Integrated reporting on greenhouse gas policies and measures and on projections in the Czech Republic

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EXECUTIVE SUMMARY

The Czech Republic is a Party to the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Paris agreement. Under these international agreements it is committed to provide annually information on its national anthropogenic greenhouse gas (GHG) emissions by sources and removals by sinks for all GHGs not controlled by the Montreal Protocol. As a member of the European Union, the Czech Republic has reporting obligations also under the Regulation (EU) No 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council, and Regulation (EU) No 2021/1119 of the European Parliament and of the Council, establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law').

The Czech Republic also biannually fulfils obligations to Regulation (EU) No 2018/1999 by submitting *Reporting on policies and measures and of projections of anthropogenic greenhouse gas emissions by sources and removals*. The reporting is organized and supported by the Czech Hydrometeorological Institute (CHMI) and the Ministry of Environment (MoE). The projections encompass two scenarios "with existing measures" (WEM) and "with additional measures" (WAM) according to guidelines published in the document FCCC/CP/1999/7, part II UNFCCC *Reporting Guidelines on National Communication,* and further in the above-mentioned EU documents. The reference year for both scenarios is the latest year for which emission estimates are available. In this case, the latest reported year is 2020. The projection years are 2025, 2030, 2035, 2040, 2045, and 2050.

1 Policies and Measures

1.1 Cross-cutting policies and measures

1.1.1 Climate Protection Policy of the Czech Republic

The Policy defines GHG reduction targets for 2020 and 2030. It also includes indicative trajectories and objectives for 2040 and 2050. Further, the Policy defines policies and measures for specific sectors on national level. Most of the identified policies and measures will be implemented by the time of the next Policy update, which is planned in 2023.

The Government adopted the Climate Protection Policy of the Czech Republic in March 2017 and this document replaced the National Programme to Abate the Climate Change Impacts in the Czech Republic (2004). This Policy reflects significant recent developments at the EU, international and national level. The long-term perspective for gradual transition to low emission development until 2050 was included in such governmental document for the first time. The Strategic Impact Assessment of the Policy was carried out and completed with an affirmative statement in January 2017.

The Climate Protection Policy sets specific targets and measures for the particular sectors on national level in order to fulfill greenhouse gas reduction targets resulting from international agreements as well as EU legislation. This Policy should contribute to gradual transition to low emission development until 2050. The Policy further sets primary and indicative emission reduction targets, which should be reached in a cost-efficient manner. Measures are proposed in the following key areas: Energy, final energy consumption, industry, transport, agriculture and forestry, waste, science, research development, and voluntary tools.

The Policy also outlines some economic aspects for the greenhouse gas reductions on the national level. The European structural and investment funds represent the main source of financing in the programming period of 2014-2020. Another key financial source is represented by the auction revenues generated by the EU ETS. The Policy was evaluated in 2021 and based on this evaluation the Policy will be updated by 2023 to reflect the news Fit for 55 package and the target of climate neutrality of the EU by 2050.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2017-2030

Implemented in scenario: WEM

Mitigation impact: The policy is a framework measure, therefore its mitigation effects is accounted under other specific measures.

Primary emission reduction targets

- Greenhouse gas reduction of 32 Mt CO_2 eq. compared to 2005 until 2020
- Greenhouse gas reduction of 44 Mt CO_2 eq. compared to 2005 until 2030

Indicative emission reduction targets

- Indicative level towards 70 Mt CO_2 eq. of emitted greenhouse gases in 2040
- Indicative level towards 39 Mt CO_2 eq. of emitted greenhouse gases in 2050

Sectors: Energy, Transport, Industrial Processes, Agriculture, LULUCF, Waste, Cross-cutting

Greenhouse gas coverage: CH_4, CO_2, N_2O, SF_6, NF_3

1.1.2 European Union Emission Trading System (EU ETS)

The EU ETS is one of the most important economic tools to reduce GHG emissions. The scheme for GHG emission allowance trading within the Community is established in the Directive 2003/87/EC amended or supplemented by Directives 2008/101/EC and 2009/29/EC, by Decision No. 1359/13/EU and by Regulation No. 421/2014/EU.

This legislation is transposed into the Czech legal system by Act No. 383/2012 Coll. on conditions for trading of emission allowances amending Acts No. 695/2004 Coll. and No. 164/2010 Coll. The Act 383/2012 was amended to transpose the revised Directive 2003/87/EC which sets rules for the new trading period 2021-2030.

Type of policy: Economic

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2005-2040

Implemented in scenario: WEM

Timeframe: Three trading periods of the EU ETS have been agreed. During the first (2005–2007) and the second (2008–2012) period, allowances were allocated free of charge in the Czech Republic. In the third period (2013–2020), there is a single EU-wide cap and allowances are allocated on the basis of harmonized rules. The single EU-wide cap on emission allowances replaces the previous system of national caps. The cap is cut each year (by 1.74%) so that by 2020 emissions will be 21% below the 2005 level. The free allocation of allowances is progressively replaced by auctioning in this period.

The legislative framework of the EU ETS for the next trading period (phase 4) was revised in early 2018 to enable it to achieve the EU's 2030 emission reduction targets in line with the 2030 climate and energy policy framework and as part of the EU's contribution to the 2015 Paris Agreement. The revision focuses on:

- Strengthening the EU ETS as an investment driver by increasing the pace of annual reductions in allowances to 2.2% as of 2021;
- Reinforcing the Market Stability Reserve (the mechanism established by the EU in 2015 to reduce the surplus of emission allowances in the carbon market);
- Continuing the free allocation of allowances as a safeguard for the international competitiveness of industrial sectors at risk of carbon leakage;
- Helping industry and the power sector via several low-carbon funding mechanisms.

Manufacturing industry will continue to receive a share of free allowances also after 2020. Free allocation is carried out based on benchmarks of greenhouse gas emissions performance. Installations that meet the benchmarks should receive all the allowances they need. Those that do not reach the benchmark values will receive fewer allowances than they need. These installations will therefore have to reduce their emissions, or buy additional allowances to cover their emissions.

A product benchmark is based on a value reflecting the average greenhouse gas emission performance of the 10% best performing installations in the EU ETS.

The benchmarks have been established for various products. This means the benchmark methodology does not differentiate according to the technology, fuel used, or according to the size of an installation.

The EU ETS influences through the increase of electricity price also the industrial, domestic and commercial sectors. For example, a substitution of electricity intensive industrial products may be expected.

In the first two phases, the cap on allowances was set at national level through national allocation plans (NAPs). The phase one caps were set mainly on the basis of historic emissions data. The total allocation of EU ETS allowances exceeded demand and in 2007, the price of phase one allowances fell close to zero.

In the second period, the cap was cut by 6.5% compared to the 2005 level. Due to the economic crisis that began in late 2008, there was again a surplus of unused allowances. The aviation sector was brought into the EU ETS on January 1st 2012 through legislation adopted in 2008.

Some work on legislation accompanying the revised Directive 2003/87/EC has been finalized – that includes delegated regulation determining the free allocation rules, regulation on the Innovation Fund and decision determining the sectors deemed to be at risk of carbon leakage. Other implementing legislation, such as detailed rules for the Modernization Fund, an EU-wide fund that will support investments in modernizing the power sector and energy efficiency, is currently under development.

As mentioned above, In the Czech Republic, the EU ETS is controlled via Act No. 383/2012 Coll., on conditions of trading with greenhouse gas emission allowances. This Act defines what facilities are subject to the system and the rights and obligations of operators. Operators monitor their emissions, report to the Ministry of the Environment and receive allowances. Part of the allowances is allocated free of charge; the remainder may be bought at the marketplace or in auctions. Allowances exist and can be transferred between allowance accounts within the registry, which is administered by the Czech electricity and gas market operator OTE, a.s.

In 2020, approximately 240 facilities participated in the system. The volume of emissions covered by the trading system in the Czech Republic represented approximately 51 % of total greenhouse gas emissions in the Czech Republic in 2019. Monitored greenhouse gases include CO_2 and N_2O.

Allocation plan represented the required premise before initiation of allowance trading in the first two trading periods. The NAP determines the quantity of allowances, which are to be distributed during the trading period to individual facility operators. The Ministry of the Environment has prepared the NAP in cooperation with the Ministry of Industry and Trade. The NAP2 (2008-2012) allocation plans covered the first Kyoto Protocol commitment period and directly followed NAP1 (2005-2007) created for the first trading period. When calculating the allocated volume of allowances, the Ministry of the Environment based its estimates on historical, only partially verifiable emissions between 2000 and 2004 (which means that the quality and availability of data for the preparation of NAP1 was limited) and on fully verified emissions for the period covering 2005 and 2006 (for NAP2). The third trading period 2013-2020 uses National Allocation Tables instead of NAP and these tables determine allocation per facility for each year according to benchmarks.

In case of NAP2 (2008-2012), the total level of allocation in the Czech Republic was decided on the 26th of March 2007 by the European Commission, which allocated 86.8 million allowances in average annually to the Czech Republic. This allocated volume includes a reserve for new entrants in the amount of 1.29 million allowances and a reserve for joint implementation (JI) projects amounting to 99 389 allowances.

In 2020, facilities covered by the EU ETS emitted 54.68 million t CO_2 eq. In comparison with 2005, there has been a reduction of emissions by 33.7 %. The Table 1-1 below shows verified emissions from individual activities and their share in total GHG emissions.

Tab. 1-1 EU ETS verified emissions 2005-2020 [kt CO2 eq.]

Activity/year	2005	2010	2015	2016	2017	2018	2019	2020
Combustion facilities	64.78	62.52	53.63	54.20	53.88	53.22	49.28	41.96
Refineries of mineral oils	1.00	1.05	0.93	0.71	1.00	0.92	0.98	0.80
Raw iron or steel	9.81	6.08	5.70	6.06	5.45	5.79	5.29	5.36
Production of coke	0.25	0.17	0.10	0.11	0.12	0.12	0.12	0.12
Production and processing of ferrous metals	0.07	0.10	0.11	0.10	0.10	0.10	0.09	0.09
Secondary aluminium	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02
Cement and lime	3.85	3.35	3.46	3.70	3.82	4.15	4.14	3.92
Manufacture of glass	0.81	0.67	0.72	0.73	0.75	0.74	0.73	0.72
Production of ceramic	0.73	0.41	0.38	0.40	0.41	0.42	0.45	0.41
Production of mineral wool	0.00	0.04	0.06	0.06	0.06	0.06	0.05	0.05
Production of pulp	0.09	0.07	0.02	0.02	0.02	0.01	0.02	0.02
Production of paper or cardboard	0.64	0.58	0.46	0.45	0.44	0.46	0.51	0.49
Chemical industry	0.43	0.54	1.00	0.92	0.84	0.80	0.75	0.64
Other	0.00	0.00	0.06	0.06	0.07	0.09	0.08	0.07
Total CO_2 eq EU ETS emissions	82.45	75.58	66.65	67.53	66.98	66.91	62.52	54.68
Total CO_2 eq emissions (without LULUCF)	147.73	139.61	127.97	129.58	130.46	128.55	122.64	113.34
Share of CO_2 eq EU ETS emissions in total emissions [%]	55.82	54.14	52.08	52.11	51.34	52.05	50.98	48.24

Source: MoE

It remains difficult to quantify the EU ETS effect on the development of emissions due to the fact that besides the EU ETS, companies are influenced also by developments in fuel prices or electricity and general economic development.

Sector: Civil aviation.

The new Directive 2009/29/ES of the European Parliament and of the Council of 23 April 2009 amending Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC included aviation activities in the scheme for greenhouse gas emission allowance trading within the Community. The new Directive, approved by decision of the Council 94/69/ES, reflecting the ultimate goal of UNFCCC i.e. to reach a stable concentration of GHG in atmosphere on the level which will prevent dangerous disruption of global climate system, should improve and extend the system of GHG´s emissions trading within the Community. The new Act 257/2014 Coll., which amended Act No. 383/2012 Coll. transposes the Directive 2009/29/ES into the Czech legal system.

Originally, the EU ETS was designed to cover all flights performed to/from and within the airports in the European Economic Area[1]. However, the Regulation (EU) No 421/2014 of the European Parliament and the Council limited the geographical scope of the EU ETS to intra-European Economic Area flights

[1] The European Economic Area is the area in which the Agreement on the European Economic Area provides for the free movement of persons, goods, services, and capital within the European Single Market. It covers EU Member States and Norway, Iceland and Lichtenstein.

only for the 2013–2016 period. The main reason of limiting the EU ETS scope was to progress negotiation within the framework of International Civil Aviation Organization (ICAO) on development of the Global Market Based Measures to reduce international aviation emissions, which was finally concluded at the 39th ICAO Assembly (September 2016, Montreal).

The rules of the European Union applicable for monitoring, reporting and verification of aviation emissions are mainly contained in Directive 2003/87/EC of the European Parliament and in the Council and Commission Delegated Regulation (EU) 2019/1603 supplementing Directive 2003/87/EC. That Directive is the legal basis for the detailed provisions in this matter, contained in Commission Regulation (EU) 601/2012 and in Commission Implementing Regulations (EU) 2018/2066 and 2018/2067.

In general, there are two trading periods for the aviation sector in EU ETS. The first period was the year 2012 only. The second trading period is already harmonized with the third trading period for stationary sources (2013-2020). The volume of European emission allowances (EUAA) in the 1st trading period was determined at 97% of historic emissions (average emissions in the EU between 2004 and 2006). In the second trading period, this volume has been reduced to 95% of historic emissions. From this amount, 15% of allowances has been auctioned and the remaining allowances are allocated to aircrafts operator free-of-charge. Moreover, the special reserve of 3% for new and fast-growing operators has been also created within the second trading period. Allocation of emission allowances free-of-charge to individual operators is determined on the basis of multiplication of a benchmark[2] and the volume of verified tonne-kilometres in 2010.

An aircraft operator included in the EU ETS is obliged to annually monitor and report CO_2 emissions produced during the calendar year. Tonne-kilometre data are monitored and reported only for the purposes of applying for free allocation of emission allowances for trading periods or for allocation of free emission allowances from the special reserve.

Each aircraft operator performing flights included in the EU ETS scope is assigned to the administrations of one of the EU Member States as determined by the aircraft operator list which is published annually by the European Commission. The overview of EU ETS coverage in the Czech Republic is included in the Table 1-2 below.

Tab. 1-2 The EU ETS coverage in the Czech Republic in the period 2012-2020

Year	# of Aicraft Operators administered	CO_2 emissions [tones]		Total CO_2 emissions [tones]
		Domestic flights	International flights	
2015	5	12 489	417 940	430 429
2016	5	13 761	464 642	478 404
2017	6	12 830	482 176	495 007
2018	6	12 228	500 602	512 831
2019	6	6 925	477 234	484 159
2020	6	2 276	102 469	104 744
2021	6	3 621	159 893	164 463

[2] The benchmark was determined by the European Commission by Decision No. 2011/638/EU

Source: MoE

Mitigation impact: The estimate of EU ETS´ impact on emissions on the demand side is a result of a simulation model based on energy prices (derived from fuel prices without and with CO_2 price) and cost curves of emission reducing measures. For the demand side, the calculation involves emissions reduction of projects realized in frame of transitional free allocations of emission permits. The main assumptions are that the EU ETS directly influences about 41% of final energy consumption in the industrial sector, and indirectly about 75% heat consumers and 100% electricity consumers. Having in mind that the State Energy Policy envisages the elimination of most coal power plants and their replacement by nuclear power plants between 2030 and 2040, the gains from EU ETS are rather low. The following table shows a drop of GHG emissions caused by energy savings and changes in use of individual energy carriers. Table 1-3 and Table 1-4 show annual emissions savings from realized and planned investments in for free transitional allocations from the year 2015.

Tab. 1-3 Expected emissions reduction of EU ETS on the demand side

Emissions reduction [kt CO_2]	**2015**	**2016**	**2020**	**2025**	**2030**	**2035**
Households	98	74	319	535	892	1194
Services	99	76	292	447	656	877
Industry	188	135	419	568	842	1127
Total	**385**	**285**	**1 030**	**1 551**	**2 390**	**3 198**

Source: MoE

Tab. 1-4 Expected emissions reduction of EU ETS due to investments within the transition period

Emissions reduction [kt CO_2]	**2015**	**2016**	**2017**	**2018**	**2019**
	90.095	177.583	1 442.445	163.286	2 360.444

Source: MoE

The following table (Table 1-5) summarizes the total effect of the EU ETS.

Tab. 1-5 Total expected emissions reduction of EU ETS

Total emissions reduction [kt CO_2]	**2015**	**2016**	**2020**	**2025**	**2030**	**2035**
	475	553	2 740	3 424	6 624	7 432

Source: MoE

Additional information: It is expected that the EU ETS policy together with the Industrial Emissions Directive has forced emission polluters to not only phase-out or reconstruct (e.g. installation of new boilers) some less efficient and outdated facilities but also to switch to cleaner fuels like natural gas or biomass.

Sector: Energy sector (public and industrial), industrial technologies (refineries, chemical sector, metallurgy, coking plants, lime production, cement, glass-making, ceramics, paper and cellulose), aviation

Greenhouse gas coverage: CO_2, N_2O

1.1.3 Effort Sharing Legislation (Effort Sharing Decision, Effort Sharing Regulation)

The Effort Sharing legislation establishes annual targets for GHG emissions of the EU Member States between 2013-2020 (by the Effort Sharing Decision, further referred as "Decision" or "ESD"[3]) and 2021-2030 (Effort Sharing Regulation, henceforth "Regulation" or "ESR"[4]) which are legally binding and only refer to GHG emissions that are not included within the scope of the EU ETS, i.e. transport (except aviation), buildings, agriculture (excluding LULUCF) and waste.

Based on the ESD, which was adopted in 2009 and forms part of the EU´s climate and energy policy framework for 2020, the emission limit for the Czech Republic is +9 % by 2020 compared to 2005 levels.

In accordance with Article 14 of the Decision, the European Commission prepared an evaluation of the implementation of the ESD up to 2015. The evaluation concluded that the commitments under the Decision have contributed to stimulating new national policies and measures promoting effective reductions of greenhouse gas emissions. It also found that the Decision has resulted in MS becoming more active in considering new measures to reduce emissions in those sectors within the Decision's scope, as well as in improved coordination between national, regional and local governments.

The results of the evaluation were used by the Commission when preparing the Regulation, legislation setting out binding annual greenhouse gas emission targets for MS for the period 2021-2030. The Regulation was adopted in 2018 and maintains the main elements of the ESD architecture, including the binding annual greenhouse gas emission targets for each Member State. The main changes in the Regulation from the current Decision are as follows:

- Existing flexibilities under the ESD (e.g. banking, borrowing, buying and selling) are retained, and two new flexibilities are added to allow for a fair and cost-efficient achievement of the targets. These are:
    - A one-off flexibility to transfer a limited amount of allowances from the EU ETS: This allows eligible MS to achieve their national targets by covering some emissions in the non-ETS sectors with EU ETS allowances which would normally have been auctioned.
    - A new flexibility to transfer a limited amount of credits from the land use, land use change and forestry sector (LULUCF): To stimulate additional action in the LULUCF sector, the proposal permits MS to use up to 280 million credits over the entire period 2021-2030 from certain land use categories to comply with their national targets.
- Emission limits will be set for each year in the 10-year period up to 2030. The limit for each year is set according to a decreasing linear trajectory. This ensures year on year reductions and adds integrity to the 2030 target because it is the culmination of reductions over 10 years rather than a stand-alone point.

In 2020, the total amount of ESD emissions was 58.65 Mt CO_2 eq.

[3] Decision No 406/2009/EC - Effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

[4] Regulation (EU) 2018/842 - Binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013

The EU is on track to overachieve its 2020 target of reducing GHG emissions by 10% compared to 2005 in the sectors covered by the legislation. In relation to ESR**,** by 2030 the national targets will collectively deliver a reduction of 30% compared to 2005 levels. The ESR translates this commitment into binding annual greenhouse gas emission targets for each MS based on the principles of fairness, cost-effectiveness, and environmental integrity. The resulting 2030 targets range from 0% to -40% compared to 2005 levels with the Czech Republic´s emission reduction target being -14 % compared to 2005 levels.

Currently a legislative procedure for the Revision of the ESR is ongoing as part of the Fit for 55 legislative package. The main proposed change is to increase the EU level target from 30 to 40% by 2030. The respective target for the Czech Republic should increase from -14% to -26% compared to 2005 levels.

Type of policy: Regulatory, Economic

Implementing entity: Ministry of the Environment

Period of implementation: ESD 2013-2020, ESR 2021-2030

Implemented in scenario: WEM

Mitigation impact: As the ESD and Regulation are a framework measure, its mitigation impact is accounted under other measures.

Sector: Energy, Transport, Industrial Processes, Agriculture, Waste

Greenhouse gas coverage: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6

1.1.4 Governance of the Energy Union

In 2018, the regulation on the governance of the Energy Union and Climate Action entered into force.

Agreed as part of the “Clean energy for all Europeans” package, the goals of the new regulation are:

- To implement strategies and measures which ensure that the objectives of the Energy Union, in particular the EU’s 2030 energy and climate targets, and the long-term EU greenhouse gas emissions commitments are consistent with the Paris agreement;
- To stimulate cooperation between EU Member States to achieve the objectives and targets of the Energy Union;
- To promote long-term certainty and predictability for investors across the EU and foster jobs, growth and social cohesion;
- To reduce administrative burdens, in line with the principle of better regulation. This was done by integrating and streamlining most of the current energy and climate planning and reporting requirements of EU countries as well as the European Commission's monitoring obligations;
- To ensure consistent reporting by the EU and its MS under the UNFCCC and the Paris agreement, replacing the existing monitoring (Regulation (EU) No 525/2013) and reporting system from 2021 onwards.

Further, according to Regulation (EU) 2018/1999 of the European Parliament and Council on Governance of the Energy Union and Climate Action, all MS shall prepare an Integrated National Energy and Climate Plan (NECP). The final version of such plan shall be submitted to the European Commission by the end of 2019. In these plans, the MS have to set out their objectives, targets and contributions

relating to the five dimensions of the Energy Union. These dimensions include decarbonisation, energy efficiency, energy security, internal energy market, research, innovation and competitiveness. The first plan will cover the time period 2021-2030. The projections will be prepared until 2040 for all dimensions of the Energy Union. Longer term perspectives in line with the objectives of the Paris Agreement should be included where relevant and possible. According to article 14 of the Regulation NECP should be updated by 30 June 2023 (draft)/30 June 2024 (final version) or else members states should provide the justification, why the update is not required. By 15 March 2023, and every two years thereafter, each Member State shall report to the Commission on the status of implementation of its integrated national energy and climate plan by means of an integrated national energy and climate progress report covering all five dimensions of the Energy Union.

According to the new rules laid out in the Governance regulation, EU countries are also required to develop national long-term strategies by 1 January 2020, and consistency between long-term-strategies and NECPs has to be ensured.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2021–2050

Implemented in scenario: WEM

Mitigation impact: As this is a framework measure, its mitigation impacts will be accounted under other measures.

Sector: Cross-sectoral

Greenhouse gas coverage: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6

1.1.5 Act No. 201/2012 Coll., on Air Protection

Current legal framework for the air protection consists of Act No. 201/2012 Coll., on Air Protection, its amendments and implementing regulations and its objective is to prevent air pollution as well as to reduce the level of air pollution to limit health risks, lower the environmental burden of substances discharged into the air and harming ecosystems and setting the conditions allowing the regeneration of the environment affected. The Act transposes a number of EU Directives in the area of air protection (such as Directive 2010/75/EU, 2008/50/ES, 2016/2284 etc.), regulates required ambient air quality and its monitoring obligations of source operators, defines emission limits and other operational **conditions** for stationary source operators.

In the recent years the Air Protection Act was amended several times, last one was the Act No. 284/2021 Coll., entered into force on January 1st, 2022 and includes changes regarding the adoption of New Building Act – Act No. 283/2021 Coll. This amendment to the Air Protection Law changes the jurisdiction of Air Protection Administrative bodies and legal form of administrative acts regarding evaluation of the potential impact of building projects and their construction on the ambient air quality. Some of the responsibilities, regarding mostly projects with potentially low or none impact on the ambient air quality, which were up until now designated to the Air Protection Administrative bodies have been transferred to the newly engineered State Building Administration bodies.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: Since 2002 (amendments in2019, 2020, 2021)

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted in other measures.

Sectors: Energy, Industrial Processes, Agriculture, Waste

Greenhouse gas coverage: CO_2, N_2O, CH_4

1.1.6 Emission Limits in Air Protection Act (201/2012 Coll.)

The Air Protection Act (No. 201/2012 Coll.) further focuses on the transposition of certain parts of the Directive 2010/75/EU on industrial emissions (the Industrial Emissions Directive, henceforth "IED") amending and subsequently repealing Directives 96/61/EC and 2008/1/EC.

The law provisions of the amended Directives were obligatory for new installations from the year 2003 and for existing installations from the year 2012. The new IED Directive is applied from 2016.

The IED sets stricter emission limits for selected basic pollutants (in comparison to repealing Directives) and requires the use of the best available techniques (henceforth "BAT").

The IED aims at minimizing pollution from various industrial sources. The operators of industrial installations operating activities covered by Annex I of the IED are required to obtain an integrated permit from the authorities in the EU countries. The permit conditions including emission limit values must be based on the use of BAT. The BAT conclusions (documents containing information on the emission levels associated with BAT) serve as references for setting permit conditions.

Certain parts of the IED are implemented into the Czech legislation also by the Act No. 69/2013 Coll. amending the Act No. 76/2002 Coll., on Integrated Prevention and Pollution Control.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Implemented in scenario: WEM

Mitigation impact: The Air Protection Act and the Act on Integrated Prevention and Pollution Control have an indirect impact on GHG emissions through the emission limits for basic pollutants and through the use of BAT. The strict emission limits are expected to have an important impact especially on coal-fired power plants and combined power and heat plants. The CO_2 emission reduction is derived from expected decommissioning of electricity and heat sources. This is a framework measure and its mitigation effect is accounted in other measures.

Tab. 1-6 Expected emissions reduction of IPPC (IED)

	2015	2020	2025	2030	2035
Emissions reduction [kt CO_2]	500	2 600	2 746	2 746	2 746

Source: CHMI

It is expected that this Act has forced emission polluters not only to phase-out or reconstruct (e.g. installation of new boilers) some less efficient and outdated facilities, but also indirectly to switch to cleaner fuels like natural gas or biomass.

Sectors: Energy, Industrial Processes, Agriculture, Waste

Greenhouse gas coverage: CO_2

1.1.7 National Emissions Reduction Programme

The National Emissions Reduction Programme (henceforth "NERP") is the fundamental conceptual material in the area of air quality and reduction of emissions from air pollution sources. It is processed on the basis of Article 8 of the Act No. 201/2012 Coll., on Air Protection, as amended.

The current Programme was approved in December 2019 by the resolution of the Czech Government No. 917. The Programme complies with the requirements set by the Directive (EU) 2016/2284 of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants for so called national air pollution control programmes (Article 6 of the Directive).

It comprises of analyses of the state of air and its development in the Czech Republic, causes of air pollution, emissions of pollutants from particular sectors of national economy, air pollution scenarios, international commitments of the Czech Republic as well as their fulfilment.

The NERP defines a set of goals together with procedures and measures to achieve these goals including terms of their attainment and the assignment of responsible authorities for the measures´ implementation.

The main objective of the NERP is to meet the national emission reduction commitments applicable from 2020 to 2029 and from 2030 onwards, as laid down by the Directive.

For the implementation of the Programme a set of 6 priority measures, 14 subsidiary measures and 7 cross-sectional measures has been introduced at the national level directly aimed to reduce emissions and to improve air quality. These measures are assigned to each central authority of the state administration to be accomplished and are described in detail on cards of measures. For the priority measures the effect of their implementation on the emission reduction was quantified.

The measures are to be implemented in the public energy sector and household heating sector, in the transport sector and agriculture sector, predominantly in the form of legislative changes and economic instruments.

Following the requirements of the Directive 2016/2284 the implementation of the measures set by the NERP and achievement of its' goals is evaluated regularly and an update of the NERP will be prepared in 2023.

Type of policy: Regulatory

Implementing entity: Ministry of Environment (Government)

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted in other measures.

Sector: Energy; Industrial processes and product use; Transport, Agriculture**,**

Greenhouse gas coverage: CH_4, N_2O, CO_2

1.2 Policies and Measures in Energy sector

Policies and Strategies

1.2.1 Energy excluding 1.A.3 Transport

1.2.1.1 State Energy Policy

The State Energy Policy (henceforth "SEP") is the main strategic document for the energy sector in the Czech Republic. The Policy is cross-sectional as it serves as the framework strategic document for the national level.

The new SEP was approved by the Government in May 2015 and replaced the previous SEP from the year 2004. The SEP is codified in Act No. 406/2000 Coll., on Energy Management. A time horizon of SEP is 25 years, with expected evaluation at least every five years and annual assessments of implementation measures. According to the aforementioned legislation, the SEP is binding for the government and state institutions and sets targets by the year 2040.

The main purpose of the SEP is to ensure reliable, secure and environmentally-friendly supply of energy to meet the needs of the population and economy of the Czech Republic, at competitive and acceptable prices under standard conditions. It must also secure uninterrupted energy supply in crisis situations to the extent necessary to ensure the functioning of the main components of the state and the survival of the population.

The SEP (2015) has three strategic objectives – the security of energy supply, competitiveness, and sustainability. These three strategic objectives are further translated into more concrete strategic priorities of the energy sector in the Czech Republic, namely i) balanced energy mix; ii) savings and efficiency; iii) infrastructure and international cooperation; iv) research, development and innovation; and v) energy security.

The indicative targets are set by the SEP for the year 2040 and are expressed in terms of corridors that ensure a balanced mix of sources for electricity generation and corridors for the composition of a diversified mix of primary energy sources. The use of domestic primary sources is prioritised (desired level of 80% of domestic sources in gross electricity production) as well as keeping import dependence at an acceptable level.

Target structure of electricity generation for the year 2040 is as follows:

Nuclear fuel	46-58%
Renewable and secondary sources	18-25%
Natural gas	5-15%
Brown and black coal	11-21%

Target structure of primary energy sources (for the year 2040):

Nuclear fuel	25-33%
Solid fuels	11-17%
Gas fuels	18-25%
Liquid fuels	14-17%

Renewable and secondary sources	17-22%

The SEP also includes other indicative indicators and targets. These should ensure the tracking of the progress and enable assessment of possible needs for SEP updates. The SEP has also a dedicated section for implementation instruments, those are mainly: i) legislative instruments; ii) instruments in the area of state administration; iii) fiscal and tax instruments; iv) foreign policy instruments; v) instruments in education and support for science and research; vi) exercise state ownership rights in energy companies in which the Czech Republic has an ownership interest; and vii) communication and media promotion. There was also annual monitoring of the progress of fulfilment of implementation instrument through dedicated reports (link).

According to Act No. 406/2000 Coll. the SEP should be assessed by maximum five years from its approval. The Assessment of SEP was prepared in 2020 (link) and approved by the government on 8th of March 2021 (by the government resolution no. 260). Based on this Assessment government approved the update of the SEP. The update of the SEP should be prepared by the end of 2023 and should reflect recommendations provided in the Assessment in particular, to extend the horizon of the Concept until 2050 and to further consider the commitments made, in particular at European Union level, the conclusions of the Coal Commission and the trend in the development of modern technologies.

Type of Policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2015-2040

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted in other measures.

Sectors: Energy, Transport, Industrial Processes (in general all combustion processes)

Greenhouse gas coverage: CO_2

1.2.1.2 National Renewable Energy Action Plan (NREAP)

The Plan implements the Renewable Energy Directive 2009/28 (henceforth "RED Directive") which requires the EU Member States to cover a specified percentage of final energy demand by renewable energy in 2020. The Czech Republic is committed to achieve 13% share of RES in 2020, while the total EU target is 20%.

The main aim of the RED Directive is to establish a common framework for the promotion of energy from renewable energy sources and its principal requirements include the following points:

- Mandatory national overall targets and measures for the use of energy from renewable sources;
- National renewable energy action plans;
- Calculation of the share of energy from renewable sources;
- Statistical transfers between Member States;
- Joint projects between Member States;
- Effects of joint projects between Member States;

- Joint projects between Member States and third countries;
- Effects of joint projects between Member States and third countries;
- Joint support schemes, etc.

The RED Directive requires that each EU Member State submits a National Renewable Energy Action Plan (henceforth "NREAP") describing how it plans to achieve its 2020 target. The Czech NREAP was submitted to the EC in July 2010 and was subsequently updated in July 2012 and in December 2015. The NREAP currently proposes for 2020 a higher share of RES in final energy consumption (15.3%) in comparison to the target of Directive 2009/28/EC (13%). The main renewable energy sources in the Czech Republic are biomass, followed by biofuels in transportation, biogas, hydropower and photovoltaic solar energy.

The NREAP is evaluated every two years by the Ministry of Industry and Trade. The results are reported to the Government and the European Commission.

The NREAP was replaced by the appropriate documents within the governance framework (based on EU Regulation 2018/1999), namely NECP and relevant integrated reports. Contribution of CZ to the RES target on the EU level was set on the level of 22 % of RES share on the gross final energy consumption (EUROSTAT methodology) by 2030.

Type of Policy: Economic, Fiscal

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2010-2020

Implemented in scenario: WEM

Mitigation impact: The plan establishes a framework for fulfilling the binding targets according to the two following tables.

Tab. 1-7 Share of RES on final consumption of energy in 2005 and the target according to Directive 2009/28/EC

	2005	2020
RES consumption [PJ]	76.2	161.7
The share of RES [%]	6.1	13

Source: European Commission

Tab. 1-8 Share of RES on final consumption of energy according to NREAP (2015) and draft National Energy and Climate Plan based also on revised methodology for 2005 data (NECP, 2019)

	2005 (NREAP)	2020 (NREAP)	2005 (NECP)	2020 (NECP)
RES consumption [PJ]	76.2	172.9	82.5	182,8
The share of RES [%]	6.1	15.3	7.09	16,3

Source: MoE, MIT

The impacts of the plan are reported under other measures supporting the introduction of RES.

Sectors: Energy

Greenhouse gas coverage: CO_2, CH_4

1.2.1.3 National Energy Efficiency Action Plan (NEEAP)

The National Energy Efficiency Action Plan (henceforth "NEEAP") sets the national target for energy savings and describes existing and planned measures to reach this target. It implements the Directive 2012/27/EU that establishes a set of binding measures to reach the EU 20% energy efficiency target by 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain, from production to final consumption.

National measures must ensure major energy savings for consumers and industry, for example:

- Energy distributors or retail energy sales companies have to achieve 1.5% energy savings per year through the implementation of energy efficiency measures;
- EU countries can opt to achieve the same level of savings through other means, such as improving the efficiency of heating systems, installing double glazed windows or insulating roofs;
- The public sector should purchase energy efficient buildings, products and services;
- Every year, governments in EU countries must carry out energy efficient renovations on at least 3% (by floor area) of the buildings they own and occupy;
- Energy consumers should be empowered to better manage consumption. This includes easy and free access to data on consumption through individual metering;
- National incentives for SMEs to undergo energy audits;
- Large companies will make audits of their energy consumption to help them identify ways to reduce it;
- Monitoring efficiency levels in new energy generation capacities.

The NEEAPs set out estimated energy consumption, planned energy efficiency measures, and the improvements a country expect to achieve. Under the Energy Efficiency Directive, EU countries must draw up these plans every three years.

The indicative national target defined in Article 3 of Directive 2012/27/EU is a framework, non-binding target. The latest update of the NEEAP from 2017 sets the target for the Czech Republic at 51.10 PJ of new final energy savings by 2020. The slight increase of the target follows the revision of energy statistics by Eurostat.

Article 7 of the Directive establishes a binding end-use energy savings target by 2020 equivalent to achieving new annual savings of 1.5% of the annual energy sales to end customers.

Tab. 1-9 Calculation of the binding savings target stipulated in the Directive, Article 7 (2)

Year	2017	2018	2019	2020
Savings [PJ]	38.93	48.66	58.40	68.13

Source: MIT

The NEEAP was replaced by the appropriate documents within the governance framework (based on EU Regulation 2018/1999), namely NECP and relevant integrated reports. Contribution of CZ to the EU EE target (art. 3 of the Energy Efficiency Directive) is to not exceed the level of 990 PJ of final energy consumption by 2030. Furthermore, there are national obligations under art. 7 of the Energy Efficiency

Directive set on the level of 462 PJ of cumulative final energy savings by 2030 and continuation with the 3 % renovation of the total floor area of heated and/or cooled buildings owned and occupied by its central government bodies each year under art. 5 of the Energy Efficiency Directive.

Type of policy: Economic, Fiscal, Information, Voluntary

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2008-2020

Implemented in scenario: WEM

Mitigation impact: This is a framework measure, its mitigation effect is accounted in other measures

Sectors: Energy, Transport, Industrial Processes (in general all combustion processes)

Greenhouse gas coverage: CO_2

Legislative Instruments

1.2.1.4 Act No. 406/2000 Coll., on energy management

This Act transposes relevant EU legislation including Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products , Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings and Directive 2012/27/EU of the European Parliament and the Council of 25 October 2012 on energy efficiency.

The Act stipulates requirements for efficiency of energy use (construction and reconstruction of the electricity generation plant, heat generation plant and combined heat and power generation plants, inspections of boilers and hot water supply, including the internal distribution of thermal energy in buildings and inspection of air conditioning systems). The Act further sets the minimum energy performance standard for new buildings on the level of nearly-zero energy standard and for major renovations and building parts changes on the cost optimum level. It further introduces energy performance certificates in case of construction, major renovation, sales and rentals of buildings or its parts. It also includes energy performance requirements for electrical appliances and introduces their certificates. Building owner, association of unit owners or building manager is obliged to arrange regular inspections of the heating and air-conditioning system with an effective rated output above 70 kW.

The Act requires large enterprises with energy consumption of their energy facilities more than 200 MWh per year to perform an energy audit. The obligation does not apply to enterprises that have the standard EN ISO 50001 established and certified. The SME are obliged to perform an energy audit if the energy consumption of their energy facilities is more than 5 000 MWh per year. The requirement to perform an energy audit also applies to government institutions, regions, municipalities and certain public organizations that have energy consumption of their energy facilities greater than 200 MWh per year.

The act sets professional requirements for energy specialists who process the energy audits, energy assessments, issue energy performance certificates and perform controls of heating and air-conditioning systems. In line with the Act energy specialists must undergo a regular training in 3 year

cycles prepared by the State energy Inspection that is also a control body for obligations defined within the Energy Management Act.

The act introduces an obligation for an electricity or thermal energy producer, in newly established installations, to provide for at least the minimum efficiency of energy use stipulated by an implementing legal regulation. This obligation also applies to installations for production of electricity or thermal energy in which a change is introduced in previously completed structures. Owners are obliged to regularly perform checks of operating boilers, and heat distribution and air conditioning systems.

The Act requires manufacturers or authorized representatives that their products comply with the eco-design requirements when placed on the market or put into the service. The specific requirements for each product group are set in the Commission regulations in order to encourage manufacturers to design products in an environmentally friendly way with the lowest possible negative environmental impact.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2000

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted in other measures. For instance, in relation to the application of eco-design, the annual energy savings were calculated in the NEEAP III of the amount of 1230 TJ/year by 2020.

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.5 Directive 2012/27/EU on energy efficiency (Article 5, Article 7)

According to the Article 5 of the Directive, 3 % of the total floor area of heated and/or cooled buildings owned and occupied by its central government has to be renovated each year to meet at least the minimum energy performance requirements.

According to the Article 7 of the Directive, the MS should annually achieve or secure specific amount of cumulative energy savings (in PJ) on final energy consumption side through specific measures introduced by government or private entities or mix of both. The Czech Republic has decided to achieve its 204,4 PJ cumulative energy savings obligation by 2020 via so-called “alternative scheme” which counts the energy savings achieved thanks to individual governmental sub-programmes which are focused on support of households, municipalities and companies´ energy saving projects.

On 14th of July 2021 European commission published legislative package “Fit for 55”, which also included proposal of the amendment of Energy Efficiency Directive.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2012-2030

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted in other measures.

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.6 Directive 2010/31/EU on the energy performance of buildings

The measure stipulates minimum requirements as regards the energy performance of new and existing buildings, requires the certification of their energy performance and the regular inspection of heating and air conditioning and ventilation systems in buildings with an effective rated output greater than 70 kW.

The Directive is transposed by the Act No. 3/2020 Coll., on energy management. The directive defines new administrative tools to reduce energy consumption of buildings. It defines a building with nearly zero energy consumption. It tightens requirements for energy building performance with the aim to reduce energy consumption and emission of GHG by 20% and increase the share of renewable sources of energy (henceforth "RES").

Energy building performance is defined as calculated/measured typical energy consumption which also includes energy used for heating, ventilation, cooling, air-conditioning, hot water and lighting.

Not only energy performance, but also optimal economic costs are emphasized. In 2011 the European Commission issued a methodological framework for the calculation of optimal cost levels for minimal requirements on energy building performance.

Since 31st December 2020, all new buildings shall be buildings with nearly zero energy consumption. From 2019 all new buildings used or owned by public administration shall be buildings with nearly zero energy consumption. According to the Directive "a building with nearly zero energy consumption" is a building with very low energy consumption. The energy performance shall be estimated in compliance with the Directive methodology. The low consumption should be mainly covered by RES.

The energy performance certificates according to the Recast directive contain new information, e.g. besides energy performance and reference values (minimal requirements for energy performance) also recommendations for decreasing of energy consumption taking into account cost optimization. Contact to other information sources, especially regarding cost efficiency shall be included in the certificate as well.

The directive introduces requirements for electromobility or ducting infrastructure for residential and non-residential buildings. Furthermore, by 1 January 2025, it stipulates the obligation to install a minimum number of charging stations in all non-residential buildings with more than twenty parking spaces.

The directive requires Member States to establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonized building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

Also, an optional common Union scheme for rating the smart readiness of buildings was prepared from the European Commission.

On 15th of December 2021 European commission published part of legislative package "Fit for 55", which also included proposal of the amendment of Energy Performance of Buildings Directive.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2010

Implemented in scenario: WEM

Mitigation impact: Emission reduction effects are shown in Table 1-10 below.

Tab. 1-10 Emissions reduction expected from implementation of Directive 2010/31/EU

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	532	474	446	446	446

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.7 Directive 2009/125/ES on eco-design

Eco-design is a method for the design and development of products, which also emphasizes a minimum negative impact of a product on the environment (including energy consumption). A set of requirements are imposed on products which must be met before products enter the market and which also ensures energy efficiency for manufacture, usage and disposal of products.

The eco-design directives have been implemented into the Czech legislation by the Energy Management Act No. 406/2000 Coll. and by its amendments 393/2007 Coll. and 53/2012 Coll. Under the EU directive a set of regulations requires a minimal energy efficiency of new electric appliances. Products categories included in the regulations and reflected in the projections are:

- Air conditioners and comfort fans;
- Air heating and cooling products;
- Circulators;
- Computers, servers and data storage products;
- Domestic cooking appliances;
- Electric motors;
- Electronic displays;
- External power supplies;
- Household dishwashers;
- Household washing machines;
- Industrial fans;
- Lighting products in the domestic and tertiary sectors;
- Local space heaters;
- Heaters and water heaters;
- Power transformers;

- Professional refrigerated storage cabinets;
- Refrigerating appliances with a direct sales function;
- Refrigerators and freezers;
- Simple set-top boxes;
- Standby and off mode electric power consumption of household and office equipment, and network standby;
- Vacuum cleaners;
- Ventilation units;
- Water pumps
- Welding equipment.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2009

Implemented in scenario: WEM

Mitigation impact: Application of the eco-design leads to electricity savings. The annual energy savings were calculated in the NEEAP III of the amount of 1230 TJ/year by 2020. The expected emissions reduction effects are shown in the Table 1-11 below.

Tab. 1-11 Emissions reduction expected from implementation of Directive 2009/125/ES on eco-design

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	438	484	466	363	363

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.8 Act No. 165/2012 Coll., on supported sources of energy

This Act was amended by Act No. 310/2013 Coll., on support of energy sources (SES Act), as amended by Act No. 407/2012 Coll., and other laws. The amendment has cancelled the support provided to some types of new electricity generating facilities from renewable sources since 2014, with one-year transition, allowing completion of projects in progress. It also defines the maximum fee levied for the support of renewable sources, which will be collected from customers within the regulated price of electricity and introduces levy on electricity generated from solar radiation effective as of January 1st, 2014 for facilities put into operation in 2010.

The Act transposes Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

This Act regulates:

a) Support provided to generation of electricity, heat and bio-methane from RES, secondary energy sources ("secondary source"), highly efficient combined production of electricity and heat and decentralized electricity generation, exercise of state administration and related rights and obligations of persons involved,

b) Content and creation of the National Action Plan of the Czech Republic for energy from RES ("National Action Plan"),

c) Conditions for issue, record-keeping and acknowledging guarantees of energy originating from RES,

d) Conditions for certification on origins of electricity generated from highly efficient combined production of electricity and heat or from secondary sources,

e) Financing of the support of electricity generated from supported sources, heat from RES, decentralized electricity production, bio-methane and provision of subsidy to market operator to cover these expenses,

f) Levies on electricity generated from solar radiation,

g) Increase of the share of RES on consumption of primary energy sources,

h) Creation of conditions for the fulfilment of binding share of energy from RES on the gross final consumption of energy in the Czech Republic while simultaneously reflecting interests of the customers on minimising the impacts on energy prices in the Czech Republic.

The main purpose of this amendment to the SES Act was to introduce measures aimed to stabilize the impact of support for energy from RES on the Czech industry competitiveness and on the citizen's energy bills of the Czech Republic due to the increasing financial burden of this support.

Key changes to the SES Act included namely:

- Suspension of support for electricity from RES (excluding hydropower plants with an installed capacity of up to 10 MW) generated in plants commissioned after 31 December 2013;
- Suspension of support for production of bio-methane after 31 December 2013 (due to the length of time required to finish installations under construction;
- Support for wind power plants (with valid building permit as of 1 October 2013) commissioned by 31 December 2014 and hydropower plants with an installed capacity of over 10 MW commissioned by 31 December 2015 shall be maintained);
- Continued support for secondary sources, in particular waste for incinerators;
- Cessation of support for decentralized production;
- Continuation of solar levy for installations commissioned in the year 2010;
- Fixing the contribution to the supported RES in cost of electricity for end consumers.
- Separation of the price component for support of RES and other supported sources from the prices for electricity transmission and distribution and its inclusion in a special price to cover costs associated with support for electricity and heat and setting a ceiling for this price at CZK 495/MWh;
- Change in the solar levy on electricity generated after January 1st, 2013.

- As of 31 July 2014, aid recipients will be required to disclose their owners (in response to passing of Act No. 134/2013 Coll., on Certain Measures to Improve Transparency of Joint Stock Companies and on Amendments to Other Laws).

Act on supported sources of energy was further amended by the Act No. 382/2021 Coll. This amendment is the most extensive amendment since the approval of the original Act in 2012. It also to a large extend implements Renewable energy directive). This amendment modifies or add a number of definitions, introduce new overall framework for the support of supported sources (most notably it introduces framework for the auctioning scheme for operational support), introduces new framework of support for the development of RES specifically in the transport sector (namely for biomethane production), revisions the rules for the sustainability criteria, modifies rules with regard to guarantees of origins etc. Following this amendment process there is on-going update and preparation of new secondary legislation.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2013

Implemented in scenario: WEM

Mitigation impact: This policy is a framework measure and thus its mitigation effect is accounted under other measures

Sectors: Energy

Greenhouse gas coverage: CO_2, CH_4

1.2.1.9 Directive 2009/28/ES on the promotion of the use of energy from renewable sources (Preferential feed-in tariffs for electricity produced from renewable energy sources)

The Directive 2009/28/ES on the promotion of the use of energy from renewable sources was replaced by the Renewable Energy Directive, Directive (EU) 2018/2001. The directive 2018/2001 was to a large extend implemented by Act 382/2021 Coll. on promoted sources of energy, which is the amendment of Act 165/2012 Coll. On 14th of July 2021 European commission published legislative package "Fit for 55", which also included proposal of the amendment of Renewable Energy Directive.

Preferential feed-in tariffs (Act 165/2012 Coll.), together with obligation of distribution companies to connect sources using renewables and to purchase the produced electricity, serve as a main tool for the promotion of RES in the CR.

Act 165/2012 Coll. transposes Directive 2009/28/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market.

According to National Renewable Energy Action Plan 2020 the target of 15.3% share of renewable energy in electricity production will be met.

Type of policy: Economic

Implementing entity: Energy Regulatory Authority (Government)

Period of implementation: Since 2009

Implemented in scenario: WEM

Mitigation impact: We attributed 50% of new installation of biomass and biogas CHPs and 100% of new installations in solar, wind and small hydro power plants to this measure. The emission reduction was calculated from expected electricity production and average system emission coefficient for electricity production.

Tab. 1-12 Emissions reduction expected from introduction of preferential feed-in tariffs for electricity produced from RES

	2015	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	3 229	3 242	3 873	4 047	3 610	3 191

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.10 Act No. 458/2000 Coll., on business conditions and public administration in the energy sectors (Energy Act)

The Act transposes relevant EU legislation[5], includes directly applicable EU legislation[6] and sets conditions for business, for public administration and for energy regulation (electricity, gas and heat) while also regulating rights and obligations of natural persons and legal entities. It concerns organization of business activities in the energy sector while maintaining economic competition, meeting the needs of consumers, rights of license holders and ensuring safe, secure and stable supply of electricity, gas and heating at acceptable prices.

[5] Directive 2009/72/EC of the European Parliament and of the Council concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

Directive 2009/73/EC of the European Parliament and of the Council concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC

Directive 2005/89/EC of the European Parliament and of the Council concerning measures to safeguard security of electricity supply and infrastructure investment.

Directive 2011/83/EU of the European Parliament and of the Council on consumer rights, amending Council Directive 93/13/EEC and Directive 1999/44/EC of the European Parliament and of the Council and repealing Council Directive 85/577/EEC and Directive 97/7/EC

[6] Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission network.

Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity.

Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators.

Council Regulation No 617/2010 of 24 June 2010 concerning the notification to the Commission of investment projects in energy infrastructure within the European Union.

Regulation (EU) No 994/2010 of the European Parliament and of the Council of 20 October 2010 concerning measures to safeguard security of gas supply.

The amendment of the Act No. 131/2015 Coll. removed some administrative barriers for small photovoltaic installations (up to 10 kW), which are no longer subject to licensing and introduced support for heat from biomass installations. The last amendment was through the Act 362/2021 Coll., which focused specifically on the strengthening of the consumer protection.

The preparation of new Energy Act is under preparation. In October 2019 the government considered thesis (principal approach) of the Act. In December 2020 the government approved substantive intent of the new Act. The new legislation introduces an active customer, a new entity in the form of an energy community, new activities in the electricity market such as aggregation, energy storage and the provision of flexibility. The resulting law should thus be in line with energy sector developments such as decentralisation of generation, greater involvement of renewable energy sources, electricity consumption management, increasing energy efficiency, energy storage and sector coupling. Considering the length of legislative process, the new Energy Act is expected to come into force in 2024 at the earliest.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2000

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is included in other measures.

Sector: Energy

Greenhouse gas coverage: CO_2

Financial Schemes and Programmes

1.2.1.11 State Program to Support Energy Savings and Use of Renewable Energy Sources (EFEKT)

The EFEKT is a national plan developed to promote measures to increase energy efficiency and to incentivize the use of renewable and secondary energy sources in accordance with the approved State Energy Policy and sustainable development principles. Specifically, it supports energy information distribution, awareness raising activities, organization of public seminars, energy information centers and small investment actions leading to energy savings and the use of RES. The sectors covered are the state administration, local (municipalities) and regional governments, schools, social and health care facilities, private sector (undertakings), households and NGOs.

The State Programme to Promote Energy Savings and the Use of Renewable Sources of Energy was adopted by Government Resolution No. 1105/2004. Its scope and funding is defined in Act No. 406/2000 Coll., on energy management (as amended by Act No. 61/2009 Coll.).

This programme represents the implementation tool for the State Energy Policy and Czech commitments toward the EU in the area of energy efficiency. It is supplemental programme to energy programmes financed from the EU Structural Funds.

The State Programme to Promote Energy Savings and the Use of Renewable Sources of Energy focuses on reducing energy consumption, use of renewable and secondary energy sources in line with economic and social needs, sustainable development and protection of the environment. Besides that it focuses on education, energy planning, small-scale investment actions and pilot projects. The most significant emission reductions have been achieved in the energy sector, protection of the

environment area, renewable sources energy (RES) and energy savings in industry and in housing sector.

The Programme has been implemented during its initial run (since 2005) not only by the Ministry of Industry and Trade (which coordinates the entire programme), but also by ten other ministries. Since 2007, the programme has been renamed to Programme EFEKT, and as such it has been fully implemented only by MIT. The Programme EFEKT has provided support for various projects during the 2007-2013 period.

In 2016, the programme has been amended for the 2017-2021 period and is now called *State programme to promote energy savings*. The yearly budget has been increased to CZK 150 mil. The new so called EFEKT 2 is particularly aimed at soft measures such as promoting education and raising awareness in the area of energy savings, but also at smaller scale investment actions and pilot projects. The new programme does not support the use of renewable energy anymore and focuses solely on energy efficiency measures. One of the most important supported areas of the programme is increasing energy efficiency in public lighting systems.

Type of policy: Economic (subsidies), Education, Information, Research

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2004-2016, since 2007 ongoing as the EFEKT Programme is implemented only by the Ministry of Industry and Trade

Implemented in scenario: WEM

Mitigation impact: The expected energy savings of the Programme EFEKT are shown in the table below.

Tab. 1-13 Expected energy savings of programme EFEKT

	2020	2025	2030	2035	2040
Energy savings [TJ]	298	298	298	298	298

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-14 Expected emissions reduction of programme EFEKT

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	21.81	20.10	19.29	17.72	15.07

Source: CHMI

Only new effects after 2015 are included in the tables.

The energy savings in 2020 are expected to be 298 TJ. The budget of the program is estimated to be CZK 0.1 bill. The programme undergoes annual evaluation to update contents and budgets of the individual parts of the programme.

Sector: Energy

Greenhouse gas coverage: CO_2

1.2.1.12 State Programme on the Promotion of Energy Savings (EFEKT 2 and EFEKT 3)

The programme financially supports the increase of energy efficiency through awareness raising and educational activities, energy consultancy centres and expert training. It is a crosscutting programme and the target sectors are the state administration and local governments, private sector, households and NGOs. This programme also supports the following activities: measures to reduce energy intensity of public street lighting; heating system reconstruction and heat generation in buildings; publications, guides and informative materials about the energy sector; introduction of an energy management system; preparation of energy-saving projects financed using the Energy Performance Contracting method. The budget of the program is estimated to be CZK 0.7 bill. for the period 2017-2020. The program contributes to reach the energy target according to Directive 2012/27/EU on energy efficiency.

In 2020, the programme has been amended for the 2022-2027 period and is now called *State programme to promote energy savings*. The yearly budget has been increased to CZK 160 mil. The new so called EFEKT 3 is particularly aimed at soft measures such as promoting education and raising awareness in the area of energy savings. The new programme does not support the use of renewable energy anymore and focuses solely on energy efficiency measures. One of the most important supported areas of the programme are pre-project preparation subsidies, education programmes and consulting services for public "EKIS". The renewed programme is expected to save in the period to 2030 17,8 PJ.

Type of policy: Economic (subsidies), Education, Information, Research

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2017 and renewed from 2022

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings are shown in the following table.

Tab. 1-15 Expected energy savings of programme EFEKT 2 and EFEKT 3

	2020	2025	2030	2035	2040
Energy savings [TJ]	778	778	778	778	778

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-16 Expected emissions reduction of programme EFEKT 2 and EFEKT 3

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	57.05	52.58	50.46	46.35	39.43

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.13 New GREEN SAVINGS Programme 2013

The New Green Savings Programme 2013 was a subsidy program of the Ministry of the Environment (administrated by the State Environmental Fund) focused on energy savings and the use of renewable energy in single-family houses.

The program exclusively focused on the insulation of family houses in combination with the replacement of inefficient boilers using solid fuels. The program further supported the installation of solar systems for hot water.

Type of policy: Economic

Implementing entity: State Environmental Fund (Government)

Period of implementation: In 2013 only

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings are shown in the following table.

Tab. 1-17 Expected energy savings of the New Green Savings Programme 2013

	2020	2025	2030	2035	2040
Energy savings [TJ]	103	103	103	103	103

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-18 Expected emissions reduction related to energy savings of the New Green Savings Programme 2013

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	5.01	4.35	4.05	3.76	3.42

Source: CHMI

Sector: Energy, Residential

Greenhouse gas coverage: CO_2

1.2.1.14 New Green Savings Programme

This programme is a follow-up of previously implemented Green Savings Program and New Green Savings Program 2013. It is implemented by the State Environmental Fund of the Czech Republic and it aims at the improvement of energy performance of single- and multi-family buildings (insulation, replacement of old inefficient boilers by new boilers using e.g. biomass; installation of heat pumps and solar systems for hot water).

The programme supports the following activities in single-family houses, multi-family houses and also in public sector buildings:

- Construction of family houses and apartment buildings in so-called passive standard (passive houses)
- Purchase of houses and flats with very low energy consumption
- Solar thermal and photovoltaic systems
- Replacement of non-environmental heat sources with heat pumps, boilers or local biomass sources, gas boilers
- Storage tanks for rainwater retention, wastewater recovery
- Green roofs, outdoor shading technology
- Use of heat from waste water
- Controlled ventilation systems with heat recovery (recuperation)
- Purchase and installation of charging stations for electric vehicles
- Planting of trees on publicly accessible land near residential buildings

Depending on the real energy savings, the support it up to 50% of the total eligible expenses (up to 60% if combined with boiler subsidies for lower income households).

During the programming period in 2014-2021, it contributed a total of 16 billion CZK to more than 74,000 beneficiaries. In 2021, the program moves on to the next stage and expands its focus to new areas. In the programming period 2021-2030, it will be financed in the first years from the Recovery and Resilience Facility (RRF) in the National Recovery Plan (total CZK 19 billion). From 2026 onwards the programme should be financed again from the share of revenues from auctioning of EU ETS emission allowances (about CZK 4 billion per year).

Type of policy: Economic

Implementing entity: State Environmental Fund (Government)

Period of implementation: 2014-2030

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings shows the following table.

Tab. 1-19 Expected energy savings of the New Green Savings Programme 2014–2020

	2020	2025	2030	2035	2040
Energy savings [TJ]	9 074	9 074	9 074	9 074	9 074

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-20 Expected emissions reduction related to energy savings of the New Green Savings Programme 2014–2020

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	529.50	467.67	437.83	404.26	364.01

Source: CHMI

Sector: Energy, Residential

Greenhouse gas coverage: CO_2

1.2.1.15 Programme PANEL / NEW PANEL / PANEL 2013 +

The Programme PANEL (NEW PANEL since 2009, PANEL 2013 + since 2013) supports complex renovation and upgrades of residential houses improving their value, lowering their energy intensity and fundamentally extending their lifetime. The program is managed by the State Investment Promotion Fund.

The Programme was established in 2001 by the Government Resolution No. 299/2001 Coll. According to the Resolution, support may be provided to:

- Natural persons or legal entities owning or co-owning a building;
- Natural persons or legal entities owning or co-owning flats or non-residential premises in a building;
- Flat-owners' associations.

Support was provided for specific types of measures or upgrades in panel houses using standardized construction systems. This support was later extended to all residential houses regardless of their construction system.

Projects supported include e.g.:

- Insulation of the building
- Replacement of old external doors and windows to decrease releasing of heat and outside noise
- Reparation and insulation of roofs
- Installation of a heating system regulation
- Modernization of a heating system, including the use of RES
- Repair or modernization of ventilation technology
- Installation of thermo-solar panels
- Installation of measurement devices for heat consumption, hot and cold water consumption
- Modernization of the hot water system (e.g. lever taps replacement, riser pipe insulation)
- Acquisition of building energy performance certificate

Support was provided in the form of:

- Guarantee for loan provided,
- Subsidy toward partial interest from loans.

Since 2013, this programme has been implemented pursuant to Government Resolution No. 468/2012. The support takes the form of a low-interest loan in the programme PANEL 2013 +.

The Ministry of Industry and Trade evaluation of the State Programme to Promote Energy Savings and the Use of Renewable Sources of Energy in 2016 demonstrated that energy savings in all so far renovated apartments receiving PANEL or New Panel support amounted to approximately 5 852 304 GJ.

The expected annual budget for the period 2021–2026 is estimated to be about CZK 270 m.

Type of policy: Economic

Implementing entity: State Housing Fund (Government)

Period of implementation: Since 2001, temporarily suspended in 2010, continues from 2013 and includes annual evaluation and budgeting exercise

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings shows the following table.

Tab. 1-21 Expected energy savings of the PANEL programme

	2020	2025	2030	2035	2040
Energy savings [TJ]	204	204	204	204	204

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-22 Expected emissions reduction related to energy savings of the PANEL programme

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	17.16	16.05	15.54	14.58	13.29

Source: CHMI

Sectors: Energy, Residential

Greenhouse gas coverage: CO_2

1.2.1.16 Operational Programme Environment 2007-2013

The Operational Programme Environment 2007-2013 was focused on improving the quality of the environment in the Czech Republic. It helped to improve air, water and soil quality. It also addressed waste and industrial pollution. The program promoted landscape care, the use of renewable sources and the building of environmental infrastructure.

This program was primarily focused on the public sector (e.g. municipalities, regions, organizations partly funded from the public purse, state enterprises, non-governmental non-profit organizations). However, in certain areas also business entities and natural persons were included.

The Operational Programme Environment 2007-2013 had eight priority axes. In terms of energy savings, the priority axis 3 was the most significant. This priority axis supported projects for the construction or reconstruction of facilities using renewable energy sources and cogeneration and projects aimed at energy savings and the reuse of waste heat in the non-business sector. Priority axis 2 was also significant. It focused on improving air quality, which also resulted in reduction of energy consumption.

According to the final programme report, the total certified costs reported to the EC of realized projects were EUR 1,069 mill.

Type of policy: Economic

Implementing entity: State Environmental Fund (Government)

Timeframe: 2007-2013

Implemented in scenario: WEM

Mitigation impact: The final programme report declares the following energy savings.

Tab. 1-23 Energy savings of Operational Program Environment 2007–2013

	2020	2025	2030	2035	2040
Energy savings [TJ]	824	824	824	824	824

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-24 Emissions reduction related to energy savings of Operational Program Environment 2007–2013

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	92.77	81.25	74.07	65.50	53.32

Source: CHMI

Besides energy savings, the programme supported use of RES as well. The calculation of emissions savings uses amounts of electricity and heat produced from RES, again with respect to development of fuel mix used for electricity and heat production. The following table shows electricity and heat production from RES as indicated in the final programme report ant the derived emission drops.

Tab. 1-25 Energy production from RES and reached emissions reduction of Operational Program Environment 2007–2013

	2020	2025	2030	2035	2040
Electricity generation from RES [TJ]	2.3	2.3	2.3	2.3	2.3
Heat generation from RES [TJ]	242.3	242.3	242.3	242.3	242.3
GHG emissions reduction [kt CO_2 eq.]	26.9	23.8	22.2	20.4	17.9

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.17 Operational Programme Environment 2014-2020

The aim of the Operational Programme Environment 2014-2020 is to protect and improve the quality of the environment in line with the principles of sustainable development in the Czech Republic. Two priority axis relevant to GHG emission reductions are priority axis 2 - Improvement of Air Quality and priority axis 5 – Energy Savings. For the programming period 2014-2020 the total allocation is more than EUR 3 billion including about EUR 1 billion for activities improving air quality and energy efficiency. The priority axis 2 supports mainly the replacement of boilers burning solid fuels with more efficient low-emission boilers combusting biomass, liquid or gas fuels, and heat pumps. The priority axis 5 supports insulation and other energy efficiency measures in public sector and promotes increased use of renewable energy sources. It also supports the exemplary role of public administration by subsidizing construction of new public buildings in passive energy standard. The program projects are financed from the European Regional Development Fund (ERDF) and from the Cohesion Fund (CF). The expected program budget for energy savings and RES support is CZK 23.6 bill. (approx. EUR 907.7 mill.).

Type of policy: Economic

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2014-2020, all supported projects must be implemented by the end of 2023 at the latest.

Implemented in scenario: WEM

Mitigation impact: It is estimated that by 2023 the energy savings from Priority axis 2 should reach about 3 PJ and energy savings from Priority axis 5 about 2 PJ. The corresponding estimated reductions of GHG emissions are 320 kt CO_2eq for Priority axis 2 and about 300 kt CO_2eq for Priority axis 5.

The expected programme energy savings shows the following table.

Tab. 1-26 Energy savings of Operational Program Environment 2014-2020

	2020	2025	2030	2035	2040
Energy savings [TJ]	4 023	4 740	4 740	4 740	4 740

Notice: The table contains not only emissions drop resulting from higher efficiency of new boilers but also drop from switching from fossil fuels to RES, because RES were calculated as energy savings.

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-27 Emissions reduction related to energy savings of Operational Program Environment 2014-2020

	2020	2025	2030	2035	2040
Emissions reduction [kt CO_2 eq.]	372.15	467.35	426.09	376.79	306.70

Source: CHMI

Besides energy savings, the programme supports use of RES as well. The programme document envisages installing 30 MWe in RES sources and heat production from RES of 150 TJ by 2023. With respect to development of fuel mix used for electricity and heat generation, the resulting mitigation impact will be:

Tab. 1-28 Energy production from RES and reached emissions reduction of Operational Program Environment 2014–2020

	2020	2025	2030	2035	2040
Electricity generation from RES [TJ]	7.9	7.9	7.9	7.9	7.9
Heat generation from RES [TJ]	150.0	150.0	150.0	150.0	150.0
GHG emissions reduction [kt CO_2 eq.]	17.8	15.7	14.6	13.3	11.6

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.18 Integrated Regional Operational Programme (IROP)

The Integrated Regional Operational Programme (IROP) is divided into the following priority axis:

- Competitive, affordable and secure regions
- Improvement of public services and living conditions for residential regions
- Good governance and the efficiency of public institutions
- Community-led local development
- Technical assistance

The priority axis 2 and its investment priority 4c “Promoting energy efficiency, intelligent systems energy management and use of energy from renewable sources public infrastructures, including in public buildings and in housing” is dealing with energy savings as well as its objective 2.5 "Reduction of energy consumption in the residential sector".

Supported measures affecting the energy performance include:

- Insulation of residential building;
- Replacement and refurbishment of windows and doors;
- Passive heating and cooling, shielding;
- Installation of systems of controlled ventilation with heat recovery.

Measures affecting equipment for space and water heating include:

- Replacement of water heating boilers using solid or liquid fossil fuels by efficient biomass boilers;
- Heat pumps;
- Condensing gas boilers or equipment for combined electricity and heat generation using RES or natural gas and covering primarily the energy needs of buildings where located.

Financial allocation of the specific objective 2.5 is EUR 622 796 485 (approximately CZK 17 billion).

Type of policy: Economic

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: 2014-2020

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings shows the following table.

Tab. 1-29 Expected energy savings of the Integrated Regional Operating Programme

Energy savings [TJ]	2020	2025	2030	2035	2040
	2.561	3.168	3.168	3.168	3.168

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-30 Expected emissions reduction related to energy savings of the Integrated Regional Operating Programme

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	164.08	248.65	240.83	225.96	205.91

Source: CHMI

The expected annual budget for the period 2014-2020 is estimated to be about CZK 13.2 bill. (EUR 507.7 mill.).

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.19 Operational Programme Prague – Growth Pole of the Czech Republic

The operational programme under the auspices of the City of Prague focuses on improving the energy performance of buildings and the technical equipment used to ensure the operation of municipal public and road transport, and the implementation of pilot projects to convert energy intensive municipal buildings into nearly-zero energy buildings. These measures fall within the priority axis 2: Sustainable mobility and energy savings. The expected annual budget for the period 2014-2020 is estimated to be about CZK 1.9 bill. (EUR 74.5 mill.)

Type of policy: Economic

Implementing entity: City of Prague

Period of implementation: 2014-2020

Implemented in scenario: WEM

Mitigation impact:

Tab. 1-31 Expected energy savings of the Operational Programme Prague Growth Pole

Energy savings [TJ]	2020	2025	2030	2035	2040
	34	36	36	36	36

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-32 Expected emissions reduction related to energy savings of the Operational Programme Prague Growth Pole

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	3.56	3.51	3.20	2.83	2.30

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.20 JESSICA Programme

The programme offers long-term low-interest loans for reconstruction or modernization of residential buildings. It is implemented by the Ministry of Regional Development. The programme is designed for all owners of residential houses:

- Municipalities
- Housing Cooperatives
- Other legal and natural persons owning residential building
- Community of apartment owners
- Non-profit organizations for social housing.
- The program focuses on:
- Insulation of internal structures and external cladding including replacement of windows and doors,
- Reconstruction of technical equipment (e.g. heating system, plumbing, heating, gas, water, air conditioning, elevators),
- Replacement or modernization of loggias, balconies, railings,
- Repairing static failures of supporting structures,
- Rehabilitation of foundations and waterproofing of substructures,
- Provision of modern social housing through renovation of existing buildings.
- The expected annual budget for the period 2014-2020 is estimated to be about CZK 0.6 bill. (USD 23.1 mill.).

Type of policy: Economic

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: 2014-2016

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings shows the following table.

Tab. 1-33 Expected energy savings of the JESSICA programme

Energy savings [TJ]	2020	2025	2030	2035	2040
	24	24	24	24	24

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-34 Expected emissions reduction related to energy savings of the JESSICA programme

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	2.05	1.91	1.85	1.74	1.59

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.21 ENERG Programme

The programme of the Ministry of Industry and Trade is focused on the provision of soft and interest-free loans for the implementation of projects improving energy performance in the business sector. The administrator of the financial instrument is the National Development Bank.

The budget for the programme was set to almost 130 mil CZK.

Type of policy: Economic

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2017

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings are shown in the following table.

Tab. 1-35 Expected energy savings of the ENERG Programme

Energy savings [TJ]	2020	2025	2030	2035	2040
	40	40	40	40	40

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-36 Expected emissions reduction related to energy savings of the ENERG programme

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	4.05	3.67	3.49	3.20	2.70

Source: CHMI

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.22 Operational Programme Enterprise and Innovation (OPEI): Eco-Energy

The Priority axis 3 (Eco-Energy) of the OPEI supported by The Ministry of Industry and Trade (MIT) had seven priority axes (e.g. Development of firms, Innovation, Business development services, Technical assistance) out of which priority axis 3 (Effective Energy or Eco-Energy) focused on energy savings and on the use of RES (renewable energy sources), thus aiming at GHG reduction. The program aimed at reducing energy intensity in production processes, reducing fossil fuel consumption and at increasing the use of renewable and secondary energy sources. The aid beneficiaries were not only small- or medium-sized, but also large enterprises.

The support also focused on the construction of new facilities for generation and transmission of electricity and thermal energy generated from RES and on the reconstruction of existing production facilities in order to use renewable energy sources. Further support was provided for the modernization of existing energy production facilities to increase their efficiency and for implementation of systems measuring and regulating energy. Further, modernization and loss reduction in the transmission of electricity to heat and to the use of waste energy in industrial processes were encouraged.

Funding was derived in part from European Regional Development Fund (ERDF) (85 %) and partly from the state budget (15 %). The support was provided in the form of subsidies or subsidized loans for all projects on the territory of the Czech Republic except the capital city. Half of the funds allocated to this priority were designated for energy savings and another half for the use of RES.

The aim of the program was to use the grants to stimulate enterprises in reducing the production energy requirements and the consumption of primary energy sources, and to promote a higher utilization of renewable and secondary energy sources.

According to the latest programme annual report, the eligible costs of realized projects were EUR 777.8 mill. The corresponding subsidies from the EU and national funds were EUR 303.3 mill.

Type of policy: Economic (subsidies)

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2007-2013

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings are shown in the following table.

Tab. 1-37 Energy savings of the OPEI programme

Energy savings [TJ]	2020	2025	2030	2035	2040
	1 105	1 105	1 105	1 105	1 105

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-38 Emissions reduction resulting from energy savings of the OPEI programme

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	107.10	98.41	95.24	88.66	75.82

Source: CHMI

Besides energy savings, the programme supported use of RES as well. The calculation of emissions savings uses amounts of electricity and heat produced from RES, again with respect to development of fuel mix used for electricity and heat production.

Tab. 1-39 Energy production from RES and corresponding emissions reduction of the OPEI programme

	2020	2025	2030	2035	2040
Electricity generation from RES [TJ]	451.8	451.8	451.8	451.8	451.8
Heat generation from RES [TJ]	58.5	58.5	58.5	58.5	58.5
GHG emissions reduction [kt CO_2 eq.]	86.8	86.8	86.8	86.8	86.8

Source: CHMI

Sectors: Energy, Manufacturing industries and construction, Agriculture

Greenhouse gas coverage: CO_2, CH_4, N_2O

1.2.1.23 Operational Programme Enterprise and Innovation for Competitiveness (2014–2020)

The Operational Programme Enterprise and Innovations for Competitiveness (OP EIC) is focused on increasing the competitiveness of the Czech economy by supporting the business environment, promoting innovations in the production and services sectors, energy treatment and the development of ICT. EU funding allocation reached EUR 4.33 billion. Direct impact on effective energy management and use of renewable sources is apparent for Priority Axis 3 'Efficient energy management, development of energy infrastructure and renewable energy sources, support for the introduction of new technologies in the management of energy and secondary raw materials'. The Priority Axis 3 covers 28.1% of the allocation of the OP EIC and is directly linked to the fulfilment of selected key objectives of the Europe 2020 strategy.

The programme is financed by the European Regional Development Fund (ERDF) to support enterprises, mostly SMEs. Four priority axes are the main content of the programme from which priority axis 3 "Improving energy efficiency and support for new low-carbon technologies" is aimed at

reducing GHG emissions. The thematic focus of priority axis 3 is the development of smart energy distribution, transmission and storage systems that include also integration of distributed generation from renewable sources. The Priority Axis 3 comprises the following specific objectives:

- Increasing share of energy from renewable sources in gross final consumption;
- Energy savings in the business sector;
- Increasing the application of smart grids in distribution networks;
- Low-carbon technology transition and use of secondary raw materials;
- Co-generation of combined heat and power for heat supply;
- Strengthening the energy security of the transmission system.

The indicated specific objectives comprise numerous activities among which are the following once:

- Installation of a remote co-generation unit using biogas from biogas plant;
- Construction and reconstruction of heat sources and combined production of electricity; and heat from biomass and subsequent heat extraction;
- Use of waste energy in production processes;
- Installation of cogeneration units for internal consumption of the enterprise;
- Installation of electricity accumulation units;
- Implementation of measures to improve the energy performance of buildings in the business sector (replacement and renovation of windows and doors, building insulation, installation of waste heat recuperation and air-conditioning, etc.);
- Support for extra costs for achieving the standard of a nearly zero energy consumption of existing and new constructions of business buildings;
- Introduction of innovative low-carbon technologies in the fields of energy production, buildings, transport, processing and use of secondary raw materials;
- Installation of renewable energy sources for internal industrial consumption;
- Construction and reconstruction of transmission networks and transformer stations;
- The total program budget for energy savings and of RES support is CZK 19 bill. (approx. EUR 730 mill.).

The specification of aid conditions within the OP EIC include an obligation to comply with sustainable development. Compliance with the principles of sustainable development is required at the individual project level of interventions involving construction works, purchase of technology, equipment, appliances, i.e. interventions showing a high probability of impacts on the environment or efficient use of resources (in particular energy resources), investments in scope of such interventions have to meet the highest standards. As a general rule, no projects with adverse effects on sustainable development will be promoted under the OP EIC. The OP EIC also contains environmental indicators which are monitored for relevant specific objectives at the project level, to be further aggregated for the needs of the Partnership Agreement. Environmental indicators mainly concern the indicator ‘Reduction in final energy consumption in supported entities’, ‘Additional capacity of renewable energy production’, ‘Estimated annual decrease of GHG’, ‘Reduction in emissions of primary particles and secondary particulate precursors’ and other related indicators. In connection with the termination terms of physical realization of supported projects these indicators have not begun to be fulfilled so far. Estimated energy saving in this period is about 20 PJ.

Type of policy: Economic (subsidies)

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2014-2020

Implemented in scenario: WEM

Mitigation impact: The expected programme energy savings shows the following table.

Tab. 1-40 Expected energy savings of the programme Operational Programme Enterprise and Innovation for Competitiveness

Energy savings [TJ]	2020	2025	2030	2035	2040
	10 640	13 030	13 030	13 030	13 030

Source: CHMI

Using emission factors, which respect changes in the fuel mix in power and heat generation and in the final energy consumption, we obtain the following reductions in greenhouse gases emissions.

Tab. 1-41 Expected emissions reduction resulting from energy savings of the programme Operational Programme Enterprise and Innovation for Competitiveness

Emissions reduction [kt CO_2 eq.]	2020	2025	2030	2035	2040
	799.37	1160.04	1122.63	1045.09	893.72

Source: CHMI

Besides energy savings, the programme supports use of RES as well. The programme document envisages installing 70 MW in RES sources that will lead to drop in GHG emissions of 300 kt by 2023. Assuming electricity to heat ratio equal to 2:1 and with respect to development of fuel mix used for electricity and heat generation, the resulting mitigation impact will be:

Tab. 1-42 Expected energy production from RES and corresponding emissions reduction of the programme Operational Programme Enterprise and Innovation for Competitiveness

	2020	2025	2030	2035	2040
Electricity generation from RES [TJ]	427.4	1 424.6	1 424.6	1 424.6	1 424.6
Heat generation from RES [TJ]	213.7	712.3	712.3	712.3	712.3
GHG emissions reduction [kt CO_2 eq.]	99.4	280.2	258.0	216.2	163.9

Source: CHMI

Additional information: The total program budget for energy savings and of RES support is CZK 19 bill. (approx. USD 730 mill.).

Sectors: Energy

Greenhouse gas coverage: CO_2

1.2.1.24 OP Technology and application for competitiveness (OP TAC) 2021 – 2027

Managing body: Ministry of Industry and Trade of the Czech Republic

Subsidy grant and FI (combination primarily aimed at SME, big companies e.g. energy sectors and research and development). It is financed from ERDF.

The main goals are:

- negative impact of pandemic mitigation
- increase of productivity of Czech enterprises
- environmental aspects

Area is all regions except Prague

Total allocation of OP TAC is total 3 136 mil Euro.

There is Priority 4 shift to law carbon economy. The allocation of this priority is 29 billion CZK.

Specific axis 4.1 Support of energy efficiency and CO2 reduction

Allocation: roughly 0,5 billion EUR

Indicative target: 3,3 PJ energy savings

Expected CO_2 reduction is 349 000 t CO_2 eq

Measures: Reducing of the energy intensity of buildings (insulation and increase of energy efficiency of technical equipment of the building), modernization of boilers for own consumption except gas boilers, increase energy efficiency of technologies, RES for own consumption (heat pumps , PV, solar collectors , biomass boilers) within complex projects, cogeneration and Ecological and innovative renewal of traction rail vehicles and Modernization of traction substations and traction supply networks (New activity).

Specific axis 4.2 Support of energy from RES

Allocation: roughly 0,26 billion EUR

Indicative target: 202 MW total installed capacity

Expected CO_2 reduction is 238 103,77 t CO_2 eq.

Measures: Heat Pumps, PVE, Wind, hydro, biogas, biomass

1.2.1.25 Modernisation Fund

The Modernisation Fund is a dedicated funding programme to support 10 lower-income EU Member States in their transition to climate neutrality by helping to modernise their energy systems and improve energy efficiency. It was established by Article 10d of the EU ETS Directive. The Modernisation Fund is funded from revenues from the auctioning of 2% of the total allowances for 2021-30 under the EU ETS and additional allowances transferred to the Modernisation Fund by beneficiary Member States. Further increase in allocation is currently debated during the ongoing revision of the EU ETS Directive.

In early 2021 the Czech government approved the programming document for the Modernisation Fund and first calls for project proposals were open in 2021. The Modernisation Fund was designed to be complementary to other national support programmes and operational programmes.

The financial support will be provided in the following areas:

- Heating Sector – change of fuel, reconstruction of networks
- New non-combustion Renewable Energy Sources for electricity production
- Improving energy efficiency and reducing emissions in industrial EU ETS installations
- Improving energy efficiency in industry outside the scope of EU ETS
- Modernisation of transport in business sector
- Modernisation of public transport
- Improving energy efficiency in public buildings and infrastructure

• Support of community energy systems

• Modernisation of public lighting systems

Type of policy: Economic (subsidies)

Implementing entity: Ministry of Environment Government)

Period of implementation: 2021-2030

Implemented in scenario: WAM

Mitigation impact: The expected programme energy savings are shown in the following table.

Tab. 1-43 Expected GHG savings of the Modernisation Fund

	2020	2025	2030	2035	2040
Energy savings [TJ]	2 905	4 375	17 500	17 500	17 500

Sectors: Energy, Manufacturing industries and construction,

Greenhouse gas coverage: CO_2, CH_4

1.2.2 Policies and Measures in 1.A.3 Transport

Policies and Strategies

1.2.2.1 National Action Plan for Clean Mobility

The National Action Plan for Clean Mobility (henceforth "NAP CM") for the period 2015-2018 with the outlook until 2030 responds to the Directive 2014/94/EU on the deployment of alternative fuels infrastructure. The Directive requires the development of domestic policy framework to support the growth of the market with alternative fuels within the transport sector as well as the development of related infrastructure.

The NAP CM focuses on electromobility, CNG, LNG, and partly also hydrogen technology (or the technology of fuel cells). Due to the direct relation to the above-mentioned Directive, the NAP CM primarily aims at alternative fuels, which are underlined in the Directive as being crucial for EU Member States, as well as the need to define, within domestic policy frameworks, national targets for the development of related infrastructure of charging and filling stations. The NAP CM sets out requirements for the construction of filling and charging stations with a time horizon between 2020 and 2030. Specifically, based on the Directive, 1 300 charging stations have to be in use by the year 2020 as well as 3-5 hydrogen filling stations. Concerning strategic goals in relation to electromobility, they include the facilitation of infrastructure development in the field of electromobility, the stimulation of demand for electric vehicles, the creation of conditions for potential customers to perceive electric vehicles in a better light, and to improve conditions to conduct business in fields related to electromobility.

The emphasis of the NAP CM is in accordance with the effort to strive mainly for technologies close to commercial use. The document will be updated every three years as required by the Directive.

By creating the NAP CM, the Government of the Czech Republic declares its will to support the development of alternative fuels in transport and thus to help achieve goals in the area of energy, transport, and environment. Reflecting the Directive, a key principle of the NAP CM is technical neutrality, which means the public sector's untargeted preference towards only one type of alternative fuels. To achieve planned emission reduction in the transport sector, it is necessary to increase the share of alternative fuels. Based on predictions, the biggest impact on the reduction of GHG emissions by the year 2020 in the transport sector in the conditions of the Czech Republic will be reached predominantly via the use of CNG.

Concerning clean mobility as such, it is financed, as stated in the NAP CM, via several subsidy programmes:

- Operational Programme Transport – helps fund infrastructure for alternative fuels
- Operational Programme Enterprise and Innovation for Competitiveness – helps fund the purchase of electric cars for entrepreneurs
- Integrated Regional Development Programme – helps fund the purchase of buses using alternative fuels
- National Programme of the Ministry of Environment of the Czech Republic to help purchase municipalities vehicles using alternative fuels

These programmes are described in more detail in the relevant section (Programming Tools and Other Measures).

The NAP CM was updated in 2020 taking into account:

- The CO2 emission standards for new vehicles
- The goal of 14% RES share in the transport sector
- Binding national targets for public procurement of clean vehicles (Clean Vehicles Directive)
- New EU funds programming period

The update also introduces new target numbers for different low and zero-emissions vehicle types and charging and refuelling stations by 2030.

Type of policy: Regulatory

Implementing entity: Ministry of Transport (Government)

Period of implementation: 2015-2018 with an outlook to 2030

Implemented in scenario: WEM

Sector: Transport

Mitigation impact: This is a policy framework, therefore its mitigation effect is accounted under other measures.

Greenhouse gases covered: CO_2

1.2.2.2 Czech National Cycling Development Strategy for 2013-2020

In May 2013, the Czech government approved the strategic document "Czech National Cycling Development Strategy for 2013-2020" aiming to increase urban cycling modal share to 10% by 2020 and up to 25% by 2025 as well as increase the efficiency of building cycling infrastructure. Further, the

Strategy calls for cooperation among the state, the regional level, and the local level, as well as the private and voluntary sectors.

The main global objective of the Cycling Strategy is to popularize bicycle to become equal-valuable natural and integral part of the transport system in cities.

The Strategy sets four specific goals:

- To secure the financing of the cycling and cycle-tourism infrastructure;
- To increase safety of cycling;
- To provide methodological support to the development of cycling in cities and to the project "Cycling Academy";
- To implement the national product "Czechia Cycles", the popularization of cycle-tourism in the Czech Republic.

The Strategy and the implementation of relevant measures to secure above mentioned goals are financed by the State Fund for Transport Infrastructure.

Type of policy: Economic

Implementing entity: State Fund of Transport Infrastructure (Government)

Period of implementation: 2013-2030

Implemented in scenario: WEM

Sector: Transport

Mitigation impact: The annual energy savings were estimated to be 585 TJ/year from 2020 with the annual budget of 150 million CZK.

Greenhouse gases covered: CO_2

Legislative Instruments

EU Level Instruments

Aviation

1.2.2.3 EU Emissions Trading System

Under the EU Emission Trading System (EU ETS), all airlines operating in Europe, European and non-European alike, are required to monitor, report, and verify their emissions, and to surrender allowances against those emissions. The airlines receive tradeable allowances covering a certain level of emissions from their flights per year. As CO_2 emissions from aviation have been included in the wider EU ETS, the main carbon pricing instrument for aviation in Europe and the first large emissions trading scheme, this measure is described in detail as a cross-cutting measure in the relevant chapter.

1.2.2.4 ICAO Agreement

The International Civil Aviation Organization (ICAO) is a UN specialized agency to manage the administration and governance of the Convention on International Civil Aviation (Chicago Convention). ICAO cooperates with Member States and industry groups on international civil aviation Standards and Recommended Practices (SARPs) and policies in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector.

The measure 'ICAO Agreement' is related to the agreement among ICAO's 191 members in October 2016 to use an offsetting scheme called CORSIA. The scheme does not take effect until 2021 and will be voluntary until 2027. Under the agreement, the global aviation emissions target is a 50% reduction by 2050 relative to 2005.

Type of policy: Economic

Implementing entity: Ministry of Transport, Ministry of the Environment in relation to EU legislation (Government)

Period of implementation: Since 2021

Implemented in scenario: WAM

Mitigation impact: The emission reduction has been calculated by subtraction of supposed energy saving from air transport related total emissions. In the context of the Czech Republic, the total emission reduction of this measure is 5.9 kt. CO_2 eq. in 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.5 EU Regulation 2019/1242 on setting CO_2 emission performance standards for new heavy-duty vehicles

The Regulation sets CO_2 emission performance requirements for new heavy-duty vehicles whereby the specific CO_2 emissions of the Union fleet of new heavy-duty vehicles shall be reduced compared to the reference CO_2 emissions as follows:

- for the reporting periods of the year 2025 onwards by 15%;
- for the reporting periods of the year 2030 onwards by 30%, unless decided otherwise pursuant to the review referred to in Article 15 in the Regulation.

The reference CO_2 emissions shall be based on the monitoring data reported pursuant to Regulation (EU) 2018/956 for the period from 1 July 2019 to 30 June 2020, excluding vocational vehicles.

Type of policy: Regulatory

Implementing entity: Ministry of Transport (Government)

Period of implementation: Since 2019

Implemented in scenario: Measure entered force only in 2019, therefore it is not implemented in scenarios.

Mitigation impact: As this is a framework measure, its mitigation impact is accounted under other measures.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.6 EU Regulation 2019/631 on setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles

The EU Regulation 2019/631 of the European Parliament and of the Council of April 2019 sets CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, and repeals Regulations (EC) No 443/2009 and (EU) No 510/2011.

The Regulation sets cost-effective CO_2 emission reduction targets for new light-duty vehicles up to 2030 combined with a dedicated incentive mechanism to increase the share of zero/low-emission vehicles. The aim of the Regulation is to ensure that the EU automotive industry maintains its technological leadership also by strengthening its competitiveness and stimulating employment while ensuring a better functioning of the internal market and aiming to fulfil Paris Agreement on climate change's objective. Further, the Regulation will also reduce fuel consumption costs for consumers. The incentive mechanism to increase the share of zero/low-emission vehicles will in particular contribute to the reduction of air pollutants and in turn increase air quality with public health benefits.

From 1 January 2020, this Regulation sets an EU fleet-wide target of 95 g CO_2/km for the average emissions of new passenger cars and an EU fleet-wide target of 147 g CO_2/km for the average emissions of new light commercial vehicles registered in the Union. The Regulation will, until the end of the year 2024, be complemented by additional measures corresponding to a reduction of 10 g CO_2/km.

According to the Regulation, the following EU fleet-wide targets shall apply from January 1st, 2025:

a) For the average emissions of the new passenger car fleet, an EU fleet-wide target equal to a 15% reduction of the target in 2021;
b) For the average emissions of the new light commercial vehicles fleet, an EU fleet-wide target equal to a 15% reduction of the target in 2021.

From January 1st, 2030 the following EU fleet-wide targets shall apply:

a) For the average emissions of the new passenger car fleet, an EU fleet-wide target equal to a 37,5% reduction of the target in 2021;
b) For the average emissions of the new light commercial vehicles fleet, an EU fleet-wide target equal to a 31% reduction of the target in 2021.

From the beginning of 2025, a zero- and low-emission vehicles' benchmark equal to a 15% share of the respective fleets of new passenger cars and new light commercial vehicles shall apply (in accordance with points 6.3 of Parts A and B of Annex I, respectively). From 1 January 2030, the following zero- and low-emission vehicles' benchmarks shall apply, in accordance with points 6.3 of Parts A and B of Annex I, respectively:

a) A benchmark equal to a 35 % share of the fleet of new passenger cars;

b) A benchmark equal to a 30 % share of the fleet of new light commercial vehicles.

A new revision of the Regulation is currently being discussed as part of the Fit for 55 package.

Compared to the CO2 emission targets applicable in 2021, the emissions of new passenger cars registered in the EU would have to be 55 % lower, and the emissions of new vans would have to be 50 % lower. By 2035 new passenger cars and vans CO2 emissions would have to be reduced by 100 %, i.e. all new vehicles would have zero emissions.

Type of policy: Regulatory

Implementing entity: Ministry of Transport, Ministry of Industry and Trade (Government)

Period of implementation: Since 2019

Implemented in scenario: Measure entered force only in 2019, therefore it is not implemented in scenarios.

Mitigation impact: As this is a framework measure, its mitigation impact is accounted under other measures.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.7 Directive 2009/33/EC on the promotion of clean and energy efficient road transport vehicles

The Directive 2009/33/EC has as its objectives the promoting and stimulating the market for clean and energy-efficient vehicles and improving the contribution of the transport sector to the environment, climate and energy policies of the Union. The Directive applies to procurement through contracts for the purchase, lease, rent or hire-purchase of road transport vehicles awarded by contracting authorities or contracting entities or, for instance, through public service contracts having as their subject matter the provision of passenger road transport services in excess of a further to be defined threshold. The Directive 2009/33/EC was amended by the Directive (EU) 2019/1161 of the European Parliament and of the Council of June 20 2019 and sets minimum procurement targets for the share of clean vehicles in the total number of road vehicles covered by contracts at Member State level, etc. The share for the Czech Republic at light-duty vehicles is set to be 29.7 % from August 2nd 2021 to December 31st 2025 as well as from January 1st 2026 to December 31st 2030; different shares are set for buses and trucks. The transposition law is in the legislative process, with effect from August 2nd 2021 a government regulation was adopted.

Type of policy: Regulatory

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: Since 2019

Implemented in scenario: Measure entered force only in 2019, therefore it is not implemented in scenarios

Mitigation impact: As this is a framework measure, its mitigation impact is accounted under other measures.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.8 Support of biofuels on the EU level

The quality of fuels used in transport is regulated by the Directive 2009/30/EC amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions. By the end of 2020, suppliers should gradually reduce

life cycle greenhouse gas emissions by up to 10 % per unit of energy from fuel and energy supplied, this reduction amounting to at least 6 % by the end of 2020 compared to the EU-average life cycle greenhouse gas emissions per unit of energy from fossil fuels in 2010, obtained through the use of biofuels, alternative fuels and reductions in flaring and venting at production sites.

Also, the EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources was transposed by the Act on Air Protection 201/2012 Coll., which sets the minimal share of biofuels in gasoline and diesel. Further, on the national level, the Government Decree 351/2012 Coll. sets sustainability criteria of biofuels, and The Law on Consumption Tax 453/2016 Coll. levies biofuels with a lower tax rate. The Directive also sets rules for the sustainable use of biofuels – greenhouse gas emissions from biofuels must be at least 35% lower than a fuel they replace. From 2017, this figure rises to 50 % and from 2018 to 60 % for biofuels produced in facilities that started production on January 1, 2017 or later.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade, Ministry of Transport

Period of implementation: Since 2009

Implemented in scenario: WEM

Mitigation impact: The mitigation impact of biofuels was calculated using modification of emission factors per a unit of energy. The resulted emission factor is a weighted average of emission factors of fossil part and bio part, where weights correspond to the percentage of these components blending, and to plans to increase bio components blending to petrol and diesel. The total emission reduction of this measure is 198 kt CO_2 eq. in 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.9 Support of electromobility on the EU level

Concerning the regulatory framework for the development of electromobility within the EU legislation, the Directive 2014/94/EU on the deployment of alternative fuels infrastructure as transposed to the national level via Act No. 152/2017 Coll. on fuels is relevant. This Act sets requirements on operators of charging stations and by registering them, the Ministry of Transport is able to publish lists of charging stations open to public.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2017

Implemented in scenario: WEM

Mitigation impact: Due to the nature of the framework measure, it is not possible to calculate its mitigation impact.

Sector: Transport

Greenhouse gas coverage: CO_2

National level

1.2.2.10 Promotion of biofuels and fuels quality on national level

The quality of fuels used in transport is regulated by the Directive 2009/30/EC amending Directive 98/70/EC. The Fuel Quality Directive 2009/30/EC has been implemented into the Czech legislation (with regards to GHG emissions) via the amendment to the Act on Air Protection No. 201/2012 Coll., which sets minimal shares of biofuels in gasoline and diesel in accordance with the EU Directive.

The Directive 2009/30/EC requires that the emission intensity of transport fuels falls to 10% by the end of the year 2020, at least 6% compared to the average emission levels. The Government Decree 189/2018 Coll. sets sustainability criteria for biofuels and methodology for calculation greenhouse gas emission production from fuels. The Law on Consumption Tax 453/2016 Coll. Levies biofuels with a lower tax rate. The baseline shall be based on EU average level life cycle GHG emissions per unit of energy from fossil fuel products in 2010. Reducing GHG emissions is likely to be achieved by harnessing biofuels and fuels with lower carbon content (e.g. natural gas).

The Directive also sets rules for the sustainable use of biofuels. GHG emissions from biofuels must be at least 50% lower than the level of GHG emissions of a fuel they replace. This figure rose to 60% from biofuels produced in installations starting operation from October 2015 until the end of the year 2020 and 65% for biofuels produced in installations starting operation from January 1st, 2021.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: since 2009

Implemented in scenario: WEM

Mitigation impact: The mitigation impact of biofuel was calculated by the modification of emission factors per a unit of energy. The resulted emission factor is a weighted average of emission factors of fossil part and bio part, where weights correspond to percentage of these components blending and to plans to increase bio components blending to petrol and diesel. The total emission reduction of this measure is 198kt CO_2 by 2035.

Sector: Transport, Energy

Greenhouse gas coverage: CO_2

1.2.2.11 Economic and tax tools for road vehicles on national level

The objective of these tools is to promote the use of less polluting vehicles. This group of measures covers the following rules:

- Road Traffic Law 13/1997 and its amendments on the charging of the use of transport infrastructure for freight vehicles
- Road Tax Law 190/1993 and its amendments on road tax
- Excise Law 353/2003 supporting alternative fuels with lower CO_2 emissions (e.g. compressed natural gas – CNG, bio fuels – tax free)

Further, the Transport Policy of the Czech Republic for 2014-2020 with the Prospect of 2050 contains the following aims:

- To apply measures minimizing negative impacts of traffic emissions and noise by appropriate transport infrastructure
- To promote low emission freight transport
- To gradually implement measures to decrease noise and vibrations in densely populated areas
- To minimize negative impacts of transport on public health and ecosystem stability
- The construction and reconstruction of traffic structures for functional permeability for animals
- To strengthen the capacity of existing transport corridors before building new communications with similar transport capacity serving the same territory
- To reduce the dependence of transport on fossil fuels
- To introduce speed limits on motorways and highways (higher speed causes more energy consumption and higher emissions).

Type of policy: Economic, Fiscal

Implementing entity: Ministry of Finance (Government)

Period of implementation: 2020-2030

Implemented in scenario: WAM

Mitigation Impact: The emission reduction will be achieved by the changed composition of fuel consumption, i.e. more alternative fuels and less petrol and diesel. Provided that no alternative fuels will be charged by excise tax, its consumption would increase while petrol and diesel consumption decreases equally. The total emission reduction of this measure is 38.4 kt. CO_2 eq. in 2035 year.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.12 Government Decree No. 173/2016 Coll. on determining binding criteria for awarding public contracts for the acquisition of road vehicles

The Decree reflects the Directive 2009/33/EC of the European Parliament and of the Council of April 2009 on the promotion of clean and energy-efficient road transport vehicles and determines binding award criteria of public contracts for the acquisition of road vehicles specifically in connection with the procurement of vehicles. The contracting authorities must define technical specification, including consumption, and emissions of CO_2, NOx, hydrocarbons, and other particles.

The possibility of contracting authorities to define their technical specifications is described in Act No. 134/2016 Coll. On Public Procurement which transposes the European Procurement Directive (Directive 2014/24/EU) as well as other Directives, such as the Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors or the Directive 2014/23/EU on the award of concession contracts, into Czech law.

Type of policy: Regulatory

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: Since 2016

Implemented in scenario: WEM

Mitigation Impact: The emission reduction will be achieved by the changed composition of fuel consumption, i.e. more alternative fuels and less petrol and diesel. Provided that no alternative fuels will be charged by excise tax, its consumption would increase while petrol and diesel consumption decreases equally. The total emission reduction of this measure is 38.4 kt. CO_2 eq. in 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

Financial Schemes and Programmes

1.2.2.13 Operational Programme Transport

The current Operational Programme Transport 2014-2020 (hereinafter OPT2) follows the Operational Programme Transport 2007-2013 (hereinafter OPT1) and represents the most important source of financing for the construction of transport infrastructure in the Czech Republic in the programming period 2014-2020. OPT2 is one of the largest operational programmes taking about 17%, cca EUR 4.56 billion, of all funds for the Czech Republic from the European Structural and Investment Funds in the programming period. Its aim is to fulfil strategic investment needs and help solve key problems in the Czech transport sector.

The main objective is to provide support to sustainable transport and to remove barriers in key network infrastructures. Specifically, the aim is to finalize the backbone infrastructure and help regions access the Trans-European Transport Network (TEN-T), improve its quality and functionality, remove narrow areas in key infrastructure, and support sustainable mobility focusing on cities mainly. The OPT implements the transport strategy and other transport-related aspects of the National Development Plan. Taking into account lessons learnt from the OPT1, the OPT2 targets its support at four priority axis:

Priority Axis 1: Infrastructure for Railways and other modes of sustainable transport

Priority Axis 2: Road infrastructure within the TEN-T, public infrastructure for clean mobility and traffic management

Priority Axis 3: Road infrastructure excluding the TEN-T

Priority Axis 4: Technical assistance

With the OPT2, there are overall 79 subsidy programmes, applications for support to certain calls can be received until June 2023.

All projects implemented within individual Priority Axes favour mass transportation, aim to increase flow of road transportation and support ecological alternatives to road automobile transportation (water-borne and railway transportation) and thus have indirect positive effect on CO_2, NO_x and solid particle emissions.

Concerning clean mobility, the subsidy scheme The Development of Infrastructure for alternative fuels in road transport, funded by the OPT2, is further divided into four sub-programmes. These sub-programmes help fund the network development of fast-charging stations and charging stations (sub-programme 1), CNG filling stations (sub-programme 2), LNG filling stations (sub-programme 3), and hydrogen filling stations (sub-programme 4).

Type of policy: Economic

Implementing entity: State Fund of Transport Infrastructure (Government)

Period of implementation: 2007-2023

Implemented in scenario: WEM

Mitigation Impact: The annual CO_2 emission drop was calculated from average emission coefficients of transport and annual energy savings estimated to 3 016 TJ/year from 2020.

Sector: Transport

Greenhouse gas covered: CO_2

1.2.2.14 Support of public transport and modal shift from road transport

- **Increasing the attractiveness of public transport**
  - Further development of the integrated transport system

    The integrated transport system provides public transport in a certain region and includes several means of transport which do not compete within the system. Individual carriers can participate in this system and their transportation services are usually harmonized. The ITS systems in Prague, South Moravia and Ostrava belong to the most efficient systems in the Czech Republic. As this measure is valid on urban and regional level, it is impossible to quantify its mitigation impact.

  - Increasing passengers' comfort

    The comfort of passengers is increased via different measures including air-conditioning, cleanliness and by the design of the internal environment of the means of transport itself. Travelling is also made more comfortable for disabled citizens or mothers with prams, for instance. Due to the character of this measure, it is not possible to determinate its contribution to GHG emission reduction.

  - Strengthening preferences for public transport vehicles

    In order to enable public transport vehicles to drive faster, extra lanes for buses or trolleybuses are designed. Also, urban public transport receives priority on intersections with light control systems.

  - Introducing the "Park and Ride" system

    Efforts to improve multi-modal passenger transport by "Park and Ride" (P&R) are made to encourage people to leave their cars at the outskirts of Prague and instead take public transport to the centre. In Prague, for instance, this system combines the increasing rates of parking fees in locations where quieter environments are preferred (so called "blue zones") with cheap fees at guarded parking places outside of the city centre.

- **Creating systems of combined freight transport**

The use of multimodal transport systems is preferred to reduce the performance of road transport in favour of those modes of transport that have less impact on the environment. Relevant measures, as described in the Transport Policy of the Czech Republic for 2014-2020 with the Prospect of 2050, seek to find effective and sustainable logistics solutions using the principle of co-modality with the view to support multimodal nature of transport, optimize the capacity of transport infrastructure and use of energy and make logistics services available to small and middle-sized businesses in industry, trade

and agriculture. Further, competitive multimodal transport chains for companies, using the railway and possibly waterborne transport with the objective to improve capacity utilization of the means of transport and reducing empty rides, reduction of heavy road transport, better cooperation and coordination among companies in the area of transport, support of small and middle-sized enterprises, and reduction of negative impacts on the environment, public health and transport safety.

Also, the support of railway transport shall be realized through investment programs for improvement of infrastructure, increasing of speed, promotion of intermodal (container) transport, construction of transship points and of logistic centers. The aim of the measure is to shift 30% of long distanced freight transport from roads to railways (in trips over 300 km).

In total, all fourteen regional authorities in the Czech Republic make effort to develop integrated transport systems (ITS) and are the implementing authorities of this measure. In some regions (Southern and Northern Moravian, Olomouc, Middle Bohemian) these systems already exist, in other regions they are being prepared**.**

Type of policy: Regulatory

Implementing entity: 14 regions/regional authorities

Period of implementation: There is no uniform period for all 14 regions. Each region has the plan of its development. The plans are partly coordinated by Ministry for Regional Development. Within the projections this measures is calculated until 2035.

Implemented in scenario: WEM

Mitigation Impact: The emission reduction will be achieved by the changed composition of fuel consumption, i.e. more alternative fuels and less petrol and diesel. Provided that no alternative fuels will be charged by excise tax, its consumption would increase while petrol and diesel consumption decreases equally. The total emission reduction of this measure is 38.4 kt. CO_2 eq. in 2035 year.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.15 Road toll

Since 2010, certain vehicles are subject to toll payment including vehicles over 3.5 tons. The charge level is derived from the type of vehicle, number of axles, and the time when the road is used.

Type of policy: Fiscal

Implementing entity: Ministry of Transport (Government)

Period of implementation: 2020-2035

Implemented in scenario: WAM

Mitigation Impact: The emission reduction has been calculated with a help of demand elasticity. Elasticity expresses how travel demand responds to transport price increases. The elasticity values for road transport were obtained from scientific literature (Dunkerley et al., 2014). The total emission reduction of this measure is thus calculated to be 161.9 kt. CO_2 eq. by 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

1.2.2.16 Clean Mobility

As mentioned above, there are several subsidy schemes funding clean mobility.

The Integrated Regional Development Programme helps fund the purchase of buses using alternative fuels. So far, there have been three calls: "Low-carbon and Zero-emission vehicles" (2016-2017, allocation: EUR 100 million, 211 vehicles were bought for public transportation), "Sustainable Transportation" (2017-2019, allocation: EUR 300 million, by the end of 2019 around 190 vehicles were bought for public transportation), and "Low-emission and Zero-emission vehicles for coal-mining regions, allocation: CZK 1 839 877 615 = EUR 71 148 067).

The Operational Programme Enterprise and Innovation for Competitiveness helps fund the purchase of electric cars for entrepreneurs. Within the programme to support low-emission technologies and via the sub-programme Electromobility, four calls were announced.

1st call (spring 2016) – allocation: CZK 80 million

2nd call (2017) – allocation: CZK 150 million

3rd call (2018) – allocation: CZK 60 million

4th call (2019) – allocation: CZK 200 million

In total (excluding the 4th call), 536 electronic cars were bought and 255 charging stations were built.

The **National Programme of the Ministry of Environment of the Czech Republic** helps purchase municipalities vehicles that use alternative fuels. The Programme is directed at applicants that are either regions or municipalities, region-owned or municipality-owned market economy operators, or contributory organisations set up by regions/municipalities and state-owned contributory organisations. So far, CZK 100 million was allocated to the first two calls (2016-2017), the third call has been launched in autumn 2018.

Further, e-vehicles are exempted from paying road tax and, in the context of adopting the NAP CM, e-vehicles are also exempted from paying motorway tolls. Vehicles using other alternative fuels pay less than conventional vehicles for motorway tolls, other discussions on further exemptions are undergoing.

Type of policy: Regulatory, Economic

Implementing entity: Ministry of the Environment, Ministry of Industry and Trade (Government)

Period of implementation: As described above for individual programmes.

Implemented in scenario: WEM

Mitigation Impact: The Programmes being in their rather initial phases, the mitigation impact of the programmes combined is not possible to calculate.

Sector: Transport

Greenhouse gas coverage: CO_2

1.3 Policies and Measures in Industrial Processes and Product Use sector

Policies and Strategies

The Czech Republic does not have one comprehensive industrial strategy or policy. Instead, it has more sub-strategies focused on specific areas. The Industry 4.0 document adopted by the Government in 2016 can also be understood as a partial strategy of industrial development in the Czech Republic. Many of these strategies focus on the relationship between industry and environmental protection. Those that affect greenhouse gas emissions are described below.

Ozone layer protection

Policies and strategies adopted in the field of ozone layer protection were adopted back in 2004 and 2005. They were aimed at the timely phase out of certain uses, notably the CFCs in metered dose inhalers, HCFCs in the refrigeration and air conditioning (henceforth as "RAC") sector, and halons in the fire-fighting sector. The objective of all respective strategic documents were met, thus all those were made obsolete roughly by the year of 2015. The only strategic document that has been recently "revived" is the one aimed on the use of halons in the fire- fighting sector. The Ministry of the Environment has adopted a new strategic document with the objective of collection/destruction/regeneration of the remaining halons being still installed in certain critical use applications. The underlying objective is the full phase-out of all critical use applications by the year 2040.

The implementation of the F-gas regulation is not subject to any strategic document. The national legislation implements both the F-gas and the Ozone Depleting Substances (henceforth as "ODS") regulation with their main objectives:

- To make both regimes identical for the "end user ";
- To adhere strictly to the minimum EU requirements on the qualification of personnel and make them applicable both to the ODS and F-gasses in the same manner;
- To keep the recovery criteria of ODS and F-gases from refrigeration and firefighting equipment as strict as possible, beyond the EU legislation.

Legislative Instruments

1.3.1 Act No. 76/2002 Coll., on integrated pollution prevention and control, on the integrated pollution register (Integrated Prevention Act), as amended

Integrated pollution prevention and control, abbreviated as IPPC, refers to the minimising of pollution from various industrial sources throughout the EU. The Integrated Prevention Act, as amended, transposes EU legislation, at the beginning Directive 96/61/EC (later replaced by codified wording under No. 2008/1/EC) on Integrated Pollution Prevention and Control (henceforth as "IPPC"). The current Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) have been transposed into national legislation in 2013 according to Article 80(1) of the Directive by amending the Act. The Regulation requires industrial and agricultural activities with a high pollution potential to have a permit; this permit can only be issued if certain environmental conditions are met, so that the companies themselves bear responsibility for preventing and reducing any pollution they may cause. The IPPC Directive is based on several principles, namely an integrated approach, best

available techniques, flexibility and public participation. The implementing regulation to Act No. 76/2002 Coll. is regulation No. 288/2013 Coll. The main objective of integrated prevention is protection of the environment as a whole against industry and agriculture pollution by regulation of operations of selected facilities listed in Annex No. 1 of the Act. Issuance of integrated permit replaces several other administrative acts according to corresponding legislation.

Prevention of pollution by implementing the so-called best available techniques (henceforth as "BAT") represents a higher degree of protection of the environment.

In the area of greenhouse gas emissions, which are generated by production and use of heat and electricity, the Act allows the regulator to apply the BAT concept, which should lead to increased energy efficiency of production. BAT includes technologies used as well as the manner in which the facility is designed, built, operated, maintained and decommissioned. This Act also allows application of emission limits or equivalent technical parameters, which are based on advanced technologies used in affected industrial sectors. Nevertheless, the possibility of imposing emission limits directly with respect to greenhouse gas emissions remains limited by law on integrated prevention only in cases where it is required, in order to prevent serious pollution at the site.

The manner and scope of ensuring information exchange by BAT is defined in Act No.76/2002 Coll., on integrated prevention, as amended. The set of BAT is specified in reference documents (BREF). For permitting purposes, the most important information is provided in the so-called conclusions on BAT.

Type of policy: Regulatory

Implementing entity: Ministry of Environment (Government)

Period of implementation: Since 2002

Implemented scenario: WEM

Mitigation impact: As this is a framework measure, its mitigation effect is accounted under other measures.

Sector: Industrial Processes

Greenhouse gas coverage: CO_2**,** CH_4**,** HFCs, PFCs, SF_6

1.3.2 Regulation (EU) No. 517/2014 on fluorinated greenhouse gases and repealing Regulation (EC) No. 842/2006

The F-Gas Regulation (EU) No 517/2014 retains many important and successful features of the previous F-Gas Regulation related to leak prevention, F-gas recovery and technical training. As its main measure is to reduce the use of HFCs, the new Regulation prescribes a cap and subsequent reduction of HFCs that can be placed on the EU market ("phase-down"). The new F-Gas Regulation also includes several bans. F-gases with high global warming potential (henceforth as "GWP") are restricted from use in new equipment in refrigeration, small air conditioners, fire protection, foams and technical aerosols. In addition, a "service ban" requires operators of existing equipment to start using more climate-friendly alternatives from 2020 onwards.

The main scope of the F-gas regulation:

- Prevention of emissions of fluorinated greenhouse gases – sets requirements for leak checks, servicing, training of the staff, record keeping, recovery of the gases at the end of the equipment's life;
- Reduction of the quantity of HFCs placed on the market - banning the use of F-gases in equipment where less harmful alternatives are available also the volume of HFCs placed on the EU market will be limited.

Producers/importers/exporters of more than 100t CO_2 eq. of F-gases must communicate information via obligatory reporting. Since 2015, a new system of quotas has been put in place.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2015-2035

Implemented scenario: WEM

Mitigation impact: The main goal of the new F-Gas Regulation is to cut the EU's F-gas emissions by two-thirds compared with 2014 levels by 2030.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs, PFCs, SF_6

1.3.3 Act No. 73/2012 Coll., on ozone depleting substances and fluorinated greenhouse gases, as amended

This Act regulates the rights and obligations of persons and competence of administrative bodies in the field of ozone layer protection and climate system protection against negative effects of regulated substances and fluorinated greenhouse gases. The implementing regulation to Act No. 73/2012 Coll., as amended, is regulation No. 257/2012 Coll., on emission prevention of substances damaging ozone layer and fluorinated greenhouse gases.

With regard to ozone layer protection, the fundamental regulation is Regulation (EC) No.1005/2009 of the European Parliament and of the Council of September 2009 on substances that deplete the ozone layer, as amended, and Regulation (EU) No. 517/2014 of the European Parliament and of the Council of April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No. 842/2006.

A process of amending this Act is to be finalised soon, the main objective being the removal of non-refillable containers from the black market by means of banning their use and storage; newly the conditions for reclamation of fluorinated gases will be introduced. Only undertaking holding permission of the Ministry of the Environment will be allowed F-gases reclamation.

Type of Policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of Implementation: Since 2012

Implemented Scenario: WEM

Mitigation impact: The Act aims to remove substances that deplete the ozone layer.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs, PFCs, SF_6

1.3.4 Directive 2006/40/EC (MAC Directive)

Directive 2006/40/EC regulates the use of F-gases with GWP higher than 150 in passenger cars (M1) and light commercial vehicles' (N1) air conditioning. The directive consists of 3 phases, from which the last one entered force on 1st January 2017. Since then, the use of HFCs with GWP higher than 150 is totally banned for new vehicles placed on the EU market.

Type of policy: Regulatory

Implementing entity: Ministry of Transport (Government)

Period of implementation: Since 2008

Implemented in scenario: WEM

Mitigation impact: Overall mitigation impact of the Directive 2006/40/EC on F-gases consumption in passenger cars (M1) and light commercial vehicles (N1) was calculated by using market information for year 2017. Car producers do not use F-gases (HFC-134a) for new cars intended for EU market but HFC-134a is used for filling of air conditioning of cars for non EU countries. If the situation on the market remains stable in future, it is expected that emissions from 1st fill will decrease by 82% in 2035 comparing to year 2015. If the car producers will switch to use of alternatives (HFO-1234yf) also for cars intended for non-EU countries the mitigation impact will be 100% in 2035 compared to 2015.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs

1.3.5 The Kigali Amendment to the Montreal Protocol

The Kigali Amendment was agreed at the 28th Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer in October 2016. The Kigali Amendment adds to the Montreal Protocol the phase-down of the use of HFCs. The Amendment sets a different time schedules and methodology for baseline calculations for Article 5 and non-Article 5 Parties. Trade with Parties that have not ratified the Amendment ("non-Parties") will be banned from 1 January 2033.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2019-2036

Implemented in scenario: WEM

Mitigation impact: The starting point for the phase down of the use of HFCs for non-article 5 parties will be year 2019. Non-article 5 Parties should reduce the production/consumption of HFCs by 85% relative to the baseline which is calculated as average production/consumption of HFCs in 2011-2013 plus 15% of HCFC baseline production/consumption.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs

Financial Schemes and Programmes

An Eco tax on imports and the use of ODS has been introduced back in 2002 and it is still in place, even though it is applied on very rare occasions as ODS have been phased out completely apart from the critical use applications.

Finances that have been acquired by means of this eco tax are used (to this day) mostly for supporting the recovery and destruction of ODS. The dominant sector being the halon installations, the RAC were supported by these means as well. Domestic RAC is, however, a subject to a take-back scheme under the waste regulation (WEEE Directive), so the recovery and destruction costs are covered by the buyers of new equipment. The reason for the above-mentioned preference of halons is their very high ozone depleting potential and the fact that their release into atmosphere is technically identical with their intended use. The support continues to be provided to these days.

Type of policy: Regulatory

Implementing entity: Ministry of Finance (Government)

Period of implementation: Since 2002

Implemented in scenario: WEM

Mitigation impact: The Act aims to remove substances that deplete the ozone layer.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs, PFCs, SF_6

1.4 Policies and Measures in Agriculture sector

The concept of sustainable and multifunctional agriculture in the Czech Republic takes into account the reduction of greenhouse gas emissions and possible needs for adaptation measures, along with other environmental and socio-economic considerations. These objectives can be achieved by the Common Agricultural Policy of the EU, as well as through national measures.

The implemented agrarian policies and measures should undoubtedly increase CO_2 fixation in the agriculture sector. The policies and measures in agriculture leading to greenhouse gas mitigation are based on prudent application of fertilizers, cultivation of cover crops, adoption of ecological and organic farming, implementation of modern and innovative technologies, monitoring fermentation of crop residues, etc. Recent agrarian policy has declared the goal of reducing nitrogen leaching and run-off.

Important measures to reduce emissions of GHGs in agriculture include optimal timing of fertilization, the exact amount of fertilizer application to crop use and optimal (covered) storage of manure.

The EU Common Agricultural Policy (henceforth "CAP") has a significant impact on the extent, orientation and profitability of agricultural activities. The CAP is based on three principles – a common market for agricultural products based on common prices, preferences for agricultural production in EU countries as opposed to external competition, and financial solidarity - financing from common contribution-based funds. The implementation of the CAP can affect the trend in GHG emissions from agriculture (methane and nitrous oxide emissions) in both directions (up or down) depending on the individual implemented measures, practices and policies in the Czech Republic.

With the new CAP after 2020 there has been published 3 new regulations in December 2021:

- Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) No 1307/2013
- Regulation (EU) 2021/2116 of the European Parliament and of the Council of 2 December 2021 on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013
- Regulation (EU) 2021/2117 of the European Parliament and of the Council of 2 December 2021 amending Regulations (EU) No 1308/2013 establishing a common organisation of the markets in agricultural products, (EU) No 1151/2012 on quality schemes for agricultural products and foodstuffs, (EU) No 251/2014 on the definition, description, presentation, labelling and the

protection of geographical indications of aromatised wine products and (EU) No 228/2013 laying down specific measures for agriculture in the outermost regions of the Union

In the period to 2020, EUR 8.3 billion will be invested from the EU budget into the Czech farming sector and rural areas. The total budget available for Czech farmers in the form of Direct Payments is EUR 6.01 billion while around EUR 2.31 billion has been allocated for measures benefiting its rural areas (including transfers from Direct Payments), which is then supplemented by further public and private funding.

Policies and Strategies

1.4.1 Action Plan for Biomass in the Czech Republic for the period 2012-2020

The main aim of the Action Plan for Biomass was to set up appropriate measures and principles that supported sustainable use of the energy potential of biomass in the Czech Republic. The main objectives included a determination of energy potential of agricultural and forest woody biomass and quantifying the amount of energy that could be produced by biomass in the Czech Republic by the year 2020. Action Plan for Biomass has expired at the end of 2020 year. Since 2021 was replaced by National Renewable Energy Action Plan (NREAP), which included also energy production from biomass.

Type of policy: Fiscal

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2012-2020

Implemented scenario: WEM

Mitigation Impact: Expected GHG emissions reduction was approximately 125 kt CO_2 eq.

Sectors: Agriculture, Energy, LULUCF

Greenhouse gas coverage: CO_2

1.4.2 Czech Action Plan for Development of Organic Farming 2016-2020

The aim of the Action Plan for the Development of Organic Farming 2016-2020 (henceforth "AP") was to support the development of organic farming in the Czech Republic until the year 2020, and was developed as the third AP in succession. This AP is followed by the new Action Plan for the Development of Organic Farming 2021-2027. Organic farming (henceforth "OF") has been developing in the Czech Republic for more than 25 years. Areas such as legislation or inspection and certification systems are agreed on at a high level, but other areas are not yet sufficiently developed (e.g. organic food processing and sale, domestic organic food market, use of OF potential in the area of nature protection, research and innovation in OF, consultancy and education) and require systematic support. A new AP has been drawn up for this purpose. It includes priority areas and recommended measures and its implementation will contribute to the further development of OF. The defined priority areas for OF development up to the year 2020 are based on an analysis of the current state of OF and an updated SWOT analysis. Specifically, the defined priority areas for OF including their strategic goals for the time period 2016-2020, as stated and further described together with priority measures in the Action Plan, are:

1. Organic Farms – Improve the economic viability of organic farms;
2. Organic Food Market – Increase the proportion of Czech organic foods on the market;

3. Consumption of organic foods – Increase the consumption of organic foods, especially of Czech origin;
4. Benefits to the environment and animal welfare – Raise awareness of the benefits of the OF to the environment and animal welfare;
5. Research – education – consultancy – Increase the use of research results and innovation.

Overall, the main aims of the Action Plan are the following:

- Organic farming will become an important part of Czech agriculture = the aim is to increase the viability of organic farms while concurrently retaining the benefits for the environment and animal welfare (fair prices along with effective and considerate methods of organic production);
- Build a stable market for organic foods with a significant proportion of foods of Czech origin (produced from domestic organic raw ingredients) = raise consumer confidence and consumption of organic foods;
- Functional cooperation within the entire supply chain (functional sales).

Type of policy: Fiscal

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2016-2020

Implemented scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted together with other PaMs in the agriculture sector.

Sector: Agriculture

Greenhouse gases coverage: CH_4, N_2O

1.4.3 Strategy for Growth – Czech Agriculture and Food Sector within the Common Agricultural Policy of the EU after 2013

The Strategy for Growth layed down strategic development targets in the field of agriculture and food production for the Czech Republic. The long-term objective of the economically justified strategic level of production in the main agricultural commodities of the moderate belt (dairy products, meat, etc.) was taken into account, also ensuring adequate market share for the production of processed agricultural and food products, especially those for which there is a potential for competitive production.

The document presented prognosis of activity data and agricultural management targets in the context of agro-environmental measures and policies.

In the field of agriculture, the main objective is to contribute on a long-term and sustainable basis to the food security on the national and European level and to contribute to the energy self-sufficiency of the Czech Republic within the framework of the set energy mix and rural development, including the increase of its recreational potential. Out of the seven targets to this objective, several of them were closely linked to mitigation efforts – e.g., to develop the use of agricultural production and waste as renewable sources of energy, or to improve the impacts of agriculture on natural resources and, in times of climate change, to increase protection with regard to sustainable farming, comprehensive development, and landscape creation. Validity of this strategy finished in 2020 year and was not prolonged or replaced.

Type of policy: Fiscal

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2013-2020

Implemented in scenario: WEM

Mitigation Impact: It is expected that GHG emissions reduction for the year 2020 will be approximately 250 kt CO_2 eq. and 300 kt CO_2 eq. for the year 2035.

Sector: Agriculture

Greenhouse gas coverage: CH_4, N_2O, CO_2

1.4.4 The Strategy of the Ministry of Agriculture of the Czech Republic with outlook up to 2030

The document is designed as an open living document and a fundamental basis for strategic management processes within the Ministry of Agriculture. Priorities, objectives and actions of the Strategy will be implemented via relevant programmes. The document was approved by the Government of the Czech Republic in May 2016.

Type of policy: Fiscal

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2016-2030

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted together with other PaMs in the agriculture sector.

Sector: Agriculture

Greenhouse gas coverage: CH_4, N_2O

Legislative Instruments

1.4.5 Cross Compliance

Cross compliance has been employed in the Czech Republic since January 2009. Based on this mechanism, direct payments and other selected subsidies can be granted only on the condition that a beneficiary meets the statutory management requirements addressing environment, public health, the health of animals and plants, and animal welfare, the standards of Good Agricultural and Environmental Conditions (GAEC). In the following years, the cross compliance mechanism underwent a number of updates reflecting the EU legislation; the requirements and evaluated standards within Cross Compliance were updated in line with the Common Agricultural Policy.

Type of policy: Research, Education

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2009-2035

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted together with other PaMs in the agriculture sector. The implementation of cross compliance should reduce direct emissions from fertilizers (N_2O) and emissions from enteric fermentation (CH_4) by improving breeding management and sustaining a healthier animal population.

Sector: Agriculture

Greenhouse gases coverage: CH_4, N_2O, CO_2

1.4.6 Nitrates Directive – Czech Republic's 4th Action Programme

The Nitrates Directive (91/676/EEC) generally requires EU Member States to:

- Monitor waters and identify waters which are polluted or are liable to be polluted by nitrates from agriculture;
- Establish a code of good agricultural practice to protect waters from this pollution;
- Promote the application by farmers of the code of good agricultural practice;
- Identify the area or areas to which an action programme should be applied to protect waters from pollution by nitrates from agricultural sources;
- Develop and implement action programmes to reduce and prevent this pollution in identified areas: action programmes are to be implemented and updated on a four-year cycle;
- Monitor the effectiveness of the action programmes and report to the EU Commission on progress.

The Directive specifies the maximum amount of livestock manure which may be applied (as the amount of fertilizers containing nitrogen per hectare per year, i.e. 170 kg N/ha).

The Czech Republic has drawn up action programmes to reduce nitrate pollution. The 4th Action programme was in force for the period from August 2016 to June 2020. A technical update of the Action Programme was carried out in March 2018. Based on the update, changes have been made in respect to seasons and limits of fertilization use, agricultural activities in proximity to surface water, crop rotation, storage of fertilizers, farming on slopes and farming near water. Altogether, the programme as such focuses on defining vulnerable areas, their revision and expansion. In the 5th Action Programme, which has been in force since July 2020, measures have been introduced to restrict the cultivation of maize in rotation, whereby this crop cannot be cultivated in application zone III. for more than 2 consecutive years. And there is the obligation to prepare a nitrogen balance for farmers farming in nitrate vulnerable areas. It should be noted that the costs associated with the implementation of the above measures and policies are not possible to estimate at present. They represent an inherent part of the landscape (agricultural and forest) management practice applied in accordance with the local environmental and other specific conditions.

Type of policy: Information

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2016-2035

Implemented in scenario: WEM

Mitigation impact: This is a framework measure and its mitigation effect is accounted together with other PaMs in the agriculture sector.

Sector: Agriculture

Greenhouse gas coverage: N_2O

Financial Schemes and Programmes

1.4.7 Czech Rural Development Programme for 2014-2020

The Rural Development Programme (RDP) for the Czech Republic was formally adopted by the European Commission in May 2015, outlining the Czech priorities for using the nearly EUR 3.1 billion of public money that is made available for the 7-year period 2014-2020. Of this budget, EUR 2.3 billion comes from the EU budget with EUR 135 million transferred from the envelope for CAP direct payments, and EUR 769 million of national co-funding. Regulation (EU) 2020/2220 of the EP and of the Council of 23.12.2020 prolonged the programming period to 2022. In 2021, within the 9th RDP modification, the national contribution was increased with the total public contribution reaching more than EUR 4.7 billion (EUR 3.1 billion from the EU budget and EUR 1.7 billion of national co-funding).

The RDP focuses mainly on ensuring the sustainable management of natural resources and on encouraging climate friendly farming practices, with around 25% of agricultural land under contract to protect biodiversity, 11% to improve water management and 12% to protect soil. Secondly, its aim is to increase the competitiveness of agriculture and forestry as well as that of the food industry. The RDP also supports organic farming, increased use of renewables, and afforestation of agricultural land. The objective of the programme is thus to restore, preserve and improve the ecosystems dependent on agriculture by means of agri-environmental measures, to invest into the competitiveness and innovation of agricultural enterprises, to encourage young people into farming, and to improve landscape infrastructure.

The RDP funds actions under six Rural Development Priorities and in the Czech context, particular emphasis is placed on Priority 4: Restoring, preserving and enhancing ecosystems related to agriculture and forestry. Under this priority, among other activities, nearly 870 000 ha of farmland will be subject to voluntary agri-environmental and climate-related commitments by farmers, who will receive training on the better delivery of environmental and climate-related benefits. Priority 5: Resource efficiency and climate is further relevant as under this priority the RDP will support renewable energy investment to produce wooden pellets and the afforestation of 250 ha of agricultural land to increase CO_2 sequestration.[7]

In general, 61.26% of public support is directed towards Priority 4 with 25.75% being used for agri-environment-climate measures in the context of water management. On the other hand, 0,26% of public support is spent on Priority 5 related to promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sector (renewable energy and carbon conservation/sequestration).

In the next period will follow CAP SP 2023-2027, targeting the same priorities and objectives specifically specific objective 5: “Fostering sustainable development and efficient management of natural resources such as water, soil and air, including by reducing chemical dependency” (SO 5) with proposed budget EUR 2.2 billion for Eco-schemes, Organic farming, Agri-environmental and climate-related management and Land consolidations from the total of EUR 7.9 billion total public expenditures.

Type of policy: Fiscal

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2014-2020

Implemented in scenario: WEM

[7] https://ec.europa.eu/agriculture/sites/agriculture/files/rural-development-2014-2020/country-files/cz/factsheet_en.pdf

Mitigation impact: It is expected that GHG emissions reduction in 2020 will be approximately 200 kt CO_2 eq. and 357 kt CO_2 eq. in 2035.

Sectors: Agriculture, LULUCF

Greenhouse gas coverage: CO_2, CH_4, N_2O

1.5 Policies and Measures in Land use, Land Use Change and Forestry sector

The land use, land use change and forestry (LULUCF) sector is linked to agriculture and some of the policies listed above in the chapter on Policies and Measures in the Agriculture Sector are partly common for both sectors. Policies and measures in the LULUCF sector are generally focused on the sustainable use of natural resources, biodiversity preservation, and on securing all functions and services that these resources provide to society.

Despite numerous EU policy processes that are linked to LULUCF, such as the Ministerial Conference on the Protection of Forests in Europe (Forest Europe, https://www.foresteurope.org), Natura 2000 etc., none of those are prescriptive in terms of CO_2, CH_4 and N_2O, emissions and removals. Their effect on greenhouse gas balance of the LULUCF sector may be indirect, however, not practicably quantifiable. Similarly, the adopted EU Decision No 529/2013/EU (on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities) is in principle not prescriptive with respect to concrete actions and targets in the LULUCF sector, but regulates accounting rules and providing information. On the other hand, the most recently adopted EU Regulation 2018/841 (on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework) may represent a stronger incentive for actions in the LULUCF sector. Specifically, it adopts a new accounting framework for forestry based on forest reference level (henceforth "FRL"). Setting FRL is mandatorily based on the continuation of forest management practices during the so-called Reference period of 2000-2009. These practices are projected to the period 2021-2030 with a limited possibility to exclude disturbances. Since the Czech forestry is currently experiencing an unpreceded large-scale decline of spruce-dominated stands (and also other species are endangered by recurrent drought), the adopted accounting framework becomes very unfavourable for the national circumstances. This issue is expected to fuel the national policymaking associated with efforts to reform and stabilize the forestry sector and management of forest resources.

It should be noted that the costs associated with the implementation of the below measures and policies are not possible to estimate at present. They represent an inherent part of the landscape (agricultural and forest) management practice applied in accordance with the local environmental and other specific conditions. Hence, the implemented measures carry over its spatial heterogeneity and discerning the particular costs is not feasible.

Policies and Strategies

1.5.1 State forestry policy until 2035

The most important land category of the Czech LULUCF sector in terms of greenhouse gas emission balance is Forest Land. Forestry in the Czech Republic is regulated by the Forestry Act (Act no. 289/1995 Coll. on Forests and Amendments to some Acts), which is the principal legislative instrument in this regard. This instrument also does not specifically target carbon balance, but its provisions affect carbon budget and greenhouse gas emissions and removals in numerous ways indirectly.

Beyond the legislation above, State forestry policy until 2035 is the basic national strategic document for forestry and forestry-related sectors. It includes specific measures being or to be implemented to alleviate the impact of expected global climate change and extreme meteorological conditions. These measures generally focus on creating more resilient forest ecosystems by promoting diversified forest stand utilizing to the greatest possible extent natural processes, appropriate species composition and variability of silvicultural approaches, reflecting the current international treaties, agreements, conventions and EU legislation.

Several of these recommendations are continuously being implemented according to the Decree No 298/2018/ Coll., on elaborating regional plans of forest development and on specification of economic complexes. The Decree has increased the minimal share of improving and stabilizing tree species (newly including larch and Douglas fir) in the forest stands. It has also increased the financial support for improving and stabilizing species and introduced support for pioneering species to speed up forest regeneration. Provisions of this decree are implemented through regional plans of forest development which are currently undergoing the process of update.

Type of policy: Economic

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2021-2035

Implemented in scenario: WEM

Mitigation Impact: The policies and measures listed above are directly aimed at mitigation, although mitigation effect is expected in long-term perspective of several decades to a century. The key aim of the above policies is the adaptation of forest ecosystems to environmental change, including both climate and societal factors. Discerning mitigation effect is, due to numerous uncertainties involved, highly uncertain. In general, mitigation benefits of this program are expected to be minimal or even negative in the coming decades. However, it is expected to turn positive in the long-term perspective of functional ecosystems fulfilling the entire spectrum of expected functions, including mitigation.

Sector: LULUCF

Greenhouse gas coverage: CO_2

Legislative Instruments

1.5.2 Regulation (EU) No. 2018/841 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry into the 2030 climate and energy framework

To ensure the contribution of the LULUCF sector to the achievement of the European Union's emission reduction target of at least 40% cuts in greenhouse gas emissions (from 1990 levels) and to the long-

term goal of the Paris Agreement, the LULUCF Regulation has established a robust accounting system for the different LULUCF land accounting categories for the period 2021-2030 in accordance with the 2006 IPCC Guidelines. The Regulation sets a binding commitment for each Member State to ensure that accounted emissions from land use are entirely compensated by an equivalent removal in the LULUCF sector (so called "no debit" rule). For the key category of managed forest land, it has established accounting based on forest reference levels, which should not take into account any new forestry policies adopted after 2009.

On 14 July 2021 the European Commission presented the Fit for 55 package. One of these proposals involves amending Regulation (EU) 2018/841 on emissions and removals from land use, land-use change and forestry . Among the main changes envisaged are to merge, as of 2030, the LULUCF sector with the non-CO_2 agricultural sector in a new climate pillar, which would have to achieve climate neutrality by 2035. Moreover, by 2030, LULUCF carbon removals would have to increase to 310 million tonnes of CO_2 equivalent. For the post-2025 period, the Commission would set individual targets for each Member State. For the Czech Republic the proposed target for 2030 is -1 228 kt

Type of policy: Regulatory

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2021-2030

Implemented in scenario: WEM

Mitigation impact: The LULUCF accounting framework has no direct mitigation impact. However, it should encourage Member States to maintain and enhance their carbon sink. The credits from LULUCF accounting could be to a limited degree used for Effort Sharing Regulation compliance and, on the other hand, the debits resulting from non-compliance with the "no debit" rule need to be compensated by Annual Emission Allocations (AEAs). According to the proposed revision this compensation will be only required in the 2021-2025 period.

Sector: LULUCF

Greenhouse gas coverage: CO_2, CH_4, N_2O

1.6 Policies and Measures in Waste sector

Greenhouse gas emissions generated by the waste sector in the Czech Republic have been growing due to organic carbon that is accumulated in landfills, increasing amount of produced municipal solid waste (henceforth as "MSW") and unfavourable mix of MSW treatment options. Recently, this trend started to change and we observe mild stagnation of emissions from landfills, which is a key source of GHG emissions from this sector in the Czech Republic. The slowing of GHG production observed is mainly due to increased landfill gas (henceforth as "LFG") capturing.

There is a potential for emission reductions in fulfilling the EU obligations of the Circular Economy Package (henceforth as "CEP") (COM/2015/0614) and other national measures with emission reduction effects related to the national common waste policy. Waste-to-energy measures will also affect industrial waste generated by other industries. Policies and measures in the waste sector aim at reducing the amount of produced waste, significant reduction of landfilled waste, minimizing the delivery of biodegradable waste in landfills, establishing and expanding separate collection system for

different waste streams (plastics, paper, glass, bio-waste, cardboard, metals, textile), promoting the energy recovery and digestion of non-recyclable waste, and increasing landfill gas recovery.

The Czech waste legislation is largely based on the EU legislation. The EU legislation with direct impact on GHG emissions from waste included the Landfill Directive (1999/31/EC) and the Waste Directive (2008/98/EU), these Directives have been modified by the CEP. The revised legislative framework on waste has entered force in July 2018. The EU Member states have 24 months to implement the CEP into national law.

There are several policies that are not part of the waste legislation that already have or will have impact on GHG emissions from waste. Most of them are mentioned in the cross sectoral section in this report, nevertheless, it is important to especially highlight the EU ETS, the Climate & Energy Package and the Energy Tax Directive which provide direct and indirect support on LFG recovery and therefore significantly influence landfill emissions.

The largest public financial support for the waste management infrastructure comes from the State Environmental Fund of the Czech Republic (SEF). The Operational Programme Environment (henceforth "OPE") also contributes significantly to the expansion of the facility network; it is financed from the EU Cohesion Fund.

Policies and Strategies

1.6.1 Waste Management Plan of the Czech Republic for the period 2003-2014

The most important instrument on the national level aimed at CH_4 emission reduction from waste was the Waste Management Plan (henceforth "WMP"). All of the targets and measures were in compliance with the obligatory EU legislation. Further, several programmes were set up to help reach the WMP goals. The main programme was the OPE 2007-2013 with its priority axis 4: Improvement of waste management and rehabilitation of old ecological burdens. This axis had a budget of EUR 713 million from the EU Cohesion Fund.

The increasing share of recovered waste to the waste disposed is the result of three factors: 1. A shift towards more efficient technology use in the manufacturing sector 2. Waste is perceived as a source of raw material 3. The financial support of EUR 713 million from the OPE 2007-2013 has helped implement the WMP as EUR 515 million was allocated to waste management alone. The total number of supported projects in this context reached 4227.

The tables below show the rates of municipal waste treatment and treatment with all waste in the Czech Republic for the time period 2009-2014. The time period begins from 2009 as the official database VISOH, operated by the Ministry of Environment, shows values from 2009.

Tab. 1-44 Municipal waste treatment in the Czech Republic in 2009-2014

Municipal Waste	Recovery	Material recovery	Energy recovery	Landfilling	Other treatment
Year 2009	29%	23%	6%	64%	7%
Year 2010	33%	24%	9%	59%	8%
Year 2011	42%	31%	11%	55%	3%

Year 2012	42%	30%	12%	54%	4%
Year 2013	42%	30%	12%	52%	6%
Year 2014	47%	35%	12%	48%	5%

Source: MoE

Tab. 1-45 Treatment with all waste in the Czech Republic in the period 2009-2014

All waste	Recovery	Material recovery	Energy recovery	Landfilling	Other treatment
Year 2009	74.5%	72.5%	2%	15%	10.5%
Year 2010	73.5%	71%	2.5%	13.5%	13%
Year 2011	78%	75%	3%	13%	9%
Year 2012	79%	75.5%	3.5%	13%	8%
Year 2013	79.5%	76%	3.5%	11%	9.5%
Year 2014	83%	79.5%	3.5%	10%	7%

Source: MoE

Type of policy: Economic, Fiscal

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2003-2014

Implemented in scenario: WEM

Mitigation impact: The total emission reduction of this measure is 974 kt CO_2 eq. in 2035.

Sector: Waste

Greenhouse gas coverage: CH_4

1.6.2 Waste Management Plan of the Czech Republic for the period 2015-2024

Today's crucial instrument in the context of waste management on the national level is the Waste Management Plan (WMP) for the period 2015-2024 adopted by the Government in December 2014.

The WMP of the Czech Republic establishes in accordance with the principles of sustainable development the objectives, policies, and measures of waste management in the Czech Republic. The WMP is also the reference document for the development of regional Waste Management Plans. The binding part of WMP constitutes the mandatory basis for decision-making and other activities of the relevant administrative authorities, regions, and municipalities in the area of waste management. The WMP has been prepared for the period of 10 years, and will be changed immediately following any fundamental change in the conditions under which it had been developed (e.g. new legislation on waste management affecting the waste management strategy, including the establishment of new objectives or the redefinition of existing objectives, policies, and measures).

From 2024, certain waste categories (recyclable and recoverable wastes) will be prohibited from being deposited in landfills. For these categories, the landfilling fee will be gradually increased to achieve gradual decrease in the quantity of waste from the relevant categories deposited at landfills.

The defined objectives and targets set in the WMP 2015-2024 include, also in light of the European Directive 2008/98/EC on waste, the following:

- In relation to municipal waste, to introduce by the year 2015 separate collection at least for waste consisting of paper, plastic, glass, and metals; (from 2015 is obligatory separate collection of biodegradable municipal waste and from 2020 is obligatory separate collection of edible oils and fats);
- By 2020, the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a minimum of overall 50% by weight.
- To use mixed municipal waste (after sorting of materially recoverable components, hazardous substances and biodegradable waste) especially for energy recovery in facilities designed for this purpose in accordance with effective legislation;
- To reduce the maximum quantity of biodegradable municipal waste deposited at landfills in such a way, so that the share of this component would in 2020 account for maximum of 35% by weight of the total quantity of biodegradable municipal waste produced in 1995;
- To increase by the year 2020, to at least 70% by weight, the rate of preparing for re-use and the rate of recycling of construction and demolition waste and other types of their material recovery;
- Objectives are also set for packaging and packaging waste, separate collection of waste electrical and electronic equipment, waste batteries and accumulators, and for the processing of end-of-life vehicles and waste tyres.

The OPE 2014-2020 is a direct continuation of the above mentioned OPE 2007-2013 and it is also financed from the EU Cohesion Fund. The priorities of the project support in waste management are determined by the obligations set in the CEP (COM/2015/0614), the WMP and by the Programme of Waste Prevention of the Czech Republic. Waste management and material flows, environmental burdens and risks are covered by the OPE's Priority Axis 3. From the Priority Axis 3's overall budget of EUR 458.8 million, for example EUR 18.3 million is allocated for preventing municipal waste generation, EUR 42.7 million for preventing industrial waste generation, EUR 68 million for construction and modernization of waste collection, sorting and treatment facilities, EUR 103 million for material recovery of waste, EUR 53 million for energy recovery of waste and EUR 22.2 million for construction and modernization of hazardous waste management facilities.

The new WMP includes modelling of the proposed and implemented measures and their impact on activity data – waste quantity and waste management practices. The result of this modelling was used as a basis for the projections of GHG emissions in this document.

Type of policy: Economic, Fiscal

Implementing entity: Ministry of Environment (Government)

Period of implementation: 2015-2024

Implemented in scenario: WEM

Mitigation impact: The assumption for GHG emission reduction is 0.56 Mt CO_2 eq. or 10% over the period of 2015-2024

Sectors: Waste, Energy

Greenhouse gas coverage: CH_4

Legislative Instruments

1.6.3 Circular Economy Package

In 2015, the European Commission published an ambitious Circular Economy Action Plan (COM/2015/0614) which includes measures that will help stimulate Europe's transition towards a circular economy. In July 2018, the revised waste legislative framework has entered force setting clear targets for reduction of waste and the establishment of a long-term path for waste management and recycling.

Key elements of the revised waste proposal, the Circular Economy Package (CEP), include:

- A common EU target for recycling 65% of municipal waste by 2035;
- A common EU target for recycling 70 % of packaging waste by 2030;
- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035;
- Recycling targets for specific packaging materials;
- Strengthening and extension of separate collection obligations to hazardous household waste (by the end of 2024), bio-waste (by end of 2023), textiles (by the end of 2024), etc.
- Establishment of minimum requirements for extended producer responsibility schemes to improve their governance and cost efficiency;
- Promotion of economic instruments to reduce landfilling;
- Improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Specific measures to promote re-use and stimulate industrial symbiosis - turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes.

Time of policy: Economic, Fiscal

Implementing entity: Ministry of Environment (Government)

Period of implementation: 2018-2035

Implemented in scenario: WEM

Mitigation impact: The assumption is that obliging with the CEP 2030 targets will also significantly contribute to the achievement of GHG reduction target.

Sector: Waste

Greenhouse gas coverage: CH_4

2 Projected greenhouse gas emissions by gas and source

Projections of greenhouse gas (GHG) emissions are prepared for following sectors:

- Energy (sector 1),
- Industrial Processes and Product Use (IPPU) (sector 2),
- Agriculture (sector 3),
- Land Use, Land Use Change and Forestry (LULUCF) (sector 4),
- Waste (sector 5).

Projections values presented in **this textual report** are calculated based on **GWPs from AR4**.

Projections values presented in **Tables 1 and 5 in Reportnet** are calculated based on **GWPs from AR5**.

The reason of the difference is due to the transition period, when projections were calculated according to the base year 2020 (new GWP values are applied to inventory reported starting from 2021), in addition, originally using the tables from previous reporting. New tables with GWP values from AR5 became available shortly before the report submission.

Re-calculating of the values and rewriting the whole text would require a lot of time and there would be more risk to make mistakes at the last moment.

Summary tables in chapters 2.1, 2.1.1 and 2.1.2 include also the the values using GWP from AR5.

The preparation of GHG emissions projections include the following steps:

(i) **Selection of the latest available National Inventory Report (NIR) –** The currently available NIR (CHMI, 2022) contains GHG emission estimates for above listed sectors for period 1990 - 2020. According to NIR (CHMI, 2022), the total GHG emissions (including indirect emissions and LULUCF) were 126 Mt CO_2 eq. in 2020. Emissions decreased in 2020 by 34 % compared to 1990. Total emissions including indirect emissions and excluding LULUCF were 113 Mt CO_2 eq. in 2020. Emissions decreased in 2020 by 43 % compared to 1990.

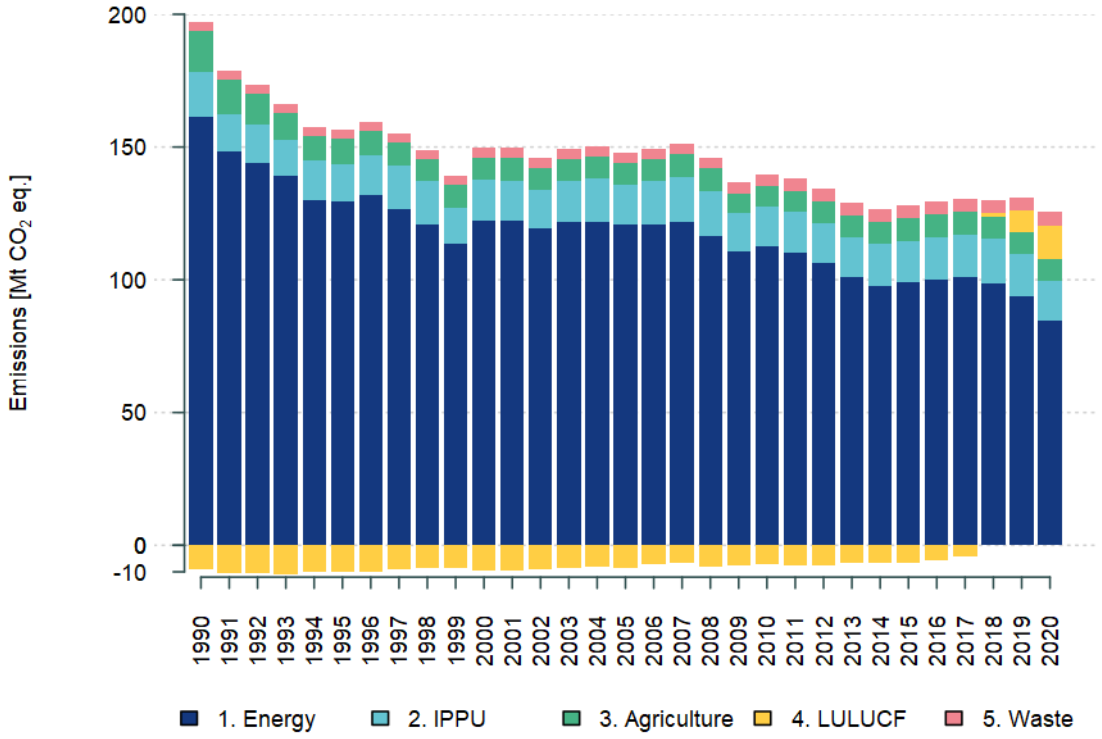


Fig. 2-1 Total GHG emissions of the Czech Republic for 1990 – 2020 (CHMI, 2022)

The total trends of GHG emission estimates (including LULUCF) published in NIR (CHMI, 2022) are shown in Tab. 2-1 and Fig. 2-1. The highest share of GHG emissions in 2020 has sector 1. Energy (67 %), where 97 % comes from 1.A Fuel combustion. The share of other sectors on total GHG emissions is following: 2. IPPU 12 %, 3. Agriculture 6 % and 5. Waste 4 %. 4. LULUCF was the only sector acting as GHG sink until 2017, however, since 2018 has been acting as an emitter. In 2020 it contributed to the balance as an emitter by 10 % due to the bark beetle mitigation measures.

Tab. 2-1 Overview of GHG emission/removal trends by CRF categories (CHMI, 2022)

	Base year kt CO_2 eq.	2020 kt CO_2 eq.	2020 Total share [%]	2020 Sectoral share [%]	Trend [%]
1. Energy	**161178.30**	**84581.01**	**67.36**	**100.00**	**-47.52**
A. Fuel combustion (sectoral approach)	149316.79	82269.20	65.52	97.27	-44.90
1. Energy industries	56855.14	41603.33	33.13	49.19	-26.83
2. Manufacturing industries and construction	47113.14	10243.90	8.16	12.11	-78.26
3. Transport	11346.84	17785.31	14.16	21.03	56.74
4. Other sectors	33807.41	12314.02	9.81	14.56	-63.58
5. Other	194.26	322.64	0.26	0.38	66.08
B. Fugitive emissions from fuels	11861.51	2311.81	1.84	2.73	-80.51
1. Solid fuels	10779.39	1700.74	1.35	2.01	-84.22
2. Oil and natural gas and other emissions from energy production	1082.12	611.07	0.49	0.72	-43.53
C. CO_2 transport and storage	NO	NO	NA	NA	0.00
2. Industrial Processes	**17250.05**	**15229.96**	**12.13**	**100.00**	**-11.71**
A. Mineral industry	4082.45	3210.62	2.56	21.08	-21.36
B. Chemical industry	2941.78	1627.97	1.30	10.69	-44.66
C. Metal industry	9809.81	5945.89	4.74	39.04	-39.39

D. Non-energy products from fuels and solvent use	125.56	133.44	0.11	0.88	6.27
E. Electronic industry	NO,NE	4.63	0.00	0.03	100.00
F. Product uses as ODS substitutes	NO	4019.87	3.20	26.39	100.00
G. Other product manufacture and use	290.46	286.60	0.23	1.88	-1.33
H. Other	NO	0.94	0.00	0.01	100.00
3. Agriculture	**15512.64**	**7841.83**	**6.25**	**100.00**	**-49.45**
A. Enteric fermentation	5737.19	3091.26	2.46	39.42	-46.12
B. Manure management	2941.45	787.39	0.63	10.04	-73.23
C. Rice cultivation	NO	NO	NA	NA	0.00
D. Agricultural soils	5537.83	3623.46	2.89	46.21	-34.57
E. Prescribed burning of savannas	NO	NO	NA	NA	0.00
F. Field burning of agricultural residues	NO	NO	NA	NA	0.00
G. Liming	1187.63	183.74	0.15	2.34	-84.53
H. Urea application	108.53	155.97	0.12	1.99	43.70
I. Other carbon-containing fertilizers	NO	NO	NA	NA	0.00
J. Other	NO	NO	NA	NA	0.00
4. Land use, land-use change and forestry	**-8936.22**	**12771.80**	**10.17**	**100.00**	**-242.92**
A. Forest land	-7497.94	14781.62	11.77	115.74	-297.14
B. Cropland	99.68	32.51	0.03	0.25	-67.39
C. Grassland	-157.14	-493.24	-0.39	-3.86	213.88
D. Wetlands	21.97	34.36	0.03	0.27	56.35
E. Settlements	275.68	146.22	0.12	1.14	-46.96
F. Other land	NO,NA	NO,NA	NA	NA	0.00
G. Harvested wood products	-1680.47	-1730.19	-1.38	-13.55	2.96
H. Other	NO	NO	NA	NA	0.00
5. Waste	**3014.26**	**5135.78**	**4.09**	**100.00**	**70.38**
A. Solid waste disposal	1792.69	3293.75	2.62	64.13	83.73
B. Biological treatment of solid waste	NE,IE	735.70	0.59	14.33	100.00
C. Incineration and open burning of waste	20.48	113.23	0.09	2.20	452.79
D. Waste water treatment and discharge	1201.08	993.09	0.79	19.34	-17.32
E. Other	NO	NO	NA	NA	0.00
Total CO_2 equivalent emissions without land use, land-use change and forestry	**196955.24**	**112788.58**			**-42.73**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**188019.02**	**125560.38**			**-33.22**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**198847.99**	**113338.55**			**-43.00**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land- use change and forestry	**189911.77**	**126110.35**			**-33.60**

(ii) **Selection of base, final, and cross-cutting years for projections** – 2020 was selected as the base year for GHG emissions projections for all sectors except 1.A.1 and 1.A.4 in Energy, as it is the latest year with available information on macroeconomic development, energy balances and emission estimates. For 1.A.1 and 1.A.4 Energy subcategories, the year 2019 was selected as the base year of the model to avoid bias by the pandemic year 2020. 2025, 2030, 2035, 2040, 2045 and 2050 are mandatory as the cross-cutting years.

(iii) **Selection of the methodology and model instruments for the projection preparation** – Detailed methodology and modelling instruments used for GHG emissions projections can be found in chapter Methodological issues for each sector.

(iv) **Collection and analysis of input data for the projection** – More detailed information about collection and analysis of input data used for GHG emissions projections can be found in chapter Methodological issues for each sector.

(v) **Establishment of initial assumptions** – More detailed information about initial assumptions used for GHG emissions projections can be found in chapter Methodological issues for each sector.

(vi) **Definition of scenarios** – GHG emission projections contain two scenarios: 'With existing measures' (WEM) and 'With additional measures' (WAM). Policies and measures (PaM) introduced before 1st July 2022

are reflected in WEM scenario, while PaMs introduced after 1st July 2022 are reflected in WAM scenario. More detailed information about PaMs and their implementation can be found in chapter 1. Policies and Measures.

(vii) **Calculation of scenarios and results presentation** – Results of GHG emission projections are presented for each sector as a total emission for sector, emissions by gases and emissions by categories. Results can be found in chapter Projected greenhouse gas emissions 'With measures (WEM) scenario' and 'With additional measures (WAM) scenario' for each sector.

(viii) **Sensitivity analysis on selected assumptions** – Detailed information are available in chapter Sensitivity analysis for each sector.

2.1 Projected greenhouse gas emissions 'With measures (WEM) scenario' and 'With additional measures (WAM) scenario'

The total GHG emissions (Tab. 2-2 and Fig. 2-2) are projected to continuously decrease for both WEM and WAM scenarios. The difference between WEM and WAM scenario is caused by additional measures in 1. Energy and 5. Waste sectors. Total GHG emissions for WEM scenario are projected to amount to 52.56 Mt CO_2 eq. in 2050, representing 72 % decrease of emissions compared to 1990. For WAM scenario the total GHG emissions in 2050 are projected to amount to 45.54 Mt CO_2 eq., representing 76 % decrease of emissions compared to 1990.

Total projected GHG emissions using GWPs from AR4 are on average 0.65 Mt CO_2 eq. lower than the total values using GWPs from AR5.

Tab.2-2 Reported and projected emissions of GHG – WEM and WAM (including LULUCF)

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2025	1990 – 2030	1990 – 2040	1990 - 2050
WEM - AR4	188.02	139.75	125.56	97.10	82.77	69.73	64.76	60.56	52.56	-48.35	-55.98	-65.56	-72.04
WAM - AR4	188.02	139.75	125.56	96.01	80.98	57.39	51.24	48.44	45.54	-48.94	-56.93	-72.75	-75.78
WEM - AR5	190.19	140.68	124.34	97.92	83.52	70.41	65.38	61.15	53.11	-48.51	-56.09	-65.62	-72.08
WAM - AR5	190.19	140.68	124.34	96.83	81.71	58.06	51.82	48.97	46.05	-49.09	-57.04	-72.76	-75.79

Note: reported values including GWPs from AR5 are taken from NIR 2023

Fig. 2-2 Reported and projected GHG emissions – WEM, WAM scenario (including LULUCF)

2.1.1 Projected greenhouse gas emissions 'With measures (WEM) scenario'

According to the WEM scenario it is expected that emissions will decrease for all the monitored greenhouse gases. Although there is the smallest decrease in emissions of N_2O, the trend has improved compared to the last projections report, where the N_2O emissions increased in 2020 – 2050.

Tab. 2-3 Breakdown of reported and projected emissions of GHG by gases - WEM scenario (including LULUCF)

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2025	1990 – 2030	1990 – 2040	1990 - 2050
CO_2	155.18	117.26	104.57	78.06	66.05	54.49	50.70	47.38	40.36	-49.70	-57.43	-67.33	-73.99
CH_4	23.42	14.59	11.55	11.49	10.55	9.85	9.09	8.63	8.05	-50.94	-54.97	-61.17	-65.63
N_2O	9.33	6.33	5.35	5.08	4.74	4.49	4.26	4.05	3.78	-45.57	-49.24	-54.38	-59.45
HFCs	NO	1.45	4.02	2.41	1.38	0.86	0.67	0.47	0.34	NA	NA	NA	NA
PFCs	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
SF_6	0.08	0.11	0.07	0.06	0.05	0.04	0.03	0.03	0.02	-30.27	-41.21	-58.09	-70.09
NF_3	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
Total	**188.02**	**139.75**	**125.56**	**97.10**	**82.77**	**69.73**	**64.76**	**60.56**	**52.56**	**-48.35**	**-55.98**	**-65.56**	**-72.04**
	1990	**2005**	**2020**	**GWP from AR5**						**1990 – 2025**	**1990 – 2030**	**1990 – 2040**	**1990 - 2050**
CO_2	155.57	117.34	102.91	78.06	66.05	54.49	50.70	47.38	40.36	-49.82	-57.54	-67.41	-74.06
CH_4	26.87	16.59	13.13	12.87	11.81	11.03	10.19	9.67	9.02	-52.10	-56.03	-62.09	-66.44
N_2O	7.66	5.27	4.49	4.52	4.21	3.99	3.79	3.60	3.37	-41.06	-45.03	-50.59	-56.08
HFCs	NO	1.35	3.73	2.41	1.38	0.86	0.67	0.47	0.34	NA	NA	NA	NA

PFCs	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
SF_6	0.09	0.12	0.07	0.06	0.05	0.04	0.03	0.03	0.02	-33.78	-44.17	-60.20	-71.59
NF_3	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
Total	**190.19**	**140.68**	**124.34**	**97.92**	**83.52**	**70.42**	**65.38**	**61.15**	**53.11**	**-48.51**	**-56.09**	**-65.62**	**-72.08**

Note: reported values including GWPs from AR5 are taken from NIR 2023

The most rapid decrease in 1990 – 2050 is expected in 1. Energy sector (79 %), as shown in the Tab. 2-4. A drop of 92 % in the same period is projected in the category 1.A.1 Energy industries, which has major share on total GHG emissions from 1. Energy. This drop is driven mainly by the category 1.A.1.a Public electricity and heat production. As for the 2. IPPU sector, current legislation mainly focuses on F-gas emissions reduction, particularly HFCs, which are used extensively in 2.F.1 Refrigeration and air conditioning systems. In 3. Agriculture, the decrease in synthetic fertilization application leads to the reduction of nitrous oxide emissions from Agricultural Soils, therefore emissions from this sector tend to decrease compared to the previous report in 2021. On the basis of 4. LULUCF projections, the sector is expected to remain a GHG emitter until 2030, after which it should regain its role of GHG sink. This is caused mainly by an exceptional outbreak of bark-beetle infestation and associated dieback of spruce. For 5. Waste sector, slight decrease of GHG emissions is expected in years 2025 - 2050.

Tab. 2-4 Breakdown of reported and projected emissions of GHG by sectors - WEM scenario (including LULUCF)

[Mt CO_2 eq.]	**Reported emissions**			**Projected emissions**						**Difference [%]**			
	1990	**2005**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**1990 – 2025**	**1990 – 2030**	**1990 – 2040**	**1990 - 2050**
1. Energy	161.18	120.86	84.58	66.34	56.44	49.16	45.86	41.87	34.45	-58.84	-64.98	-71.54	-78.63
2. IPPU	17.25	15.15	15.23	14.42	13.37	12.75	12.51	12.26	12.08	-16.40	-22.48	-27.46	-29.98
3. Agriculture	15.51	8.12	7.84	7.95	7.70	7.48	7.34	7.16	7.03	-48.75	-50.39	-52.65	-54.69
4. LULUCF	-8.94	-8.34	12.77	3.44	0.92	-3.26	-4.09	-3.63	-3.78	138.46	110.26	54.26	57.72
5. Waste	3.01	3.96	5.14	4.95	4.34	3.60	3.12	2.90	2.78	64.33	44.12	3.62	-7.70
Total	**188.02**	**139.75**	**125.56**	**97.10**	**82.77**	**69.73**	**64.76**	**60.56**	**52.56**	**-48.35**	**-55.98**	**-65.56**	**-72.04**
	1990	**2005**	**2020**	**GWP from AR5**						**1990 – 2025**	**1990 – 2030**	**1990 – 2040**	**1990 - 2050**
1. Energy	163.20	121.84	84.91	66.66	56.73	49.45	46.12	42.10	34.64	-59.15	-65.24	-71.74	-78.78
2. IPPU	17.12	14.91	14.76	14.38	13.33	12.71	12.47	12.22	12.03	-15.98	-22.11	-27.14	-29.69
3. Agriculture	15.14	7.81	7.72	7.97	7.75	7.57	7.47	7.30	7.20	-47.32	-48.77	-50.67	-52.43
4. LULUCF	-8.59	-8.26	11.27	3.44	0.92	-3.26	-4.09	-3.62	-3.78	140.04	110.69	52.41	56.01
5. Waste	3.32	4.36	5.68	5.47	4.78	3.94	3.40	3.16	3.01	64.69	44.00	2.56	-9.21
Total	**190.19**	**140.68**	**124.34**	**97.92**	**83.52**	**70.41**	**65.38**	**61.15**	**53.11**	**-48.51**	**-56.09**	**-65.62**	**-72.08**

Note: reported values including GWPs from AR5 are taken from NIR 2023

2.1.2 Projected greenhouse gas emissions 'With additional measures (WAM) scenario'

The difference between WEM and WAM is caused by additional measures included in WAM scenario for 1. Energy and 5. Waste. The trend of individual gases projections (Tab. 2-5) is very similar to the WEM scenario.

Tab. 2-5 Breakdown of reported and projected emissions of GHG by gases - WAM scenario (including LULUCF)

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 - 2050	1990 - 2050	1990 - 2050	1990 - 2050
CO_2	155.18	117.26	104.57	77.06	64.36	42.35	37.63	35.86	33.63	-50.34	-58.52	-75.75	-78.33
CH_4	23.42	14.59	11.55	11.44	10.44	9.69	8.70	8.11	7.75	-51.18	-55.43	-62.85	-66.91
N_2O	9.33	6.33	5.35	5.04	4.74	4.44	4.20	3.97	3.80	-45.98	-49.21	-55.04	-59.29
HFCs	NO	1.45	4.02	2.41	1.38	0.86	0.67	0.47	0.34	NA	NA	NA	NA
PFCs	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
SF_6	0.08	0.11	0.07	0.06	0.05	0.04	0.03	0.03	0.02	-30.27	-41.21	-58.09	-70.09
NF_3	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
Total	**188.02**	**139.75**	**125.56**	**96.01**	**80.98**	**57.39**	**51.24**	**48.44**	**45.54**	**-48.94**	**-56.93**	**-72.75**	**-75.78**
	1990	**2005**	**2020**	**GWP from AR5**						**1990 - 2050**	**1990 - 2050**	**1990 - 2050**	**1990 - 2050**
CO_2	155.57	117.34	102.91	77.06	64.36	42.35	37.63	35.86	33.63	-50.47	-58.63	-75.81	-78.38
CH_4	26.87	16.59	13.13	12.81	11.69	10.86	9.74	9.09	8.68	-52.33	-56.49	-63.73	-67.70
N_2O	7.66	5.27	4.49	4.48	4.22	3.94	3.73	3.53	3.38	-41.50	-44.99	-51.30	-55.91
HFCs	NO	1.35	3.73	2.41	1.38	0.86	0.67	0.47	0.34	NA	NA	NA	NA
PFCs	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
SF_6	0.09	0.12	0.07	0.06	0.05	0.04	0.03	0.03	0.02	-33.78	-44.17	-60.20	-71.59
NF_3	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
Total	**190.19**	**140.68**	**124.34**	**96.83**	**81.71**	**58.06**	**51.82**	**48.97**	**46.05**	**-49.09**	**-57.04**	**-72.76**	**-75.79**

Note: reported values including GWPs from AR5 are taken from NIR 2023

The trend of projected GHG emissions for individual sectors in WAM scenario (Tab. 2-6) is also very similar to the WEM scenario. According to the WAM scenario, emissions from 1. Energy and 5. Waste should be lower compared to WEM scenario.

Tab. 2-6 Breakdown of reported and projected emissions of GHG by sectors - WAM scenario (including LULUCF)

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 - 2050	1990 - 2050	1990 - 2050	1990 - 2050
1. Energy	161.18	120.86	84.58	65.26	54.74	36.92	32.45	29.94	27.72	-59.51	-66.04	-79.87	-82.80
2. IPPU	17.25	15.15	15.23	14.42	13.37	12.75	12.51	12.26	12.08	-16.40	-22.48	-27.46	-29.98
3. Agriculture	15.51	8.12	7.84	7.95	7.70	7.48	7.34	7.16	7.03	-48.75	-50.39	-52.65	-54.69

4. LULUCF	-8.94	-8.34	12.77	3.44	0.92	-3.26	-4.09	-3.63	-3.78	138.46	110.26	54.26	57.72
5. Waste	3.01	3.96	5.14	4.94	4.26	3.49	3.02	2.71	2.50	63.80	41.27	0.20	-17.09
Total	**188.02**	**139.75**	**125.56**	**96.01**	**80.98**	**57.39**	**51.24**	**48.44**	**45.54**	**-48.94**	**-56.93**	**-72.75**	**-75.78**
	1990	**2005**	**2020**	**GWP from AR5**						**1990 - 2050**	**1990 - 2050**	**1990 - 2050**	**1990 - 2050**
1. Energy	163.20	121.84	84.91	65.59	55.02	37.22	32.68	30.14	27.90	-59.81	-66.29	-79.98	-82.90
2. IPPU	17.12	14.91	14.76	14.38	13.33	12.71	12.47	12.22	12.03	-15.98	-22.11	-27.14	-29.69
3. Agriculture	15.14	7.81	7.72	7.97	7.75	7.57	7.47	7.30	7.20	-47.32	-48.77	-50.67	-52.43
4. LULUCF	-8.59	-8.26	11.27	3.44	0.92	-3.26	-4.09	-3.62	-3.78	140.04	110.69	52.41	56.01
5. Waste	3.32	4.36	5.68	5.45	4.68	3.82	3.29	2.94	2.70	64.15	41.10	-0.91	-18.76
Total	**190.19**	**140.68**	**124.34**	**96.83**	**81.71**	**58.06**	**51.82**	**48.97**	**46.05**	**-49.09**	**-57.04**	**-72.76**	**-75.79**

Note: reported values including GWPs from AR5 are taken from NIR 2023

2.1.3 Split of greenhouse gas emissions between EU ETS and ESD/ESR sectors

Following tables contain historic and projected greenhouse gas emissions under EU ETS sectors and ESD/ESR sectors for WEM and WAM scenario. Negative projected values for subcategory 1.A.1.a in WAM scenario for years 2045 and 2050 are caused by introduction of CCUS from biomass (chapter 2.2.4).

Tab. 2-7 Split of historic and projected EU ETS and ESD/ESR emissions – WEM scenario

[Mt CO_2 eq.]	Reported emissions		Projected emissions						Difference [%]			
	2005	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2005 – 2025**	**2005 – 2030**	**2005 – 2040**	**2005 - 2050**
EU ETS	82.45	56.74	37.53	28.27	22.31	21.24	20.13	20.12	-54.48	-65.72	-74.24	-75.59
ESD	64.50	56.04	56.13	53.58	50.67	47.60	44.05	36.21	-12.98	-16.93	-26.21	-43.86

Tab. 2-8 Split of historic and projected EU ETS and ESD/ESR emissions – WAM scenario

[Mt CO_2 eq.]	Reported emissions		Projected emissions						Difference [%]			
	2005	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2005 – 2025**	**2005 – 2030**	**2005 – 2040**	**2005 - 2050**
EU ETS	82.45	56.74	36.75	28.90	19.12	18.68	16.76	16.31	-55.43	-64.95	-77.35	-80.22
ESD	64.50	56.04	55.81	51.15	41.52	36.64	35.30	33.01	-13.47	-20.70	-43.19	-48.83

2.2 Energy

The 1. Energy sector in the Czech Republic is driven by the combustion of fossil fuels in stationary and mobile sources; however, fugitive emissions are also an important source of emissions. The two main categories are 1.A Fuel combustion and 1.B Fugitive emissions from fuels.

CO_2 emissions from the category 1.A Fuel combustion decreased by 45 %, from 147 Mt in 1990 to 81 Mt in 2020. Furthermore, CO_2 emissions from the 1.B Fugitive emissions from fuels decreased by 89 % from 458 kt in 1990 to 53 kt in 2020, as well as CH_4 emissions from 1.B Fugitive emissions from fuels decreased by 80 % from 456 kt in 1990 to 90 kt in 2020. GHG emission trend from sector 1. Energy for 1990 - 2020 is depicted in Fig. 2-3 (CHMI, 2022).

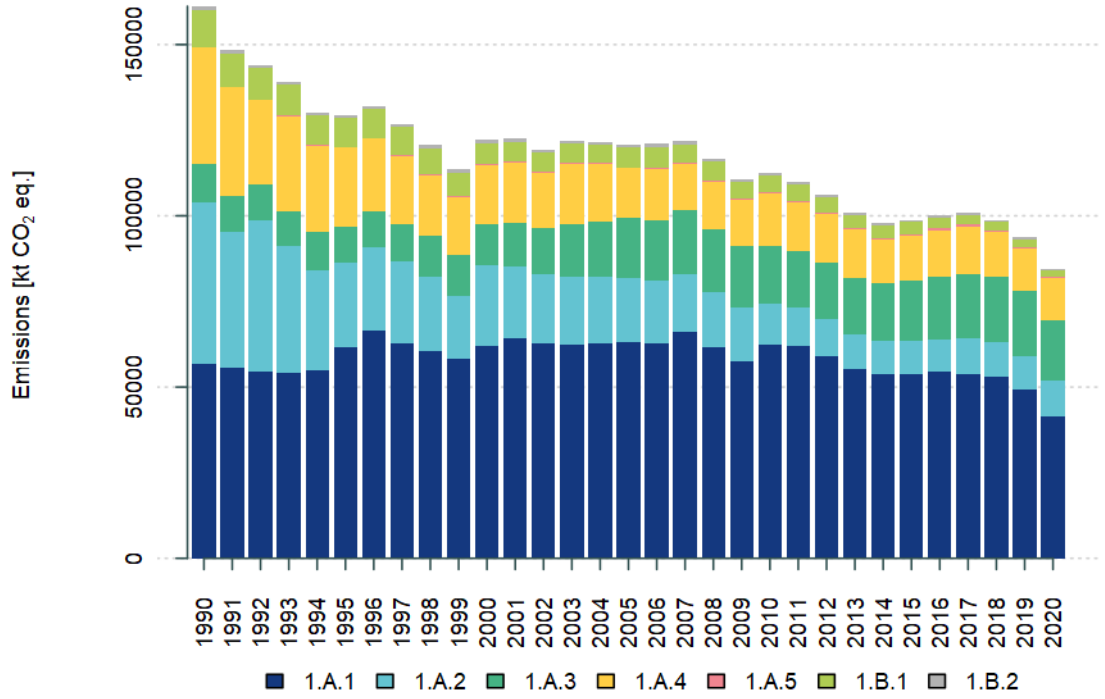


Fig. 2-3 The emission trend in 1. Energy during reporting period 1990 – 2020 (CHMI, 2022)

Tab. 2-9 The emission trend in 1. Energy during reporting period 1990 – 2020 (CHMI, 2022)

year	CO_2 kt	CH_4 kt	N_2O kt
1990	147 109	531.11	2.66
1991	135 622	478.52	2.44
1992	132 076	449.39	2.39
1993	127 494	440.31	2.30
1994	118 944	417.09	2.25
1995	118 532	407.00	2.25
1996	121 225	402.73	2.28

1997	116 279	392.65	2.20
1998	110 829	370.02	2.13
1999	104 568	336.57	2.08
2000	113 812	307.51	2.21
2001	114 528	292.83	2.12
2002	111 659	281.56	2.12
2003	114 223	280.97	2.18
2004	114 237	270.49	2.22
2005	113 028	287.19	2.21
2006	112 898	297.05	2.23
2007	114 186	278.78	2.30
2008	109 058	275.56	2.26
2009	103 767	250.75	2.16
2010	105 458	256.18	2.16
2011	102 996	255.32	2.18
2012	99 415	247.75	2.16
2013	94 914	213.35	2.13
2014	91 932	210.90	2.16
2015	93 076	205.36	2.19
2016	94 764	188.03	2.24
2017	95 846	176.74	2.27
2018	93 948	165.61	2.25
2019	89 328	153.59	2.21
2020	80 689	130.70	2.10
Trend 1990 - 2020	**-45 %**	**-75 %**	**-21 %**

2.2.1 Methodological issues

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 (Rečka & Ščasný, 2017), (Rečka & Ščasný, 2018).

In the current submission, projections of greenhouse gas (GHG) emissions from sector 1. Energy are prepared by three different methodological approaches for following categories:

- Projections of emissions from category 1.A.1 and 1.A.4 – projections are prepared by using data from TIMES-CZ model.
- Projections of emissions from categories 1.A.2, 1.A.5, 1.B.1 and 1.B.2 – projections are prepared using a data-driven model structure using some of the modelled expectations by TIMES-CZ for 1.A.2.

- Projections of emissions from category 1.A.3 – projections are prepared by using data from COPERT.

Chapter Methodological issues is divided to three sections according to different approaches that are implemented.

2.2.1.1 Methodological issues – 1.A.1 and 1.A.4

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) (IEA-ETSAP, 2022). 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 (Loulou, et al., 2020).

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 (Capros, et al., 2014) 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, N_2O) and other pollutants (SO_2, NOx, NMVOC, PM) are included in the model. GHG emissions from agriculture and Land Use and Land Use Change and Forestry Use (LULUCF) are not included in the model.

Model assumptions

<u>Common assumption for WEM and WAM scenarios:</u>

Final energy service demand is based on National Energy Climate Plan (NECP) (MIT, 2019). Nuclear power development is an exogenous assumption according to NECP: Temelín nuclear power plant remains in operation for the whole period (2020 – 2050), 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 temporary overlap with the Dukovany nuclear power plant.

The electricity export balance is assumed according to NECP (Tab. 2-10). 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) (ČEPS, 2022).

Assumptions of fuel prices are taken from Recommended parameters for reporting on GHG projections in 2023 (DG Climate Action, 2022).

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 Vřesová are included in category 1.A.1.c only until 2020. Then coal gasification ends and both sources move to 1.A.1.a 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 current energy crisis and war is limited to the updated price assumptions based on Recommended parameters for reporting on GHG projections in 2023 (DG Climate Action, 2022). 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.

Tab. 2-10 Assumed net electricity export (TWh)

	2019	2020	2025	2030	2035	2040	2045	2050
TWh	17.68073	10.15286	7.753474	6.359068	4.767547	1.233029	1.137333	0.3608

WEM scenario specific assumptions:

Emission allowance prices are taken from the WEM scenario from Recommended parameters for reporting on GHG projections in 2023 (DG Climate Action, 2022).

The electricity consumption in road transport is in line with the medium scenario of the National Clean Mobility Action Plan (MIT, 2020).

WAM scenario specific assumptions:

Compared to the WEM scenario, the WAM scenario differs as following:

- The price of emission allowances are taken from the Net Zero Emission (NZE) scenario of the World Energy Outlook 2021 (IEA, 2021).
- An extension of the EU ETS to buildings and transport (ETS2) from 2026 is considered. The allowance price starts at 48 € and gradually converges to the allowance price in the original emissions trading scheme (ETS1) (Tab. 2-11).
- In 2033, lignite mining ceases and coal is no longer used for electricity and heat generation.
- Electricity consumption in road transport is taken from the ETS2 scenario of the Fit for 55 analysis (Rečka, et al., 2022) and is 3.1 TWh (11.2 PJ) higher than in the WEM scenario.

Tab. 2-11 Applied EUA prices (EUR_{2020}/t CO_2)

	ETS1		ETS2	
	WEM	**WAM**		**WAM**
2020	24	24		
2025	80	79		
2030	80	114		48
2035	82	145		91
2040	85	180		134
2045	130	202		177
2050	160	220		220

Scenario results – activity data

The results of modelling reflect the given assumptions. As a result of decreasing elctricity net export and high price of EUA, the input of hard coal and lignite for heat and power generation decreases sharply. Renewable energy sourses and natural gas are the main substitutes for hard coal and lignite in heat and power generation. Consumption of lignite decreases slower in sector 1.A.2 (autoproducers) than in sector 1.A.1.a.

In sector 1.A.4, the low rate of renovations of buildings – that does not reflect the current energy crisis – and construction of new (non-passive) buildings result in constant or slightly increasing energy consumption.

Residential sector (1.A.4.b) and commercial/institutional sector (1.A.4.a) are similar in terms of technology for heating. Therefore, there could be fuel substitution between those two sectors.

Detalied results for scenarios WEM and WAM are described below.

WEM

In 1.A.1.a Public electricity and heat production, the total energy input decreases until 2030 as a result of lower electricity export, as depicted in Tab. 2-12. 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 in 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 increase in use of natural gas (up to 139 PJ in 2050) and renewable energy sources (mainly solar and wind).

The decrease in consumption of and lignite in 1.A.1.a Public electricity and heat production is faster than in autoproducers. In order to provide a complete overview of the heat and power generation, Tab. 2-13 depicts total fuel input for heat and power generation including the autoproducers.

Tab. 2-12 Fuel input for heat and power generation in 1.A.1.a – WEM scenario

PJ	2020	2025	2030	2035	2040	2045	2050
Hard coal	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 gas	62.6	30.4	51.4	68.9	68.7	82.7	139.1
Other gases	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 fossil	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**

Tab. 2-13 Fuel input for heat and power generation (including autoproducers) – WEM scenario

PJ	2020	2025	2030	2035	2040	2045	2050
Hard coal	43.1	18.9	7.1	2.1	1.9	0.2	0
Lignite	311.8	211.1	96.9	32.9	25.4	11.3	5.3
Natural gas	67	58	132	148.1	144.7	139	195.4

Other gases	5.4	8	3.7	2.7	0.3	0.3	0.3
Biogas	19.8	18.5	16.8	16.7	9.8	7	7.4
Biomass	27.3	26.5	25.7	24.4	26.5	30.7	32.7
Liquid fossil	0.3	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	6	17.5	17.6	17.2	16.2	22.9	22.9
Total	**820.9**	**719.4**	**674.4**	**674.5**	**713.8**	**699.8**	**760.5**

Final energy consumption in 1.A.4 Other sectors is depicted in Tab. 2-14. Total energy consumption in 1.A.4.a Commercial/Institutional increases due to increasing underlaying activity – growth of GDP and heated area. Total energy consumption in 1.A.4.b Residential decreases by 33 PJ (12 %) until 2050. As mentioned before, there might be a fuel substitution between 1.A.4.a and 1.A.4.b due to similar type of heating technologies and the sum of 1.A.4.a and 1.A.4.b is more representative. The improvement in energy efficiency is almost completely offset by increasing of activity (mainly heating area). Due to competition for biomass with limited availability between 1.A.1.a and in 1.A.4 Other sectors, consumption of biomass in 1.A.4 Other sectors decreases from 85 PJ in 2020 to 75 PJ in 2050. Consumption of electricity is increasing mainly in 1.A.4.a. The ambient heat for heat pumps is not included in Tab. 2-14.

Tab. 2-14 Final fuel consumption in sector 1.A.4 – WEM scenario

	2020	2025	2030	2035	2040	2045	2050
a.Commercial/institutional	**147**	**153**	**159**	**161**	**164**	**171**	**176**
Bio liquids							
Biogas	0.8	1.0	1.3	1.5	2.2	3.6	3.7
Biomass	2.5	3.5	6.9	9.7	21.8	21.1	21.1
Coal	1.3	1.2	0.2				
Electricity	60.2	62.9	64.3	65.4	65.5	63.3	68.6
Fossil liquids	0.7	0.7	0.6	0.5	0.4	0.4	0.4
Geothermal	0.2	0.4	0.4	1.6	2.2	4.6	4.6
Heat	25.1	23.5	21.1	24.8	24.0	31.8	31.8
LPG	0.1	0.1	0.1	0.0			
Natural gas	56.0	59.0	63.5	57.4	48.4	45.9	45.9
Solar	0.4	1.0	0.5	0.0	0.0		
b. Residential	**282.6**	**280.4**	**277.7**	**269.1**	**261.0**	**255.4**	**249.1**
Bio liquids	2.2	3.2	7.2	12.4	14.1	12.0	11.0
Biomass	76.9	61.7	60.7	53.8	43.5	44.2	44.2
Electricity	57.5	57.5	57.5	57.5	57.5	57.5	57.5
Fossil liquids		0.0	0.0	0.0	0.9	0.4	0.0
Geothermal		0.3	0.3	0.3	0.3	0.3	0.3
Hard coal	6.4	6.3	6.6	8.4	6.2	2.2	1.0
Heat	42.5	39.0	33.4	29.6	27.2	27.6	26.0

Lignite	21.1	22.1	21.8	21.4	21.1	20.8	19.0
LPG	0.3	0.2	0.2	0.0	0.1	0.3	
Natural gas	75.2	90.0	90.0	85.6	90.0	90.0	90.0
Solar	0.6	0.1	0.0	0.0	0.0		
c.Agriculture/forestry/fishing	**26.9**	**26.7**	**25.0**	**24.9**	**24.8**	**24.5**	**23.8**
Bio liquids			0.1	0.1	0.0	0.0	
Biomass and biogas	5.4	5.4	7.6	8.3	9.0	9.6	10.0
Coal	0.3	0.2	0.2	0.1	0.1	0.0	
Electricity	3.2	3.1	3.0	3.0	3.0	2.9	3.0
Fossil liquids	14.2	14.0	10.2	10.0	8.4	7.4	6.3
Geothermal	0.0	0.1	0.2	0.2	0.3	0.4	0.5
Heat	0.3	0.3	0.3	0.3	0.3	0.3	0.3
LPG	0.3						
Natural gas	3.3	3.2	3.0	2.9	2.9	2.8	2.7
Solar	0.0	0.2	0.4		0.8	1.0	1.1
Total	**456.8**	**460.3**	**461.7**	**455.1**	**450.3**	**450.6**	**449.0**

WAM

In 1.A.1.a Public electricity and heat production, the total energy input decreases until 2030 as a result of lower electricity export, as depicted in Tab. 2-15. Then the total energy input increases again up to 712 PJ in 2050. The most significant changes occur in lignite, hard coal, natural gas, solar and wind. Compared to WEM scenario, lignite and hard coal decrease faster after 2025 up to zero in 2035 – as a result of coal phase-out in 2033. The decrease in hard coal and lignite is substituted partly by increase in use of natural gas (up to 145 PJ in 2050) and renewable energy sources (mainly solar and wind). Biomass and waste fuel input is for heat a power generation is higher than in WEM scenario.

The decrease in consumption of and lignite in 1.A.1.a Public electricity and heat production is faster than in autoproducers. In order to provide a complete overview of the heat and power generation, Tab. 2-16 depicts total fuel input for heat and power generation including the autoproducers.

Tab. 2-15 Fuel input for heat and power generation in 1.A.1.a – WAM scenario

PJ	2020	2025	2030	2035	2040	2045	2050
Hard coal	33.3	18.5	5.9	0	0	0	0
Lignite	299	190	77.7	0	0	0	0
Natural gas	62.2	29.8	83.1	147.2	155.3	151.8	145.2
Other gases	5.5	2.1	2.1	0	0	0	0
Biogas	2.5	1.3	0.2	0.2	7	7.6	8.1
Biomass	19.9	19	17	16	14	39.8	48.8
Liquid fossil	0.2	0.2	0.1	0	0	0	0
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	17.2	23.7	32.5	34.5	41.1	51.8	56.8

Wind	2.1	5.1	10.1	14.7	17.1	19.6	22
Waste	3.7	15.7	24.4	25.4	34.6	35.4	36.2
Total	**766**	**637.2**	**585.1**	**619.1**	**699.8**	**723**	**734.7**

Tab. 2-16 Fuel input for heat and power generation (including autoproducers) – WAM scenario

PJ	2020	2025	2030	2035	2040	2045	2050
Hard coal	43	18.6	5.9	0.6	0	0	0
Lignite	311.8	210.3	90.6	0	0	0	0
Natural gas	66.7	60.9	136.7	213	208.6	207.7	201.1
Other gases	5.5	2.1	2.1	0	0	0	0
Biogas	19.8	18.5	18.5	18.3	8.5	8	8.5
Biomass	27.3	26.4	26.1	26	36.4	45	49.1
Liquid fossil	0.3	0.2	0.1	0	0	0	0
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	17.2	23.7	32.5	34.5	41.1	51.8	56.8
Wind	2.1	5.1	10.1	14.7	17.1	19.6	22
Waste	5.5	17.5	26.2	27.2	34.6	35.4	36.2
Total	**819.6**	**715.1**	**680.8**	**715.4**	**777**	**784.5**	**791.3**

Final energy consumption in 1.A.4 Other sectors is depicted in Tab.2-17. The applied additional measures (ETS2 for buildings) induce additional improvement in energy efficiency. Total energy consumption in 1.A.4.a Commercial/Institutional increases due to increasing underlaying activity – growth of GDP and heated area – but it culminates around 2040 as a results of energy efficiency improvement. Total energy consumption in 1.A.4.b Residential decreases by 48 PJ (17 %) until 2050. As mentioned before, there might be a fuel substitution between 1.A.4.a and 1.A.4.b due to similar type of heating technologies and the sum of 1.A.4.a and 1.A.4.b is more representative. Due to competition for biomass with limited availability between 1.A.1.a and in 1.A.4 Other sectors, consumption of biomass in 1.A.4 Other sectors decreases from 85 PJ in 2020 to 75 PJ in 2050. Consumption of electricity is higher than in WEM scenario. The ambient heat for heat pumps is not included in Tab. 2-17.

Tab. 2-17 Final fuel consumption in sector 1.A.4 – WAM scenario

	2020	2025	2030	2035	2040	2045	2050
a.Commercial/institutional	**148.2**	**160.4**	**171.6**	**184.5**	**193.7**	**170.3**	**159.3**
Bio liquids		2.0	6.0	5.5		0.1	
Biogas	0.8	1.1	1.4	1.8	2.2	3.0	3.7
Biomass	2.4	3.7	5.7	9.7	19.0	18.9	18.5
Coal	1.3	1.2	0.2				
Electricity	60.0	63.1	63.2	68.6	69.6	71.4	70.1
Fossil liquids	0.7	0.7	0.6	0.5	0.4	0.4	0.4
Geothermal	0.2	0.5	0.5	1.6	2.2	6.0	9.3

Heat	24.4	24.0	24.7	33.0	31.9	24.4	23.4
LPG	0.2	0.3	0.3	0.1			
Natural gas	57.2	57.4	63.5	25.7	19.0	12.7	8.5
Solar	0.4	1.0	0.0		0.0		
b. Residential	**282.6**	**280.2**	**275.2**	**268.0**	**257.0**	**249.1**	**234.3**
Bio liquids	2.2	3.1	7.0	10.8	16.3	14.9	11.0
Biomass	76.9	61.5	60.7	56.9	42.9	44.2	46.1
Electricity	57.5	57.5	57.5	57.5	57.5	57.5	57.5
Fossil liquids					0.0		
Geothermal		0.1	0.1	0.3	0.3	0.3	0.3
Hard coal	6.3	6.2	6.8	6.9	4.7	0.8	0.1
Heat	42.7	39.3	33.0	30.0	40.5	38.7	37.9
Lignite	20.9	22.1	21.8	19.5	4.7	2.7	2.5
LPG	0.3	0.2	0.0	0.0	0.0	0.0	0.0
Natural gas	75.2	90.0	88.2	86.0	90.0	90.0	77.3
Solar	0.6	0.1	0.0		0.0		1.5
c.Agriculture/forestry/fishing	**26.9**	**26.6**	**25.0**	**24.9**	**25.2**	**25.4**	**24.9**
Bio liquids			0.1	0.0	0.3	0.9	0.9
Biomass and biogas	5.4	5.7	7.6	8.3	9.0	9.6	10.0
Coal	0.3	0.2	0.2	0.1	0.1	0.0	
Electricity	3.2	3.1	3.0	3.0	3.0	3.0	2.9
Fossil liquids	14.2	13.7	10.2	10.0	8.2	7.1	5.5
Geothermal	0.0	0.1	0.2	0.2	0.3	0.4	0.5
Heat	0.3	0.3	0.3	0.3	0.3	0.3	1.0
LPG	0.3				0.3	0.3	0.3
Natural gas	3.3	3.2	3.0	2.9	2.9	2.8	2.7
Solar	0.0	0.2	0.4		0.8	1.0	1.2
GTotal	**457.7**	**467.3**	**471.8**	**477.3**	**475.8**	**444.8**	**418.5**

2.2.1.2 Methodological issues - 1.A.2, 1.A.5 and 1.B

For these categories were applied data driven model with application of the assumptions related to the 1.A.1 and 1.A.4 categories. Further for the estimation in 1.A.2 it was also observed possible relations with categories under 2. Industrial production and product use sector. Final fuel inputs for heat and power generation are provided in Tab. 2-13. Category 1.A.5 Other is also related to the 1.A.3 Transport, however the sector 1.A.5 is expected decline slower than 1.A.3 Transport since 1.A.5 includes army, air force and rescue service for which slower electrification can be expected

Projected emissions in 1.B Fugitive emissions from fuels are dominantly linked to projections of domestic coal mining as that is the major source of 1.B emissions.

Data for electricity and heat production are provided by the Ministry of Industry and Trade (MIT), who collects data regarding future plans of energy and industrial companies, such as constructions of new sources or shutdowns, technical details, life expectancy, investment, operating costs.

2.2.1.3 Methodological issues – 1.A.3 Transport

Road transport shows steadily growing activity and consequently energy consumption and GHG emissions. After the year 2007, transport, especially fright transport, was hit by the economic crisis. However, the growing trend of transport activity continued also in the period 2010 – 2019. The decrease in 2020 is probably due to COVID19 pandemic.

In 2020, the total emissions from 1.A.3 Transport were 18876 kt CO_2 eq. GHG emission trend from 1.A.3 Transport for 2000 to 2020 is depicted in Fig. 2-4.

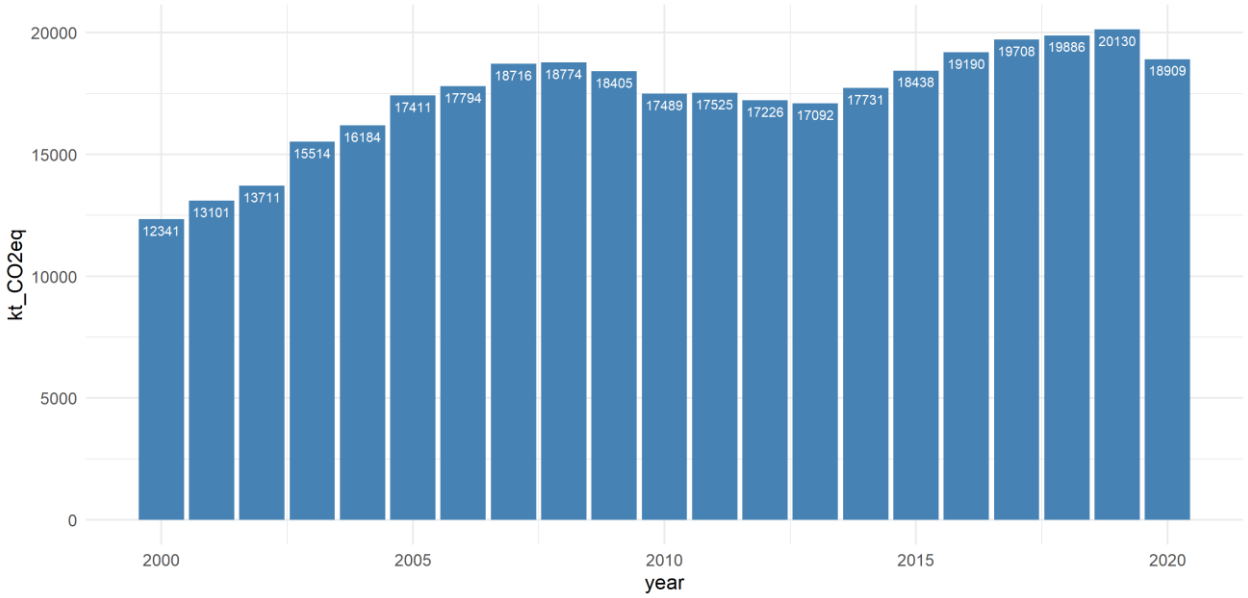


Fig. 2-4 The emission trend in 1.A.3 Transport during reporting period 2000 – 2020 (CHMI, 2020)

The projected structure of energy carriers in the 1.A.3 Transport counts with growing shares of biofuels and natural gas use. A significant increase of electric and hybrid cars is supposed to start following 2030.

The update of the projections for this reporting was based mainly on the new road transport data, which were obtained from COPERT. COPERT is the EU standard vehicle emissions calculator which uses a detailed methodology for EMEP/CORINAIR transport emissions calculations (EEA , 2016). The overall transport performance forecast and the division of transport work are based on the Transport Sector Strategy (MT, 2019). Also, non-road transport forecasts were not changed. In the field of road transport projections, the procedure was as follows:

- Aggregation of downloaded data from COPERT for the period 2000 - 2020 into less detailed categories (aggregation type - sum). COPERT has a total of 432 categories of vehicles, the projection cannot be performed for such a number of categories. Aggregation was made by transport mode, the fuel used and the EURO emission standard. The original 432 COPERT categories have been aggregated to groups by vehicle category, used fuel and Euro Standard.
- Addition of vehicle categories with supposed use in future, which are not in COPERT now.
- Addition of non-road vehicle categories.
- Including these additions, the model has in total 112 vehicle categories.

- Calculation of annual vehicle kilometres (2000 – 2020), from fleet and mileage data.
- Updating data on new registrations and discarded vehicles.
- Distribution of future vehicle kilometres from older vehicle categories (2021 – 2050), so that their number is continuously falling to zero as part of ongoing fleet renewal.
- Input of official transport prognosis data (from Transport Sectoral Strategy (MT, 2019)) to emissions projections model.
- Calculation of future vehicle kilometres from new vehicles for each year (2021 - 2050), based on the difference between total prognosis data (from Transport Sectoral Strategy (MT, 2019)) and sums of performance of older vehicles.
- Input of official energy consumption prognosis data (from Czech Ministry of Industry and Trade).
- Splitting of future vehicle kilometres from new vehicles by fuel, with a help of mentioned energy consumption prognosis data.
- Export of implied emission factors from the COPERT program and their appropriate distribution for vehicle categorization in the projection model.
- Calculation of projected emissions, multiplying outputs and emission factors.
- Expression of GHG emissions as CO_2 equivalent, based on the global warming potential of CH_4 and N_2O.
- Calculation of supposed emissions reductions by individual Policies and Measures (PaM), their aggregation to With existing measures (WEM) and With additional measures (WAM) scenarios and calculation of GHG emissions in WEM and WAM scenarios.

With regards to emission reductions by the application of individual policies and measures (for more details please see chapter 1.2.2), only quantifiable measures have been calculated. Calculable measures are described in following table (2-18).

Tab. 2-18 Overview of PaMs with estimated emission reductions

PaM title	Changes in the prediction model
Support of biofuels	CO_2 emission factors resulting from an increased share of biofuels.
Regulation on CO_2 from cars	Modification of new cars activity data to have its weighted average equal to 95 g/km.
Regulation on CO_2 from vans	Modification of new cars activity data to have its weighted average equal to 147 g/km.
ICAO agreement (International Civil Aviation Org.)	No changes from the previous projections (2019).
Modal shift	Reduced road freight transport performance with an estimated share of trips longer than 300 km, of which 30 % should be shifted to rail.
Economical and tax tools	Change in prospective energy consumption where environmentally friendly fuel predominates, which should be less taxed.
Road toll	There is a change in the demand for road freight transport, based on price-demand dependency.
Further reduction of CO_2 emissions	Modification of new cars and light duty vehicles activity data to achieve required decrease of CO_2 emissions in 2025 and 2030.
Fit for 55	Modification of new cars and light duty vehicles activity data to achieve required decrease of CO_2 emissions in 2030 and only zero emissions from new cars from 2035.

2.2.2 Projected greenhouse gas emissions 'With existing measures (WEM) scenario' and 'With additional measures (WAM) scenario'

According to the projections of GHG emissions in 1. Energy sector (Tab. 2-19) it is expected that emissions are going to decrease for both scenarios. Decrease of emissions is more visible for WAM scenario which includes additional measures for category 1.A.1 Energy industries, 1.A.2 Manufacturing Industries and construction, 1.A.3 Transport and 1.A.4 Other sectors. For 2050, the difference between WEM and WAM scenario is calculated as 6.73 Mt CO_2 eq.

In total numbers it is expected that GHG emissions from 1. Energy sector will decrease approximately by 79 % in 2050 compared to 1990, by 71 % compared to 2005 and by 59 % compared to current level (2020) of emissions for WEM scenario. It is projected, that GHG emissions will decrease in WAM scenario approximately by 83 % in 2050 compared to 1990, by 77 % compared to 2005 and 67 % compared to current level (2020).

Tab. 2-19 Reported and projected emissions of GHG in 1. Energy sector – WEM and WAM scenarios

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2025	1990 – 2030	1990 – 2040	1990 – 2050
WEM	161.18	120.87	84.58	66.34	56.44	49.16	45.86	41.87	34.45	-58.84	-64.98	-71.54	-78.63
WAM	161.18	120.87	84.58	65.26	54.74	36.92	32.45	29.94	27.72	-59.51	-66.04	-79.87	-82.80

2.2.3 Projected greenhouse gas emissions 'With existing measures (WEM) scenario'

The 1. Energy sector is source of CO_2, CH_4 and N_2O emissions. It is expected that emissions are going to decrease for all gases emitted by 1. Energy sector during projected period (Tab. 2-20). CO_2 emissions are projected to decrease in 2050 by 60 %, CH_4 by 45 % and N_2O by 64 % compared to current level (2020) of emissions.

Tab. 2-20 Breakdown of reported and projected emissions of GHG by gases - WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2025	1990 – 2030	1990 – 2040	1990 - 2050
CO_2	147.11	113.03	80.69	62.79	53.30	45.98	43.03	39.27	32.44	-57.32	-63.77	-70.75	-77.95
CH_4	13.28	7.18	3.27	3.10	2.76	2.81	2.48	2.26	1.78	-76.68	-79.22	-81.29	-86.58
N_2O	0.79	0.66	0.62	0.46	0.39	0.37	0.35	0.34	0.23	-42.36	-51.05	-56.07	-71.51
Total	**161.18**	**120.87**	**84.58**	**66.34**	**56.44**	**49.16**	**45.86**	**41.87**	**34.45**	**-58.84**	**-64.98**	**-71.54**	**-78.63**

In 2020 the dominant GHG source in the 1. Energy sector was category 1.A.1 Energy industries (49 %), followed by 1.A.3 Transport (21 %), 1.A.4 Other Sectors (15 %) and 1.A.2 Manufacturing industries (12 %) (Tab. 2-1). Emissions from category 1.B Fugitive emissions from fuels has 3 % share on total emissions from 1. Energy sector. A significant reduction of GHG emissions can be observed in 1.A.2 Manufacturing industries (78 %) and 1.A.4 Other Sectors (64 %) during the past three decades (1990 – 2020), mainly due to transition from domestic coal to other fuels, in particular natural gas.

For the vast majority of categories under 1. Energy sector is expected that emissions will decrease in 2050 compared to the current level of emissions. For category 1.A.1 Energy Industries, which has major share on total GHG emissions from 1. Energy, it is expected that emissions will decrease in 2050 compared to 2020 level of emissions by 92 %.

The emission trend in category 1.A.1 Energy industries is mainly driven by the category 1.A.1.a Public electricity and heat production and shows a rapid decrease after the year 2020. This change in electricity generation is result of the deceasing power generation due to decreasing net export of electricity (exogeneous assumption) and price of EUA that induces phase-out of lignite power plants. Renewable energy sources and natural gas replace the decreasing power generation from lignite. In the period between 1990 and 2050 a drop of 92 % is projected in the category 1.A.1 Energy industries. This drop is driven mainly by the category 1.A.1.a Public electricity and heat production. The increase in CH_4 emissions from 2045 onwards in sector 1.A.1.a is related to the increasing energy recovery from waste.

The projected emissions in category 1.A.2 Manufacturing industries and construction are slightly decreasing. The drop of GHG emission in this sector is 79 % in the period 1990 – 2050.

In the category 1.A.4 Other sectors drop up to 74 % in 2050 compared to 1990 is expected to be achieved. In the 1.A.4.a commercial sector even a drop up to 79 % will be reached if all existing measures will be applied. The highest emission share (> 66%) in 1.A.4 Other sectors is from the category 1.A.4.b Residential.

The projected decline of 1.B Fugitive emissions from fuels results mainly from decreasing mining of hard and brown coal and includes methane leakages from deep and open coal mines, crude oil mining and cracking, natural gas leakages from mining, transmission and distribution of natural gas and natural gas leakages from power plants and heating plants.

Tab. 2-21 Breakdown of reported and projected emissions of GHG by categories in Energy – WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990-2025	1990-2030	1990-2040	1990-2050
1. Energy	**161.18**	**120.87**	**84.58**	**66.34**	**56.44**	**49.16**	**45.86**	**41.87**	**34.45**	**-58.84**	**-64.98**	**-71.54**	**-78.63**
A. Fuel combustion (sectoral approach)	**149.32**	**114.20**	**82.27**	**64.06**	**54.50**	**47.20**	**44.17**	**40.30**	**33.01**	**-57.10**	**-63.50**	**-70.42**	**-77.89**
1. Energy industries	56.86	63.17	41.60	25.76	18.26	12.51	11.03	8.76	4.71	-54.69	-67.89	-80.61	-91.71
a. Public electricity and heat production	54.84	56.48	36.95	24.43	17.18	11.77	10.38	8.19	4.33	-55.44	-68.67	-81.07	-92.10
b. Petroleum refining	0.49	0.89	0.43	0.58	0.54	0.52	0.44	0.42	0.33	17.47	9.98	-10.53	-32.03
c. Manufacture of solid fuels and other energy industries	1.52	5.79	4.22	0.75	0.54	0.22	0.21	0.16	0.05	-50.53	-64.48	-86.44	-96.85
2. Manufacturing industries and construction	47.11	18.85	10.24	10.21	10.05	9.98	9.89	9.74	9.81	-78.34	-78.67	-79.02	-79.17
3. Transport	11.35	17.37	17.79	14.21	12.50	11.85	11.02	10.22	9.41	25.27	10.20	-2.88	-17.07
a. Domestic Aviation	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-0.48	-14.67	-2.88	-51.03

2 Projected greenhouse gas emissions by gas and source

b. Road Transportation	10.42	16.95	17.41	13.92	12.23	11.59	10.78	10.00	9.20	33.58	17.36	3.46	-11.71
c. Railways	0.86	0.32	0.26	0.24	0.22	0.21	0.19	0.18	0.17	-71.86	-73.90	-77.55	-80.69
d. Domestic Navigation	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-79.04	-81.53	-85.66	-88.87
e. Other Transportation	0.01	0.07	0.09	0.03	0.03	0.03	0.03	0.03	0.03	506.03	506.03	506.03	506.03
4. Other sectors	33.81	14.55	12.31	13.56	13.37	12.54	11.92	11.15	8.76	-59.89	-60.47	-64.74	-74.09
a.Commercial/institutional	9.96	3.53	2.69	3.73	3.85	3.15	2.66	2.51	2.04	-62.59	-61.39	-73.33	-79.49
b. Residential	19.91	9.68	8.37	8.54	8.54	8.44	8.44	7.90	6.07	-57.11	-57.13	-57.62	-69.53
c.Agriculture/forestry/fishing	3.95	1.34	1.25	1.30	0.98	0.95	0.83	0.74	0.65	-67.20	-75.09	-79.03	-83.49
5. Other	0.19	0.27	0.32	0.32	0.32	0.32	0.32	0.31	0.31	68.89	67.98	66.17	65.27
B. Fugitive emissions from fuels	**11.86**	**6.66**	**2.31**	**2.28**	**1.95**	**1.96**	**1.69**	**1.57**	**1.44**	**-80.80**	**-83.60**	**-85.71**	**-87.88**
1. Solid fuels	10.78	5.76	1.70	1.54	1.36	1.35	1.05	0.94	0.82	-85.68	-87.40	-90.22	-92.37
2. Oil and natural gas and other emissions from energy production	1.08	0.90	0.61	0.73	0.59	0.61	0.64	0.63	0.61	-32.10	-45.68	-40.69	-43.06
C. CO_2 transport and storage	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

2.2.4 Projected greenhouse gas emissions 'With additional measures (WAM) scenario'

Additional measures in 1. Energy sector are applicable for projections of GHG emissions from category 1.A.1 Energy industries, 1.A.2 Manufacturing Industries and construction, 1.A.3 Transport and 1.A.4 Other sectors. Additional measures applied for 1.A.1 Energy industries and 1.A.4 Other sectors are described in section 2.2.1.1.

Table 2-22 breaks down the reported and projected emissions of GHG by categories in Energy for WAM scenario.

Fig. 2-5 compares the emissions of GHG in categories 1.A.1 and 1.A.4 between WEM and WAM scenarios based on TIMES-CZ results. In the 1.A.1 Energy industries, the emissions of GHG decrease faster in WAM than in WEM after 2030 as a result of higher EUA price and phase-out of lignite in 2033. In 2050 the emissions of GHG are 0.65 Mt CO_{2e} (14 %) lower in WAM than in WEM, in 1.A.1 Energy industries. Pilot carbon capture and storage technology is applied to natural gas heat and power cogeneration from 2035 and to biomass power generation from 2045. The increase in CH_4 emissions from 2030 onwards in sector 1.A.1.a is related to the increasing energy recovery from waste. The use of waste for energy purposes is higher than in WEM scenario and as a result the CH_4 emissions in 1.A.1 Energy industries are higher WAM scenario than in WEM scenario.

In the 1.A.4 Other sectors, the emissions of GHG decrease faster in WAM than in WEM after 2035 mainly as a result of introduction of ETS2 for buildings. In 2050 the emissions of GHG are 2.8 Mt CO_{2e} (32 %) lower in WAM than in WEM, in 1.A.4 Other sectors.

Tab. 2-22 Breakdown of reported and projected emissions of GHG by categories in Energy – WAM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990-2025	1990-2030	1990-2040	1990-2050
1. Energy	**161.18**	**120.87**	**84.58**	**65.26**	**54.74**	**36.92**	**32.45**	**29.94**	**27.72**	**-59.51**	**-66.04**	**-79.87**	**-82.80**
A. Fuel combustion (sectoral approach)	**149.32**	**114.20**	**82.27**	**62.99**	**52.79**	**34.96**	**30.75**	**28.37**	**26.28**	**-57.82**	**-64.65**	**-79.41**	**-82.40**
1. Energy industries	56.86	63.17	41.60	25.48	18.02	5.74	4.76	4.23	4.07	-55.19	-68.30	-91.63	-92.85
a. Public electricity and heat production	54.84	56.48	36.95	24.15	16.97	5.08	4.24	3.91	3.79	-55.95	-69.06	-92.27	-93.09
b. Petroleum refining	0.49	0.89	0.43	0.57	0.52	0.47	0.39	0.24	0.23	15.69	6.89	-20.73	-52.89
c. Manufacture of solid fuels and other energy industries	1.52	5.79	4.22	0.76	0.53	0.19	0.13	0.08	0.05	-50.25	-64.91	-91.35	-96.85
2. Manufacturing industries and construction	47.11	18.85	10.24	10.21	10.05	9.98	9.89	9.85	9.81	-78.34	-78.67	-79.02	-79.17
3. Transport	11.35	17.37	17.79	13.95	11.54	8.48	7.47	6.78	6.12	22.98	1.67	-34.15	-46.10
a. Domestic Aviation	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-0.48	-14.67	-36.11	-51.03
b. Road Transportation	10.42	16.95	17.41	13.66	11.26	8.22	7.23	6.56	5.91	31.08	8.07	-30.59	-43.31
c. Railways	0.86	0.32	0.26	0.24	0.22	0.21	0.19	0.18	0.17	-71.86	-73.90	-77.55	-80.69
d. Domestic Navigation	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-79.04	-81.53	-85.66	-88.87
e. Other Transportation	0.01	0.07	0.09	0.03	0.03	0.03	0.03	0.03	0.03	506.03	506.03	506.03	506.03

4. Other sectors	33.81	14.55	12.31	13.03	12.86	10.44	8.32	7.20	5.97	-61.46	-61.97	-75.40	-82.35
a.Commercial/institutional	9.96	3.53	2.69	3.26	3.49	1.42	1.05	0.71	0.49	-67.23	-64.99	-89.42	-95.10
b. Residential	19.91	9.68	8.37	8.49	8.39	8.08	6.44	5.76	4.89	-57.35	-57.87	-67.66	-75.46
c.Agriculture/forestry/fishing	3.95	1.34	1.25	1.27	0.98	0.94	0.82	0.73	0.59	-67.76	-75.11	-79.13	-84.99
5. Other	0.19	0.27	0.32	0.32	0.32	0.32	0.32	0.31	0.31	68.89	67.98	66.17	65.27
B. Fugitive emissions from fuels	**11.86**	**6.66**	**2.31**	**2.28**	**1.95**	**1.96**	**1.69**	**1.57**	**1.44**	**-80.80**	**-83.60**	**-85.71**	**-87.88**
1. Solid fuels	10.78	5.76	1.70	1.54	1.36	1.35	1.05	0.94	0.82	-85.68	-87.40	-90.22	-92.37
2. Oil and natural gas and other emissions from energy production	1.08	0.90	0.61	0.73	0.59	0.61	0.64	0.63	0.61	-32.10	-45.68	-40.69	-43.06
C. CO_2 transport and storage	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

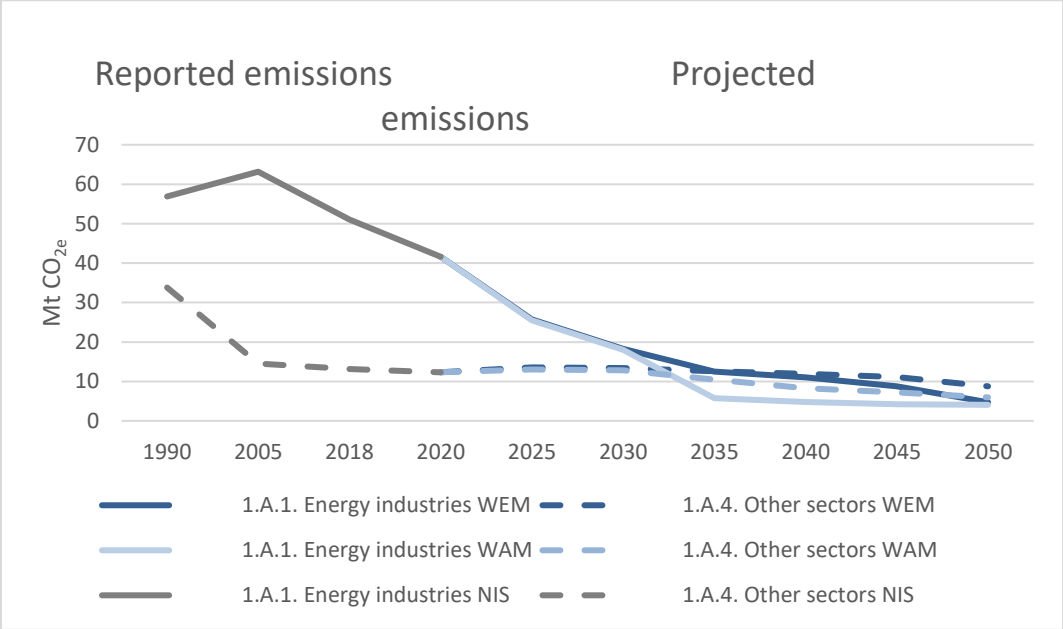


Fig. 2-5 Reported and projected GHG emissions - WEM and WAM scenarios for 1.A.1 and 1.A.4

2.2.4.1 WAM for 1.A.3 Transport (including WEM)

Only difference between WEM and WAM scenario in Energy sector is in additional measures used for projections of GHG emissions from category 1.A.3 Transport. Following chapter will describe category 1.A.3 in more detail with focus on difference between WEM and WAM scenario.

The GHG emissions from transport are expected to decline in both scenarios WEM and WAM from 2025 (Tab. 2-23 and Fig. 2-6). This results from fuel switches in favour of fuels with lower carbon content, from obligatory improved energy efficiency of new personal cars and especially from a higher share of electric and hybrid vehicles. Due to reduction measures the decrease of CO_2 emissions is

supposed to 2050. The main efficiency has the application of CO_2 regulation of cars and vans and also the support of biofuels.

Tab. 2-23 Reported and projected emissions of GHG in 1.A.3 Transport – WEM and WAM scenarios

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
WEM	11.43	17.41	18.91	14.21	12.50	11.85	11.02	10.22	9.41	65.44	9.41	-3.58	-17.67
WAM	11.43	1..41	18.91	13.95	11.54	8.48	7.47	6.78	6.12	65.44	0.94	-34.63	-46.48

Note: reported values include biomass, compared to the values from NIR

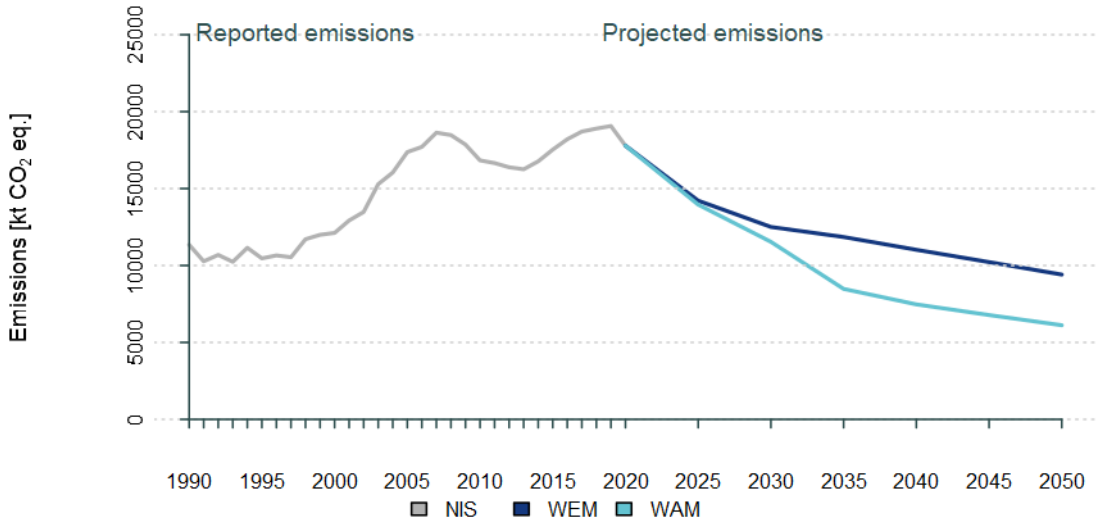


Fig. 2-6 Reported and projected emissions of GHG in 1.A.3 Transport – WEM, WAM scenario

Following tables contain breakdown of reported and projected emissions by gases and by categories for WEM scenario. According to the WEM scenario, emissions from 1.A.3 Transport should decrease by 3.58 % in 2040 compared to 1990.

Tab. 2-24 Breakdown of reported and projected emissions of GHG by gases in 1.A.3 Transport - WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
CO_2	11.17	17.15	18.69	14.06	12.37	11.73	10.91	10.11	9.31	67.3	10.76	-2.36	-16.63
CH_4	0.08	0.07	0.02	0.02	0.01	0.01	0.01	0.01	0.01	-70.15	-83.97	-83.75	-82.91
N_2O	0.18	0.19	0.2	0.14	0.12	0.11	0.1	0.09	0.09	9.63	-33.57	-43.96	-53.07
Total	11.43	17.41	18.91	14.21	12.5	11.85	11.02	10.22	9.41	65.44	9.41	-3.58	-17.67

Note: reported values include biomass, compared to the values from NIR

Tab. 2-25 Breakdown of reported and projected emissions of GHG by categories in 1.A.3 Transport - WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
1.A.3.a Domestic Aviation	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0	0	16.72	-14.67	-36.1	-51.02
1.A.3.b Road Transportation	10.44	16.99	18.59	13.92	12.23	11.59	10.78	10	9.2	78.12	17.16	3.28	-11.85
1.A.3.c Railways	0.86	0.32	0.26	0.24	0.22	0.21	0.19	0.18	0.17	-69.66	-73.9	-77.55	-80.69
1.A.3.d Domestic Navigation	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-76.21	-81.53	-85.66	-88.88
1.A.3.e Other Transportation	0.07	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.03	-53.05	-53.05	-53.05	-53.05
Total	11.43	17.41	18.91	14.21	12.50	11.85	11.02	10.22	9.41	65.44	9.41	-3.58	-17.67

Note: reported values include biomass, compared to the values from NIR

It is projected, that additional measures *Economic tax tools, Road toll* and mainly *Further decrease of CO_2 emissions in 2025 and 2030* will influence GHG emissions from 1.A.3 Transport as it is shown in following tables. Description of the measures is specified in Chapter 1.2.2. According to the WAM scenario, emissions from 1.A.3 Transport should decrease by 34.6 % in 2040 compared to 1990.

Tab. 2-26 Breakdown of reported and projected emissions of GHG by gases in 1.A.3 Transport - WAM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
CO_2	11.17	17.15	18.69	13.81	11.41	8.38	7.38	6.70	6.04	67.3	2.17	-33,90	-45,90
CH_4	0.08	0.07	0.02	0.02	0.01	0.01	0.01	0.01	0.01	-70.15	-85.25	-90,86	-91,44
N_2O	0.18	0.19	0.2	0.13	0.11	0.09	0.08	0.07	0.07	9.63	-37.34	-55,33	-62,99
Total	11.43	17.41	18.91	13.95	11.54	8.48	7.47	6.78	6.12	65.44	0.94	-34.63	-46.48

Note: reported values include biomass, compared to the values from NIR

Tab. 2-27 Breakdown of reported and projected emissions of GHG by categories in transport – WAM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
1.A.3.a Domestic Aviation	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	16.72	-14.67	-36.1	-51.02
1.A.3.b Road Transportation	10.44	16.99	18.59	13.66	11.26	8.22	7.23	6.56	5.91	78.12	7.89	-30.71	-43.41
1.A.3.c Railways	0.86	0.32	0.26	0.24	0.22	0.21	0.19	0.18	0.17	-69.66	-73.9	-77.55	-80.69
1.A.3.d Domestic Navigation	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-76.21	-81.53	-85.66	-88.88
1.A.3.e Other Transportation	0.07	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.03	-53.05	-53.05	-53.05	-53.05
Total	11.43	17.41	18.91	13.95	11.54	8.48	7.47	6.78	6.12	65.44	0.94	-34.63	-46.48

Note: reported values include biomass, compared to the values from NIR

2.2.5 Sensitivity analysis

2.2.5.1 Sensitivity analysis of 1.A.2, 1.A.5 and 1.B

Sensitivity analysis for the 1.A.2, 1.A.5 and 1.B is based on the changes in input data for +/-5% in the major indicators. Those changes are resulting in changes in the final projected emissions. The details of resulting emissions after these changes for each category are provided in following tables.

Tab. 2-28 Sensitivity analysis of 1.A.2 Manufacturing industries and construction on input activity data (WEM scenario)

[Mt CO_2 eq.]	2020	2025	2030	2035	2040	2045	2050
WEM	10.24	10.21	10.05	9.98	9.89	9.74	9.81
WEM +5%	9.7317	9.6957	9.5483	9.4786	9.3914	9.2563	9.3229
WEM -5%	10.7561	10.7163	10.5534	10.4764	10.3800	10.2306	10.3042

Tab. 2-29 Sensitivity analysis of 1.A.5 Manufacturing industries and construction on input activity data (WEM scenario

[Mt CO_2 eq.]	2020	2025	2030	2035	2040	2045	2050
WEM	0.32	0.32	0.32	0.32	0.32	0.30	0.31
WEM +5%	0.31	0.30	0.30	0.30	0.30	0.29	0.30
WEM -5%	0.34	0.34	0.34	0.33	0.33	0.32	0.33

Tab. 2-30 Sensitivity analysis of 1.B Manufacturing industries and construction on input activity data (WEM scenario

[Mt CO_2 eq.]	2020	2025	2030	2035	2040	2045	2050
WEM	2.31	2.28	1.95	1.96	1.69	0.09	1.44
WEM +5%	2.20	2.16	1.85	1.86	1.61	0.09	1.37
WEM -5%	2.43	2.39	2.04	2.06	1.78	0.10	1.51

2.2.5.2 Sensitivity analysis of 1.A.1 and 1.A.4

Two parameters are adjusted for the sensitivity analysis of projections of greenhouse gas emissions from 1.A.1.a and 1.A.4. Firstly, the low and high price of the natural gas from the Recommended parameters for reporting on GHG projections in 2023 (DG Climate Action, 2022) are applied. Second, the final energy service demands in category 1.A.4 are increased or decreased by 5 %. Those two adjusted parameters are combined together in the following way. In the +5 % option, low price of natural gas and increased demand of final energy services in category 1.A.4 are applied. In the -5 % option, high price of natural gas and decreased demand of final energy services in category 1.A.4 are applied. The sensitivity analysis is provided for both WEM and WAM scenarios.

Tab. 2-31 provides the values of emissions of GHG for the sensitivity analysis of 1.A.1.a Public electricity and heat production and 1.A.4 Other sectors.

Tab. 2-31 Sensitivity analysis of emission of GHG from 1.A.1.a Public electricity and heat production and 1.A.4 Other sectors

[Mt CO2 eq.]		2025	2030	2035	2040	2045	2050
WEM -5%	1.A.1.	38.6	21.2	17.4	10.8	7.3	5.4
	1.A.4.	11.7	11.7	10.4	9.3	8.6	7.2
WEM +5%	1.A.1.	40.1	18.1	19.3	14.4	13.7	11.2
	1.A.4.	12.1	13.4	12.9	12.5	11.7	9.8
WAM -5%	1.A.1.	38.6	20.8	15.9	5.0	4.4	4.1
	1.A.4.	11.7	11.5	9.7	8.0	7.2	6.6
WAM +5%	1.A.1.	40.3	17.4	18.0	8.2	5.8	5.2
	1.A.4.	12.1	13.0	12.1	10.4	8.3	6.7

2.2.5.3 Sensitivity analysis of 1.A.3 Transport

The sensitivity analysis for 1.A.3 Transport was done with a help of the Monte Carlo method that relies on repeated random sampling to obtain numerical results. Essential idea of the Monte Carlo method is using randomness to solve problems that might be deterministic in principle. The method is often used in physical and mathematical problems and is the most useful in the cases when it is difficult or impossible to use other approaches. From the methods of Monte Carlo, the probability density function was preferred.

A statistical analysis of the used emission factors was carried out using the example of carbon dioxide CO_2, basic statistical analysis and graphical representation, with the help of box plots. The R program was again used as a tool. Within the framework of statistics, the following statistical indicators were evaluated for each type of transport and fuel used: minimum, 1st quartile, median, arithmetic mean, 3rd quartile and maximum.

Tab. 2-32 Basic statistical analysis of CO_2 emission factors

Category	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Passenger_Cars Petrol	128,1404	151,5357	173,506	182,2228	209,2723	282,3935
Passenger_Cars Diesel	123,9636	177,7773	178,3135	194,3462	225,2791	245,2108
Passenger_Cars LPG	200,7887	204,4284	205,3952	205,1393	205,4638	210,4394
Passenger_Cars CNG	237,5078	237,5261	237,5444	237,5451	237,5736	237,5736
Light_Commercial_Vehicles Petrol	167,0682	208,6025	230,7941	224,2562	252,3916	270,271
Light_Commercial_Vehicles Diesel	196,2346	239,5782	269,2146	264,6384	281,0667	306,5755
Heavy_Duty_Trucks Diesel	343,9522	600,3441	754,0099	726,89	883,3578	1155,585
Buses Diesel	644,3637	782,1573	859,7694	908,1302	1087,214	1352,788
Buses CNG	1175,969	1176,38	1176,792	1176,792	1177,203	1177,614
L_Category Petrol	51,04198	53,14733	68,75892	73,55148	87,18936	110,4895

This assessment was used for the calculations of total emissions in the lower and upper band and determination of the possible statistical error (uncertainty) in the calculations. Uncertainty calculations were made for the years 2030 and 2050. It must be emphasized that the uncertainty reflects the

different CO_2 production of different categories of vehicles and not the overall projected development of traffic or the development of fuel and energy consumption. Therefore, the same traffic performance was always entered into the calculations of CO_2 emissions in the lower and higher uncertainty bands. As for the emission factors, the minimum and maximum values were deliberately not selected, due to large deviations from the averages. The first and third quartile values were preferred. The first quartile separates the lowest 25 % of the data from the highest 75 %, while the third quartile separates the lowest 75 % of the data from the highest 25 %.

The total uncertainty of the calculations of CO_2 emission projections (from emission factors, not from activity data) in 2030 is estimated at 13 %. The uncertainty number in 2050 is further reduced slightly to 12 %. This seemingly illogical drop can be explained by the fact that this year there will already be more zero-emission vehicles (electric cars, hydrogen vehicles) and fewer emissions-producing vehicles, which means fewer sources of uncertainty.

2.2.6 Difference between previously and currently reported projections

There are some significant changes in projections of GHG emissions from the 1. Energy sector compared to the previous projections. These changes were mentioned in the section 2.2.1.1. Methodological issues. The biggest change is that we started using TIMES-CZ model for categories 1. Energy industries and 4. Other sectors. The increased assumed fuel and EUA prices (DG Climate Action, 2022) imply the biggest part of differences between the projected GHG emissions from 1. Energy sector in this and the previous submission. On the other hand, no significant differences occurred while preparing projections from 1.A.2, 1.A.5 and 1.B categories. Slight difference is occurring for 1.A.2 where partly input data generated by TIMES-CZ were used for the projections estimates. Otherwise the assumptions haven't changes since the last projections reporting.

Projections for category 1.A.3 Transport were calculated in R-project. In road transport, COPERT time series from 2000 to 2020 were used for emissions projections. COPERT data are very detailed and need to be aggregated and processed in various ways. Also, the projections are more closely related to the prediction of energy consumption in the fleet area, with the newly registered vehicles being assigned categories respecting the expected development of fuel consumption. Emission factors used for projections are available from the COPERT database, which is generally recognized as very reliable data source.

2.3 Industrial Processes and Other Product Use

For consistency with greenhouse gas (GHG) emission inventory, the sector 2. Industrial processes and other product use (IPPU) category includes only emissions from technological processes and not from the fuel combustion used to supply energy for carrying out these processes (CHMI, 2022).

In 2020, the total aggregate GHG emissions from 2. IPPU were 15,229.96 kt of CO_2 eq., which represent decrease of 4 % compared to the previous year. Emissions decreased by 11 % compared to the base year 1990. The major share of CO_2 emissions in this sector comes from subcategories 2.C.1 Iron and steel production, 2.F.1 Refrigeration and air conditioning and 2.A Mineral industry. N_2O emissions coming from 2.B Chemical industry are less significant (CHMI, 2022).

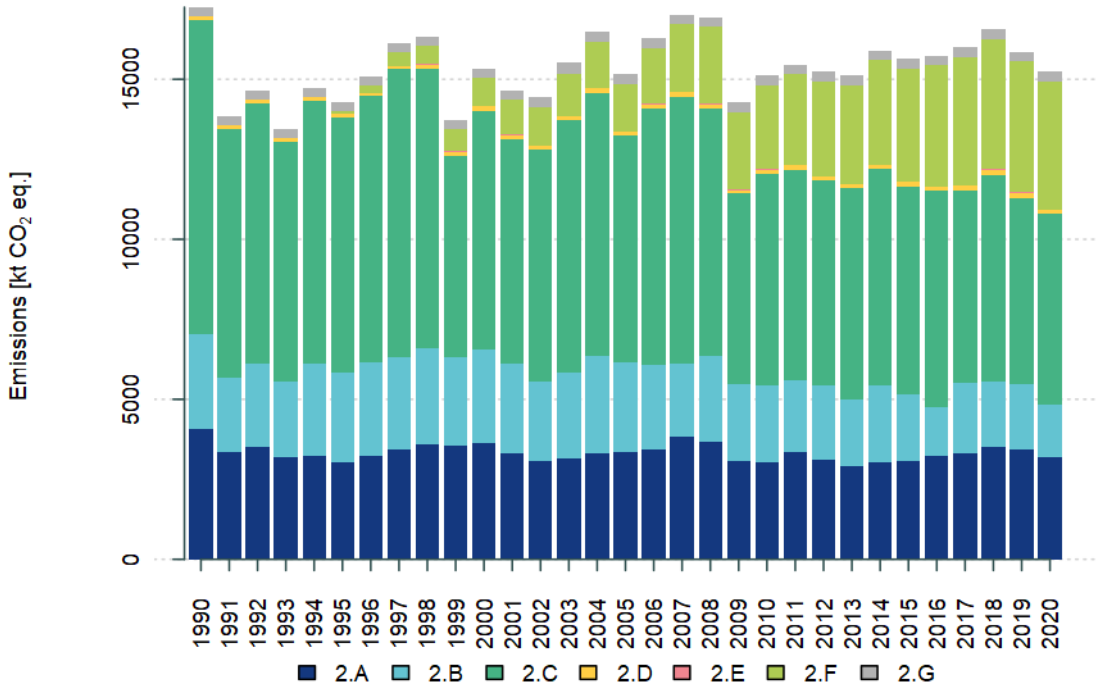


Fig. 2-7 The emission trend in 2. IPPU sector during reporting period 1990 – 2020 (CHMI, 2022)

Tab. 2-33 The emission trend in 2. IPPU sector during reporting period 1990 – 2020 (CHMI, 2022)

[kt CO_2 eq.]	Mineral industry (2.A)	Chemical industry (2.B)	Metal industry (2.C)	Non-energy products from fuels and solvent use (2.D)	Electronic industry (2.E)	Product uses as ODS substitutes (2.F)	Other product manufacture and use (2.G)
1990	4 082.45	2 941.78	9 809.81	125.56	NO,NE	NO	290.46
1991	3 365.96	2 308.70	7 789.95	109.65	NO,NE	NO	290.29
1992	3 506.00	2 625.03	8 098.70	126.15	NO,NE	NO	291.62
1993	3 195.85	2 375.21	7 491.92	93.14	NO,NE	NO	292.78
1994	3 249.88	2 876.14	8 201.32	113.77	NO,NE	NO	293.88

1995	3 019.09	2 805.62	7 979.75	103.75	NO,NE	13.83	294.90
1996	3 247.34	2 897.53	8 327.05	90.19	NO,NE	98.49	304.52
1997	3 435.56	2 886.96	9 019.13	76.63	1.14	222.14	302.32
1998	3 599.41	3 012.65	8 719.72	135.10	1.14	276.40	301.19
1999	3 553.49	2 765.07	6 289.88	130.22	8.51	315.54	294.14
2000	3 633.37	2 936.67	7 433.43	156.41	11.17	437.68	306.04
2001	3 322.41	2 800.91	7 005.78	127.98	21.03	603.16	290.39
2002	3 064.16	2 473.87	7 255.68	114.06	20.32	739.98	320.06
2003	3 165.55	2 665.04	7 893.31	122.87	4.87	886.13	347.88
2004	3 330.41	3 008.42	8 240.24	138.33	4.36	1000.68	326.61
2005	3 345.75	2 800.88	7 078.74	143.53	6.64	1136.37	316.93
2006	3 445.51	2 618.62	8 015.18	146.20	22.03	1426.07	310.54
2007	3 826.59	2 303.08	8 308.22	158.87	19.68	1852.58	299.55
2008	3 674.72	2 676.42	7 749.38	123.80	28.94	2158.11	311.27
2009	3 075.56	2 386.91	5 963.63	111.52	35.50	2204.68	311.88
2010	3 048.42	2 368.61	6 609.01	123.75	41.95	2481.74	304.69
2011	3 356.80	2 254.57	6 561.39	133.95	6.69	2740.27	309.89
2012	3 092.40	2 356.45	6 396.80	116.10	4.12	2843.22	314.14
2013	2 912.52	2 092.66	6 585.55	122.48	3.93	2969.69	304.29
2014	3 049.90	2 367.20	6 768.81	122.32	4.20	3123.18	302.04
2015	3 084.24	2 070.59	6 494.55	145.40	5.30	3340.82	299.04
2016	3 220.27	1 527.20	6 759.03	145.86	6.39	3578.54	298.31
2017	3 298.43	2 216.61	6 015.11	151.20	7.13	3748.83	294.37
2018	3 505.16	2 047.56	6 464.85	163.90	6.64	3828.65	291.13
2019	3 442.48	2 019.67	5 838.59	158.43	5.49	3795.69	289.02
2020	3 210.62	1 627.97	5 945.89	133.44	4.63	4 019.87	286.60

2.3.1 Methodological issues

The projections of GHG emissions in 2. IPPU are based on data and methodology used for inventory emission estimates reported in National Inventory Report (NIR) (CHMI, 2022).

The projections are estimated separately for each subcategory under 2. IPPU sector and also for each GHG. In the Czech Republic, there is no additional measure for 2. IPPU sector and thus only scenario With Existing Measures (WEM) is calculated.

The projections are implemented directly to the calculation sheets used for inventory emission estimates to NIR (CHMI, 2022). This approach allows using country specific emission factors (EF) and the same or slightly modified methodology where appropriate. For example, in cases where Tier 3 methodology is used, data are not projected for each producer/facility but rather for a group of producers/facilities.

First are the projected activity data and EFs, which are then used for projection of the entire period 2021 - 2050.

Projection of activity data:

For most of the subcategories under 2.A Mineral production, 2.B Chemical production and 2.C.1 Iron and steel production, the activity data were forecasted by the Ministry of Industry and Trade (MIT, 2022) for 2021 - 2050. The activity data for 2.C.2 - 2.C.7 were projected using statistical methods (see Tab. 2-34) by experts from the Czech Hydrometeorological Institute (CHMI); however, the emissions are under the threshold of significance (0.05%) for the whole time series (1990 – 2050). For category 2.D Non-energy products from fuels and solvent use the activity data were projected (see Tab. 2-34) by experts from CHMI.

There is no official forecasts of the fluorinated GHG (F-gases) consumption for 2.E Electronics industry, 2.F Substitutes for ozone depleting substances and 2.G Other product manufacture and use. Thus, the activity data is based on expert judgement at CHMI, strictly following Regulation No 517/2014, Directive 2006/40/EC and Kigali Amendment of the Montreal Protocol. Correlation of F-gases consumption with GDP or number of inhabitants is also investigated for better accuracy of activity data projections.

Source of activity data used for projections for each subcategory under 2. IPPU is summarized in Tab. 2-34.

Projection of EFs:

Emission projections are based on the same approaches as in NIR (CHMI, 2022), which follows the IPCC 2006 Guidelines (Gl.) (IPCC, 2006). In most cases, projections of EFs are based on values of EFs in previous years. EFs used for projections are derived as an average of EFs for selected period or EFs are calculated by forecasting methods (Tab. 2-34). Where default EFs are used for inventory emission estimates in NIR, there is the same approach applied for projections (mainly for Tier 1 methodology and F-gases inventory emission estimates).

Detailed information about EFs used for projections in subcategories under 2. IPPU is described in Tab. 2-34.

Projection of emissions:

Final projections for selected subcategory under 2. IPPU are calculated by using projected activity data and EFs. The approach is in line with IPCC 2006 Gl. (IPCC, 2006). For example, projections for category 2.F.1 Refrigeration and air conditioning equipment are calculated by model Phoenix, which is used in NIR (Ondrusova & Krtkova, 2018(1)) (CHMI, 2022). Methodology used for projections is Tier 2a, following the inventory emission estimates in NIR (CHMI, 2022) (IPCC, 2006).

Tab. 2-34 Detailed information about methodology assumptions used for projections of (sub-)categories under 2. IPPU

Projections 2019 – 2050			
Category	**Activity data**	**Emission factors**	**Methodology**
2.A Mineral Production			
2.A.1 Cement production	MIT data	Average for 2009 – 2020	Modified Tier 3
2.A.2 Lime production	MIT data	Average for 2014 – 2020	Modified Tier 3
2.A.3 Glass production	to 2030 from MIT, to 2050 derived from MIT data	Average for 2010 – 2020	Modified Tier 3
2.A.4.a Brick and ceramics	Trend of data obtained from MIT was applied on data from NIR	Average for 2015 – 2020	Modified Tier 3
2.A.4.b Soda ash production	Average production from 2012 to 2020	Plant specific	Modified Tier 3
2.A.4.d Mineral wool production, flue-gas desulphurisation and denitrification	Mineral wool - Average production from 2014 to 2020	Mineral wool – Default Desulphurisation – plant specific Denitrification – average for 2017 - 2020	Tier 1 for mineral wool production, Modified Tier 3 for desulphurisation and denitrification

Projections 2019 – 2050			
Category	**Activity data**	**Emission factors**	**Methodology**
	Desulphurisation – based on trends in coal power plants Denitrification - Average consumption from 2017 to 2020		
2.B Chemical Production			
2.B.1 Ammonia production	to 2030 from MIT, to 2050 derived from MIT data	Default	Tier 1
2.B.2 Nitric acid production	to 2030 from MIT, to 2050 derived from MIT data	Average for 2010 - 2020	Modified Tier 3
2.B.4.a Caprolactam	Constant production	Default	Tier 1
2.B.8.b Ethylene	to 2030 from MIT, to 2050 derived from MIT data	Default	Tier 1
2.B.8.c Vinyl chloride monomer	to 2030 from MIT, to 2050 derived from MIT data	Default	Tier 1
2.B.8.f Carbon black	Average consumption from 2014 to 2020	Default	Tier 1
2.B.8.g Styrene	Average consumption from 2010 to 2020	Plant specific, Default	Modified Tier 3, Tier 1
2.B.10 Other non-energy use in chemical industry	Average consumption from 2010 to 2020	Default, country specific	Tier 1
2.C Iron and Steel Production			
2.C.1 Iron and steel production	to 2050 from MIT	Default, country specific, plant specific	Tier 2
2.C.2 Ferroalloys production	Average consumption from 2012 to 2020	Default	Tier 1
2.C.5 Lead production	Average consumption from 2012 to 2020	Default	Tier 1
2.C.6 Zinc production	Average consumption from 2012 to 2020	Default	Tier 1
2.D Non-energy products from fuels and solvent use			
2.D.1 Lubricant use	Average consumption from 2012 to 2020	Default	Tier 1
2.D.2 Paraffin wax use	Average consumption from 2012 to 2020	Default	Tier 1
2.D.3 Other	Average consumption from 2012 to 2020	Default	Tier 1
2.E Electronics Industry			
2.E.1 Integrated circuit or semiconductor	SF_6 – projections of consumption are based on correlation with GDP NF_3 – projections of consumption are based on correlation with GDP	Default	Tier 2a
2.F Product uses as substitutes for ODS			
2.F.1 Refrigeration and air conditioning	Projections of consumption are based on previous trends (Regulation No 517/2014), and Kigali	Country specific and default	Tier 2a Model Phoenix was used for projections of subcategories under

Projections 2019 – 2050			
Category	**Activity data**	**Emission factors**	**Methodology**
	Amendment of the Montreal Protocol For 2.F.1.e, vehicle fleet projections are based on correlation with population, MIT data, Directive 2006/40/EC		2.F.1, except 2.F.1.e, where country specific approach was applied following NIR (CHMI 2022)
2.F.2 Foam blowing agents to 2.F.5 Solvents	Projections of consumption are based on previous trends or average consumption, Regulation No 517/2014, and Kigali Amendment of the Montreal Protocol	Default	Tier 1a
2.G Other product manufacture and use			
2.G.1 Electrical equipment	Average consumption from 2017 to 2020	Default	Tier 1
2.G.2 SF_6 and PFCs from other product use	Projections of consumption based on previous trend	Default	Default
2.G.3 N_2O from product uses	Constant consumption	Default	Default

(CHMI 2022, IPCC 2006, MIT 2022)

2.3.2 Projected greenhouse gas emissions 'With existing measures (WEM) scenario' and 'With additional measures (WAM) scenario'

The WEM scenario includes policies and measures which affect consumption of F-gases. Those policies and measures are described in Chapter 1.3. **There is no additional measure for 2. IPPU sector and thus only WEM scenario is calculated.**

According to WEM scenario, total emissions from 2. IPPU will be stagnant in next few years and then slightly decreasing. It is not expected that the production capacity for main products, such as lime, cement, ammonia, iron and steel is going to decrease rapidly in the Czech Republic. The expectation is rather that the decrease of GHG emissions until 2050 will be very slight, mainly influenced by the ban on F-gases. According to the current projections (Tab. 2-35 and Fig. 2-8), it is expected that total emissions from 2. IPPU in 2050 will decrease by 29 % compared to year 1990 and by 21 % compared to 2020. Emission projections are based on the current situation in the Czech industry and legislation. However, it is highly probable that during next few years, producers will renovate their units and introduce new mitigation techniques and thus there is a space for reduction of GHG emissions from 2. IPPU.

Tab. 2-35 Reported and projected emissions of GHG in 2. IPPU – WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions					Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2050	1990 – 2025	1990 – 2030	1990 – 2040	1990 – 2050
WEM	17.11	14.83	15.22	14.42	13.37	12.75	12.51	12.08	-15.71	-21.84	-26.87	-29.41

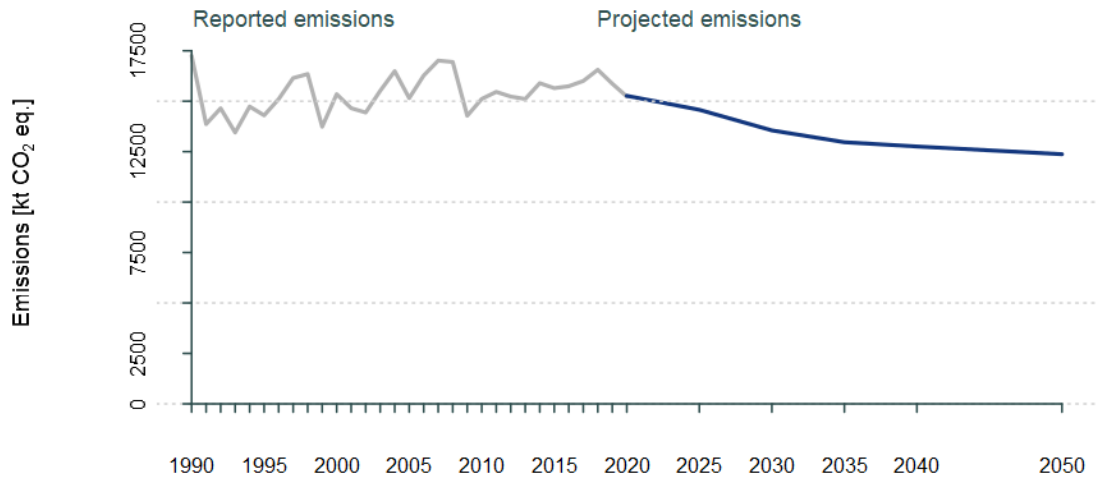


Fig. 2-8 Reported and projected emissions of GHG in IPPU – WEM scenario

2.3.2.1 Projected greenhouse gas emissions 'With existing measures (WEM) scenario'

WEM scenario takes into account following policies and measures:

Regulation No 517/2014,
Directive 2006/40/EC,
Kigali Amendment of the Montreal Protocol.

As visible from Tab. 2-36, major share on total emissions from 2. IPPU has by far CO_2. It is expected that emissions of CO_2 will be stagnant until 2050, as no major changes are expected in 2.A Mineral, 2.B Chemical or 2.C Metal industry and thus emissions will not change rapidly. Only a small change of CO_2 emissions compared to the current situation is expected. No significant changes are expected in CH_4 emissions, where the main source is sinter production. N_2O emissions are expected to raise with the anticipated increase of its main source, the N_2O production.

Tab. 2-36 Breakdown of reported and projected emissions of GHG by gases in 2. IPPU - WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions					Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2050	1990 – 2025	1990 – 2030	1990 – 2040	1990 –2050
CO_2	15.65	12.39	10.72	11.42	11.41	11.31	11.26	11.16	-26.99	-27.06	-28.03	-28.70
CH_4	0.05	0.06	0.06	0.07	0.07	0.07	0.07	0.07	29.97	31.60	31.53	31.54
N_2O	0.35	0.31	0.39	0.41	0.41	0.42	0.42	0.43	11.67	15.23	19.42	22.73
HFCs	NO	1.07	4.02	2.41	1.38	0.86	0.67	0.34	NA	NA	NA	NA
PFCs	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
SF6	0.08	0.11	0.06	0.06	0.05	0.04	0.04	0.03	-20.33	-40.05	-53.01	-61.38
NF3	NO	NO	0.00	0.00	0.01	0.01	0.01	0.01	NA	NA	NA	NA
Total	17.11	14.83	15.22	14.42	13.37	12.75	12.51	12.08	-15.71	-21.84	-26.87	-29.41

Legislation currently in force is focusing on F-gas emissions reduction, mainly HFCs, which are used extensively in 2.F.1 Refrigeration and air conditioning systems. The applicable policies and measures

(PaM) are reflected in the presented projections. Reported and projected emissions of F-gases are shown in Tab. 2-36 and overall results of F-gases projections in Fig. 2-9. Decrease of HFCs, PFCs, NF_3 emissions compared to 1990 cannot be calculated because at that time these F-gases were not used in the Czech Republic and thus emissions are reported as not occurring (NO) (Tab. 2-36). Therefore, the base year for F-gases is 1995 (CHMI, 2022) (IPCC, 2006). It is expected that HFCs emissions will start to decrease around 2020. Compared to 2020, HFCs emissions should be 91 % lower in 2050. The decrease of F-gases emissions will not be as rapid as one could expect because released during the equipment's lifetime, which in some cases can be more than a decade. SF_6 and NF_3 are used by semiconductor manufacturers and SF_6 also as and insulation gas in switchgears. Emissions of SF_6 will start to decline unlike emissions of NF_3, which is expected to be more commonly used in near future. For NF_3 is expected that emissions will increase unless new PaM will be adopted. PFCs are not used anymore in the Czech Republic but formation of CF_4 as a byproduct during etching and cleaning in semiconductor industry is taken into account and thus emissions will be still occurring.

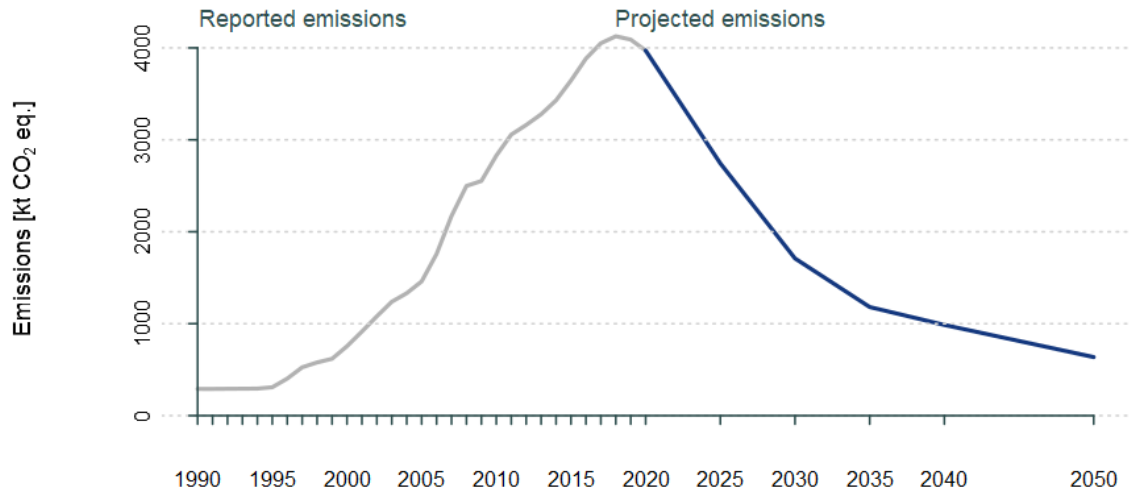


Fig. 2-9 Reported and projected F-gases (HFCs, PFCs, SF_6, NF_3) emissions from categories 2.E, 2.F, 2.G – WEM scenario

As shown in Tab. 2-37, GHG emissions decline is expected in comparison to 1990 for all categories, except 2.D Non-energy use of fuels. Emissions from 2.A Mineral industry are projected to decrease in 2020 and then slightly increase until 2050. This trend directly follows projections of cement production (MIT, 2022). It is expected that emissions from 2.B Chemical industry will decrease slightly until 2050, althought there was already an exceptional sink detected in 2020. 2.C.1 Iron and steel production is the main emission subcategory of 2. IPPU. It is expected that the 2.C.1 production and thus emissions are going to slightly decrease compared to the current situation.

It is expected that F-gas emissions for category 2.E.1 Electronic industry will increase in the next few years because currently there is no legislative measure influencing F-gases use in this category. Projections for this category are based on positive correlation of F-gases consumption in semiconductor manufacturing with GDP but it should be taken into account that emissions from semiconductor manufacturing are under the threshold of significance (0.05 %). The main source of F-gas emissions is category 2.F Product uses as substitutes for ODS, in particular subcategory 2.F.1 Refrigeration and air conditioning. It is expected that emissions will start decreasing when important deadlines banning certain substances (Regulation No 517/2014) enter into force.

Tab. 2-37 Breakdown of reported and projected emissions of GHG by individual categories in 2. IPPU - WEM scenario

[Mt CO_2 eq.]	Reported emissions			Projected emissions					Difference [%]		
	1990	2005	2020	2025	2030	2035	2040	2050	1990 – 2030	1990 – 2040	1990 – 2050
2.A. Mineral industry	4.08	3.35	3.21	3.14	3.14	3.14	3.15	3.17	-23.14	-22.86	-22.27
2.B. Chemical industry	2.94	2.84	1.63	2.16	2.08	2.02	1.95	1.82	-29.19	-33.64	-38.21
2.C. Metal industry	9.67	7.10	5.95	6.26	6.32	6.28	6.28	6.28	-34.68	-35.04	-35.04
2.D. Non-energy products from fuels and solvent use	0.13	0.13	0.13	0.17	0.18	0.19	0.20	0.22	38.00	52.56	67.22
2.E. Electronics industry	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA
2.F. Product uses as substitutes for ODS	NO	1.08	4.02	2.41	1.39	0.86	0.67	0.34	NA	NA	NA
2.G. Other product manufacture and use	0.29	0.32	0.29	0.28	0.27	0.26	0.26	0.25	-7.51	-11.89	-14.91
2.H. Other	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA
Total	17.11	14.83	15.22	14.42	13.37	12.75	12.51	12.08	-21.84	-26.87	-29.41

2.3.3 Sensitivity analysis

Projections of GHG emissions from 2. IPPU sector are based on calculation sheets used for inventory emission estimates in NIR (CHMI, 2022). Activity data is only variable which changes during projected period 2021 – 2050 (see chapter 1.3.1 for detailed information about activity data projections). EFs are constant during projected period and thus sensitivity analysis would not bring any interesting outcomes for categories under 2. IPPU sector (except category 2.F.1). If activity data will change by ±5% then emissions will change by ±5%, because emission factors used for inventory emission estimates are constant during the projected period.

Only category where sensitivity analysis could bring interesting output is category 2.F.1 Refrigeration and air conditioning, which is also a key category (CHMI, 2022). The projections are prepared with national model Phoenix, which takes into account a specific approach for calculating the amount of chemicals remaining in the equipment at decommissioning, using the Gaussian distribution model with mean at the lifetime expectancy for newly filled equipment and assuming only half lifetime expectancy for serviced equipment (Ondrusova & Krtkova, 2018(1)). Sensitivity analysis for category 2.F.1 is implemented using variable consumption of F-gases by ±5%, while respecting the emission trend from NIR (CHMI, 2022). The result of the sensitivity analysis is depicted in Tab. 2-38.

Tab. 2-38 Sensitivity analysis using variable consumption of F-gases in category 2.F.1 under 2. IPPU sector

Emission difference [%]	2025	2030	2035	2040	2045	2050
WEM and WEM +5%	0.13	0.15	-0.07	2.16	1.44	3.35
WEM and WEM -5%	-0.46	-0.85	-1.40	-1.07	-1.16	-1.55

2.3.4 Difference between previously and currently reported projections

Since current and previous projections are based on the same methodology, differences are mainly due to the changes in updated activity data. The most visible difference is for F-gases projections. The decrease of F-gases emissions were projected to be slower in previous projections. The increase in the current projection is caused by changed approach to activity data projections, where the gases used for servicing were included in consumption next to the first fill, whose projections is decreasing according to adopted legislative measures.

2.4 Agriculture

Agriculture sector (livestock production included only) in 2020 was the fourth largest producer of greenhouse gas (GHG) emissions in the Czech Republic, to which Agriculture contributed by 6.3 %. The total emissions from Agriculture in 2020 were 7 842 kt CO_2 eq., 46 % originated from Agricultural Soils, 39 % from Enteric Fermentation and 10 % from Manure Management. Carbon dioxide (CO_2) emissions from Liming and Urea Application on Agricultural Soils contributed to the total emissions by 4 % (CHMI 2022).

The total emissions from Agriculture decreased within reported period 1990-2020 by about 50 %, mostly because of population reduction during 1990-2010 and then as a result of refinement progress in methodology procedures for emissions reporting. The total emissions from 1997-2020 are fluctuating by 10 %, with the lowest value in 2010.

Quantitative data overview and emission trends in Agriculture categories for the period 1990-2020 are shown in Fig. 2-10, Tab. 2-39 and 2-40 (CHMI, 2022).

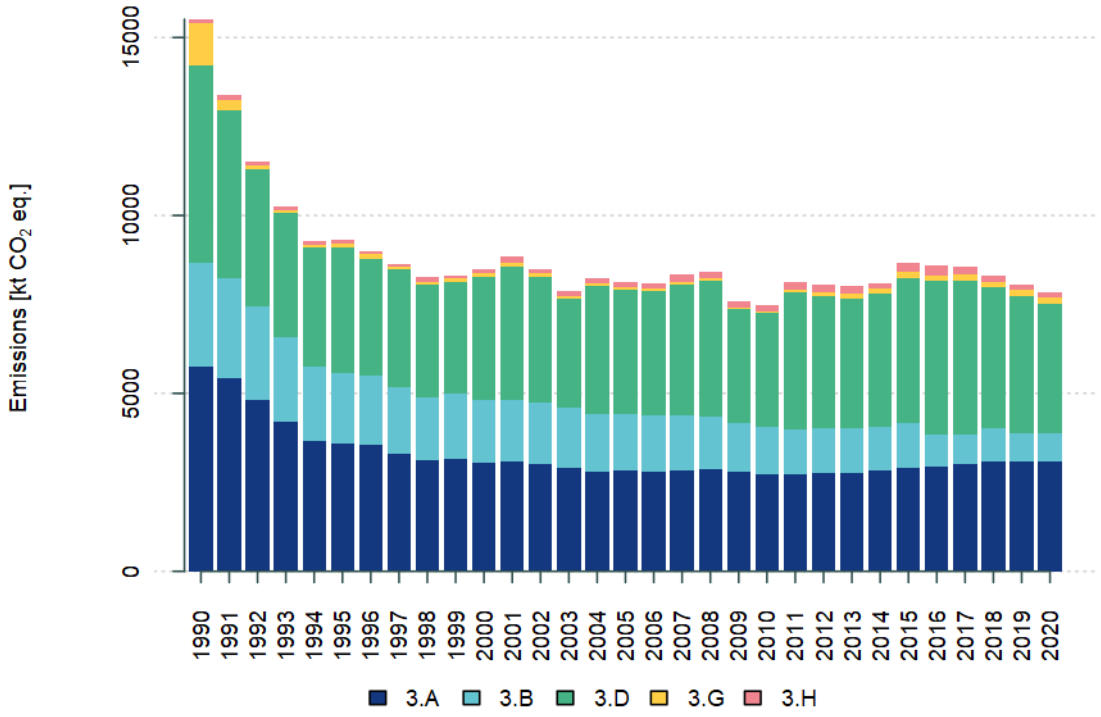


Fig. 2-10 The emission trend in 3. Agriculture sector in period 1990-2020 (CHMI, 2022)

Tab. 2-39 The emission trend in 3. Agriculture sector in period 1990-2020 (sorted by IPCC categories)(CHMI, 2022)

[kt CO2 eq.]	TOTAL	Enteric Fermentation (3.A)	Manure Management (3.B)	Agricultural soils (3.D)	Liming (3.G)	Urea Application (3.H)
1990	15 513	5 737	2 941	5 538	1 188	109
1991	13 393	5 411	2 811	4 723	316	132
1992	11 510	4 821	2 612	3 859	109	109
1993	10 255	4 202	2 382	3 474	104	93
1994	9 280	3 667	2 091	3 327	104	91
1995	9 317	3 583	1 982	3 531	111	109
1996	9 004	3 548	1 935	3 307	113	100
1997	8 632	3 315	1 850	3 306	93	67
1998	8 284	3 104	1 788	3 158	91	143
1999	8 317	3 174	1 812	3 155	88	88
2000	8 488	3 049	1 755	3 456	113	116
2001	8 838	3 073	1 728	3 775	105	157
2002	8 497	3 008	1 742	3 515	100	132
2003	7 861	2 902	1 710	3 049	79	120
2004	8 243	2 790	1 614	3 612	77	151
2005	8 124	2 837	1 581	3 494	65	146
2006	8 095	2 812	1 562	3 487	78	156
2007	8 339	2 842	1 545	3 674	80	197
2008	8 422	2 874	1 490	3 783	96	179
2009	7 573	2 805	1 372	3 184	65	148
2010	7 472	2 721	1 329	3 199	62	161
2011	8 127	2 728	1 275	3 837	81	207
2012	8 044	2 760	1 245	3 715	117	206
2013	8 013	2 761	1 269	3 649	137	198
2014	8 083	2 819	1 246	3 736	152	130
2015	8 668	2 897	1 261	4 078	164	268
2016	8 605	2 960	868	4 320	168	290
2017	8 562	2 999	855	4 324	159	225
2018	8 322	3 098	907	3 970	161	185
2019	8 070	3 094	788	3 846	193	149
2020	7 842	3 091	787	3 623	184	156

Source: CHMI 2022

Whilst the ratio of emissions from Enteric Fermentation and managed Agricultural Soils is relatively stable, the ratio of emissions from Manure Management gradually decreases, because of implementing methodology updates on estimations (Manure Management in biogas stations since

2016, country-specific data on nitrogen excreted since 2019). Urea Application during the reported period reached the maximum in 2015-2017 and decreased slightly from 2018.

Tab. 2-40 Breakdown of reported GHG emissions from Agriculture by emitted gases

GHG	Reported emissions from Agriculture [Mt CO_2 eq.]						
	1990	1995	2000	2005	2010	2015	2020
CO_2	1.30	0.22	0.23	0.21	0.22	0.43	0.34
CH_4	7.28	4.64	3.96	3.69	3.42	3.58	3.44
N_2O	6.93	4.45	4.30	4.23	3.83	4.66	4.06
Total	15.51	9.31	8.49	8.13	7.47	8.67	7.84

Source: CHMI 2022

2.4.1 Methodological issues

In general, the emissions quantifications and estimates projections are being prepared in compliance with IPCC methodology (IPCC, 2006), and in case of Enteric Fermentation in compliance with IPCC refinements concerning the sector (IPCC, 2019). All the calculation procedures correspond to the GHG estimates methodology as it is being prepared for 2023 submission for Agriculture sector.

2.4.1.1 Activity data

Activity data and emission factors (EF) trends applied for prediction accounting were derived from the activity data delivered from Institute of Agricultural Economics and Information, which had requested them directly from Ministry of Agriculture, from sectoral institutes (Crop Research Institute, Institute of Animal Science) or which had been derived from agricultural development model predictions composed by Institute of Agricultural Economy and Information directly.

Note: If there were no possibility to predict future development for any activity data (e.g. amount of sewage sludge applied to soils, etc.), a constant values were used for reporting purposes.

The below activity (input) data were available (Tab. 2-41 – Tab. 2-47):

2.4.1.1.1 Livestock population

Tab. 2-41: Livestock population within the projected period

Livestock category	*Projected data [thousands of animals]*						
	2020*	2025	2030	2035	2040	2045	2050
Cattle	1 404	1 481	1 478	1 495	1 503	1 506	1 506
- dairy cattle	360	387	360	360	360	360	360
- suckler cows	226	229	232	235	238	238	238
- mature heifers (>2 yrs.)	68	81	84	85	86	86	86
- mature bulls (>2 yrs.)	21	21	22	22	22	22	22
- heifers 1-2 yrs.	208	222	230	232	234	234	234
- bulls 1-2 yrs.	99	113	117	118	119	119	119

Livestock category	*Projected data [thousands of animals]*						
	2020*	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
- heifers 0.5-1 yr.	114	114	114	115	115	116	116
- bulls 0.5-1 yr.	70	74	74	75	75	77	77
- calves (<0.5 yrs.)	239	240	245	253	254	254	254
Swine	1 499	1 500	1 600	1 600	1 600	1 600	1 600
Sheep	204	240	165	165	165	165	165
Goats	29	35	25	25	25	25	25
Horses	38	35	35	35	35	35	35
Poultry	24 247	24 180	26 695	26 695	26 695	26 695	26 695

**Data of CZSO*

The table above shows a work data, which predicts maintenance of the current trend for shorter period and then a neutral trend without decreasing or increasing development. According to the MoA Strategy, there are higher plans for livestock populations for years 2025 and 2030, currently the MoA estimate is considered as overestimated.

2.4.1.1.2 Milk production, milk quality

Tab. 2-42: Milk production and quality projection

	Daily milk production [kg/day/head]	**Fat content [%]**	**Protein content [%]**
2020	24.97	3.89	3.46
2030	27.58	3.90	3.50
2040	28.99	3.90	3.55
2050	30.48	3.90	3.60

Source: 2020 Yearbook of cattle breeding, 2030-2050 (Expert estimate, Institute of Animal Science, 2022)

While the Czech Republic has already been lined up among EU countries with the highest productivity (and considering probable population growth in systems of organic farming, where high milk yield is hardly being assumed), it is predicted that an average daily milk production will increase by 1 % per year, however this increase will slow down to about 0.5 % per year between 2030 and 2050. As for the content of milk components, the future trend in breeding of dairy cattle populations in the Czech Republic will be essential there. The fat content remains at the current values, while the protein content increases slightly.

2.4.1.1.3 Manure Management systems

Tab. 2-43: Manure Management systems, projection 2020-2040

	Manure Management system - Nitrogen fraction of Manure Management per system [%]			
	Anaerobic digestion	**Liquid**	**Solid**	**Pasture**
Dairy cattle				
2020	32.5	10.7	56.8	0
2030	32.5	10.7	56.8	0
2040	32.5	10.7	56.8	0
Other cattle				
2020	2.8	6.5	62.3	28.4
2030	2.8	6.5	62.3	28.4
2040	2.8	6.5	62.3	28.4
Swine				
2020	44.8	22.8	32.4	0
2030	44.8	22.8	32.4	0
2040	44.8	22.8	32.4	0
Poultry				
2020	6.0	35.1	58.9	0
2030	6.0	35.1	58.9	0
2040	6.0	35.1	58.9	0

Source: CHMI, 2022; 2030-2050 Expert estimate, Institute of Crop Research, 2022

For the purposes of predictions, the proportion of individual Manure Management systems has remained the same as in 2020, 2016-2020 respectively. An increase in the number of biogas stations based on the manure use is not presumed, as there is a need to increase the return of a quality organic matter into the soil thus, not to increase the amount of slurry, especially the manure entering the biogas stations.

An estimate of manure production and application in the Czech Republic is based on the proportion of various bedding technologies and coefficient from Decree No. 377/2013 Coll. (Coll., 2013), considering the input of manure and slurry into biogas stations according to the study of Institute of Agricultural Economics and Information (Klír, 2019).

2.4.1.1.4 Nitrogen content of mineral fertilizers

Tab. 2-44: Nitrogen content in mineral fertilization projection

Nitrogen content	Projected data						
	2020*	2025	2030	2035	2040	2045	2050
Projection [%]		- 8 %	- 12 %	- 10 %	- 8 %	- 7 %	- 5 %
Projection [kt N]	285	262	228	200	177	157	143
F2F target [%]			- 20 %				- 50 %

Source: MoA, Ing. Budňáková; Institute of Crop Research (actual values), Institute of Agricultural Economics and Information, a suggestion according to F2F 2025-2030 and on; note.: yr. 2025-2050: the percentage reduction for the given 5 yr. period is reduced cumulatively, in relation to 2020

A significant source of nitrogenous emissions from Agricultural Soils management is an application of synthetic nitrogen fertilizers. There is a target of 25 % reduction of a maximal doses applied for crops where high doses are applied (winter wheat, winter canola, corn). This target is reachable by supporting services providing a qualified decision making to encourage locally based nutrition principles and enhance purchasing of technologies enabling more various fertilization application. The support of organic farming is an alternative to these measures. Partial measures also include a cultivation of low leguminous intercrops and a reduced tillage (no-till farming practises).

Strategical plan SZP 21+ (State Agricultural Policy 21+) for 2024-2028 counts with an increase in area of precision agriculture by 500 thousand ha/yr. The increase in area of organic farming is planned as continuous, at a level of 7 %/yr., the plan for its area in 2024 is of 494 thousand hectares.

2.4.1.1.5 Sowing area and annual harvest of individual crops

Tab. 2-45: Annual harvest of the selected crops projection

Annual harvest	Projected data [kt]						
	2020	2025	2030	2035	2040	2045	2050
Cereals [1]	8 126	2 051	2 051	2 051	2 250	2 219	2 188
Pulses [1]	92	43	43	43	47	46	46
Potatoes [1]	696	20	20	20	22	22	22
Sugar beet [1]	3 671	96	96	96	105	104	102
Fodder (hay) [2]	5 295	6 307	6 307	6 307	7 344	7 344	7 436
Soya [3]	33	29	33	38	42	42	42

Source: 2020 CZSO, projections 2025-2050 Institute of Agricultural Economics and Information (Foltýn, Farma 6 on the background of LPIS)

[1] since 2025 – original mass data, but for the main product only, i.e. in bulb, in grain, etc.

[2] data corresponding to the production of 50 % grassland (the rest of 50 % considered as pastures), original mass data (14 t/ha in original mass)

[3] economic data on soya bean production is not available in model Farma 6, kept constant

Tab. 2-46: Sowing area of the selected crops projection

Annual harvest	Projected data [th. ha]						
	2020	2025	2030	2035	2040	2045	2050
Cereals	1 345	1 463	1 408	1 431	1 147	1 307	1 314
Pulses	37	64	64	64	38	44	42
Potatoes	24	14	14	14	12	14	13
Sugar beet	57	64	64	64	57	65	63
Fodder (hay)	507	451	451	451	525	525	531
Soya*	14	14	14	14	14	14	14

Source: 2020 CZSO, projections 2025-2050 Institute of Agricultural Economics and Information (Foltýn, Farma 6 on the background of LPIS)
** economic data on soya bean production is not available in model Farma 6, kept constant*

2.4.1.1.6 Limestone consumption and Urea Application in Agriculture

Tab. 2-47: Limestone/dolomite and Urea Application in Agriculture

	Projected data [kt]						
	2020	2025	2030	2035	2040	2045	2050
Limestone/dolomite	338	408	449	494	543	598	598
Urea/DAM	213	198	180	180	180	180	180

Source: Limestone/dolomite – GCRI, Ing. Klem Karel, Urea/DAM – Institute of Crop Research, Research Institute of Agricultural Engineering, Dědina M.

Limestone/dolomite consumption by 2025 is brought in a more realistic way and the following years represent the optimum. There is a significant representation of agricultural soils of low to very low pH in the Czech Republic and it is estimated that this unfavourable situation would be improved by application of 2 500 kt/yr. (MoA, Ing. Budňáková 2022). The prediction is based on need of increasing liming. There is a real increase of +10 % for each 5 years prediction planned, increased by 77 % for the whole predicted period. This prediction is based on reasoning of Dr. Karel Klem (Global Change Research Institute, Czech Academy of Sciences), who was kindly requested for consultation.

For DAM, there was a decreasing trend of use reported during last 5 years. However, it is still a fertilization applied within vegetation period as a fast acting, which can be used for fertilizing intercrops, etc. During the last 20 years period, nitrogen consumption from DAM mostly reached a level around 85 kt. There is an expectation of increased consumption for the future. Nitrogen consumption from urea decreased by 40 % during last 5 years. There is a decreased trend of its application expected, in regard with a legal duty of its immediate application into the soil, which can bring complications to farmers and an application cost increase – so its atractivity was legislatively reduced. However, urea with urease inhibitors, which doesn´t have to be applied immediately, can be used instead, but the solution is more expensive (Research Institute of Agricultural Engineering, Dědina, M. 2022).

2.4.1.2 Methane emissions

For the purposes of the emissions estimates, a computing tools on the basis of an excel sheets with pre-defined macros (functions and command lines automating the calculations), which had been standardly being used for emissions estimations were used. All the methodology updates planned for 2023 submission was involved even for 2025+ predictions.

Enteric Fermentation and Manure Management are the main sources of CH_4 emissions in Agriculture sector. Activity data on livestock population is decisive for estimating, especially the number of cattle in case of Enteric Fermentation and animal waste management in stables, feedlots, and manure storage systems.

Emissions from Enteric Fermentation are estimated in compliance with IPCC Refinement (IPCC 2019), Tier 2 methods for cattle and Tier 1 methods for other livestock. Methane (CH_4) emissions from Manure Management are quantified by use of Tier 2 methods for cattle and swine and Tier 1 for other livestock.

The default values for emission factors used for estimating methane emissions according to Tier 1 methods are taken from IPCC GL 2006 (horses, sheep, goats, swine). The predicted values for emission factors calculated according to Tier 2 (Enteric Fermentation, Manure Management, cattle) are accounted based on expected energy consumption in the individual livestock categories. The emission factors for predicting methane emissions from Manure Management of swine are derived from Decree No. 377/2013 Coll., on the manure storage and management.

The emission factor (EF) for methane emissions from Enteric Fermentation from cattle is being derived from the energy intake of animal providing milk production, weight gain or maintenance respectively. The dependence of the emission factor from Enteric Fermentation on milk production and body weight is explicit from Tab. 2-48, where the reported and predicted values are shown.

Tab. 2-48: Values of calculated emission factor (EF) for enteric fermentation for dairy cattle, relevant milk production and body weight, development within time period 1990-2050

Dairy cattle	Reported data				Projected data					
	1990	2010	2015	2020	2025	2030	2035	2040	2045	2050
EF for enteric fermentation [kg CH_4/head/yr]	98	131	137	147	147	156	156	160	160	165
Milk production [kg/day]	11	18	23	25	26	28	28	29	29	30
Body weight [kg]	520	590	650	650	650	650	650	650	650	650

Source: IFER, 2022

2.4.1.3 Nitrous oxide emissions

There are two main sources of nitrous oxide (N_2O) emissions in Agriculture sector: Manure Management and Agricultural Soils.

Direct and indirect emissions from Manure Management depend on livestock population, the amount of nitrogen in their excrements and Animal Waste Management System (AWMS) that is currently applied. Tier 2 methods are used for the associated GHG estimation in the National Inventory Report (CHMI 2022) as there are country-specific data for AWMS and the nitrogen excretion value (Nex) available for the individual categories of livestock. The emission factors are taken from IPCC GL 2006.

The total N_2O emissions from Manure Management decreased rapidly by 60 % during the period 1990-2015 (CHMI 2022), due to the reduction of livestock herds. Further decrease by 10 % occurred in this category within the period of 2016-2018, when a new category of the AWMS was reflected in the inventory (anaerobic digestion). Further decrease by about 4 % during years 2019-2020 arises from

the transition to use of the country-specific data on the amount of nitrogen excreted (CZ Decree No. 317/2013 Coll.).

Thus, in 2020, the emissions from Manure Management were only 20 % of the 1990 estimate. There is no further decrease predicted for the period 2025-2050.

Direct and indirect nitrous oxide emissions from managed Agricultural Soils decreased from 1990 by 35 %, with the minimum in 2010. The estimate is based on the Tier 1 method. This category is determined by the amount of mineral fertilization applied, which accounts for up to 55 % (2019) of N_2O emissions from Agricultural Soils. From the data prepared by the Ministry of Agriculture, it is obvious that there is the decreased consumption expected.

The amount of nitrogen from crop residues entering the soil after harvest is the other important input into the estimate. In 2019, the contribution on the total nitrogen emissions form Managed Soils category was 28 %. It follows from the prediction that there is no significant trend of increasing yield or sowing area expected nor is there an increase in the amount of biomass from crop residues expected. The calculation of prediction contains the update of use of the country-specific coefficients for estimating the amount of dry matter content, nitrogen content and the amount of crop biomass, which is used as a feed or bedding. This update has been prepared in cooperation with colleagues from Institute of Crop Research for 2023 submission.

2.4.1.4 Carbon dioxide emissions

There are two main sources of CO_2 emissions in Agriculture reported in the National Inventory Report (CHMI 2022):

1. Liming (3G)

2. Urea Application (3H)

Tier 1 methods of IPCC GL 2006 and the default emission factors (CHMI 2022) are used for estimating of the amount of CO_2 emissions from both the listed sources.

2.4.2 Projected greenhouse gas emissions 'With existing measures (WEM) scenario' and 'With additional measures (WAM) scenario'

In projections composed for the requirements of MoE and reporting purposes for EU authorities, two scenarios are distinguished: WEM scenario (With Existing Measures) and WAM scenario (With Additional Measures).

There are no additional measures planned to decrease GHG emissions in Agriculture sector currently. Therefore, **there are no differences between WEM and WAM scenario**.

The scenario for predictions presented already during activity data development includes corresponding policies and measures, which may influence the emissions development in the short and medium term. WEM scenario expects a relatively slightly increasing trend in production of GHG emissions from Agriculture. The total emissions from Agriculture for 2050 are estimated at 7 029 kt CO_2 eq., approximately 10 % less than it was reported in 2020 (7 842 kt CO_2 eq.).

Quantitative data overview and emission trends for the reported and projected period are shown in Tab. 2-49 – Tab. 2-54 and Fig. 2-11.

Tab. 2-49: GHG in Agriculture sector reported and projected – WEM scenario

	Reported data (CHMI 2022) [Mt CO_2 eq.]				Projected data [Mt CO_2 eq.]					
	1990	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agriculture	15.51	7.47	8.67	7.84	7.95	7.70	7.48	7.34	7.16	7.03

Source: CHMI, IFER, 2022

Tab. 2-50: The difference of the reported/projected emissions of GHG to the base year 1990, Agriculture sector

	Difference [%]			
	1990-2020	1990-2030	1990-2040	1990-2050
Agriculture	- 49.5	- 50.4	- 52.7	- 54.7

Source: CHMI, IFER, 2022

The emission changes reported in Agriculture sector are consequent to the activity data development:

1. cattle production increases, which leads to the increase of methane emissions from Enteric Fermentation by 11 %, compared to the current estimate for 2020;
2. nitrous oxide and methane emissions from Manure Management increase by 8.5 %, which is associated with population growth by about 4 % for cattle and 6 % for swine;
3. the decrease in synthetic fertilization application leads to the reduction of nitrous oxide emissions from Agricultural Soils, up to 33 %;
4. the increased intensity of Liming increases carbon dioxide emissions in this sub-category: 2025-2050 by 64 %, the increase in emissions is estimated to 116 kt CO_2 for the whole projected period.

Tab. 2-51: Breakdown of the reported and projected emissions of GHG from Agriculture by its categories

Agriculture, source category	Reported emissions [Mt CO_2 eq.]				Projected emissions [Mt CO_2 eq.]					
	1990	2010	2015	2020	2025	2030	2035	2040	2045	2050
3A Enteric Fermentation	5.74	2.72	2.90	3.09	3.40	3.40	3.43	3.49	3.49	3.54
3B Manure Management	2.94	1.33	1.26	0.79	0.81	0.84	0.84	0.85	0.85	0.86
3D Agricultural Soils	5.54	3.20	4.08	3.62	3.40	3.10	2.84	2.61	2.40	2.22
3G Liming	1.19	0.06	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.28
3H Urea Application	0.11	0.16	0.27	0.16	0.15	0.13	0.13	0.13	0.13	0.13
Total	15.5	7.47	8.67	7.84	7.95	7.70	7.48	7.34	7.16	7.03

Source: CHMI, IFER, 2022

Tab. 2-52: The difference of the reported/projected emissions of GHG to the base year 1990, Agriculture sector

Agriculture, source category	Difference [%]			
	1990-2020	1990-2030	1990-2040	1990-2050
3A Enteric Fermentation	- 46.16	- 40.77	- 40.24	- 38.33
3B Manure Management	- 73.13	- 71.42	- 71.09	- 70.75
3D Agricultural Soils	- 34.66	- 44.04	- 52.89	- 59.93
3G Liming	- 84.87	- 83.19	-78.15	-76.47
3H Urea Application	+ 45.46	+ 18.18	+18.18	+ 18.18
Total	- 49.45	- 50.35	- 52.68	- 54.67

Source: CHMI, IFER, 2022

Tab. 2-53: Breakdown of reported and projected emissions of GHG from Agriculture by emitted gases

Agriculture, GHG	Reported emissions [Mt CO_2 eq.]				Projected emissions [Mt CO_2 eq.]					
	1990	2010	2015	2020	2025	2030	2035	2040	2045	2050
CO_2	1.30	0.22	0.43	0.34	0.34	0.35	0.37	0.39	0.41	0.41
CH_4	7.28	3.42	3.58	3.44	3.75	3.78	3.80	3.87	3.87	3.92
N_2O	6.93	3.83	4.66	4.06	3.85	3.57	3.31	3.09	2.87	2.70
Total	15.5	7.47	8.67	7.84	7.95	7.70	7.48	7.34	7.16	7.03

Source: CHMI, IFER, 2022

Tab. 2-54: The difference of the reported/projected emissions of GHG to the base year 1990, Agriculture sector by emitted gases

Agriculture, GHG	Difference [%]			
	1990-2020	1990-2030	1990-2040	1990-2050
CO_2	- 73.84	- 73.08	- 70.00	- 68.46
CH_4	- 52.74	- 48.08	- 46.84	- 46.15
N_2O	- 41.41	- 48.48	- 55.41	- 61.03
Total	- 49.45	- 50.35	- 52.68	- 54.67

Source: CHMI, IFER, 2022

The total GHG emissions from Agriculture (Agriculture sector + the selected LULUCF sub-categories, 4B and 4C) originates mostly from Agriculture sector emissions (livestock production). However, the CO_2 offset in the above mentioned LULUCF sub-categories is an order lower number, so the total results reduced just slightly (Fig. 2-11).

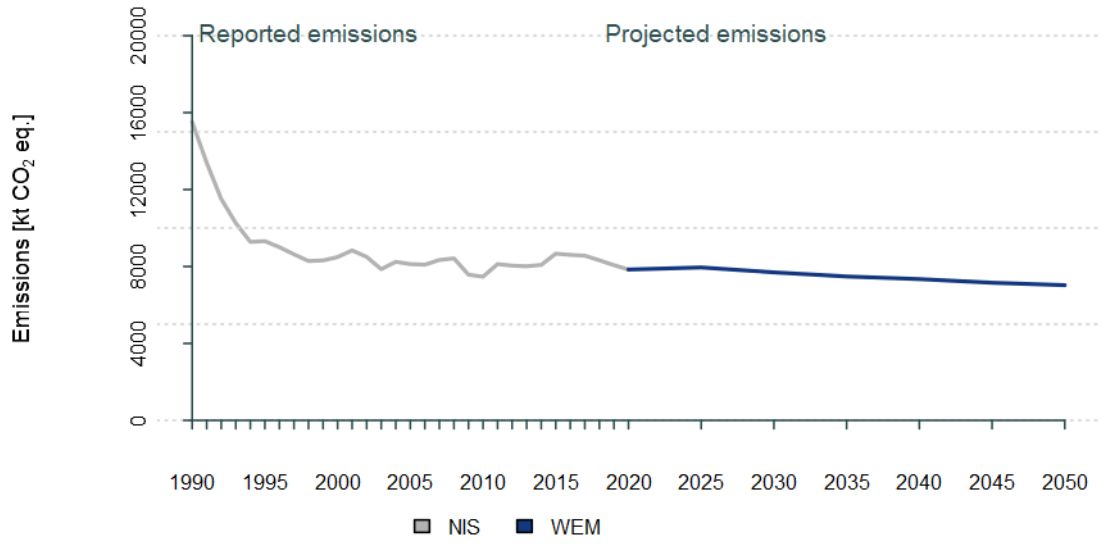


Fig. 2-11: Total emissions from Agriculture, reported and projected, 1990-2050

2.4.3 Sensitivity analysis

The projections of GHG emissions from Agriculture are built on calculation procedures in tables used for GHG estimation in National Inventory Report (CHMI 2022). The activity data predicted for 2025-2050 are being used. The majority of emission factors within the projected period remains constant and so the sensitivity analysis would not come up with any reporting value. If there is a change in activity data by ± 5 %, then there will be a change by ± 5 % in the estimated emissions too.

More complicated situation arises, when the country-specific data consequent to Tier 2 method is used to derive the emission factors, e.g. for Enteric Fermentation or methane emissions from Manure Management. Calculation of emission factors is then determined by additional parameters – a nutrition (DMI), digestibility of feed, energy for maintenance and production, a management system and temperature of environment within individual AWMS. The emissions estimates are then influenced by a knowledge of the individual process.

Tab. 2-55 shows the dependence of emission factors and the milk production. It is obvious, that the predicted milk production may increase emissions by up to 18 kg CH_4/head/yr.

Tab. 2-55: The comparison of projected and reported value of CH4 emission factor (EF) for Enteric Fermentation, the sensitivity of calculation

Dairy cattle	Projected data [kg CH_4/head/yr]						
	2020	2025	2030	2035	2040	2045	2050
EF from enteric fermentation Calculated with projected milk production	147	147	155	155	160	160	165
EF from enteric fermentation Calculated with constant milk production (2020)	147	147	147	147	147	147	147

2.4.4 Difference between previously and currently reported projections

The predictions for Agriculture sector within this study have a different trend compared to the previous predictions prepared in 2020 (Fig. 2-12).

Predictions from 2020 followed the trend of increasing livestock populations according to a revised Strategy of MoA from 2016 (MoA, 2016), and updated for 2020, clearly. However, the current activity data prediction works more detailed and the trend of increasing livestock populations is less distinct.

The progress of the prediction significantly affects the increase in the number of cattle and pigs and the gradual reduction of emissions due to the reduction of the number of synthetic fertilizers applied to agricultural land. The trend of projections is different, the projections from 2020 have a noticeable increasing trend, the current projections signal emission decrease. For 2020, the current emissions are 4 % lower than the predicted in 2020. For 2050, the current projections are 20 % lower than the 2020 predictions.

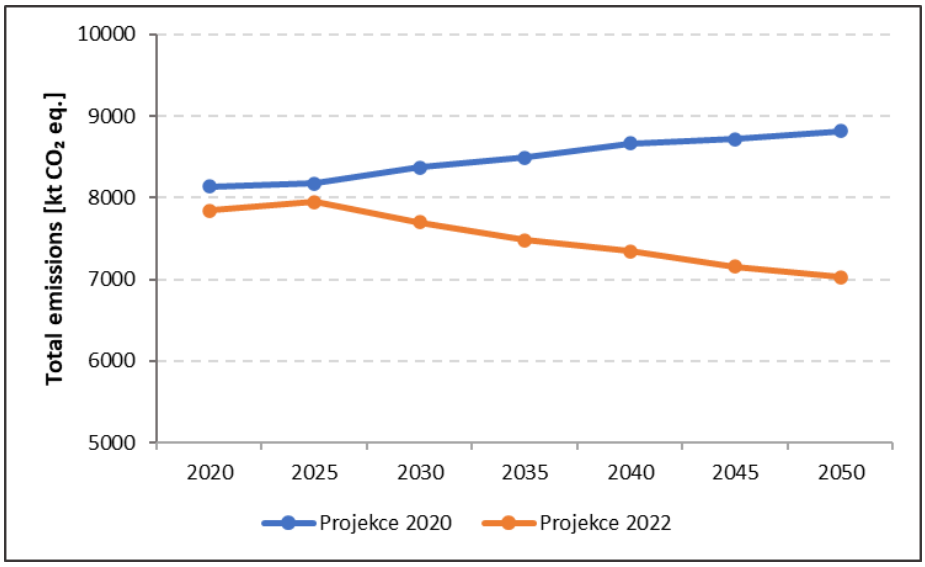


Fig. 2-12: The comparison of projected value of GHG emissions in projections estimated for Agriculture sector in 2020 and 2022

2.5 Land Use, Land-Use Change and Forestry

4. Land use, land-use change and forestry (LULUCF) is a specific sector within the emission inventory framework, as it is the only one able to directly offset CO_2 emissions due to photosynthetic fixation of carbon in plants and increasing individual ecosystem carbon pools. Carbon accounting has always been challenging for the 4. LULUCF sector, despite voluminous methodological advice compiled specifically for this sector by the International Panel on Climate Change (IPCC) (2003) (IPCC, 2006) (IPCC, 2014a) (IPCC, 2014b) (IPCC, 2019). Therefore, the estimates related to the 4. LULUCF sector are commonly accompanied by the largest uncertainty, often in range of tens of percent and larger.

The estimated and reported emissions by the individual LULUCF sub-categories for the period 1990 to 2020 are shown in Fig. 2-13 below. The emissions are expressed in units of CO_2 eq., including CO_2, CH_4 and N_2O. The dominant greenhouse gas (GHG) in the 4. LULUCF sector is CO_2, whereas the contribution of other two gases is fragmental - two orders of magnitude smaller. Therefore, the individual gases are not specifically discerned in Fig. 2-13, but can be found in the latest National Inventory Report (NIR) (CHMI, 2022).

As apparent from Fig. 2-13, the emission quantities are largely determined by carbon stock changes in 4.A Forest land, followed by contribution of 4.G Harvested wood products (HWP), whereas the contribution of other categories is minor.

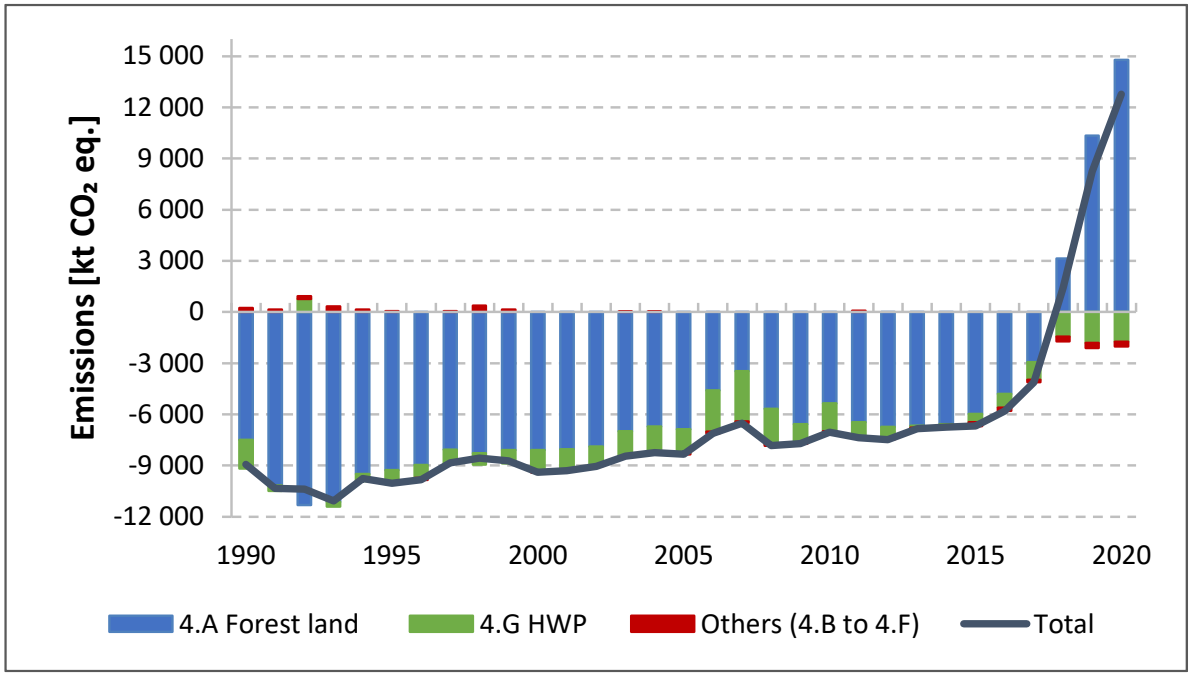


Fig. 2-13 The emission trend in 4. LULUCF sector during reporting period 1990 – 2020 (CHMI, 2022)

Tab. 2-56 The emission trend in 4. LULUCF sector during reporting period 1990 – 2020 (CHMI, 2022)

[kt CO2 eq.]	TOTAL	Forest land (4.A)	Cropland (4.B)	Grassland (4.C)	Wetlands (4.D)	Settlements (4.E)	Harvested wood products (4.G)
1990	-8 936	-7 498	100	-157	22	276	-1 680
1991	-10 326	-10 157	93	-180	29	209	-323
1992	-10 383	-11 319	97	-176	11	232	770
1993	-11 068	-11 124	145	-176	10	352	-276
1994	-9 770	-9 488	122	-283	7	290	-419
1995	-10 038	-9 268	124	-322	10	245	-827
1996	-9 832	-8 959	135	-524	12	269	-766
1997	-8 848	-8 072	157	-380	15	266	-836
1998	-8 561	-8 274	301	-281	26	326	-660
1999	-8 720	-8 084	161	-372	27	342	-795
2000	-9 388	-8 103	139	-429	29	246	-1 271
2001	-9 303	-8 046	112	-403	13	220	-1 201
2002	-9 039	-7 888	98	-408	35	221	-1 099
2003	-8 444	-6 997	120	-397	24	289	-1 483
2004	-8 234	-6 710	117	-410	20	294	-1 546
2005	-8 340	-6 875	110	-410	22	246	-1 434
2006	-7 119	-4 597	101	-423	20	199	-2 418
2007	-6 515	-3 476	93	-407	20	179	-2 925
2008	-7 831	-5 686	117	-409	21	173	-2 048
2009	-7 715	-6 579	105	-394	19	174	-1 042
2010	-7 040	-5 360	117	-399	37	185	-1 620
2011	-7 357	-6 465	178	-322	40	178	-967
2012	-7 477	-6 735	103	-343	26	158	-687
2013	-6 832	-6 670	106	-368	34	183	-118
2014	-6 750	-6 572	103	-418	28	191	-83
2015	-6 678	-5 985	74	-464	26	147	-478
2016	-5 793	-4 806	76	-464	27	178	-804
2017	-4 116	-2 947	62	-449	22	224	-1 027
2018	1 408	3 129	30	-466	21	127	-1 434
2019	8 235	10 339	32	-486	23	140	-1 813
2020	12 772	14 782	33	-493	34	146	-1 730

2.5.1 Methodological issues

There are several fundamental methodological steps of emission estimates in the 4. LULUCF sector, which must accordingly be considered in designing projections. These include a) treatment of land use

areas b) emission estimates for individual land-use categories c) including 4.G HWP contribution. These steps are described below and summarized in Tab. 2-60.

a) Treatment of land use areas

The emission estimates in the 4. LULUCF sector are to a large degree determined by development of land areas categorized by their use. Therefore, the 4. LULUCF emission estimates and their projections must primarily methodologically solve the issue of land areas. The data on areas used in National Inventory Reporting (CHMI, 2022) are exclusively based on the cadastral land use information of the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz). The land-use representation and the land-use change identification system of the 4. LULUCF emission inventory use annually updated COSMC data, elaborated at the level of about 13 000 individual cadastral units. The observed development of the major IPCC land use categories (IPCC, 2006) is reported in NIR (CHMI, 2022).

The projections beyond 2020 are based on the observed trends, additional data from 2021 (known when preparing this material) and anticipation of in general gradually diminishing category-specific land use changes until 2050. Specifically, for land use categories 4.A Forest land and 4.C Grassland, a half-declining trend with respect to the changes since 1990 is foreseen for the period until 2050. For 4.D Wetlands and 4.E Settlements, a continuation of the trend since 1990 is foreseen. The trend projections of land areas are constructed based on either nonlinear fit using a sigmoid function (4.A Forest land, 4.E Settlement), parabolic function (4.C Grassland), or linear fit (4.D Wetlands). For 4.B Cropland, the estimate is given by balancing total land area with the other projected land use categories.

The historical and projected land use areas are shown in Tab. 2-57 and Fig. 2-14 below. There is an increase of land use categories 4.A Forest land, 4.C Grassland, 4.D Wetlands and 4.E Settlements. The area of 4.B Cropland is expected to further decrease. The changes in the land use category 4.B (Cropland) represent in both relative and absolute numbers the most significant shift in land use expected in the country from 2021 until 2050, the end year of the projection period. During that time, the area share of 4.B Cropland would decrease from 40.2 % to 38.3 % in the country (Fig. 2-15), which means a loss of 152 kha in this period.

Tab. 2-57 Land use areas (kha): reported until 2020, projected until 2050 (*IE - areas of 4.F Other land are included within 4.E Settlements)

	Reported area [kha]						Projected area [kha]					
Land use category	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
4.A Forest land	2629	2637	2647	2657	2668	2677	2686	2692	2696	2699	2700	2701
4.B Cropland	3455	3319	3286	3248	3211	3178	3125	3095	3070	3050	3033	3018
4.C Grassland	833	961	974	986	1001	1023	1051	1067	1082	1095	1107	1118
4.D Wetlands	158	159	161	163	165	167	169	170	172	174	175	177
4.E Settlements	812	810	819	833	841	842	856	863	867	870	872	873
4.F Other land*	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

Source: CHMI 2022, IFER (unpublished data)

Fig. 2-14 Actual areas of the major IPCC land use categories in the Czech Republic for the period 1990 to 2020 and the projected trends shown for the period until 2050. Within each category, a note on extrapolation approach is provided.

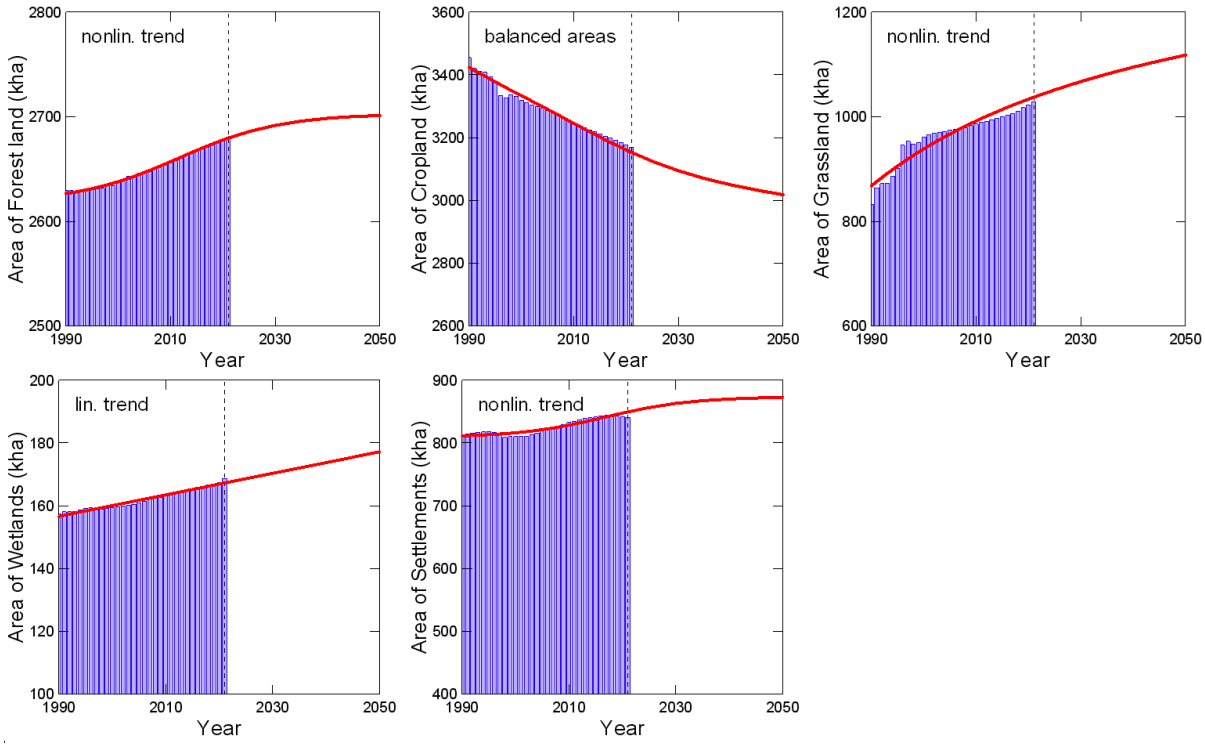
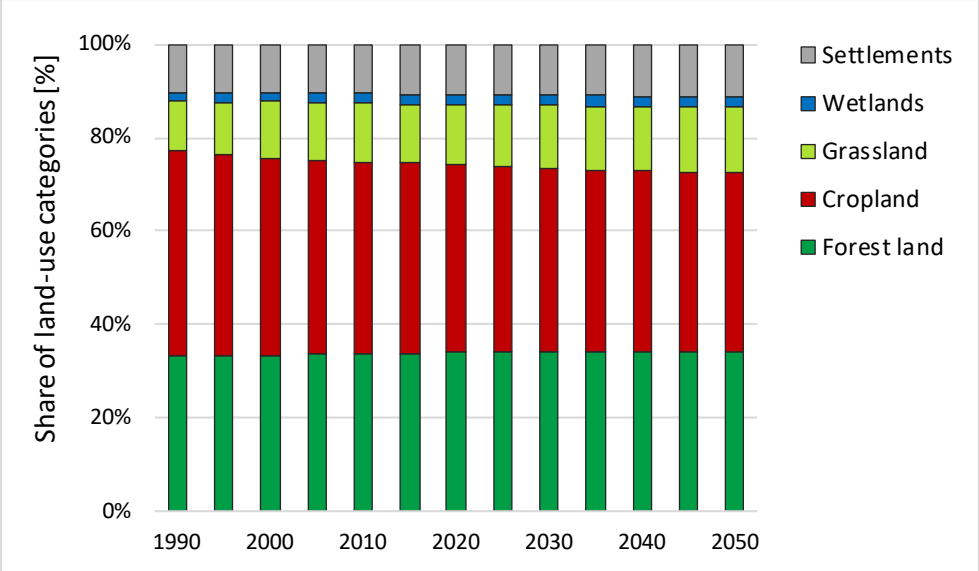


Fig. 2-15 Share of areas for the six IPCC land use categories (*4.E Settlements also include a fraction representing an area of 4.F Other land) in 5-year intervals since 1990 to 2050, using the actual data (until year 2020 in the graph) and projections until 2050.



b) Emission estimates for individual land-use categories

Secondarily, following the projection setup of land use areas, the projections of emission estimates for individual categories are prepared.

Specific attention is given to 4.A Forest land, which always represents the key emission category of the 4. LULUCF sector as well as within the entire NIR (CHMI 2020). For this reason, the projections related to forestry are elaborated using the nationally calibrated Operational Scale Carbon Budget Model of the Canadian Forest Service (CBM-CFS3, v. 1.2) (Kull, et al., 2016), (Kull, et al., 2019), (Kurz, et al., 2009). This is coherent with the GHG emission reporting of 4. LULUCF sector under UNFCCC (CHMI 2022). CBM-CFS3 is an empirical model driven by yield and standing inventory data, the same as used by operational foresters in timber supply analysis and forest management planning tools.

CBM-CFS3 has previously been used to project forest resources of the Czech Republic for setting up the national Forest Reference Level (FRL) under EU Regulation 2018/841 for the period 2021-2025, which is described in detail in the Czech National Forest Accounting Plan (NFAP)[8].

2.5.1.1 CBM-CFS3 model set-up for the Czech Republic

To use CBM-CFS3 in the Czech national circumstances, the European Archive Database as prepared by the JRC (Pilli et al., 2018) was modified to include the locally applicable biomass allometry functions for beech, pine, spruce and oak (Cienciala et al., 2006; 2008; Vonderach et al., 2018). Czech Republic comprises 5 climatic regions according to Hijmans et al. (Hijmans, et al., 2005). Since CBM-CFS3 does not consider precipitation in decay rates, only one climatic unit with a mean annual temperature of 7,5°C was employed.

For this study, we used CBM-CFS3 using the Czech Republic with its forestry as the simulated domain, spatially categorized by NUTS3 regions (Fig. 2-16; regional labels as follows: CZ010 Prague, CZ020 Central Bohemia, CZ031 South Bohemia, CZ032 Plzeň, CZ041 Karlovy Vary, CZ042 Ústí nad Labem, CZ051 Liberec, CZ052 Hradec Králové, CZ053 Pardubice, CZ063 Vysočina, CZ064 South Moravia, CZ071 Olomouc, CZ072 Zlín, CZ080 Moravia-Silesia). The input data requested for the model run include growth and yield functions, current annual increment, growing stock data (m^3 under bark) aggregated by the main species groups and age classes, together with their associated specific areas. These data were provided by the Forest Management Institute (FMI), the administrator of the national database of forest management plans.

Apart from the above-described spatial categorization, forest data were categorized by species groups (Tab. 2-58). These included seven categories by the key tree species and or species of ecological importance. Additionally, temporarily unstocked areas and areas with dead standing spruce trees were treated individually.

The run performed by CBM-CFS3 cover the period from 2018 to 2050, in which the input data for 2018-2021 were the observed/reported data on forest resources, while the 2022-2050 period is a scenario projection. The carbon pools included in the projected emissions include changes in all five carbon pools, namely above- and below-ground biomass, deadwood, litter and soil. This is identical as used in the NIR (CHMI, 2020).

[8] https://www.mzp.cz/C1257458002F0DC7/cz/opatreni_v_ramci_lulucf/$FILE/OEOK-CZ_NFAP_FRL_final-20200203.pdf

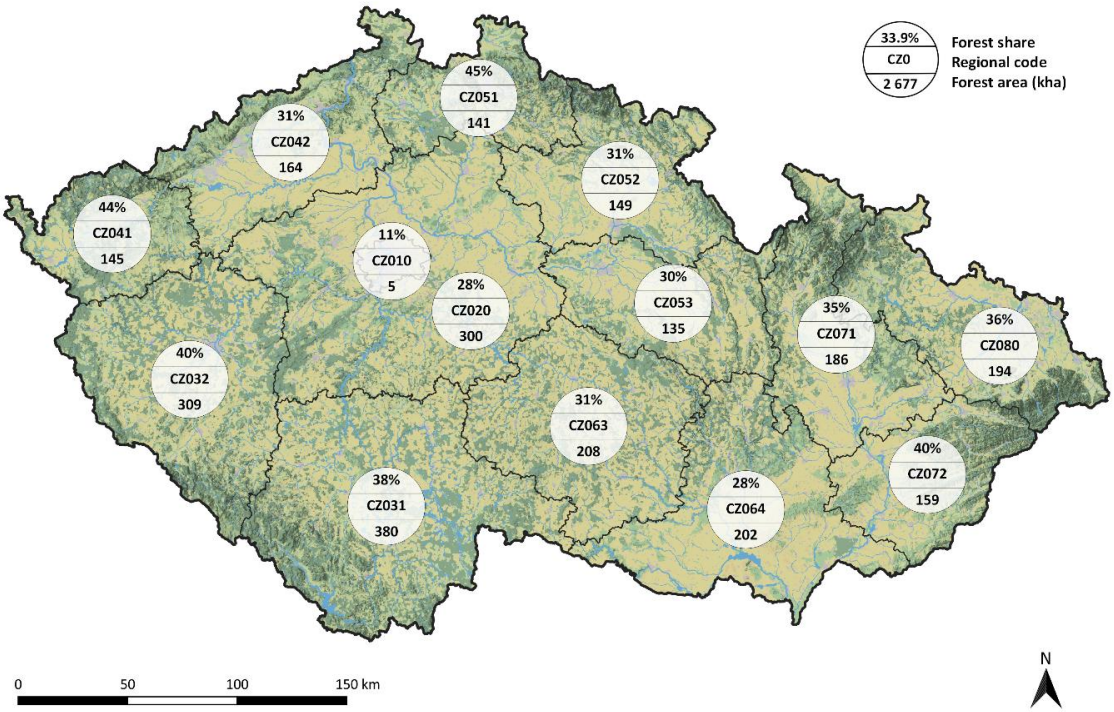


Fig. 2-16: Simulated domain 4.A Forest land area share and total 4.A Forest land area divided by the regions of Czech Republic (NUTS 3), showing the specific forestation (%) and forest area (kha) in 2020. The NUTS 3 legend shows overall total for the Czech Republic (MoA, 2021) (MoA, 2020). Background map: Natural Czechia.

Tab. 2-58: Forest types by main tree species and corresponding area share by area and/or volume in 2018. Two additional categories are clearcut areas and spruce snag representing unprocessed dead standing spruce trees (assembled from data available on Forest Management Institute web depository – www.uhul.cz).

Forest type	Main species	Area share	Volume share
Spruce	*Picea abies (L.) Karst.*	49.6%	59.8%
Pine	*Pinus sylvestris L., Pinus nigra Arnold*	20.2%	19.9%
Beech	*Fagus sylvatica L.*	8.6%	6.7%
Oak	*Quercus petrae (Matt.) Liebl. , Q. robur L.*	7.4%	5.4%
Longlived broadleaves	*Tilia cordata Mill., Tilia platyphyllos Scop., Fraxinus excelsior L., Acer pseudoplatanus L., Carpinus betulus L.*	6.1%	4.0%
Shortlived broadleaves	*Betula pendula Roth., Alnus glutinosa (L.) Gaertn., Populus spp., Alnus incana (L.) Moench*	5.3%	2.6%
Fir	*Abies alba Mill., Pseudotsuga menziesii (Mirb.) Franco*	1.4%	1.5%
Clearing, gap	Temporarily unforested area, e.g., after clear-cut.	1.4%	-
Spruce snag	Additional forest type representing temporarily unprocessed dead spruce forest due to drought-induced bark-beetle mortality	-	-

The applicable harvest used for the scenario "With existing measures (WEM)" corresponds in principle to the BLACK scenario as in the Czech NFAP[9] (WEM scenario details see in Section 2.5.1.2 below). However, the applicable harvest volumes were based on the available stock for individual harvest categories for each forest type. The harvest categories include thinning, salvage logging and planned final cut. At the same time, both the amount and proportion of salvage and planned logging was regionally specific, based on the available information on forestation (Fig. 2-76) and forest dieback applicable to spruce stands. Harvest volumes is derived for two regimes, one is dominated by salvaging, while the other represents the ordinary planned management with limited salvage. Salvage regime is based on the most recent known data (in 2018-2021), which set the amount of harvest for salvage-dominated period. For the following planned management, harvest is determined by wood available to harvest by age classes, forest type (Tab. 2-58) and felling type (thinning, final cut, salvage). For this regime, harvest rate meets the sustainability requirement as prescribed in the Czech Forest Act. The harvest includes the share of so-called unregistered felling volumes, which represent the harvest residues extracted in individual years as reported by the Czech Statistical Office (CzSO), in the same manner as adopted in the emission inventory estimates for 4.A Forest land. As for thinning, its quantity depends on the intensity of salvaging and development of age class structure for individual forest types within each region. For the year with extreme salvage felling, the share of planned thinning is fragmental, cca. 2 %, whereas it gradually increases once the effect of spruce forest dieback diminishes as planned management dominates over the residual salvaging and the share of younger stands requiring thinning increases. Finally to note, during the period of extreme dieback, the technical harvest capacities in the country are insufficient for a complete harvest of infected and/or dead standing trees, which is in normal conditions mandatory under the Czech Forest Act. This is considered and the harvest quantities of left-over dead trees are specifically accounted for. The harvest demand used in CBM is summarized by planned and sanitary operations in Tab. 2-59.

Tab. 2-59 Harvest volumes used to drive CBM-CFS3 model run for particular years, together with the expressed share of thinning by volume.

Period	Planned (%)	Sanitary (%)	Total removals (Mm^3/yr)
2018	11	89	26.79
2019	5	95	33.84
2020	5	95	37.10
2021	13	87	31.71
2025	25	75	23.76
2030	33	67	21.27
2035	54	46	16.82
2040	70	30	16.58
2045	71	29	16.99
2050	75	25	17.09

Linked to sanitary felling and planned final cut, the model run incorporates gradual changes of species composition for new planting/regeneration, which is based on the actually reported data (2018-2021) and the specific scenario assumptions (Section 2.5.1.2 below).

[9] https://www.mzp.cz/C1257458002F0DC7/cz/opatreni_v_ramci_lulucf/$FILE/OEOK-CZ_NFAP_FRL_final-20200203.pdf

The projections of GHG emissions related to other land use categories except 4.A Forest land (i.e., 4.B Cropland, 4.C Grassland, 4.D Wetlands, 4.E Settlements) are based on simple correlations of the estimated emissions for the reference year linked exclusively to the corresponding land areas for the predicted years.

Finally, the contribution of 4.G HWP was projected using the harvest activity data as reported in NIR (CHMI, 2020). For the period from 2021 to 2050, harvest volume as adopted for the CBM-assisted estimates, were used as input and proxy for estimation of 4.G HWP contribution following the identical methodology for 4.G HWP as described in NIR (CHMI, 2020), and projection in accordance with the approach detailed in the Czech NFAP[10].

Tab. 2-60 Summary of the methodological approaches used for the 4. LULUCF categories

Activity data and category	Approaches
Land use areas for individual land use categories	COSMC data for 1990 - 2020, thereon projections until 2050 using - linear trend (4.D Wetlands), sustained rate - non-linear/sigmoidal trend (4.E Settlements), sustained rate - non-linear/sigmoidal trend (4.A Forest land, 4.B Cropland, 4.C Grassland), half-reduced trend relative to 1990 – 2018
Emission estimates for 4.A Forest land	NIR data for 1990 - 2020 (CHMI 2022), thereon projections using CBM-CFS3 model version 1.2 (Kull et al. 2016, 2019), with ex-ante adjustment for change in 4.A Forest land area.
Emission estimates for other land use categories except 4.A Forest land	NIR data for 1990 – 2020 (CHMI 2022), thereon a rescaled reference data from 2020 using projected land area as a proxy for individual land-use categories
4.G HWP contribution	Production approach as in NIR 1990 - 2020 (CHMI 2022), thereon estimates until 2050 using harvest demand (logs) as applied for CBM-assisted projection

2.5.1.2 Definition of 'With existing measures' (WEM) and 'With additional measures' (WAM) scenario

The WEM scenario includes the development of land areas of individual land use categories as shown in Tab. 2-57 and Fig. 2-54. Land area is used as a proxy for the projected emissions. Hence, development of land areas and land use changes drive the projected emissions relative to the reference year (2020) for the individual land use categories with exception of CO_2 emissions from 4.A Forest land and HPW emission contribution (Tab. 2-60).

For 4.A Forest land, the entire WEM scenario concept was redesigned to address the recent catastrophic decline of coniferous stands due to drought-induced bark-beetle infestation. Also, the newly adopted modelling toll, the CBM-CFS3 model v1.2 (Kull et al., 2016, 2019), permitted a more detailed representation of processes associated with both management of disturbed managed forest ecosystems. The WEM scenario includes the currently implemented forest management recommendations (age-specific thinning and felling per forest types) of the Czech Forest Act and actual species composition in the reference year. At the same time, salvage felling is mandatorily prioritized over the planned management interventions, which is in full accordance with the valid legislation – Czech Forest Act and its amendments.

[10] https://www.mzp.cz/C1257458002F0DC7/cz/opatreni_v_ramci_lulucf/$FILE/OEOK-CZ_NFAP_FRL_final-20200203.pdf

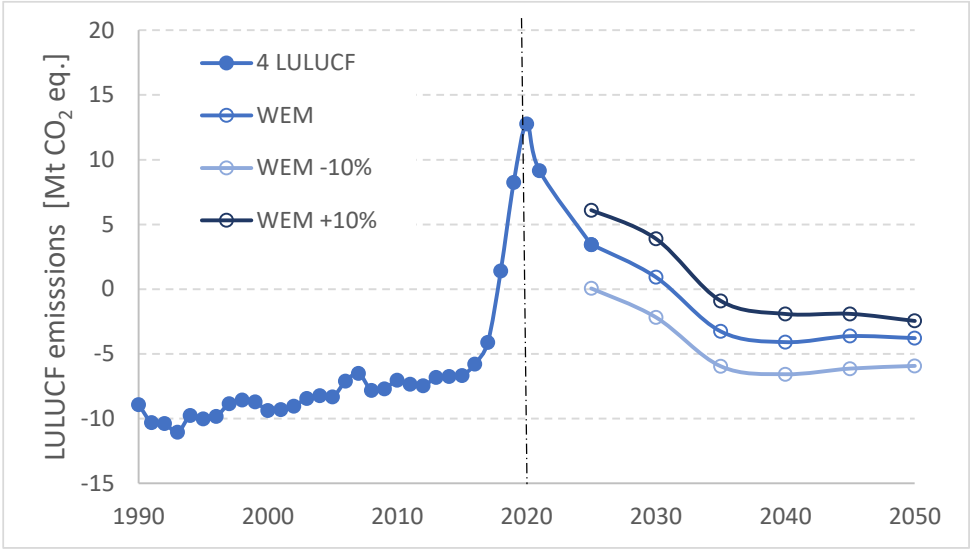
Specifically, the currently defined WEM scenario for forestry assumes Norway spruce share to decline from the recent 45 % to under 28 % in 2050. Correspondingly, the share of broadleaved tree species would increase. This is in line with the long-term adaptation strategy of the country (Krejzar, 2008) (MoE, 2017), which includes the proposed tree species change of dominantly spruce even-aged forests stand to more diverse stands with higher share of broadleaved tree species such as beech and oak. The assumed species conversion under the current WEM scenario would be significantly accelerated by the ongoing forest decline. The felling request is defined for the initial years of model run (2018-2021), for which the harvest level is known based on the reported data by CzSO, while the harvest volume for the following projection years is determined interactively using the CBM-CSF3 model operating at the level of regions and forest type, based on wood available for harvest by individual harvest categories (Tab. 2-59).

It should be understood that in the conditions of the current outbreak and share of sanitary felling of 95 % (in 2020), the Czech forest management resembles a crisis management instead of the conventionally planned activity guided by forest management plans. Hence, the current forest development is dominantly driven by disturbance (drought and bark-beetle infestation) and any projection of forest resources is inherently uncertain. **This justifies using one single WEM scenario, whereas any additional pragmatically implementable management intervention under any WAM scenario would likely not have any effects larger than uncertainties associated with the current disturbance to forestry.** Therefore, no WAM scenario is elaborated in this material.

2.5.2 Projected greenhouse gas emissions 'With existing measures' (WEM) scenario

The historical data and projections using the WEM scenario are shown in Tab. 2-61 and Fig. 2-17. It can be observed that for the nearest projected period, the 4. LULUCF sector is projected to significantly contribute to GHG emissions in the country. The projection follows the reported years 2018-2020 (CHMI, 2022). The emissions start to decline since 2020 (IFER 2022 - unpublished data), which is also reflected in the adopted scenario and scenario results facilitated by CBM.

Fig. 2-17 Reported (1990-2020; NIR 2022) and projected (since 2025) emissions of GHG in 4. LULUCF sector for WEM scenario. It includes a sensitivity analysis on LULUCF emissions using reduced (WEM -10%) and increased (WEM +10%) harvest applied in 4.A Forest land relative to that used in the WEM scenario. The estimate for year 2021 is a preliminary result prepared for NIR 2023.



(IFER, 2022)

The essence of the presented emission trend under the revised WEM scenarios can be interpreted as follows:

- The Czech forestry has been experiencing an exceptional outbreak of bark-beetle infestation and associated dieback of spruce (and in minor scale also pine) stands. This results in rapidly increasing share of sanitary felling until 2020.
- The increasing share of sanitary logging has resulted in overall record-high felling volumes in 2019 and 2020 (CzSO). (Tab. 2-59).
- In the current decade until 2030, the harvest level would gradually decline resulting in decreasing emissions in the forestry sector to zero level at about 2030.
- For the last two projected decades (2031-2050), the harvest would decrease to about 16 mil. m^3 wood volume per year, well below the projected increment in forestry. This would mean creating a sink of emissions, turning the entire LULUCF sector into GHG sink category again.
- The WEM scenario represents an adaptive scenario for the Czech forestry. It will result in a rapid conversion of productive, but instable coniferous stands into a more resilient, dominantly broadleaved and/or mixed forest stands (Fig. 2-18). This is the desired direction of forest transition under the adaptation strategies as adopted in the country (MoE, 2017).
- The overall importance of wood harvest on emission balance in forestry sector is demonstrated with sensitivity analysis using changed harvest levels (Fig. 2-18). Evidently, any disturbance to forests leading to elevated harvest volume levels would negatively affect carbon balance in the sector.

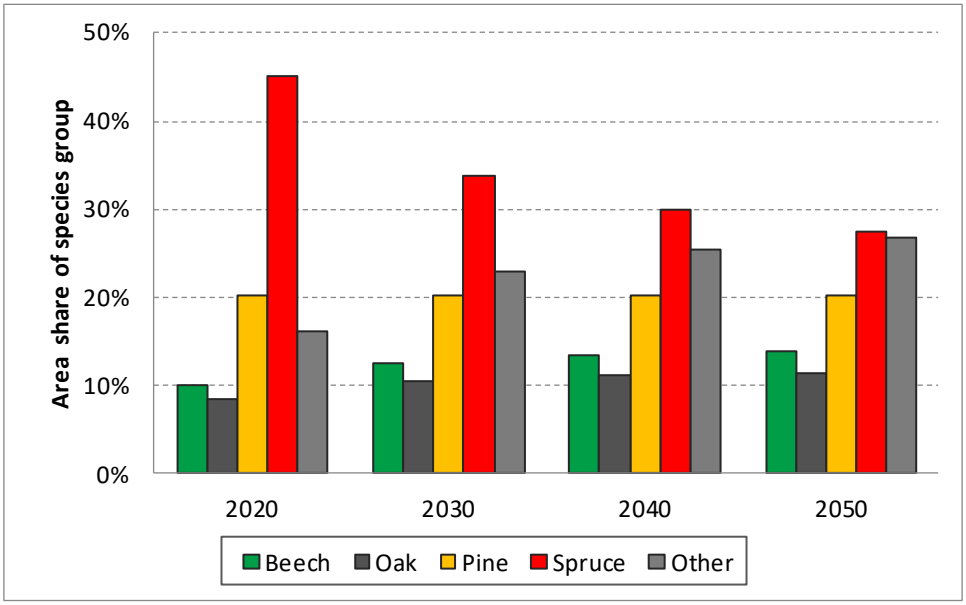


Fig. 2-18 Current (2020) and projected (2030 - 2050) tree species composition within the WEM scenario, expressed by the share of the forest area occupied by the individual species groups. There is a notable decline of spruce species group, compensated by an increased share of dominantly broadleaved forest types (including the group Other, which is dominantly composed by broadleaves).

Tab. 2-61 Reported and projected emissions of GHG in 4. LULUCF sector – WEM scenario

[Mt CO_2 eq.]	Reported emissions		Projected emissions			Difference			
	1990	2020	2030	2040	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
WEM	-8.94	12.77	0.92	-4.09	-3.78	21.71	9.85	4.85	5.16

(IFER, 2022)

The breakdown of historical and projected (WEM scenario) emissions by gases and individual land use categories is shown in Tab. 2-62 and Tab. 2-63, including the individual 4. LULUCF categories. The emissions in the 4. LULUCF sector are mostly determined by carbon stock changes in the category 4.A Forest land and partly by the newly reported contribution of 4.G HWP. For the interpretation of the estimated emission levels trends in 4.A under WEM, see the lead text in chapter 2.5.1.2.

Tab. 2-62 Breakdown of reported and projected emissions of GHG by gases in 4. LULUCF sector - WEM scenario

[Mt CO_2 eq.]	Reported emissions		Projected emissions			Difference			
	1990	2020	2030	2040	2050	1990– 2020	1990– 2030	1990– 2040	1990– 2050
CO_2	-9.03	12.72	0.86	-4.14	-3.83	21.75	9.90	4.89	5.20
CH_4	0.05	0.03	0.03	0.03	0.03	-0.02	-0.02	-0.02	-0.02
N_2O	0.04	0.02	0.02	0.02	0.02	-0.02	-0.02	-0.02	-0.02
Total	**-8.94**	**12.77**	**0.92**	**-4.09**	**-3.78**	**21.71**	**9.85**	**4.85**	**5.16**

(IFER, 2022)

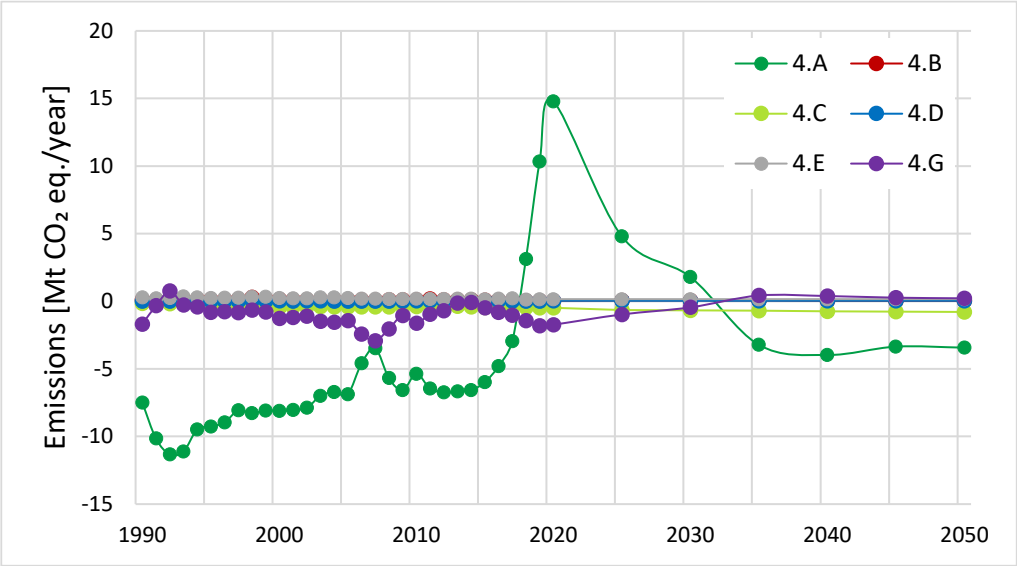
Tab. 2-63 Breakdown of reported and projected emissions of GHG by categories in 4. LULUCF sector - WEM scenario

[Mt CO_2 eq.]	Reported emissions		Projected emissions			Difference			
	1990	2020	2030	2040	2050	1990– 2020	1990– 2030	1990– 2040	1990– 2050
4.A Forest land	-7.50	14.78	1.80	-3.97	-3.43	22.28	9.30	3.53	4.07
4.B. Cropland	0.10	0.03	0.06	0.04	0.03	-0.07	-0.04	-0.06	-0.06
4.C Grassland	-0.16	-0.49	-0.68	-0.74	-0.80	-0.34	-0.52	-0.58	-0.64
4.D Wetlands	0.02	0.03	0.03	0.04	0.04	0.01	0.01	0.01	0.01
4.E Settlements	0.28	0.15	0.15	0.15	0.15	-0.13	-0.13	-0.12	-0.12
4.G HWP	-1.68	-1.73	-0.45	0.39	0.23	-0.05	1.23	2.07	1.91
Total	**-8.94**	**12.77**	**0.92**	**-4.09**	**-3.78**	**21.71**	**9.85**	**4.85**	**5.16**

(IFER, 2022)

The quantitative share and trends of emissions under WEM scenario by individual 4. LULUCF categories shows Fig. 2-19. The category 4.A Forest land dominates in both historical period until 2020 and during the projected period until 2050, followed by the 4.G HWP contribution.

Fig. 2-19 Breakdown of reported and projected (WEM scenario) emissions of GHG by land-use categories within 4. LULUCF, namely Forest land (CRF 4.A), Cropland (CRF 4.B), Grassland (CRF 4.C), Wetlands (CRF 4.D) and Settlements (CRF 4.E), plus the quantified HWP contribution (CRF 4.G).



(IFER, 2022)

2.5.3 Sensitivity analysis

Sensitivity analysis is conducted by analyzing the changes effect of harvest on the total emissions of the 4. LULUCF sector. Harvest level affects emissions of the land use category 4.A Forest land, and correspondingly also 4.G HWP contribution. These are the key categories of the Czech emission inventory, determined by biomass carbon stock changes in the sub-category 4.A.1 Land remaining Forest land and the stocks of 4.G HWP. Harvest intensity reflecting the forest management and natural disturbance sin the country is the factor affecting changes in forest growing stock volume, ecosystem carbon stock and GHG emission balance in the LULUCF sector.

The role of harvest quantity is demonstrated on the sensitivity analysis using smaller or larger overall harvest demand by 10 % with respect to the selected baseline (harvest as in WEM scenario) using the CBM-CSF3 model. The model outcome as implemented for the WEM scenario and its two variants is shown in Fig. 2-8. It is apparent that a relatively small change in harvest demand would have a significant effect on greenhouse gas emissions from the 4. LULUCF sector. It should also be noted that harvest demand is a more powerful short-term factor affecting emissions as compared to gradual tree species change as implemented in the WEM scenario and affects carbon balance more on long-term basis.

2.5.4 Difference between previously and currently reported projections

There is no fundamental methodological difference in the concept of the 4. LULUCF projections as compared to the previous reported projections. In both cases, the nationally calibrated CBM-CSF3 model was used for projecting forest resource and the associated ecosystem carbon balance. The details on the model application are given in Section 2.5.1 above.

This projection could build on two additional known years (2019-2020) with known activity data – specifically harvest level, its division into types of harvest (sanitary, planned, thinning, final cut) and its geographical attribution at regional (NUTS3) level. This improves the near-time projection for the current challenging period for the Czech forestry that responds to an unprecedented drought-induced decline of coniferous forest stands, with an exceptional bark-beetle outbreak. The current projection reaffirms the previous assessment that 4.A Forest land and the entire 4. LULUCF would represent mostly emissions for the current decade. Although the emissions from 4.A Forest land evidently peaked in 2020, it still may require almost a decade to stabilize the situation in the Czech Forestry sector. Generating a net sink of emissions in 4.A Forest land and LULUCF might be expected at around year 2030.

2.6 Waste

The 5. Waste sector in the Czech Republic can be separated to four distinctive source categories. First, so far dominant category is 5.A Solid waste disposal, which is a primary source of CH_4 emissions. Emissions of CO_2 from 5.A are of a biogenic origin and therefore, not included to the projected emissions. Category 5.B Biological treatment of waste is a source category which consists of composting and anaerobic waste digestion. As composting is an aerobic process and anaerobic digestion is a technologically controlled process, emissions from this source category tend to be negligible, even when this category seems to be growing in the Czech Republic. Emissions from use of biogas produced in anaerobic digestion are not part of this source category, as they are part of category 1.A Energy. However, emissions leakage from digestion process is accounted for. Emissions form category 5.C Waste incineration are accounted in 1.A Energy sector, when it produces useable energy. Only hazardous and industrial 5.C Waste incineration is accounted for in 5.C, which is the same approach as in the National Inventory Report (NIR) (CHMI, 2022). 5.C Waste incineration produces all the three major greenhouse gases (GHG), but predominantly it's a fossil CO_2 source. The last category, 5.D Wastewater treatment, includes both public and private wastewater treatment plants as well as industrial counterparts and it is a source of CH_4 and N_2O emissions. In 2020, the total aggregate GHG emissions from 5.Waste were 5,135.78 kt CO_2 eq., which represent increase of 70 % compared to 1990. GHG emissions trend from the 5. Waste sector is depicted in Fig. 2-20 (CHMI, 2022).

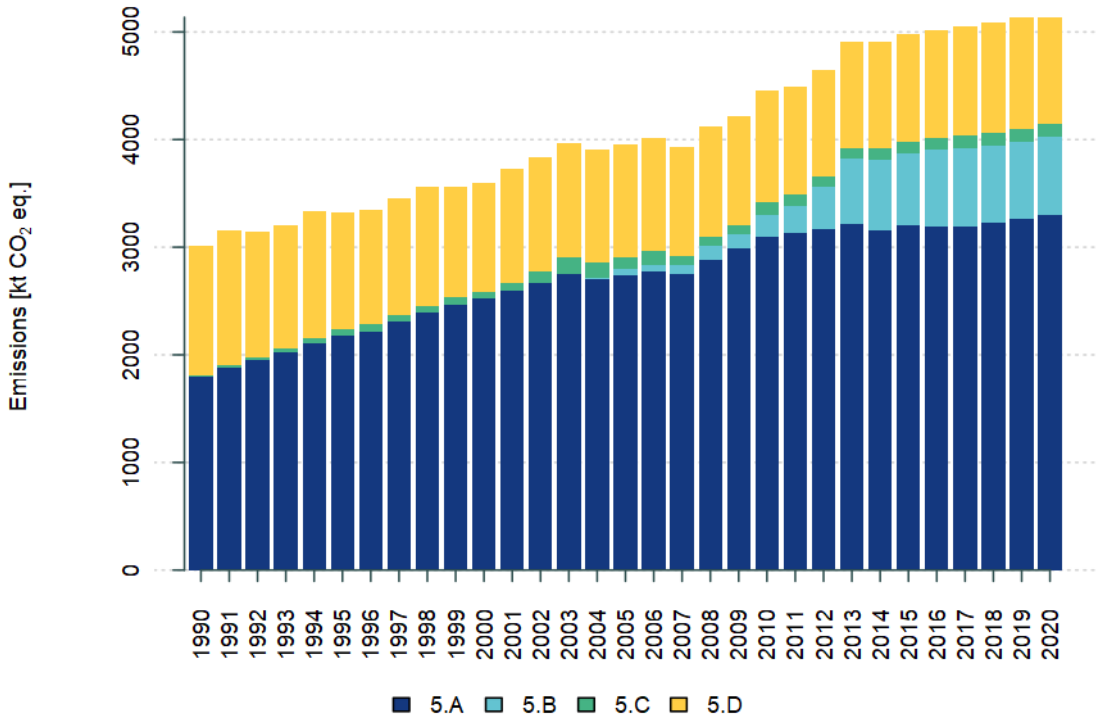


Fig. 2-20 The emission trend in 5. Waste sector during the reporting period 1990 – 2020 (CHMI, 2022)

Tab. 2-64 The emission trend in 5. Waste sector during the reporting period 1990 – 2020 (CHMI, 2022)

[kt CO2 eq.]	Solid waste disposal (5.A)	Biological treatment of solid waste (5.B)	Incineration and open burning of waste (5.C)	Waste water treatment and discharge (5.D)
1990	1 793	NE,IE	20	1 201
1991	1 875	NE,IE	24	1 255
1992	1 947	NE,IE	28	1 165
1993	2 027	NE,IE	38	1 145
1994	2 106	NE,IE	54	1 181
1995	2 179	NE,IE	60	1 087
1996	2 220	NE,IE	60	1 072
1997	2 305	NE,IE	62	1 089
1998	2 388	NE,IE	62	1 114
1999	2 470	NE,IE	63	1 027
2000	2 527	NE,IE	51	1 021
2001	2 599	NE,IE	70	1 057
2002	2 669	NE,IE	100	1 061
2003	2 747	4	159	1 060
2004	2 708	3	149	1 053
2005	2 743	61	107	1 045
2006	2 777	57	137	1 043
2007	2 750	79	89	1 016
2008	2 888	121	93	1 019
2009	2 988	131	80	1 017
2010	3 097	203	120	1 038
2011	3 128	252	104	1 012
2012	3 173	383	104	991
2013	3 215	603	101	988
2014	3 162	651	107	984
2015	3 198	679	106	1 000
2016	3 191	711	114	1 000
2017	3 198	721	118	1 011
2018	3 226	721	117	1 030
2019	3 262	717	118	1 033
2020	3 294	736	113	993

Overall development of the 5. Waste sector in the past decades is dominated by landfilling of waste in Solid Waste Disposal Sites (SWDS). Landfilling is still dominant type of waste management, but its importance is decreasing due to rise of waste recycling; collection of separated waste parts,

composting and energy recovery. In not so distant future, landfilling (mainly of municipal (MW) and organic waste) might disappear as the capacity of landfills is decreasing and other options are preferred by national legislation and obligations of the Circular Economy Package (CEP) (EC, 2018). However, the steady increase in energy recovery and even the impressive leaps in composting and material recovery during the past four years did not lead to a decrease in landfill due to a steady increase in total amount of MW (CHMI, 2022).

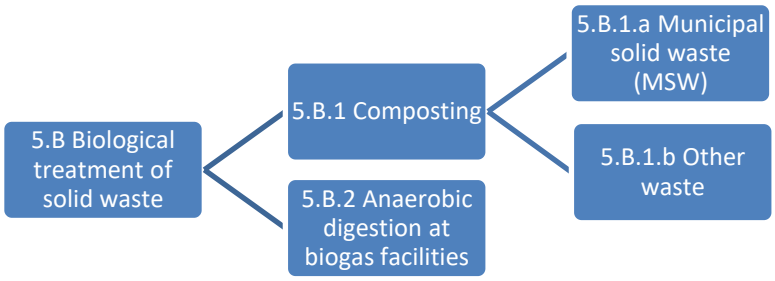
5. Waste sector has high uncertainty in regards to emission levels as many of processes behind the emissions are either not sufficiently understood or are strongly dependent on local conditions which makes top down assessment such as this very difficult. Furthermore, 5. Waste sector is ultimate end point of all consumption and economic activity and therefore, it is also highly dependent of the whole economy setting, which makes it even harder to predict. Default uncertainty for the GHG emission levels in 5. Waste sector are around ±40 %, with some source subcategories reaching to the factor of two. This uncertainty originates mainly from emission factors. Activity data is also uncertain, but due to economic nature of waste management it is regularly scrutinised and controlled (CHMI, 2022).

2.6.1 Methodological issues

The projections of GHG emissions in 5. Waste sector are based on data and methodology used for emission estimates reported in NIR (CHMI, 2022). Activity data reported in NIR (CHMI, 2022) are obtained from the Czech official database of waste management VISOH ("Veřejné informace o produkci a nakládání s odpady"). Time series of spreadsheets from the NIR (CHMI 2022) were extended to cover also time period 2020-2050 for all the sectors.

Emissions, activity data and parameters up to current reporting year are from the common reporting format (CRF) and VISOH. From 2020 to 2050, extended time series were aligned with assumptions from the Waste Management Plan 2014 (WMP) (MoE, 2014) and by the obligations of the CEP (EC, 2018). The forecasted scenario in the WMP (MoE, 2014) was the guiding pathway for updating the projections. The main assumption from the WMP (MoE,2014) is, that landfilling can be ended by 2030 or soon after. The CEP assumptions and obligations are explained in the chapter 1.6.3.

The category 5.A Solid waste disposal has default emission factors (EF) and methodology from the 2006 IPCC Guidelines. Activity data is from VISOH. The category 5.A has also With additional measures (WAM) scenario. The difference between the With existing measures (WEM) and (WAM) scenarios is increased recovery of landfill gas, which is increasing more sharply in WAM scenario due to increased pressure from renewables market. The WAM scenario has higher projected trend for recovered landfill gas (LFG) than WEM from 2025. Recovered CH_4 from LFG is used for energy purposes and is subtracted from total emissions (CHMI, 2022). The projected trend of emissions from category 5.A is thus, decreasing steeply after 2025 (see Tab. 2-70).



Wet weight data and default emission factors (EF) 4 kg CH_4/t and 0.24 kg N_2O/t from IPCC 2006 GL (IPCC, 2006) were used for both subcategories (5.B.1 and 5.B.2). Activity data values in NIR 5.B.1 spreadsheet were extended up to 2050 by linear extrapolation. This category took big annual leaps in the past, but the latest reductions in increase are reflected in the more conservative estimates. For the subcategory 5.B.2 Anaerobic digestion at biogas facilities, a default 5% from the 2006 IPCC Guidelines was applied for the methane leakage. An average increase of methane leakage from 2013 – 2019 was selected as a driver % and applied as a constant to the entire forecast 2021-2050. The leakage amounted to 0.6 Mt CO_2 eq. The projected trend of emissions from category 5.B is slightly increasing between 2020 and 2050 (Tab. 2-70).

The category 5.C Incineration and open burning of waste includes only waste that is not used for energy production. Estimation of CO_2 emissions from hazardous/industrial waste (H/IW), clinical, sludge and a small amount of municipal solid waste (MSW) incineration, is based on the Tier 1 approach (IPCC, 2006] (CHMI, 2022). Activity data was extrapolated until 2050 and the results were inserted into the spreadsheet to get emission forecast for CO_2, CH_4 and N_2O until 2050. The default emission factors used for projections (0.56 kg CH_4/Gg and 100 kg N_2O/Gg) are from the IPCC 2006 GL (IPCC, 2006). The projected H/IW is within the existing incineration capacity. The projected trend of emissions from category 5.C is increasing slightly between 2020 and 2050 (Tab. 2-70).

In the category 5.D Wastewater treatment and discharge, the method is based on default Tier 1 and EFs used for projection are also default from the IPCC 2006 GL (IPCC, 2006) (CHMI, 2022). Only in the category 5.D.1, MCF was changed to 0.039 due to the 2021 ESD review recommendation. Country specific MCF is based on the observation, that the central wastewater treatment waste plants (WWTP) have 13% overflow i.e. they are not optimally managed. Timelines for CH_4 and N_2O emissions were extrapolated until 2050.Population estimates from Eurostat (2022) were applied to the extended time series of the NIR spreadsheets. Modernisation and improvement of WWTP's is ongoing task in the Czech Republic. Benefits of technological and capacity improvements resulting in better wastewater treatment and less emissions, is reflected in the slightly decreasing MCF for the WWTPs in the category 5.D.1. The projected trend of emissions from 5.D is slightly decreasing between 2020 and 2050 (Tab. 2-70).

Tab. 2-65 Reported and projected MMW production, divided by subjects in the Czech Republic

	Reported								Projected			
[Mil. Tons]	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Municipalities	1.54	1.84	1.86	2.18	2.18	2.27	2.46	2.29	2.29	1.99	1.90	1.82
Non-municipal entities	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Total	**2.44**	**2.74**	**2.76**	**3.08**	**3.08**	**3.17**	**3.36**	**3.19**	**3.19**	**2.89**	**2.80**	**2.72**

(MoE 2014, CHMI 2022)

Tab. 2-66 Reported and projected MW management

	Reported								Projected			
[Mt]	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Material recovery	1.56	1.85	1.88	2.14	2.14	2.23	2.41	2.21	2.22	2.26	2.31	2.36
Composting	0.20	0.30	0.37	0.58	0.62	0.64	0.72	0.75	0.78	0.80	0.83	0.85
Energy recovery	0.61	0.63	0.62	0.68	0.69	0.68	0.69	0.72	0.71	0.73	0.74	0.75
Landfill	2.95	2.83	2.76	2.78	2.84	2.92	2.96	3.00	3.07	2.38	2.12	1.86
Incineration	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

(MoE, 2014) (CHMI, 2022)

Tab. 2-67 Detailed information about methodology assumptions used in projections for 5. Waste sector (sub-)categories

	Projections 2021- 2050		
Category	**Activity data**	**EFs**	**Methodology**
5.A Solid waste disposal on land	to 2020 obtained from NIR (CHMI 2022) and VISOH database, linear extrapolation was aligned with the WMP (MoE 2014) and CEP (EC 2018) assumptions.	Default	Tier 1
5.B Biological treatment of solid waste	to 2020 obtained from NIR (CHMI 2022) and VISOH database, linear extrapolation was aligned with the WMP (MoE14) and CEP (EC 2018) assumptions.	Default	Tier 1
5.C Incineration and open burning of waste	to 2020 obtained from NIR (CHMI 2022) and VISOH database, linear extrapolation was aligned with the WMP (MoE14) and CEP (EC 2018) assumptions.	Default	Tier 1
5.D Wastewater treatment and discharge	to 2020 obtained from NIR (CHMI 2022) and VISOH database, extrapolation to 2050 was aligned with the projected trend of mid population from Czech Statistical Office (CzSO).	Default	Tier 1

(CHMI, 2022) (IPCC, 2006)

2.6.2 Projected greenhouse gas emissions 'With existing measures (WEM) scenario' and 'With additional measures (WAM) scenario'

As indicated in Tab. 2-68, emission estimates up to the latest reported year (2020) are from NIR (CHMI, 2022) and VISOH database. Timeline was prolonged up to 2050 by building upon the outlined scenario in WMP (MoE 2014) and by the new obligations of the CEP (EC, 2018).

Scenario in WMP (MoE, 2014) fulfils description of WEM scenario, the document is taking into account all measures that are already in effect, although further measures will be implemented in the future, based on the roadmap proposed in WMP. For both WEM and WAM scenarios it is expected that emissions will be decreasing for 2025 - 2050, compared to 2020. Decrease of emissions is more obvious for WAM scenario which takes into account stricter LFG recovery coefficients after 2025. The expected total emissions from 5. Waste should decrease by 7.70% according WEM and decrease by 17.09 % according WAM between 1990 and 2050. Overall results for the 5. Waste sector are shown in Tab. 2-68. Reported and projected emission trend for both scenarios is depicted in Fig. 2-21 below.

Tab. 2-68 Reported and projected emissions of GHG in 5. Waste – WEM and WAM scenarios

	Reported emissions				Projected emissions						Difference [%]			
[Mt CO_2 eq.]	**1990**	**2005**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**1990 – 2020**	**1990 – 2030**	**1990 – 2040**	**1990 – 2050**
WEM	3.01	3.96	4.98	5.14	4.95	4.34	3.60	3.12	2.90	2.78	70.38	44.12	3.62	-7.70
WAM	3.01	3.96	4.98	5.14	4.94	4.26	3.49	3.02	2.71	2.50	70.38	41.27	0.20	-17.09

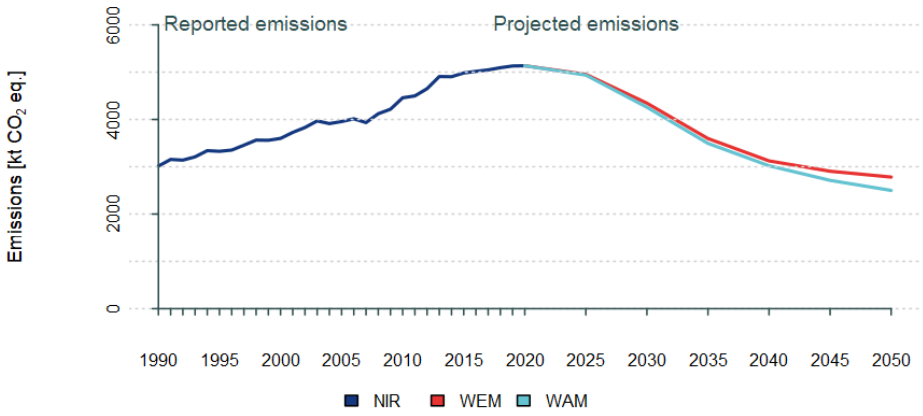


Fig. 2-21 Reported and projected emissions of GHG in 5. Waste – WEM and WAM scenarios

2.6.2.1 Projected greenhouse gas emissions 'With existing measures (WEM) scenario'

Development of the WEM scenario is based on following assumptions: MW production is decreasing slightly, landfilling is gradually declining and composting and energy recovery is taking place instead (MoE, 2014) within the 10 % landfill limit by 2035 as per CEP (EC, 2018). The shift from landfilling to composting and anaerobic digestion decreases overall emissions, because composting and anaerobic digestion produce lower emissions. As landfilling decreases, a slight increase of emissions can be observed in 5.B Biological treatment of solid waste due the default 5% leakage from anaerobic digestion, which was 0.56 Mt in 2020, and due the effects of establishing a mandatory system for separate collection of biodegradable waste and its waste management.

The shift from landfilling to 5.C Waste incineration is less visible here, as waste used for energy is reported under 1.A Energy sector, where it does not leave a significant footprint when compared to the size of 1.A Energy sector. Detailed breakdown of the emissions by gases and categories is shown in Tab. 2-69 and Tab. 2-70.

Tab. 2-69 Breakdown of reported and projected emissions of GHG by gases in 5. Waste - WEM scenario

[Mt CO_2 eq.]	Reported emissions				Projected emissions						Difference [%]			
	1990	2005	2015	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
CO_2	0.02	0.10	0.10	0.10	0.12	0.13	0.14	0.15	0.16	0.18	422.85	541.05	659.25	777.44
CH_4	2.76	3.61	4.64	4.75	4.55	3.91	3.14	2.64	2.40	2.25	72.30	41.79	-4.19	-18.31
N_2O	0.23	0.24	0.25	0.28	0.29	0.30	0.32	0.33	0.34	0.35	17.85	29.23	39.61	50.28
Total	**3.01**	**3.96**	**4.98**	**5.14**	**4.95**	**4.34**	**3.60**	**3.12**	**2.90**	**2.78**	**70.38**	**44.12**	**3.62**	**-7.70**

Tab. 2-70 Breakdown of reported and projected emissions of GHG by categories in 5. Waste - WEM scenario

[Mt CO_2 eq.]	Reported emissions				Projected emissions						Difference [%]			
	1990	2005	2015	2020	2025	2030	2035	2040	2045	2050	1990 – 2020	1990 – 2030	1990 – 2040	1990 – 2050
5.A Solid waste disposal	1.79	2.74	3.20	3.29	3.09	2.46	1.69	1.19	0.95	0.80	87.80	33.03	-35.80	-60.63
5.B Biological treatment of solid waste	NO/IE	0.06	0.68	0.74	0.77	0.80	0.83	0.85	0.88	0.91	NA	NA	NA	NA
5.C Incineration and open burning of waste	0.02	0.11	0.11	0.11	0.13	0.14	0.15	0.16	0.18	0.19	452.79	577.75	702.71	827.67

5.D Waste water treatment and discharge	1.20	1.04	1.00	0.99	0.97	0.95	0.93	0.91	0.89	0.88	-17.32	-20.90	-24.05	-27.03
5.E Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**3.01**	**3.96**	**4.98**	**5.14**	**4.95**	**4.34**	**3.60**	**3.12**	**2.90**	**2.78**	**70.38**	**44.12**	**3.62**	**-7.70**

2.6.2.2 Projected greenhouse gas emissions 'With additional measures (WAM) scenario'

WAM scenario is almost identical to WEM scenario because all planned changes in waste management practice are implemented according to the WMP (MoE, 2014) and by the new obligations of the CEP (EC, 2018). The difference between WEM and WAM scenarios is an increased recovery of landfill gas, which is raising more sharply in WAM scenario due to amplified pressure from renewables market. The effects can be observed in CH_4 values (Tab. 2-71) and in 5.A Solid waste disposal category (Tab 2-72). Total amount of emissions is reduced by 17.09 % compared to 7.70 % decrease in WEM scenario from the base year 1990 until 2050. Breakdown by gases and source categories is shown in Tab. 2-71 and Tab. 2-72.

Tab. 2-71 Breakdown of reported and projected emissions of GHG by gases in 5. Waste - WAM scenario

	Reported emissions				**Projected emissions**						**Difference [%]**			
[Mt CO_2 eq.]	**1990**	**2005**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**1990 – 2020**	**1990 – 2030**	**1990 – 2040**	**1990 – 2050**
CO_2	0.02	0.10	0.10	0.10	0.12	0.13	0.14	0.15	0.16	0.18	422.85	541.05	659.25	777.44
CH_4	2.76	3.61	4.64	4.75	4.53	3.83	3.04	2.54	2.21	1.97	72.30	38.68	-7.92	-28.56
N_2O	0.23	0.24	0.25	0.28	0.29	0.30	0.32	0.33	0.34	0.35	17.85	29.23	39.61	50.28
Total	**3.01**	**3.96**	**4.98**	**5.14**	**5.26**	**4.59**	**3.77**	**3.21**	**2.87**	**2.65**	**70.38**	**41.27**	**0.20**	**-17.09**

Tab. 2-72 Breakdown of reported and projected emissions of GHG by categories in 5. Waste - WAM scenario

	Reported emissions				**Projected emissions**						**Difference [%]**			
[Mt CO_2 eq.]	**1990**	**2005**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**1990 – 2020**	**1990 – 2030**	**1990 – 2040**	**1990 – 2050**
5.A Solid waste disposal	1.79	2.74	3.20	3.29	3.08	2.37	1.59	1.09	0.76	0.52	83.73	32.35	-39.25	-71.00
5.B Biological treatment of solid waste	NO/IE	0.06	0.68	0.74	0.77	0.80	0.83	0.85	0.88	0.91	NA	NA	NA	NA
5.C Incineration and open burning of waste	0.02	0.11	0.11	0.11	0.13	0.14	0.15	0.16	0.18	0.19	452.79	577.75	702.71	827.67
5.D Waste water treatment and discharge	1.20	1.04	1.00	0.99	0.97	0.95	0.93	0.91	0.89	0.88	-17.32	-20.90	-24.05	-27.03
5.E Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**3.12**	**4.29**	**5.70**	**5.66**	**5.26**	**4.59**	**377**	**3.21**	**2.87**	**2.65**	**70.38**	**41.27**	**0.20**	**-17.09**

2.6.3 Sensitivity analysis

Projections of GHG emissions from 5. Waste sector are based on calculation sheets used for emission estimates in NIR (CHMI 2022). Activity data is only variable which changes during 2020 – 2050 (see chapter 2.6.1 for detailed information about projections of activity data). EFs are constant during the projected period and thus, sensitivity analysis would not bring any interesting outcomes. If activity

data will change by ±5% then emissions will change by ±5% because EFs used for emission estimates are constant during the projected period.

2.6.4 Difference between previously and currently reported projections

In category 5.A Solid waste disposal, fraction of methane was changed from country specific 0.55 to default 0.5 from the 2006 IPCC Guidelines due to EU ESD review recommendation in NIR (CHMI, 2022). The change is reflected in the projections lowering CH_4 emissions.

In category 5.C Waste incineration, activity data was disaggregated further to MSW, clinical and sludge enabling to use default EFs to each waste stream from the 2006 IPCC Guidelines in NIR (CHMI, 2022). This increased accuracy and lowered CO_2 emissions in the projections.

In the category 5.D Waste water treatment and discharge, default 0.5 MCF value was used for centralised plants, but it was changed to 0.039 due to the EU ESD review recommendation, based on observation, that 13% of the central plants are overloaded i.e. not optimally managed. This lowered CH_4 emissions in the projections.

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