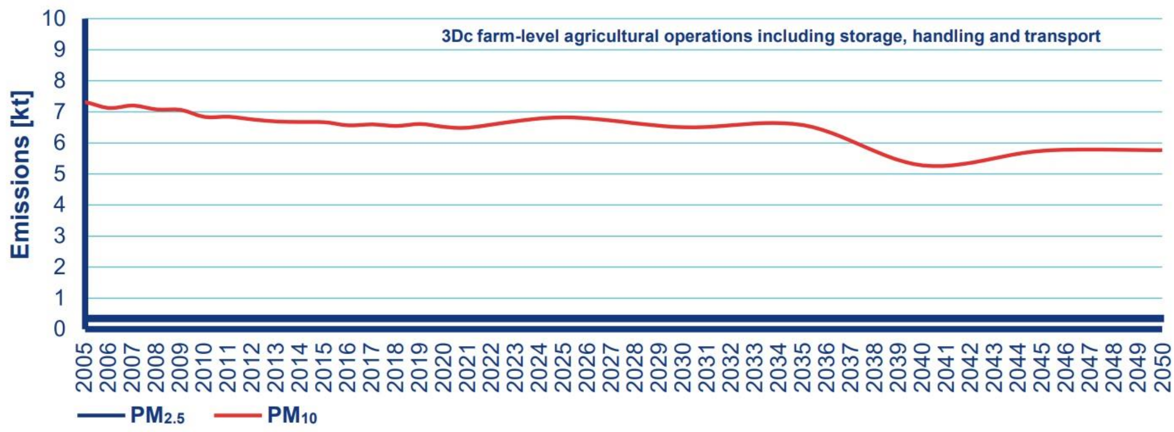


Figure 15 - PM emissions originating from farm-level agricultural operations including storage, handling and transport of agricultural

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.

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 [1]. 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.

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