First Biennial Transparency Report of the Czech Republic under the Paris Agreement

Ministry of the Environment
of the Czech Republic

Table of contents

List of abbreviations

BAT	Best available techniques
BDC	Bilateral development cooperation
BEV	Battery electric vehicle
BTR	Biennial Transparency Report
CAP	Common Agricultural Policy
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CDV	Transport Research Centre
CEAP	Circular Economy Action Plan
CENIA	Czech Environmental Information Agency
CF	Cohesion Fund
CHP	Combined heat and power
CNG	Compressed natural gas
CO_2eq	Carbon dioxide equivalent
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CHMI	Czech Hydrometeorological Institute
CRI	Crop Research Institute
CRF	Common reporting format
CRT	Common reporting tables
CZK	Czech Crown
CzSO	Czech Statistical Office
DAC	Development Assistance Committee OECD
EC	European Commission
EEA	European Environment Agency
EF	Emission factor
EPBD	Energy Performance of Buildings Directive
ERDF	European Regional Development Fund
ESPR	Ecodesign for Sustainable Products Regulation
ESR	Effort-Sharing Regulation
EU	European Union
EU ETS	European Union Emission Trading System
EUR	Euro
FMI	Forest Management Institute
FRL	Forest reference level
FVZ	Forest vegetation zone
GAEC	Good agricultural and environmental conditions
GCF	Green Climate Fund
GCMs	Global climate models
GDP	Gross domestic product
GHG	Greenhouse gases
GWL	Global warming level
HFCs	Hydrofluorocarbons
HCFCs	Hydrochlorofluorocarbons
HWP	Harvested wood products
ICAO	International Civil Aviation Organization
ICT	Information and communication technologies
IDEES	Integrated Database of the European Energy System
IFER	Institute of Forest Ecosystem Research
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated pollution prevention and control
IPPU	Industrial processes and product use
IROP	Integrated Regional Operational Programme
JRC	Joint Research Centre
LFG	Landfill gas
LPG	Liquified petroleum gas
LTS	Long-term strategy

LULUCF	Land use, land-use change and forestry
MDC	Multilateral development cooperation
MIT	Ministry of Industry and Trade
MoA	Ministry of Agriculture
MoE	Ministry of the Environment
MRV	Monitoring, reporting, and verification
MSW	Municipal solid waste
NAP	National Action Plan on Adaptation to Climate Change
NAP CM	National Action Plan for Clean Mobility
NAS	Strategy on Adaptation to Climate Change in the Czech Republic
NATECH	Natural Disasters Triggering Technological Hazards
NDC	Nationally determined contribution
NECP	National energy and climate plan
NERP	National Emissions Reduction Programme
NFAR	National forest accounting plan of the Czech Republic
NID	National Inventory Document
NIS	Network and information systems
NMVOCs	Non-methane volatile organic compounds
NUTS	Nomenclature of Territorial Units for Statistics
ODA	Official development assistance
ODS	Ozone-depleting substances
OECD	Organisation for Economic Co-operation and Development
OP	Operational programme
OPEI	Operational Programme Enterprise and Innovation
OP EIC	Operational Programme Enterprise and Innovation for Competitiveness
OPT	Operational Programme Transport
OP TAC	Operational Programme Technologies and Application for Competitiveness
QA	Quality assurance
QC	Quality control
PA	Paris Agreement
PaMs	Policies and measures
PHEV	Plug-in hybrid electric vehicle
PPP	Purchasing power parity
RAC	Refrigeration and air-conditioning
RCMs	Regional climate models
RCPs	Representative Concentration Pathways
RDP	Rural Development Programme
RED	Renewable energy directive
RES	Renewable energy sources
SEF	Standard electronic format
SEP	State Energy Policy
SME	Small and medium enterprises
SSPs	Shared Socioeconomic Pathways
TEN-E	Trans-European Networks for Energy
TEN-T	Trans-European Networks for Transport
TMA	Temperature maximum
TMI	Temperature minimum
TPES	Total primary energy supply
WEM	With existing measures
WAM	With additional measures
UHI	Urban heat island
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WEEE	Waste from Electrical and Electronic Equipment
ZEV	Zero emission vehicle

Summary

The European Union, acting jointly with its 27 Member States, submitted an updated NDC in 2023, committing to achieving a net GHG reduction of at least 55% by 2030 compared to 1990. This represents a legally binding target under EU law and is supported by a number of strategic, regulatory and funding mechanisms. Moreover, the EU aims to become climate neutral by 2050, which is an objective that stands at the heart of the European Green Deal, and also a binding target set in the European Climate Law.

Czechia has played and will continue to play its part in contributing to these ambitious mitigation goals, having reduced its annual GHG emissions already by more than 40% since 1990. At the same time, it is experiencing the worsening impacts of climate change first-hand. Be it the long dry spell that lasted between 2015-2020 or the destructive floods that hit the country in September 2024, the necessity to increase adaptation capacity has become painfully evident.

This report represents a comprehensive overview of the state of climate policy in Czechia. It offers an insight into both the historical emission inventories and to the future projections, while also contextualizing Czechia's efforts into a broader institutional, sectoral and regulatory framework. Some of the information provided is common for all EU Member States.

Faced with the multifaceted nature of ensuring a just transition towards a low-carbon economy, the Czech government utilises a broad range of instruments to steer this process. These include carbon pricing as well as various forms of financial or technical support and advice as well as regulation. Pending the adoption of certain key strategic documents on the national level, some of the data and information presented in this report may become outdated. However, given the contested nature of these documents, the timing of their adoption as well as the scenarios and policies contained therein cannot be prejudged.

As regards the structure of the report, the first chapter presents an inventory of GHG emissions by sources and removals by sinks, in a complete and transparent manner. The second chapter begins with an overview of Czechia's national circumstances and a summary of the state of key sectors before moving towards institutional arrangements, description of EU's common Nationally Determined Contribution, and finally two detailed sub-chapters: one presenting Czechia's climate-relevant policies and measures, and the other showing a set of GHG projections. The third chapter focuses on climate adaptation, summarizing current and future climate trends and hazards, including through a sectoral impact analysis, and concluding with a framework for climate change adaptation. In the fourth chapter, the support provided and mobilized by Czechia for third countries is discussed.

This narrative report is complemented by the Common Tabular Format tables exported from the ETF Reporting Tools and the National Inventory Document.

1. National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases

1.1. Definitions

Annual monitoring of greenhouse gas emissions and removals is one of the obligations stemming from the *UN Framework Convention on Climate Change* and its *Paris Agreement* namely 18/CMA.1 and 5/CMA.3. In addition, as a result of its membership in the European Union, the Czech Republic must also fulfil its reporting obligations concerning GHG emissions and removals following from Regulation of the European Parliament and Council No. 2018/1999/EC and Implementing regulation No. 2020/1208/EC. The GHG emission data presented in this Biennial Transparency Report are consistent with the GHG emissions and removals reported by the Czech Republic in the National Inventory Document (NID). The inventory covers anthropogenic emissions of direct greenhouse gases CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3 and indirect greenhouse gases NO_X, CO, NMVOC and SO_2.

1.2. National circumstances and institutional arrangements

1.2.1. Institutional Arrangements

Responsible person for international reporting on greenhouse gases:
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Responsible person for compilation of the inventory:
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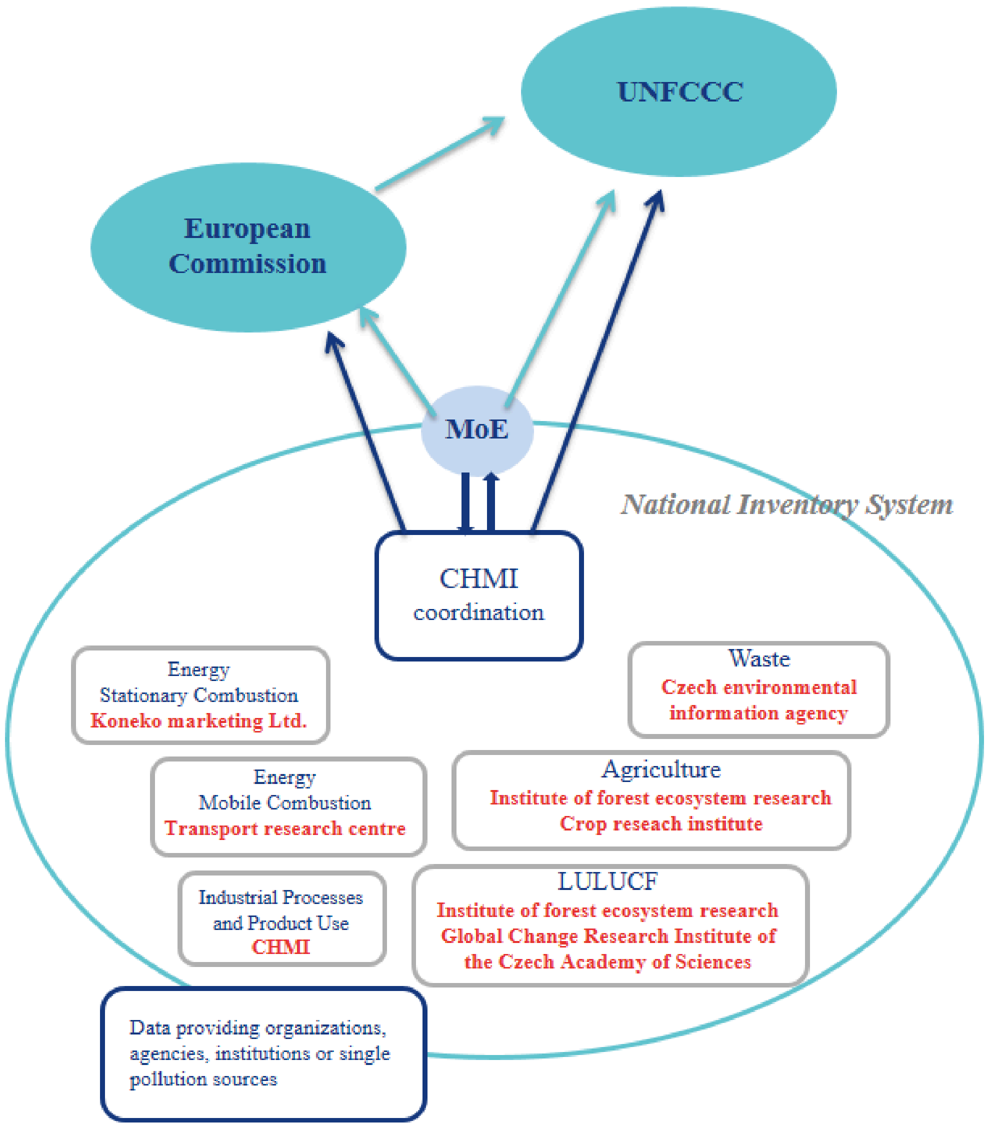
The Czech Hydrometeorological Institute (CHMI), under the supervision of the Ministry of the Environment, is designated as the coordinating and managing organisation responsible for the compilation of the national GHG inventory and reporting its results. The main tasks of CHMI consist in inventory management, general and cross-cutting issues, QA/QC, data reporting, archiving and documentation management, and communication with the relevant UNFCCC and EU bodies.

Sectoral inventories are prepared by sectoral experts from sector-solving institutions, which are coordinated and controlled by CHMI:

- KONEKO marketing Ltd. (KONEKO), Prague, is responsible for compilation of the inventory in sector 1. Energy, for stationary sources including fugitive emissions

- Transport Research Centre (CDV), Brno, is responsible for compilation of the inventory in sector 1. Energy, for mobile sources
- Czech Hydrometeorological Institute (CHMI), Prague, is responsible for compilation of the inventory in sector 2. Industrial Processes and Product Use
- Institute of Forest Ecosystem Research Ltd. (IFER), Jilove u Prahy, is responsible for compilation of the inventory in sectors 3. Agriculture and 4. Land Use, Land Use Change and Forestry
- Crop Research Institute (CRI), Prague, is co-responsible for compilation of the inventory in sector 3. Agriculture (IFER has the main responsibility)
- Global Change Research Institute of the Czech Academy of Sciences (GCRI), Brno, is co-responsible for compilation of the inventory in sector 4. Land Use, Land Use Change and Forestry (IFER has the main responsibility)
- Czech Environmental Information Agency (CENIA), Prague, is responsible for compilation of the inventory in sector 5. Waste.

Figure 1.1: Institutional arrangements of National Inventory System in the Czech Republic

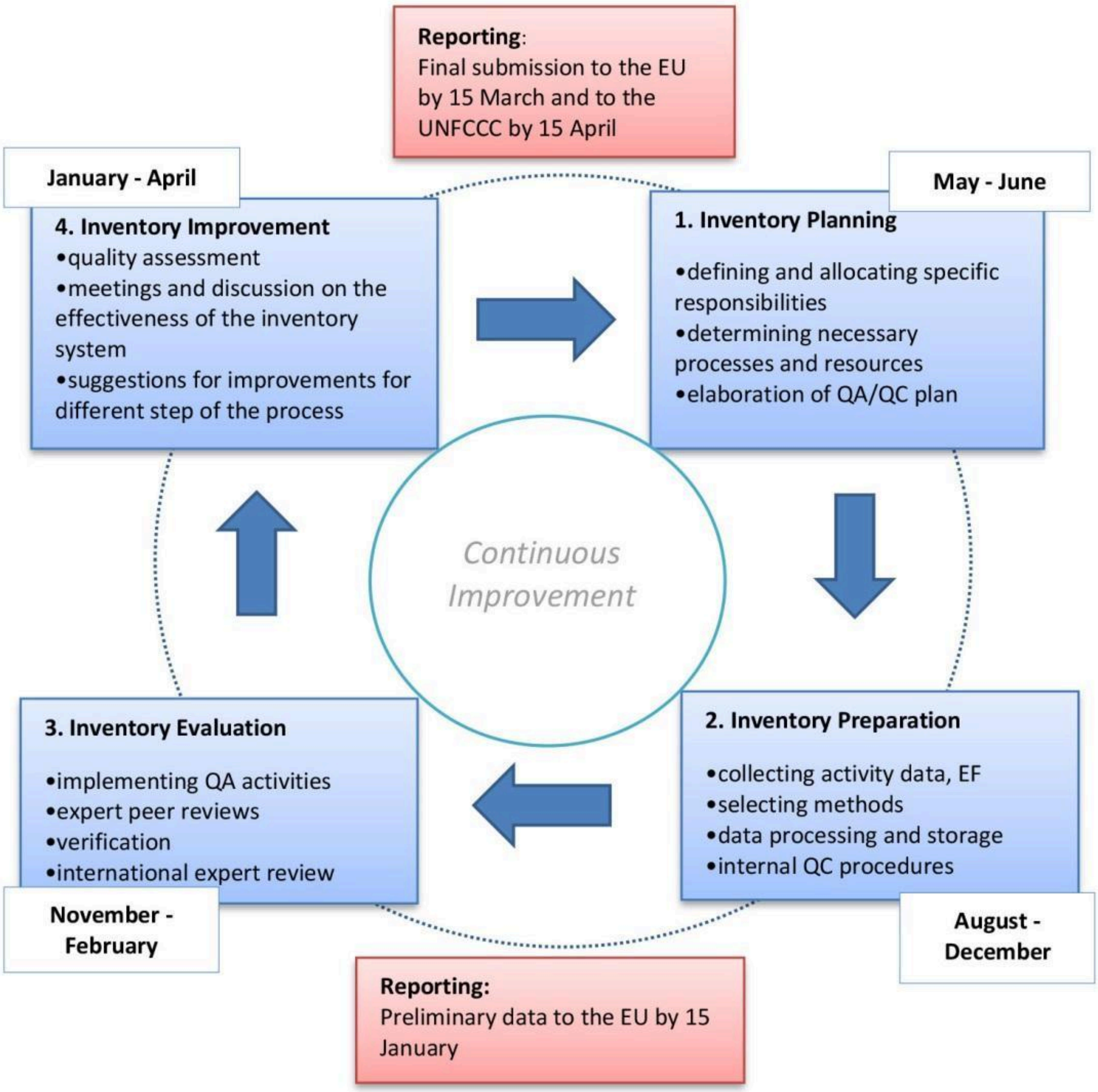


Source: CHMI

1.2.2. Inventory process

The annual inventory process consists of four main stages: planning, preparation, evaluation and improvement (Figure 1.2). The quality control and quality assurance elements are integrated into the production system of the inventory. The documentation ensures the transparency of the inventory: it enables external evaluation of the inventory and, where necessary, its replication.

Figure 1.2: Time schedule of submissions and QA/QC procedures



Source: CHMI

1.2.3. Official inventory result approval process

The approval procedure is led by the Ministry of the Environment of the Czech Republic. The procedure involves that the draft report is shared with the relevant ministries in the Czech Republic (e.g. Ministry of Finance, Ministry of Transport, Ministry of Foreign Affairs, Ministry of Education, Youth and Sports, etc.), organisations (e.g. Czech Environmental Inspectorate, Czech Environmental Information Agency, non-governmental organisations, etc.), as well as with key trade unions and industry associations before the official submission to the UNFCCC. Their comments and observations are then considered and resolved by the Climate Change Department of the Ministry of the Environment in consultation with CHMI.

1.2.4. Methodological aspects

National inventory of greenhouse gases is based on the IPCC methodology and principles of good practice.[1]

Inventory of greenhouse gas emissions is a multi-level process including data collection, estimating emission sources and sinks, controls and verification, determining uncertainties and reporting. The main phases of inventory are:

Data collection: Collection of activity data is based mainly on the official documents of the Czech Statistical Office (CzSO), which are published annually, where the Czech Statistical Yearbook is the most representative example. However, for industrial processes, because of the Czech Act on Statistics, production data are not generally available when there are fewer than 4 enterprises in the whole country. In such cases, inventory compilers have to rely either on specific statistical materials edited by sectoral associations or, in some cases, inventory experts have to carry out the relevant inquiries. In a few cases, the Czech register of individual sources and emissions, called REZZO, is used as a source of activity data.

Emission estimates from Sector 1.A Fuel Combustion Activities are based on the official Czech Energy Balance, compiled by the Czech Statistical Office. Data from the Czech Energy balance are processed both in the Reference Approach (TPES – primary sources data are used) and in the Sectoral Approach (data for fuel transformations and final consumptions). However, in the latter case, some additional data are required (e.g. data on transportation statistics).

For the purposes of the Energy sector, EU ETS data are further used primarily for control purposes (see the dedicated chapter), while for the purpose Industrial Processes and Product Use, EU ETS data are utilised to a considerable extent (e.g. in Cement Production or Lime Production).

Determining uncertainties: This process provides valuable information for inventory compilers and for inventory users. Uncertainties must be defined for each separate category of sources, as well as for total emissions and their trends. The determination of uncertainties is one of the important principles of good practice as it helps inventory compilers to better focus on those categories that considerably contribute to larger uncertainty in emission estimates (including allocation of funding) and to gradual improvement of quality, respectively.

Identification of key categories: Good practice requires that key categories are identified. Key categories are important for use of development diagrams during selection of

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

appropriate methods, and the inventory coordinator seeks to apply more sophisticated higher tiers methods of inventory to these key categories.

QA/QC control procedures: The application of QA/QC processes represents an important phase in compiling the NIR. The QA/QC processes include planning, conducting controls and reviewing relevant documentation, verification of data and their review by independent providers. The correct application of QA/QC processes is also one of the principles of good practice, allowing for the removal of potential errors and discrepancies.

Reporting inventory results: Reporting to the UNFCCC takes place annually on April 15 except for 2024 where the deadline for the submission is postponed till 31 December of the year because of the transition from CRF to CRT reporting tool.

The documents submitted include:

- National Inventory Document
- Export of complete data inventory – in xml format
- CRT tables (Common Reporting Tables)
- SEF tables (Standard Electronic Format)

The text below specifies some other tools ensuring the required quality of reporting:

Tier approach: Depending on the complexity of the calculation and types of emission factors used (generally recommended – *default*, country-specific, site-specific and technology-specific), the approaches described in the IPCC methodology consist of three tiers. Tier 1 is typically characterised by simpler calculations, based on the basic statistical data and on the use of generally recommended emission factors (*default*) of global or continental applicability, tabulated directly in above mentioned methodical manuals.

Tier 2 is based on sophisticated calculation and usually requires more detailed and less accessible statistical data. The emission factors (country-specific or technology-specific) are usually derived using calculations based on more complex studies and better knowledge of the source. Even in these cases, it is sometimes possible to find the necessary parameters for the calculation in IPCC manuals. Procedures in Tier 3 are usually considered to consist of procedures based on the results of direct measurements carried out under local conditions and locally parameterized models.

Methods of higher tiers should be applied mainly for key categories. Key categories (key source categories) are defined as categories that cumulatively contribute 90% or more to the overall uncertainty either in level or in trend. Apparently, procedures in higher tiers should be more accurate and should better reflect reality. However, they are more demanding in all respects, and especially they are more expensive.

Because of the above-described problems encountered in the application of the methods of higher tiers, these procedures have so far been introduced only for some key categories. For example, for combustion of fuels, country-specific factors are employed only for Brown/Hard Coal, Brown Coal + Lignite, Bituminous Coal, Coking Coal, Gas Works Gas, Refinery Gas, LPG and Natural Gas, while the default emission factors are employed for the rest of the other fuels. For Bituminous Coal, Brown Coal + Lignite and Brown Coal Briquettes are used country specific oxidation factors as well. Similarly, for Industrial Processes, only the Tier 1 method is used for the production of iron and steel. In contrast, the methods of higher tiers and/or country-specific factors are employed far more frequently for other key categories.

Emission factors: As described above, continuous development of country specific emission factors is occurring. The choosing of emission factor and methodology for emission estimates is specific for each sector and category. For more information on emission factors and applied methodologies please see Chapters 3 to 9 of National Inventory Report submitted in March 2024 to the EC.

Key categories: The key categories concept lies in the identification of categories having significant impact on total national GHG emissions or which could contribute to uncertainties (trends) since 1990. Key categories contribute to the total uncertainty of emission estimate in an actual year or in determining trends. The key categories enjoy special attention while compiling the National Inventory, demanding more complex methods and a thorough application of QA/QC processes, and while conducting more rigorous methods in planning the inventory improvement. The prioritization of funding allocation is directly tied to the output of the key categories' analyses.

Adherence to good practice principles leads to achieving all required quality criteria, which include: transparency, completeness, consistency, comparability and accuracy.

Transparency: Transparency means transparent and clear documenting of applied processes, allowing the understanding of how the inventory was compiled and whether all relevant principles of good practice were taken into account.

Completeness: The national inventory must include all categories of sources and sinks of GHG emissions. Any missing categories must be clearly identified and an appropriate justification provided of why they could not be included in the inventory or what steps are being taken for their future inclusion.

Consistency: Ensuring consistency of time series is important for demonstrating credibility of trends. The methodological manual describes ways of ensuring this consistency. Inventory emissions for the entire period must be determined using identical methods and same or similar data sources. The time series should encompass development of emissions over time and not potential changes in methods applied during the monitored period.

Comparability: The national inventory of GHGs shall be compiled in a manner allowing comparison with inventories taken in other countries. This may be achieved by the application of unified IPCC methods, including identical classification of sources and sinks, the identification of key sources, prescribed manner of reporting, etc.

Accuracy: The national inventory should not be over or under-estimated. It is therefore necessary to avoid systematic mistakes in estimating emissions.

The driving forces in applying recalculations in the Czech greenhouse gas inventory are provided by the implementation of the guidance given in the IPCC 2006 GI. (IPCC, 2006) and the recommendations from the UNFCCC inventory reviews. Recalculations of previously submitted inventory data are performed following the above-mentioned IPCC manuals only to improve the GHG inventory.

Even though a QA/QC system helps to eliminate potential error sources, it is sometimes necessary to make some revisions (called recalculations) under the following circumstances:

- An emission source was not considered in the previous inventory.
- A source/data supplier has delivered new data. This could be because the previous data were only preliminary data (by estimation, extrapolation) or because the method of data collection has been improved.
- Some errors in data transfer or processing have been identified: wrong data, unit-conversion, software errors, etc.
- Methodological changes – when a new methodology must be applied to fulfil the reporting obligations for one of the following reasons:
  - to decrease uncertainties,
  - an emission source becomes a key source,
  - consistent input data needed for applying the methodology is no longer accessible,
  - input data for more detailed methodology is now available,
  - the methodology is no longer appropriate

Key categories

The IPCC 2006 Guidelines provide two approaches to determining the key categories (key sources). Key categories by definition contribute to 95% of the overall uncertainty in a level (in emissions per year) or in a trend. Approach 2 follows from this definition, and requires a thorough analysis of the uncertainty and use of sophisticated statistical procedures and evaluation of sources in terms of the appropriate characteristics.

Table 1.1: Identification of key categories by level assessment (LA) and trend assessment (TA) for 2022 evaluated with LULUCF (Approach 2)

IPCC Source Categories	GHG	Cumulative Total (LA, %)	Cumulative Total (TA, %)	KC type
1.A.1 Energy industries – Solid Fuels	CO_2	41.01	88.41	LA, TA
1.A.2 Manufacturing Industries and Construction – Solid Fuels	CO_2	88.32	74.21	LA, TA
1.A.2 Manufacturing Industries and Construction – Gaseous Fuels	CO_2	90.37	97.62	LA
1.A.2 Manufacturing Industries and Construction – Other Fossil Fuels	CO_2	79.94	80.53	LA, TA
1.A.3.b Road Transportation	CO_2	55.25	76.69	LA, TA
1.A.3.b Road Transportation	N_2O	78.14	83.31	LA, TA
1.A.4 Other Sectors – Solid Fuels	CO_2	81.65	67.87	LA, TA
1.A.4 Other Sectors – Solid Fuels	CH_4	87.57	78.74	LA, TA
1.A.4 Other Sectors – Gaseous Fuels	CO_2	83.25	87.56	LA, TA
1.A.4 Other Sectors – Biomass	CH_4	76.34	82.05	LA, TA
1.B.1.a Coal Mining and Handling	CH_4	51.45	44.41	LA, TA
1.B.2.b Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas	CH_4	85.89	89.86	LA, TA
2.B.8 Petrochemical and Carbon Black Production	CO_2	74.15	85.61	LA, TA
2.C.1 Iron and Steel Production	CO_2	59.01	95.24	LA
2.F.1 Refrigeration and Air conditioning	F-gases	34.03	61.36	LA, TA
3.A Enteric Fermentation	CH_4	69.06	93.27	LA
3.B Manure Management	CH_4	93.54	89.17	TA
3.B Manure Management	N_2O	86.74	92.37	LA
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	65.88	92.83	LA
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	84.57	98.10	LA
3.G Liming	CO_2	97.00	86.65	TA
4.A.1 Forest Land remaining Forest Land	CO_2	25.53	33.03	LA, TA
4.A.2 Land converted to Forest Land	CO_2	89.04	96.23	LA
4.C.1 Grassland remaining Grassland	CO_2	89.73	90.55	LA, TA
4.G Harvested wood products	CO_2	47.60	84.48	LA, TA
5.A Solid Waste Disposal	CH_4	12.96	52.90	LA, TA
5.B Biological treatment of solid waste	CH_4	62.69	71.53	LA, TA
5.D Wastewater treatment and discharge	CH_4	71.91	91.21	LA

Source: CHMI

Table 1.2: Identification of key categories by level assessment (LA) and trend assessment (TA) for 2022 evaluated without LULUCF (Approach 2)

IPCC Source Categories	GHG	Cumulative Total (LA, %)	Cumulative Total (TA, %)	KC type
1.A.1 Energy industries – Solid Fuels	CO_2	36.44	79.64	LA, TA
1.A.1 Energy industries – Solid Fuels	N_2O	90.18	97.57	LA
1.A.2 Manufacturing Industries and Construction – Solid Fuels	CO_2	88.61	67.23	LA, TA
1.A.2 Manufacturing Industries and Construction – Liquid Fuels	CO_2	97.93	88.92	TA
1.A.2 Manufacturing Industries and Construction – Gaseous Fuels	CO_2	89.42	95.82	LA
1.A.2 Manufacturing Industries and Construction – Other Fossil Fuels	CO_2	77.87	73.02	LA, TA
1.A.3.b Road Transportation	CO_2	46.24	63.34	LA, TA
1.A.3.b Road Transportation	N_2O	75.57	77.59	LA, TA
1.A.4 Other Sectors – Solid Fuels	CO_2	80.07	53.40	LA, TA
1.A.4 Other Sectors – Solid Fuels	CH_4	87.64	70.17	LA, TA
1.A.4 Other Sectors – Gaseous Fuels	CO_2	82.11	83.08	LA, TA
1.A.4 Other Sectors – Biomass	CH_4	73.26	75.52	LA, TA
1.B.1.a Coal Mining and Handling	CH_4	41.37	16.43	LA, TA
1.B.2.b Fugitive Emissions from Fuels – Oil and Natural Gas – Natural Gas	CH_4	85.49	89.80	LA, TA
2.B.8 Petrochemical and Carbon Black Production	CO_2	70.46	81.56	LA, TA
2.C.1 Iron and Steel Production	CO_2	51.05	98.02	LA
2.F.1 Refrigeration and Air conditioning	F-gases	27.50	43.95	LA, TA
3.A Enteric Fermentation	CH_4	63.94	96.46	LA
3.B Manure Management	CH_4	92.76	86.96	TA
3.B Manure Management	N_2O	86.58	90.49	LA, TA
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	59.86	88.01	LA, TA
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	83.80	99.15	LA
3.G Liming	CO_2	96.62	84.59	TA
5.A Solid Waste Disposal	CH_4	16.61	30.46	LA, TA
5.B Biological treatment of solid waste	CH_4	55.77	59.24	LA, TA
5.D Wastewater treatment and discharge	CH_4	67.59	85.89	LA, TA
3.B Manure Management	N_2O	86.58	90.49	LA, TA
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	59.86	88.01	LA, TA
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	83.80	99.15	LA
3.G Liming	CO_2	96.62	84.59	TA
5.A Solid Waste Disposal	CH_4	16.61	30.46	LA, TA
5.B Biological treatment of solid waste	CH_4	55.77	59.24	LA, TA
5.D Wastewater treatment and discharge	CH_4	67.59	85.89	LA, TA

Source: CHMI

Table 1.3: Identification of key categories by level assessment (LA) and trend assessment (TA) for 2022 evaluated with LULUCF (Approach 1)

IPCC Source Categories	GHG	Cumulative Total (LA, %)	Cumulative Total (TA, %)	KC type
1.A.1 Energy industries – Solid Fuels	CO_2	30.72	69.85	LA, TA
1.A.1 Energy industries – Liquid Fuels	CO_2	95.91	93.22	TA
1.A.1 Energy industries – Gaseous Fuels	CO_2	81.33	84.79	LA, TA
1.A.2 Manufacturing Industries and Construction – Solid Fuels	CO_2	67.77	18.04	LA, TA
1.A.2 Manufacturing Industries and Construction – Liquid Fuels	CO_2	94.76	80.09	LA, TA
1.A.2 Manufacturing Industries and Construction – Gaseous Fuels	CO_2	63.87	86.39	LA, TA
1.A.2 Manufacturing Industries and Construction – Other Fossil Fuels	CO_2	95.19	92.13	LA, TA
1.A.3.b Road Transportation	CO_2	45.67	47.03	LA, TA
1.A.4 Other Sectors – Solid Fuels	CO_2	78.95	59.36	LA, TA
1.A.4 Other Sectors – Solid Fuels	CH_4	96.97	89.03	TA
1.A.4 Other Sectors – Liquid Fuels	CO_2	89.00	87.59	LA, TA
1.A.4 Other Sectors – Gaseous Fuels	CO_2	50.54	77.08	LA, TA
1.A.4 Other Sectors – Biomass	CH_4	91.74	92.68	LA, TA
1.B.1.a Coal Mining and Handling	CH_4	88.03	64.96	LA, TA
2.A.1 Cement Production	CO_2	86.57	96.43	LA
2.A.2 Lime Production	CO_2	93.89	96.16	LA
2.A.4 Other Process Uses of Carbonates	CO_2	92.33	89.71	LA, TA
2.B.1 Ammonia Production	CO_2	93.45	99.27	LA
2.B.2 Nitric Acid Production	N_2O	99.01	94.76	TA
2.B.8 Petrochemical and Carbon Black Production	CO_2	89.80	93.74	LA, TA
2.C.1 Iron and Steel Production	CO_2	59.78	91.57	LA, TA
2.F.1 Refrigeration and Air conditioning	F-gases	76.45	73.50	LA, TA
3.A Enteric Fermentation	CH_4	73.63	94.27	LA, TA
3.B Manure Management	CH_4	96.51	90.99	TA
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	83.57	95.19	LA, TA
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	91.14	98.78	LA
3.G Liming	CO_2	98.70	90.36	TA
4.A.1 Forest Land remaining Forest Land	CO_2	55.32	34.35	LA, TA
4.A.2 Land converted to Forest Land	CO_2	94.33	97.94	LA
4.G Harvested wood products	CO_2	85.11	95.54	LA
5.A Solid Waste Disposal	CH_4	70.72	82.59	LA, TA
5.B Biological treatment of solid waste	CH_4	92.91	88.34	LA, TA
5.D Wastewater treatment and discharge	CH_4	90.51	98.15	LA

Source: CHMI

Table 1.4: Identification of key categories by level assessment (LA) and trend assessment (TA) for 2022 evaluated without LULUCF (Approach 1)

IPCC Source Categories	GHG	Cumulative Total (LA, %)	Cumulative Total (TA, %)	KC type
1.A.1 Energy industries – Solid Fuels	CO_2	33.19	58.92	LA, TA
1.A.1 Energy industries – Liquid Fuels	CO_2	96.32	94.37	TA
1.A.1 Energy industries – Gaseous Fuels	CO_2	82.70	83.54	LA, TA
1.A.2 Manufacturing Industries and Construction – Solid Fuels	CO_2	68.06	20.07	LA, TA
1.A.2 Manufacturing Industries and Construction – Liquid Fuels	CO_2	95.08	77.59	LA, TA
1.A.2 Manufacturing Industries and Construction – Gaseous Fuels	CO_2	63.84	85.82	LA, TA
1.A.2 Manufacturing Industries and Construction – Other Fossil Fuels	CO_2	95.54	93.80	TA
1.A.3.b Road Transportation	CO_2	49.35	36.17	LA, TA
1.A.4 Other Sectors – Solid Fuels	CO_2	80.14	49.90	LA, TA
1.A.4 Other Sectors – Solid Fuels	CH_4	97.21	89.59	TA
1.A.4 Other Sectors – Liquid Fuels	CO_2	89.33	87.07	LA, TA
1.A.4 Other Sectors – Gaseous Fuels	CO_2	54.61	69.75	LA, TA
1.A.4 Other Sectors – Biomass	CH_4	92.29	91.74	LA, TA
1.B.1.a Coal Mining and Handling	CH_4	88.28	65.13	LA, TA
2.A.1 Cement Production	CO_2	86.71	95.41	LA, TA
2.A.2 Lime Production	CO_2	94.61	96.33	LA
2.A.4 Other Process Uses of Carbonates	CO_2	92.93	88.83	LA, TA
2.B.1 Ammonia Production	CO_2	94.14	98.62	LA
2.B.2 Nitric Acid Production	N_2O	99.08	94.93	TA
2.B.8 Petrochemical and Carbon Black Production	CO_2	90.20	93.12	LA, TA
2.C.1 Iron and Steel Production	CO_2	59.42	98.33	LA
2.F.1 Refrigeration and Air conditioning	F-gases	77.44	74.22	LA, TA
3.A Enteric Fermentation	CH_4	74.39	97.15	LA
3.B Manure Management	CH_4	96.98	92.43	TA
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	85.13	90.33	LA, TA
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	91.64	99.62	LA
3.G Liming	CO_2	98.75	91.05	TA
5.A Solid Waste Disposal	CH_4	71.24	80.77	LA, TA
5.B Biological treatment of solid waste	CH_4	93.56	87.99	LA, TA
5.D Wastewater treatment and discharge	CH_4	90.96	95.73	LA

Source: CHMI

On the whole, 33 (Approach 1) and 28 (Approach 2) key categories were identified either by level assessment or by trend assessment. A summary of the assessed numbers concerning key categories is given in Table 1.5.

Table 1.5: Figures for key categories assessed

	Approach 1	Approach 2
Key categories (KC) with LULUCF	33	28
KC identified by LA	28	26
KC identified by TA	26	20
KC identified by LA + TA concurrently	21	18
KC identified by only LA	7	8
KC identified by only TA	5	2
Key Categories (KC) without LULUCF:	30	26
KC identified by LA	24	23
KC identified by TA	24	21
KC identified by LA + TA concurrently	18	18
KC identified by only LA	6	5
KC identified by only TA	6	3

Source: CHMI

1.2.5. Inventory uncertainties

Uncertainty analysis characterises the extent (i. e. possible interval) of results for the entire national inventory and for its individual components. Knowledge of the individual and overall uncertainties enables compilers of emission inventories better understanding of the inventory process, which encompasses collection of suitable input data and their evaluation. Uncertainty analysis also helps in identifying those categories of emission sources and sinks that contribute most to the overall uncertainty and thus establish priorities for further improvement of the quality of the data.

A method of uncertainty determination based on the error propagation method (Tier 1), using calculation sheets obtained according to the prescribed IPCC methodology, has been used in the Czech national inventory for a number of years. The accuracy of the calculation algorithm has been sufficiently verified, uncertainty in the activity data and emission factors for the individual categories are updated every submission. Experts from CHMI and all the contributing sectoral organisations are participating in this work. The individual experts investigated the uncertainty parameters coming under their field of work and proposed new ones or defended the original ones in discussions.

Uncertainty analysis of Tier 1, which is presented in the current volume of NIR, employs the same source categorization as used in key categories assessment. Actual results of the uncertainty analysis for 2022 after above mentioned revision of the input parameters are given in Annex 2 of the NIR.

Further, uncertainty bases are yearly evaluated for LULUCF, Waste and Energy sector, which are then used for the overall uncertainty analysis.

Results of uncertainty assessment were obtained (i) for all sectors including LULUCF and (ii) for comparison also for all sectors without LULUCF. The estimated overall uncertainty in level assessment (case with LULUCF) reached 3.57%. The corresponding uncertainty in trend is 1.7%. Without LULUCF, the estimated overall uncertainty in level assessment is 3.15%, and 1.66% in trend.

The same source categories used in key sources assessment have also been used even in uncertainty analysis. In this way, the uncertainty analysis result was used later in Approach 2 key source analysis. The uncertainty analysis is provided in Annex 2 tables of the NIR.

1.2.6. QA/QC control procedures

The QA/QC processes are carried out annually pursuant to an updated plan. The plan preparation reflects institutional arrangements: Each institution prepares its own QA/QC procedures, including the authorization of responsible QA/QC experts for each sector. The sector QA/QC plan is an integral part of the entire QA/QC plan, which is prepared by a QA/QC manager. The national inventory of GHGs is a part of client processes at the CHMI following the ISO 9001 quality standard (CHMI obtained certification). The processes relating to national inventory are elaborated in the form of development diagrams and include all main principles that need to be adhered to during the compilation of the inventory including the QA/QC processes.

QC processes include routine technical inspections of inventory quality to ensure consistency, integrity, accuracy, and completeness of the data and to reveal and remove any error and omissions. The QC processes are applied to all fundamental processes carried out during the inventory: Data collection, selection of appropriate method and emission factors, and calculations of emissions and processes documentation. These QC procedures are carried out in line with the IPCC methodology. Sector compilers undertake parts of these processes; the rest is carried out by the NIS coordinator. The sector compilers focus primarily on activity data control, emission factors, and applied sector-specific methods, the NIS coordinator reviews the appropriateness of method selection, and analyses trends and compares data from several possible sources. The sector compilers and the NIS coordinator use control tools available in the CRF Reporter.

The QA processes include control activities and reviews by third parties not directly involved in the national inventory compilation, but rather competent experts in the given field. The CHMI cooperates on the QA processes with Slovak experts from the Slovak Hydrometeorological Institute, who are involved in the preparation and compilation of the Slovak national inventory. Also, the QA cooperation was broadened five years ago by including in the processes experts from the Hungarian and Polish national inventory teams.

The regular international inspections undertaken by the UNFCCC play a significant role in increasing the quality of the national inventory. The inspections identify shortcomings and provide recommendations that are thoroughly analysed by the Czech NIS team; inspection conclusions are used to improve the quality of the Czech national inventory.

A detailed QA/QC management explanation is provided in the National Inventory Document, Chapter 1.2.3.

1.2.7. Systematic improvement of inventory quality

The plan for improvement of inventory quality also constitutes one of the good practice tools besides being one of the fundamental provisions of the Paris Agreement (PA).[2] The National inventory system has drafted and annually updates an improvement plan for the existing inventory system. One of the basic tools for this planning is, among other, analysis of key categories. The improvement plan is yearly evaluated and updated. Focus on the improvement is on key categories, as well as on the development of country specific emissions factors and other necessary computational factors. Important part of the improvement plan are annual reviews held by UNFCCC and EU. For further details please consult Chapter 10 of the National Inventory Document.

1.3. Summary tables

This chapter describes greenhouse gas emissions (GHGs) trends over time, covering the period between 1990 and 2022.

In 2022, the most important GHG in the Czech Republic was CO_2 contributing 81.7% to total national GHG emissions and removals expressed in CO_2 eq. (including LULUCF), followed by CH_4 with 10.9% and N_2O with 4.3%. PFCs, HFCs, SF_6 and NF_3 combined contributed to the overall GHG emissions in the country by 3%.

Over the period 1990 – 2022 CO_2 emissions and removals decreased by 36.6%. CH_4 emissions decreased by 51.2% during the same period mainly due to lower emissions from 1 Energy and 3 Agriculture; N_2O emissions decreased by 37% over the same period due to emission reduction in 3 Agriculture. Emissions of HFCs and PFCs increased by orders of magnitude, whereas SF_6 emissions kept a steady trend over the whole period.

In 2022, 87 907.2 kt CO_2eq (73% of all GHG emissions including 4 Land Use, Land-Use Change and Forestry) arose from 1 Energy; over 97% of these emissions can be attributed to fuel combustion. The most important sub-category of 1 Energy with 48.7% of total sectoral emissions in 2022 was 1.A.1 Energy Industries, with 1.A.2 Manufacturing Industries and Construction responsible for 13.3% and 1.A.3 Transport for 22.1% of total sectoral emissions. From 1990 to 2022, emissions from 1 Energy decreased by 46.1%.

2 Industrial Processes is the second largest category responsible for 15 045.2 kt CO_2eq, (12.5% of total GHG emissions including 4 Land Use, Land-Use Change and Forestry) in 2022 ; the largest sub-category is 2.C Metal Production with 37.6% of sectoral share. From 1990 to 2022 emissions from 2 Industrial Processes decreased by 12%.

[2] Decision 18/CMA.1, Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, https://unfccc.int/resource/tet/0/00mpg.pdf

3 Agriculture is the third largest category in the Czech Republic with a 6.99% share of total GHG emissions (including 4 Land Use, Land-Use Change and Forestry), producing 8 422.3 kt CO_2eq in 2022; 43.14% of these emissions arose from 3.D Agricultural Soils. From 1990 to 2022 emissions from 3 Agriculture decreased by 46.5%.

4 In 2022, Land Use, Land-Use Change and Forestry was contributing by 3 378.1 kt CO_2eq (2.8% of the total GHG emissions). Subcategory 4.A. Forest Land contributed to these emissions by more than 100%; the balance is partly offset thanks to the removals in 4.G Harvested Wood Products and 4.C Grassland.

5 Waste contribution to the total GHG emissions was 5 702.1 kt CO_2eq in 2022, accounting for 4.73% of the total (including 4 Land Use, Land-Use Change and Forestry) , and increasing by 71.8% as compared to 1990. Almost two thirds from the sectoral emissions arose from 5.A Solid waste disposal.

Table 1.6 presents a summary of GHG emissions excl. bunkers emissions for the period from 1990 to 2022. For CO_2, CH_4 and N_2O the base year is 1990; for F-gases the base year is 1995.

Table 1.6: Trends in greenhouse gas emissions in the 1990-2022 period [kt CO_2eq]

	CO_2[1]	CH_4[3]	N_2O[3]	HFCs	PFCs	NF_3	SF_6	Total emissions[4]	
								excl. LULUCF	incl. LULUCF
1990	164250.45	26832.80	8235.99	NO			86.83	201313.55	192478.23
1991	148883.28	25443.42	6462.79				86.66	182610.78	172274.75
1992	145705.82	23495.97	5720.28				88.03	176618.42	166085.78
1993	140124.10	22951.11	5016.02				89.22	169805.56	158442.96
1994	132668.12	21537.12	5127.81				90.35	160985.25	150868.83
1995	131622.32	21175.02	5458.59	86.89	0.01	NO	91.40	159950.44	149568.92
1996	135018.76	21187.31	5139.51	215.49	0.68	NO	101.32	163153.61	153049.43
1997	130941.74	20591.32	5220.40	389.02	1.62	NO	99.06	158682.41	149619.64
1998	125715.92	19678.22	5183.79	529.49	1.54	NO	97.89	152611.38	143893.07
1999	116672.03	18704.80	5012.07	636.10	1.08	NO	98.88	142429.51	133490.88
2000	127236.14	17631.81	5619.34	800.04	4.43	NO	111.73	152636.19	142952.22
2001	127144.52	16959.09	5936.88	998.32	9.15	NO	101.85	152317.20	142661.70
2002	123967.85	16596.30	5525.60	1098.75	15.17	NO	125.00	148460.26	139010.52
2003	127571.89	16460.55	5043.49	1212.19	8.36	NO	149.14	151546.36	142596.83
2004	128291.81	15909.12	5753.10	1343.12	12.41	NO	124.32	152501.24	143837.50
2005	125690.86	16541.88	5611.67	1347.96	14.38	NO	115.28	150439.30	141717.43
2006	126537.10	16767.69	5609.86	1600.80	29.02	NO	108.34	151810.92	144146.17

	CO_2[1]	CH_4[3]	N_2O[3]	HFCs	PFCs	NF_3	SF_6	Total emissions[4]	
								excl. LULUCF	incl. LULUCF
2007	128366.40	16212.63	5735.93	1958.20	27.20	NO	96.67	153500.96	146070.08
2008	122934.90	16276.20	5767.98	2217.19	37.05	NO	91.39	148404.55	139721.81
2009	114982.54	15458.08	4792.40	2233.98	42.14	NO	91.79	138572.33	130135.07
2010	117476.26	15721.11	4770.72	2450.62	44.34	0.14	85.30	141524.81	133813.24
2011	115189.18	15650.53	5528.19	2660.72	8.08	0.55	91.36	140090.97	131757.53
2012	111287.35	15587.77	5461.73	2764.27	6.17	0.83	95.28	136118.89	127563.12
2013	106722.49	14896.04	5192.34	2893.55	4.18	1.32	85.59	130620.31	122710.76
2014	104246.04	14888.14	5296.69	3073.55	3.12	2.22	82.36	128418.04	120566.48
2015	105000.92	14943.34	5893.07	3324.47	2.11	2.01	80.67	130057.11	122203.40
2016	106648.40	14516.50	6011.67	3542.93	1.78	2.01	81.04	131571.67	124625.76
2017	107745.84	14272.38	5792.18	3749.86	1.97	3.12	76.30	132367.78	127029.71
2018	106335.55	14167.23	5402.89	3815.33	2.07	2.91	72.72	130499.02	130487.31
2019	101008.82	13800.85	5221.93	3838.56	1.57	2.36	70.09	124591.16	131084.48
2020	91673.77	13096.94	4815.35	3747.36	0.97	2.02	67.16	114040.85	123740.54
2021	96645.18	13213.83	5090.52	3738.83	30.95	1.46	64.68	119425.24	126013.19
2022	95107.76	13080.32	5183.35	3610.40	47.86	1.95	65.70	117687.98	121066.04
%[2)]	**-42.10**	**-51.29**	**-37.06**	**4212.56**	**10769.90**	**NA**	**-24.33**	**-41.54**	**-37.10**

Note: Global warming potentials (GWPs) used (100 years time horizon): CH_4 = 28; N_2O = 265; SF_6 = 23 500; NF_3 = 16 100; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances

[1]GHG emissions excluding emissions/removals from LULUCF

[2] relative to base year

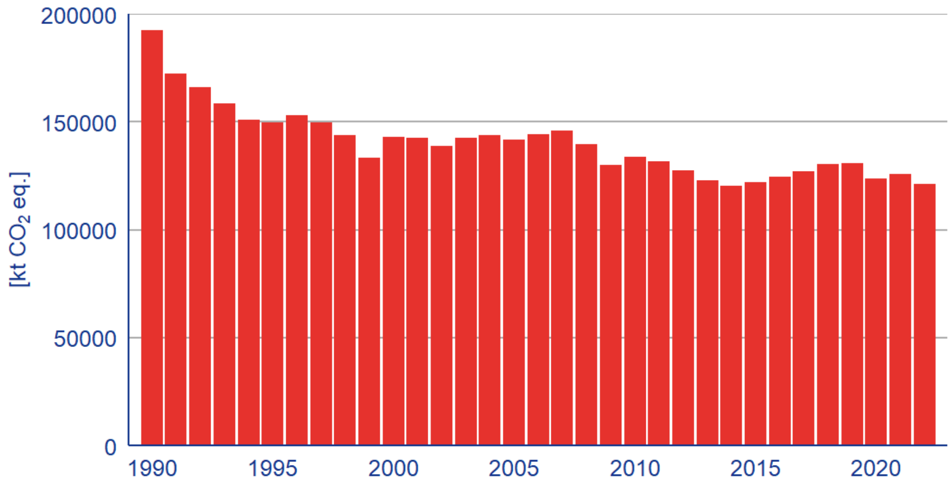
[3]incl. LULUCF

[4] incl.indirect emissions

Source: CHMI

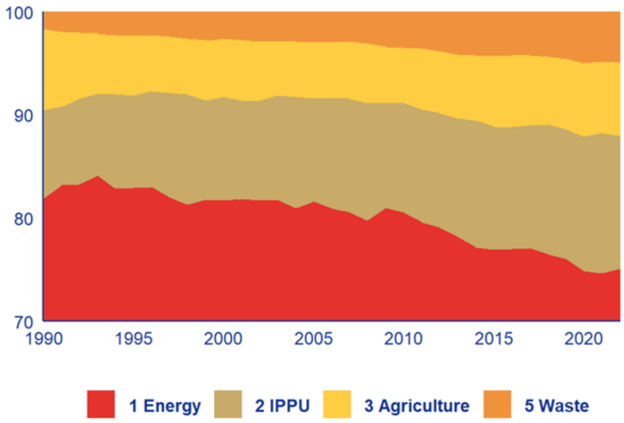
Czechia's GHG emissions have significantly decreased between 1990 and 1995, mainly driven by an economic transition and a substantial drop in industrial production. This period was followed by a decade of plateauing GHG emissions at around 140 000 kt CO_2eq (see Figure 1.3), and later in the 2010s by a temporary drop under 125 000 kt CO_2eq. This trend was however not sustained, which can at least partly be attributed to the shifting emissions balance of the LULUCF sector in recent years. A more pronounced reduction in emission balance was related to the impacts of the COVID-19 pandemic.

Figure 1.3: Trends in greenhouse gas emissions in the 1990 – 2022 period (kt CO_2eq)



Source: CHMI

Figure 1.4: Percentual share of GHGs (Y-axis begins at 70% – part of CO_2 share is hidden)



Source: CHMI

1.4. Descriptive summary

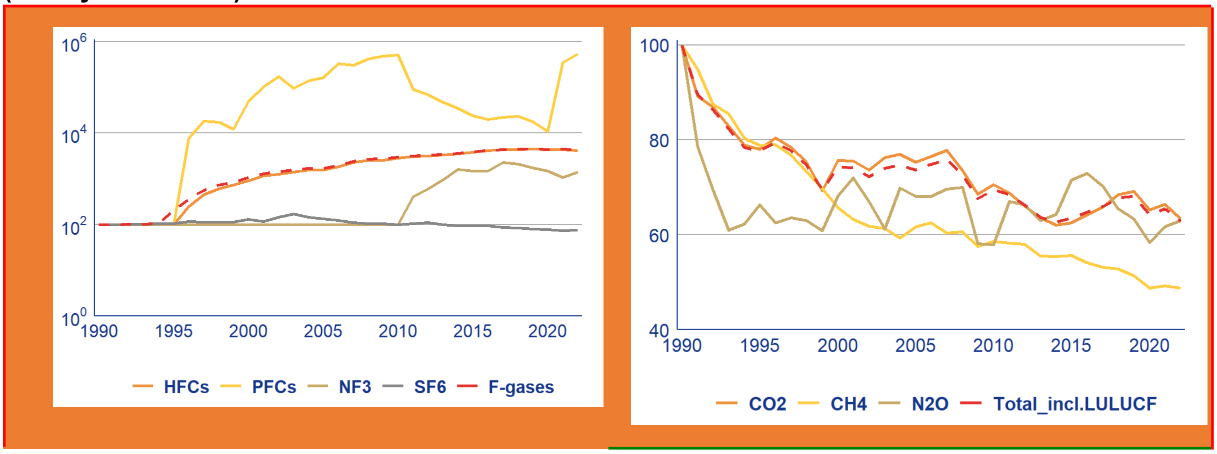
Inventories of greenhouse gases for the purposes of the UN Framework Convention on Climate Change monitor emissions and sinks of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and F-gases emissions (HFCs, PFCs, SF_6 and NF_3). Besides these substances, the inventory also takes stock of precursors: volatile organic compounds (NMVOC), carbon monoxide (CO), nitrogen oxides (NO_X) and sulphur dioxide (SO_2). Emphasis is placed on accurate calculations of emissions of greenhouse gases with direct radiation absorption effect (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3). The total impact of emissions of these gases is given as the aggregated emissions, expressed as the equivalent amount of carbon dioxide, taking into account the global warming potential values GWP for a time period of 100 years.

Greenhouse gas inventories are prepared in accordance with the standard IPCC method. A detailed description of the methodology, emission factors employed and activity data is contained in the National Inventory Report, which is updated annually[3].

1.4.1. Description and interpretation of emission trends by gas

The major greenhouse gas in the Czech Republic is CO_2, which represented 81.2% of total GHG emissions in 2022, compared to 82.4% in the base year (excl. indirect emissions, excl. LULUCF). It is followed by CH_4 (11.2% in 2022, 13.5% in the base year), N_2O (4.4% in 2022, 4.1% in the base year) and F-gases (3.09% in 2022, 0.04% in 1990). The trend of individual GHG emissions relative to emissions in the respective base years is presented in Figure 1.5.

Figure 1.5: Trend in CO_2, CH_4 and N_2O emissions 1990 – 2022 in index form (base year = 100%) and Trend in HFCs, PFCs (1995 – 2022) and SF_6 (1990 – 2022) actual emissions in index form (base year = 100%)



Source: CHMI

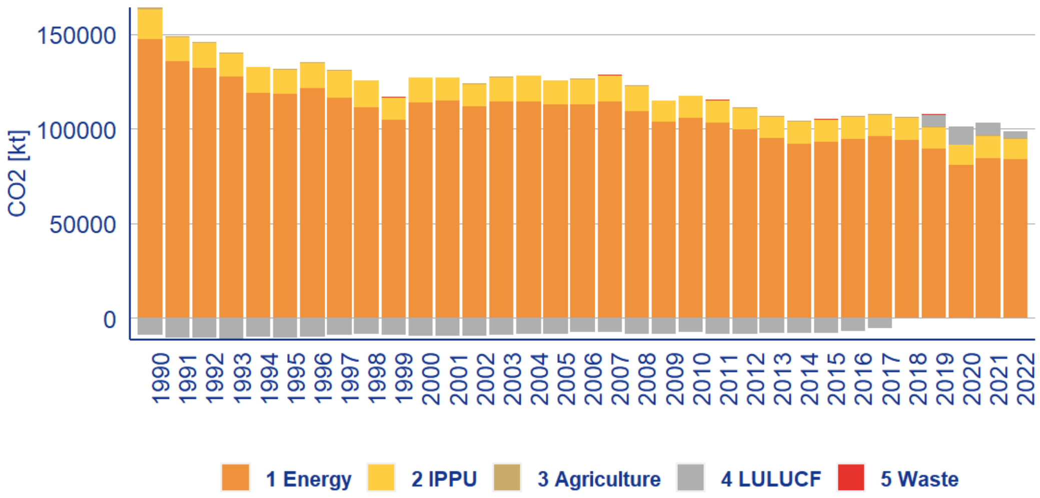
Carbon dioxide

CO_2 emissions have been rapidly decreasing in the early 1990's, after 1994 the emissions have kept at an average of 72% of the amount produced in 1990. Inter-annual decrease in CO_2 emissions (excl. LULUCF, excl. indirect emissions) from 2010 to 2022 by 19% results the total decrease of 42.10% from 1990 to 2022. Quoting in absolute figures, CO_2 emissions and removals decreased from 164 250.44 to 95 107.76 kt CO_2 in the period from 1990 to 2022, mainly due to lower emissions from the 1 Energy category (mainly 1.A.2 Manufacturing Industries & Construction, 1.A.4.a Commercial/Institutional and 1.A.4.b Residential).

The main source of CO_2 emissions is fossil fuel combustion; within the 1.A Fuel Combustion category, 1.A.1 Energy Industry and 1.A.4 Other sectors are the most important. CO_2 emissions increased remarkably between 1990 and 2022 from the 1.A.3 Transport category from 11 077.63 to 19 189.63 kt CO_2eq.

[3] National Inventory Report and data sets for each year are available at CHMI website, http://portal.chmi.cz/files/portal/docs/uoco/oez/nis/nis_do_aj.html.

Figure 1.6: Trends of CO_2 emissions per sector in the Czech Republic, 1990 – 2022 (kt CO_2)

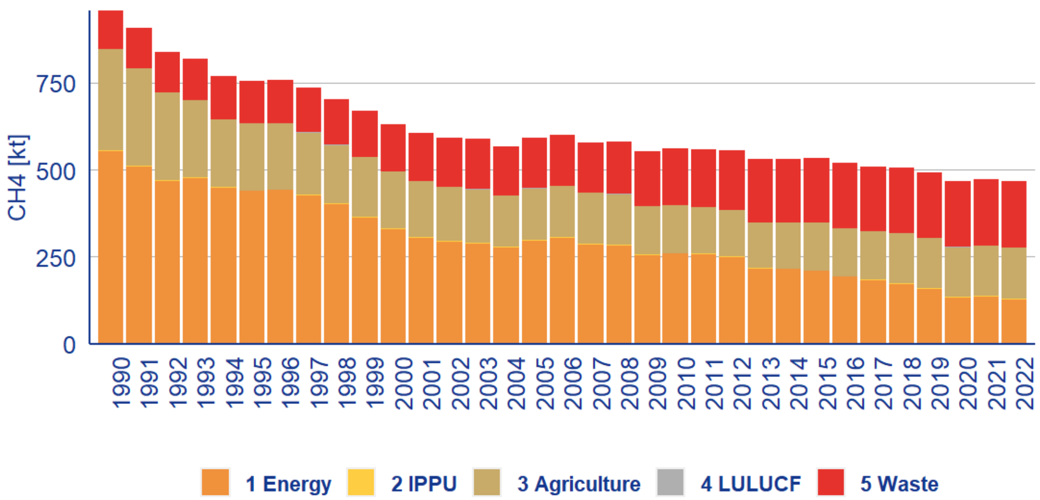


Source: CHMI

Methane

CH_4 emissions share decreased almost steadily during the period from 1990 to 2004, from 2004 methane fluctuated around 60% of its base year emissions. In 2022 CH_4 emissions were 51.25% below the base year level (incl. LULUCF), mainly due to lower contribution of 1.B Fugitive Emissions from Fuels and emissions from 3 Agriculture and despite increase from the 5 Waste category. The main sources of CH_4 emissions are 1.B Fugitive Emissions from Fuels (solid fuel), 3.A Enteric Fermentation and 5.A Solid Waste Disposal on Land.

Figure 1.7: Trends of CH_4 emissions per sector in the Czech Republic, 1990 – 2022 (kt CH_4)



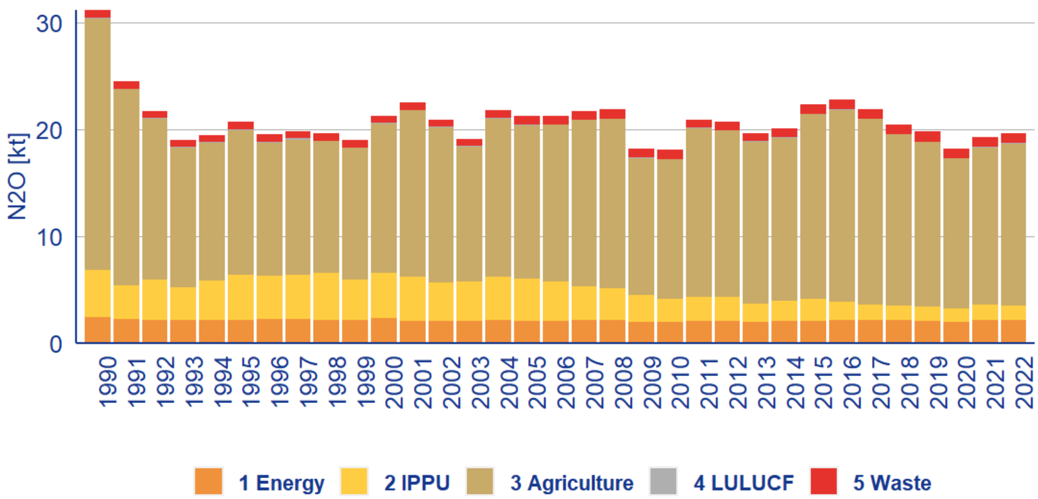
Source: CHMI

Nitrous oxide

N_2O emissions strongly decreased from 1990 to 1994 by 32% over this period and then showed a slow decreasing trend with inter-annual fluctuation. N_2O emissions decreased between 1990 and 2022 from 8 235.99 to 5 196.86 kt CO_2 eq. (incl. LULUCF). In 2022 N_2O emissions were 37.05% below the base year level, mainly due to lower emissions from 3 Agriculture and 2.B Chemical Industry and despite increase from the 5 Waste.

The main source of N_2O emission is category 3.D Agricultural Soils (others less important sources are 1.A Fossil Fuel Combustion and 2 Industrial Processes – 2.G Other product manufacture and use).

Figure 1.8: Trends of N_2O emissions per sector in the Czech Republic, 1990 – 2022 (kt N_2O)



Source: CHMI

HFCs

HFCs actual emissions increased remarkably between 1995 and 2022 from 86.89 to 3 610.40 kt CO_2eq. The rapid increase of emissions was driven mainly by increased consumption of HFCs in subcategory 2.F.1 Refrigeration and Air Conditioning. In 2022, HFCs emissions were more than 42-times higher than in the base year 1995.

The main sources of HFCs emissions are 2.F Product Uses as ODS substitutes (specifically above mentioned subcategory 2.F.1 Refrigeration and Air Conditioning). HFCs and PFCs have not been imported and used before 1995.

PFCs

PFCs emissions rapidly increased between 1995 and 2010. Since 2010, PFCs emissions were decreasing up to 2020 (0.97 kt CO_2eq), however in 2022 there is an apparent rapid increase again to 47.86 kt CO_2eq. Rapid decrease of emissions is caused by reduced consumption of PFCs.

The main sources of PFCs emissions are 2.E Semiconductor Manufacture and 2.F.1 Refrigeration and Air Conditioning equipment.

SF_6

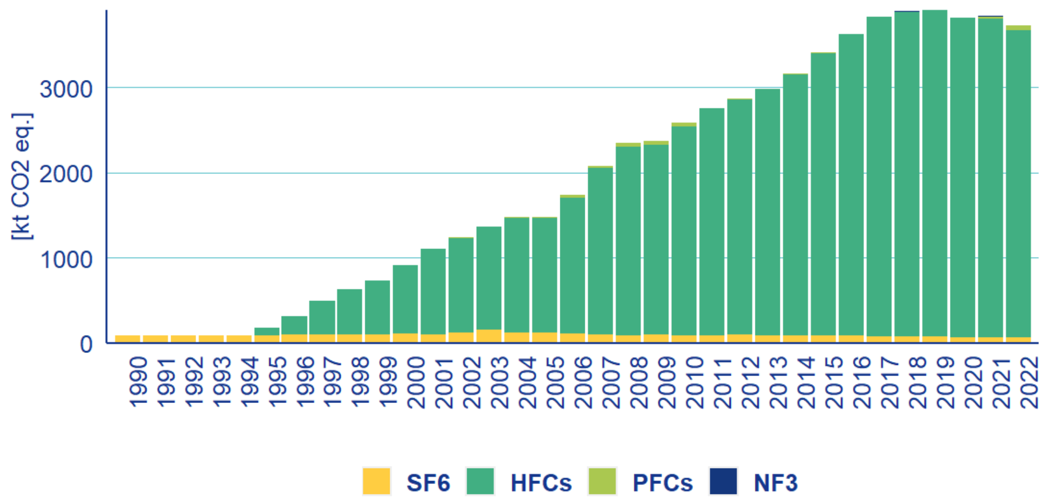
SF_6 emissions in 1995 accounted for 89.22 kt CO_2eq. Between 1995 and 2022 they inter-annually fluctuated with a maximum of 149.14 kt CO_2eq. In 2022 SF_6 reached amount of 65.70 kt CO_2eq., the level was 24.33% lower than the base year (1995).

The main sources of SF_6 emissions is 2.G Other product manufacture and use.

NF_3

With technological progress a new gas has been used since 2010 in semiconductor manufacturing. NF_3 is a gas, used mainly for manufacturing of LCD displays, solar panels and etching semiconductors. Base year for this gas is 1995. In 2022 the emissions of NF_3 equaled 1.95 kt CO_2eq.

Figure 1.9: F-gases inventories in the Czech Republic, 1990 – 2022 (kt CO_2eq)



Source: CHMI

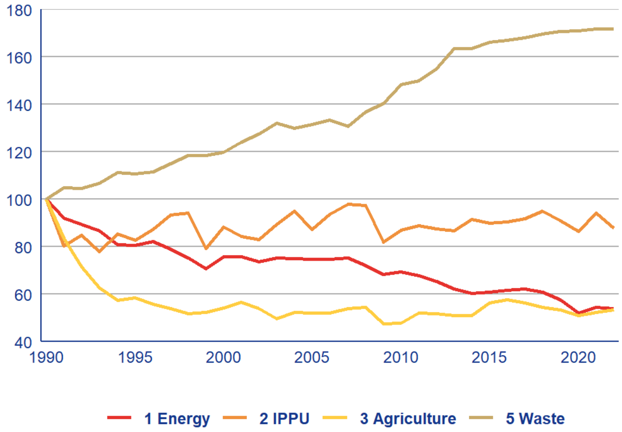
1.4.2. Description and interpretation of emission trends by categories

Table 1.7 presents a summary of GHG emissions by categories for the period 1990 to 2022:

- Category 1 Energy
- Category 2 Industrial Processes and Product Use
- Category 3 Agriculture
- Category 4 LULUCF
- Category 5 Waste

The trend of GHG emissions by categories is presented in Figure 1.10 (indexed relative to the base year).

Figure 1.10: Emission trends in 1990-2022 by categories in index form (base year = 100)



Source: CHMI

The dominant category is the 1 Energy, which caused for 75.1% of total GHG emissions in 2022 (81.9% in 1990) incl. LULUCF and indirect emissions, followed by the sectors 2 Industrial Processes and Product Use and 3 Agriculture, which caused for 12.9% and 7.1% of total GHG emissions in 2022 (8.6% and 7.9% in 1990, resp.), 5 Waste sector covered 4.9% (1.7% in 1990) and 4 LULUCF category caused 7% (removals prevailed in 1990).

Table 1.7: Summary of GHG emissions by category, 1990-2022 [kt CO_2eq]

	1 Energy	2 IPPU	3 Agriculture	4 LULUCF	5 Waste
1990	163204.12	17115.22	15747.95	-8835.33	3319.42
1991	150464.78	13767.97	13146.72	-10336.04	3482.86
1992	145724.75	14522.80	11272.09	-10532.64	3468.80
1993	141387.77	13351.21	9874.73	-11362.60	3542.85
1994	132043.93	14607.00	9060.36	-10116.41	3689.59
1995	131369.36	14160.54	9214.88	-10381.51	3671.07
1996	134178.20	14956.03	8797.92	-10104.18	3698.76
1997	128901.85	15981.74	8499.89	-9062.77	3815.72
1998	122929.68	16137.99	8179.49	-8718.32	3934.44
1999	115394.19	13547.56	8231.56	-8938.63	3933.21
2000	123740.37	15137.16	8528.71	-9683.97	3979.80
2001	123672.96	14424.27	8926.15	-9655.50	4118.03
2002	120399.33	14193.63	8495.31	-9449.74	4230.67
2003	122943.62	15280.69	7822.09	-8949.53	4378.88
2004	122614.65	16253.68	8237.86	-8663.74	4315.41
2005	121841.88	14914.54	8192.26	-8721.87	4362.37

2006	121943.42	16047.68	8221.81	-7664.75	4425.41
2007	122753.89	16780.69	8505.25	-7430.88	4340.86
2008	117523.76	16679.19	8563.57	-8682.74	4546.62
2009	111392.65	14033.46	7505.18	-8437.25	4658.77
2010	113213.37	14881.87	7519.34	-7711.58	4922.25
2011	110723.38	15220.26	8208.17	-8333.45	4971.95
2012	106911.98	14980.28	8157.85	-8555.77	5145.52
2013	101479.46	14858.11	8023.82	-7909.55	5431.57
2014	98462.27	15663.25	8034.23	-7851.57	5425.52
2015	99457.16	15396.58	8875.44	-7853.71	5512.08
2016	100690.32	15471.95	9093.25	-6945.91	5545.24
2017	101465.94	15702.63	8889.34	-5338.06	5579.54
2018	99297.44	16267.70	8594.26	-11.71	5630.50
2019	94283.80	15558.12	8422.67	6493.35	5669.27
2020	84886.54	14779.81	8051.05	9699.69	5675.72
2021	88699.77	16135.46	8239.51	6587.95	5702.11
2022	87907.24	15045.20	8422.28	3378.06	5702.11
[1]%	-0.89	-6.76	2.22	-48.72	0.00
[2]%	-46.14	-12.09	-46.52	-138.23	71.78
[1] Difference relative to previous year					
[2] Difference relative to base year					

Source: CHMI

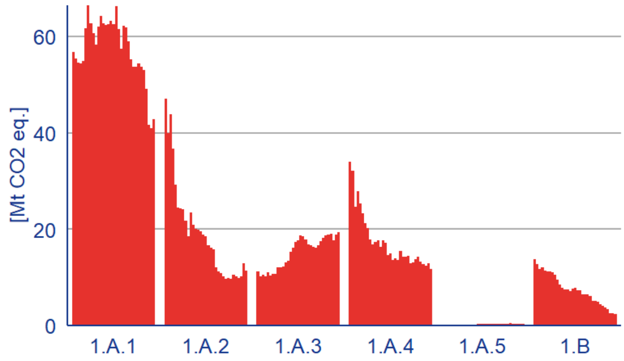
Energy (IPCC Category 1)

The trend for GHG emissions from 1 Energy category shows decreasing trend of emissions. They strongly decreased from 1990 to 1994 and then fluctuated by 2002. After 2002 they stayed relatively stable until 2007. In the period 2002 – 2007 emissions kept around 120 000 kt CO_2eq. Total decrease between 1990 and 2020 is 45.6%. Between 2017 to 2022 emissions from category 1 Energy rapidly decreased by 11.5%.

From the total 87 907.24 kt CO_2eq. in 2022 97% comes from 1.A Fuel Combustion, the rest are 1.B Fugitive Emissions from Fuels (mainly Solid Fuels). 1.B Fugitive Emissions from Fuels is the largest source for CH_4, which represented 27% of all CH_4 emissions in 2022.

CO_2 emissions from fossil fuels combustion (category 1.A Energy) are the main source in Czechia's inventory with a share of 97% in total emissions from the Energy sector. CO_2 emissions from category 1 Energy contributed 74% to total GHG emissions, CH_4 for 3% and N_2O for 0.5% in 2022 (excl. LULUCF).

Figure 1.11: Trends in Energy by categories, 1990-2022 (Mt CO_2eq)



Source: CHMI

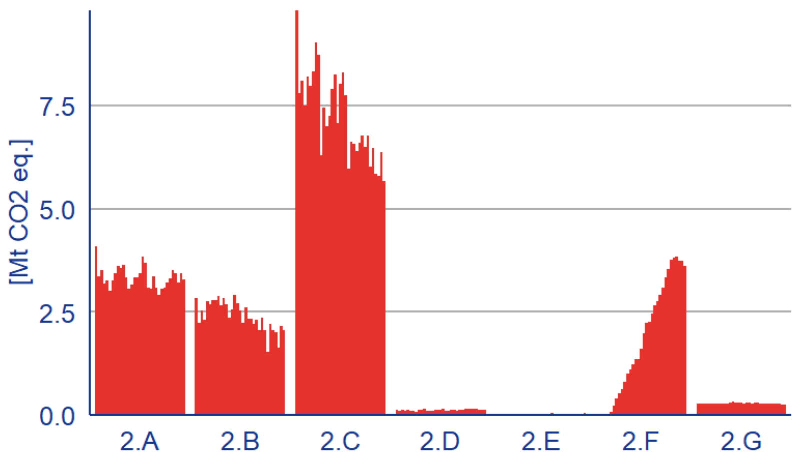
Industrial Processes and Product Use (IPCC Category 2)

GHG emissions from the 2 Industrial Processes and Product Use category fluctuated with decreasing trend during the whole period 1990 to 2022. In the early 90's emissions decreased rather rapidly. They reached a decade minimum in 1993 and since then they have fluctuated. By the end of the nineties they reached their decade minimum due to global economic recession. Between 1990 and 2022, emissions from this category decreased by 12.09%. In 2022 emissions amounted for 15 045.20 kt CO_2eq.

The main categories in the 2 Industrial Processes and Product Use category are 2.C Metal Industry (40%), 2.F Product Uses as ODS substitutes (23%), 2.A Mineral Industry (22%) and 2.B Chemical Industry (14%) of the sectoral emissions in 2022 (Figure 2.12).

The most important GHG of the 2 Industrial Processes and Product Use category was CO_2 with 74% of sectoral emissions, followed by F-gases (23%).

Figure 1.12: Trends in IPPU by categories, 1990-2022 (Mt COeq)



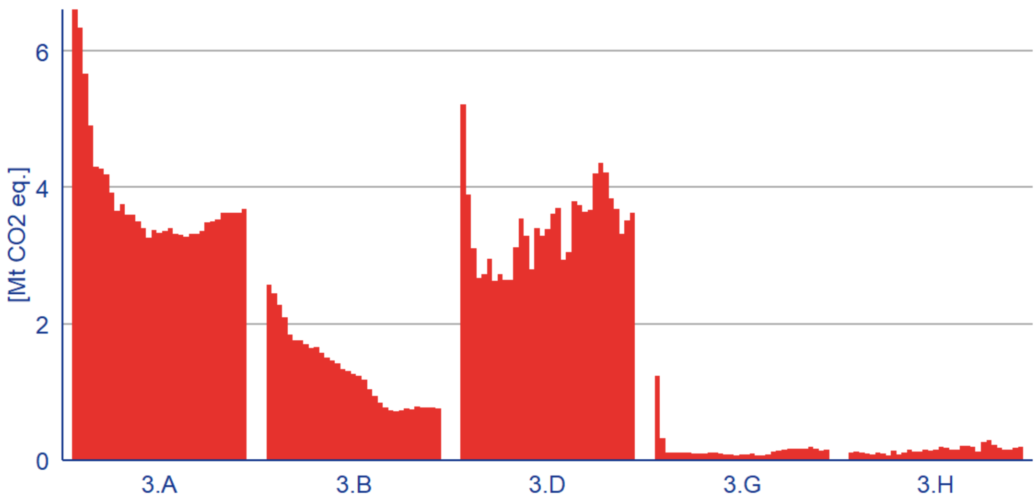
Source: CHMI

Agriculture (IPCC Category 3)
GHG emissions from the category 3 Agriculture decreased relatively steadily over the period from 1990 to 2003 and then fluctuated. In 2010 emissions reached a minimum level, which is 53% below the base year level.

Agriculture amounted to 8 422.28 kt CO_2eq in 2022 which corresponds to 7% of national total emissions (excl. indirect emissions, excl. LULUCF). The most important sub-category 3.A Enteric Fermentation (N_2O emissions) contributed by 44% to sectoral total in 2022, followed by the 3.D Agricultural Soils (CH_4 emissions, 43%).

3 Agriculture is the largest source for N_2O and second largest source for CH_4 emissions (77% of total emissions of N_2O and 31% of total emissions of CH_4, excl. LULUCF). However its emission trend steadily decreases over the whole observed period.

Figure: 1.13 Trends in Agriculture by categories, 1990-2022 (Mt CO_2eq)



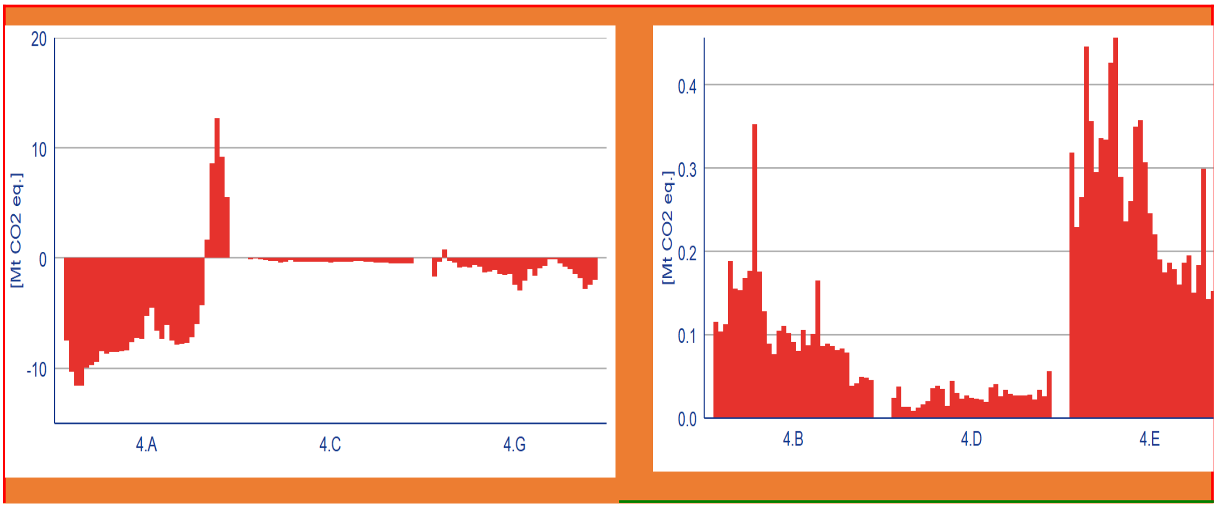
Source: CHMI

Land Use, Land-Use Change and Forestry (IPCC Category 4)
GHG removals from the 4 Land Use, Land-Use Change and Forestry category vary through the whole time series with maximum of -10 687.22 kt CO_2eq in 1993 and minimum in 2017 (-4 498.83 kt CO_2eq).

Emissions and removals amounted to 3 378.06 kt CO_2eq in 2022, which corresponds to 3% of total national emissions.

The LULUCF category is no longer a sink for CO_2. Starting with 2015 the removals decreased and since 2019, resulted in emissions. The situation is caused by the extreme drought-induced bark-beetle outbreak calamity experienced in the Czech forestry, peaking in 2020.

Figure 1.14: Trends in LULUCF by separate source and sink categories, 1990 – 2022 (Mt CO_2eq)



Source: CHMI

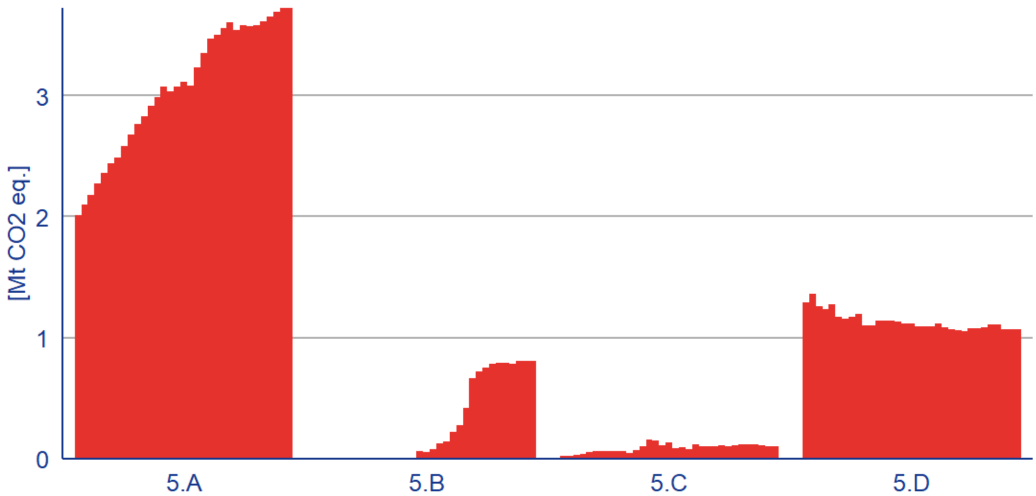
Waste (IPCC Category 5)

GHG emissions from category 5 Waste substantially increased during the whole period. In 2022 emissions amounted for 5 702.11 kt CO_2eq, which is 72% above the base year level. The increase of emissions is mainly due to higher emissions of CH_4 from 5.A Solid Waste Disposal and due higher emissions in 5.B Biological treatment of solid waste. The share of category 5 Waste in total emissions was 5% in 2022.

The main source is solid 5.A Solid Waste Disposal, which accounted for 65% of sectoral emissions in 2022, followed by 5.D Wastewater Treatment and Discharge (19%) and 5.B Biological treatment of solid waste (14%). Trends of the separate sub-categories in Waste sector can be observed on Figure 1.15.

94% of all emissions from the Waste category are CH_4 emissions; CO_2 contributes by 2% and N_2O by 4%.

Figure 1.15: Trends in Waste by categories 1990-2022 (Mt CO_2eq)



Source: CHMI

2. Information necessary to track progress

2.1. National circumstances

2.1.1. Government Structure

Czechia is a parliamentary democracy with division of powers between the legislative, executive and judicial branches of the Government. The President is the head of the State, elected directly for a five-year term. The fundamental constitutional arrangement is laid down by the Constitution of the Czech Republic, effective as of 1 January 1993. The supreme legislative body is the two-chamber Parliament, comprising the Chamber of Deputies and the Senate, which adopts all proposed bills, approves international treaties, conventions, protocols and other important political strategic documents. The executive powers rest with the Government, which is formed on the basis of elections into the Chamber of Deputies.

Czechia is divided into 14 higher territorial self-governing units – regions, corresponding to NUTS 3 categories. Regional Authorities act as the local bodies exercising delegated powers of the state Government. The head of each regional county is a Governor; in Prague the head is the Mayor. Regions represent a self-governing level between the Government and local municipalities, be it cities, towns or smaller units. Municipalities are self-governing units managed by the locally elected municipal and city boards of representatives and are headed by Mayors.

The Ministry of the Environment functions as the central body of State administration and the supreme supervising body in all matters related to the environment. Among others, the Ministry has primary competence in the following areas: transition to a low-carbon economy; protection of climate system; adaptation to climate change; protection of nature and landscape; protection of mineral deposits, incl. protection of natural resources and groundwater; waste management. The Ministry of the Environment coordinates activities of all other ministries and other central State administration bodies in all matters relating to the environment. As of late-2024, the Ministry of the Environment was divided into five expert sections (Section of State Secretary, Section of Environmental Economics, Section of Nature and Landscape Protection, Section of Environmental Protection and Section of Climate Protection).

As regards climate change mitigation and adaptation, other ministries have a fundamental role to play as well. These include the Ministry of Industry and Trade responsible i.a. for industrial, energy and resource policy; the Ministry of Agriculture responsible i.a. for water management and forestry; Ministry of Foreign Affairs responsible i.a. for foreign policy including external economic relations; and the Ministry of Finance responsible i.a. for state budgeting and fiscal policy.

2.1.2. Population

As of March 2024, the population of Czechia was 10.86 million. This corresponds to an increase of approximately 340 thousand compared to 2021, primarily due to immigration, which includes hundreds of thousands of Ukrainian refugees following Russia's full-scale invasion after February 2022. The Czech Statistical Office in its middle scenario projects a generally stable development of the number of inhabitants in the near future, with a slow and gradual decreasing trend in later years due to falling fertility rates. A crucial socio-economic aspect will be the projected ageing of the population (estimated 3.25 million persons aged 65+ by 2061 compared to 2.21 million in 2021).

The average population density of Czechia is 137 inhabitants per square kilometre. Czechia is characterised by a scattered settlement structure, with 6250+ municipalities as of 2023 while only a fraction of these can be called towns by international standards. High population density and high urban dwellers ratio exceeding 70% means that a large number of inhabitants live in areas with disrupted natural environment, especially due to emissions from intensive traffic, household heating using solid fuels and other local negative impacts. More than 10% of the population live in the capital of Prague while five other cities have more than 100 thousand inhabitants (Brno, Ostrava, Plzeň, Liberec and Olomouc).

2.1.3. Geographical Profile

Czechia has an area of 78 871 square kilometres. The highest mountain is Sněžka (1 603 m above sea level), while the lowest point in the country is located near Hřensko where the River Elbe crosses into Germany (115 m above sea level) unless accounted for the bottom of a human-made surface lignite mine (20 m above sea level). From the perspective of altitude, lowlands under 200 m above sea level take up 5%, areas between 200–500 m above sea level take up 74%, areas 600–1 000 m above sea level take up 19% and areas with altitude exceeding 1 000 m above sea level take up less than 2% of the territory. The average altitude is 450 m above sea level. Out of the overall area of the country, 37% comprised arable land, 34% forests, 13% grasslands, 2% water bodies, 1.7% settlements and developed land. The rest included gardens, orchards and other land.

The divide among the main watersheds of Europe passes through Czechia (the North, Baltic and Black Seas), which is not favourable from the standpoint of water management, as most rivers have their source here. The vast majority of the territory of Bohemia is drained by the Elbe into the North Sea, the major part of Moravia is drained by the Morava River into the Danube and Black Seas and the majority of Czech Silesia is drained by the Oder River into the Baltic Sea. Natural lakes are scarce while artificial water reservoirs are far more numerous, with more than 24 000 located in the country, the vast majority of which are fishponds. Mineral springs are very common, occurring in about 350 locations.

2.1.4. Economic profile

Czechia is a medium-sized open and export-driven economy. Industry (especially manufacturing) historically plays an important role in the Czech economy in terms of both gross value added (approx. 30%) and employment (more than 1.2 million persons). Since entering the European Union in 2004, Czechia has been part of the European single market, reaping the benefits of unrestricted trade in goods and services. As of 2024, the currency remains the Czech Crown (CZK).

With a GDP per capita (PPP) nearing 50 000 USD in 2024, Czechia's economic output stood at around 90% of the EU-27 average. The Czech economy is substantially reliant on the performance of its key trade partners (mostly Germany and other EU countries, which account for approx. 70% of Czech exports). Throughout the past five years, the unemployment rate in Czechia was the lowest in the EU, standing at around 3% in 2024. The public debt stood at 42 % of the GDP by 2023, corresponding to an increase of 14 percentage points since 2019.

At the same time, many Czech households have been negatively affected by the energy and cost-of-living crisis associated primarily with Russia's full-scale invasion of Ukraine, which also manifested itself in very high inflation rates peaking at 15% in 2022. By 2023, approximately 1 million people (close to 10% of the population) were considered at risk of income poverty.

2.1.5. Climate profile

Czechia lies within the Atlantic-continental area of the moderate climate zone of the northern hemisphere with fluctuating average annual temperatures. There is a recorded linear warming trend since the early 1960s when the moving 5-year average temperature was just under 7°C, into early-2020s when the same average exceeded 9°C. The lowest temperature averages are recorded in mountainous regions along the northern, eastern and south-western borders of the territory. The warmest regions lie in altitudes not exceeding 200 m (esp. lowlands in Southern Moravia and along the Elbe River).

Average spring and autumn temperature oscillate around 8 °C, during the summer months the temperature rises to 17 °C on average, in winter the temperature drops to about 0 °C on average. Prague represents a specific region, as within its heat island the average annual temperature is higher by approximately 2 °C above the value normal for its geographic location. The number of days with a maximum temperature exceeding 30 °C has been on the rise while the number of frost and ice days decreased substantially.

Table 2.1: Changes in average number of days with extreme temperatures in 1961–1990, 2015–2020 periods

Summer days TMA ≥ 25 °C	1961–1990	33	**Frost days** TMI < 0 °C	1961–1990	120
	2015–2020	76		2015–2020	32
	Change	**43**		**Change**	-88
Tropical days TMA ≥ 30 °C	1961–1990	5	**Ice days** TMA < 0 °C	1961–1990	39
	2015–2020	23		2015–2020	7
	Change	**18**		**Change**	-32

Source: CHMI

The long-term average precipitation in Czechia equals 686 mm with approximately 25% of this amount flowing out of the country in watercourses. The cumulative annual precipitation has remained stable on average thus far in spite of the effects of climate change. However, precipitation patterns have been changing: there tends to be less snow- and rainfall in the winter and spring months as opposed to summer and early autumn. There are also more frequent intense rain- and snowfall in shorter periods of time. Between 2015 and 2020, Czechia has recorded the longest period of drought since measurements began.

Relative humidity, cloud amount, sunshine, snow cover and duration trends remain consistent and correspond to temperature trends and their amplitudes. Winter, spring and summer are characterised by extended sunshine, lower cloud amount and lower relative humidity. Average number of days with snow cover in altitudes below 600m above sea level and in higher altitudes has dropped in the last two decades in comparison with the usual number of days in the second half of the 20th century. Snow cover maxima have decreased in lowlands and also in uplands. Similar trends are also recorded for overall new snow precipitation.

2.1.6. Energy

At present, energy-based emissions (including in transport) continue to make up the bulk of the overall national GHG emissions balance. In 2022, this amounted to just under 88 Mt CO_2eq, which is however a decrease of more than 46% compared to 1990. In energy supply, a vast majority of these emissions have been historically related to the combustion of lignite. With the continued energy transition and particularly the phase-out of coal from power and heat generation, the emission reduction trend is set to continue. In 2022, the emissions from combustion of coal and natural gas in producing power and heat made up approx. 40 Mt CO2eq. Their vast majority are produced in large facilities (power plants and CHP plants) covered by the EU ETS.

In 2022, Czechia produced 84.5 TWh of electricity (gross), covering a consumption of 60.4 TWh and an export of 13.5 TWh. Out of this more than 43% came from lignite or hard coal, 37 % from nuclear plants, 12% from RES and 6% from natural gas. In the same year, 151 PJ of heat (gross) was produced in district heating plants, out of which 47% was based on lignite or hard coal, 20% on natural gas and 18% on RES. The Czech economy is highly dependent on the import of energy commodities (especially oil and natural gas). Under available scenarios, there will soon be a dip in the production of electricity in the context of phase-out of coal plants, which may make Czechia import-reliant.

The energy intensity of the Czech economy has been decreasing in the long run (by nearly 35% between 2010 and 2020), including thanks to utilising less energy and emission intensive technologies and fuels, building renovations and saving achieved in households, municipalities and industry. Nevertheless, in the EU context, Czechia remains among the energy intensive economies (7.8 MJ/EUR puts it nearly at double of EU27 average).

Czech energy policy is largely determined by EU-level energy policy and developments on the global and European markets. A crucial factor for the development of Czechia's energy systems is the regulation adopted at the EU level. In this regard, there has been a clear emphasis on significantly reducing greenhouse gas emissions and a set of related targets, particularly as regards the deployment of renewable energy sources (also referred to as "RES"), and energy efficiency.

The Czech energy sector is currently undergoing a fundamental transformation due to both external conditions and political goals. This involves a change in the resource base for electricity and heat production (replacement of sources aiming at lower emissions and higher efficiency, as well as significant decentralisation), a change in the use of primary energy sources, increased use of electricity in transport and industry, and achieving significant energy savings on the consumption side.

The following can be considered the key current trends in energy in Czechia:
i) decarbonization; ii) decentralisation; iii) digitalization; and iv) democratisation. A partial trend can also be identified as the gradual increase in the use of more refined forms of energy, specifically a higher utilisation of electricity at the expense of other energy carriers and fuels, which is in turn related to the trend of interconnecting various sectors. These trends are motivated primarily by the energy policies of individual countries, developments in the global energy market, and also by the gradually changing preferences of end consumers.

Through the continuing trend of electrification, decarbonization of parts of sectors, such as transport or industry, should be enabled, with both sectors also contributing to the efficiency of electricity system operation by utilising demand response opportunities. This trend will place increasing demands on the availability, quality, and also the emissions of produced and consumed electricity in the context of rising electricity production from intermittent sources and declining performance of controllable sources.

According to government policy, the Czech electricity mix should primarily be based on the use of nuclear energy and energy from renewable sources. In this regard, natural gas is expected to play the role of a supplementary fuel, which will gradually be replaced by renewable and low-emission alternatives that ensure system management, complemented by a comprehensive portfolio of services for storage, aggregation, and flexibility. All of this is, of course, contingent on the establishment of the necessary infrastructure, both in terms of hardware and software. To ensure the safety and reliability of electricity supply, it is also wise to ensure a certain level of self-sufficiency and resource adequacy, particularly through sufficient production capacities in an appropriate structure.

The heat supply segment, including combined heat and power production and distribution, is also set to undergo significant changes, reflecting the conditions set by the state, the opportunities for business entities, and consumer behaviour. Currently, about 50% of heat supply is conducted through district heating. Increasingly, heat energy is produced from renewable energy sources (especially biomass, biogas, solar collectors for water heating, and heat pumps), as well as from secondary energy sources (primarily utilising waste and waste heat), and in the future, the use of hydrogen can also be anticipated, depending on its price and availability, alongside synthetic fuels (as possible substitutes for natural gas), and possibly geothermal energy.

Intense competition for access to mineral resources leads to the formation of new alliances and a global emphasis on energy security. A fundamental challenge for the Czech energy sector as a whole as well as for the preparation of individual policies is therefore the resolution of the relationship between global and regional aspects of environmental protection and ensuring a safe energy supply. The structure of the energy mix and a prospective diversification of energy sources will shape the future of the energy sector for a long time to come. For the Czech Republic, this is relevant because, despite a relatively low level of overall import dependence compared to other EU countries—partly due to the historical use of domestic coal in power and heating —there is essentially full dependence on imports of oil and natural gas. Replacing imported fossil fuels with locally available sources will therefore be one of the significant challenges.

2.1.7. Transport

Passenger and freight transport is annually responsible for approx. 20 Mt CO_2eq, which as of recently amounted to 16% of all Czech GHG emissions. Unlike in all other sectors, transport-based emissions have been on the rise in the long term, especially as a result of increased demand for transport, increased ownership of passenger cars, and the increase of their average size and weight.

Two thirds of all emissions in the transport sector can be attributed to passenger transport and one third to freight transport. While passenger cars are responsible for 63% of all transport capacity (in pkm), their share of GHG emissions among all passenger transport is 80%. On the other hand, public transport including rail, bus and local transport provides 29% of transport capacity with just a 10% share of emissions. This makes it a much more efficient mode than individual passenger transport, particularly as regards the efficiency of electrified rail transport. The remaining 9% of transport capacity and 10% of emissions are attributable to flights. In freight transport, 71% of the capacity (in tkm) and 98% of the emissions are covered by road transport. 29% of the capacity and just 2% of the emissions are attributed to rail freight transport. The role of active mobility (pedestrian and biking) cannot be underestimated but concrete national data is unfortunately not available.

Apart from GHG, transport (esp. road transport) remains an important source of local pollution in Czechia. It is presumed that the future decarbonization of transport will also yield a reduction in this pollution. By 9/2023, there were 33 thousand registered electric passenger cars (BEV and PHEV) in the country, amounting to only 0.5 % of the total number of registered passenger vehicles, which stood at 6.5 million. The share of BEV and PHEV on newly-registered vehicles remained equally relatively low, at 5%. All the while, the charging infrastructure has been slowly expanding, with around 2 000 charging stations offering approx. 4 000 EV charging points in 2023. The share of hydrogen passenger cars remains negligible.

Given the prevalence of fuel combustion in transport, the electrification of the sector remains low in Czechia. The consumption of low-emissions hydrogen and synthetic fuels is practically non-existent. There is a notable trend of utilising waste-produced biofuels in transport as well as bioCNG and bioLPG. However, biofuels are not expected to play an important role in the sector in the long run.

As for the prospective developments in the transport sector, it is expected to be based on the following pillars:

For passenger transport:
- Significant development and increased share of quality low-emission public transport including a supporting role of new concepts (e-carsharing, demand-based transport).
- Decarbonization of individual passenger transport, primarily based on a shift towards BEV. This requires a decrease in the sales prices of BEV compared to ICE as well as substantial development of charging infrastructure and a sufficient supply of low-emission electricity.
- Auxiliary role of smart urbanisation in support of public, pedestrian and bicycle transport.
- Significant development of rail infrastructure so as to increase its capacity.

For freight transport:
- Shift of a part of the freight volume from roads towards electrified railways, including through an increased share of multimodal transport with rail as the primary mode.
- Potentially an electrification of light trucks.
- Development of zero- and low-emission truck transport via bioCNG and bioLPG in the near future, and via BEV and hydrogen-cell trucks later in the future.

2.1.8. Industry

Czechia is a highly industrialised economy with more than one in three economically active people working in the secondary sector, and with industry contributing to the overall added value produced in the country by nearly ¼, both substantially above EU average. The GHG share of industry on the aggregate emission balance stands similarly at around 24%. The high level of industrialization is not a recent phenomenon but rather a historical constant, although the industrial sector underwent various changes in the past. Importantly, after 1990 many enterprises (particularly in energy-intensive heavy industry and manufacturing) closed their operations, and others have introduced measures towards energy savings. This has resulted in a drop of GHG emissions from approx. 60 Mt CO_2eq in 1990 to approx 40 Mt CO_2eq by 1995. In the following years, the emissions reduction trend had slowed down and in the past ten years, industrial emissions stagnated at around 30 Mt CO_2eq.

At present, a majority of GHG emissions in the industrial sector are linked to a relatively small number of subsectors and enterprises. Their predominant share stems from the production of primary commodities such as production steel and other metals (29% of sectoral emissions) or cement and minerals (20%). These are followed by chemical industry (18% sectoral emissions) and then by the emission balance of F-gases (12%) as a specific sub-category related to the whole lifetime of certain products (especially refrigerators and air-conditioners). A smaller emission share can be attributed to the processing of fuels and petroleum (6%), food industry (4%) and paper industry (3%). A fundamental component of the Czech industrial base, albeit with a smaller GHG footprint, has been the automotive industry.

Industry-related emissions may be broken down into two key categories: combustion-based emissions, and emissions from industrial processes. In the case of the former, the main solution to ensure decarbonisation is the replacement of conventional fuels with electricity or low-carbon ones, particularly hydrogen. Emissions from industrial processes can be to a large extent reduced by changes in production processes and technologies, introduction of secondary materials (e.g. steel scrap) or by the introduction of CCUS technologies. Even so, it is not expected that industrial emissions could be reduced to a net-zero. CCUS in the Czech context is in a very initial stage of development, taking the form of several small pilot projects. A country-wide strategy or vision is so far lacking.

Until 2030, it is expected that most emissions reductions will be achieved by applying pre-existing technologies yielding emissions savings, improved energy efficiency, use of waste heat, and other ways of achieving energy savings or improved circularity. Beyond 2030, the long-term vision relies on the successful deployment of three key technologies: a) low carbon energy and especially the sufficient supply of green affordable electricity, b) availability of renewable or low-carbon hydrogen to be used in numerous industrial processes, c) CCUS as a way to reduce process-based emissions and the decarbonization of cement production, potentially also serving as an auxiliary technology for steel production.

2.1.9. Agriculture

Cropland represented 53.2% of the total area of the country in 2023. In 2003 the figure was 54.1% and there is a continuous slightly decreasing trend. Between 2022 and 2023 there was a slight decrease in arable land (by 0.3%) and a slight increase in permanent grassland (by 0.4%). The conversion of arable land to grassland is also a long-term trend.

Czechia's agricultural production predominantly focuses on crops, including cereals and oilseeds, as well as grains, potatoes, sugar beet, hops, fruit, vegetables, and grapevines. Wheat remains the predominant crop. Livestock production is largely focused on bovine animals, pigs, poultry, sheep, and goats.

There are around 26 530 agricultural holdings in the country, with around 75% of farmland cultivated by large farms. The average share of employment in agriculture in total employment is 2.5% (in 2005 it was 3%, in EU-27 it is currently about 4%). The share of agriculture in gross value added was about 1.4% in 2023.

The development of organic farming shows a positive trend. The number of organic farms has been steadily growing in recent years. Numbers of distributors and producers of organic food are also on the rise. Currently, approximately 4% of arable land is managed under organic farming, as are 44% grasslands, 5.5% vineyards and 7.5% orchards.

In 2022, the GHG emissions from agriculture reached a total of 8 422 kt CO_2 eq. (about 7% of all GHG emissions). GHG emissions from agriculture decreased by about a half during the 1990s and since then remained relatively stable. Agriculture is the largest source of N_2O emissions (75% of the total N_2O emissions) and second largest source of CH_4 (30% of total emissions of CH_4). Approximately half of the sectoral emissions can be attributed to cattle farming and most of the remaining emissions are related to the application of nitrogen fertilisers, although overall chemical fertiliser use in Czechia remains below EU average. While grasslands contribute to carbon sequestration by about 500 kt CO_2 eq annually, the contribution of arable land is negligible as a result of wind and water erosion often related to improper management.

With a view ahead, it is expected that the following measures will contribute to reducing the carbon footprint of Czech agriculture while also enhancing the resilience of agricultural land towards climate impacts:

- Reduced use of nitrogen mineral fertilizers including by applying methods of precision agriculture.
- Support of environmentally friendly farming practices (organic, regenerative, carbon farming).
- Utilizing the potential of sequestering carbon in arable land.
- Restoration of a diverse landscape structure.

2.1.10. Forestry

Forests cover more than ⅓ of the area of the country. The sector of forestry has been undergoing dramatic developments in recent years. Until 2015, it contributed to the overall emission balance with an annual sequestration of approx. 6 Mt CO_2eq. However, in the context of a lasting dry spell that led to the deterioration of the health of many forests, and the related massive outbreak of bark-beetle infestation, the annual removals of forest biomass started to substantially exceed the annual forest biomass increment. This resulted in a net contribution of the sector towards the annual emission balance, surpassing 10 Mt CO_2eq by 2020. Sooner than predicted, total timber harvesting fell to 18.49 million m^3 in 2023, marking a return to CO_2 sinks from forest management after several years. However, even in the future, the CO_2 balance will be at risk if large-scale disturbances recur (see in more detail in the chapter on projections).

Czech forests are still dominated by spruce (43% of the forest area) followed by pine (10%). Young forest stands below 20 years of age have a smaller share of both spruce (35%) and pine (5%). In the European context, the health of Czech forests is below average, mostly due to the history of planting monocultures (especially spruce), which cannot thrive in the new climatic conditions. Historically, the deteriorating health of forests was also attributable to the emissions of harmful substances (such as sulphur) resulting from coal combustion in large plants.

The overall biomass stock of Czech forests and forest soils is estimated at around 2 Gt CO_2eq, nearly twenty-fold the overall Czech annual emissions. It is therefore understood that the state of the forests will be a critical contributing factor to the country's efforts related to climate change mitigation. However, the primary goal remains to adapt Czech forests to climate change. The potential increase in carbon stock requires the cultivation of forests resilient to climate change and its impacts, which in turn demands a varied composition of the forests, in species, age and area of the forest stands. Such forest composition and structure cannot be achieved without harvest, so the process of adapting forests to future climate conditions can temporarily decrease the amount of stored carbon. However, the rejuvenation of Czech forests faces major challenges, including the current overpopulation of game.

While always proceeding according to the specifics of the given locations, the outlook for climate-resilient forestry in Czechia includes the following measures:

- Support natural forest regeneration and enhanced resilience including by reducing the numbers of game in the forests, that threaten the vitality and growth of particularly young trees.
- Increase biodiversity by minimising forest clearings and by promoting integrative forest management, incl. leaving habitat trees behind.
- Continue implementing sustainable forest management for an equal fulfilment of environmental, economic, and social functions of forests and provide for a multitude of ecosystem services.
- Systematically reduce the risk of forest fires so as to protect forest stands and prevent a massive release of carbon.

2.1.11. Waste

There is a notable trend of a decreasing material intensity of the Czech economy (44.6% between 2000 and 2021). However, the overall waste production including municipal solid waste has been increasing in the longer-term. The main goal as regards the handling of waste is to substantially reduce its landfilling and promote its material use, applying the principles of a circular economy.

In 2022, Czechia witnessed a year-to-year dip in the production of both all types of waste, and solid municipal waste in particular. The overall waste production amounted to 39.1 million tonnes, out of which 1.6 million tonnes was dangerous waste and 5,8 million tonnes municipal solid waste. A substantial share of all waste can be attributed to construction and demolition waste. Per capita waste production amounted to 3.7 tonnes for all waste and 553 kg for municipal solid waste. 86% of all waste was reused (83% for material use, 3 % for energy use), as was 53% of municipal solid waste (41% for material use, 12% for energy use). 13% of all waste and 45% of municipal solid waste was deposited in landfills, which is substantial but at the same time the lowest share in a decade. Material use has increased by more than 10 percentage points between 2009 and 2022. A notable trend is the increase of the production of packaging waste, which more than doubled in the same period.

In terms of the waste-related GHG emissions, the long-term trend was negative, marking a gradual increase of emissions towards 5.6 Mt CO2eq in 2022. With the intended policy changes that shall lead to a decrease in landfill waste deposits and increased material reuse, Czechia is aiming at breaking the trend in the coming years. The vast majority of waste-related emissions can be attributed to methane.

Apart from the transition away from landfilling and the application of circular economy principles, the key objectives in waste management include effective management of wastewater (including full use of the produced biogas) and the modernization of existing biogas plants so as to limit methane leaks.

2.2. Institutional arrangements

2.2.1. Institutional arrangements for tracking progress

The EU and its Member States have specific arrangements in place for the tracking of progress towards the implementing and achieving of the EU NDC. These arrangements include the tracking of GHG emissions and removals, the reporting of policies and measures, and projections of GHG emissions and removals. These processes are specified in the Regulation on the Governance of the Energy Union and Climate Action (Governance Regulation)[4] and in the Directive establishing a system for greenhouse gas emission allowance trading within the Community (ETS Directive)[5]:

Under the Governance Regulation, the EU has established a Union Inventory System to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of the data reported by the EU and its Member States. This inventory system includes a quality assurance and quality control programme, procedures for setting emission estimates, and comprehensive reviews of national inventory data.

Each EU Member State compiles its GHG inventory in accordance with the requirements of the Paris Agreement[6] and the relevant Intergovernmental Panel on Climate Change (IPCC) guidelines[7]. Inventory data on GHG emissions and removals, including information on methods, are submitted electronically using a reporting system managed by the European Environment Agency (EEA). The submitted data are subject to quality control procedures and feed into the compilation of the GHG inventory of the EU. Net GHG emissions, calculated from emissions and removals reported in the GHG inventory of the EU, are the key information used for tracking progress towards the EU NDC target of a -55% net emission reduction by 2030 compared to 1990.

Given the scope of the EU NDC related to international aviation and navigation, a specific share of international aviation and navigation emissions as reported in the GHG inventory data is calculated based on the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES)[8]. Details on the methodology applied to identify GHG emissions from international aviation and navigation in the scope of the EU NDC,

[4] Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, http://data.europa.eu/eli/reg/2018/1999/oj.

[5] Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, as amended, http://data.europa.eu/eli/dir/2003/87/2024-03-0 1.

[6] Chapter II of the annex to decision 18/CMA.1, https://unfccc.int/documents/193408; and decision 5/CMA.3, https://unfccc.int/documents/460951.

[7] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc-nggip.iges.or.jp/public/2006gl/; and on a voluntary basis: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

[8] European Commission, Joint Research Centre, Rózsai, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Tattini, J. and Neuwahl, F., JRC-IDEES-2021: the Integrated Database of the European Energy System – Data update and technical documentation, Publications Office of the European Union, Luxembourg, 2024, https://publications.jrc.ec.europa.eu/repository/handle/JRC137809.

which are added to the national totals from the EU GHG inventory, are given in Annex 2 to this BTR.

Under the Governance Regulation, Member States further operate national systems for policies and measures and projections and submit standardised information, which is subject to quality and completeness checks. Based on the submitted data, the EEA compiles projections of GHG emissions and removals for the EU. The EU-wide information is summarised annually in the Climate Action Progress Report[9] by the European Commission and in the 'Trends and projections' report by the EEA.[10]

2.2.2. Institutional arrangements for implementation of the NDC

The EU and its Member States have set up a comprehensive system for the implementation of the EU climate change mitigation targets. The European Climate Law[11] sets the goal of climate neutrality by 2050 and the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. These targets cover emissions and removals that are regulated in the Union law.

These targets cover emissions and removals that are regulated in the Union law. To ensure that the EU and its Member States achieve their target, the 2030 Climate and Energy Framework was put in place. The main elements of this framework are the EU Emissions Trading System (EU ETS)[12], which caps GHG emissions in energy, industry, aviation and maritime transport; the LULUCF Regulation which includes national net removal targets for the LULUCF sector; and the Effort Sharing Regulation (ESR) which establishes national reduction targets for GHG emissions not covered by the EU ETS or the LULUCF Regulation. The implementation of the ESR is supported by additional sectoral policies and measures (details can be found in this BTR in the chapter on mitigation policies and measures). The legislative acts under the 2030 Climate and Energy Framework require the European Commission and the EU Member States to set up the institutional arrangements for implementing the specific policies and measures.

Progress in the implementation of these policies and measures is monitored under the Governance Regulation. Relevant information which is reported regularly and archived at the EEA include GHG inventories, approximated GHG inventories for the previous year, information on policies and measures, projections, and progress towards the implementation of integrated National Energy and Climate Plans (NECP). This information helps the EU and its Member States to correct their course if progress towards the targets of the 2030 Climate and Energy Framework is behind schedule. As an example, the European Commission

[9] Climate Action Progress Report 2024 (under the Energy Union Reporting set out in the Governance Regulation), https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-climate-action_en

[10] Trends and Projections in Europe 2024, https://www.eea.europa.eu/en/analysis/publications/trends-and-projections-in-europe-2024/trends-and-projections-in-europe-2024

[11] Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), http://data.europa.eu/eli/reg/2021/1119/oj.

[12] This refers to the ETS1, i.e. the Emission Trading System for stationary sources (Chapter III of the ETS Directive) and for aviation and maritime transport (chapter II of the ETS Directive). Note that the 'Emissions trading system for buildings, road transport and additional sectors' (ETS2), added in 2023 as Chapter IVa of the ETS Directive, forms an instrument under the Effort Sharing Regulation (ESR).

assesses the drafts of new or updated NECPs and provides recommendations for improved planning and implementation. In addition, the reported information is subject to quality checks, and the GHG inventories reported by EU Member States are subject to comprehensive reviews in 2025, 2027 and 2032.[13]

All EU legislation, including the legislation under the 2030 Climate and Energy Framework, is subject to a stakeholder engagement process. So-called ‘better regulation tools’ ensure that policy is based on evidence and the best available practice[14]. During the preparation of legislative proposals, the European Commission invites citizens, businesses and stakeholder organisations to provide their views on the subject of the new legislation. These comments are documented in a dedicated portal[15], and the European Commission reports on how it takes these comments into account in the development of the legislative proposals. Furthermore, the Governance Regulation sets requirements for Member States to ensure that the public is given early and effective opportunities to participate in the preparation of the NECPs.

2.3. Description of the Nationally Determined Contribution

Under their updated NDC[16], the EU and its Member States, acting jointly, are committed to a legally binding target of a domestic reduction of net greenhouse gas emissions by at least 55% compared to 1990 by 2030. The term ‘domestic’ means without the use of international credits.

The NDC consists of a single-year target, and the target type is ‘economy-wide absolute emission reduction’. The scope of the NDC covers the 27 Member States of the EU. Details on the EU NDC can be found in Table 1.

Table 2.2.: Description of the NDC of the EU

Information	Description
Target and description	Economy-wide net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. The term ‘domestic’ means without the use of international credits.
Target type	Economy-wide absolute emission reduction.
Target year	2030 (single-year target)
Base year	1990
Base year value	Net greenhouse gas emissions level in 1990: 4 699 405 kt CO_2eq.
Implementation period	2021-2030
Geographical scope	EU Member States (Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary,

[13] Consolidated text (2023) of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, https://eur-lex.europa.eu/eli/reg/2018/1999/2023-11-20.

[14] Decision-making process, https://ec.europa.eu/info/strategy/decision-making-process/how-decisions-are-made_en.

[15] Have your say – Public consultation and feedback, https://ec.europa.eu/info/law/better-regulation/have-your-say_en.

[16] The update of the nationally determined contribution of the European Union and its Member States, https://unfccc.int/sites/default/files/NDC/2023-10/ES-2023-10-17%20EU%20submission%20NDC%20update.pdf.

Information	Description
	Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden) including EU outermost regions (Guadeloupe, French Guiana, Martinique, Mayotte, Reunion, Saint Martin (France), Canary Islands (Spain), Azores and Madeira (Portugal)).
Sectors	Sectors as contained in Annex I to decision 5/CMA.3: Energy, Industrial processes and product use, Agriculture, Land Use, Land Use Change and Forestry (LULUCF), Waste. International Aviation: Emissions from civil aviation activities as set out for 2030 in Annex I to the EU ETS Directive are included only in respect of CO_2 emissions from flights subject to effective carbon pricing through the EU ETS. With respect to the geographical scope of the NDC these comprise emissions in 2024-26 from flights between the EU Member States and departing flights to Norway, Iceland, Switzerland and the United Kingdom. International Navigation: Waterborne navigation is included in respect of CO_2, methane (CH_4) and nitrous oxide (N_2O) emissions from maritime transport voyages between the EU Member States.
Gases	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3)
LULUCF categories and pools	The included LULUCF categories and pools are as defined in decision 5/CMA.3.
Intention to use cooperative approaches	The EU's at least 55% net reduction target by 2030 is to be achieved through domestic measures only, without contribution from international credits. The EU will account and report for cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.
Any updates or clarifications of previously reported information, as applicable	The information on the NDC scope contains clarifications/further details compared to the information provided in the updated NDC of the EU.

Note: This table is identical to table 'Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates,' which has been submitted electronically together with this BTR. This table is also annexed to this BTR.

Source: Updated NDC of the EU[17]

As specified in Table 2.2, the NDC covers the emissions and removals from all sectors of the EU GHG inventory. In addition, CO_2 emissions from specific international flights (covered by the EU ETS) and GHG emissions from maritime voyages between EU Member States are included in the scope of the NDC.

[17] The update of the nationally determined contribution of the European Union and its Member States, https://unfccc.int/sites/default/files/NDC/2023-10/ES-2023-10-17%20EU%20submission%20NDC%20update.pdf.

2.4. Indicators, definitions, methodologies and progress

2.4.1. Indicator

For the tracking of progress towards implementing and achieving the NDC of the EU, an indicator is used which has the same unit and metric as the NDC base year and target values. The chosen indicator is ‘annual total net GHG emissions consistent with the scope of the NDC in CO_2eq’. Table 2 provides more information on this indicator.

Table 2.3: Indicator for tracking progress

Information	Description
Selected indicator	Annual total net GHG emissions consistent with the scope of the NDC in CO_2eq.
Reference level and base year	The reference level is total net GHG emissions of the EU in the base year (1990). The reference level value for the EU is 4 699 405 kt CO_2eq.
Updates	This is the first time the reference level is reported, hence there are no updates. The value of the reference level may be updated in the future due to methodological improvements to the EU GHG inventory and to the determination of international aviation and navigation emissions in the NDC scope.
Relation to the NDC	The indicator is defined in the same unit and metric as the target of the NDC. Hence it can be used directly for tracking progress in implementing and achieving the NDC target.
Definitions	Definition of the indicator ‘annual total net GHG emissions in CO_2eq’: Total net GHG emissions correspond to the annual total of emissions and removals reported in CO_2 equivalents in the latest GHG inventory of the EU. The totals comprise all sectors and gases listed in the table entitled ‘Reporting format for the description of a Party’s nationally determined contribution under Article 4 of the Paris Agreement, including updates’. Indirect CO2 emissions are included from those Member States that report these emissions.

Note: The information in this table is identical to the information in Common Tabular Format (CTF) tables 1 (‘Description of selected indicators’) and 2 (‘Definitions needed to understand the NDC’), which were submitted electronically together with this BTR. These tables are also annexed to this BTR.

Source: The reference level is based on the Annual European Union GHG inventory 1990-2022.

2.4.2. Methodologies and accounting approach

The EU and its Member States use the following accounting approach for tracking progress towards the EU NDC: Annual GHG data from the national GHG inventory of the EU, complemented for international aviation and navigation with estimations from the Joint Research Centre’s Integrated Database of the European Energy System[18] . The total net GHG emissions are provided in the scope of the EU NDC and are compared to the economy-wide absolute emission reduction target as defined in the NDC. The EU will account for its cooperation with other Parties in a manner consistent with guidance adopted by the CMA.

[18] European Commission, Joint Research Centre, Rózsai, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Tattini, J. and Neuwahl, F., JRC-IDEES-2021: the Integrated Database of the European Energy System – Data update and technical documentation, Publications Office of the European Union, Luxembourg, 2024, https://publications.jrc.ec.europa.eu/repository/handle/JRC137809.

As far as emissions and removals from the LULUCF sector are concerned, net emissions are used for tracking progress towards the 2030 target of the NDC based on all reported emissions and removals.

Details on methodologies and accounting approaches consistent with the accounting guidance[19] under the Paris Agreement can be found in CTF table 3 ('Methodologies and accounting approaches'), which was submitted electronically together with this BTR. This table is also annexed to this BTR.

2.4.3. Structured summary – status of progress

An important purpose of the BTR is to demonstrate where the EU and its Member States stand in implementing their NDC, and which progress they have made towards achieving it. The most recent information on GHG emissions and removals in the scope of the NDC constitutes the key information for tracking this progress. Table 3 summarises the current status of progress.

Table 2.4: Summary of progress towards implementing and achieving the NDC

	Unit	Base year value	Values in the implementation period			Target level	Target year	Progress made towards the NDC
			2021	2022	2030			
Indicator: Total net GHG emissions consistent with the scope of the EU NDC	Kt CO_2eq	4 699 405	3 272 650	3 205 223	NA	2 115 076 (55% below base year level)	2030	The most recent level of the indicator is 31.8 % below the base year level.

NA: Not Applicable.

Note that an annual emissions balance consistent with chapter III.B (Application of corresponding adjustment) will be provided in a subsequent BTR upon finalisation of relevant further guidance by the CMA, based on the annual information reported under Article 6.2.

Note: More detailed information can be found in CTF table 4 ('Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement'), which has been submitted electronically together with this BTR. This table is also annexed to this BTR.

Source: The indicator values are based on the Annual European Union GHG inventory 1990-2022.

Based on the GHG inventory data and data on international aviation and navigation for 2022, the EU and its Member States reduced net GHG emissions by 31.7 % compared to 1990. The EU and its Member States made progress towards implementing and achieving their NDC. The legal and institutional framework is in place to make further progress in the years ahead and to achieve the NDC target by 2030.

[19] Decision 4/CMA.1, Further guidance in relation to the mitigation section of decision 1/CP21, https://unfccc.int/documents/193407.

2.5. Mitigation policies and measures, actions and plans

2.5.1. Climate policy development

The Ministry of the Environment is responsible for compliance with the UNFCCC, the Kyoto Protocol and the Paris Agreement in the Czech Republic. The climate change agenda is addressed primarily within the Department of Energy and Climate Protection, which also serves as the National Focal Point for the Convention, Protocol and the Paris Agreement. Having in mind the cross-sectoral nature of climate change, which affects many other departments, the Ministry of the Environment is responsible primarily for the drafting of national policies in areas of mitigation and adaptation. Individual State departments (Ministries), such as the Ministry of the Environment, Ministry of Industry and Trade, Ministry of Transport, Ministry of Agriculture, Ministry of Regional Development etc. are then responsible for the drafting and implementation of sector-specific policies and measures aiming to reduce emissions of greenhouse gases and/or adapt to climate change impacts, according to the nature of the measures.

Since 2000, an integrated and complex system of strategic and operational planning has gradually been created, which is further modified in line with different international commitments of the Czech Republic whether assumed pursuant to post-Kyoto processes or EU policies and legislation. Legislative measures lay down rules for institutional responsibilities for coordination and implementation of various programmes and impose obligations for their regular evaluation.

A wider strategic framework is created primarily by the following documents:

- Czech Republic 2030 (adopted by the Czech Government in 2017)[20]
- National Reform Programme (updated annually, last update in 2024)[21]
- Regional Development Strategy 2021+ (adopted in 2019)[22]

The most important strategic documents with direct or demonstrable indirect effect on greenhouse gas emissions are:

- State Environmental Policy of the Czech Republic 2030 with a view to 2050[23]
- Climate Protection Policy of the Czech Republic[24]
- National Emission Reduction Programme

[20] Strategic Framework Czech Republic 2030, https://vlada.gov.cz/assets/ppov/udrzitelny-rozvoj/projekt-OPZ/Strategic_Framework_CZ2030.pdf.
[21] National Reform Programme of the Czech Republic, https://vlada.gov.cz/assets/evropske-zalezitosti/aktualne/NPR-2024_EN-version_2.pdf.
[22] Regional Development Strategy of the Czech Republic 2021+, https://mmr.gov.cz/getattachment/Microsites/Uzemni-dimenze/Regionalni-rozvoj/Strategie-regionalniho-rozvoje-CR-2021/Dokumenty/Propagacni-materialy/Regional-Development-Strategy-of-the-Czech-Republi/MMR_SQ_XL_01-02_2021.pdf.aspx?lang=cs-CZ&ext=.pdf.
[23] State Environmental Policy of the Czech Republic, https://www.mzp.cz/C125750E003B698B/en/state_environmental_policy/$FILE/OPZPUR-State_Environmental_Policy_of_the_Czech_Republic_2030_with_a_view_to_2050-20220524.pdf.
[24] Climate Protection Policy of the Czech Republic: executive summary (2017), https://www.mzp.cz/C125750E003B698B/en/climate_protection_policy/$FILE/OEOK_CPPES_20180105.pdf.

- National Energy and Climate Plan of the Czech Republic[25]
- Strategy on Adaptation to Climate Change in the Czech Republic[26]
- National Action Plan on Adaptation to Climate Change
- State Energy Policy[27]
- National Action Plan for Clean Mobility
- Waste Management Plan for 2025 – 2035
- Czechia's National Recovery and Resilience Plan[28]
- State Forest Policy until 2035

2.5.2. Cross-cutting policies and measures

2.5.2.1. Key instruments at the EU level

EU's long-term strategy and the European Climate Law

In addition to the 2030 target, the EU and its Member States committed to the objective of a climate-neutral EU by 2050. This objective was agreed by the European Council in December 2019 and communicated in March 2020 as the EU's long-term low GHG emissions development strategy under the Paris Agreement.[29] With the submission of its long-term strategy, the EU became the first large economy that committed to economy-wide climate neutrality. In addition to the EU as a whole, Czechia communicated its own long-term strategy under the Paris Agreement (see below). The strategy presents a vision to achieve climate neutrality by 2050, through a fair transition encompassing all sectors of the economy. It mentions seven strategic priorities, including reaping the full benefits of bioeconomy and creating essential carbon sinks. The binding objective of climate neutrality by 2050 is enshrined in the European Climate Law, which entered into force in July 2021. The European Climate Law also contains the 2030 climate target of reducing domestic emissions by at least 55% compared to 1990. It constitutes a net target, i.e. removals of CO2 from the atmosphere are taken into account. However, the total amount of removals which can be counted towards the achievement of the target is limited to a maximum of 225 Mt CO_2eq.

The European Climate Law also sets out the process for developing the 2040 climate target, which will take into account an indicative greenhouse gas budget for 2030 to 2050. Based on a detailed impact assessment and the advice of the European Scientific Advisory Board on

[25] National Energy and Climate Plan of the Czech Republic, https://www.mpo.gov.cz/en/energy/strategic-and-conceptual-documents/the-national-energy-and-climate-plan-of-the-czech-republic--252018/.
[26] Strategy on Adaptation to Climate Change in the Czech Republic: executive summary, https://www.mzp.cz/C125750E003B698B/en/strategy_adaptation_climate_change/$FILE/OEOK_Adaptation_strategy_20171003.pdf.
[27] State Energy Policy, https://www.mpo.gov.cz/dokument12265.html.
[28] Czechia's recovery and resilience plan, https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/country-pages/czechias-recovery-and-resilience-plan_en.
[29] Long-term low greenhouse gas emission development strategy of the European Union and its Member States, https://unfccc.int/documents/210328.

Climate Change set up by the Climate Law, on 6 February 2024 the European Commission presented its 2040 climate target communication and recommended reducing the EU's net GHG emissions by 90% by 2040 relative to 1990.[30] Based on the scenarios presented in the impact assessment, this requires a further deployment of carbon capture, substantial reductions of GHG emissions in the land sector and a fully developed carbon management industry by 2040. Carbon capture will need to cover all emissions from industrial processes emissions and deliver sizable carbon removals. In addition, high levels of production and consumption of e-fuels will be necessary to further decarbonise the energy mix. Finally, the European Climate Law requires the EU and Member States to adopt adaptation strategies and sets out the rules for assessing progress towards the climate targets.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2018-2050

Implemented in scenario: WAM

Mitigation impact: Reduction of EU's net greenhouse gas emissions by at least 55% by 2030 compared to 1990 and reaching EU-wide climate neutrality by 2050.

European Union Emissions 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, as amended. This legislation is transposed into the Czech legal system by Act 383/2012 Coll. on conditions for trading of emission allowances, as amended.

The system is implemented in several phases. Phase 4 of the EU ETS implementation was launched in 2021 and will last until 2030. The annual reduction factor was increased to 2.2%, equal to the amount by which the emissions cap will decrease each year. From 2024-2027, the reduction factor is set at 4.3% per year, and from 2028 onwards at 4.4% per year. Moreover, a cap rebasing is set to take place twice, withdrawing 90 million allowances in 2024 and additional 27 million in 2026. From 2024, maritime transport emissions were brought under the system. Freely allocated allowances to the manufacturing industry are meanwhile being phased out over the current period, starting from 2026. These measures combined are set to bring an overall emission reduction in the EU ETS-covered sectors of 62% by 2030 compared to 2005.

As mentioned above, In the Czech Republic, the EU ETS is implemented via Act 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.

[30] Communication from the Commission COM/2024/63 on Europe's 2040 target and path towards climate neutrality by 2050, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2024%3A63%3AFIN.

As of 2040, approximately 230 Czech facilities participated in the system. The volume of emissions covered by the trading system in the Czech Republic represented approximately 48.7% of total greenhouse gas emissions in the Czech Republic in 2022 (average share for the whole EU was about 38%). Monitored greenhouse gases include CO_2 and N_2O.

In 2023, facilities covered by the EU ETS emitted 46.67 Mt CO_2eq. In comparison with 2005, there has been a reduction of emissions by 43.4%. The Table 4.1 below shows verified emissions from individual activities and their share in total GHG emissions.

As regards aviation, under EU ETS all airlines operating in the EU are required to monitor, report, and verify their emissions, and to surrender allowances against those emissions. The airlines receive tradable allowances covering a certain level of emissions from their flights per year. The latest revision of the EU ETS Directive brought about some substantive changes. These include the following:

- Free allocation to aircraft operators will be reduced by 25% in 2024 and by 50% 2025, moving to full auctioning for the sector by 2026.
- The Commission is establishing an MRV system for non-CO_2 aviation effects to apply from 2025. By the end of 2027, the Commission will deliver a report on the results and if appropriate, will make a legislative proposal to address non-CO_2 effects of aviation.
- In 2026, the Commission will carry out an assessment of CORSIA to determine if it is sufficiently delivering on the goals of the Paris Agreement. The assessment will evaluate whether CORSIA has been strengthened and its level of coverage of international aviation emissions.

As CO_2 emissions from aviation have been included in the 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.

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 2.5 below.

Type of policy: Economic

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2005-2040

Implemented in scenario: WEM

Table 2.5: EU ETS verified emissions 2005-2023 [kt CO_2eq]

Activity/year	2005	2010	2015	2020	2021	2022	2023
Combustion facilities	65.47	63.40	54.59	42.78	45.24	45.64	37.28
Refineries of mineral oils	1.00	1.05	0.93	0.80	0.96	0.90	0.95
Production of coke	0.14	0.07	0.00	0.00	0.00	0.00	0.00
Raw iron and steel	9.67	5.96	5.61	5.29	5.71	4.94	3.90

Production and processing of ferrous metals	0.07	0.10	0.11	0.09	0.10	0.09	0.08
Secondary aluminium	0.00	0.00	0.02	0.02	0.02	0.02	0.02
Cement and lime	3.85	3.35	3.46	3.92	4.03	3.69	2.98
Manufacture of glass	0.81	0.67	0.72	0.72	0.74	0.72	0.68
Production of ceramic	0.73	0.41	0.38	0.41	0.42	0.42	0.26
Production of mineral wool	0.00	0.04	0.06	0.05	0.06	0.06	0.05
Production of pulp	0.09	0.07	0.02	0.02	0.02	0.02	0.01
Production of paper or cardboard	0.33	0.15	0.13	0.12	0.13	0.12	0.11
Chemical industry	0.29	0.32	0.56	0.39	0.39	0.35	0.30
Other	0.00	0.00	0.06	0.07	0.07	0.07	0.07
Total CO_2 eq EU ETS emissions	82.45	75.58	66.65	54.68	57.87	57.04	46.67
Total CO_2 eq emissions (without LULUCF)	149.31	140.54	129.24	113.39	118.78	117.08	–
Share of CO_2 eq EU ETS emissions in total emissions [%]	55.22	53.78	51.57	48.22	48.72	48.72	–

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 the framework 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 or other low-carbon sources 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 2.6 and Table 2.7 show annual emissions savings from realized and planned investments from 2015 onwards.

Table 2.6 Expected emissions reduction of EU ETS on the demand side

Emissions reduction [kt CO_2]	2025	2030	2035
Households	535	892	1194
Services	447	656	877
Industry	568	842	1127

Total	**1 551**	**2 390**	**3 198**

Source: MoE

Table 2.7 Total expected emissions reduction of EU ETS

	2025	2030	2035
Total emissions reduction [kt CO_2]	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.

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

Greenhouse gas coverage: CO_2, N_2O

Effort Sharing Regulation

Similarly to EU ETS, the EU Effort Sharing Regulation in its current shape and form provides a regulatory framework for emissions reductions between 2021 and 2030. It is based on a series of national targets covering GHG emissions of each Member State, which are out of the scope of the original ETS, i.e. transport (except aviation), buildings, agriculture (excluding LULUCF) and waste. The regulation was adopted in 2018 and has undergone further changes in 2022 as part of the "Fit for 55" legislative package.[31] As a result of the amendments, which put forward more stringent national targets, the ESR-covered emissions in the EU are expected to drop by at least 40% by 2030 as 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. For Czechia, this amounts to a reduction of 26% between 2005 and 2030 (as opposed to 14% before the 2022 revision of the legislation). In 2022, the total amount of ESR-covered emissions for Czechia was 60.63 Mt CO_2 eq. The annual progress towards the national targets under the Effort Sharing Legislation is assessed by comparing effort sharing sector GHG emission levels with the relevant annual targets under the legislation. To achieve compliance under the ESR, Member States are permitted to use flexibility options to a certain extent. Under Article 9(2) of the ESR, any debit (i.e., excess emissions) under the LULUCF Regulation in the period 2021 to 2025 is automatically deducted from Member States' AEAs under the ESR first compliance period.

[31] Fit for 55 – The EU's plan for a green transition, https://www.consilium.europa.eu/en/policies/fit-for-55/.

Type of policy: Regulatory, Economic

Implementing entity: Ministry of the Environment

Period of implementation: 2021-2030

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

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

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

Governance of the Energy Union and Climate Action

The overall governance of the Energy Union and the EU climate action is set by a dedicated regulation (EU) 2018/1999 of the European Parliament and the Council, which entered into force in 2018. Its goals include implementing measures towards meeting the EU 2030 energy and climate targets in line with the Paris Agreement. On its basis, all Member States are expected to draft and periodically update their National Energy and Climate Plans (NECP). Czechia has submitted the final version of its plan before the end of 2019, setting a series of targets for 2030.[32] The updated plan responding to the new EU legislative developments including the Fit for 55 package was about to be approved before the end of 2024. Moreover, the Governance regulation also requires Member States to submit their long-term climate strategies, which Czechia did in the form of the Climate Protection Policy described above.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2021–2050

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Cross-sectoral

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

2.5.2.2. Instruments at the national level

Climate Protection Policy of the Czech Republic

The Government adopted the Climate Protection Policy of the Czech Republic in March 2017, replacing the National Programme to Abate the Climate Change Impacts in the Czech Republic (2004). The Policy reflects significant recent developments at the EU, international

[32] National Energy and Climate Plan of the Czech Republic, https://www.mpo.gov.cz/en/energy/strategic-and-conceptual-documents/the-national-energy-and-climate-plan-of-the-czech-republic--252018/.

and national levels. The Strategic Impact Assessment of the Policy was carried out and completed with an affirmative statement in January 2017.

The Policy defines GHG reduction targets for 2020 and 2030 while also including indicative trajectories and objectives for 2040 and 2050. Further, the Policy defines policies and measures for specific sectors on the national level in order to fulfill greenhouse gas reduction targets resulting from international agreements as well as EU legislation. The Policy aims to contribute to a gradual transition to a 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.

Primary emission reduction targets

- Greenhouse gas reduction of 32 Mt CO_2eq by 2020 compared to 2005
- Greenhouse gas reduction of 44 Mt CO_2eq by 2030 compared to 2005

Indicative emission reduction targets

- Indicative target of 70 Mt CO_2eq of emitted greenhouse gases by 2040
- Indicative target of 39 Mt CO_2eq of emitted greenhouse gases by 2050

The Policy also outlined some economic aspects of GHG reductions on the national level. The European structural and investment funds represented the main source of financing in the programming period of 2014-2020. Another key financial source was represented by the auction revenues generated by the EU ETS.

The Policy was evaluated in 2021. A comprehensive update of the Policy and the underlying emission scenarios was drafted in 2023-2024, taking into account the Fit for 55 legislative package. At the time of writing, the updated document was pending a government approval.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2017-2030

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

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

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

Act 201/2012 Coll., on Air Protection

Act 201/2012 Coll., on Air Protection is the cornerstone of the legislative framework in this area. Its objective is to prevent or limit air pollution so as to reduce health risks, lower the environmental burden of substances discharged into the air and harming ecosystems and set conditions allowing for the regeneration of the affected environment. The Act transposes a number of EU Directives in the area of air protection, regulates required ambient air quality and its monitoring obligations of source operators, defines emission limits and other operational conditions for stationary source operators.

The Act further transposes certain parts of Directive 2010/75/EU on industrial emissions (the Industrial Emissions Directive, IED), which sets stricter emission limits for selected basic pollutants and requires the use of the best available techniques (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 a reference for setting permit conditions. Certain parts of the IED are implemented into the Czech legislation also by Act 76/2002 Coll., on Integrated Prevention and Pollution Control (see below).

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: Since 2002

Implemented in scenario: WEM

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

Sectors: Energy, Industrial Processes, Agriculture, Waste

Greenhouse gas coverage: CO_2, N_2O, CH_4

Table 2.8 Expected emissions reduction of IPPC (IED)

Emissions reduction [kt CO_2]	2025	2030	2035
	2 746	2 746	2 746

Source: CHMI

National Emissions Reduction Programme

The National Emissions Reduction Programme (NERP) is the fundamental conceptual material in the area of air quality and reduction of emissions from sources of air pollution. It is implemented on the basis of Article 8 of Act 201/2012 Coll., on Air Protection. The first Programme was adopted in 2007 and its latest version was approved in December 2023. The Programme complies with the requirements set by the Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants for so called national air pollution control programmes (Article 6 of the Directive). 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 3 priority measures, 11 subsidiary measures and 6 cross-sectional measures has been introduced at the national level directly aimed to reduce emissions and to improve air quality. Each of these measures is assigned to a central authority of the state administration to oversee its accomplishment. 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 Directive 2016/2284, the implementation of measures set by the NERP and achievement of its goals is evaluated regularly on a biennial basis.

Type of policy: Regulatory

Implementing entity: Ministry of Environment (Government)

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

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

Greenhouse gas coverage: CH_4, N_2O, CO_2

Gender Equality Strategy 2021-2030

In late 2024, an update to the Czech Gender Equality Strategy was adopted, including for the first time a set of climate-relevant indicators. These include:

- Increasing the awareness of climate impacts in the context of gender inequalities
- Undertake an analysis of different health and social impacts of unfavourable environment on women and men
- Support the research of decarbonisation policy impacts on the most vulnerable groups including single mothers
- Publish an analysis on gender inequalities in the field of energy, their causes and solutions, using gender disaggregated data
- Involve the gender perspective in public communication on decarbonisation and just transition

These indicators are not expected to yield a direct impact in terms of emissions savings but over the long run can support the coherence of mitigation policies in Czechia as well as their public acceptance.

Type of policy: Regulatory

Implementing entity: Office of the Government

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Energy; Industrial processes and product use; Transport; Agriculture; Waste

Greenhouse gas coverage: N/A

2.5.3. Sectoral policies and measures

2.5.3.1. Energy

Policies and Strategies

a) ***State Energy Policy***

The State Energy Policy (SEP) is the main strategic document for the energy sector in the Czech Republic. The Policy is cross-sectional and it serves as the framework document for the national level. The current SEP was approved by the Government in May 2015, replacing the previous SEP from 2004. The SEP is codified in Act 406/2000 Coll., on Energy Management. The 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 until 2040. In 2024, a draft update of the SEP was prepared, in line with the updates of the NECP and Climate Protection Policy and reflecting key recent developments in both energy and climate policy. This update would extend the time horizon of this document from 2040 to 2050. However, at the time of writing, the adoption of the updated SEP was still pending.

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 should 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 – 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.

Type of Policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2015-2040

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sectors: Energy, Transport, Industrial Processes

Greenhouse gas coverage: CO_2, CH_4

Legislative Instruments

*a) **Act 406/2000 Coll., on energy management***

This Act transposes the relevant EU legislation including Directive 2009/28/EC on the promotion of the use of energy from renewable sources, Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products, Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. The Act stipulates requirements for efficient energy use while also setting minimum energy performance standards for new buildings and for major renovations. 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 electric appliances and introduces their certificates.

The Act requires large enterprises with energy consumption of their energy facilities more than 200 MWh per year to perform an energy audit. SMEs 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 energy audits, energy assessments, issue energy performance certificates and perform controls of heating and air-conditioning systems. It also introduces an obligation for electricity or thermal energy producers in newly-established installations, to provide for at least the minimum efficiency of energy use stipulated by an implementing legal regulation. This obligation evenly 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.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2000

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sectors: Energy

Greenhouse gas coverage: CO_2

*b) **Directive 2012/27/EU on energy efficiency***

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. Member States are required to contribute to an EU-wide target of energy savings equivalent to 11.7% until 2030 as compared to the projected energy use (based on the 2020 reference scenario). On average, Member States are expected to achieve energy savings of 1.5% p.a. until 2030. This is based on the review of the Directive that entered into force in October 2023. The updated indicative national target for Czechia equals 669 PJ of cumulative energy savings until 2030, which is also reiterated in the draft updated NECP.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2012-2030

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sectors: Energy

Greenhouse gas coverage: CO_2

c) Directive EU/2024/1275 on the energy performance of buildings (EPBD)

The Directive, introduced first in 2002, stipulates minimum requirements as regards the energy performance of new and existing buildings, and 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 contributes to the objective of reducing GHG emissions by at least 60% in the building sector by 2030 compared to 2015, and achieving a decarbonised, zero-emission building stock by 2050. Moreover, the Directive envisages the gradual introduction of minimum energy performance standards for non-residential buildings based on national thresholds to trigger the renovation of buildings with the lowest energy performance. It also sets a binding target to increase the average energy performance of the national residential building stock by 16% by 2030 in comparison to 2020, and by 20-22% by 2035, based on national trajectories. The Directive should ensure a gradual phase-out of boilers powered by fossil fuels, starting with the end of subsidies to stand-alone boilers powered by fossil fuels from 1 January 2025. The latest revised version of EPBD entered into force in May 2024.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2024 (previous Directive since 2002)

Implemented in scenario: WEM

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

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.9 Emissions reduction expected from implementation of EPBD

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	474	446	446	446

Source: CHMI

d) Regulation (EU) 2024/1781 on ecodesign requirements for sustainable products (ESPR)

This Regulation, which entered into force in 2024, replaced an earlier 2009 Directive. It aims to significantly improve the sustainability of products placed on the EU market by improving their circularity, energy performance, recyclability and durability. The relevant EU legislation has been implemented into Czech legislation by the Energy Management Act 406/2000 Coll. and by its amendments. The ESPR enables the setting of performance and information rules for almost all categories of physical goods, including:

- Improving product durability, reusability, upgradability and reparability
- Enhancing the possibility of product maintenance and refurbishment
- Making products more energy and resource-efficient
- Addressing the presence of substances that inhibit circularity
- Increasing recycled content
- Making products easier to remanufacture and recycle
- Setting rules on carbon and environmental footprints
- Limiting the generation of waste
- Improving the availability of information on product sustainability

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: since 2024 (previous Directive since 2009)

Implemented in scenario: WEM

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

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.10 Emissions reduction expected from implementation of ESPR

	2025	2030	2035	2040
Emissions reduction [kt CO_2eq]	484	466	363	363

Source: CHMI

e) Directive (EU) 2018/2001 as regards the promotion of energy from renewable sources (RED)

In November 2023, an amending Directive (EU) 2023/2413 entered into force. Building on the 2009 and 2018 directives, the amending Directive introduces stronger measures to ensure that all possibilities for the further development and uptake of renewables are fully utilised. This will be key to achieving the EU's objective of climate neutrality by 2050 and to strengthen Europe's security of energy supply. It responds to the need to speed up the EU's clean energy transition, setting up an overall renewable energy target of at least 42.5% binding at EU level by 2030 – but aiming for 45%. To support renewables uptake in transport and heating and cooling, the revised directive converts into EU law some of the concepts outlined in the energy system integration and hydrogen strategies, published in 2020. These concepts aim at creating an energy-efficient, circular and renewable energy system that facilitates renewables-based electrification and promotes the use of renewable fuels, including hydrogen, in sectors like transport or industry where electrification is not yet a feasible option. For these hard-to-electrify sectors, the directive sets new binding targets for renewable fuels of non-biological origin. As an important bottleneck to the deployment of renewables on the ground, permitting procedures will also be easier and faster both for renewable energy projects, including through shorter approval periods and the creation of 'renewables acceleration areas', and for the necessary infrastructure projects.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: since 2018 (previous Directive 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.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.11 Emissions reduction expected from introduction of preferential feed-in tariffs for electricity produced from RES

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	3 873	4 047	3 610	3 191

Source: CHMI

f) Act 165/2012 Coll., on supported sources of energy

The Act transposes the earlier Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Its aim is to enhance the development of RES, secondary energy sources and the highly efficient combined production of electricity and heat as well as to contribute to the increasing RES share on final energy use in line with national targets. It regulates the public support provided to the generation of electricity, heat and bio-methane from RES, secondary energy sources, highly efficient combined production of electricity and heat and decentralized electricity generation. Over time, it has gone through a number of amendments to keep up with legislative and market developments, ensuring that the public support is efficient and reasonable. Notably, these lately included the setup of a regulatory framework for energy communities, enabling citizens and municipalities to become active prosumers and encouraging the creation of local energy markets.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2013

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sectors: Energy

Greenhouse gas coverage: CO_2, CH_4

g) Act 458/2000 Coll., on business conditions and the performance of public administration in energy (Energy Act)

The Act transposes relevant EU legislation, includes directly applicable EU legislation and sets conditions for business, for public administration and for energy regulators (electricity, gas and heat) while also regulating the rights and obligations of natural persons and legal entities. It organizes 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 affordable prices. A major update of the Energy Act is pending a conclusion of a parliamentary procedure at the time of this writing. The new legislation introduces the concept of an active customer, a new entity in the form of an energy community, and 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.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2000

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Energy

Greenhouse gas coverage: CO_2

Financial Schemes and Programmes

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

EFEKT was 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 supported 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 were state administration, local (municipalities) and regional governments, schools, social and health care facilities, private sector, households and NGOs.

The Programme was implemented during its initial run (since 2005) not only by the Ministry of Industry and Trade but also by ten other ministries. Since 2007, the programme has been renamed to EFEKT, and as such it has been fully implemented solely by MIT.

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

Implementing entity: Ministry of Industry and Trade (Government)

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

Implemented in scenario: WEM

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

Sector: Energy

Greenhouse gas coverage: CO_2

Table 2.12 Expected energy savings of programme EFEKT

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

Source: CHMI

Table 2.13 Expected emissions reduction of programme EFEKT

	2025	2030	2035	2040
Emissions reduction [kt CO_2eq]	20.10	19.29	17.72	15.07

Source: CHMI

b) State Programme on the Promotion of Energy Savings (EFEKT II and III)

In 2016, the EFEKT programme was amended for the 2017-2021 period and renamed as State Programme on the Promotion of Energy Savings. The yearly budget was increased to CZK 150 mil. The so-called EFEKT II 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 did not support the use of renewable energy anymore and focused solely on energy efficiency measures. One of the most important supported areas of the programme was increasing energy efficiency in public lighting systems.

A continuation scheme was set up for 2022-2027, called EFEKT III. The programme financially supports the increase of energy efficiency through awareness-raising and educational activities, energy consultancy centres and expert training as well as energy management, providing only non-investment support. By doing so, it contributes to the energy efficiency target set by Directive 2012/27/EU on energy efficiency. The planned aggregate budget for the current operating period 2022-2027 is just under CZK 1 bn. The expected energy savings induced by this programme amount to 16.5 PJ on aggregate between 2021 and 2030.

Type of policy: Education, Advisory, Information, Research

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2017-2021, 2022-2027

Implemented in scenario: WEM

Mitigation impact: The expected energy and GHG savings are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.14 Expected energy savings of programme EFEKT 2 and EFEKT 3

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

Source: CHMI

Table 2.15 Expected emissions reduction of programme EFEKT 2 and EFEKT 3

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	52.58	50.46	46.35	39.43

Source: CHMI

c) New Green Savings Programme 2013

The New Green Savings Programme 2013 was a subsidy program of the Ministry of the Environment (administered 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 energy and GHG savings are shown in the following tables.

Sector: Energy, Residential

Greenhouse gas coverage: CO_2

Table 2.16 Expected energy savings of New Green Savings Programme 2013

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

Source: CHMI

Table 2.17 Expected emissions reduction of New Green Savings Programme 2013

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	4.35	4.05	3.76	3.42

Source: CHMI

d) New Green Savings Programme

This funding scheme is a follow-up of a previously implemented Green Savings Programme. 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). It is generally considered the most successful and most effective programme in this area, and has served as a template for similar schemes abroad. Between 2014 and 2021, it has had over 74 thousand recipients and disbursed 16 bn CZK. In the past, it was funded directly from national EU ETS revenue. Since 2021, it has been funded via the National Recovery Plan (i.e. from the Recovery and Resilience Facility), and after its conclusion, it will be funded by the Modernization Fund. The recipients of support can claim up to 50% of eligible expenses.

Type of policy: Economic

Implementing entity: State Environmental Fund (Government)

Period of implementation: 2014-2030

Implemented in scenario: WEM

Mitigation impact: The expected energy and GHG savings are shown in the following tables.

Sector: Energy, Residential

Greenhouse gas coverage: CO_2

Table 2.18 Expected energy savings of the New Green Savings Programme 2014–2020

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

Source: CHMI

Table 2.19 Expected emissions reduction related to energy savings of the New Green Savings Programme 2014–2020

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	467.67	437.83	404.26	364.01

Source: CHMI

e) 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. Since 2013, the support has taken exclusively the form of low-interest discounted loans. Owners of apartment buildings are eligible for support, be it natural or legal persons, including municipalities. The supported activities include complex repairs of building malfunctions, repairs and renovation of common space, and modernization of apartments. In this context, the approved support may or may not have a direct impact on energy savings. The expected annual budget for the current period 2021–2026 is estimated to be about CZK 270 mil.

Type of policy: Economic

Implementing entity: State Investment Promotion 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 energy and GHG savings are shown in the following tables.

Sectors: Energy, Residential

Greenhouse gas coverage: CO_2

Table 2.20 Expected energy savings of the PANEL programme

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

Source: CHMI

Table 2.21 Expected emissions reduction related to energy savings of the PANEL programme

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	16.05	15.54	14.58	13.29

Source: CHMI

f) 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 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 as recipients of support. The Programme 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 outside of the 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 mil.

Type of policy: Economic

Implementing entity: State Environmental Fund (Government)

Timeframe: 2007-2013

Implemented in scenario: WEM

Mitigation impact: The expected energy and GHG savings, including related to RES deployment, are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.22 Expected energy savings of Operational Programme Environment 2007–2013

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

Source: CHMI

Table 2.23 Expected emissions reduction related to energy savings of Operational Programme Environment 2007–2013

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	81.25	74.07	65.50	53.32

Source: CHMI

Table 2.24 Expected energy production from RES and reached emissions reduction of Operational Programme Environment 2007–2013

	2025	2030	2035	2040
Electricity generation from RES [TJ]	2.3	2.3	2.3	2.3
Heat generation from RES [TJ]	242.3	242.3	242.3	242.3
GHG emissions reduction [kt CO_2eq]	23.8	22.2	20.4	17.9

Source: CHMI

g) Operational Programme Environment 2014–2020

The aim of the Operational Programme Environment 2014–2020 was to protect and improve the quality of the environment in line with the principles of sustainable development. Two priority axes relevant to GHG emission reductions were axis 2 – Improvement of Air Quality and axis 5 – Energy Savings. For the programming period 2014–2020 the total allocation was more than EUR 3 billion including about EUR 1 billion for activities improving air quality and energy efficiency. Priority axis 2 supported 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 supported insulation and other energy efficiency measures in the public sector and promoted increased use of renewable energy sources. It also subsidized the construction of new public buildings in passive standard. The program projects were financed from the European Regional Development Fund (ERDF) and from the Cohesion Fund (CF). The expected program budget for energy savings and RES support was CZK 23.6 bn. (approx. EUR 908 mil.).

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: The expected energy and GHG savings, including related to RES deployment are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.25 Expected energy savings of Operational Programme Environment 2014–2020

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

Note: 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

Table 2.26 Expected emissions reduction related to energy savings of Operational Programme Environment 2014–2020

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	467.35	426.09	376.79	306.70

Source: CHMI

Table 2.27 Expected energy production from RES and reached emissions reduction of Operational Programme Environment 2014–2020

	2025	2030	2035	2040
Electricity generation from RES [TJ]	7.9	7.9	7.9	7.9
Heat generation from RES [TJ]	150.0	150.0	150.0	150.0
GHG emissions reduction [kt CO_2eq]	15.7	14.6	13.3	11.6

Source: CHMI

h) Operational Programme Environment 2021-2027

The third edition of this Operational Programme offers an overall funding allocation of CZK 61 bn. for a broad range of projects, most of which promise a positive climate impact. There are six areas of support: energy savings (CZK 12.2 bn), renewable energy sources (CZK 7 bn), climate change adaptation (CZK 10.2 bn), water supply and sewage (CZK 14.1 bn), circular economy (CZK 7.1 bn), nature and pollution (CZK 10.6 bn). The overarching goal of the Programme is securing a quality environment for people's lives, supporting a transition towards circular economy and efficient resource use, limiting negative impacts of human activities on the environment and climate, and mitigating the impacts of climate change. There is a broad number of potential recipients of funding including municipalities, businesses, state-established organisations, public institutions, research entities, natural persons or NGOs.

Type of policy: Economic

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2021-2027

Implemented in scenario: WEM

Mitigation impact: The expected GHG reduction amounts to 258kt CO_{2eq} by 2030.

Sectors: Energy, Industrial Processes and Product Use

Greenhouse gas coverage: CO_2

i) Integrated Regional Operational Programme (IROP)

The EU Integrated Regional Operational Programme (IROP) has existed since 2014 with the current programming period running from 2021 until 2027. In the preceding programming period, there was one priority that yielded energy savings: "Promoting energy efficiency, intelligent systems energy management and use of energy from renewable sources public infrastructures, including in public buildings and in housing", with a financial allocation of approx CZK 17 bn. Currently, the Programme is divided into ten areas/specific targets. Out of those, the following two are relevant for the use of this report: green infrastructure of cities and municipalities (CZK 10.9 bn); clean and active mobility (CZK 20.4 bn). Revitalization of parks or the purchase of ZEV for public transport and construction of charging stations by municipalities are examples of projects that can earn support from these schemes.

Type of policy: Economic

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: 2014-2027

Implemented in scenario: WEM

Mitigation impact: The expected energy and GHG savings of the 2014-2020 Programme are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.28 Expected energy savings of the Integrated Regional Operational Programme

	2025	2030	2035	2040
Energy savings [TJ]	3,168	3,168	3,168	3,168

Source: CHMI

Table 2.29 Expected emissions reduction related to energy savings of the Integrated Regional Operational Programme

	2025	2030	2035	2040
Emissions reduction [kt CO_2eq]	248.65	240.83	225.96	205.91

Source: CHMI

j) Operational Programme Prague – Growth Pole of the Czech Republic

The operational programme under the auspices of the City of Prague was focused 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 near-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 was estimated at about CZK 1.9 bn (EUR 74.5 mil).

Type of policy: Economic

Implementing entity: City of Prague

Period of implementation: 2014-2020

Implemented in scenario: WEM

Mitigation impact: The expected energy and GHG savings are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.30 Expected energy savings of the Operational Programme Prague Growth Pole

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

Source: CHMI

Table 2.31 Expected emissions reduction related to energy savings of the Operational Programme Prague Growth Pole

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	3.51	3.20	2.83	2.30

Source: CHMI

k) JESSICA Programme

The programme, which ran from 2014 until 2016 offered long-term low-interest loans for the reconstruction or modernization of residential buildings. It was implemented by the Ministry of Regional Development. The programme was designed for all owners of residential houses. The program focused 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 was estimated at about CZK 0.6 bn (EUR 23.1 mil).

Type of policy: Economic

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: 2014-2016

Implemented in scenario: WEM

Mitigation impact: The expected energy and GHG savings are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.32 Expected energy savings of the JESSICA programme

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

Source: CHMI

Table 2.33 Expected emissions reduction related to energy savings of the JESSICA programme

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	1.91	1.85	1.74	1.59

Source: CHMI

I) 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 CZK 130 mil.

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 energy and GHG savings are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.34 Expected energy savings of the ENERG Programme

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

Source: CHMI

Table 2.35 Expected emissions reduction related to energy savings of the ENERG programme

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	3.67	3.49	3.20	2.70

Source: CHMI

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

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.

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

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 energy and GHG savings, including related to RES deployment are shown in the following tables.

Sectors: Energy, Manufacturing industries and construction, Agriculture

Greenhouse gas coverage: CO_2, CH_4, N_2O

Table 2.36 Expected energy savings of the OPEI programme

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

Source: CHMI

Table 2.37 Expected emissions reduction resulting from energy savings of the OPEI programme

	2025	2030	2035	2040
Emissions reduction [kt CO_2eq]	98.41	95.24	88.66	75.82

Source: CHMI

Table 2.38 Expected energy production from RES and corresponding emissions reduction of the OPEI programme

	2025	2030	2035	2040
Electricity generation from RES [TJ]	451.8	451.8	451.8	451.8
Heat generation from RES [TJ]	58.5	58.5	58.5	58.5
GHG emissions reduction [kt CO_2eq]	86.8	86.8	86.8	86.8

Source: CHMI

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

Operational Programme Enterprise and Innovations for Competitiveness (OP EIC) was 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 was 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’. Priority Axis 3 covered 28.1% of the allocation of the OP EIC and was directly linked to the fulfilment of selected key objectives of the Europe 2020 strategy. The programme was financed by the European Regional Development Fund (ERDF) to support enterprises, mostly SMEs.

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 energy and GHG savings, including related to RES deployment are shown in the following tables.

Sectors: Energy

Greenhouse gas coverage: CO_2

Table 2.39 Expected energy savings of the programme Operational Programme Enterprise and Innovation for Competitiveness

Energy savings [TJ]	2025	2030	2035	2040
	13 030	13 030	13 030	13 030

Source: CHMI

Table 2.40 Expected emissions reduction resulting from energy savings of the programme Operational Programme Enterprise and Innovation for Competitiveness

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	1160.04	1122.63	1045.09	893.72

Source: CHMI

Table 2.41 Expected energy production from RES and corresponding emissions reduction of the programme Operational Programme Enterprise and Innovation for Competitiveness

	2025	2030	2035	2040
Electricity generation from RES [TJ]	1 424.6	1 424.6	1 424.6	1 424.6
Heat generation from RES [TJ]	712.3	712.3	712.3	712.3
GHG emissions reduction [kt CO_2eq]	280.2	258.0	216.2	163.9

Source: CHMI

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

The programme is primarily aimed at providing financial support to SMEs and large companies. Its principal aim is to increase the value added and productivity performed by Czech companies (especially SMEs) and to improve their standing in global value chains. It is financed from the European Regional Development Fund. Among its five priorities, one is focused on supporting the transition towards a low-carbon economy and another on improving efficient resource management. The supported measures include reducing energy intensity of commercial buildings, increased use of RES, combined heat and power generation or heat pumps, energy accumulation, improving energy efficiency of production processes, development of intelligent energy systems or employing principles of circular economy. The overall financial allocation of the programme is approx. CZK 81.5 bn.

Type of policy: Economic

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2021-2027

Implemented in scenario: WEM

Mitigation impact: The expected energy savings amount to 3.575 TJ/year by 2029. The expected GHG savings amount to 639 kt CO_2eq/year by 2029 as compared to the 2020 baseline.

Sectors: Energy

Greenhouse gas coverage: CO_2

p) Modernisation Fund

The Modernisation Fund is a dedicated funding programme to support 13 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 the revised EU ETS Directive in 2018 and has undergone a further update including an increase in allocation in the meanwhile. The Modernisation Fund is funded from revenues from the auctioning of 2% of the total allowances for 2021-30 under the EU ETS, 2.5% of the total allowances for 2024-2030, and additional allowances transferred to the Modernisation Fund by beneficiary Member States. 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. In terms of its size, it is a key funding instrument for Czechia's decarbonization efforts, potentially reaching a size of up to CZK 500 bn., depending on the EU ETS price. At the time of this writing, it consisted of eight programmes/thematic support schemes:

1. Deployment of new RES
2. Modernization of heating systems
3. Energy efficiency and energy savings
4. Modernization of transport
5. Renewable gaseous and liquid fuels
6. Modernization of energy networks
7. Energy communities
8. Innovative and complex projects

Type of policy: Economic (subsidies)

Implementing entity: Ministry of Environment Government)

Period of implementation: 2021-2030

Implemented in scenario: WAM

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

Sectors: Energy, Manufacturing industries and construction, Buildings

Greenhouse gas coverage: CO_2, F-gases, CH_4

Table 2.42 Expected GHG savings of the Modernisation Fund

Emissions reduction [kt CO_2eq]	2025	2030	2035	2040
	4 375	17 500	17 500	17 500

Source: MoE

q) OP Just Transition

The Operational Programme Just Transition is a funding scheme established to disburse funds from the EU Just Transition Fund. In Czechia, projects from three coal regions in transition (Karlovarský, Moravskoslezský, Ústecký) are eligible for funding from this source. Its goal is to mitigate the impact of the transition process on the economy, on inhabitants and on the environment in those regions, which are expected to be most affected as a result of their dependence on fossil fuels or emission-intensive industrial processes. The specific priorities vary from region to region, based on the territorial just transition plan but include digitalization, innovations, upskilling or support for cultural and creative industries. The overall financial allocation for the Programme is CZK 42.7 bn.

Type of policy: Economic

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2021-2027

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sectors: Energy, Industry

Greenhouse gas coverage: CO_2, CH_4

r) National Recovery and Resilience Plan

Responding to the impacts of the COVID-19 pandemic, the EU Recovery and Resilience Facility was set up to mitigate the economic and social impact of the pandemic and make European economies and societies more sustainable and resilient. It finances reforms and investments aligned with EU priorities carried out in EU Member States from the start of the pandemic in February 2020 until 31 December 2026. It has a total budget of around EUR 650 billion. Member States were required to allocate in their national plans for spending RFF support at least 37% of their budget to climate measures and 20% to digital measures. According to Czech government data, the modified plan, which includes the REPowerEU chapter, devotes 43% of the allocated funds to measures in support of climate objectives.

This includes substantial support for investments in energy efficiency (including in public buildings) and renewable energy including strengthening its integration in modernising distribution grids. Apart from that, more than EUR 1 bn is allocated to sustainable mobility projects, notably in low-emission vehicles for the business sector, improving railway infrastructure, and promoting electric charging stations and cycling pathways. Further areas of support include circular economy and sustainable forest management. The funding from the Plan is dependent on the meeting of pre-defined reform criteria.

Type of policy: Economic

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: 2021-2026

Implemented in scenario: WEM

Mitigation impact: N/A

Sectors: Energy, Transport, Industry, Forestry

Greenhouse gas coverage: CO_2, CH_4

2.5.3.2. Industrial processes and product use

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. Another one would be the Economic Strategy of the Czech Republic, adopted in late 2024. These strategies focus on the relationship between industry and environmental protection. Those aspects that affect greenhouse gas emissions are described below.

Legislative Instruments

a) ***Act 76/2002 Coll., on integrated pollution prevention and control, on the integrated pollution register (Integrated Prevention Act)***

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, transposes EU legislation, which initially meant the Directive 96/61/EC on Integrated Pollution Prevention and Control (IPPC). The current Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) was transposed into national legislation in 2013. The Act requires industrial and agricultural activities with a high pollution potential to obtain 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 (BAT) flexibility and public participation.

In the area of greenhouse gas emissions, which are generated by the 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 a given facility is designed, built, operated, maintained and decommissioned. This Act also allows the 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 for cases where it is required in order to prevent serious pollution at the site.

Type of policy: Regulatory

Implementing entity: Ministry of Environment (Government)

Period of implementation: Since 2002

Implemented scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Industrial Processes

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

b) Regulation (EU) 2024/573 on fluorinated greenhouse gases

This EU Regulation, which entered into force in 2024, replaced an earlier regulation (EU) 517/2014. Its key measures include reducing hydrofluorocarbons (HFCs), expanding the quota system for HFCs in metered dose inhalers, stricter rules to prevent emissions, facilitating better monitoring, and capping EU production of all HFCs starting in 2025. All producers/importers/exporters of more than 100t CO_2 eq of F-gases must communicate the relevant information via obligatory reporting.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: 2025-2050

Implemented scenario: WEM

Mitigation impact: The main goal of the new F-Gas Regulation is to cut the EU's F-gas emissions over time towards zero by 2050, while aiming at a 90% reduction by 2030.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs, PFCs, SF_6

c) Act 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. With regard to ozone layer protection, the Act implements Regulation (EC) 1005/2009 on substances that deplete the ozone layer, as amended, and Regulation (EU) 517/2014 on fluorinated greenhouse gases (later replaced by Regulation (EU) 2024/573). A 2023 amendment of this act banned the use of single-use containers with F-gases and established a robust certification and evaluation procedure for handling and disposing of these substances.

Type of Policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of Implementation: Since 2012

Implemented Scenario: WEM

Mitigation impact: N/A.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs, PFCs, SF_6

d) Directive 2006/40/EC relating to emissions from air conditioning systems in motor vehicles (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 has been completely 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: The overall mitigation impact was calculated by using market information for 2017. Car producers do not use F-gases (HFC-134a) for new cars intended for the EU market but HFC-134a is used for filling the 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% by 2035 compared to 2015. If the car producers switch to use of alternatives (HFO-1234yf) also for cars intended for non-EU countries the mitigation impact can be up to 100% by 2035 compared to 2015.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs

e) ***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 as substances with high GWP, which had largely replaced CFCs. The Amendment sets a different time schedules and methodology for baseline calculations for Article 5 and non-Article 5 Parties. Trade of HFCs 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 including Czechia is 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, ending with an 85% reduction in 2036, measured against the same baseline.

Sector: Industrial Processes

Greenhouse gas coverage: HFCs

2.5.3.3. Agriculture

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 either by applying tools of EU Common Agricultural Policy (“CAP”) or through national measures.

The policies and measures in agriculture leading to GHG 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 the fermentation of crop residues, etc. Recently, 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.

In practice, the CAP has a significant impact on the extent, orientation and profitability of agricultural activities. The CAP has been historically based on three fundamental 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 depending on the individual implemented measures, practices and policies in the Czech Republic.

Policies, Strategies and Financial Schemes

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

The Strategy laid down strategic development targets in the field of agriculture and food production for the Czech Republic. The long-term objective of the economically rational strategic level of production in the main agricultural commodities (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.

In the field of agriculture, the main objective was to contribute towards a long-term and sustainable basis for food security on the national and European level and to contribute to the energy self-sufficiency of the Czech Republic 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. The strategy was not renewed or replaced after 2020.

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 reductions will reach approx. 300 kt CO_2eq by 2035.

Sector: Agriculture

Greenhouse gas coverage: CH_4, N_2O, CO_2

b) 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 b.n of public money that was made available for the 7-year period 2014-2020. Regulation (EU) 2020/2220 prolonged the programming period until 2022 with the overall allocation reaching more than EUR 4.7 bn. (EUR 3.1 billion from the EU budget and EUR 1.7 bn. of national co-funding).

The RDP focused mainly on ensuring the sustainable management of natural resources and on encouraging climate friendly farming practices. Secondly, its aim was to increase the competitiveness of agriculture and forestry as well as that of the food industry. The RDP also supported organic farming, increased use of renewables, and afforestation of agricultural land. The RDP funded actions under six Rural Development Priorities and in the Czech context. Particular emphasis (including budgetary) was placed on Priority 4: Restoring, preserving and enhancing ecosystems related to agriculture and forestry.

Type of policy: Economic

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2014-2020

Implemented in scenario: WEM

Mitigation impact: It is expected that GHG emissions reduction will reach approximately 357 kt CO_2eq in 2035.

Sectors: Agriculture, LULUCF

Greenhouse gas coverage: CO_2, CH_4, N_2O

c) CAP Strategic Plan

The ongoing CAP cycle of 2023-2027, which strives to make EU'S agriculture fairer and greener, is accompanied by a series of strategic plans drafted and published by the individual Member States, including Czechia's, which was adopted in late 2022. The Plan aims at ensuring the sustainable competitiveness and resilience of farms while improving the protection of natural resources and the climate. It substantially contributes to improving the redistribution of financial support to small- and medium-sized farms, strengthening the position of organic farming, and improving the vitality and quality of life in rural areas through investments. The total envisaged funding for 2023-2027 under the plan is just over EUR 8 bn., out of which EUR 5.6 bn. is provided from the EU budget. Approximately half of the overall sum should be handed out in direct payments, and just under half is allocated for rural development. At the same time, around EUR 2 bn. or 25% of the plan should be reserved for meeting either environmental and climate objectives under rural development, or for eco-schemes under direct payments. It is expected that the plan will help increase Czechia's already high share of organic production (from 15.6% to 21.3% of agricultural land) while improving animal welfare, and supporting training and advisory.

Type of policy: Economic, Regulatory

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2023-2027

Implemented scenario: WEM

Mitigation Impact: N/A

Sectors: Agriculture, LULUCF

Greenhouse gas coverage: CO_2, CH_4, N_2O

d) Action Plan for the Development of Organic Farming 2021-2027

The aim of the Action Plan for the Development of Organic Farming for 2021-2027 ("AP") is to support the further growth of organic farming in Czechia. It is the fourth successive edition of such a plan. Organic farming ("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 others 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. According to the Plan, by 2027 organic farming should be a fully developed sector with functioning trade relationships, stable demand and consistently supportive state policy.

Type of policy: Regulatory, Economic

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2021-2027

Implemented scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Agriculture

Greenhouse gases coverage: CH_4, N_2O

e) ***Strategy of the Ministry of Agriculture of the Czech Republic with an Outlook Into 2030***

The document is designed as an open living framework document and a fundamental basis for strategic management processes within the Ministry of Agriculture. It reiterates the long-term vision of the Ministry, which entails a competitive and sustainable Czech agriculture, forestry and water management. It openly acknowledges the risks posed by climate change and the need to go beyond an elementary cost-benefit analysis when striving for the protection of the environment and of natural resources. The priorities, objectives and actions of the Strategy are implemented via relevant programmes. The document was approved by the Czech Government in May 2016.

Type of policy: Regulatory

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2016-2030

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Agriculture

Greenhouse gas coverage: CH_4, N_2O

Legislative Instruments

a) ***Conditionality***

Conditionality (formerly Cross-compliance) has been employed by 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, and the standards of Good agricultural and environmental conditions (GAEC). In the following years, the Conditionality mechanism underwent a number of updates reflecting the EU legislation; the requirements and evaluated standards were updated in line with the Common Agricultural Policy. From 2023 onwards, Conditionality has been an integral part of the Czech CAP Strategic Plan.

Type of policy: Regulatory

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2009-2035

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures). The implementation of conditionality 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

b) ***Nitrates Directive – Czech Republic's 6th Action Programme***

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

- Monitor and identify waters which are polluted or are at risk of being polluted by nitrates from agriculture;
- establish a code of good agricultural practice to protect waters from this pollution;
- promote the application of the code of good agricultural practice by farmers;
- 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).

Subsequently, Czechia has drawn up a sequence of action programmes to transpose the Directive and reduce nitrate pollution. At the time of this writing, the 6th Action programme for 2024-2028 has just entered into force, offering a practical tool for introducing and fulfilling the requirements set by the Directive.

Type of policy: Regulatory

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2016-2028

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Agriculture

Greenhouse gas coverage: N_2O

2.5.3.4. LULUCF

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 and pan-European policy processes that are linked to LULUCF, such as the Ministerial Conference on the Protection of Forests in Europe – FOREST EUROPE, Natura 2000 etc., none of those had been prescriptive in terms of CO_2, CH_4 and N_2O, emissions and removals. Their effect on the greenhouse gas balance of the LULUCF sector may be indirect, however, it is not practicably quantifiable.

On the other hand, the more 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) should represent a stronger normative incentive for action in the LULUCF sector. Specifically, it adopts a new accounting framework for forestry based on forest reference level (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 was recently 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. What is more, the revised LULUCF regulation sets an aggregate EU target for natural sinks of 310 Mt CO_2eq, translated into targets for Member States for the period 2026-2030, which should also be reflected in their updated National Energy and Climate Plans.

Policies and Strategies

a) ***Nature Restoration Law – Regulation (EU) 2024/1991***

The Nature Restoration Regulation provides for a general objective to put in place effective and area-based restoration measures that cover at least 20% of the EU's land and sea areas by 2030 and all ecosystems in need of restoration by 2050. The Regulation includes in its general objectives to contribute to achieving the EU's overarching objectives on climate change mitigation, climate change adaptation, land degradation neutrality and food security as well as meeting EU's international commitments. The Nature Restoration Law includes specific targets for terrestrial/coastal/freshwater ecosystems, marine ecosystems, urban ecosystems, rivers and floodplains, pollinators, agricultural ecosystems and forest ecosystems. Member States will be required to develop national restoration plans, which have to include the quantification of areas to be restored to reach restoration targets and indicative maps of potential areas to be restored. In doing so, Member States will identify synergies with climate change mitigation, climate change adaptation, land degradation neutrality and disaster prevention and prioritise restoration measures accordingly. They will also identify synergies with the national CAP Strategic Plan.

Type of policy: Regulatory

Implementing entity: Ministry of the Environment (Government)

Period of implementation: since 2024

Implemented in scenario: WEM

Mitigation Impact: N/A

Sector: LULUCF, Agriculture

Greenhouse gas coverage: CO_2

b) *State Forest Policy until 2035*

The most important category of the Czech LULUCF sector in terms of greenhouse gas emission balance is forest land. Forestry in the Czech Republic is primarily regulated by the Forest Act 289/1995 Coll. This instrument does not specifically target carbon balance but its provisions affect carbon budget and greenhouse gas emissions and removals indirectly in a number of ways.

Beyond this legislation, State forest policy until 2035 is the key national strategic document for forestry and forestry-related sectors. It includes specific measures that are or should be implemented to alleviate the envisaged impacts of climate change and extreme climatic conditions. These measures generally focus on creating more resilient forest ecosystems. They do so by promoting diversified forest stands utilizing to the greatest possible extent natural processes, appropriate species composition and a 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 298/2018 Coll., on elaborating regional plans of forest development and on the specification of management sets of stands. 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 pioneer species to speed up forest regeneration. Provisions of this decree are implemented through regional plans of forest development.

Type of policy: Regulatory

Implementing entity: Ministry of Agriculture (Government)

Period of implementation: 2021-2035

Implemented in scenario: WEM

Mitigation Impact: The policies and measures listed above are among other goals directly aimed at GHG mitigation. However, the desired effect is only achievable in the long-term (up to a century) while in the near future, mitigation effects expected to be achieved by this program are considered marginal.

Sector: LULUCF

Greenhouse gas coverage: CO_2

c) *Czech Wood Policy*

As a follow-up document on the State Forest Policy until 2035, in 2024, the new Czech Wood Policy was adopted by the government. It offers a novel approach insofar that wood is considered a strategic material, a renewable resource and an environmentally-friendly construction material. The key objective is to increase the added value of the wood processed in Czechia and ensure its more efficient use. Concretely, the Policy sets three priorities:

- To ensure sustainable long-term supply for the domestic wood- processing industry.
- To promote the use of wood as a renewable raw material in relevant sectors of the economy and everyday life.
- Continuously increase the production of wood-based products with higher added value and long life cycle, and increase domestic consumption to scale up the use of raw timber and primary processed wood.

In practical terms, meeting the objectives set by this policy document goes hand in hand with the intended increase in the use of wood as a construction material. In fact, by 2035, up to ¼ of all new buildings for family housing buildings by 2035 should use wood as a primary construction material. The other objective is to increase the percentage of wood used in public buildings and refurbishment projects.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: since 2024

Implemented in scenario: WEM

Mitigation Impact: N/A

Sector: LULUCF

Greenhouse gas coverage: CO_2

Legislative Instruments

a) *Regulation (EU) 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 adequate contribution of the LULUCF sector to the achievement of the European Union’s emission GHG reduction target of at least 55% (formerly 40%) between 1990 and 2030, and to the long-term goal of the Paris Agreement, the LULUCF Regulation has established a robust accounting system for the different 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. The later revision of the regulation sets a new EU level target of increasing removals to -310 million tonnes of CO_2eq in 2030. This target is distributed among the Member States and the respective target for the Czech Republic for 2030 is -1 228 kt CO_2eq. The Member States also need to comply with an aggregate carbon budget for 2026-2029.

Type of policy: Regulatory

Implementing entity: Ministry of Environment (Government)

Period of implementation: 2021-2030

Implemented in scenario: WEM

Mitigation impact: The LULUCF accounting framework provides incentives for maintaining and enhancing carbon sink. However, the mitigation impact is difficult to quantify.

Sector: LULUCF

Greenhouse gas coverage: CO_2, CH_4, N_2O

2.5.3.5. Waste

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

There is a potential for sectoral emission reductions by fulfilling the EU obligations of the Circular Economy Package (COM/2015/0614) and national measures. 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 accumulation of biodegradable waste in landfills, establishing and expanding separate collection systems for different waste streams (plastics, paper, glass, bio-waste, cardboard, metals, textile), promoting the energy use and digestion of non-recyclable waste, and improving landfill gas recovery.

The Czech waste legislation is largely based on the EU legislation. The EU legislation with a direct impact on GHG emissions from waste included the Landfill Directive (1999/31/EC) and the Waste Directive (2008/98/EU), both of which have been modified by the Circular Economy Package.

There are several policies that are not part of the waste legislation, which already have or will have an impact on GHG emissions from waste. Most of them are mentioned in the cross-sectoral section in this report. Nevertheless, it is important to highlight the EU ETS, the Climate & Energy Package and the Energy Taxation Directive, which provide direct and indirect support for 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. Operational Programme Environment also contributes significantly to the expansion of the facility network.

Policies and Strategies

a) ***Waste Management Plan of the Czech Republic for the period 2015-2024***

A crucial strategic 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 binding part of WMP constitutes a mandatory basis for decision-making and other activities of the relevant administrative authorities, regions, and municipalities in the area of waste management. From 2024, certain waste categories (recyclable and recoverable wastes) are 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. At the time of this writing, a follow-up plan for the period 2025-2035 was being finalized. Moreover, a legislative proposal tabled by the Government on the establishment of a deposit system for PET bottles and cans, is being discussed by the Parliament.

Type of policy: Regulatory

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_2eq or 10% of sectoral emissions over the period of 2015-2024.

Sectors: Waste, Energy

Greenhouse gas coverage: CH_4

Legislative Instruments

a) ***EU Circular Economy Action Plan***

The new Circular Economy Action Plan (CEAP) was adopted by the European Commission in March 2020 as one of the building blocks of the European Green Deal. This replaced an earlier version of the plan adopted in 2015. CEAP introduces both legislative and non-legislative measures targeting areas where action at the EU level brings real added value. The new action plan announces initiatives along the entire life cycle of products. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented and the resources used are kept in the EU economy for as long as possible. Moreover, in 2023, the Commission revised the circular economy monitoring framework and also adopted several initiatives on microplastics.

Time of policy: Regulatory

Implementing entity: Ministry of Environment (Government)

Period of implementation: 2020-2035

Implemented in scenario: WEM

Mitigation impact: Not quantified. There is an assumption that meeting CEAP targets will strongly support EU mitigation efforts.

Sector: Waste

Greenhouse gas coverage: CH_4, CO_2

2.5.3.6. Transport

Policies and Strategies

a) ***National Action Plan for Clean Mobility***

The National Action Plan for Clean Mobility (NAP CM) for the period 2015-2018 with an outlook until 2030 responds to Directive 2014/94/EU on the deployment of alternative fuels infrastructure. The Directive requires the development of a 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 (fuel cells). It sets out requirements for the construction of filling and charging stations between 2020 and 2030. The emphasis of the NAP CM is to strive mainly for technologies close to commercial use. NAP CM undergoes regular updates with the last one taking place in 2024. This update sets milestones for 2025, 2030 and 2035 as regards the rollout of the respective alternative fuels. Moreover, the intended rollout of ETS2 is presumed to be an important trigger for the development of alternative fuels.

Type of policy: Regulatory

Implementing entity: Ministry of Transport (Government)

Period of implementation: 2015-2030 and beyond

Implemented in scenario: WEM

Sector: Transport

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures). Overall fossil fuel consumption in the transport sector is expected to drop by approx. 13 PJ annually from 2027 onwards, equivalent to a GHG reduction of approx. 0.9 Mt CO_2eq.

Greenhouse gases covered: CO_2

b) ***Czech National Cycling Development Strategy for 2013-2020***

In May 2013, the Czech government approved this Strategy, aiming to increase urban cycling modal share to 10% by 2020 and up to 25% by 2025 while also enhancing 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 strategy was not prolonged or replaced after 2020.

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 CZK 150 mil.

Greenhouse gases covered: CO_2

Legislative Instruments

a) ICAO Agreement and CORSIA

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 and policies in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector. In 2016, there was an agreement among ICAO’s 191 members to use an offsetting scheme called Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA is implemented in three phases: a pilot phase (2021-2023), a first phase (2024-2026), and a second phase (2027-2035). In 2022, ICAO states parties adopted a net-zero 2050 global aspirational goal for international flight operations.

Type of policy: Regulatory

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_2eq in 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

b) 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 emissions of the Union fleet of new heavy-duty vehicles shall be reduced compared to the reference as follows:

- for the reporting periods from 2025 onwards by 15%;
- for the reporting periods from 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: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Transport

Greenhouse gas coverage: CO_2

c) 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 April 2019 sets CO_2 emission performance standards for new passenger cars and for new light commercial vehicles. It 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 edge also by strengthening its competitiveness and stimulating employment while ensuring a better functioning of the internal market and aiming to fulfil the goals of the Paris Agreement. From 2020, this Regulation set 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. To help achieve the EU's climate targets, from 2025 onwards, stricter EU-wide fleet targets (WLTP) will apply: Cars: 93,6 g CO2/km (2025-2029) and 49.5 g CO2/km (2030-2034); Vans: 153.9 g CO2/km (2025-2029) and 90.6 g CO2/km (2030-2034). From 2035 onwards, the EU fleet-wide CO_2 emission target for both cars and vans is 0 g CO_2/km, corresponding to a 100% reduction.

Type of policy: Regulatory

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

Period of implementation: Since 2019

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Transport

Greenhouse gas coverage: CO_2

d) Directive 2009/33/EC on the promotion of clean road transport vehicles in support of low-emission mobility

The Directive 2009/33/EC has as its objectives the promotion and stimulation of a 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, which among other things defined as ‘clean vehicles’ only zero-emission vehicles from 2026 onwards.

Type of policy: Regulatory

Implementing entity: Ministry of Regional Development (Government)

Period of implementation: Since 2019

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Transport

Greenhouse gas coverage: CO_2

e) Support of biofuels on the EU level

The quality of fuels used in transport is regulated by the Directive 2009/30/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 have gradually reduced life cycle greenhouse gas emissions by up to 10% per unit of energy from fuel and energy supplied. The Czech Act on Air Protection 201/2012 Coll. transposing the RES Directive sets the minimum 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 those of the fuel they replace. From 2017, this figure rose to 50% and from 2018 to 60% for biofuels produced in facilities that started production in 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 a modification of emission factors per a unit of energy. The resulting 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 envisaged emission reduction of this measure is 198 kt CO_2eq in 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

f) Support of electromobility on the EU level

Concerning the regulatory framework for the development of electromobility within the EU legislation, the key instrument is Regulation 2023/1804 on the deployment of alternative fuels infrastructure (and repealing an earlier 2014 Directive). The specific objectives of the Regulation are:

1. to ensure minimum infrastructure to support the required uptake of alternative fuel vehicles across all transport modes and in all EU Member States to meet the EU's climate objectives;
2. to ensure full interoperability of the infrastructure; and
3. to ensure comprehensive user information and adequate payment options at alternative fuels infrastructure.

For publicly available electric recharging infrastructure for light duty road vehicles (cars and vans), the regulation sets out mandatory national fleet based targets. It also sets out distance-based targets for light duty and heavy-duty road vehicles on the TEN-T core and comprehensive network. It also requires EU Member States to ensure a number of recharging stations are in place for heavy-duty vehicles in urban nodes and in safe and secure parklings.

Type of policy: Regulatory

Implementing entity: Ministry of Industry and Trade (Government)

Period of implementation: Since 2017

Implemented in scenario: WEM

Mitigation impact: Framework measure (mitigation impact is accounted for under specific measures).

Sector: Transport

Greenhouse gas coverage: CO_2

g) *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 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 Czech Government Decree 189/2018 Coll. sets sustainability criteria for biofuels and methodology for calculation greenhouse gas emission production from fuels while the Excise Tax Act 353/2003 Coll. Levies biofuels with a lower tax rate. The baseline shall be based on EU average 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).

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 biofuels was calculated using a modification of emission factors per a unit of energy. The resulting 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 envisaged emission reduction of this measure is 198 kt CO_2eq in 2035.

Sector: Transport, Energy

Greenhouse gas coverage: CO_2

h) *Creating systems of combined freight transport*

The use of multimodal transport systems is preferred to reduce the share 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 logistical 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. 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 distance freight transport from roads to railways (in trips over 300 km).

All fourteen regional authorities in the Czech Republic are set to develop integrated transport systems (ITS) and are the implementing authorities of this measure.

Type of policy: Regulatory

Implementing entity: 14 regions/regional authorities

Period of implementation: There is no uniform period for all 14 regions. The plans are partly coordinated by the Ministry for Regional Development. Within the projections these measures are 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 calculated at 38.4 kt CO_2eq by 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

Financial Schemes and Programmes

a) Operational Programme Transport

The current Operational Programme Transport 2021-2027 (OPT3) follows the two previous editions of this EU-sponsored funding scheme and represents the most important source of financing for the construction of transport infrastructure in the Czech Republic in the programming period. OPT3 is one of the largest operational programmes with an allocation of approx. EUR 4.9 bn. Its aim is to fulfil strategic investment needs and help solve key problems in the Czech transport sector. The Programme responds to the goals and requirements set by EU legislation and strategies as well as national strategies. 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. Taking into account lessons learnt from the OPT1 and OPT2, the OPT3 targets its support at three priorities (apart from technical support): 1) European, national and regional mobility; 2) National road mobility ensuring TEN-T connectivity; 3) Sustainable municipal mobility. In its programming for sustainable transport, the funding scheme refers to the NAP CM mentioned above.

Type of policy: Economic

Implementing entity: State Fund of Transport Infrastructure (Government)

Period of implementation: 2007-2027

Implemented in scenario: WEM

Mitigation Impact: The annual CO_2 emission decrease 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

b) Economic and tax tools for road vehicles on national level

The objective of these tools is to promote the use of less polluting vehicles. They include the following rules:

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

Moreover, the Transport Policy of the Czech Republic for 2021-2027 with an outlook into 2050 contains a long-term vision for Czechia's transport system. It assumes that Czechia and its individual regions will be provided with a transport system that meets the requirements of transport needs in both passenger and freight transport, supports sustainable economic development and inclusive policy aimed at structurally disadvantaged regions and their inhabitants. At the same time, this transport system will meet the requirements in terms of sustainability, which means that it will be neutral in terms of impact on global (not only climate) changes (in terms of mitigation and adaptation), will have the least possible impact on public health, will have minimal impact on biodiversity, nature and landscape and will make a balanced use of natural resources based on renewables so as not to increase debt to future generations. It will therefore be necessary to meet the need for the mobility of people and things, the way in which these needs are provided must be influenced in such a way as to ensure sustainability in relation to further economic development.

Type of policy: Economic, Fiscal

Implementing entity: Ministry of Finance (Government)

Period of implementation: 2020-2050

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 would be charged by excise tax, their consumption would increase while petrol and diesel consumption would decrease equally. The total emission reduction of this measure is calculated at 38.4 kt CO_2eq by 2035.

Sector: Transport

Greenhouse gas coverage: CO_2

c) Other funding for clean mobility

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

The Integrated Regional Development Programme entails a specific goal “Support of sustainable multimodal municipal transport in the context of the transition to a climate neutral economy”, which supports i.a. the purchase of ZEV and low-emission vehicles for public transport, and the construction of charging and filling stations as well as the enhancement of multimodal transport. The overall funding allocation is CZK 20.4 bn.

Modernisation Fund is another key funding instrument as it includes a funding priority for clean transport, namely the purchase of ZEV and the construction of the required infrastructure. There are two sub-programmes, depending on the recipients of such support – either businesses or municipalities (when developing public transport). The former sub-programme is allocated 1.5% of the overall funding of the Modernisation Fund, while the latter is allocated 8.5%, which can reach up to approx. CZK 40 bn.

Type of policy: Regulatory, Economic

Implementing entity: Ministry of Regional Development, Ministry of the Environment (Government)

Period of implementation: As described above for the individual programmes.

Implemented in scenario: WEM

Mitigation Impact: N/A

Sector: Transport

Greenhouse gas coverage: CO_2

d) 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. 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

2.5.4. Key planned policies and measures

ETS2

In 2023, a new emissions trading system (ETS2) was introduced, which also covers CO2 emissions from road transport, buildings and small industries not covered by the existing EU ETS. The introduction of carbon pricing in those sectors will provide a market incentive for investments in building renovations and low-emission mobility. Like the existing EU ETS, ETS2 is a ‘cap-and-trade’ emission mechanism, but it will address fuel suppliers rather than end consumers such as households or car users. Fuel suppliers will have to monitor and report emissions from fuels supplied by them and buy sufficient allowances at auctions to cover these emissions. The ETS2 cap will be set in such a way as to bring emissions down by 42% by 2030 compared with 2005 levels. Part of the revenues will be earmarked for the Social Climate Fund, and EU Member States will be required to use their remaining revenues for climate action and social measures. The annual monitoring and reporting cycle will start on 1 January 2025. By then, regulated entities covered by ETS2 are required to have a greenhouse gas emissions permit and an approved monitoring plan for monitoring and reporting on their annual emissions. Every year, they must report on their emissions in the previous year by 30 April. From 2026, the reported data for a given year will have to be verified by an accredited verifier. From 2028, once the annual verified emissions are reported, regulated entities will have to surrender an equivalent number of allowances by 31 May of that year. Over the course of 2027, an additional 30% of allowances will be auctioned to provide market liquidity. ETS2 is expected to become fully operational in 2027. However, if gas or oil prices are exceptionally high in 2026, the launch of the ETS2 system could be postponed until 2028 to ensure a smooth implementation.

CBAM

The CBAM was established by Regulation (EU) 2023/956 (CBAM Regulation) as part of the European Green Deal and was introduced to put a price on GHGs emitted during the production of carbon-intensive goods imported into the EU and to encourage cleaner industrial production in non-EU countries. The CBAM is being introduced in phases. The transitional phase started in 2023 and is based on Commission Implementing Regulation (EU) 2023/1773. It introduces the new mechanism gradually, requiring only that the reporting of GHG emissions be embedded in imports, without imposing financial obligations. The transitional phase (2023-2026) covers the following sectors that are most at risk of carbon leakage: cement, iron and steel, aluminium, fertilisers, electricity and hydrogen. The final phase of CBAM will enter into force in January 2026 and will be phased in as free allocation in the respective sectors under the EU ETS is phased out. Under the final CBAM arrangements, importers of goods in the CBAM sectors will be required to register with national authorities. They will also need to purchase CBAM certificates corresponding to the carbon price that would have been paid if the goods had been produced under the EU's carbon pricing rules. EU importers will then report the emissions embedded in their imports and surrender a corresponding number of CBAM certificates to cover them.

Action Plan for the Development of CCUS

At the time of writing this report, the Action Plan for the Development of CCUS was about to be sent into the governmental legislative procedure. The plan responds both to requests of the Czech industry and to EU legislation, particularly Regulation (EU) 2024/1735 – the Net-Zero Industry Act, which aims at ensuring an annual geological storage of at least 50 Mt CO_2 by 2030 across the EU. It is reflected that existing strategic documents on the national level lack the required level of detail and concrete measures as regards CCUS development. The draft Plan proposes a set of 23 measures distributed among five key areas of implementation: political measures; regulatory measures; exchange of knowledge and stakeholder engagement; science and research; and future financing. The overall horizon is until 2027. Given the novel character of CCUS, the Plan describes the key technologies in some detail, including the related opportunities, barriers to their development and expected costs. The Plan envisages the establishment of a National CCUS Platform, which would involve representatives of public administration, industrial associations, scientific institutions and academia, which should coordinate and evaluate the implementation of the proposed measures. The document also tackles the issue of social acceptance of CCUS technologies, which is key should a geological deposit be established in Czechia.

2.6. Projections of greenhouse gas emissions and removals

The preparation of GHG emissions projections include the following steps:

(i) **Selection of the latest available National Inventory Report (NIR)** – The latest available NIR (NIR 2022) at the time of preparation of the projections contained GHG emission estimates for the period 1990-2020.

(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 for 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 the 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 the 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 the 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 the WEM scenario, while PaMs introduced after 1st July 2022 are reflected in the WAM scenario.

(vii) **Calculation of scenarios and results presentation** – Results of GHG emission projections are presented for each sector as a total emission for the given sector, emissions by gases and emissions by categories. Results can be found in the 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 is available in the chapter Sensitivity analysis for each sector.

2.6.1. Emission projection scenarios and division to sectors

The following projections have been prepared in line with methodological guidelines for projection compilation[33] and in line with Regulation (EU) No 2018/1999. Projections contain two scenarios:

- With existing measures (WEM) – with measures implemented and effective as of the date when preparation of projections began (July 2022);
- With additional measures (WAM) – with measures which are going to be implemented in the near future or which are planned to be implemented in the future.

Table 2.43 below provides an overview of projection results. Reported data of greenhouse gases emissions in the tables of Biennial transparency report have been updated based on the last inventory submission in 2022, with 2020 as the last reported year. Projected data of the greenhouse gases emissions are based on the projections reported in March 2023. Therefore 2020 values can differ for reported and projected emissions. Projections in 2024 were not updated due a (at time of this writing) still ongoing process of accepting the updated National Climate and Energy Plan by the Czech Government.

The differences for 2020 between projected emissions and reported emissions are caused by the fact that while preparing the projections of emissions for the reporting in 2023, all input data were based on projected data which were not expecting such a significant impact of the COVID-19 pandemic. Contrary, the data for the greenhouse gas inventory submitted in April 2022 was already prepared based on the real statistical data for 2020, which is actually reflecting the real situation in 2020.

All specific Policies and Measures (PaMs) included in WEM and WAM scenarios are presented for each sector in respective chapters.

Table 2.43: Reported and projected emissions of GHG – WEM and WAM (including LULUCF) [Mt CO_2eq, % reduction in comparison with 1990]

[Mt CO_2eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2025	1990–2030	1990–2040	1990–2050
WEM	190.55	140.59	123.09	126.35	97.92	83.52	70.41	65.38	53.11	-48.61	-56.17	-65.69	-72.13
WAM	190.55	140.59	123.09	126.35	96.83	81.71	58.06	51.82	46.05	-49.19	-57.12	-72.81	-75.83

Source: CHMI

The projections of greenhouse gas emissions are prepared for the following sectors (division to the sectors is in line with IPCC 2006 Guidelines:

1. Energy (sector 1) – greenhouse gas emissions from combustion processes and fugitive emissions,
2. Industrial Processes and Product Use (IPPU) (sector 2) – greenhouse gas emissions resulting from industrial activities and not from fuel combustions used to supply energy for carrying out these activities,

[33] 18/CMA.1Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement.

3. Agriculture (sector 3),
4. Land use, Land Use Change and Forestry (LULUCF) (sector 4),
5. Waste (sector 5).

Total greenhouse gas emissions are calculated as a sum of CO_2, N_2O, CH_4, HFCs, PFCs, SF_6 and NF_3 emissions expressed in CO_2eq. Methodological operations and modelling tools used for projections of greenhouse gases are described in the text below for every sector.

2.6.1.1. Energy (sector 1)

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.

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 .

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.

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

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 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, NO_X, 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.

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

Final energy service demand is based on the National Energy Climate Plan (NECP). Nuclear power development is an exogenous assumption according to NECP: Temelín nuclear power plant remains in operation for the whole period (2020 – 2050), while 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 . The maximum potential of renewable energy sources (RES) for electricity generation corresponds to the Progressive Scenario of the Resource Adequacy Assessment of the Electrical Grid of the Czech Republic until 2040.

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

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

The heating plant and the ICGT plant 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 synthetic gas.

All new electricity generating (or CHP) sources are reclassified from sector 1.A.4.a to sector 1.A.1.a.

The reflection of the recent energy crisis and the impacts of Russia's war against Ukraine is limited to the updated price assumptions based on Recommended parameters for reporting on GHG projections in 2023. 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 recent spike in energy prices and neither does it reflect the current induced boost in energy efficiency.

Table 2.44: 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

Source: CHMI

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

In sector 1.A.4, the low rate of renovations of buildings – not reflecting the recent 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.

Detailed results for scenarios WEM and WAM are described in tables below.

Table 2.45: 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

Source: CHMI

Table 2.46: 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**

Source: CHMI

Final energy consumption in 1.A.4 Other sectors is depicted in the following table. Total energy consumption in 1.A.4.a Commercial/Institutional increases due to increasing underlying 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 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 the following tables.

Table 2.47: 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**

Source: CHMI

Table 2.48: 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**

Source: CHMI

Table 2.49: 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**

Source: CHMI

Final energy consumption in 1.A.4 Other sectors is depicted in the next table. 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 underlying activity – growth of GDP and heated area – but it culminates around 2040 as a result 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 the WEM scenario. The ambient heat for heat pumps is not included in the table.

Table 2.50: 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
Total	**457.7**	**467.3**	**471.8**	**477.3**	**475.8**	**444.8**	**418.5**

Source: CHMI

<u>Methodological issues – 1.A.2, 1.A.5 and 1.B</u>

For these categories, a data driven model was applied, including assumptions related to the 1.A.1 and 1.A.4 categories. Moreover, for the estimation in 1.A.2 possible interactions with categories under 2 (Industrial production and product use) were observed. Final fuel inputs for heat and power generation are provided in a table above. Category 1.A.5 (Other) is also related to 1.A.3 (Transport), however 1.A.5 is expected to decarbonize slower than 1.A.3

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), which collects data regarding future plans of energy and industrial companies, such as constructions of new sources or shutdowns, technical details, life expectancy, investment, and operating costs.

Methodological issues – 1.A.3 Transport

Road transport shows steadily growing activity and consequently energy consumption and GHG emissions. After 2007, transport, especially freight 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 can be attributed to COVID-19 pandemic.

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. The overall transport performance forecast and the division of transport work are based on the Transport Sector Strategy. Also, non-road transport forecasts were not changed.

With regards to emission reductions by the application of individual policies and measures, only quantifiable measures have been calculated. Calculable measures are described in the following table.

Table 2.51: Overview of PaMs with estimated emission reductions

PaM title	Changes in the prediction model
Support of biofuels	CO2 emission factors resulting from an increased share of biofuels.
Regulation on CO2 from cars	Modification of new cars activity data to have its weighted average equal to 95 g/km.
Regulation on CO2 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 CO2 emissions	Modification of new cars and light duty vehicles activity data to achieve required decrease of CO2 emissions in 2025 and 2030.
Fit for 55	Modification of new cars and light duty vehicles activity data to achieve required decrease of CO2 emissions in 2030 and only zero emissions from new cars from 2035.

Source: CHMI

Projection results – WEM and WAM scenarios

According to the projections of GHG emissions in 1. Energy sector it is expected that emissions are going to decrease for both scenarios. The decrease of emissions is more pronounced in the 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 scenarios is calculated as 6.74 Mt CO_2eq.

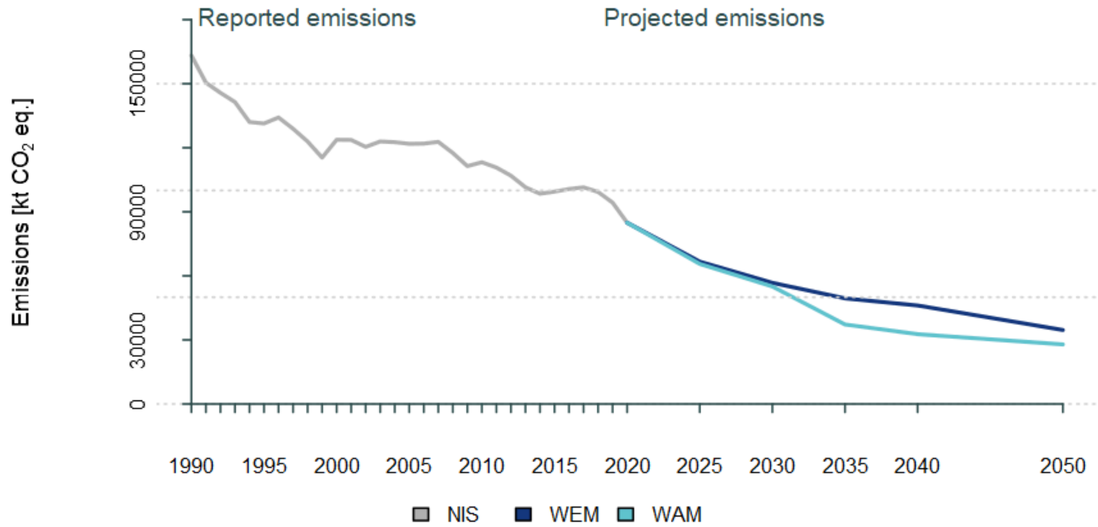
In total numbers WEM scenario projects that GHG emissions from 1. Energy sector will decrease approximately by 79% by 2050 compared to 1990, by 72% compared to 2005 and by 59% compared to current level (2020). In the WAM scenario, GHG emissions are projected to decrease approximately by 83% in 2050 compared to 1990, by 77% compared to 2005 and 67% compared to current level (2020).

Table 2.52: Projections of total greenhouse gas emissions from the Energy sector – WEM and WAM scenarios [Mt CO_2eq, respectively % reduction in comparison with 1990]

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
WEM	163.20	121.84	84.89	84,90	66,66	56.73	49.45	46.12	34.64	-47.98	-65.24	-71.74	-78.78
WAM	163.20	121.84	84.89	84,90	65,59	55.02	37.22	32.68	27.90	-47.98	-66.29	-79.98	-82.90

Source: CHMI

Figure 2.1: Reported and projected emissions of GHG in 1. Energy (including Transport) – WEM, WAM scenarios



Source: CHMI

WEM scenario

1. Energy sector is a source of CO_2, CH_4 and N_2O emissions. It is expected that emissions are going to decrease for all gases emitted by this sector during the projected period. It is expected that by 2050 CO_2 emissions would decrease by 78%, CH_4 by 87% and N_2O by 68% compared to 1990.

For the vast majority of categories under 1. Energy sector it is expected that emissions will decrease by 2050 compared to current levels. For category 1.A.1 Energy Industries, which has a major share of total GHG emissions from 1. Energy, it is expected that emissions will decrease by 2050 compared to 2020 levels 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 a result of the decreasing power generation due to decreasing net export of electricity (exogeneous assumption) and price of EUA, which accelerates a 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 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.

Table 2.53: Breakdown of reported and projected emissions of GHG by gases in Energy – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
CO_2	147.10	113.05	80.68	80.69	62.79	53.30	45.98	43.03	32.44	-45.15	-63.77	-70.75	-77.95
CH_4	15.48	8.24	3.69	3.66	3.47	3.09	3.15	2.78	2.00	-76.37	-80.04	-82.02	-87.11
N_2O	0.63	0.55	0.52	0.55	0.41	0.34	0.33	0.31	0.20	-11.46	-44.96	-50.61	-67.97
Total	**163.20**	**121.84**	**84.89**	**84.90**	**66.66**	**56.73**	**49.45**	**46.12**	**34.64**	**-47.98**	**-65.24**	**-71.74**	**-78.78**

Source: CHMI

Table 2.54: 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	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
1. Energy	**163.2**	**121.84**	**84.89**	**84.90**	**66.66**	**56.73**	**49.45**	**46.12**	**34.64**	**-47.98**	**-65.24**	**-71.74**	**-78.78**
A. Fuel combustion (sectoral approach)	**149.37**	**114.22**	**82.27**	**82.32**	**64.12**	**54.56**	**47.26**	**44.23**	**33.03**	**-44.89**	**-63.47**	**-70.39**	**-77.89**
1. Energy industries	56.83	63.14	41.59	41.59	25.75	18.25	12.50	11.02	4.72	-26.83	-67.88	-80.61	-91.70
2. Manufacturing industries and construction	47.11	18.84	10.27	10.24	10.20	10.05	9.98	9.88	9.81	-78.26	-78.67	-79.02	-79.17
3. Transport	11.25	17.36	17.70	17.77	14.20	12.49	11.84	11.01	9.40	57.93	11.05	-2.13	-16.42
4. Other sectors	33.99	14.61	12.40	12.40	13.64	13.45	12.63	12.00	8.79	-63.51	-60.44	-64.68	-74.14
5. Other	0.19	0.27	0.31	0.32	0.32	0.32	0.32	0.31	0.31	65.44	63.66	61.90	61.03
B. Fugitive emissions from fuels	**13.84**	**7.63**	**2.61**	**2.58**	**2.54**	**2.17**	**2.19**	**1.89**	**1.61**	**-81.33**	**-84.29**	**-86.31**	**-88.39**
1. Solid fuels	12.64	6.62	1.93	2.58	2.54	2.17	2.19	1.89	1.61	-79.56	-82.80	-85.01	-87.29
2. Oil and natural gas and other emissions from energy production	1.20	1.00	0.68	1.90	1.72	1.52	1.51	1.18	0.92	58.56	26.67	-1.73	-23.35
C. CO_2 transport and storage	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Source: CHMI

WAM scenario

According to the projected WAM scenario, emissions from Energy should witness a substantial decrease by 2050 compared to 2020.

The following table breaks down the reported and projected emissions of GHG by categories in Energy for WAM scenario.

In the 1.A.1 Energy industries, GHG emissions decrease faster in WAM than in WEM after 2030 as a result of higher EUA price and the phase-out of lignite in 2033. It is projected that additional measures (tax tools, Road toll and mainly the new financial support schemes) will decrease GHG emissions from 1.A.3 Transport in the WAM 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 EU ETS 2 for buildings.

Table 2.55: Breakdown of reported and projected emissions of GHG by gases in Energy – WAM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
CO_2	147.10	113.05	80.68	80.69	61.79	51.61	33.84	29.96	25.71	-45.15	-64.92	-79.63	-82.52
CH_4	15.48	8.24	3.69	3.66	3.42	3.06	3.09	2.46	1.98	-76.37	-80.20	-84.13	-87.24
N_2O	0.63	0.55	0.52	0.55	0.37	0.35	0.29	0.25	0.21	-11.46	-44.52	-59.31	-65.87
Total	**163.20**	**121.84**	**84.89**	**84.90**	**65.59**	**55.02**	**37.22**	**32.68**	**27.90**	**-47.98**	**-66.29**	**-79.98**	**-82.90**

Source: CHMI

Table 2.56: Breakdown of reported and projected emissions of GHG by categories in Energy – WAM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
1. Energy	**163,2**	**121,84**	**84,89**	**84,90**	**65,59**	**55,02**	**37,22**	**32,68**	**27,90**	**-47,98**	**-66,29**	**-79,98**	**-82,90**
A. Fuel combustion (sectoral approach)	**149,37**	**114,22**	**82,27**	**82,32**	**63,04**	**52,85**	**35,02**	**30,78**	**26,29**	**-44,89**	**-64,62**	**-79,39**	**-82,40**
1. Energy industries	56,83	63,14	41,59	41,59	25,47	18,02	5,74	4,76	4,07	-26,83	-68,29	-91,62	-92,84
2. Manufacturing industries and construction	47,11	18,84	10,27	10,24	10,20	10,05	9,98	9,88	9,81	-78,26	-78,67	-79,02	-79,17
3. Transport	11,25	17,36	17,70	17,77	13,94	11,53	8,47	7,46	6,11	57,93	2,45	-33,65	-45,69
4. Other sectors	33,99	14,61	12,40	12,40	13,11	12,93	10,52	8,36	5,99	-63,51	-61,95	-75,40	-82,38
5. Other	0,19	0,27	0,31	0,32	0,32	0,32	0,32	0,31	0,31	65,44	63,66	61,90	61,03
B. Fugitive emissions from fuels	**13,84**	**7,63**	**2,61**	**2,58**	**2,54**	**2,17**	**2,19**	**1,89**	**1,61**	**-81,33**	**-84,29**	**-86,31**	**-88,39**
1. Solid fuels	12,64	6,62	1,93	1,90	1,72	1,52	1,51	1,18	0,92	-84,97	-88,00	-90,69	-92,74

2. Oil and natural gas and other emissions from energy production	1,20	1,00	0,68	0,68	0,82	0,66	0,68	0,72	0,69	-42,89	-45,18	-40,14	-42,53
C. CO_2 transport and storage	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Source: CHMI

Table 2.57: Reported and projected emissions of GHG in 1.A.3 Transport – WEM and WAM scenarios

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	**2005**	**2020**	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**	**1990–2020**	**1990–2030**	**1990–2040**	**1990–2050**
WEM	11.25	17.36	17.70	17.77	14.20	12.49	11.84	11.01	9.40	57.93	11.05	-2.13	-16.42
WAM	11.25	17.36	17.70	17.77	13.94	11.53	8.47	7.46	6.11	57.93	2.45	-33.65	-45.69

Source: CHMI

Sensitivity analysis – 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 the following tables.

Table 2.58 Sensitivity analysis of 1.A.2 Manufacturing industries and construction on input activity data (WEM scenario)

[Mt CO_2eq]	2020	2025	2030	2035	2040	2045	2050
WEM	10.24	10.20	10.05	9.98	9.88	9.85	9.81
WEM -5%	9.73	9.69	9.55	9.48	9.39	9.35	9.32
WEM +5%	10.75	10.71	10.55	10.47	10.38	10.34	10.30

Source: CHMI

Table 2.59: Sensitivity analysis of 1.A.2 Other on input activity data (WEM scenario)

[Mt CO_2eq]	2020	2025	2030	2035	2040	2045	2050
WEM	0.32	0.32	0.32	0.32	0.31	0.31	0.31
WEM -5%	0.31	0.30	0.30	0.30	0.30	0.30	0.30
WEM +5%	0.34	0.34	0.33	0.33	0.33	0.33	0.33

Source: CHMI

Table 2.60 : Sensitivity analysis of 1.B Fugitive emissions from fuels on input activity data (WEM scenario)

[Mt CO_2eq]	2020	2025	2030	2035	2040	2045	2050
WEM	2.58	2.54	2.17	2.19	1.89	1.75	1.61
WEM -5%	2.45	2.42	2.06	2.08	1.80	1.66	1.53
WEM +5%	2.71	2.67	2.28	2.30	1.99	1.84	1.69

Source: CHMI

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 prices of natural gas from the Recommended parameters for reporting on GHG projections in 2023 (DG Climate Action, 2022) are applied. Secondly, 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, a low price of natural gas and an increased demand of final energy services in category 1.A.4 are applied. In the -5 % option, high price of natural gas and a decreased demand of final energy services in category 1.A.4 are applied. The sensitivity analysis is provided for both WEM and WAM scenarios.

The following table 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.

Table 2.61: Sensitivity analysis of emissions of GHG from 1.A.1.a Public electricity and heat production and 1.A.4 Other sectors

[Mt CO_2eq]	2020	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

Source: CHMI

Sensitivity analysis – 1.A.3 Transport

The sensitivity analysis for 1.A.3 Transport was done utilising the Monte Carlo method that relies on repeated random sampling to obtain numerical results. The 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 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.

Table 2.62: 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

Source: CHMI

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 emphasised that the uncertainty reflects the varying 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.

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. The biggest change is that we started using the TIMES-CZ model for categories 1. Energy industries and 4. Other sectors. The increased assumed fuel and EUA prices 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 have not changed 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 a very reliable data source.

2.6.1.2. Industrial Processes and Product Use (sector 2)

For consistency with greenhouse gas (GHG) emission inventory, 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.

Methodological issues

The projections of GHG emissions in 2. IPPU are based on data and methodology used for inventory emission estimates reported in the National Inventory Report. 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. This approach allows for 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.

The projected activity data are used for projection of the entire period 2021-2050.

Projection results

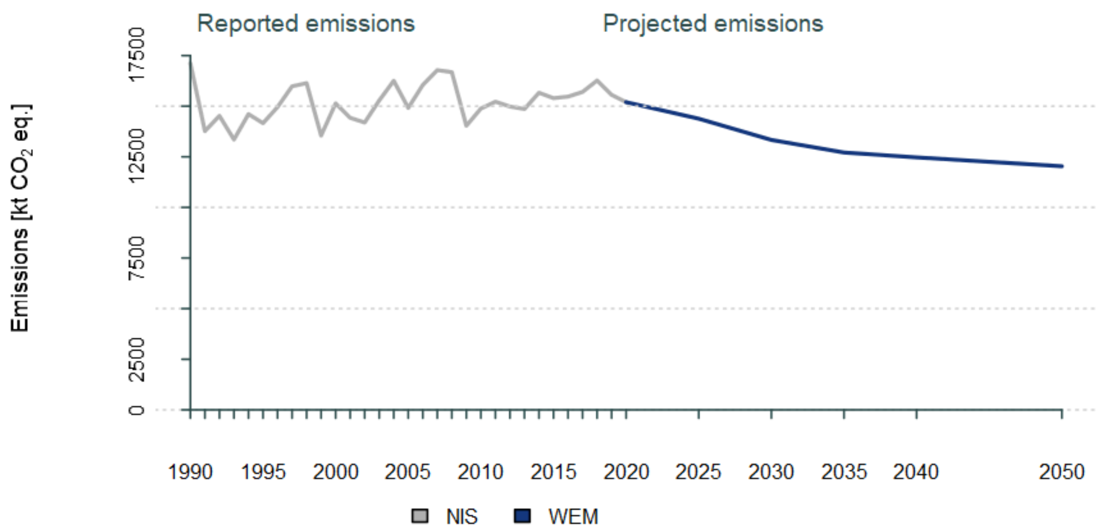
According to the WEM scenario, the total emissions from 2. IPPU will be stagnant in the next few years and then slightly decrease. It is not expected that the production capacity for main products, such as lime, cement, ammonia, iron and steel would decrease rapidly in the Czech Republic. The expectation is rather that the drop in GHG emissions until 2050 will be very slight, mainly influenced by the ban on F-gases. According to the current projections, it is expected that total emissions from 2. IPPU will decrease by 29% by 2050 compared to 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 the next few years, producers will renovate their units and introduce new mitigation techniques and thus there is a space for further reduction of GHG emissions from 2. IPPU.

Table 2.63: Reported and projected emissions of GHG in 2. IPPU – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2025	1990–2030	1990–2040	1990–2050
WEM	17.12	14.91	14.78	15.20	14.38	13.33	12.71	12.47	12.03	-15.98	-22.11	-27.14	-29.69

Source: CHMI

Figure 2.2: Reported and projected emissions of GHG in 2. IPPU – WEM scenario



Source: CHMI

<u>WEM scenario</u>

WEM scenario takes into account following policies and measures:

Regulation No 517/2014,

Directive 2006/40/EC,

Kigali Amendment of the Montreal Protocol.

As evident from the next table, a major share of total emissions from 2. IPPU takes the form of CO_2. No major changes are expected in 2.A Mineral, 2.B Chemical or 2.C Metal industry and thus CO_2 emissions are likely to stagnate. No significant changes are expected in CH_4 emissions, where the main source is sinter production. N_2O emissions are expected to rise with the anticipated increase of its main source, the N_2O production.

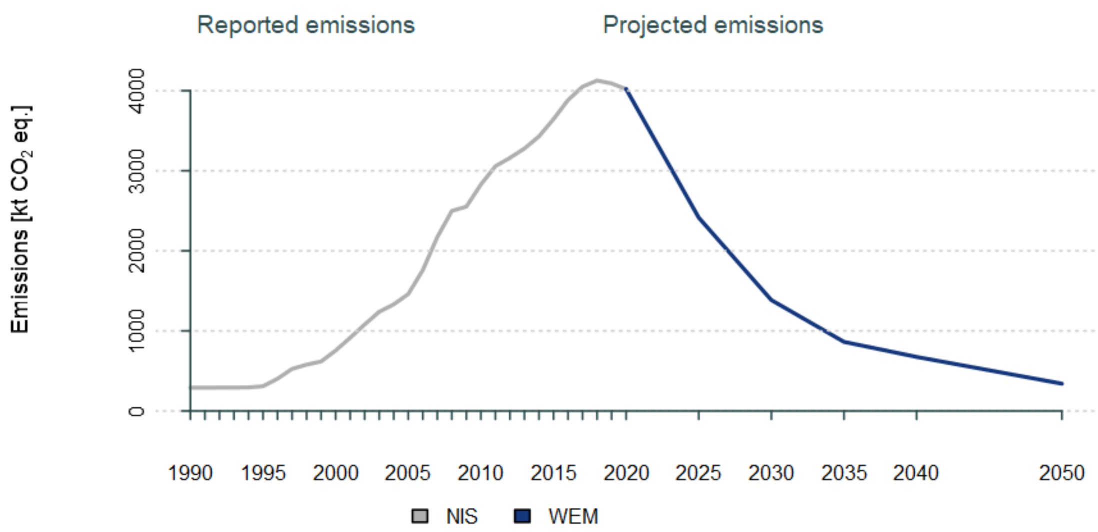
Table 2.64: Breakdown of reported and projected emissions of GHG by gases in 2. IPPU – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2025	1990–2030	1990–2040	1990–2050
CO_2	15.79	12.32	10.57	10.72	11.43	11.41	11.32	11.26	11.16	-27.62	-27.69	-28.65	-29.31
CH_4	0.06	0.07	0.06	0.06	0.07	0.08	0.08	0.08	0.08	30.57	30.97	30.89	30.88
N_2O	1.18	1.04	0.33	0.33	0.41	0.41	0.42	0.42	0.43	-65.73	-65.73	-64.48	-63.50
HFCs	NO	1.35	3.75	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	0.00	NA	NA	NA	NA
SF_6	0.09	0.12	0.07	0.00	0.00	0.00	0.00	0.00	0.00	-100.00	-100.00	-100.00	-100.00
NF_3	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
Total	**17.12**	**14.91**	**14.78**	**15.20**	**14.38**	**13.33**	**12.71**	**12.47**	**12.03**	**-15.98**	**-22.11**	**-27.14**	**-29.69**

Source: CHMI

The legislation currently in force focuses 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. 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). Therefore, the base year for F-gases is 1995. It is assumed that HFCs emissions started to decrease around 2020. Compared to 2020, HFCs emissions should be 92% lower by 2050. The limited decrease in time can be attributed to a continuous decrease 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 an insulation gas in switchgears. Emissions of SF_6 are expected to decline sooner than emissions of NF_3, which is expected to be more commonly used in the near future. For NF_3 it is expected that emissions will increase unless new PaM are 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.

Figure 2.3: Reported and projected F-gases (HFCs, PFCs, SF_6, NF_3) emissions from categories 2.E, 2.F, 2.G – WEM scenario



Source: CHMI

As shown in the next table, 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 2025 and then slightly increase until 2050. This trend directly follows projections of cement production as provided by the Ministry of Industry and Trade . It is expected that emissions from 2.B Chemical industry will decrease slightly until 2050, although 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 2.C.1 production related-emissions are going to slightly decrease compared to the present.

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.

Table 2.65: Breakdown of reported and projected emissions of GHG by categories in 2. IPPU – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2025	1990–2030	1990–2040	1990–2050
2.A. Mineral industry	4.08	3.35	3.22	3.21	3.14	3.14	3.14	3.15	3.17	-23.20	-23.19	-22.91	-22.32
2.B. Chemical industry	2.83	2.71	1.62	1.62	2.14	2.06	2.00	1.93	1.79	-24.41	-27.01	-31.71	-36.51
2.C. Metal industry	9.81	7.08	5.80	5.95	6.27	6.32	6.28	6.28	6.28	-36.14	-35.60	-35.96	-35.96
2.D. Non-energy products from fuels and solvent use	0.13	0.12	0.13	0.13	0.17	0.18	0.19	0.20	0.22	35.33	42.87	57.95	73.13
2.E. Electronics industry	NO	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
2.F. Product uses as substitutes for ODS	NO	1.36	3.75	4.02	2.41	1.38	0.86	0.67	0.34	NA	NA	NA	NA
2.G.Other product manufacture and use	0.27	0.30	0.26	0.26	0.25	0.25	0.24	0.23	0.22	-6.07	-9.28	-14.19	-17.60
2.H. Other	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA
Total	**17.12**	**14.91**	**14.78**	**15.20**	**14.38**	**13.33**	**12.71**	**12.47**	**12.03**	**-15.98**	**-22.11**	**-27.14**	**-29.69**

Source: CHMI

Sensitivity analysis

Projections of GHG emissions from 2. IPPU sector are based on calculation sheets used for inventory emission estimates in NIR. Activity data is the only variable which changes during the projected period 2021–2050. EFs remain constant during the projected period and thus sensitivity analysis would not bring any interesting outcomes for categories under 2. IPPU sector (except for 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.

The only category where sensitivity analysis could bring interesting output is 2.F.1 Refrigeration and air conditioning, which is also a key category. The projections are prepared with the national Phoenix model, 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 . Sensitivity analysis for category 2.F.1 is implemented using variable consumption of F-gases by ±5%, while respecting the emission trend from NIR. The result of the sensitivity analysis is depicted in the next table.

Table 2.66: Sensitivity analysis using variable consumption of F-gases in category 2. F.1 under IPPU sector

Emission difference [%]	2020	2025	2030	2035	2040	2045	2050
WEM and WEM +5%	0.13	0.15	-0.07	2.16	1.44	3.35	0.13
WEM and WEM -5%	-0.46	-0.85	-1.40	-1.07	-1.16	-1.55	-0.46

Source: CHMI

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 is projected to be slower in previous projections. The increase in the current projection is caused by an altered approach to activity data projections, where the gases used for servicing were included in consumption next to the first fill, whose projections are decreasing according to adopted legislative measures.

2.6.1.3. Agriculture (sector 3)

The total emissions from Agriculture decreased within the reported period of 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.

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.

Methodological issues

In general, the emissions quantifications and estimates projections are being prepared in compliance with IPCC methodology, and in case of Enteric Fermentation in compliance with IPCC refinements concerning the sector. All the calculation procedures correspond to the GHG estimates methodology as it is being prepared for the Agriculture sector.

Activity data and emission factors (EF) trends applied for prediction accounting were derived from the activity data from the Institute of Agricultural Economics and Information, which had requested them directly from the 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: Where there was no possibility to predict future development for any activity data (e.g. amount of sewage sludge applied to soils, etc.), constant values were used for reporting purposes.

Livestock population

Table 2.67: Activity data – 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
- 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

Source: CzSO

The table above shows working data, which predicts a continuation of the current trend for a shorter period followed by a stagnating trend. According to the MoA Strategy, there are higher estimates for livestock populations for years 2025 and 2030 but these were assessed as excessive.

Milk production, milk quality

Table 2.68: Activity data – 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 among EU countries with the highest productivity (and considering probable growth in systems of organic farming), it is predicted that 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 is estimated to increase slightly.

Manure Management systems

Table 2.69: Activity data – 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, or 2016-2020 respectively. An increase in the number of biogas stations based on manure use is not presumed, as there is a need to increase the return of quality organic matter into the soil.

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., considering the input of manure and slurry into biogas stations according to the study of Institute of Agricultural Economics and Information.

Nitrogen content of mineral fertilizers

Table 2.70: Activity data – 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 the application of synthetic nitrogen fertilisers. There is a target of 25% reduction of the maximal doses applied for selected crops (winter wheat, winter canola, corn). This target is reachable by supporting services providing qualified decision-making to encourage locally based nutrition principles and enhance purchasing of technologies enabling a more varied application of fertilisers. The support of organic farming can serve as an alternative to these measures. Partial measures also include a cultivation of low leguminous intercrops and a reduced tillage (no-till farming practises).

The strategic plan SZP 21+ for 2024-2028 envisages an increase in area of precision agriculture by 500 thousand ha/yr. The increase in the area of organic farming is envisaged as a continuation of current trends, at an annual level of 7 %.

Sowing area and annual harvest of individual crops

Table 2.71: Activity data – 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
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

Table 2.72: Activity data – 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
** economic data on soya bean production is not available in model Farma 6, kept constant*

Limestone consumption and Urea Application in Agriculture

Table 2.73: Activity data – 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 expected to increase to a presumed optimum by 2045. There is a significant share 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 the application of 2 500 kt/yr.

For DAM, there was a decreasing trend of reported use during the 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, nitrogen consumption from DAM reached an annual level around 85 kt. There is an expectation of increased consumption for the future. Nitrogen consumption from urea decreased by 40 % during the last 5 years. A decreased trend of its application is expected, related to a legal obligation of its immediate application into the soil, which can increase application costs and thus reduce its desirability among farmers.

Methodological issues – Methane emissions

For the purposes of the emissions estimates, computing tools on the basis of excel sheets with pre-defined macros (functions and command lines automating the calculations), which had been standardly used for emissions estimates were used. All the methodological updates planned for this submission were involved even for 2025+ predictions.

Enteric Fermentation and Manure Management are the main sources of CH_4 emissions in the Agriculture sector. Activity data on livestock population is decisive for estimating, especially as regards 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, 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 377/2013 Coll., on manure storage and management.

The emission factor (EF) for methane emissions from Enteric Fermentation from cattle is derived from the energy intake of milk producing animals, weight gain or maintenance, respectively. The dependence of the emission factor from Enteric Fermentation on milk production and body weight is explicit from the next table, where the reported and predicted values are shown.

Table 2.74: 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

<u>*Methodological issues – Nitrous oxide emissions*</u>

There are two main sources of nitrous oxide (N_2O) emissions in the 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 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, 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). A 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 (Decree 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 fertilisation 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 an expectation of a decreased consumption.

The amount of nitrogen from crop residues entering the soil after harvest is the other important input into the estimate. In 2019, the contribution to the total nitrogen emissions from 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 expected increase in the amount of biomass from crop residues. 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 the Institute of Crop Research.

Methodological issues – Carbon dioxide emissions

There are two main sources of CO_2 emissions in Agriculture reported in the National Inventory Report:

1. Liming (3G);

2. Urea Application (3H).

Tier 1 methods of IPCC GL 2006 and the default emission factors are used for estimating the amount of CO_2 emissions from both the listed sources.

Projection results – WEM and WAM scenarios

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 currently no additional measures planned to decrease GHG emissions in the Agriculture sector. Therefore, there are no differences between the WEM and WAM scenarios.

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. The WEM scenario expects a slightly decreasing trend in production of GHG emissions from Agriculture. The total emissions from Agriculture for 2050 are estimated at 7 200 kt CO_2eq, approximately 8 % less than it was reported in 2020 (7 806 kt CO_2eq).

Quantitative data overview and emission trends for the reported and projected period are shown in the following tables and figure.

Table 2.75: Reported and projected emissions of GHG in 3. Agriculture – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
WEM	15.75	8.19	8.05	7.81	7.97	7.75	7.57	7.47	7.20	-50.43	-50.76	-52.58	-54.28

Source: CHMI, IFER, 2022

The emission changes reported in the 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.

Table 2.76: Breakdown of reported and projected emissions of GHG by gases in Agriculture – WEM scenario

GHG	Reported emissions			Projected emissions						Difference [%]			
[Mt CO_2eq]	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
CO_2	1.35	0.21	0.32	0.34	0.34	0.35	0.37	0.39	0.41	-74.75	-74.15	-71.07	-69.29
CH_4	8.19	4.18	4.02	3.86	4.20	4.23	4.26	4.33	4.39	-52.89	-48.29	-47.08	-46.41
N_2O	6.22	3.80	3.71	3.61	3.43	3.17	2.94	2.75	2.40	-41.94	-48.96	-55.84	-61.40
Total	**15.75**	**8.19**	**8.05**	**7.81**	**7.97**	**7.75**	**7.57**	**7.47**	**7.20**	**-50.43**	**-50.76**	**-52.58**	**-54.28**

Source: CHMI, IFER, 2022

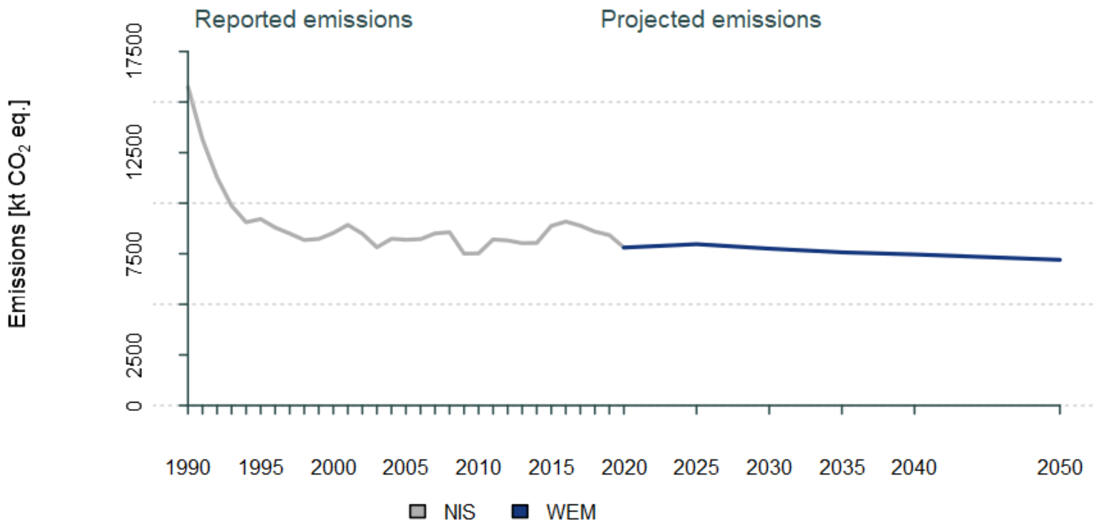
Table 2.77: Breakdown of the reported and projected emissions of GHG by categories in Agriculture – WEM scenario

GHG source category	Reported emissions			Projected emissions						Difference [%]			
[Mt CO_2eq]	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
3.A Enteric fermentation	6.61	3.38	3.63	3.46	3.81	3.82	3.84	3.91	3.96	-47.64	-42.28	-40.92	-40.10
3.B Manure management	2.57	1.31	0.78	0.78	0.80	0.83	0.83	0.85	0.85	-69.61	-67.73	-67.07	-66.95
3.D Agricultural soils	5.22	3.29	3.32	3.22	3.02	2.76	2.53	2.33	1.98	-38.27	-47.12	-55.45	-62.13
3.G Liming	1.24	0.07	0.16	0.18	0.20	0.22	0.24	0.26	0.28	-85.14	-82.56	-79.20	-77.27
3.H Urea application	0.11	0.15	0.16	0.16	0.15	0.13	0.13	0.13	0.13	43.70	21.62	21.62	21.62
Total	**15.75**	**8.19**	**8.05**	**7.81**	**7.97**	**7.75**	**7.57**	**7.47**	**7.20**	**-50.43**	**-50.76**	**-52.58**	**-54.28**

Source: CHMI, IFER, 2022

The total GHG emissions from Agriculture (Agriculture sector + 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 i lower by an order of magnitude, so the total results reduced just slightly.

Figure 2.4: Reported and projected emissions of GHG in 3. Agriculture – WEM scenario



Source: CHMI

Sensitivity analysis

The projections of GHG emissions from Agriculture are built on calculation procedures in tables used for GHG estimation in the National Inventory Report. 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.

A 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.

The next table 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.

Table 2.78: The comparison of projected values of CH_4 emission factor (EF) for Enteric Fermentation, the sensitivity of calculation

Dairy cattle	Projected data [kg CH_4/head/year]						
	2020	2025	2030	2035	2040	2045	2050
EF for enteric fermentation Calculated with projected milk production	147	147	155	155	160	160	165
EF for enteric fermentation Calculated with constant milk production (2020)	147	147	147	147	147	147	147

Source: IFER

Difference between previously and currently reported projections

The predictions for the Agriculture sector within this study have a different trend compared to the previous predictions prepared in 2020.

Predictions from 2020 followed the trend of increasing livestock populations according to a revised Strategy of MoA from 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.

2.6.1.4. Land Use, Land-use Change and Forestry (sector 4)

Land use, land-use change and forestry (LULUCF) is a specific sector within the emission inventory framework, as it is the only one capable of directly offsetting 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 Intergovernmental Panel on Climate Change. Therefore, the estimates related to the 4. LULUCF sector are commonly accompanied by the largest uncertainty, often in a range exceeding tens of percent.

The estimated and reported emissions by the individual LULUCF sub-categories for the period 1990 to 2020 can be found in the latest National Inventory Report (NIR) . The dominant greenhouse gas in the 4. LULUCF sector is CO_2, whereas the contribution of CH_4 and N_2O is fragmental – two orders of magnitude smaller.

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.

Methodological issues

There are several fundamental methodological steps when carrying out 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 the following table.

2.79: 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

Source: CHMI

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 are exclusively based on the cadastral land use information of the Czech Office for Surveying, Mapping and Cadastre. 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 is reported in NIR.

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 the next table. 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 decrease further. 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 overall area share of 4.B Cropland would decrease from 40.2 % to 38.3 %, which equals to a loss of 152 kha in this period.

2.80: Land use areas (kha): projected until 2050 (*IE – areas of 4.F Other land are included within 4.E Settlements)

Land use category	Reported area [kha]			Projected area [kha]				
	1990	2005	2020	2025	2030	2035	2040	2050
4.A Forest land	2629	2647	2677	2686	2692	2696	2699	2701
4.B Cropland	3455	3286	3178	3125	3095	3070	3050	3018
4.C Grassland	833	974	1023	1051	1067	1082	1095	1118
4.D Wetlands	158	161	167	169	170	172	174	177
4.E Settlements	812	819	842	856	863	867	870	873
4.F Other land*	IE	IE	IE	IE	IE	IE	IE	IE

Source: CHMI, IFER (unpublished data)

b) Emission estimates for individual land-use categories

Secondly, following the projection setup of land use areas, the projections of emission estimates for the 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. For this reason, the projections related to forestry are elaborated using the nationally calibrated Operational Scale Carbon Budget Model of the Canadian Forest Service[34]. This is coherent with the GHG emission reporting of 4. LULUCF sector under UNFCCC. 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).

Methodological issues – 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 was modified to include the locally applicable biomass allometry functions for beech, pine, spruce and oak. Czech Republic comprises 5 climatic regions

[34] Kull, S. et al., 2016. *Operational-scale carbon budget model of the Canadian forest sector (CBM-CFS3): version 1.2, user's guide.* s.l.:Northern Forestry Centre.
Kull, S. et al., 2019. *Operational-Scale Carbon Budget Model of the Canadian Forest Sector(CBM-CFS3) Version 1.2: User's Guide..* s.l.:Northern Forestry Centre.

Kurz, W. et al., 2009. *CBM-CFS3: a model of carbon-dynamics in forestry and land-use change implementing IPCC standards. Ecol. Modell..* s.l.:s.n.

according to Hijmans et al.[35]. 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 categorised by NUTS3 regions. 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 categorised by species groups. 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 covers 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.

Table 2.81: 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

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	-	-

Source: assembled from data available on Forest Management Institute web depository – www.uhul.cz

The applicable harvest used for the WEM scenario corresponds in principle to the BLACK scenario as in the Czech NFAP. 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 available information on reforestation and forest dieback applicable to spruce stands. Harvest volumes are derived for two regimes, one is dominated by salvaging, while the

[35] Hijmans, R. et al., 2005. Very high resolution interpolated climate surfaces for global land areas. *Int. J. Climatol. 25*, pp. 1965–1978, https://doi.org/10.1002/joc.1276.

other represents the ordinary planned management with limited salvage. Salvage regime is based on the most recent known data (in 2018-2021). For the following planned management, harvest is determined by wood available to harvest by age classes, forest type and felling type (thinning, final cut, salvage). For this regime, harvest rate meets the sustainability requirement as prescribed by 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 marginal, 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 summarised by planned and sanitary operations in the next table.

Table 2.82: 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 (Mm3/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

Source: IFER

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 reported data (2018-2021) and the specific scenario assumptions (Section Projection results – WEM and WAM scenario below).

The projections of GHG emissions related to other land use categories except for 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. 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, and projection in accordance with the approach detailed in the Czech NFAP[36].

Projection results – WEM and WAM scenarios

The WEM scenario includes the development of land areas of individual land use categories as shown in Table 3.6.1.38. 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 the exception of CO_2 emissions from 4.A Forest land and HPW emission contribution (Table 3.6.1.37).

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, 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 prioritised over planned management interventions, which is in full accordance with the valid legislation – Czech Forest Act and its amendments.

Specifically, the currently defined WEM scenario for forestry assumes the share of Norway spruce to decline from the recent 45% to under 28% in 2050. Correspondingly, the share of broadleaved tree species is projected to increase. This is in line with the long-term adaptation strategy of the country , which includes the proposed tree species change of dominantly spruce even-aged forests 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.

It should be understood that in the conditions of the recent bark-beetle outbreak and the related spike in share of sanitary felling of 95 % (in 2020), the Czech forest management was for several years akin to crisis management instead of the conventionally planned activity guided by forest management plans. Hence, the recent forest development was dominantly driven by disturbance (drought and bark-beetle infestation) and any projection of forest resources is inherently uncertain. This justifies using a 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 report.

[36] National forest accounting plan of the Czech Republic, https://www.mzp.cz/C1257458002F0DC7/cz/opatreni_v_ramci_lulucf/$FILE/OEOK-CZ_NFAP_FRL_final-20200203.pdf.

WEM scenario

The historical data and projections using the WEM scenario are shown in the next table and figure. 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 started to decline after 2020 (IFER 2022 – unpublished data), which is also reflected in the adopted scenario and scenario results facilitated by CBM.

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 resulted in a rapidly increasing share of sanitary felling until 2020.
- The increased share of sanitary logging has resulted in overall record-high wood removals in 2019 and 2020 (CzSO).
- In the current decade until 2030, the harvest level would gradually decline resulting in decreasing emissions in the forestry sector, reaching zero 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, and turning the entire LULUCF sector into GHG sink category again.
- The WEM scenario represents an adaptive scenario for the Czech forestry. It is expected to result in a rapid conversion of productive but unstable coniferous stands into a more resilient, dominantly broadleaved and/or mixed forest stands. This is the desired direction of forest transition under the Czech adaptation strategy (MoE, 2017).
- The overall importance of wood harvest on emission balance in the forestry sector is demonstrated with sensitivity analysis using changed harvest levels. Evidently, any disturbance to forests leading to elevated harvest volume levels would negatively affect carbon balance in the sector.

Table 2.83: Reported and projected emissions of GHG in 4. LULUCF sector – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
WEM	-8.84	-8.72	9.70	12.77	3.44	0.92	-3.26	-4.09	-3.78	244.56	110.39	53.75	57.26

Source: IFER, 2022

The breakdown of historical and projected (WEM scenario) emissions by gases and individual land use categories is shown in Table 3.6.1.42 and Table 3.6.1.43, 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.

Table 2.84: Breakdown of reported and projected emissions of GHG by gases in 4. LULUCF sector – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
CO_2	-8.87	-8.74	9.68	12.72	3.38	0.86	-3.31	-4.14	-3.8	243.32	109.74	53.36	56.8
CH_4	0.02	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.0	72.73	73.66	74.09	74.27
N_2O	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.0	-1.39	-1.18	-1.10	-1.12
Total	-8.84	-8.72	9.70	12.77	3.44	0.92	-3.26	-4.09	-3.78	-244.56	-110.39	-53.75	-57.26

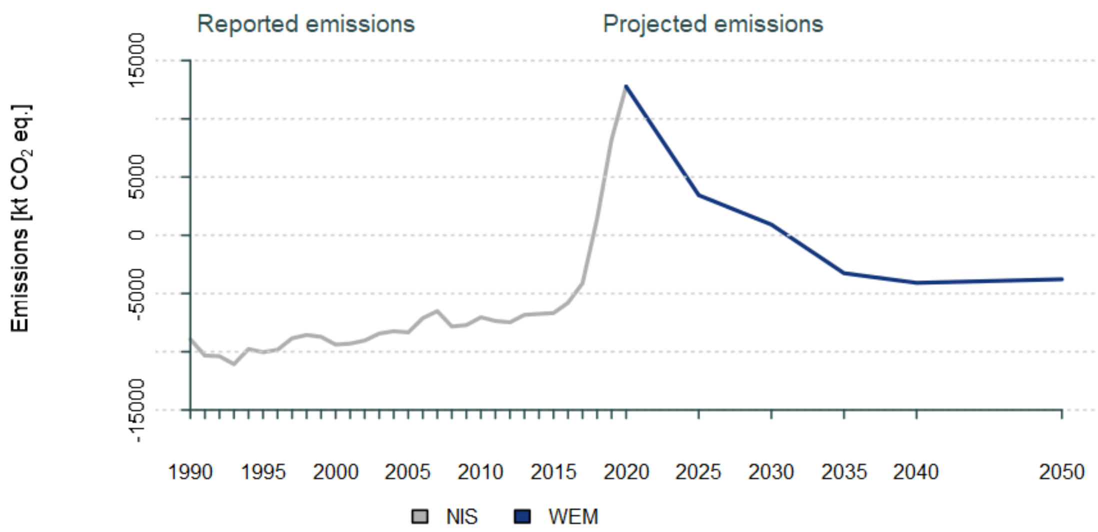
Source: IFER, 2022

Table 2.85: Breakdown of reported and projected emissions of GHG by category in 4. LULUCF sector – WEM scenario

[Mt CO_2eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
4.A Forest land	-7,47	-7,36	12,67	14,78	4,81	1,80	-3,22	-3,97	-3,43	297,86	124,12	46,86	54,14
4.B. Cropland	0,12	0,10	0,05	0,03	0,06	0,06	0,05	0,04	0,03	-72,17	-51,83	-62,56	-70,12
4.C Grassland	-0,14	-0,36	-0,48	-0,49	-0,65	-0,68	-0,71	-0,74	-0,80	-242,86	-371,71	-413,90	-455,13
4.D Wetlands	0,02	0,03	0,03	0,03	0,03	0,03	0,04	0,04	0,04	42,54	45,08	47,99	50,91
4.E Settlements	0,32	0,31	0,21	0,15	0,15	0,15	0,15	0,15	0,15	-54,12	-52,99	-52,60	-52,47
4.G HWP	-1,68	-1,43	-2,79	-1,73	-0,97	-0,45	0,43	0,39	0,23	-2,96	-2,96	123,41	113,46
Total	**-8,84**	**-8,72**	**9,70**	**12,77**	**3,44**	**0,92**	**-3,26**	**-4,09**	**-3,78**	**-244,56**	**-110,39**	**-53,75**	**-57,26**

Source: IFER, 2022

Figure 2.5: Reported and projected emissions of GHG in 4. LULUCF – WEM scenario



Source: CHMI

Sensitivity analysis

Sensitivity analysis is conducted by analysing the 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. 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 disturbances in 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 applying a smaller or larger overall harvest demand by 10% with respect to the selected baseline (harvest as in WEM scenario) using the CBM-CSF3 model. 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 in the long run.

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 resources and the associated ecosystem carbon balance.

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 Czech forestry (see above). The current projection reaffirms the previous assessment that 4.A Forest land and the entire 4. LULUCF category would be a net-contributor to Czech 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 stabilise 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 2030.

2.6.1.5. Waste (sector 5)

The Waste sector in the Czech Republic can be split into four distinctive source categories. The first and 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 in 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 if this category's emissions contribution 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 the digestion process is accounted for. Emissions from category 5.C Waste incineration are accounted for in 1.A Energy sector, when it produces usable 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). 5.C Waste incineration produces all three major greenhouse gases, dominated by CO_2. The last category, 5.D Wastewater treatment, includes both public and private wastewater treatment plants as well as their industrial counterparts and it is a source of both CH_4 and N_2O emissions. In 2020, the total aggregate GHG emissions from 5.Waste were 5 675 kt CO_2eq, which represented an increase of 71 % compared to 1990.

The overall development of the 5. Waste sector in the past decades is dominated by landfilling of waste in Solid Waste Disposal Sites (SWDS). Landfilling remains the dominant type of waste management, but its importance is decreasing due to a rise of waste recycling; collection of separated waste parts, composting and energy recovery. In the 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). However, the steady increase in energy use and even the impressive leaps in composting and material use during the past four years did not lead to a decrease in landfilling due to a steady increase in total amount of MW.

5. Waste sector is marked by high uncertainty in regards to emission levels as many of the 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 the ultimate end point of all consumption and economic activity and therefore, it is also highly dependent on the overall development of the economy. The default uncertainty for the GHG emission levels in the 5. Waste sector stands at 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 the economic nature of waste management it is regularly scrutinised and controlled (CHMI, 2022).

Methodological issues

The projections of GHG emissions in the 5. Waste sector are based on data and methodology used for emission estimates reported in NIR. Activity data reported in NIR are obtained from the Czech official database of waste management VISOH. Time series of spreadsheets from the NIR were extended to cover the 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) and with the obligations stemming from 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 terminated 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. Moreover, category 5.A is employing a WAM scenario. The difference between the WEM and WAM scenarios is the increased recovery of landfill gas, which is increasing more sharply in the WAM scenario due to an increased pressure from renewables market. The WAM scenario has a higher projected trend for recovered landfill gas (LFG) than WEM from 2025 onwards. Recovered CH_4 from LFG is used for energy purposes and is subtracted from total emissions . The projected trend of emissions from category 5.A is thus decreasing steeply after 2025

Wet weight data and default emission factors (EF) 4 kg CH_4/t and 0.24 kg N_2O/t from IPCC 2006 GL 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 slowing of increase is 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 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 (Table 3.6.1.49).

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 Tier 1 approach. Activity data was extrapolated until 2050 and the results were inserted into the spreadsheet to obtain an 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. 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.

Table 2.86: Reported and projected MMW production, divided by subjects in the Czech Republic

[Mil. Tons]	Reported								Projected			
	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**

Source: MoE 2014, CHMI 2022

Table 2.87: Reported and projected MW management

[Mt]	Reported								Projected			
	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

Source: MoE 2014, CHMI 2022

Table 2.88: Detailed information about methodology assumptions used in projections for 5. Waste sector (sub-)categories

Category	Projections 2021- 2050		
	Activity data	**EFs**	**Methodology**
5.A Solid waste disposal on land	until 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	until 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	until 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	until 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

Source: CHMI 2022, IPCC 2006

Projection results – WEM and WAM scenarios

As indicated in the next table, emission estimates up to the latest reported year (2020) are from NIR and VISOH database. The timeline was prolonged up to 2050 by building upon the outlined scenario in WMP and by the new obligations of the CEP.

Scenario in WMP meets the parameters of WEM scenario given that 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 throughout 2025 – 2050, as compared to 2020. The decrease of emissions is more obvious for the WAM scenario which takes into account stricter LFG recovery coefficients after 2025. The expected total emissions from 5. Waste should decrease by 9.21 % according to WEM and by 18.76% according to WAM scenarios between 1990 and 2050. Overall results for the 5. Waste sector are shown in the next table. Reported and projected emission trend for both scenarios is depicted in the figure below.

Table 2.89: Reported and projected emissions of GHG in Waste – WEM and WAM scenarios

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
WEM	3.32	4.36	5.68	5.68	5.47	4.78	3.94	3.40	3.01	70.99	44.00	2.56	-9.21
WAM	3.32	4.36	5.68	5.68	5.45	4.68	3.82	3.29	2.70	70.99	41.10	-0.91	-18.76

Source: CHMI

WEM scenario

The development of the WEM scenario is based on the following assumptions: MW production is decreasing slightly, landfilling is gradually declining and composting and energy recovery is taking place instead within the 10% landfill limit employed by 2035 as per CEP. The shift from landfilling to composting and anaerobic digestion leads to a drop in 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 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 the next two tables.

Table 2.90: Breakdown of reported and projected emissions of GHG by gases in Waste – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	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	0.18	422.85	541.05	659.25	777.44
CH_4	3.09	4.04	5.33	5.33	5.09	4.38	3.52	2.96	2.52	72.30	41.79	-4.19	-18.31
N_2O	0.21	0.22	0.25	0.25	0.26	0.27	0.28	0.29	0.31	17.85	29.23	39.61	50.28
Total	**3.32**	**4.36**	**5.68**	**5.68**	**5.47**	**4.78**	**3.94**	**3.40**	**3.01**	**70.99**	**44.00**	**2.56**	**-9.21**

Source: CHMI

Table 2.91: Breakdown of reported and projected emissions of GHG by categories in Waste – WEM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
5.A Solid waste disposal	2.01	3.07	3.69	3.69	3.46	2.75	1.89	1.33	0.90	83.73	37.14	-33.51	-55.22
5.B Biological treatment of solid waste	NE/IE	0.06	0.81	0.81	0.84	0.87	0.90	0.93	0.99	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	0.19	454.99	580.45	705.91	831.37
5.D Waste water treatment and discharge	1.29	1.12	1.07	1.07	1.04	1.02	1.00	0.98	0.94	-17.40	-21.16	-24.43	-27.53
5.E Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**3.32**	**4.36**	**5.68**	**5.68**	**5.47**	**4.78**	**3.94**	**3.40**	**3.01**	**70.99**	**44.00**	**2.56**	**-9.21**

Source: CHMI

WAM scenario

The WAM scenario is almost identical to the WEM scenario because all planned changes in waste management practice are implemented according to the WMP and to the new obligations introduced by CEP. The difference between WEM and WAM scenarios is due to an increased recovery of landfill gas, which is rising more sharply in the WAM scenario due to amplified pressure from the renewables market. The effects can be observed in CH_4 values and in 5.A Solid waste disposal category.

The total amount of emissions is reduced by 18.76 % compared to a 9.21 % decrease in the WEM scenario between 1990 and 2050. Breakdown by gases and source categories is shown in the next two tables.

Table 2.92: Breakdown of reported and projected emissions of GHG by gases in Waste – WAM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	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	0.18	422.85	541.05	659.25	777.44
CH_4	3.09	4.04	5.33	5.33	5.07	4.29	3.40	2.85	2.21	72.30	38.68	-7.92	-28.56
N_2O	0.21	0.22	0.25	0.25	0.26	0.27	0.28	0.29	0.31	17.85	29.23	39.61	50.28
Total	**3.32**	**4.36**	**5.68**	**5.68**	**5.45**	**4.68**	**3.82**	**3.29**	**2.70**	**70.99**	**41.10**	**-0.91**	**-18.76**

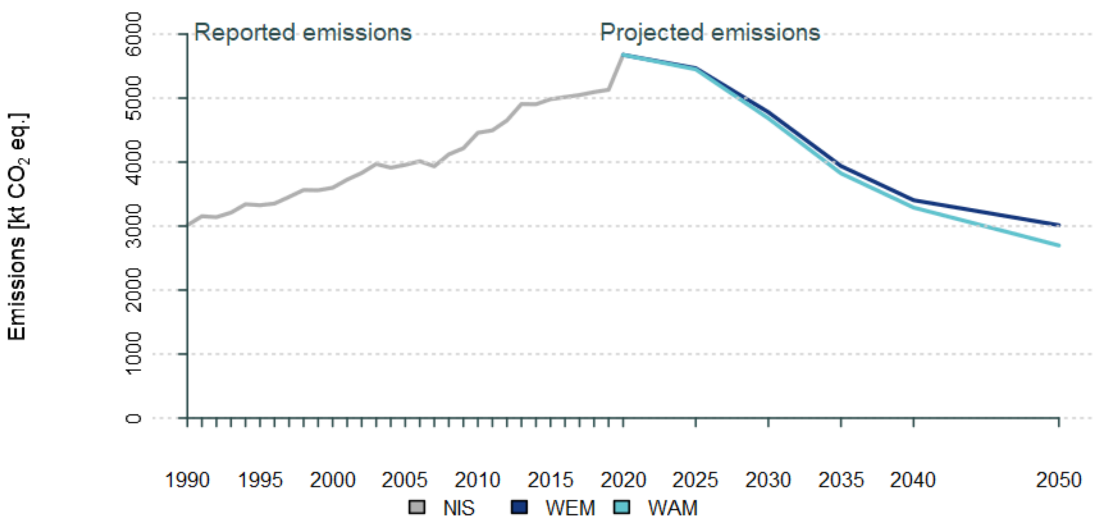
Source: CHMI

Table 2.93 Breakdown of reported and projected emissions of GHG by categories in Waste – WAM scenario

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2020	1990–2030	1990–2040	1990–2050
5.A Solid waste disposal	2.01	3.07	3.69	3.69	3.45	2.66	1.78	1.22	0.58	83.73	32.35	-39.25	-71.00
5.B Biological treatment of solid waste	NE/IE	0.06	0.81	0.81	0.84	0.87	0.90	0.93	0.99	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	0.19	454.99	580.45	705.91	831.37
5.D Waste water treatment and discharge	1.29	1.12	1.07	1.07	1.04	1.02	1.00	0.98	0.94	-17.40	-21.16	-24.43	-27.53
5.E Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**3.32**	**4.36**	**5.68**	**5.68**	**5.45**	**4.68**	**3.82**	**3.29**	**2.70**	**70.99**	**41.10**	**-0.91**	**-18.76**

Source: CHMI

Figure 2.6: Reported and projected emissions of GHG in 5. Waste – WEM and WAM scenarios



Source: CHMI

<u>Sensitivity analysis</u>

Projections of GHG emissions from 5. Waste sector are based on calculation sheets used for emission estimates in NIR. Activity data is the only variable which changes during 2020 – 2050 (see Methodological issues for detailed information about projections of activity data). EFs are constant during the projected period and thus, sensitivity analysis would not bring any remarkable 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.

Differences 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. 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, which enabled the use of default EFs for each waste stream from the 2006 IPCC Guidelines in NIR. This increased accuracy and lowered CO_2 emissions in the projections.

In category 5.D Waste water treatment and discharge, the default value of 0.5 MCF 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.

Aggregate projections

Projection results – WEM and WAM scenarios

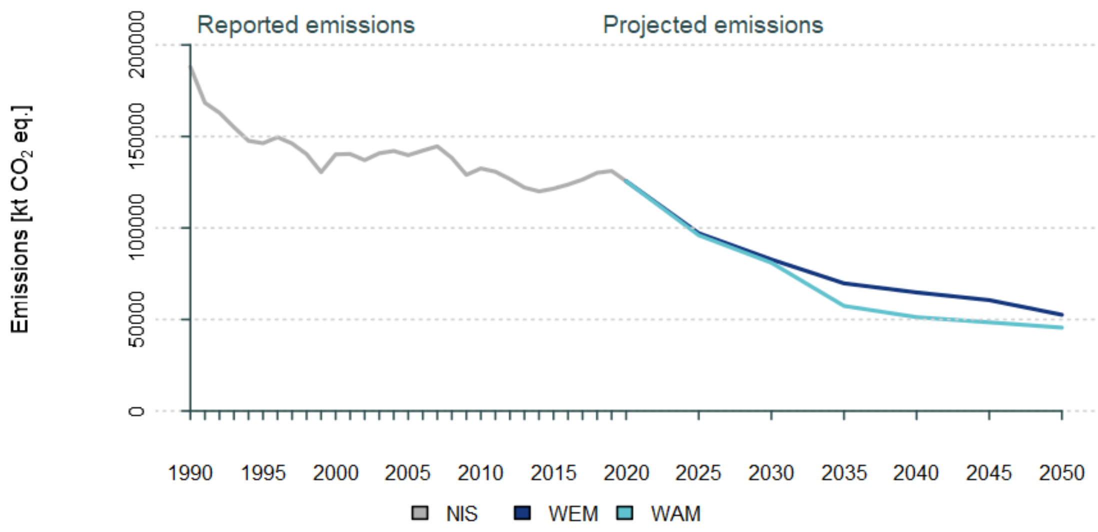
Aggregate GHG emissions are projected to decrease continuously for both WEM and WAM scenarios. The difference between WEM and WAM scenarios can be attributed to additional measures in 1. Energy and 5. Waste sectors. Total GHG emissions for the WEM scenario are projected to amount to 53.11 Mt CO_2eq by 2050, representing a 72% decrease compared to 1990. For the WAM scenario the total GHG emissions in 2050 are projected to amount to 46.05 Mt CO_2eq, representing a 76% decrease of emissions compared to 1990.

Table 2.94: Reported and projected emissions of GHG – WEM and WAM (including LULUCF)

[Mt CO_2eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	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
Source: CHMI

Figure 2.7 Total reported and projected GHG emissions – WEM, WAM scenario (including LULUCF)



Source: CHMI

WEM scenario

According to the WEM scenario it is expected that emissions will decrease for all the monitored greenhouse gases. Although only a marginal decrease of emissions of N_2O is projected, the trend has improved compared to the last projections report, where the N_2O emissions were projected to increase between 2020 – 2050.

Table 2.95: Breakdown of reported and projected emissions of GHG by gases – WEM scenario (including LULUCF)

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990–2025	1990–2030	1990–2040	1990–2050
CO_2	155.57	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
Source: CHMI

The most rapid decrease between 1990 – 2050 is expected in 1. Energy sector (79%), as shown in the table above.

A drop of 92% over the same period is projected in the category 1.A.1 Energy industries, which has a major share of 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 fertilisation 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 as a GHG sink. This is caused mainly by an exceptional outbreak of bark-beetle infestation and associated dieback of spruce. For 5. Waste sector, a slight decrease of GHG emissions is expected between years 2025 – 2050.

Table 2.96: Breakdown of reported and projected emissions of GHG by sectors – WEM scenario (including LULUCF)

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	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
Source: CHMI

WAM scenario

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

Table 2.97: Breakdown of reported and projected emissions of GHG by gases – WAM scenario (including LULUCF)

[Mt CO_2eq]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2025	2030	2035	2040	2045	2050	1990–2025	1990–2030	1990–2040	1990–2050
CO_2	155.57	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
Source: CHMI

The trend of projected GHG emissions for individual sectors in the WAM scenario 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 the WEM scenario.

Table 2.98: Breakdown of reported and projected emissions of GHG by sectors – WAM scenario (including LULUCF)

[Mt CO_2eq.]	Reported emissions			Projected emissions						Difference [%]			
	1990	2005	2020	2020	2025	2030	2035	2040	2050	1990–2025	1990–2030	1990–2040	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
Source: CHMI

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

The following tables contain both historic and projected greenhouse gas emissions under EU ETS sectors and ESD/ESR sectors for both WEM and WAM scenarios. Negative projected values for subcategory 1.A.1.a in the WAM scenario for years 2045 and 2050 are caused by the introduction of CCUS from biomass.

Table 2.99: Split of historic and projected EU ETS and ESD/ESR emissions – WEM scenario (including LULUCF)

[Mt CO_2eq]	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

Source: CHMI, EEA

Table 2.100: Split of historic and projected EU ETS and ESD/ESR emissions – WAM scenario (including LULUCF)

[Mt CO_2eq.]	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	35.39	33.01	-13.47	-20.70	-43.19	-48.83

Source: CHMI, EEA

2.6.2. Information on models used for projections calculations

Table 2.101: Detailed information on models used for projections calculations

Model 1	
Model name (abbreviation)	Phoenix
Full model name	Phoenix
Model version and status	1.6
Latest date of revision	December 2018
URL to model description	https://www.chmi.cz/files/portal/docs/reditel/SIS/casmz/assets/2018/chmu_mz_1-18.pdf
Model type	top-down model
Summary	Phoenix is country specific model developed by the Czech national inventory team for F-gases emission estimates used in refrigeration and air conditioning systems (category 2.F.1).
Intended field of application	Emissions estimates of F-gases used in refrigeration and air conditionig systems
Description of main input data categories and data sources	Phoenix is used for emission estimates and projection of emissions from categories under 2.F.1 (2.F.1.a, 2.F.1.b, 2.F.1.c, 2.F.1.d and 2.F.1.f (emissions from category 2.F.1.e are not estimated by using model Phoenix)). Input data represent data about consumption of specific gas in category 2.F.1.
Validation and evaluation	-
Output quantities	Emissions in kt CO_2eq
GHG covered	HFC's and PFC's
Sectoral coverage	Industrial Processes and Product Use
Geographical coverage	Czech Republic
Temporal coverage (e.g. time steps, time span)	one year time step
Other models which interact with this model, and type of interaction (e.g. data input to this model, use of data output from this model)	no interface with other models
Input from other models	no input from other models
References to the assessment and the technical reports that underpin the projections and the models used	https://www.chmi.cz/files/portal/docs/reditel/SIS/casmz/assets/2018/chmu_mz_1-18.pdf
Model structure (if diagram please attach to your submission in Reportnet)	https://www.chmi.cz/files/portal/docs/reditel/SIS/casmz/assets/2018/chmu_mz_1-18.pdf
Strengths	Takes into account the phasing out F-gases. Simulates a natural process of F-gases leakages from equipment over the years
Weaknesses	Relatively high uncertainty in the distribution of F-gases according to the specific use.
Model 2	
Model name (abbreviation)	NIR_skot
Full model name	NIR_skot, Personal Macro Workbook in Excel
Model version and status	version07112022
Latest date of revision	10.11.2022
URL to model description	
Model type	Excel Open XML Macro-Enabled Spreadsheet

Summary	It enables the calculation of basic parameters important for the calculation of methane emissions for individual subpopulations of cattle based on nationally specific input data.
Intended field of application	3A Cattle and 3B1 Cattle
Description of main input data categories and data sources	Productivity, body weight, population, digestibility etc.
Validation and evaluation	regularly
Output quantities	
GHG covered	CH_4
Sectoral coverage	40%
Geographical coverage	No
Temporal coverage (e.g. time steps, time span)	Year
Other models which interact with this model, and type of interaction (e.g. data input to this model, use of data output from this model)	Generates inputs to main excel spreadheet
Input from other models	No
References to the assessment and the technical reports that underpin the projections and the models used	Output No 23 of the project funded by TACR, 2022
Model 3	
Model name (abbreviation)	CBM
Full model name	CBM-CFS3 – Carbon Budget Model of the Canadian Forest Sector
Model version and status	1.2.8213.356
Latest date of revision	July 2022
URL to model description	https://www.nrcan.gc.ca/climate-change/climate-change-impacts-forests/carbon-accounting/carbon-budget-model/13107
Model type	Empirical model
Summary	See URL above
Intended field of application	Emission inventory, carbon budgeting
Description of main input data categories and data sources	See URL above
Validation and evaluation	See URL above
Output quantities	See URL above
GHG covered	See URL above
Sectoral coverage	See URL above
Geographical coverage	See URL above
Temporal coverage (e.g. time steps, time span)	Annual
Other models which interact with this model, and type of interaction (e.g. data input to this model, use of data output from this model)	User-defined
Input from other models	User-defined
References to the assessment and the technical reports that underpin the projections and the models used	Czech NIR report in 2022

Model structure (if diagram please attach to your submission in Reportnet)	See URL above
Model 4	
Model name (abbreviation)	R_v2020_01
Full model name	Model of the calculation of projected emissions in transport
Model version and status	
Latest date of revision	November, 2022
URL to model description	no URL address
Model type	R-project
Summary	Model calculated future emissions from transport
Intended field of application	GHG pollutants, other limited pollutants, vehicle fleet
Description of main input data categories and data sources	Transport is now split to 112 model transport categories, by transport mode / category, used fuel and Euro Standards.
Validation and evaluation	Input data of road transport are from COPERT model. Inputs from non road transport are from the form "Model_reporting_UNFCCC_CTLRAP".
Output quantities	Estimation of future emissions of GHG to 2050.
GHG covered	CO2, CH4, N2O
Sectoral coverage	Transport, all modes
Geographical coverage	Czech Republic
Temporal coverage (e.g. time steps, time span)	
Other models which interact with this model, and type of interaction (e.g. data input to this model, use of data output from this model)	Model of transport prediction. Prediction of energy consumption.
Input from other models	Inputs are future transport volumes from transport analysis (this is an annex to Czech Republic Transport Policy), projection of energy consumption.
References to the assessment and the technical reports that underpin the projections and the models used	
Model structure (if diagram please attach to your submission in Reportnet)	Model scheme is available.

Source: CHMI

3. Impacts, Risks and Vulnerabilities

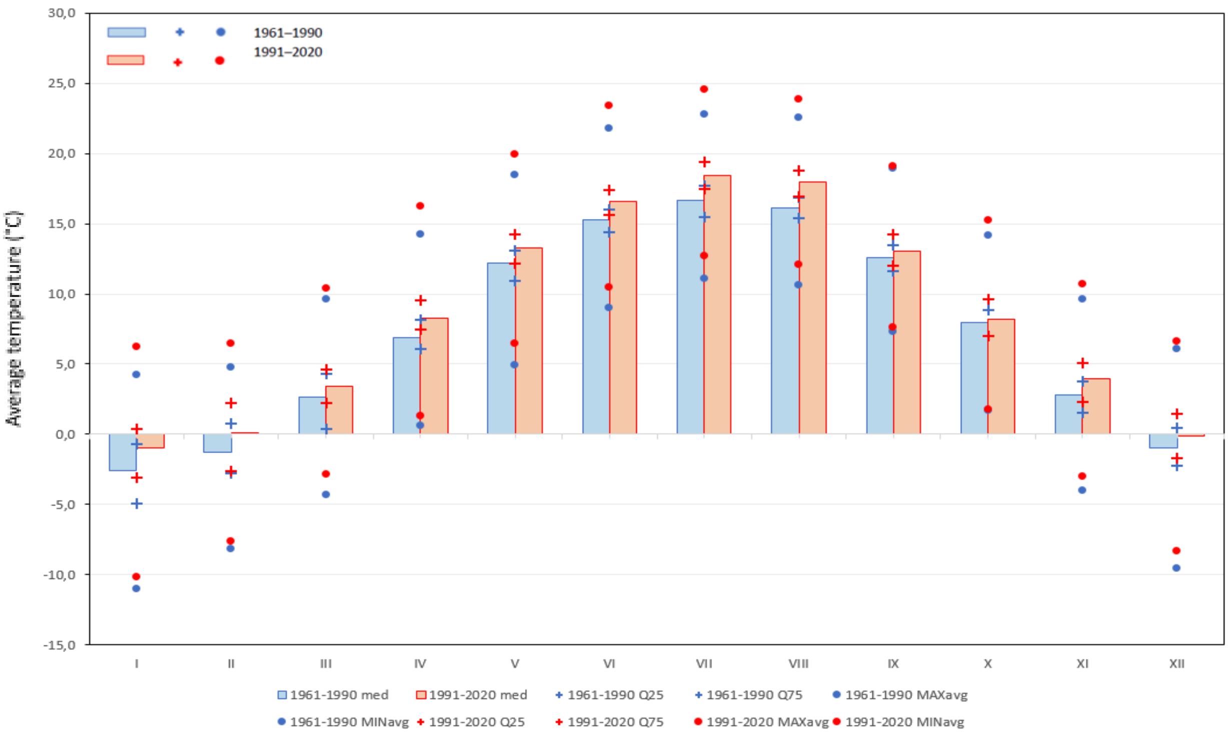
3.1. Current and projected climate trends and hazards

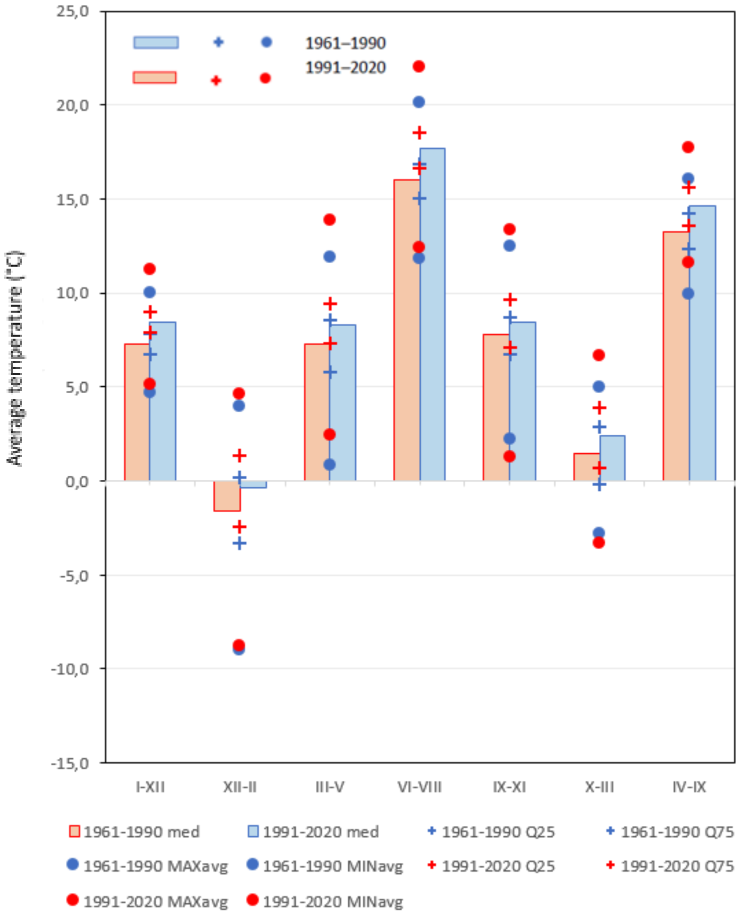
The rate of observed temperature change in the Czech Republic expressed in trends over 10 years has increased. The scenario data are compared with the 1981-2010 normal, which is higher than the original 1961-1990 normal. This corresponds to lower estimates of temperature change. For precipitation, the signal of change is still ambiguous, with models currently projecting a slight increase in annual totals. Significant projected changes in extreme temperatures are reflected in the estimates of tropical and frost days.

3.1.1. Air Temperature

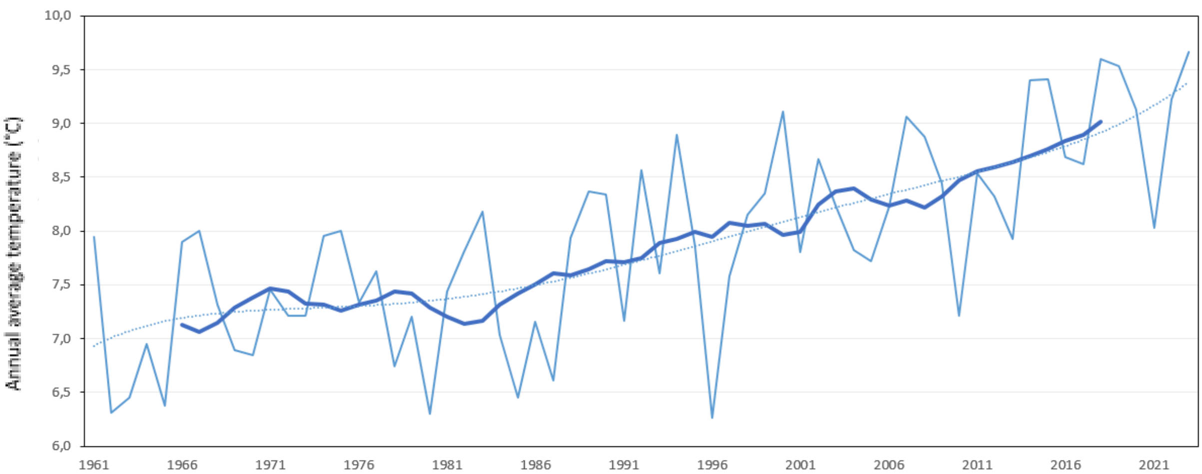
Since the 1960s, a gradual increase in air temperatures has been observed, which has accelerated especially since the 1980s. As can be seen in Figure 1, the warmest period of all the selected periods is the last 20 years, i.e. the period between 2001 and 2023. During this period, the average air temperature for the Czech Republic was 8.6 °C. In contrast, the average air temperature for the Czech Republic in the reference period 1961–1990 was only 7.3 °C, a 1.3 °C lower value compared to the current situation. The greatest warming is observed mainly in large cities such as Prague and Brno, where the heat island of the city is also active (Figure 3.2).

Figure 3.1: Average air temperature in the Czech Republic for two selected periods (1961–1990 and 1991–2020; top) and temperature trends for the whole period 1961–2023 (bottom)



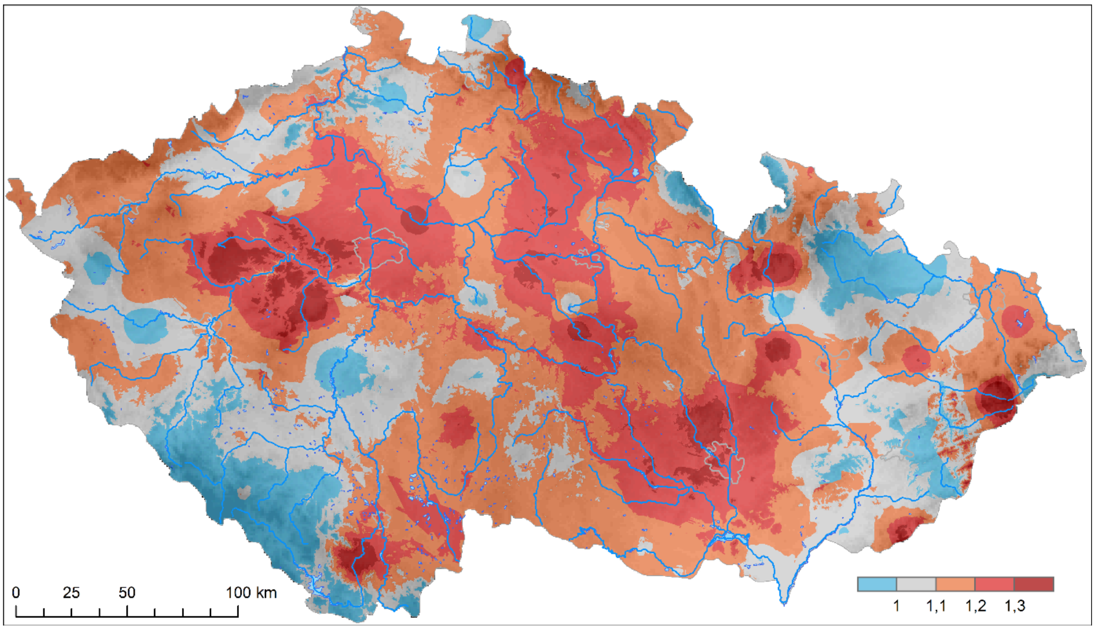


Source: CHMI



Source: CHMI

Figure 3.2: Deviation of average annual air temperature in 1991–2020 from the 1961–1990 normal



Source: CHMI

Air temperature increase for the period 1961-2020 is statistically significant in all seasons. A positive trend of 0.38°C/10 years is observed for the annual values for the period 1961-2020 (Table 3.1). The warming is fastest in summer (0.49 °C/10 years). In contrast, as can be seen in Table 3.1, the least pronounced warming trend occurs in autumn (0.23 °C/10 years). A statistically significant trend is observed in individual months in January (0.48 °C/10 years), March (), April (0.42 °C/10 years), May (0.35 °C/10 years), June (0.42 °C/10 years), July (0.51 °C/10 years), August (0.55 °C/10 years) and December (0.32 °C/10 years). The change of the number of tropical days is statistically significant in year, spring and summer.

Precipitation change is not statistically significant in any month nor season.

Table 3.1: Trends in average air temperature (°C/10 years), precipitation (mm/10 years), and number of tropical days (days/10 years) in the Czech Republic for the period 1961-2020 for each month, season and year (bold and italic correspond to increases statistically significant at the p=0.05 significance level)

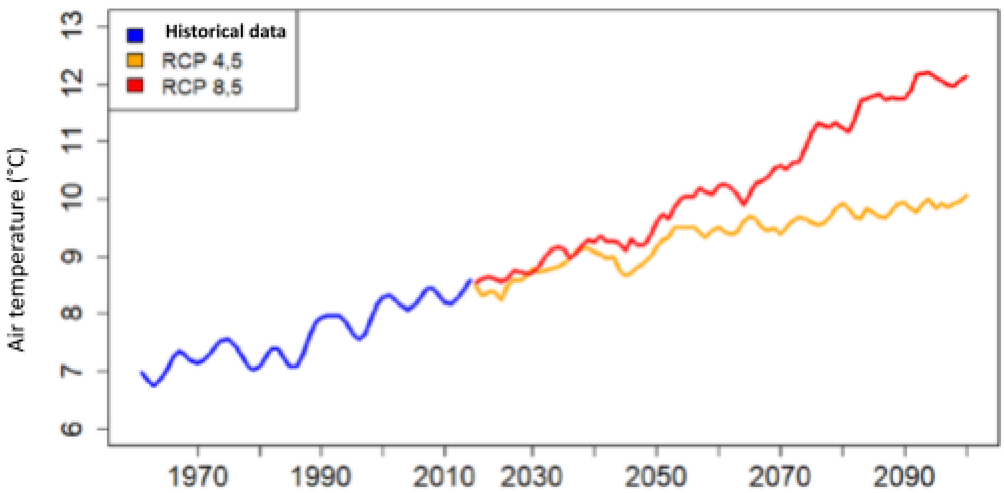
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Air temperature	***0.48***	0.32	***0.35***	***0.42***	***0.35***	***0.42***	***0.51***	***0.55***	0.18	0.19	***0.32***	***0.49***
Precipitation	2.20	0.17	0.83	–2.48	–1.05	–1.40	1.67	-0.31	2.69	2.04	–1.82	–0.44
Number of tropical days	0.00	0.00	0.00	0.00	***0.06***	***0.36***	***0.67***	***0.67***	0.03	0.00	0.00	0.00
	Year	**Winter**	**Spring**	**Summer**	**Autumn**							
Air temperature	***0.38***	***0.43***	***0.37***	***0.49***	***0.23***							
Precipitation	2.10	1.93	–2.69	-0.05	2.91							
Number of tropical days	***1.79***	0.00	***0.06***	***1.70***	0.03							

Source: CHMI

It is projected that the annual air temperature in the Czech Republic will increase by 2.0 °C by the end of the 21st century (RCP4.5) or by 4.1 °C in the RCP8.5 scenario compared to the reference period (1981-2010). As shown in Figure 3, air temperature will increase at a similar rate until 2050 regardless of the emission scenario used. The temperature will be 1 °C higher in the period 2021-2040 compared to the period 1981-2010. After 2050 we see increasing differences between the emission scenarios. The temperature simulated by RCP8.5 increases sharply and, for example, the HadGEM2-ES RCA experiment projects a climate warming of 5 °C by the end of this century compared to the 1981-2010 reference period (Figure 3.5). In contrast, the RCP4.5 scenario from 2061 onwards points to a virtually stable climate with a warmer temperature of around 2 °C compared to the present. Under the RCP2.6 scenario, which assumes substantial success of mitigation measures and thus very rapid reductions in GHG emissions, we see a gradual stabilisation of the climate towards the end of the 21st century and a 'return' to the 1981-2010 temperature range. This analysis shows that by 2050 the changes that have been set in motion are virtually beyond our control. On the contrary, changing human behaviour will be absolutely crucial for climate development after 2050.

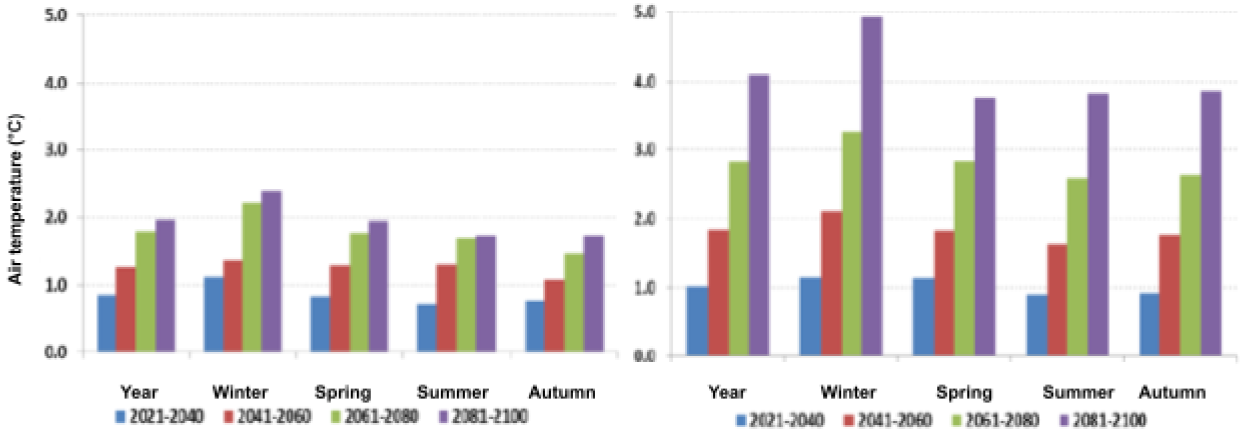
From a seasonal perspective (Figure 3.4 and Table 3.2), the most intense increase in average air temperature is projected to occur in winter. At the end of the 21st century, winter temperatures are projected to be 2.4-4.9 °C higher depending on the RCP scenario used. For other seasons, an increase in air temperatures between 1.7-3.8 °C is observed.

Figure 3.3: Evolution of annual air temperature for the Czech Republic according to the ensemble average of 11 RCM model runs (smoothed with a 10-year low-pass filter)



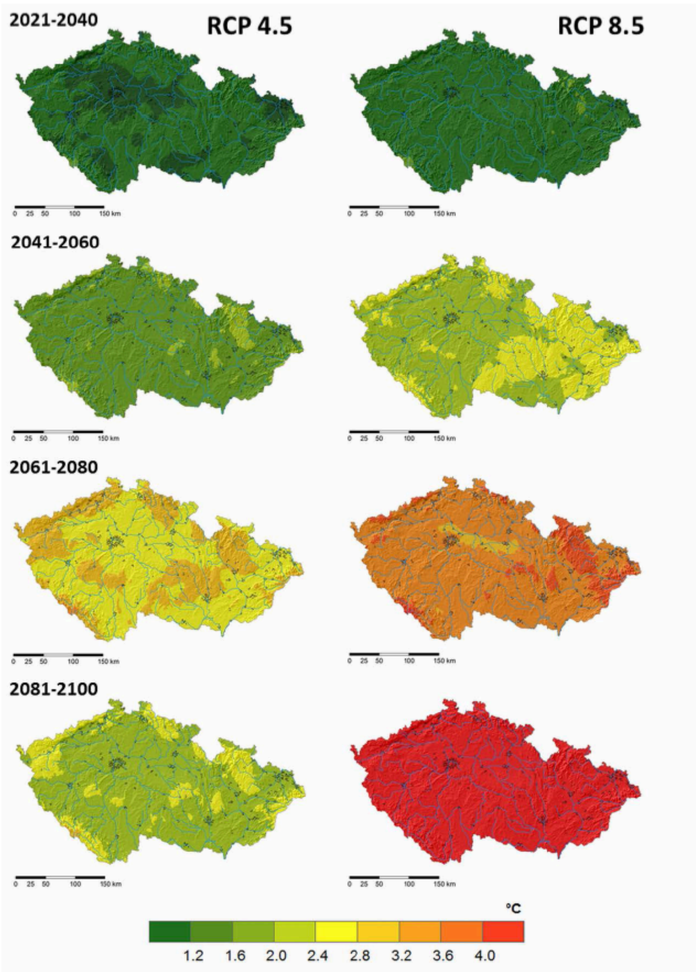
Source: CHMI

Figure 3.4: Air temperature difference (°C, on y axis in graphs) for the Czech Republic according to the ensemble average of 11 RCM model runs for individual seasons (on x axis starting from the left: the whole year, winter, spring, summer, autumn) compared to the reference period 1981-2010 (RCP4.5 on the left, RCP8.5 on the right)



Source: CHMI

Figure 3.5: Difference in mean annual air temperatures in the future relative to the reference period (1981-2100) for the selected HadGEM2-ES-RCA mod



Source: CHMI

Table 3.2: Air temperature difference (°C) for the Czech Republic according to the ensemble average of 11 RCM model runs for each period and season compared to the reference period 1981-2010

Emission scenario	Period	Year	Winter	Spring	Summer	Autumn
RCP4.5	2021-2040	0.9	1.1	0.8	0.7	0.8
	2041-2060	1.8	2.2	1.8	1.7	1.5
	2061-2080	1.8	2.2	1.8	1.7	1.5
	2081-2100	2.0	2.4	1.9	1.7	1.7
RCP8.5	2021-2040	1.0	1.1	1.1	0.9	0.9
	2041-2060	1.8	2.1	1.8	1.6	1.8
	2061-2080	2.8	3.3	2.8	2.6	2.6
	2081-2100	4.1	4.9	3.8	3.8	3.9

Source: CHMI

A more significant change will occur in the maximum and minimum air temperatures. The models predict that the highest increase in maximum air temperatures will occur in winter and the lowest in spring. Annual maximum temperatures will increase by 2.3 to 4.6 °C by the end of the century, depending on the RCP scenario. In winter, the outputs show an increase of 3.4-6.0 °C. Minimum temperatures are expected to increase even more sharply, particularly in winter (4.5 °C) and then spring (3.5 °C) for RCP4.5 and RCP8.5, respectively, with annual results similar to those for winter.

3.1.2. Precipitation

Precipitation in the Czech Republic is very variable. Dry and wet periods alternate significantly. This is the reason why precipitation does not show a statistically significant trend (Table 3.3). However, there is a change in the character of precipitation. We observe a statistically significant increase in the number of days with higher rainfall totals, which are mostly due to storm activity in the summer months. In contrast, the number and length of episodes with little or no rain is increasing.

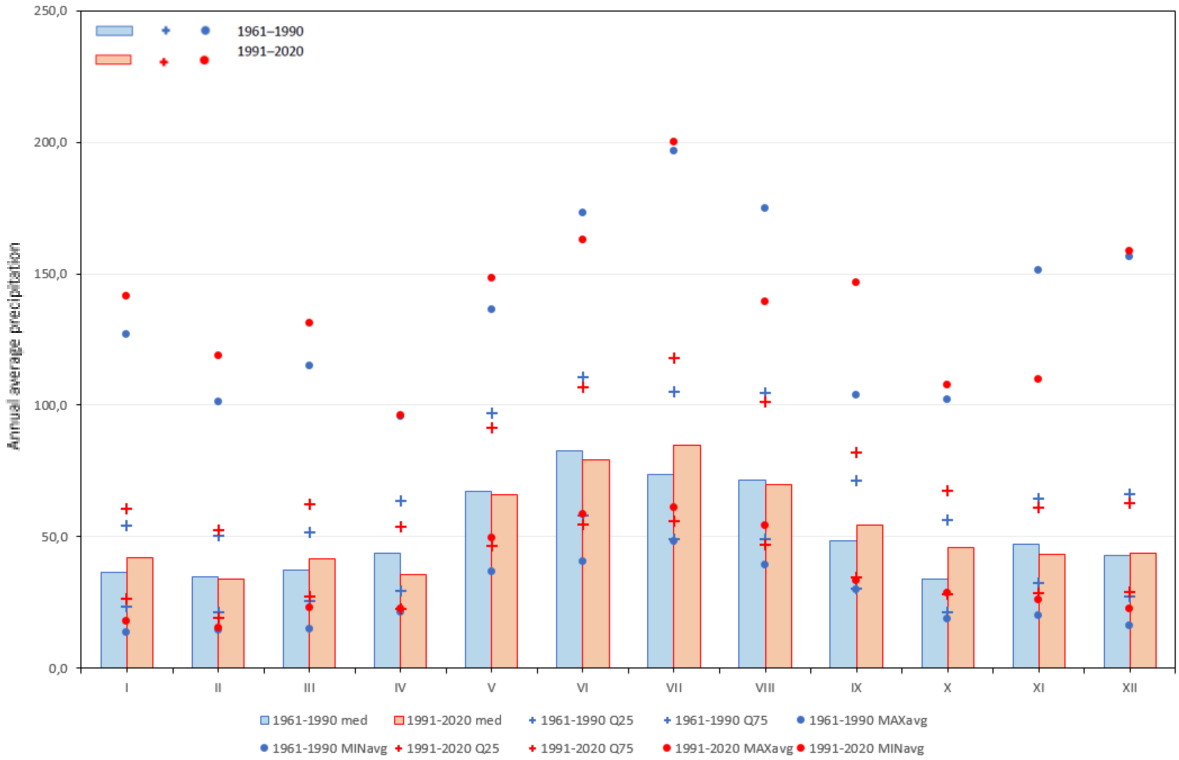
Table 3.3: Percentage of precipitation totals for the Czech Republic according to the ensemble average of 11 RCM model runs for individual periods and seasons compared to the reference period 1981-2010

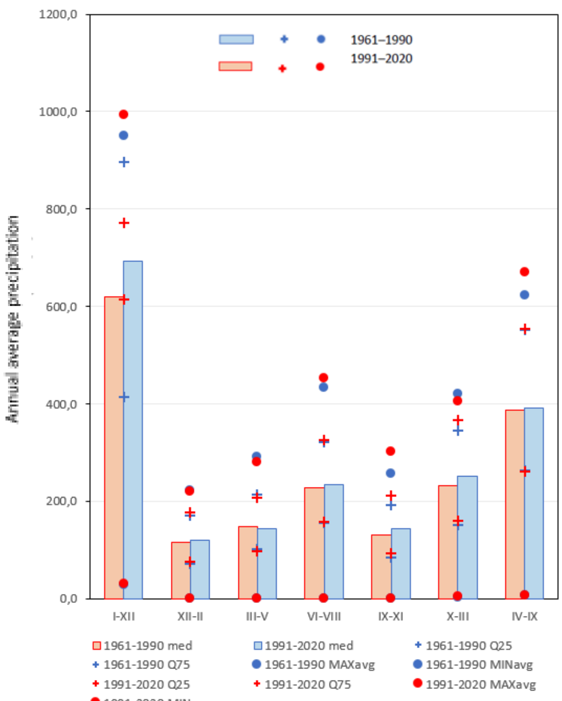
Emission scenario	Period	Year	Winter	Spring	Summer	Autumn
RCP4.5	2021-2040	106.6	109.3	105.9	105.0	107.4
	2041-2060	107.0	110.5	111.5	100.9	108.7
	2061-2080	110.3	115.9	115.1	104.4	109.5
	2081-2100	112.7	114.0	119.3	107.5	112.4
RCP8.5	2021-2040	106.5	110.6	109.3	103.4	106.2
	2041-2060	112.2	120.4	115.4	105.8	112.3
	2061-2080	113.7	126.1	118.7	104.3	113.8
	2081-2100	116.3	135.1	123.5	102.4	115.9

Source: CHMI

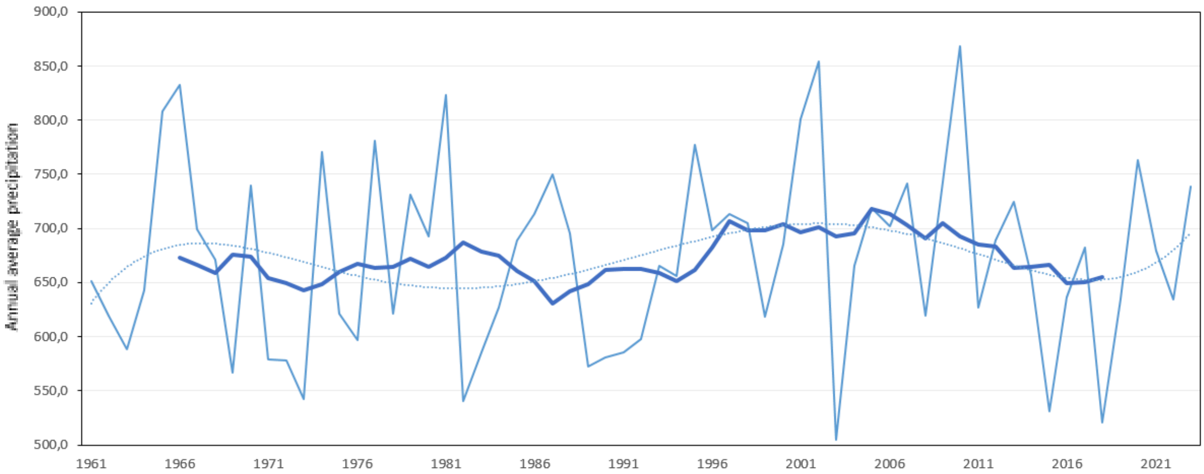
In the new normal period 1991-2020, the average annual precipitation for the Czech Republic was 684 mm, which was very similar to the previous normal range for 1961-1990 of 674 mm (Figure 3.6). In the last short period 2011-2023, the average precipitation was measured only at 655 mm because of a dry spell in the period 2014-2018. This is not a statistically significant change between two normal periods as there is a large fluctuation, which is characteristic of the climate of central Europe. Most precipitation falls in the summer months, mainly due to storm situations that result in higher runoff from the landscape. In contrast, the least rainfall occurs in winter. The least change occurs in the spring months, when rainfall is almost the same from season to season.

Figure 3.6: Annual precipitation (on y axis) in the Czech Republic for two selected periods (1961–1990 and 1991-2020; top) and precipitation trends for the whole period 1961–2023 (bottom)





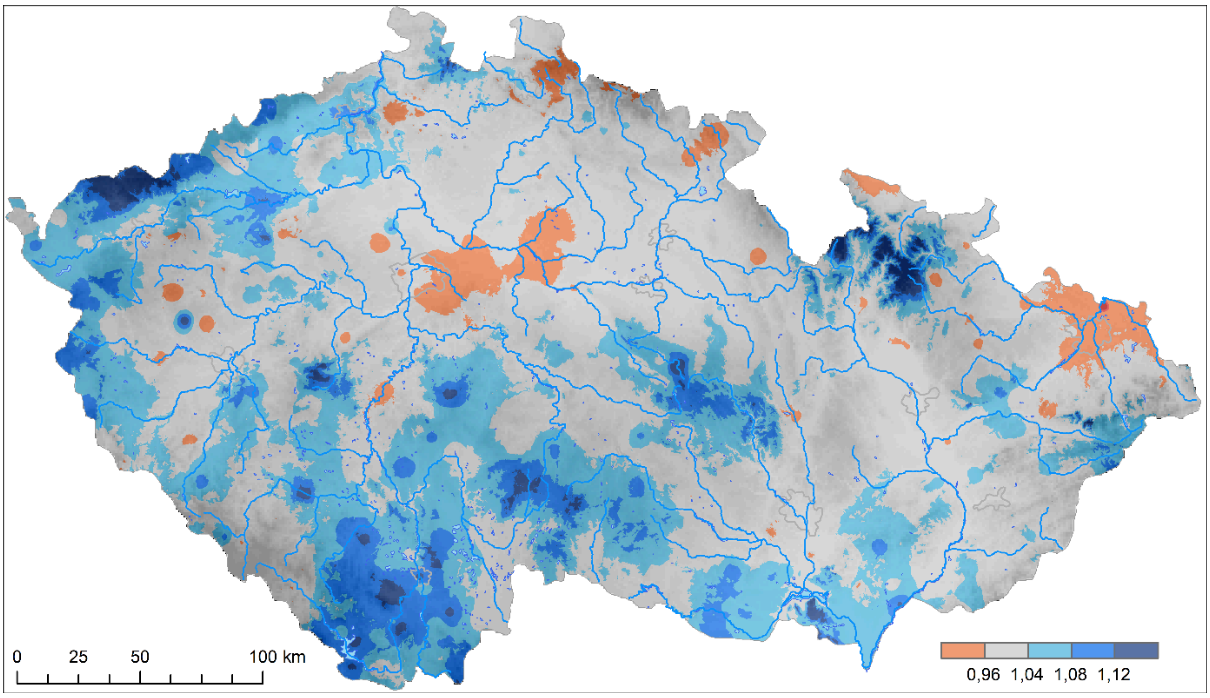
Source: CHMI



Source: CHMI

The greatest change in precipitation occurred in southern Bohemia, where we observe an increase of over 10%. There was also an increase in precipitation in the west of the country. In the rest of the country, the changes are mostly up to 4% (Figure 8).

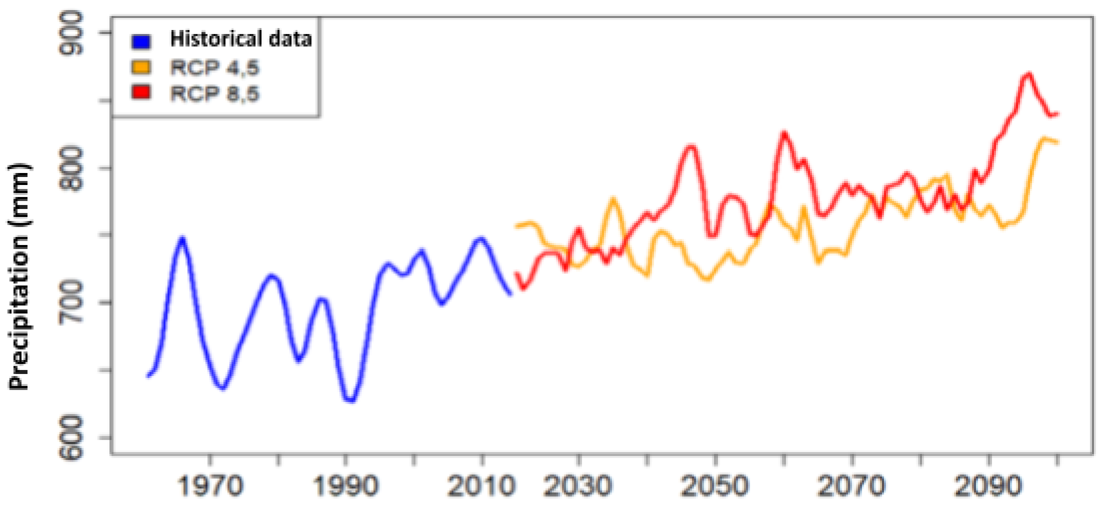
Figure 3.7: Share of average annual precipitation in the 1991–2020 period compared to 1961–1990



Source: CHMI

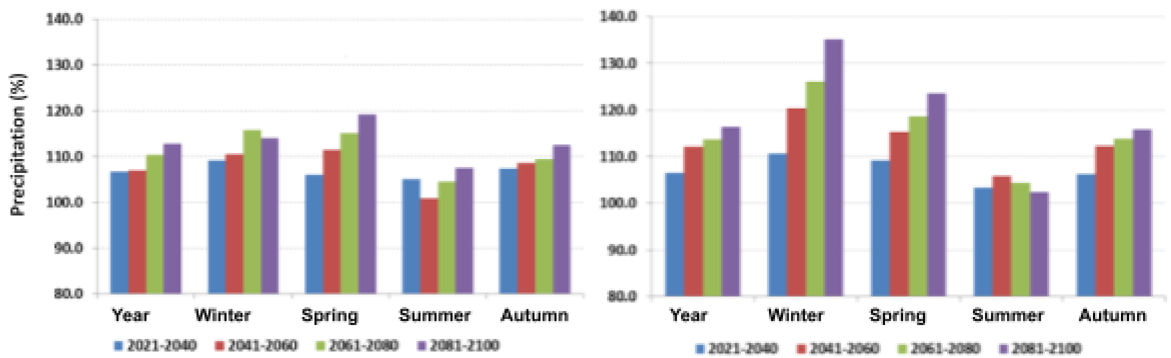
Precipitation predictions based on all 11 RCM experiments show a slight increase of 7-13% for RCP4.5 or 6-16% for RCP8.5. Higher precipitation is observed by the end of the 21st century (Figure 3.9). A statistically significant trend (8.3 mm/10 yr) was found for RCP4.5 for the period 2061-2100. Emission scenarios 8.5 show a statistically significant trend of 16 mm/10 yr for the period 2021-2060 and 13 mm/10 yr for the period 2061-2100. RCP2.6 projects an increase in precipitation only in the first period 2021-2060 (14.7 mm/10 years). The largest difference is seen in winter precipitation, which may increase up to 35% by the end of the 21st century (Figure 3.9 and Table 3.3). In contrast, the least change can be expected in summer precipitation.

Figure 3.8: Evolution of average annual precipitation (mm) for the Czech Republic according to the ensemble average of 11 RCM model runs (smoothed with a 10-year low-pass filter)



Source: CHMI

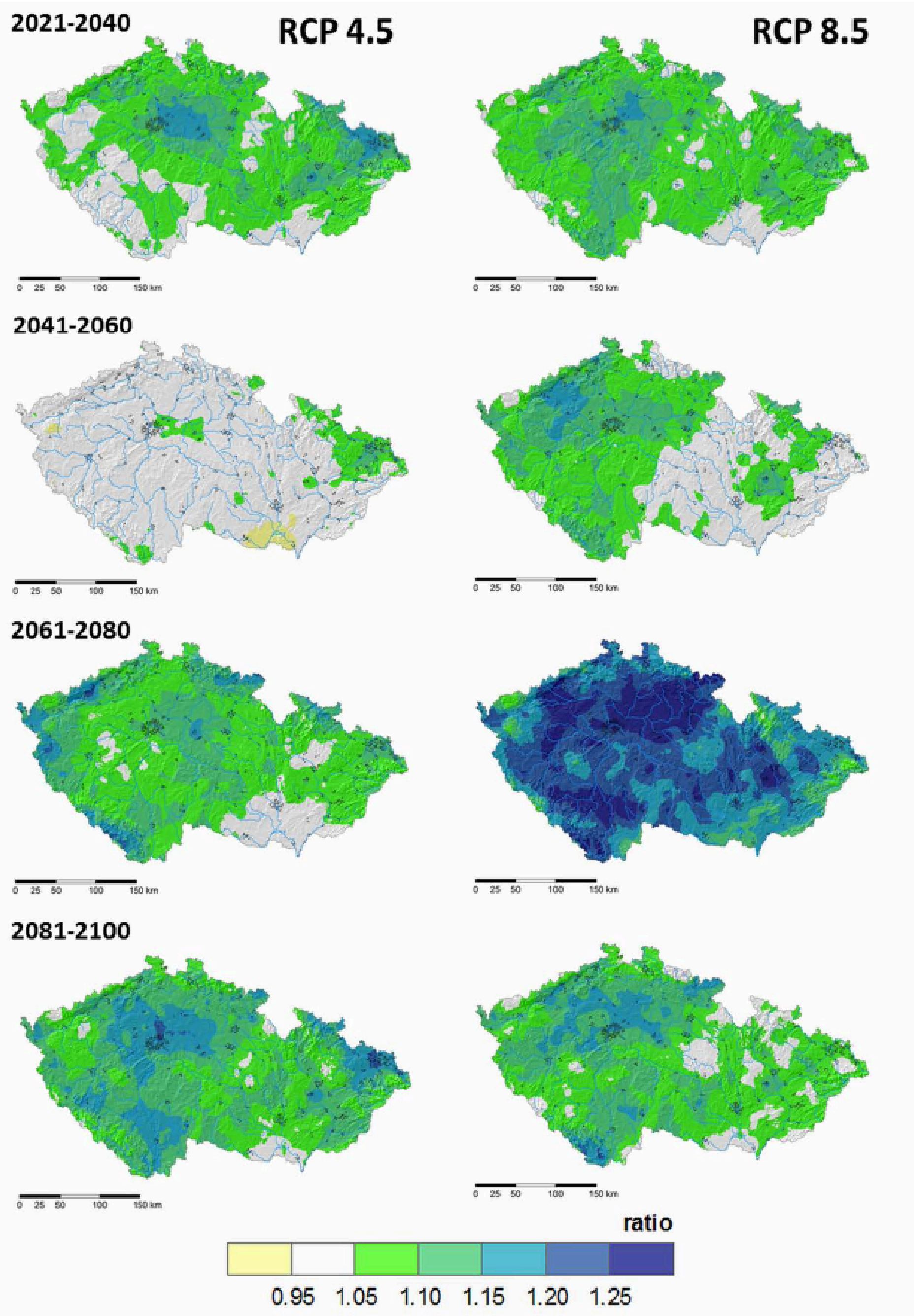
Figure 3.9: Percentage of precipitation (y axis) totals for the Czech Republic according to the ensemble average of 11 RCM model runs for individual periods and seasons (x axis) compared to the reference period 1981-2010



Source: CHMI

As can be seen in Figure 3.10, changes in precipitation are not spatially consistent. The HadGEM2-ES RCA example shows that the smallest increase should occur in South Moravia, which is one of the most important agricultural areas. The differences between periods and emission scenarios are large. A significant difference can be observed between the periods 2041-2060 (RCP4.5) and 2061-2080 (RCP8.5). In the first case, similar precipitation totals are predicted as in the 1981-2010 reference period, but in the second case significantly higher precipitation values are modelled, by more than 20%.

Figure 3.10: Future mean annual precipitation relative to the reference period (1981-2100) for the selected HadGEM2-ES-RCA model



Source: CHMI

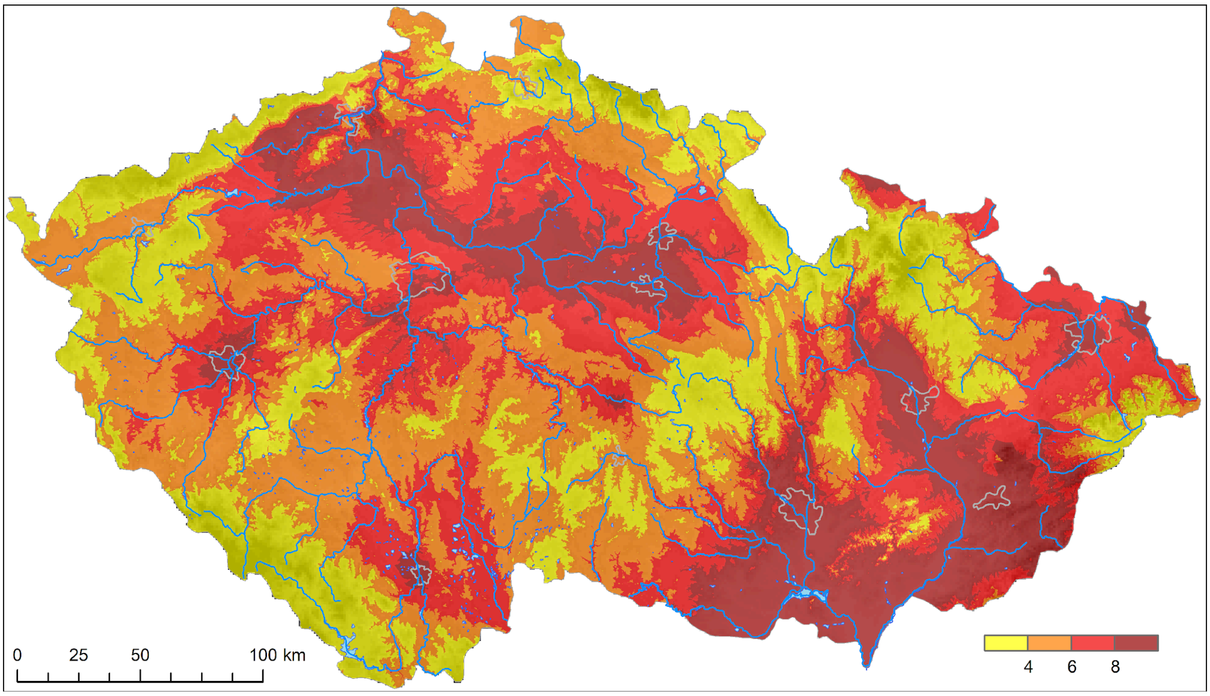
3.1.3. Climate indexes

Climate change is not only expressed in changes in basic climatological elements, but also in changes in special characteristics that are often more important for understanding change and setting adaptation measures. For this chapter, the number of tropical days was chosen as an indicator. Based on these, both the actual change and the estimated development will be described in more detail. Changes in other selected characteristics are described in summary tabular and graphical form.

Tropical days

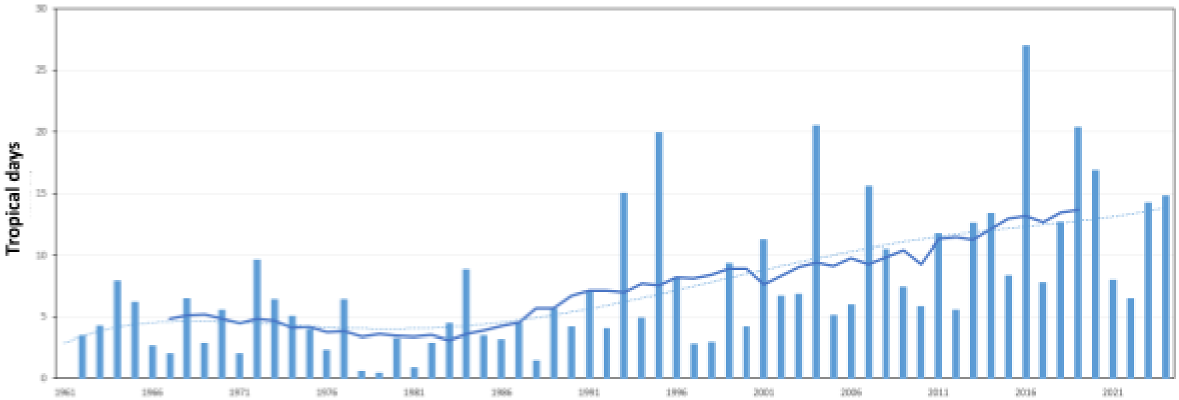
A tropical day is a day when the maximum air temperature is 30 °C or more. This is a temperature extreme that usually already has negative effects on the landscape (increased evapotranspiration of plants, drying of the landscape) and on human health, especially when the corresponding conditions occur for several days in a row (so-called heat waves). Tropical days occur on average only a limited number of days per year for the whole country (on average 8 days per year during the period 1961-2023), but in recent years we observe a significant increase (Figures 3.11 and 3.12). For example, in 2015, almost 30 tropical days occurred on average across the country (spatially highly differentiated). During 1961-1990, only 4.4 tropical days per year were observed on average. In the period 1991-2020 there has already been a significant increase to 10.4 days per year.

Figure 3.11: Difference in the number of tropical days in 1991-2020 from the 1961-1990 normal



Source: CHMI

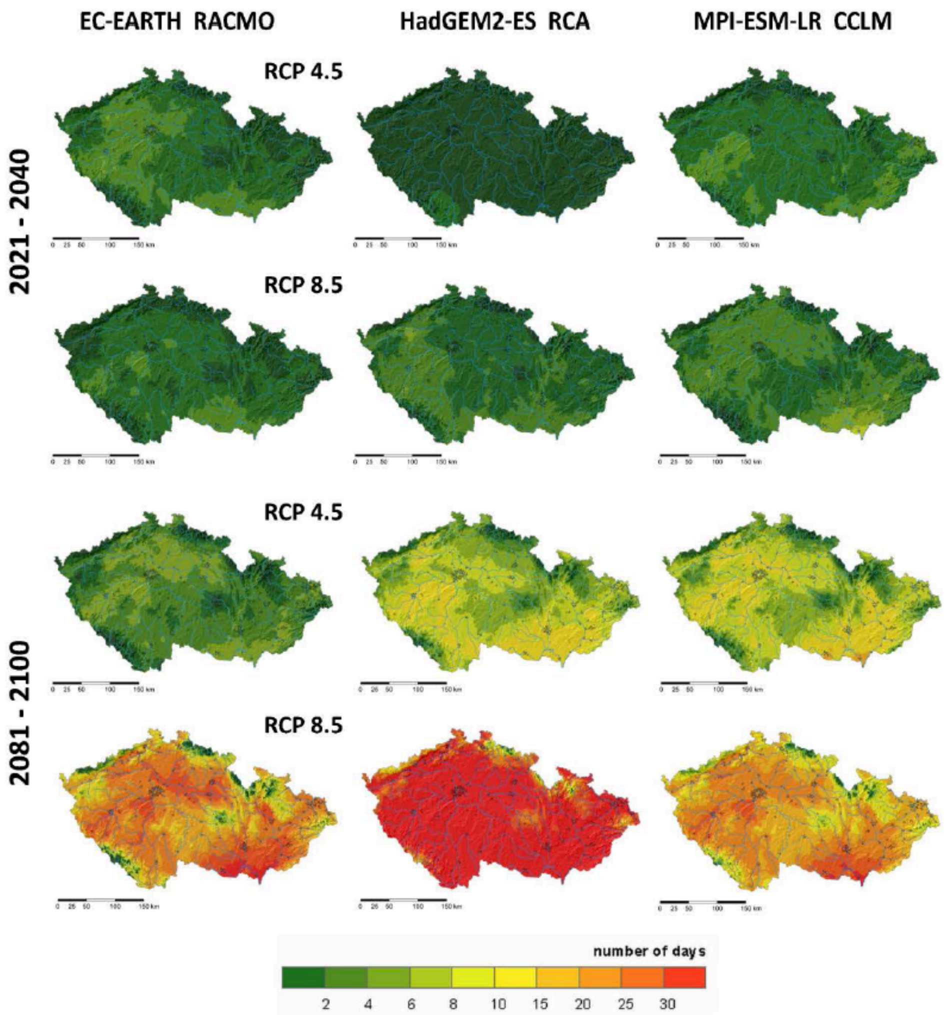
Figure 3.12: Average number of tropical days on the territory of the Czech Republic in 1961-2023 (area interpolation for the whole territory)



Source: CHMI

Based on current model outputs, there would be no significant increase in the number of tropical days in the near future (2021-2040). The values are consistent with the situation in recent years. A larger difference in model predictions and other emission scenarios is observed at the end of the century (period 2081-2100). The RCP4.5 emission scenario predicts twice the number of tropical days compared to the 1981-2010 period. RCP8.5 is even more pessimistic in this case. It predicts that the number of tropical days should increase to three to four times the current average (Figure 3.13).

Figure 3.13: Change in the number of tropical days (temperature 30 °C and above) relative to the reference period 1981-2010 calculated from three RCM models for the period 2021-2040 and 2081-2100

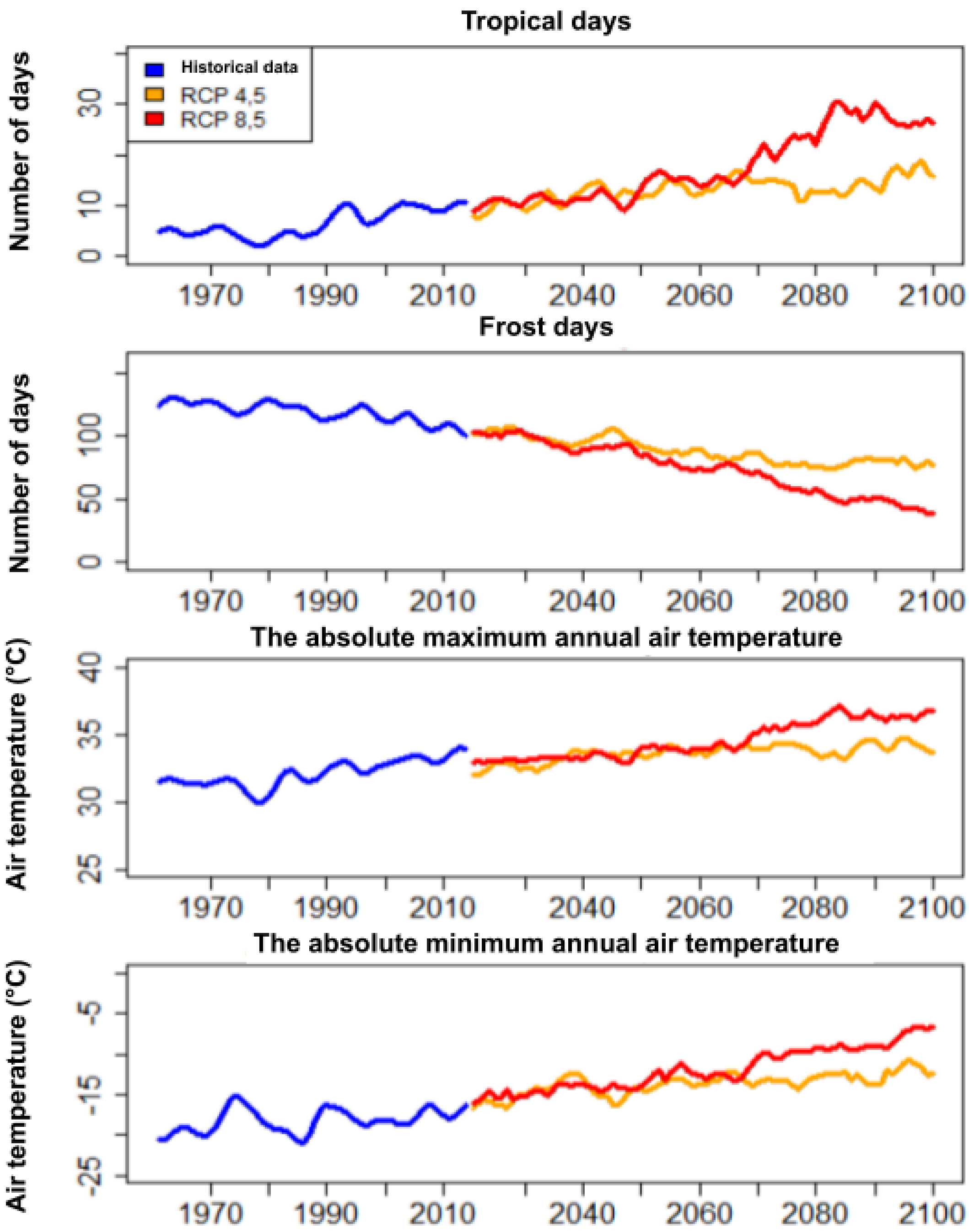


Source: CHMI

Frost days

Another climatological index is the number of frost days (coldest temperature below 0 °C). In the current period, there is a statistically significant downward trend in the number of frost days, which will continue in the future (Figure 3.14). In the near future (2021-2040), the number of frost days decreases by 15% under both emission scenarios. By the end of the century, there would then be a decrease of 35% to 60% and in the most pessimistic scenario up to 70%.

Figure 3.14: Trend of selected climatological temperature indices for the period 1961-2100, for the Czech Republic according to the ensemble average of 11 RCM model runs (smoothed with a 10-year low-pass filter)



Source: CHMI

Both air temperature extremes are also bound to change. Currently, the average annual maximum temperature for the Czech Republic is 32.5 °C. There will not be a significant increase between 2021 and 2040, but by the end of the century the temperature will be 1.3 to 3.9 °C higher (Table 3.4). In the least optimistic model outlook, the annual absolute maximum would rise to 38.3 °C (Table 3.4). This would mean that values above 40 °C would be reached quite regularly at lower altitudes. Extremely low temperatures would become scarcer. Currently, the average annual minimum temperature in the Czech Republic is -18.2 °C. This average should rise by almost 4 °C between 2021 and 2050, and by as much as 10 °C in the long term.

Table 3.4: Selected climatological characteristics (mean change – ensemble mean, minimum and maximum (range of all models) for the near term (2021-2040) and the long term (2081-2100), relative to the current climate (1981-2010), under two RCP4.5 and RCP8.5 emission scenarios. (TMA>=30 °C = number of tropical days; TMI<0 °C = number of frost days; TMA MAX = annual mean maximum air temperature; TMI MIN = annual mean minimum air temperature; SRA>X indicates the number of days with precipitation above the limit)

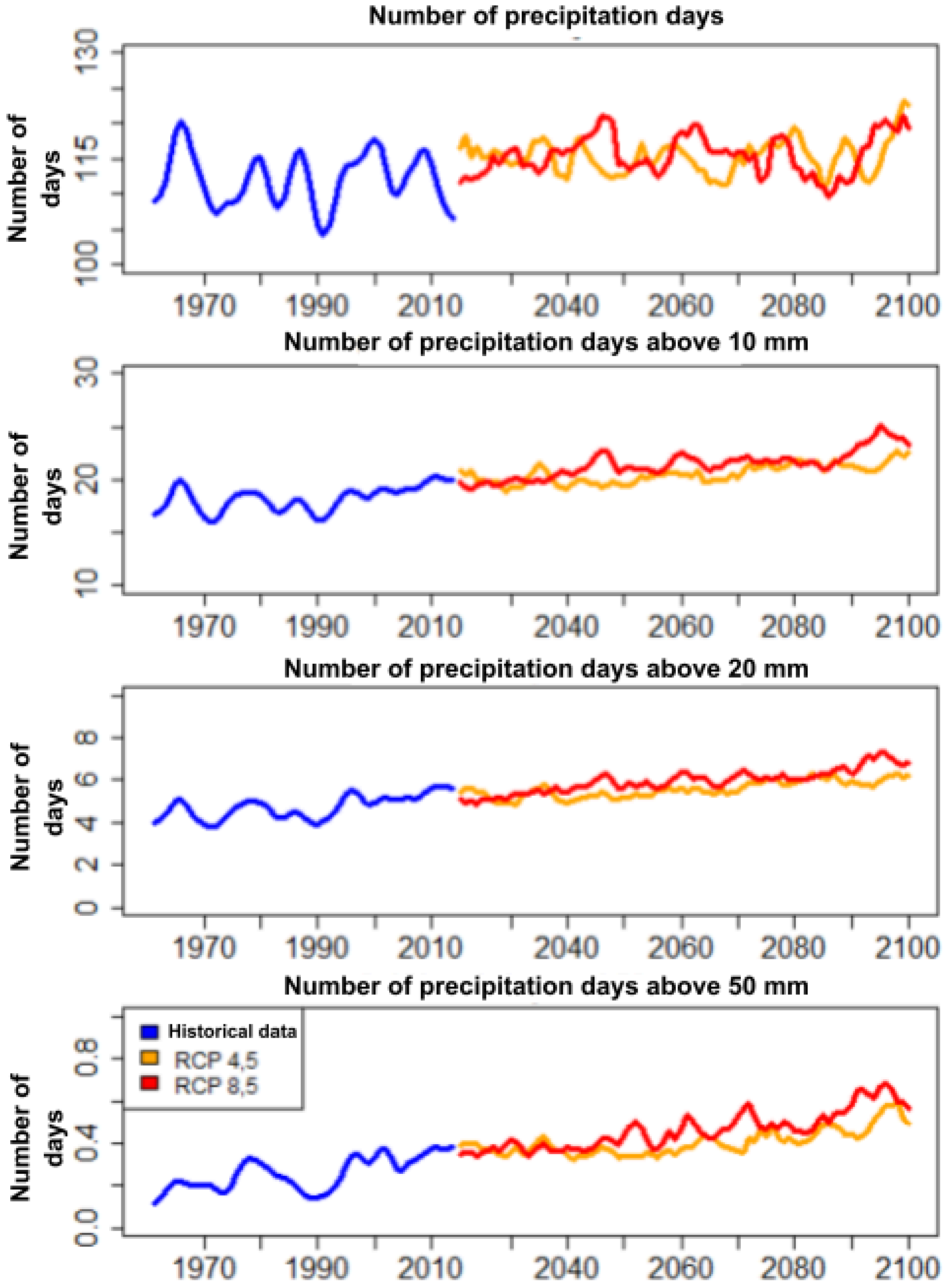
Index	Scenario	2021-2040			2081-2100		
1981-2010		Median	Min	Max	Median	Min	Max
TMA=>30 °C	RCP4.5	10.4	8.3	14.1	15.5	11.9	30.3
7.6 days	RCP8.5	10.5	8.7	14.9	27.4	20.0	40.6
TMI<0 °C	RCP4.5	99.0	88.1	104.2	77.7	70.2	94.1
116.6 days	RCP8.5	99.2	88.6	110.2	48.6	38.7	58.2
TMA MAX	RCP4.5	32.8	31.5	34.1	33.8	32.7	37.6
32.5 °C	RCP8.5	33.0	32.6	33.8	36.4	35.2	38.3
TMI MIN	RCP4.5	−14.6	−17.0	−12.5	−12.6	−15.0	−10.0
−18.2 °C	RCP8.5	−14.5	−17.1	−12.4	−8.9	−11.3	−5.7
SRA>0.1 mm	RCP4.5	114.8	111.1	118.4	114.6	111.4	121.6
112.5 days	RCP8.5	114.3	109.9	118.7	115.5	106.1	123.8
SRA>10 mm	RCP4.5	19.9	18.4	21.5	21.3	20.2	23.8
18.2 days	RCP8.5	19.8	18.4	21.5	23.0	21.5	24.7
SRA>20 mm	RCP4.5	5.2	4.8	5.7	6.0	5.5	7.0
4.8 days	RCP8.5	5.3	4.8	6.2	6.7	6.2	7.3
SRA>50 mm	RCP4.5	0.4	0.3	0.6	0.5	0.4	0.8
0.3 days	RCP8.5	0.4	0.3	0.7	0.6	0.4	0.9

Source: CHMI

Days with precipitation

Over the last decade, we have observed changes in the nature of precipitation in the Czech Republic, but without any change in the precipitation totals. We analysed the number of days with precipitation above 1, 10, 20 and 50 mm. No statistically significant trends were observed for the number of days with precipitation of 1 mm or more (at the p = 0.05 level), but for 10 mm, 20 mm or 50 mm we observed a positive statistically significant linear trend into the future (Figure 3.15). The increase in these intense precipitation events is primarily predicted by the RCP8.5 emission scenario. For example, the number of days with precipitation above 10 mm increases by about 0.6 days/10 years in RCP8.5 over the period 2021-2060 and by 0.5 days/10 years over the period 2061-2100.

Figure 3.15: Trends in selected precipitation climatological indices for the period 1961-2100, for the Czech Republic according to the ensemble average of 11 RCM model runs (smoothed with a 10-year low-pass filter)



Source: CHMI

3.2. Observed and potential impacts of climate change, including sectoral, economic, social and/or environmental vulnerabilities

The following chapters describe in detail the impacts and associated vulnerability under the projected climate change scenarios in the relevant areas of interest. The analysis is mainly based on the scenarios described above.

3.2.1. Water management

The negative impacts of climate change on water management can already be observed in some river basins in the Czech Republic in the form of a significant decline in runoff in the observed series since 1961. The cause of this negative phenomenon is the continuous increase in temperature leading to an increase in evapotranspiration, which has been compensated for by an increase in precipitation in most areas over the period 1990-2013; however, in some (still limited) areas this compensation has not been occurring in the long term. Low flows, reduced water flow speed, and increased water temperature will cause water to stay longer in rivers and reservoirs and to heat up more, which are generally the main reasons for the reduction in surface water quality. The expected changes in the hydrological cycle and water quality pose a risk of impairment of water management infrastructure and are likely to lead to increased abstraction demands. Increasing demands on water resources may lead to conflicts of interest between abstractors and with the interest of protecting aquatic ecosystems and ecosystems linked to the aquatic environment.

The nature of possible changes in the hydrological balance in our area has been known for many years. It is based on projections of changes in the precipitation and air temperature regime for Europe, i.e. a gradual increase in temperature throughout the year and a decrease in summer, increase in winter and stagnation of annual precipitation. Accurate assessment of the direct consequences of climate change on water regime changes is still burdened with uncertainties and regional differences. The envisaged rising air temperatures throughout the 21st century will result in an increase in potential evapotranspiration, particularly between March and September (Table 3.5).

Table 3.5 Long-term monthly and annual totals of potential evapotranspiration of grassland [mm] in reference and scenario periods

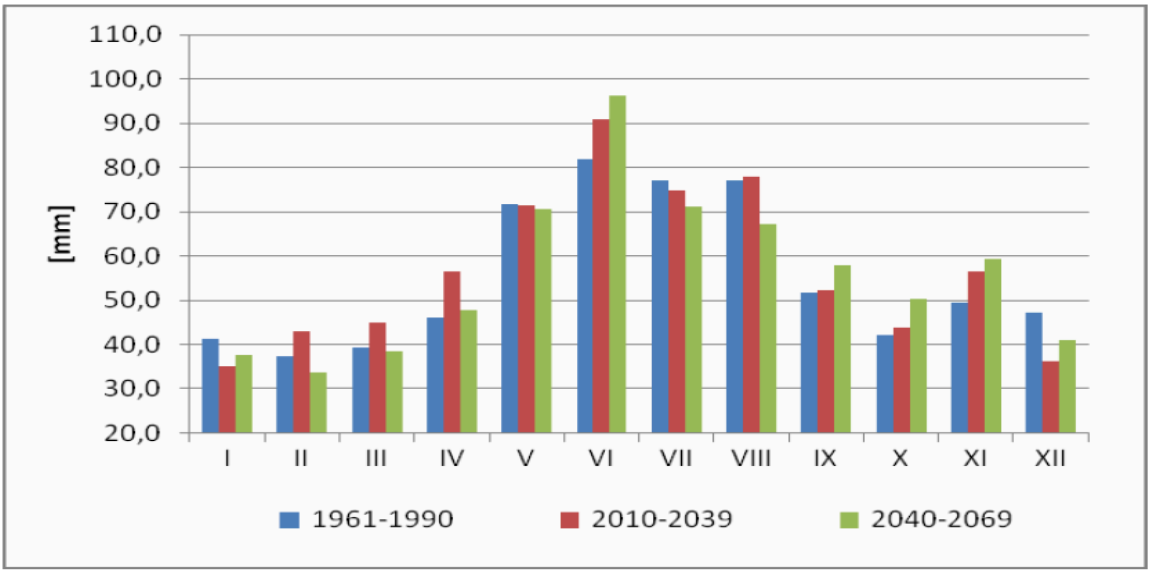
Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
1961–1990	7	11	25	51	76	84	88	76	49	31	16	11	524
2010–2039	9	13	27	54	83	81	96	83	53	34	15	11	559
2040–2069	9	14	32	64	89	87	104	96	60	33	17	13	617
2070–2099	10	15	36	67	88	92	117	110	67	35	18	13	669

Source: CHMI

The modelled changes in precipitation are subject to significant uncertainty and there is no clear consensus between the models. The assumption of a change in the distribution of precipitation at different time horizons is shown in Figure 3.16. In contrast, Hanel et al (2011), using the results of the ENSEMBLES project, suggests an increase in winter precipitation at the 2025, 2055 and 2085 time frames, but agrees with the work of Pretel (2011) in the increase in spring and decrease in summer precipitation (Table 3.6). Higher decreases in summer precipitation are projected in the south and east of our area (mostly by

5-10%, even 15% in the east), but the spatial distribution of precipitation changes is unclear. Very similar results are also obtained from the EURO-CORDEX models used in the update of this study. The difference is in the positive trend of change even in summer and the overall larger increases in precipitation.

Figure 3.16: Average monthly precipitation in the Czech Republic in the reference period 1961-1990 and in the scenario periods 2010-2039 and 2040-2069 (Pretel 2011)



Source: CHMI

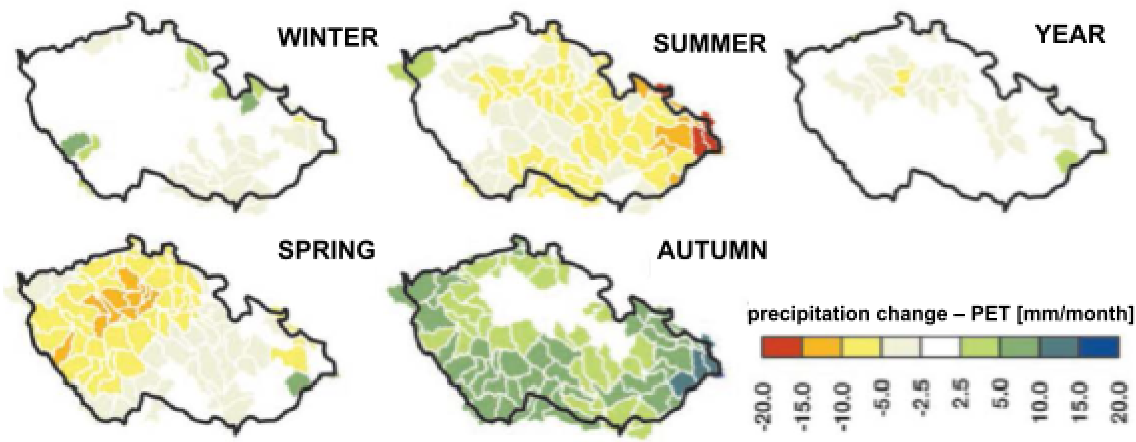
Table 3.6 Average precipitation changes (%) for the Czech Republic in the ENSEMBLES and EURO-CORDEX climate model ensemble (Hanel et al 2011)

Precipitation	Winter	Spring	Summer	Autumn	Year
ENSEMBLES					
2025	4,83	1,32	2,79	5,75	3,35
2055	8,05	5,21	–1,9	6,19	3,94
2085	13,74	9,71	–6,61	7,51	5,49
EURO-CORDEX (RCP4.5)					
2021–2040	9,3	5,9	5,0	7,4	6,6
2041–2060	10,5	11,5	0,9	8,7	7,0
2061–2080	15,9	15,1	4,4	9,5	10,3
2081–2100	19,2	19,3	7,5	12,4	12,7

Source: CHMI

Predictions of future changes in the precipitation regime are highly uncertain. A more detailed analysis shows that the increase in total precipitation in the model results mainly consists of intense precipitation events with totals greater than 20 or 50 mm, while the total number of precipitation days remains unchanged. This would suggest an increase in the proportion of convective precipitation events (at the same time, the models predict a decrease in mean relative humidity in summer), so it is necessary to consider the findings of Svoboda et al. (2017) of a large systematic bias of the models in simulating intense precipitation events. Hanel et al (2011) also report that the seasonal variation in precipitation and potential evapotranspiration changed differently in the 1981-2005 period compared to the 1961-1980 period. While in spring, there is a decrease of more than 5 mm per month in most of the Czech Republic, in summer the decrease is more pronounced in the eastern half of the territory, while in autumn an increase in this indicator is observed, Figure 3.17.

Figure 3.17 Change in evapotranspiration balance between 1961-1980 and 1981-2005 (top: winter, summer, the whole year; bottom: spring, autumn)



Source: CHMI

From the above-mentioned expected changes in climate parameters, potential changes in the hydrological regime can also be predicted. A shift of the spring maximum to an earlier date can be expected due to less snow cover accumulation and earlier melting due to warmer air temperatures. At the same time, the decline in runoff and total water availability during the spring months would begin earlier. These two phenomena are also suggested by the results of the analysis of observed flows from 1961 to 2005, which showed an increase in average flow in February and March (a shift of the runoff maximum especially in mountainous areas). On the contrary, a decrease in May and June (which can probably be attributed to increasing evapotranspiration). A similar regime shift would be observed for groundwater.

Overall, based on the observed hydrological data, it can be concluded that air temperature (influencing the magnitude of potential evapotranspiration) appears to be the dominant controlling factor for the emergence of significant trends in the runoff regime from our area for the time being. No trend changes have been detected in the case of precipitation, or they have not been sufficiently reflected in the hydrological variables.

In the case of the mechanism of climate change on the hydrological regime, several parallel processes with different outcomes can be identified:

- Increased temperature -> higher potential evapotranspiration -> lower average soil saturation.
- Longer rainfall-free periods -> lower average soil saturation.
- Higher precipitation extremes -> higher erosion potential and greater volume of water entering the runoff process at a higher rate.
- Increased winter temperature -> less snowpack formation -> less soil saturation and groundwater recharge.
- Lower average soil saturation before precipitation -> lower runoff coefficient during precipitation.

- Lower average soil saturation before precipitation -> greater soil water retention and less groundwater recharge during precipitation.

Regarding the future development of climate change impacts on the water regime, it can be stated that the projected changes in runoff are uncertain, but indicate an increase in winter runoff and rather a decrease in total runoff in other seasons. In terms of changes in the annual balance, runoff projections are uncertain even in the more distant future, but the probability of decreasing summer and autumn runoff increases significantly (Pretel, 2011). In terms of flooding, there is a significant change of opinion in new studies on the expected summer rainfall regime. In the scenarios available for the original study, a decrease in summer precipitation was considered as a very likely scenario, which was agreed upon by the vast majority of models developed before 2015, while in EURO-CORDEX an increase in summer precipitation is assumed. Given the generally problematic simulation of precipitation in climate models and the resulting inconsistency in the results of these simulations between generations of climate scenarios, it is advisable to respond to the resulting inconsistency with caution while being aware of the economic consequences. As the dynamics of the expected changes will increase over time, it may be recommended to validate the runoff scenarios in the coming years with a detailed focus on the conditions of the Czech Republic, applying correct methodologies for evaluating changes in the occurrence of extreme events. This issue is addressed by the PERUN project (TA ČR, SS02030040, Prediction, Evaluation and Research for Understanding National sensitivity and impacts of drought and climate change for Czechia) launched in 2020. The system is based on the ALADIN/CLIMATE-CZ model with a horizontal resolution of about 3 km. If specific flood protection measures are proposed or implemented, it is necessary to take into account their subsequent adjustments in the context of the current climate change scenario.

Part of the hydrological cycle is directly related to the climate system, so changes in the parameters of the climate elements are necessarily reflected in changes in the hydrological cycle. However, the propagation of changes is not linear, but is a complex of differently strong feedbacks between the atmosphere, hydrosphere and land surface. Changes in the hydrological regime have the effect of affecting the temporal and spatial distribution of freshwater resources, and the socio-economic activities and ecosystems that depend on them.

In theory, all elements of water quality and quantity under the Water Framework Directive are sensitive to climate change. In simple terms, climate change affects the following variables:

- Water availability (stream flow, standing water volume and groundwater supplies);
- water demand (especially at peak demand during dry periods);
- changes in design variables determining the management of water and other sensitive infrastructure;
- surface water quality, which includes temperature, nutrient content, pollutant content and intensity of degradation processes;
- the biodiversity of aquatic systems and terrestrial ecosystems linked to water;
- groundwater quality;
- how pollutants are mobilised in the soil and how they are decomposed and mobilised.

Selected national and European research activities provide only limited empirical data that would clearly indicate impacts, mainly due to the difficulty of identifying climate impacts from other impacts. On the other hand, there is much to suggest that freshwaters that are already affected by human activities may be highly vulnerable to the impacts of climate change and that climate change may, in the long term, significantly complicate attempts to restore the health of some water bodies or reduce the level of water security.

3.2.2. Agriculture

Agriculture is probably the sector where climate change is currently having the greatest impact. It is key to food security and the combination of climate change and adaptive agriculture will significantly affect the state of ecosystem services in Czech landscapes. At the same time, agriculture is a sector with a potential to mitigate the impacts of climate change on other sectors and to capture atmospheric carbon while reducing emissions of other greenhouse gases, particularly methane and nitrous oxide. The impacts of a changing climate in the agricultural sector are mainly connected to rising temperatures, which is also one of the main factors influencing changes in the water balance. In particular, the lowlands or regions formerly at the very peak of productivity (i.e. the original beet and maize production areas) will be increasingly vulnerable to episodes of agricultural drought, with significant effects on the yield-forming elements of individual crops and consequently on the size and quality of yields. Their production potential will be permanently reduced compared to the cereal and fodder production areas.

Higher temperatures will cause an earlier start to the growing season, which will increase the impact of spring frosts not only in the fruit and wine sector. In the event of warmer winters, water will not be stored in the snow but will run off, and more water will evaporate, which may result in incomplete spring saturation of the soil profile, leading to premature depletion of water by vegetation and a multiplication of drought caused by higher temperatures in the spring months. Another precursor to higher drought incidence will be the expected change in rainfall variability, with the number of rainfall days decreasing, especially in spring and summer, while the intensity of individual rainfall events increases. The risk of both wind and water erosion will increase and, in combination with drought, their damaging potential will also increase, as unused nutrients from mineral fertilisers will be readily carried away from the soil surface posing a higher risk of pollution of watercourses as well as the air.

Changes in temperature and precipitation directly affect the conditions for farming, and if such changes are indeed occurring, there should also be a change in other climatic and agro-climatic characteristics, and in particular a response in natural and managed ecosystems. However, the issue of temperature and precipitation changes is more complex and varies from season to season. If we focus on the period from April to June, which is the key period in terms of yield formation for the vast majority of crops, we find that temperature and precipitation change even more than the annual average. This is reflected quite significantly in the dynamics of soil moisture, which is a key factor for agricultural production.

One of the tools that can be used to illustrate changes in soil moisture is the use of so-called drought indices. When drought episodes are assessed on the basis of drought indices, there is a trend towards more frequent/intense drought episodes. However, due to the way the indices are calculated, it is very difficult to verify this trend using measured data. At the same time, the calculation of the drought indices does not fully take into account the site conditions (in particular soil type, terrain geomorphology and also vegetation cover dynamics). Therefore, in this chapter, soil moisture was used as an indicator of drought occurrence. This method also confirms a decrease in the average surface water storage in the first half of the growing season by about 13% in the period 1961-2018, and this change is statistically significant ($p = 0.01$). It is therefore clear that the soil profile as a whole contains considerably less water in the period from April to June than it did in the 1960s, and this trend is very robust and is reflected over a large part of the territory. Conversely, in the second half of the growing season (July-September), no significant trend can be observed, as soil moisture becomes entirely dependent on actual rainfall patterns once reserves are depleted. The period from April to June shows a marked tendency towards higher inter-annual variability, especially in the case of the surface layer, particularly in the eastern part of the Czech Republic. The extent of the area affected by drought in a given season was on average 7% of the area in the 1960s, while in the first decade of this century the size of the drought-affected area practically doubled and has significantly exceeded 15% since 2010.

Changes in climate conditions are reflected in the water available in the soil during the growing season. However, we have not yet addressed the second effect of increasing temperatures, namely their effect on the onset, duration and timing of phenological phases. Indeed, if we accept as an established fact that there is an increase in temperature, this trend must be reflected (and can be independently verified) in the onset and duration of phenological phases if they are examined over a sufficiently long period.

In general, a wide range of mechanisms and processes determining yield levels in crop production are being affected by a changing climate. There is a combination of both positive and negative influences, the proportion and importance of which will continue to evolve. Positive factors include, for example, the increasing level of atmospheric CO_2 concentration stimulating photosynthesis and leading to more efficient plant water use management. There is also the possibility of higher temperatures or a longer growing season. On the other hand, the negatives include a greater likelihood of drought occurrence and intensity, faster vegetation development (this translates into a shorter time to biomass formation in the case of existing varieties), a higher risk of stress from high temperatures during sensitive developmental stages, a higher risk of flooding or negatively affecting intense rainfall situations. We anticipate a change in average yield levels for winter wheat and spring barley, maize, rapeseed and other crops but primarily based on expected technological progress. The effect of higher CO_2 concentration will itself be reflected in better water management. In the case of arable forage and permanent grassland production, as well as longer maturing root crops (e.g. potatoes and beet), the possible lack of moisture in summer predicted by some models will have a negative impact and here too there is a question of potential yield reduction.

Furthermore, it is clear that the situation will vary from region to region, with adverse situations becoming more pronounced in already dry and warm regions, while cooler regions will experience more favourable conditions. Thermophilic crops and varieties will be favoured. At the same time, an increased frequency of dramatic drops in yields is predicted for the expected scenarios. Intercropping will not be a saving grace for the soil in some years due to water scarcity. These may cause a problem for the next target crop due to the soil moisture consumed. Nevertheless, their cultivation seems to be essential for restoring organic matter, stabilising the soil environment and field production. At higher altitudes, the average yield levels of the most important crops are expected to increase. The situation on individual plots will be influenced by the existing soil characteristics in terms of soil retention capacity, overall soil fertility or the nature of the terrain. The results of the above analyses are based on the assumption that soil quality will be maintained as it is at present. However, if the soil properties deteriorate, a negative impact on future yields can be expected. Restoration of soil structure, microbial environment and water retention capacity is and will be a key condition for the sustainability of agriculture. According to available data, more than 50% of arable land in the Czech Republic is threatened by severe to very severe erosion and about 40% of soils are moderately to severely compacted. The continuation of these processes in the context of climate change could have fatal consequences for Czech agriculture. Because of changes in soil moisture availability, stable production of permanent grassland will be problematic in some areas.

Recent studies have also shown that inter-annual variability in crop yields can be expected to increase due to increased frequency and intensity of adverse situations for crop production such as significant drought episodes, occurrence of high temperature stress at sensitive developmental stages, low temperature damage, etc. The analysis of yield variability between 2011 and 2018 alone has shown the crucial role of extreme weather. The question remains how significant disease and pest pressure will be, which are also not yet directly included for future yield forecasts. However, trends can be inferred based on the occurrence of more favourable conditions (including climate) for a given pathogen. Another unknown for the future is the characteristics of new varieties. Despite its limitations, modelling of future agro-climatic conditions undoubtedly plays an indispensable role in defining the most important expected risks to which research, development (including breeding activities – drought tolerance, resistance to high temperatures) and practice (e.g. use of local irrigation, increased representation of thermophilic crops – maize, sunflower, soybean) should respond.

The primary driver of the increased variability in production and its absolute level is the direct impact of extreme weather events (high temperatures and droughts, heavy rains, severe frost and other weather anomalies), which have increased in frequency in recent years as a result of a changing climate. Unfortunately, we are also observing a negative development of factors promoting soil erosion, which are further aggravating the situation. Increased protection of the agricultural and forest soil stock is crucial, as is the preservation of soil health, but even if the negative practices that degrade the quality of the soil stock can be reversed, we cannot a priori expect a substantial reduction in the level of yield variability. It is evident that the values of agro-meteorological production assumptions will change significantly, more so than we have seen in at least the last 200 years. Of the range of potential indicators that have been evaluated and presented in part above, the following have been selected as impact indicators:

- Effective growing season length, as an indicator of potential production;
- Surface soil moisture stress (0-40 cm), as an indicator of agricultural drought.

It is evident that there is a risk of reducing the potential productivity of key agricultural areas in the Czech Republic, as the effective length of the growing season is stagnating and possibly decreasing due to lack of moisture, primarily in the lowlands. Conversely, at higher altitudes with relative abundance of moisture, the value increases, but agricultural production at higher altitudes will not be able to make up for the shortfalls at lower altitudes in the long term. The resulting value of the indicator is quite sensitive to the choice of climate model, but a significant proportion of the models indicate a risk of productivity decline, a fact that has been neglected by some previous studies. Changes in the duration of snow cover are crucial and unfavourable for winter crop production. Although the short duration of the snow cover will allow some alternative practices to be applied, Czech territory remains vulnerable to extremely low temperatures during the winter months without snow cover. In general, the risk of drought will increase, in some scenarios several times. This, in combination with the above changes, will undermine the production capacity of those regions that are currently in the maize and beet production area in particular. The number of extremely warm days will increase dramatically and the risk of negative impacts for crops, livestock and aquaculture is high. In addition, unlike moisture deficiency, the increase in the number of extremely warm days cannot be solved by technical measures. The risk of days with maximum temperatures above 35 °C increases dramatically, as does the risk of high temperatures already in May.

The most important factor representing the primary economic impact of climate change on agriculture is crop losses due to both natural disasters and longer-term climate change. Agriculture as a sector is an essential element of national security and, particularly in the context of this sector; it should be borne in mind that its stability largely determines the functioning of society as a whole. Although the presented analysis focuses mainly on direct impacts, in the case of agriculture indirect impacts can be of staggering proportions.

3.2.3. Forestry

The main impacts of climate change that pose risks to forestry are rising air temperatures, particularly spring and summer temperatures, decreasing summer precipitation and increased evapotranspiration. This leads to higher drought severity, increased frequency of dry periods and increased length of dry periods. This progression of meteorological factors is significantly weakening Czech timber forests. Biotic agents, especially bark beetles, play a decisive role in tree mortality. Their increased activity is partly due to the weakened resistance of trees caused by the drought. For these reasons, they respond positively to ongoing climate change and can often spread rapidly. Increased incidence of strong winds may contribute to the disruption of declining forests. Biotic factors currently pose a major risk to spruce and pine (mainly bark beetles), ash and alder (fungal pathogens). In general, the activation of insect pests of other tree species can also be expected. These changes are already manifesting themselves in the decline and in some cases collapse of forest stands. The shift of forest vegetation stages zones(FVZ), which are the basis of the system for differentiated forest management, is related to the increasing temperature. Today's areas of uplands and hills (mainly FVZ 4-5) no longer meet the criteria corresponding to the ecological valence of the key tree species of Czech forestry, i.e. spruce. However, the shift in vegetation zones also affects stands of other tree species. However, the shifts in forest stages zones cannot be viewed mechanically: in addition to the 'average' meteorological values by which they are defined, the extremity of meteorological elements is also increasing.

When assessing the risks for growing forest tree species at a local scale, soil conditions cannot be omitted, for they significantly influence drought manifestations and tree resilience and can both amplify and weaken the effects of meteorological elements on the forest. We therefore observe and will continue to observe climate-related changes with varying intensity, among other things due to the different conditions of the different sites. They confirm, almost without exception, earlier forecasts and differ from those predicted by the speed of onset, which is precisely linked to the recent occurrence of extreme seasons.

Negative factors that have been known for a long time have an impact on the health of forest stands. The abiotic factors are mainly wind, snow, drought, immission stress and nutritional deficiencies, while the biotic factors are mainly insects (bark beetles, leaf-eating insects, etc.), fungal pathogens, wildlife, small rodents and undesirable vegetation in the case of forest regeneration and young stands. Significant decline of forest tree species continued in 2018 as a consequence of drought (high temperatures, unevenly distributed rainfall, e.g. www.intersucho.cz) during the growing season, the associated spread of various biotic insects, and also due to the effects of damaging winds. As a result of the bark beetle calamity, extensive clearings have been created in recent years. The incidence of dying pine trees, subsequently attacked by various biotic pests in the middle and lower elevations, remained high. In warmer areas, broadleaved stands have been attacked by folivorous insects and ash stands have experienced increased dieback.

Forestry is a rather problematic sector in the context of climate change, especially due to the extremely long (over 100 years) production period of forest stands. It follows logically that forests, which are being established or regenerated today will reach production maturity in a completely different climate. The synergistic effect of extreme climate fluctuations and anthropogenic influences, especially long-term immissions and management interventions, has resulted in a reduction in the vitality of forest stands in almost all of central Europe. Some key tree species have been grown at or even beyond their current ecological tolerance limit. This is particularly the case of spruce, the dominant tree species in Czech forestry.

A related impact of climate change and the current decline in vegetation is an increase in fire risk. Forest fires are mainly associated with the arid regions of southern Europe and the Mediterranean, but severe drought and the accumulation of dry and highly flammable biomass and dead wood in forests also pose an increased risk to forest areas in central and northern Europe, and Czechia has seen some major occurrences of wildfires in the recent past. It is well documented that in clearings without functional vegetation cover, there is a significant increase in surface temperatures, which in turn increases the risk of fire.

In accordance with projected climate change scenarios, a shift in habitat conditions by at least two FVZ is expected by the end of the 21st century. The changed habitat conditions will act as a predisposing stressor and predispose individual tree species and entire stands of forest trees to activate other, especially biotic, stressors. The proportion of spruce in the Czech Republic with poor health is estimated at 43-48 %.

3.2.4. Industry

Services and business in the industrial and energy sectors (including chemical, mining, automotive and other types) in the Czech Republic already are and in the future certainly will be affected and threatened by the impacts of climate change, both directly and indirectly.

Among the industrial sectors, the impact of climate change is particularly significant for the energy sector, as most stakeholders in this area are aware. Inevitable climate change creates clear challenges for the energy sector, which provides essential energy services that underpin quality of life and economic development. Improving the resilience of the energy sector to climate change is therefore vital for the economy, households and governments.

The relevant impacts on industry are related both to climate mitigation and to climate change itself. Most economically challenging is the necessary change in the structure and efficiency of industry in the face of anthropogenic climate impacts. This is mainly to meet the goals of the Paris Agreement and other policies requiring reductions in greenhouse gas emissions and resource depletion. This will require major changes in technology, a high degree of innovation and therefore high investment costs. The energy sector is expected to be the one most affected. In terms of the impact of climate change, we are already experiencing risks to business continuity due to high temperatures, water shortages and extreme weather events (threats to operational capacity without physically endangering the energy installations themselves), but also direct impacts on businesses from natural disasters. The risk of insufficient speed of adaptation to climate change, including the implementation of low-carbon energy and industry on a global scale, is significant. Current strategies may require an update so as to ensure the level and quality of services into the future.

Because of a slow adaptation to climate change and a slow transition to low-carbon energy, the Czech Republic and its industry may lose its current (and future) competitiveness both compared to neighbouring EU countries and globally. Insufficient adaptation to changing climate conditions may also result in significant and prolonged blackouts, as well as NATECH (Natural Disasters Triggering Technological Hazards) accidents.

The relationship between industry, particularly energy industry, and climate change is characterised by a complex system of feedbacks and interactions. In an oversimplification, industry is a source of wealth, but also of greenhouse gas emissions and other effects contributing to climate change and is itself at risk from the climate change it helps to trigger. The complexity of the issue, together with the large number and diversity of stakeholders involved and the still limited knowledge, thus leads to inconsistent attitudes and a dynamically evolving knowledge base. This, together with society's value system, which is also evolving dramatically, is the basis for climate change adaptation policies and for building preparedness for potential environmental, technical and social crises.

Climate change also poses clear challenges for the energy sector. In addition to the need to reduce emissions, the energy sector faces increasing risks from a range of climate impacts that present a serious threat to energy security. While the energy sector is already taking a number of measures to mitigate short-term risks to energy supply (e.g. developing emergency response systems, diversifying energy sources and implementing energy and water efficiency measures), climate change is likely to exacerbate these risks both in the short and in the long term. Climate change affects not only the functioning of the energy sector and its actors, but also society, which relies on the provision of energy services. This includes industry, commercial operations, hospitals, schools and other social services, as well as the individual households that rely on them. Increasing the resilience of the energy sector thus protects not only energy companies, but also the economies and populations that rely on energy services. A wide range of climate change impacts could affect the core components of the energy sector: generation, transformation, transport and storage, but also demand. These impacts vary by region, and the risks depend on the vulnerability of the area to physical exposure to hazards. Changes in climate and weather affect the physical nature and extraction of the energy resources on which the energy system fundamentally depends.

3.2.5. Transport

The Czech Republic plays an important role as a transit country in both road and rail transport. In terms of lower transport performance and relatively small scale of infrastructure, air transport plays a less important role. Road transport is the most sensitive to climate change. The high density of the transport network, together with the surface materials of the transport infrastructure, are relatively vulnerable to damage, particularly from extreme temperatures and flooding. Roads also carry large numbers of people who are negatively affected by extreme hydrometeorological events. Rail transport is affected in the same way as road transport, but due to the different organisation of transport, a significantly less dense transport infrastructure and the different technology of its construction, the impacts of climate change are not as intense. For all modes of transport, extremes of precipitation represent the highest subjective risk. Extreme temperatures are more likely to affect passenger and driver comfort and cause less severe, though often more extensive, damage to transport infrastructure.

From a climate change perspective, the biggest problem remains the steady increase in the production of greenhouse gases in the sector. Transport is therefore one of the factors contributing to climate change and part of the mitigation measures should therefore be aimed directly at reducing the negative impact of transport on the climate. Climate change can cause extreme weather events (torrential rain or snow storms, floods, storms, heat waves, etc.) which can have a negative impact on road, rail, air and water transport operations as well as on transport infrastructure. Another long-term phenomenon may be the negative impact of increased temperatures on transport structures, which may cause damage to them.

Due to the geographical location of the Czech Republic in the central part of Europe and its position in relation to major logistics centres and ports located in its territory, several transcontinental transport routes of a major nature meet:

- the central European north-south route connecting ports on the northern Adriatic coast and ports in the Baltic Sea,
- the west-eastern route connecting the major logistics centres in Western Europe with those in Russia and Ukraine,
- a direction linking ports in the North Sea with ports in the Balkan Peninsula.

These facts make the Czech territory one of the important transit territories within the expanding European Union. The projected impacts of climate change on the functioning of the transport network can be assessed on two basic scales. Firstly, in terms of the European context and, secondly, in the context of the impacts themselves, which are mainly manifested on the territory of the Czech Republic.

In the transport sector, the main economic impacts of climate change can be expected in the form of changes in the costs of maintaining, repairing and ensuring the functionality of infrastructure. In this sector, some of the impacts are likely to be positive. An example would be a reduction in the costs needed to keep roads safe during the winter period. Of the indirect impacts, the impacts on public transport and the reliability of connections will be particularly significant.

3.2.6. Urbanised landscape

The main impacts of climate change in urban environments include increased temperatures, flooding and heavy rainfall and, in the future, water scarcity. Increasing temperatures will affect water circulation (quantity, quality) and the availability of water resources. Climate change is also likely to affect air conditions (humidity, quality), and some extreme events may become more frequent. This will have an impact on the population (health, well-being), buildings and public infrastructure (disruptions and failures of transport and technical infrastructure networks). A major anticipated manifestation of climate change in the urban environment is the further intensification of the urban heat island, especially in the absence of adaptation measures aimed at increasing evaporation from water and green features in cities. With expected further population growth in large cities, there may be greater exposure to the negative impacts of extreme hydrometeorological events, including floods, heavy rainfall and drought and water scarcity. Because of the above factors, socio-economic phenomena in society may be affected.

The urbanised landscape, i.e. the landscape of settlements, includes built-up areas including public spaces and areas of public greenery, industrial and logistics complexes and residential and recreational buildings, but also transport and technical infrastructure (network of roads, motorways and railways, navigation channels), water reservoirs and other areas transformed by human activity. The landscape of settlements is the landscape most significantly transformed by human activity. Within Czechia, the settlement landscape is characterised primarily by a high population density, a high proportion of built-up area, a high proportion of paved and impermeable surfaces, a high concentration of economic activity and services (a high percentage of workplaces) and a high concentration of infrastructure (including networks). In addition, there is a trend towards a gradual increase in the size of the urbanised landscape. The high proportion of built-up areas affects the overall microclimate of the area and causes surface overheating, higher air temperatures, increased evaporation, rapid runoff of rainwater, dustiness, air pollution, etc.

The predicted climate change will have a significant impact on the local climate of Czech cities, especially in the context of the empirically documented regularity that cities form an urban heat island (UHI). UHI generates increased air temperature compared to rural environments. The main manifestations of climate change that have a particularly significant impact on cities and are sources of risk include:

- The length and frequency of heat waves due to the increasing frequency and magnitude of extreme air temperatures,
- the change in the frequency of flooding, and in particular urban flooding caused when the capacity of drainage systems is exceeded,
- the length of droughts potentially threatening water security.

Heat waves and flooding together represent the main risks of climate change for urbanised areas in the Czech Republic. In some areas, droughts and water scarcity add to these. In addition to heat waves and the urban heat island, flooding is another risk posed by climate change to Czech cities. Extreme events are expected to recur with increasing frequency. This will make cities located on rivers more vulnerable to flooding. Similarly, cities are expected to face more water scarcity and drought in the future.

3.2.7. Biodiversity

In the last decade, environmental science has documented such significant changes in the geographic distribution of organisms due to global climate change that the "changing geography of life" on our planet is being discussed. The redistribution of biodiversity at the scale of the global ecosystem (biosphere) induced by climate change (so-called range shifts of species) affects human well-being both directly (e.g., through changes in food security and the spread of new pathogens) and indirectly (e.g., through ecosystem degradation). Documented global changes in the Earth's vegetation cover indicate unprecedented changes in the distribution of planetary biomes, completely unmatched by any other global ecosystem changes since the end of the last ice age. Climate-driven redistribution of biodiversity can lead to the establishment of new communities and consequently to rapid changes in ecosystem services. In the context of climate change, 'carbon sinks' are probably the most important of the ecosystem services.

In the Czech Republic, ecological research on the ability of ecosystems to fix atmospheric carbon has been carried out since 2005 in four types of ecosystems: mountain spruce forest, mountain meadow ecosystem, maize agroecosystem and wet meadow ecosystem. Fixing atmospheric carbon in vegetation and increasing the carbon content of soil organic matter is one of the potentially important ways to reduce the amount of greenhouse gases escaping into the atmosphere. Designing appropriate ecosystem management in terms of carbon cycle management (with the aim of carbon sequestration) requires detailed knowledge of the dynamics of carbon fluxes and quantification of carbon stocks at global, regional and local scales.

From these existing, but still preliminary, data on the importance of terrestrial ecosystems in the Czech Republic for carbon storage, several general key conclusions for the management of ecosystems in the landscape in the context of biodiversity conservation emerge:

- To promote carbon sink in forest ecosystems of the Czech Republic, striving to achieve the target tree species composition of management forests is a suitable strategy. From the point of view of the legitimate interests of forest owners, the target species composition of forests seems to be a suitable compromise between the current and natural state, which is not realistically achievable. From the point of view of maintaining and restoring forest biodiversity, the target tree species composition in currently managed forests represents a significantly positive goal.
- For carbon sink in managed agroecosystems in agricultural landscapes, it is essential to maintain and, if possible, improve the amount of soil organic matter, which is only possible through agrotechnical measures that take into account the principles of good agricultural practice aimed at sustainable management of agricultural landscapes.

As already indicated in the previous chapters of this study, dealing with detailed forest, agriculture and water management issues, most of the observed or predicted impacts of climate change on landscapes do not act in isolation and their synergic effects cannot be assessed only in a "sectoral" manner. Large-scale clearings, resulting in some regions of the Czech Republic from widespread spruce mortality due to drought and because of bark beetle calamity, are the cause of ongoing biodiversity changes at local and regional scales.

The predicted trends of changes in climate conditions of vegetation stages will be reflected in Czechia by a significant gradual improvement of conditions for xerothermophilic Pontic-Pannon biota, which will in turn result in an increase in the area with climatic conditions of the 1st vegetation level. This may result in a dramatic deterioration of growing conditions for some forest tree species. For example, the currently prevalent cultivation of spruce monocultures at lower altitudes will likely not be possible. Conversely, the extent of the area with conditions for upland boreal species, which are linked to a cooler and wetter climate, will be reduced, as the extent of the area with conditions of the 6th to 8th vegetation level will radically decrease (in the 2050 prediction horizon) and gradually even disappear altogether (2070 prediction horizon).

Due to the expected effects of climate change, a shift of ranges with an increased risk of extinction of species of conservation or economic importance can be predicted with high probability. Sometimes, however, range shifts may in turn increase the value of ecosystem services. Some biodiversity changes may affect ecosystem services directly. For example, the expansion of species' distributions into new areas may lead to increased economic damage associated with insects, or conversely, species essential for the provision of key services such as pollination in agriculture may disappear. The occurrence of extreme weather events can lead to an increased frequency of forest fires, with impacts on forest ecosystem services such as carbon sinks.

3.2.8. Health and hygiene

Because of climate change, the Czech population may be more exposed to some hazardous hydrometeorological phenomena and their impacts on their lives and health. Summer mortality is likely to increase due to the occurrence of heat waves. The elderly and socially excluded population, including young children, are likely to be most at risk. Preventive measures will need to specifically address the population from socially excluded areas. Increased mortality during heat waves will particularly affect populations outside hospitals or other facilities (vulnerable populations without social supervision), and outreach health and social services will need to be strengthened. A positive effect of climate change is the reduction in cold-related mortality. There will be an increase in hospital admissions and deterioration in the health of populations with chronic diseases of all age groups due to heat waves.

Conditions for the proliferation of pathogens in natural waters and food will be created. There will be a need for stricter sanitary surveillance, including testing for contamination of raw materials and products by food and drinking water producers. There is the possibility of increased diarrhoeal disease associated with temperature-insecure diets. Prevention means focusing attention on the appropriate technical design of water and sewage systems, on early identification of the causative agent, and on prompt solutions. The risk of transmission of digestive diseases may also be related to the quality of water in wells. After large-scale flooding, conditions will be suitable for the spread of tropical mosquitoes, ticks and other insects that transmit infections in the domestic environment. The situation should be under control, including monitoring for insects. In 2018, the emergence of tropical disease due to domestic infections has been recorded in Czechia. One person died from West Nile fever, which is transmitted by "domestic" mosquito Culex pipiens. Attention must also be paid to migratory birds carrying out long-distance transmission of parasites.

Drought is putting drinking water sources at risk. Water conservation and unnecessary use of drinking water must be addressed. In some areas, groundwater sources are already drying up and the situation is being addressed with new or replacement storage in the locality. There are contributing conditions, such as strip mining, soil compaction and other practices that devastate the soil so that rainfall is not absorbed and drinking water sources are not recharged. Groundwater quality is mostly unsatisfactory due to pesticide content. The National Institute of Health has estimated the health risk from drinking water with atrazine as low, but unless new water treatment is implemented, the uptake of pesticides through drinking water may persist.

All populations are vulnerable to the health impacts of climate change – but some groups are more so. Stronger impacts will be found for young children, the elderly and those dependent on social or health care or chronically sick. Where people live is a very important characteristic. People living in mountain areas and cities are vulnerable to climate change for different reasons. Climate change is a long-term process and we can assume that there has already been adaptation due to natural resilience (resilience) due to the impact of information availability, access to care and social contacts. The impact on health is related to:

- heat waves, frost days, weather changes,
- forest fires and associated air pollution,
- floods,
- landslides and rockfall,
- shortage of drinking water,
- contamination of drinking water with chemicals (pesticides, chlorination products from eutrophication),
- loss of productivity, loss of employment in poor areas (very highly reliable),
- food and drinking waterborne diseases (highly reliable) related to poor food and water hygiene,
- deterioration in the quality of surface water used for bathing,
- air pollution and related diseases, (pollen, mineral component, pesticides, traffic, ozone and ultrafine particles.

The entire population of the Czech Republic is vulnerable to climate change. In particular, changes in temperature, both in annual averages and in extreme temperatures in summer, represent a widespread factor with significant impacts. The size of the population and the size of vulnerable groups play a role. More generally, climate change affects major social and environmental determinants of health, such as the availability and quality of drinking water, ecosystems, agriculture and food production, economic development and migration.

Climate change affects the basic conditions that humans, like any other animal, need to live – safety, a microclimate adequate for their thermoregulation, the quality and sufficiency of drinking water, the quality and sufficiency of food, the presence of biological determinants of their health, and air pollution in the form of aerosol particles and secondary ozone. In general, the elderly or sick people are most at risk. Geographically, the most affected population in our conditions are mainly inhabitants of large cities, i.e. the majority of the population of the Czech Republic. This is due to the construction of cities and the high concentration of solid surfaces, which cause the so-called heat island of the city, which amplifies the effects of high temperatures even more. In general, the larger the size of the city, the higher the heat island of the city. Living in blocks of flats increases the risk. In addition, the more vulnerable and socially excluded sections of the population are often found in inner cities. In some cities, there are even more such population groups. However, the impact of high temperatures on mortality and hospitalisation can be expected throughout the Czech Republic.

The following groups are particularly vulnerable to climate change:

- people with undeveloped or altered thermoregulation (seniors, children),
- chronically ill people (circulatory and heart diseases, respiratory diseases, musculoskeletal diseases, endocrine diseases, mental and nervous diseases, disabled people),
- people living in socially excluded areas, single people,
- immigrants who do not know the Czech environment, realities and language,
- certain professions, carried out in an outdoor environment, carried out in an indoor environment without air conditioning,
- people living in an area where medical care is not available.

The economic analysis of climate change impacts on health and sanitation focuses on the assessment of health effects. In order to determine the total value of these impacts, it is important to consider primarily health care costs, opportunity costs and negative benefit costs. Climate change can have both negative and positive effects on human health. For example, milder or warmer winters may contribute to a decrease in deaths related to cold temperatures. In addition, a reduction in the number of illnesses caused by classical air pollutants due to their lower concentrations in the air caused by lower consumption of fossil fuels for heating. In contrast, the increased frequency and intensity of summer tropical days and heat waves can result in increased morbidity. Those most susceptible to heat extremes are young children, the sick and the elderly, who currently make up a large proportion of the Czech population.

3.2.9. Tourism

Climate change is affecting the conditions for tourism, both natural and socio-economic. Socio-economic conditions are affected indirectly by climate change, through its impact on other economic areas and the overall economic stability of the region or country. This may mean a reduction in tourism potential due to the deterioration of basic facilities (accommodation), accompanying and transport infrastructure, and the deterioration of complementary tourism services. The type of tourism most closely linked to climate change is 'sport and outdoor' tourism, which is closely linked to natural conditions. The Czech winter sports season is the most affected by direct impacts on natural conditions. As the number of ice and frost days decreases, the amount of snowfall decreases and the period with snow cover shortens, natural conditions for snow-related winter sports such as downhill skiing, cross-country skiing, ski mountaineering, snowboarding, etc. deteriorate. Furthermore, tourism linked to natural attractions whose existence may be threatened by climate change, is under threat.

Cultural heritage is a specific area where climate change may have negative impacts. The significance of the potential losses increases the irreplaceability of cultural heritage once lost. This can occur particularly through the effects of extreme events, but also through the long-term negative effects of climate conditions on objects and the potential acceleration of their degradation. Tourism itself also has an impact on greenhouse gas emissions through transport, accommodation and leisure activities. It is estimated that tourism accounts for 4.9% of global greenhouse gas emissions.

Climate change is expected to have an ambivalent effect on tourism in Czechia. On the one hand, rising average temperatures will extend the summer tourist season and thus (after appropriate investments in infrastructure) increase the income of the sector. On the other hand, it will shorten the winter tourist season and have a negative impact on winter tourism in mountain areas. The average snow cover is expected to decrease and the cost of artificial snow is expected to increase proportionally. It is likely that some traditional winter tourism areas will be impacted by a lack of natural snow and a decrease in the number of snow days, resulting in increased pressure on higher altitude resorts, which will also be at a relative advantage compared to lower altitude resorts.

3.3. Approaches, methodologies and tools, and associated uncertainties and challenges

Czech authorities use RCP scenarios (Representative Concentration Pathways) for which the probability of their occurrence is not implicit. For most analyses, until about mid-century, the difference between RCP scenarios in the magnitude of expected impacts is not substantial, and significant and noticeable differences in estimated indicator values can only be reliably indicated for the second half of the century (see http://www.klimatickazmena.cz). Of the selected RCP scenarios, RCP2.6 is the closest relative representation of climate development under the Paris Agreement. However, its achievement is linked to a relatively major emissions reversal already by 2030, and real data do not yet indicate such a turn-around. On the other hand, in the short term, the development of emissions according to RCP8.5 cannot be ruled out and its inclusion was also driven by the ambition to show the benefit of mitigation measures also for impacts in the Czech Republic. However, as mitigation efforts continue, we believe that it is most realistic to expect the development of emissions according to the RCP4.5 scenario.

For the observed present-day climate change, the 1961-1990 normal is used for reference as the climate was relatively stable during this period (the variables do not show significant upward or downward trends). However, this period is less suitable for assessing the state of the future climate, and it therefore seems more appropriate to make a comparison with the values measured over the most recent period of record, i.e. 1991-2020. The analysis of future climate is based on two data sources. Regional climate models have been used for most of the conclusions. For selected outputs, global climate models (GCMs) were also used to better indicate the possible dispersion of future developments.

The most recent regional climate models (RCMs) currently based on the CORDEX initiative (part of the WCRP, http://www.wcrp-climate.org/) are used to investigate future climate. The CORDEX project (http://wcrp-cordex.ipsl.jussieu.fr/) is currently the most important research in the field of regional modelling; the European part of the project is called EURO-CORDEX (www.euro-cordex.net). The results of the EURO-CORDEX regional modelling are used as inputs for the study of climate change and its impacts, including adaptation measures in both the IPCC Fifth and Sixth Assessment Reports. EURO-CORDEX uses new RCP emission scenarios and is based on simulations of global climate models CMIP5 up to 2100. GCM models were used for some of the outputs in this report. These GCM data were used as outputs for the six meteorological characteristics required for the CzechAdapt analyses (i.e., global radiation, maximum and minimum temperature, precipitation, wind speed, and relative humidity).

Statistically checked meteorological data from the Czech Hydrometeorological Institute (CHMI) were used to compare the outputs of the climate models. Each time series contains measurement errors, time series inhomogeneities and also missing values. In order to limit the influence of these problems on the results of the analysis, the selected time series were subjected to data quality control, their inhomogeneity was tested and any detected breaks in the time series were corrected. Finally, any missing data were filled in using interpolation methods. The processing was carried out in a daily step. The checked and homogenized data were then interpolated into grid layers with a resolution of 500x500 m using a custom interpolation method based on regression kriging. Elevation used as a predictor in the regression was smoothed in the case of rainfall and sunshine, while un-smoothed terrain was used for maximum, minimum air temperature, wind and humidity. Otherwise, for the so-called auxiliary predictors such as terrain roughness, slope and exposure, cooling was used for all the elements.

3.4. Framework for climate change adaptation

3.4.1. Institutional arrangements

The chief institution in charge of climate change adaptation, including the development and regular update of the Strategy on Adaptation to Climate Change in the Czech Republic (“Strategy” or “NAS”) and National Action Plan on Adaptation to Climate Change (“Action Plan” or “NAP”), is the Ministry of the Environment (MoE).

However, the measures included in NAP cover various sectors and policy areas; some of them (e.g., water management, forestry, agriculture) are, given by the existing legal arrangements, the subject of shared responsibility of several ministries. Based on that, the responsibility for their implementation of measures included in NAP is distributed across several ministries, the MoE being the supervisor and coordinator. The MoE is also in charge of monitoring and evaluation, including collecting and synthesizing information from other subjects responsible for the implementation of NAP and reporting to the government.

Concerning the assessment of the impacts of climate change, the Czech Hydrometeorological Institute is the chief institution in charge of assessing climate change impacts and risks and providing the knowledge base for formulating adaptation policy priorities.

Although the measures included in NAS and NAP refer only to the ministries responsible for discussed sectors and policy areas, concerning the update of NAS and NAP, representatives of NGOs and academia are also invited to the process.

Apart from the activities above, the MoE also continuously puts an effort to integrate adaptation concerns into sectoral strategies, e.g. through interservice consultation on the transposition of the EU Directive on the Resilience of Critical Entities.

3.4.2. Legal and policy framework

The adaptation policy framework is defined by NAS and is implemented by the NAP. NAS and NAP covering all relevant sectors and policy areas and including responsibilities for the implementation of particular adaptation measures. These measures include new measures going beyond existing sectoral strategies as well as requests to integrate adaptation concerns into existing sectoral strategies. In Czechia, there is no comprehensive legal framework like, e.g. climate law.

The last update of both NAS and NAP was conducted in 2021 with both documents adopted in September 2021. The update builds upon the number of analytic documents providing a knowledge base, including the evaluation of NAP until 2019, Complex Study on Impacts, Vulnerability, and Sources of Risks Related to Climate Change, updated in 2019, and Vulnerability Assessment of the Czech Republic, assessing the vulnerability to various climate change manifestation based on data from 2017. Updated NAS and NAP include measures from previous documents that were not fully implemented, measures that were reformulated based on the current development, and new measures, responding to new findings and challenges.

As the existing NAP is valid until 2025, the discussion on its update has just been initiated. This includes also the update of the study on impacts, vulnerability, and risks and the update of the related indicators.

4. Support provided and mobilized

4.1. National circumstances and institutional arrangements

Czechia is aware of the urgency and seriousness of climate change as well as the necessity to keep the global average temperature increase well below 2°C above preindustrial levels and shifting towards low greenhouse gas emissions development pathway while fostering climate resilience. In this context, Czechia supports the implementation of climate change mitigation and adaptation measures through its official development assistance (ODA) and remains committed to the goal of the developed countries to jointly mobilize USD 100 billion a year by 2020 and through to 2025.

Czechia has been providing climate-specific support to developing countries since 2010. The Development Cooperation of the Czech Republic (DC) is the main means through which climate finance and technology transfer support have been delivered to developing countries. The DC has two main delivery channels: a) Bilateral Development Cooperation and b) Multilateral Development Cooperation.

The key strategic document is the Development Cooperation Strategy of the Czech Republic 2018–2030[37], which defines territorial and sectoral priorities of foreign development cooperation of the Czech Republic and reflects international commitments and actual challenges. The main framework for development and humanitarian activities between 2015 and 2030 is defined by Agenda 2030 which was adopted in September 2015. Agenda 2030 defines seventeen Sustainable Development Goals (SDGs) and sets the objectives for global development until 2030, interlinking the economic, social and environmental dimensions of development.

Czechia's development activities focus on five thematic priorities: from building stable and democratic institutions, through sustainable management of natural resources, agriculture and rural development to inclusive social development and economic growth. In the implementation of development and humanitarian activities, the Czech Republic uses both project and financial instruments to efficiently achieve the intended results, including the interconnection of its bilateral cooperation with the financial instruments of the EU, the UN and other international organizations and financial institutions.

Czechia faces challenges and limitations especially with regard to the provision of ex-ante information on climate financing. The main reason is that the budget of Czech bilateral development cooperation, including financial resources dedicated to climate action in developing countries, is approved by the Government of the Czech Republic around June of the preceding year with an indicative outlook for two following years while ODA is being identified ex-post.

In terms of public interventions to partner with the private sector, Czech Development Agency B2B programme and Czech-UNDP partnership programme mobilize private finance via simple co-financing. Under the Czech Trust Fund with UNDP Istanbul, a SDG Challenge Fund was established in 2019, which promotes innovative, often climate- and

[37] Development Cooperation Strategy of the Czech Republic 2018-2030, https://mzv.gov.cz/file/2710363/CZ_Development_Cooperation_Strategy_2018_2030.pdf.

environment-related solutions presented by Czech companies, NGOs and universities. The Financial Instruments programme of the National Development Bank (NDB) leverages the vast majority of investment from private capital. The International Development Cooperation (IDC) Guarantee programme continues in cooperation with NDB and from 2023 has been extended to the IDC Financial Instruments and implemented under the joint responsibility of the MoFA and the NDB.

For reporting purposes, the climate-specific funding has been identified in accordance with the OECD-DAC methodology. As a Member State of the EU, the Czech Republic is annually reporting its bilateral and multilateral climate-specific finance provided in accordance with the respective EU regulation[38].

Only projects with adaptation or mitigation RIO Markers (significant or principal objective) are accounted towards the climate specific funding. Coefficients for quantifying the climate relevant part of projects with significant objective are not being applied. Other financial support provided to developing countries, which is also accountable for ODA, but where the climate related component could not be identified, is being reported as the core/general funding.

The core objective of the Czech Republic's development cooperation and humanitarian assistance is to contribute – using its capacities and experience and in line with international commitments – to building a stable, secure, inclusive, prosperous and sustainable world and to strengthen its position within it. Very important parts of the development cooperation and also of the Sustainable Development Goals embody the technology transfer and capacity building.

4.2. Underlying assumptions, definitions and methodologies

Bilateral Development Cooperation (BDC)

The Ministry of Foreign Affairs is the main administrator of activities related to BDC and is responsible for the provision of development cooperation including the identification of suitable projects, their wording, the advertising of competitions (in the form of public contracts and grants), the signing of contracts and monitoring of projects.

In the choice of partner countries, the Czech Republic focuses, according to the Development Cooperation Strategy of the Czech Republic 2018–2030, in a balanced way on cooperation with low-income countries (LDCs, Least Developed Countries) as well as with middle-income countries (MICs) in terms of OECD classification. A new list of priority partner countries of the Czech Republic has been approved for the period from 2018 onwards (Government Resolution No. 631 of 11 July 2016). Currently, the Czech Republic focuses its bilateral development assistance on six priority countries: Bosnia and Herzegovina, Moldova, Georgia, Cambodia, Ethiopia and Zambia. The list of specific countries may be amended and supplemented by government resolutions to reflect, inter alia, the Government's interest to developing partnerships or targeted support of selected countries in

[38] Article 19 of the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action and Article 6 of the Commission Implementing Regulation (EU) 2020/1208 of 7 August 2020 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 of the European Parliament and of the Council.

the context of a post-conflict stabilization and reconstruction processes. With each priority country, we have agreed on a framework document, the cooperation programme for the 2018-2023 period.

In general, The Czech International Development Cooperation is focusing on these thematic priorities: good democratic governance, sustainable management of natural resources (especially water), economic growth including energy, agriculture and rural development, and inclusive social development. In the implementation of all development, transformation and humanitarian activities, gender equality and climate protection are cross-cutting principles. The sectoral focus was designed in consultation with each priority country in the respective programme document (usually 1-3 sectors, e.g. agriculture, water and sanitation, energy etc., including sub-sectors) – five-digit purpose codes introduced by the OECD DAC have been used.

All of the public climate finance Czechia is providing to the developing countries constitutes ODA. The budget of CZ bilateral ODA, including financial resources explicitly dedicated to climate change in developing countries, is being approved by the Government on a yearly basis, specifically around June of the preceding year with an indicative outlook for two following years. Only projects with adaptation or mitigation RIO Markers (significant or principal objective) have been accounted towards the climate specific funding in 2021 and 2022 and they include projects supporting capacity building and/or technology development.

Multilateral Development Cooperation (MDC)

Multilateral finance reporting is based on the Party’s inflow contribution to multilateral institutions. Climate-specific multilateral finance was reported based on the multilateral imputed shares as provided by the OECD.

In 2021 and 2022 the Czech Republic was involved in a number of multilateral activities overseen by a number of international organizations, which aim to achieve global development objectives and other international commitments.

The Czech Republic participates in and contributes to funding of development activities of the UN, EU, OECD, international financial institutions and other organizations. The Czech Republic considers only those organizations whose activities are in line with OECD-DAC definition of development cooperation and contributions provided are fully or partially creditable towards official development assistance (ODA). Organizations are divided into four groups: 1) EU, 2) development banks and financial institutions, 3) programs and funds of the UN, and 4) other organizations. The Czech Republic has been a member of the Development Assistance Committee OECD (DAC) since 14 May 2013.

Czechia’s climate finance contributions are part of the EU's collective reporting. The European Union, as a Party to the UNFCCC, coordinates climate finance among its member states to ensure that contributions are accurately tracked and reported. Within this EU-wide system, there are mechanisms in place to prevent double counting of financial contributions. This includes the use of clear reporting channels and methodologies to distinguish between bilateral contributions by individual member states and joint contributions made on behalf of the EU.

Czechia does not use any specific definition of public and private finance. No private finance has been mobilized and reported through public interventions in Czechia between 2021-2022.

Czech Development Cooperation is based on a principle of ownership and partnership. This means that the vast majority of projects are demand-driven and reflect the needs of recipient countries, which are set in the respective cooperation programmes, based on the consultation with each priority country in the respective programme document.

The climate-related projects supported by Czechia are concentrated in several sectors in the priority countries, which are both in accordance with the requirements of the respective countries and in the sectors in which the Czech Republic offers expert experience and personal capacities. These are mainly the following developing countries and sectors focused on climate change issues: Sustainable management of natural resources with an emphasis on energy that is primarily obtained from renewable sources (Bosnia and Herzegovina, Ethiopia, Moldova, Cambodia); Agriculture and Rural Development with an emphasis on climate change mitigation (Bosnia and Herzegovina, Ethiopia, Moldova, Georgia, Zambia).

In Czech ODA, being always identified ex-post, no definition of the "new and additional" resources is applicable.

Czechia's reporting on technology development, transfer, and capacity-building support is based on internationally agreed definitions and methodologies, in line with the UNFCCC and OECD standards. We assume that technology transfer encompasses both hard and soft technologies that support mitigation and adaptation efforts, such as renewable energy systems, climate-smart agricultural practices and enhancing resilience to climate change. Capacity-building is defined as activities aimed at enhancing the abilities of individuals and institutions to address climate change effectively, including training, technical assistance, and institutional strengthening. The data is collected at the project level and aligned with the respective international reporting frameworks to ensure transparency.

4.3. Information on financial support provided and mobilized under Article 9 of the Paris Agreement

Through Bilateral Development Cooperation climate-specific finance in total of 13 359 721 USD (297 724 517 CZK) has been disbursed by Czechia in 2021 and 2022 in following countries: Albania, Bosnia and Herzegovina, Philippines, Ethiopia, Niger, Haiti, Moldova, Armenia, Ukraine, Georgia, Cambodia, Zambia, Brazil, Nepal, Mali, Sudan. Projects implemented in these countries focused on increasing energy efficiency, incl. introducing new technologies and renewable energy sources; promoting innovative education and research development; strengthening climate resilience; recovering from floods and responding to droughts; promoting sustainable agriculture and forestry; disaster risk reduction and adaptation to climate change.

Regarding the technology development and transfer and capacity building projects, in 2021 and 2022, the Czech Republic has implemented several bilateral projects within its ODA that contributed to the technology development and transfer to developing countries and a large number of these projects includes some capacity building elements.

In 2021 and 2022, climate specific Multilateral Development Cooperation accounted in total for 9 172 172 USD (205 773 164 CZK). During these years, Czechia continued the cooperation with the United Nations (UN), especially with the UN's Development Programme (UNDP) where the Czech Republic began its three-year long membership in the UNDP Executive Board in 2020. Czechia also continued to provide its obligatory contributions to the United Nations Framework Convention on Climate Change (UNFCCC) and contributed to the International Bank for Reconstruction and Development, the International Development Association. Furthermore, Czechia also provided contributions to the Council of Europe Development Bank and in 2022 there was a contribution made to the Global Environment Facility.

In 2021 and 2022, the climate specific funding of MDC has been channelled to the Global Environmental Facility, the International Development Association, the International Bank for Reconstruction and Development, the Council of Europe Development Bank and the UNFCCC. In October 2022 the Czech Government decided to annually contribute 1 mil. USD to the Green Climate Fund in the years 2024 to 2027.

All climate specific finance provided to MDC have been provided in grants, except for contributions to IBRD and IDA in 2021 and 2022 and contribution to International Finance Corporation in 2021 which have been provided as capital subscription on deposit basis.

Over the 2021-2022 period, Czechia continued to provide its financial and technical support under the Paris Agreement, in accordance with the respective EU regulation. Czechia is continually working on increasing both the scale and scope of contributions. For example, in 2022 Czechia has committed to contribute annually USD 1 million to the Green Climate Fund (GCF) over the 2024-2027 period. The first payment to the GCF was made in July 2023. Czechia has been also working on enhancing its tracking and reporting systems, providing more transparent and detailed data on public finance. This increased effort reflects Czechia's ongoing commitment to keep providing climate finance, in line with the Paris Agreement's goals, and thus to continue contributing to the global effort of achieving a 1.5°C pathway.

Detailed overview of climate specific bilateral projects supported by the Czech Republic is included in CTF Table III.1 and overview of climate specific multilateral support is included in CTF Table III.2 which are submitted in a separate file.

5. Improvements in reporting over time

This is the first Biennial Transparency Report and no technical expert review has yet taken place. However, in preparation of this report we have tried to incorporate the lessons learned and relevant recommendations coming from the other reporting processes such as the Biennial Reports and National Communications. The Czech Republic will strive to improve its Biennial Transparency Report continuously. Improvements in reporting of greenhouse gas emission inventories are described in the National Inventory Document, Chapter 10.

Annexes

Annex 1: Common tabular formats on information necessary to track progress

Description of a Party’s nationally determined contribution under Article 4 of the Paris Agreement, including updates[a]

	Description
Target(s) and description, including target type(s), as applicable[b, c]	**Economy-wide net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990.** **The term ’domestic’ means without the use of international credits.** **Target type: Economy-wide absolute emission reduction.**
Target year(s) or period(s), and whether they are single-year or multi-year target(s), as applicable	**Single year target, 2030.**
Reference point(s), level(s), baseline(s), base year(s) or starting point(s), and their respective value(s), as applicable	**Base year: 1990.** **Net greenhouse gas emissions level in 1990:** **4 700 168 kt CO_2eq.**
Time frame(s) and/or periods for implementation, as applicable	**2021-2030**
Scope and coverage, including, as relevant, sectors, categories, activities, sources and sinks, pools and gases, as applicable	**Geographical scope: EU Member States (Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden) including EU outermost regions (Guadeloupe, French Guiana, Martinique, Mayotte, Reunion, Saint Martin (France), Canary Islands (Spain), Azores and Madeira (Portugal)).** **Sectors covered, as contained in Annex I to decision 5/CMA.3:** **Energy** **Industrial processes and product use** **Agriculture** **Land Use, Land Use Change and Forestry (LULUCF)** **Waste** **International Aviation: Emissions from civil aviation activities as set out for 2030 in Annex I to the EU ETS Directive are included only in respect of CO_2 emissions from flights subject to effective carbon pricing through the EU ETS. With respect to the geographical scope of the NDC these comprise emissions in 2024-26 from flights between the EU Member States and departing flights to Norway, Iceland, Switzerland and United Kingdom.**

	International Navigation: Waterborne navigation is included in respect of CO2, methane (CH_4) and nitrous Oxide (N_2O) emissions from maritime transport voyages between the EU Member States. **Gases:** **Carbon Dioxide (CO_2)** **Methane (CH_4)** **Nitrous Oxide (N_2O)** **Hydrofluorocarbons (HFCs)** **Perfluorocarbons (PFCs)** **Sulphur hexafluoride (SF_6)** **Nitrogen trifluoride (NF_3)** **The included LULUCF categories and pools are as defined in decision 5/CMA.3.**
Intention to use cooperative approaches that involve the use of ITMOs under Article 6 towards NDCs under Article 4 of the Paris Agreement, as applicable	**The EU's at least 55% net reduction target by 2030 is to be achieved through domestic measures only, without contribution from international credits.** **The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**
Any updates or clarifications of previously reported information, as applicable[d]	**The information on the NDC scope contains clarifications/further details compared to the information provided in the updated NDC of the EU.**

Note: This table is to be used by Parties on a voluntary basis.

[a] Each Party shall provide a description of its NDC under Article 4, against which progress will be tracked. The information provided shall include required information, as applicable, including any updates to information previously provided (para. 64 of the MPGs).

[b] For example: economy-wide absolute emission reduction, emission intensity reduction, emission reduction below a projected baseline, mitigation co-benefits of adaptation actions or economic diversification plans, policies and measures, and other (para. 64(a) of the MPGs).

[c] Parties with both unconditional and conditional targets in their NDC may add a row to the table to describe conditional targets.

[d] For example: recalculation of previously reported inventory data, or greater detail on methodologies or use of cooperative approaches (para. 64(g) of the MPGs).

1. Structured summary: Description of selected indicators

Indicator(s) selected to track progress[a]	*Description*
{Indicator}	**Annual total net GHG emissions consistent with the scope of the NDC in CO_2eq.**
Information for the reference point(s), level(s), baseline(s), base year(s) or starting point(s), as appropriate[b]	**The reference level is total net GHG emissions of the EU in the base year (1990). The reference level value for the EU is 4 700 168 kt CO_2eq.**
Updates in accordance with any recalculation of the GHG inventory, as appropriate	**This is the first time the reference level is reported, hence there are no updates.** **The value of the reference level may be updated in the future due to methodological improvements to the EU GHG inventory and to the determination of international aviation and navigation emissions in the NDC scope.**
Relation to NDC[c]	**The indicator is defined in the same unit and metric as the target of the NDC. Hence it can be used directly for tracking progress in implementing and achieving the NDC target.**

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs. (3) The Party could add rows for each additional selected indicator and related information.

[a] Each Party shall identify the indicator(s) that it has selected to track progress of its NDC (para. 65 of the MPGs).

[b] Each Party shall provide the information for each selected indicator for the reference point(s), level(s), baseline(s), base year(s) or starting point(s) and shall update the information in accordance with any recalculation of the GHG inventory, as appropriate (para. 67 of the MPGs).

[c] Each Party shall describe for each indicator identified how it is related to its NDC (para. 76(a) of the MPGs).

2. Structured summary: Definitions needed to understand NDC

Definitions[a]	
Definition needed to understand each indicator:	
Annual total net GHG emissions	**Total net GHG emissions correspond to the annual total of emissions and removals reported in CO_2 equivalents in the latest EU GHG inventory. The totals comprise all sectors and gases listed in the table entitled 'Reporting format for the description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates'**
Any sector or category defined differently than in the national inventory report:	
{Sector} **Not applicable**	
{Category} **Not applicable**	
Definition needed to understand mitigation co- benefits of adaptation actions and/or economic diversification plans:	
{Mitigation co-benefit(s)} **Not applicable**	
Any other relevant definitions:	
Not applicable	

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs. (3) The Party could add rows for each additional sector, category, mitigation co-benefits of adaptation actions and/or economic diversification plans, indicator and any other relevant definitions.

[a] Each Party shall provide any definitions needed to understand its NDC under Article 4, including those related to each indicator identified in para. 65 of the MPGs, those related to any sectors or categories defined differently than in the national inventory report, or the mitigation co-benefits of adaptation actions and/or economic diversification plans (para. 73 of the MPGs).

3. Structured summary: Methodologies and accounting approaches – consistency with Article 4, paragraphs 13 and 14, of the Paris Agreement and with decision 4/CMA.1

Reporting requirement	*Description or reference to the relevant section of the BTR*
For the first NDC under Article 4:[a]	
Accounting approach, including how it is consistent with Article 4, paragraphs 13–14, of the Paris Agreement (para. 71 of the MPGs)	**Net GHG emissions, calculated from emissions and removals from the GHG inventory of the EU and supplemented with data on international aviation and navigation collected in the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES), are used to quantify progress towards implementing and achieving of the NDC in respect of the NDC target. This approach promotes environmental integrity, transparency, accuracy, completeness, comparability and consistency and ensures the avoidance of double counting, as described below. Existing methods and guidance under the Convention are taken into account, as described below.**
For the second and subsequent NDC under Article 4, and optionally for the first NDC under Article 4:[b]	
Information on the accounting approach used is consistent with paragraphs 13–17 and annex II of decision 4/CMA.1 (para. 72 of the MPGs)	**The European Union accounts for anthropogenic emissions and removals corresponding to its NDC consistent with paragraphs 13–17 and annex II of decision 4/CMA.1, as detailed below.**
Explain how the accounting for anthropogenic emissions and removals is in accordance with methodologies and common metrics assessed by the IPCC and in accordance with decision 18/CMA.1 (para. 1(a) of annex II to decision 4/CMA.1)	**The accounting for anthropogenic emissions and removals is based on the data contained in the EU GHG inventory, which is compiled in accordance with the 2006 IPCC Guidelines. The accounting for emissions from international aviation and navigation in the scope of the NDC is based on activity data, emission factors and methods which are in line with the IPCC guidelines. The accounting approach is also in accordance with decision 18/CMA.1 because the EU GHG inventory conforms with the provisions of chapter II of the Annex to decision 18/CMA.1.**
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7(a), of the Paris Agreement, if applicable (para. 2(b)	**The GHG data used for accounting is based on the GHG inventory of the EU. The methodology used for accounting consists of a balancing of GHG emissions and removals, which is consistent with the**

of annex II to decision 4/CMA.1)	**methodologies used in the GHG inventory of the EU.**
Explain how overestimation or underestimation has been avoided for any projected emissions and removals used for accounting (para. 2(c) of annex II to decision 4/CMA.1)	**Not applicable. Projected emissions and removals are not used for accounting.**
For each NDC under Article 4:[b]	
Accounting for anthropogenic emissions and removals in accordance with methodologies and common metrics assessed by the IPCC and adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement:	
Each methodology and/or accounting approach used to assess the implementation and achievement of the target(s), as applicable (para. 74(a) of the MPGs)	**The methodology used to assess the implementation and achievement consists of a comparison of the reduction of net GHG emissions from the GHG inventory national total, including a share of GHG inventory international aviation and navigation emissions in line with the NDC scope, with the NDC target.** **The EU will account for its cooperation with other Parties in a manner consistent with guidance adopted by the CMA.**
Each methodology and/or accounting approach used for the construction of any baseline, to the extent possible (para. 74(b) of the MPGs)	**Progress is tracked by comparing annual net emissions with net emissions in the base year. No baseline is constructed.**
If the methodology or accounting approach used for the indicator(s) in table 1 differ from those used to assess the implementation and achievement the target, describe each methodology or accounting approach used to generate the information generated for each indicator in table 4 (para. 74(c) of the MPGs)	**Not applicable. The methodology/accounting approach used for the indicator in table 1 is the same as the methodology/accounting approach used to assess the implementation and achievement the target.**
Any conditions and assumptions relevant to the achievement of the NDC under Article 4, as applicable and available (para. 75(i) of the MPGs)	**Not applicable. The NDC is unconditional.**
Key parameters, assumptions, definitions, data sources and models used, as applicable and available (para. 75(a) of the MPGs)	**Net GHG emissions are the key parameter used for tracking progress in implementing and achieving the NDC. The GHG inventory of the EU is the data source used. Details on assumptions, definitions and models used for determining net GHG emissions can be found in the National Inventory Document of the EU.**
IPCC Guidelines used, as applicable and available (para. 75(b) of the MPGs)	**2006 IPCC Guidelines; and 2019 refinement to the 2006 IPCC Guidelines for some source categories.**

Report the metrics used, as applicable and available (para. 75(c) of the MPGs)	**100-year time-horizon global warming potential (GWP) values from the IPCC Fifth Assessment Report.**
For Parties whose NDC cannot be accounted for using methodologies covered by IPCC guidelines, provide information on their own methodology used, including for NDCs, pursuant to Article 4, paragraph 6, of the Paris Agreement, if applicable (para. 1(b) of annex II to decision 4/CMA.1)	**Not applicable.**
Provide information on methodologies used to track progress arising from the implementation of policies and measures, as appropriate (para. 1(d) of annex II to decision 4/CMA.1)	**Progress arising from the implementation of policies and measures is expressed in a reduction of GHG emissions or increase of GHG removals. The methodology used to assess such progress is based on the estimation of GHG emissions and removals in the GHG inventory of the EU and on data on international aviation and navigation monitored in the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES).**
Where applicable to its NDC, any sector-, category- or activity-specific assumptions, methodologies and approaches consistent with IPCC guidance, taking into account any relevant decision under the Convention, as applicable (para. 75(d) of the MPGs)	**Sector-, category- and activity-specific assumptions, methodologies and approaches applicable to the NDC are described in the national inventory document of the EU and are consistent with IPCC guidance.** **Emissions from international aviation and navigation in the scope of the NDC are determined based on activity data from the JRC-IDEES, using emission factors and methodologies consistent with IPCC guidance.**
For Parties that address emissions and subsequent removals from natural disturbances on managed lands, provide detailed information on the approach used and how it is consistent with relevant IPCC guidance, as appropriate, or indicate the relevant section of the national GHG inventory report containing that information (para. 1(e) of annex II to decision 4/CMA.1, para. 75(d)(i) of the MPGs)	**The EU does not disaggregate emissions and removals on managed land into those considered to result from human activities and those considered to result from natural disturbances.**
For Parties that account for emissions and removals from harvested wood products, provide detailed information on which IPCC approach has been used to estimate emissions and removals (para. 1(f) of annex II to decision 4/CMA.1, para. 75(d)(ii) of the MPGs)	**The EU accounts for emissions and removals from harvested wood products as an integral part of net GHG emissions and removals in the scope of the NDC. GHG emissions and removals from harvested wood products are determined in accordance with the production approach, as defined in Annex 12.A.1 to**

	Volume 4 of the 2006 IPCC Guidelines for National GHG Inventories.
For Parties that address the effects of age-class structure in forests, provide detailed information on the approach used and how this is consistent with relevant IPCC guidance, as appropriate (para. 1(g) of annex II to decision 4/CMA.1, para. 75(d)(iii) of the MPGs)	**The EU does not address the effects of age-class structure in forests in the accounting approach for its NDC.**
How the Party has drawn on existing methods and guidance established under the Convention and its related legal instruments, as appropriate, if applicable (para. 1(c) of annex II to decision 4/CMA.1)	**The EU has drawn on existing methods and guidance established under the Convention by using an NDC target which is an advancement of the quantified economy-wide emission reduction target for 2020, which was communicated and tracked under the Convention.**
Any methodologies used to account for mitigation co- benefits of adaptation actions and/or economic diversification plans (para. 75(e) of the MPGs)	**The NDC does not consist of mitigation co-benefits of adaptation actions and/or economic diversification plans. Hence these co-benefits were not accounted for, and no related methodologies were used.**
Describe how double counting of net GHG emission reductions has been avoided, including in accordance with guidance developed related to Article 6 if relevant (para. 76(d) of the MPGs)	**GHG emissions and removals from the EU's GHG inventory, complemented with JRC-IDEES data for determining the share of emissions form international aviation and navigation in the NDC scope, are used for tracking the net GHG emission reductions. Emissions and removals are reported in line with IPCC guidelines, with the aim of neither over- nor underestimating GHG emissions.** **GHG emissions and removals are reported by the EU and its Member States in their respective GHG inventories. For tracking progress towards implementing and achieving the EU NDC, only those net GHG emission reductions are counted which are reported at EU level.** **For cooperative approaches under Article 6, corresponding adjustments are made in a manner consistent with guidance adopted by the CMA.**
Any other methodologies related to the NDC under Article 4 (para. 75(h) of the MPGs)	**Not applicable.**
Ensuring methodological consistency, including on baselines, between the communication and implementation of NDCs (para. 12(b) of the decision 4/CMA.1):	
Explain how consistency has been maintained in scope and coverage, definitions, data sources, metrics, assumptions and methodological	**The scope, coverage, definitions, data sources, metrics and approaches are consistent between the communicated**

approaches including on baselines, between the communication and implementation of NDCs (para. 2(a) of annex II to decision 4/CMA.1)	**NDC and its implementation, as described in the BTR.**
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7(a), of the Paris Agreement, if applicable (para. 2(b) of annex II to decision 4/CMA.1) and explain methodological inconsistencies with the Party's most recent national inventory report, if applicable (para. 76(c) of the MPGs)	**The GHG inventory of the EU is the primary source for the GHG data used for accounting. The share of GHG inventory emissions from international aviation and navigation in the scope of the NDC have been determined separately based on JRC-IDEES data, using emission factors and methodologies consistent with IPCC guidance. There are no methodological inconsistencies with the most recent national inventory report.**
For Parties that apply technical changes to update reference points, reference levels or projections, the changes should reflect either of the following (para. 2(d) of annex II to decision 4/CMA.1):	
Technical changes related to technical corrections to the Party's inventory (para. 2(d)(i) of annex II to decision 4/CMA.1)	**No technical changes related to technical corrections to the GHG inventory were applied to update reference points, reference levels or projections.**
Technical changes related to improvements in accuracy that maintain methodological consistency (para. 2(d)(ii) of annex II to decision 4/CMA.1)	**No technical changes related to improvements in accuracy were applied to update reference points, reference levels or projections.**
Explain how any methodological changes and technical updates made during the implementation of their NDC were transparently reported (para. 2(e) of annex II to decision 4/CMA.1)	**Methodological changes and technical updates are reported in the chapter entitled 'recalculations and improvements' of the National Inventory Document of the EU.** **GHG emissions from international aviation and navigation in the scope of the EU NDC are reported for the first time in this BTR (see Annex 3 to the BTR).**
Striving to include all categories of anthropogenic emissions or removals in the NDC and, once a source, sink or activity is included, continuing to include it (para. 3 of annex II to decision 4/CMA.1):	
Explain how all categories of anthropogenic emissions and removals corresponding to their NDC were accounted for (para. 3(a) of annex II to decision 4/CMA.1)	**The indicator used for tracking progress towards implementing and achieving the NDC target comprises all categories of anthropogenic emissions and removals corresponding to the NDC.**

Explain how Party is striving to include all categories of anthropogenic emissions and removals in its NDC, and, once a source, sink or activity is included, continue to include it (para. 3(b) of annex II to decision 4/CMA.1)	**The scope of the NDC of the EU covers all categories of emissions and removals reported in the GHG inventory, in line with IPCC guidelines. Member States report some specific source categories as 'not estimated' when the estimates would be insignificant as defined in paragraph 32 of the annex to decision 18/CMA.1. Information on these categories is provided in Common Reporting Table 9 of the respective Member States' GHG inventory submission.** **Besides including all sectors listed in decision 18/CMA.1, a share of emissions from international aviation and navigation are also included in the NDC scope.**
Provide an explanation of why any categories of anthropogenic emissions or removals are excluded (para. 4 of annex II to decision 4/CMA.1)	**All categories of anthropogenic emissions and removals contained in the national total of the EU GHG inventory are included in the NDC.**
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of its NDC	
Provide information on any methodologies associated with any cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 (para. 75(f) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**
Provide information on how each cooperative approach promotes sustainable development, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**
Provide information on how each cooperative approach ensures environmental integrity consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**
Provide information on how each cooperative approach ensures transparency, including in governance, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**
Provide information on how each cooperative approach applies robust accounting to ensure, inter alia, the avoidance of double counting, consistent with decisions adopted by the CMA on Article 6	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further**

(para. 77(d)(iv) of the MPGs)	**guidance agreed by the CMA.**
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77(d)(iii) of the MPGs)	**The EU will account and report for its cooperation with other Parties in a manner consistent with the guidance adopted by CMA1 and any further guidance agreed by the CMA.**

Notes: (1) Pursuant to para. 79 of the MPGs, each Party shall report the information referred to in paras. 65–78 of the MPGs in a narrative and common tabular format, as applicable. (2) A Party may amend the reporting format (e.g. Excel file) to remove specific rows in this table if the information to be provided in those rows is not applicable to the Party's NDC under Article 4 of the Paris Agreement, in accordance with the MPGs.

[a] For the first NDC under Article 4, each Party shall clearly indicate and report its accounting approach, including how it is consistent with Article 4, paras. 13–14, of the Paris Agreement (para. 71 of the MPGs).

[b] For the second and subsequent NDC under Article 4, each Party shall provide information referred to in chapter III.B and C of the MPGs consistent with decision 4/CMA.1. Each Party shall clearly indicate how its reporting is consistent with decision 4/CMA.1 (para. 72 of the MPGs). Each Party may choose to provide information on accounting of its first NDC consistent with decision 4/CMA.1 (para. 71 of the MPGs).

4. Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement[a]

	Unit, as applicable	Reference point(s), level(s), baseline(s), base year(s) or starting point(s), as appropriate (paras. 67 and 77(a)(i) of the MPGs)	Implementation period of the NDC covering information for previous reporting years, as applicable, and the most recent year, including the end year or end of period (paras. 68 and 77(a)(ii–iii) of the MPGs)		Target level[b]	Target year or period	Progress made towards the NDC, as determined by comparing the most recent information for each selected indicator, including for the end year or end of period, with the reference point(s), level(s), baseline(s), base year(s) or starting point(s) (paras. 69–70 of the MPGs)
			2021	**2022**			
Indicator(s) selected to track progress of the NDC or portion of NDC under Article 4 of the Paris Agreement (paras. 65 and 77(a) of the MPGs):							
Annual total GHG emissions and removals consistent with the scope of the NDC	**kt CO_2eq**	**4 700 168**	**3 276 832**	**3 210 895**	**2 115 076 (55% below base year level)**	**2030**	**The most recent level of the indicator is** 31.7 % **below the base year level.**
Where applicable, total GHG emissions and removals consistent with the coverage of the NDC (para. 77(b) of the MPGs)	**kt CO_2eq**		**3 276 832**	**3 210 895**			
Contribution from the LULUCF sector for each year of the target period or target year, if not included in the inventory time series of total net GHG emissions and removals, as applicable (para. 77(c) of the MPGs)	**NA**		**NA**	**NA**			
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 of the Paris Agreement, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of the NDC, shall provide (para. 77(d) of the MPGs):							

If applicable, an indicative multi-year emissions trajectory, trajectories or budget for its NDC implementation period (para. 7(a)(i), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
If applicable, multi-year emissions trajectory, trajectories or budget for its NDC implementation period that is consistent with the NDC (para. 7(b), annex to decision 2/CMA.3)	**NA**		**NA**	**NA**			
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the emission or sink categories as identified by the host Party pursuant to paragraph 10 of annex to decision 2/CMA.3 (para. 23(a), annex to decision 2/CMA.3) (as part of para. 77 (d)(i) of the MPGs)	**kt CO_2eq**		**3 276 832**	**3 210 895**			
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the portion of its NDC in accordance with paragraph 10, annex to decision 2/CMA.3 (para. 23(b), annex to decision 2/CMA.3)	**kt CO_2eq**		**3 276 832**	**3 210 895**			

If applicable, annual level of the relevant non-GHG indicator that is being used by the Party to track progress towards the implementation and achievement of its NDC and was selected pursuant to paragraph 65, annex to decision 18/CMA.1 (para. 23(i), annex, decision 2/CMA.3)	**NA**		**NA**	**NA**			
Annual quantity of ITMOs first transferred (para. 23(c), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
Annual quantity of mitigation outcomes authorized for use for other international mitigation purposes and entities authorized to use such mitigation outcomes, as appropriate (para. 23(d), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)	**NA**		**NA**	**NA**			
Annual quantity of ITMOs used towards achievement of the NDC (para. 23(e), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
Net annual quantity of ITMOs resulting from paras. 23(c)-(e), annex to decision 2/CMA.3 (para. 23(f), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
If applicable, the cumulative amount of ITMOs, divided by the number of elapsed years in the NDC implementation period (para. 7(a)(ii), annex to decision 2/CMA.3)	**NA**		**NA**	**NA**			

Total quantitative corresponding adjustments used to calculate the emissions balance referred to in para. 23(k)(i), annex to decision 2/CMA.3, in accordance with the Party's method for applying corresponding adjustments consistent with section III.B, annex to decision 2/CMA.3 (Application of corresponding adjustments) (para. 23(g), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
The cumulative information in respect of the annual information in para. 23(f), annex to decision 2/CMA.3, as applicable (para. 23(h), annex to decision 2/CMA.3)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			
For metrics in tonnes of CO2 eq. or non-GHG, an annual emissions balance consistent with chapter III.B (Application of corresponding adjustment), annex, decision 2/CMA.3 (para. 23(k)(i), annex to decision 2/CMA.3) (as part of para. 77 (d)(ii) of the MPGs)	**kt CO_2eq**		**To be reported in subsequent BTR**	**To be reported in subsequent BTR**			

For metrics in non-GHG, for each non-GHG metric determined by participating Parties, annual adjustments resulting in an annual adjusted indicator, consistent with para. 9 of chapter III.B (Corresponding adjustments), annex to decision 2/CMA.3, and future guidance to be adopted by the CMA (para. 23(k)(ii), annex to decision 2/CMA.3)	**NA**		**NA**	**NA**			
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77(d)(iii) of the MPGs)	**This information can be found in the separate annex ‘Information in relation to the participation in cooperative approaches’**						

Annex 2: Methodology applied for the identification of GHG emissions from international aviation and navigation in the scope of the EU NDC

The scope of the EU NDC goes beyond national GHG emissions and removals in the scope of the national GHG inventory; it also includes specific emissions from international aviation and navigation. This annex describes the methodology for identifying these emissions.

International aviation and maritime emissions are estimated by using the Joint Research Centre's Integrated Database of the European Energy System (JRC-IDEES).[39] It allows to split the international transport CO_2 emissions reported in the GHG inventory into intra-EU/extra-EU and intra-EEA/extra-EEA categories and the ongoing flights from the EU to UK and Switzerland, backwards in time (i.e. for the time period back to 1990).[40] In this annex, EEA stands for European Economic Area, which comprises the 27 EU Member States, Iceland, Liechtenstein and Norway.

For international transport, JRC-IDEES applies a decomposition methodology that reconciles the scopes of available primary statistics and harmonises historical data on international aviation and maritime emissions, energy use, and transport activity. The resulting annual dataset covers 1990-2021 and distinguishes domestic, intra-EU/intra-EEA, and extra-EU/extra-EEA activity for each EU Member State, Norway and Iceland.

In aviation, JRC-IDEES distinguishes passenger and freight modes, with three geographical categories of flight origin/destinations for each mode: domestic, intra-EEA + UK, and extra-EEA + UK. Intra-EU, the UK, and EEA categories are also used internally during calibration but aggregated for reporting. For each mode/category combination, JRC-IDEES estimates activity (as passenger-km or tonnes-km), energy use and CO_2 emissions, aircraft stock (expressed as representative aircraft), load factors, and aircraft efficiencies. As country-specific activity statistics are not available, the decomposition first allocates EU-level activity data from the Transport Pocketbook[41] of the European Commission's Directorate-General for Mobility and Transport to each country and flight category.

For passenger modes, this allocation calculates average load factors using Eurostat data on total passengers and flights. These load factors and total flight numbers are combined with average flight distances from EUROCONTROL, the pan-European organisation dedicated to air traffic management, to yield an initial estimate for passenger transport activity. For intra-EU activity, a uniform scaling factor is then applied across Member States to match total EU-level Transport Pocketbook data. Freight activity follows a similar process, using a 'representative flight' concept with a common load factor across all Member States to account for mixed passenger-freight flights.

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39 European Commission, Joint Research Centre, Rózsai, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Tattini, J. and Neuwahl, F., JRC-IDEES-2021: the Integrated Database of the European Energy System – Data update and technical documentation, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/614599.

40 The JRC-IDEES analytical database is designed to support energy modelling and policy analysis, by combining primary statistics with technical assumptions to compile detailed energy-economy-emissions historical data for each key energy sector. For aviation, EEA emissions includes emissions related to the UK but not to Switzerland, where total CO_2 emissions for the scope are additionally estimated from EUROCONTROL data.

41 Statistical pocketbook 2023, https://transport.ec.europa.eu/facts-funding/studies-data/eu-transport-figures-statistical-pocketbook/statistical-pocketbook-2023_en.

Next, the decomposition estimates fuel use from EUROCONTROL data, by deriving a distance-dependent average aircraft efficiency, then applying it to the country-specific ensemble of flights and routes. The final step scales the estimates to meet Eurostat energy balances for total domestic and international consumption back to 1990 values, maintaining intra-EEA/extra-EEA fuel use ratios derived from EUROCONTROL. JRC-IDEES additionally reports resulting differences with submissions by Parties to the UNFCCC. The above process is followed throughout the entire decomposition period (1990-2021). Data gaps are estimated from the existing indicators as follows:

- The process iterates backwards towards 1990, starting from the oldest years in which data is available in each Member State.
- Average flight distance is kept constant for early years without EUROCONTROL data (generally before 2004).
- If the load factor (passengers per flight) cannot be calculated due to a lack of passenger and/or flight data, it is estimated from the trend of the existing time series.
- Missing numbers of flights are calculated from the load factor and the passengers carried.
- If no passenger data is available, the total mileage is estimated from the energy consumption, and combined with average flight distance to estimate the number of flights. The number of flights is then combined with the load factor to estimate the total passengers carried.
- For early years without data, constant values are assumed for the factors used to *i)* scale intra-EU activity to the Transport Pocketbook, *ii)* adjust the estimated fuel use to EUROCONTROL data for specific routes, and *iii)* scale this adjusted fuel use to Eurostat energy balances (e.g. before 1995 for Transport Pocketbook data; before 2004 for EUROCONTROL data).

For international maritime transport, JRC-IDEES estimates data both for intra-EU/extra-EU and intra-EEA/extra-EEA geographical categories. The emission estimates in the GHG inventory already include CO_2, CH_4, and N_2O gases. Transport activity (tonnes-km) is estimated from Eurostat data on gross weight of transported goods, using port-level and country-level data for intra-EU and extra-EU categories, respectively. Intra-EU activities are then scaled to match the Transport Pocketbook totals, accounting for domestic coastal shipping (calibrated separately in JRC-IDEES). Next, transport activity is combined with data reported under the monitoring, reporting and verification system for maritime transport under the EU ETS ('THETIS MRV'[42]), namely EU-level mileage data and country-specific vessel sizes to estimate load factors (tonnes per movement). The load factors and resulting annual mileage (km) are calibrated to meet EU-level THETIS MRV mileage. The annual mileage is in turn combined with THETIS MRV average efficiency to yield a total technical energy consumption, with corresponding emissions derived from default emissions factors. This energy consumption is scaled to Eurostat energy balances to minimise discrepancy to total intra-EU THETIS MRV emissions. As with aviation, JRC-IDEES reports corresponding differences to submissions under the UNFCCC. Early years with data gaps are estimated from existing indicators as follows:

[42] THETIS MRV, https://mrv.emsa.europa.eu/#public/eumrv.

- The process iterates backwards towards 1990, starting from the oldest years in which data is available in each Member State.
- Average distance of voyages is kept constant for early years without Eurostat activity data (generally before 1997-2000).
- If the load factor (tonnes per movement) cannot be estimated due a lack of activity data, it is kept constant.
- If activity data is not available, it is estimated from Eurostat energy consumption.
- Missing mileage data is derived from the activity and load factor estimates.
- For early years without data, constant values are assumed for the factors used to i) scale intra-EU activity to the Transport Pocketbook, ii) scale estimated mileage to meet EU-level THETIS MRV mileage, and iii) scale domestic and intra-EU CO_2 emissions estimated from energy consumption so as to match total THETIS MRV CO_2 emissions.
- Finally, the ratios between the estimated MRV emissions and the CO_2 emissions for the reported transport activity (for intra-EU/EEA and extra-EU/EEA categories) between 2018 and 2021 are used to calculate the MRV compliant estimates back to 1990 levels.

For the year 2022, the international navigation and aviation emissions under the EU NDC scope have been estimated by applying the same share of those emissions on the total international navigation and aviation emissions (as reported in the GHG inventory) as in 2021.

Annex 2 and Annex 3

Common reporting tables for the electronic reporting of the national inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases as well as *Information on financial, technology development and transfer and capacity-building support provided and mobilized under Articles 9–11 of the Paris Agreement* are submitted as separate XLS files.