



REPUBLIC OF CROATIA

MINISTRY OF ECONOMY AND SUSTAINABLE DEVELOPMENT

**EIGHTH NATIONAL COMMUNICATION AND FIFTH BIENNIAL
REPORT OF THE REPUBLIC OF CROATIA UNDER THE UNITED
NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE
(UNFCCC)**

Zagreb, 2024

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LIST OF ABBREVIATIONS

AD	Activity data
ADCP	Annual Data Collection Plan
ARR	Annual Review Report of the GHG inventory submission
AR4/AR5	Fourth/Fifth Assessment Report of the IPCC on Climate Change
BSRN	Baseline Surface Radiation Network
CAP	Common Agricultural Policy
CCUS	Carbon Capture, Use and Storage
CDD	Consecutive dry days
CLC	Corine Land Cover
CLRTAP	Convention on Long-range Transboundary Air Pollution
CBS	Croatian Bureau of Statistics
COP	Conference of the Parties to the Kyoto Protocol
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CRF	Common Reporting Format
CSDI	Cold Spell Duration Index
CSEUR	Consolidated System of European Registries
CTF	Common Tabular Format
CTS	Centralised thermal systems
DHMZ	Meteorological and Hydrological Service
EC	European Commission
ECV	Essential Climate Variable
EEA	European Environment Agency
EERA	European Energy Research Alliance
EIHP	Energy Institute Hrvoje Požar
EMEP	European Monitoring and Evaluation Programme
ERT	Experts Review Team
ESI	European Structural and Investment (Funds)
ESCO	Energy Service Company
ETIP	European Technology and Innovation Platform
EU	European Union
EU ETS	EU Emissions Trading System
EUR	Euro
EUCR	European Union Consolidated Registry
EUTL	European Transaction Log
FIT	Feed-in Tariff System
FSRU	Floating Storage Regasification Unit
GCM	Global Climate Model
GCMP	Global Climate Monitoring Principles
GCOS	Global Climate Observing System
GDD	Growing degree days
GDP	Gross domestic product
GHG	Greenhouse gas
GLOBE	Global Learning and Observation for Benefit of the Environment
GLOSS	Global Sea Level Observing System
GRFCS	Global Reporting Ship Fuel Consumption System

GSL	Growing season length
GWP	Global Warming Potential
HAOP	Croatian Environment and Nature Agency
HERA	Croatian Energy Regulatory Agency
HGK	Croatian Chamber of Economy
HI	Huglin Heliothermal Index
HNB	Croatian National Bank
HR PSOR	Croatian Business Council for Sustainable Development
HRK	Croatian kuna
HROTE	Croatian Energy Market Operator
HUP	Croatian employers' association
ICAO	International Civil Aviation Organization
IDRS	Inventory Data Record Sheets
IEA	International Energy Agency
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
ITL	International Transaction Log
LULUCF	Land Use, Land-use Change and Forestry
MESD	Ministry of Economy and Sustainable Development
MPI-ESM	Max Planck Institute Earth System Model
NAPNAV	National irrigation program
NGO	Non-governmental organization
NIR	National Inventory Report
NPOO	National Recovery and Resilience Plan
nZEB	Nearly Zero Energy Building standard
OG	Official Gazette
ODS	Ozone-depleting substances
PaM	Policy and measure
PAP/RAC	Priority Actions Programme / Regional Activity Centre
PME	Predicted methane emissions
PPSR	Previous Period Surplus Reserve
QA/QC	Quality Assurance / Quality Control
RegCM(RCM)	Regional Climate Model
RES	Renewable energy sources
RFI	Residual Feed Intake
SDII	Standard Daily Precipitation Intensity Index
SECAP	Sustainable Energy and Climate Action Plan
SEMEP	South Eastern Mediterranean Sea Project
SET	Strategic Energy Technology
SLCF	Short-lived climate forcers
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VOSclim	Voluntary Observing Ship Climate Project
WAM	With additional measures
WEM	With existing measures
WMO	World Meteorological Organization
WSDI	Warm Spell Duration Index

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1. EXECUTIVE SUMMARY

1.1. INTRODUCTION

The Republic of Croatia became a party to the United Nations Framework Convention on Climate Change (UNFCCC) (hereinafter: the Convention) by passing a law on its ratification in the Croatian Parliament on January 17, 1996 (Official Gazette-International Agreements 2/96). For the Republic of Croatia, the Convention came into force on July 17, 1996. As a country undergoing the process of transition to market economy, Croatia has, pursuant to Article 22, paragraph 3 of the Convention, taken over the commitments of countries included in Annex I. By the amendment that came into force on August 13, 1998, Croatia was listed among Parties included in Annex I to the Convention.

The Republic of Croatia ratified the Kyoto Protocol (hereinafter: the Protocol) in April 2007 and it entered into force on August 28, 2007. By ratifying the Protocol (Official Gazette-International Agreements 5/07), the Republic of Croatia, as the Protocol Annex B party, took over the obligation of limiting the emissions of all greenhouse gases in the period 2008-2012 to 95% of the amount of emissions in the base year 1990.

At the 18th Conference of the Parties to the Convention and the 8th Conference of the Parties to the Kyoto Protocol, held in December 2012 in Doha, Qatar, Croatia agreed to be covered by the amendment to Annex B of the Kyoto Protocol. Obligations for the Republic of Croatia in the second binding period of the Kyoto Protocol, from 2013 to 2020, will be met jointly by the European Union and its Member States, and Iceland. On November 25, 2015, the Republic of Croatia adopted the Act on the Ratification of the Doha Amendment to the Kyoto Protocol (Official Gazette-International Agreements 6/15). The instrument of ratification was deposited in December 2017.

The Paris Agreement is the climate agreement signed in 2015 at the 21st Conference of the Parties (COP 21) to the Convention, in Paris. The agreement was reached on December 12, 2015, and it entered into force on October 4, 2016, after the ratification by the European Union. The Republic of Croatia ratified the Paris Agreement on May 24, 2017, and it entered into force on June 23, 2017.

Pursuant to provisions of Articles 4 and 12 of the Convention, the Republic of Croatia is obliged to prepare national greenhouse gas inventory and periodically prepare national communication on climate change, by which it reports on the implementation of obligations from the Convention. The content, methodology, periodicity and deadline for submitting the emissions inventory and national communication are defined by the decisions and instructions of the Conference of the Parties.

By joining the European Union (EU) on July 1, 2013, the Republic of Croatia, following the obligations arising from harmonization with the EU acquis, incorporated into its legal framework the obligations of reporting on the implementation of policies and measures to reduce emissions and increase removals of greenhouse gases and on the long-term projections of greenhouse gas emissions, which must be periodically submitted to the competent authorities of the European Union.

Croatia has thus far produced seven national communications since 2002, whereby the second, third and fourth were combined into one report, while the last, seventh report was submitted to the Secretariat of the Convention in May 2018.

The content, format and deadline for submitting national communications on climate change are set by UNFCCC decisions. Decision 6/CP.25 established the deadline for the delivery of the Eighth National Communication, with data on emissions for the period from 1990 to 2020. Instructions for the preparation of the national communication are provided in the same Decision, including reporting elements according to the Kyoto Protocol (Decision 15/CMP.1).

Furthermore, in addition to the Eighth National Communication, the Fifth Biennial Report of the Republic of Croatia under the UNFCCC was prepared as well, and it is included in Annex I.

1.2. NATIONAL CIRCUMSTANCES

Sociopolitical structure

The Republic of Croatia became an independent country on October 8, 1991, by decision of the Croatian Parliament. The Croatian Constitution was adopted on December 22, 1990. The Republic of Croatia has been a member of the United Nations since May 22, 1992 and the European Union since July 1, 2013. The state government is organized based on power division into the legislature (the Croatian Parliament), the executive (the President of the Republic, the Croatian Government) and the judicial power. The state administrative bodies are ministries and state administrative organisations. The Ministry of Economy and Sustainable Development is the central state administrative body in charge of administrative and expert environmental protection activities relating to climate protection.

Population

According to the 2021 census, the total number of inhabitants in the Republic of Croatia is 3,871,833, of which 2,006,704 are women and 1,865,129 are men. Demographic trends are negative. The average population density amounts 68.4 inhabitants/km², with a broad range from 8.0 to 1,196.8 inhabitants/km² showing that the territory of the Republic of Croatia is not equally populated.

Economy

In 2015, economic recovery was recorded in the Republic of Croatia after the global financial crisis of 2007-2008. The economy continued to grow until 2020, when due to the global coronavirus pandemic (COVID-19) there was a decline, only for recovery to follow in 2021.

Geographic profile and land use

The Republic of Croatia belongs to the Central European, Adriatic-Mediterranean and Pannonia-Danube group of countries. The total area of the Republic of Croatia amounts to 88,073 km². The land area amounts to 56,594 km² and the area of territorial sea and interior sea waters to 31,479 km². Total length of the land boundaries of the Republic of Croatia amounts to 2,370.5 km (including river borders). The sea border is 948 km long and extended at outer boundary of territorial sea. The exclusive economic zone of the Republic of Croatia in the Adriatic Sea continues to the sea border. According to the Corine Land Cover database for the last reference year 2018, the most represented land use classes (level 1) are Forest and seminatural areas, whereas Agricultural areas cover 94.5% of the land area of the Republic of Croatia.

Climate

According to Köppen classification the largest part of the Republic of Croatia has a moderately warm, rainy climate characterised by a mean monthly temperature ranging between -3°C and +18°C. The highest parts of Lika and Gorski Kotar (>1,200 m a.s.l.) have a snow forest climate with a mean

temperature below -3°C in the coldest month. The islands and the coastal area of the middle and southern Adriatic have a Mediterranean (olive) climate. In inland, the warmest month of the year has an average temperature lower than 22°C and in the coastal area higher than 22°C . More than four months within a year have a monthly average temperature higher than 10°C . Mean annual quantity of precipitation in the Republic of Croatia ranges from 300 mm to slightly above 3,500 mm. There are no extremely dry months in the lowland continental part. The month with the smallest amount of precipitation is in the cold part of the year and in the annual course of precipitation there are two maxima. In Lika and Gorski Kotar, higher parts of Istria and in parts $> 1,200$ m a.s.l. there are no dry periods. The highest monthly amount of precipitation is in the cold part of the year, whereas the winter rainy period is divided into the autumn-winter and the spring maximum. On the islands and in the coastal area of the middle and southern Adriatic dry period is in the warm part of the year. The driest month has even less than 40 mm of precipitation and less than a third of the amount in the rainiest month in the cold part of the year. There are also two precipitation maxima in the larger part of that area.

Energy

The production of primary energy in the Republic of Croatia was decreasing in the period 2015-2021 and amounted to 214.52 PJ in 2021, of which greater part were fuel wood and biomass and hydro power (63.0 %). Energy imports and exports were growing. Total primary energy supply in the period 2015-2021 was increasing and amounted to 412.95 PJ in 2021. The exception in growth of total primary energy supply was year 2020, when the global coronavirus pandemic (COVID-19) caused reduced economic and social activities and mobility and thus lower energy consumption. Final energy consumption (industry, transport and other sectors) had the largest share in total primary energy supply. Installed capacities for energy production from renewable sources were growing. The share of renewable energy sources in gross final energy consumption in 2021 was estimated at 31.7 %.

Transport

Passenger transport and transport of goods in the Republic of Croatia is carried out by road transport, railway transport, maritime and coastal transport, transport by inland waterways, air transport and good transport also via pipelines. The largest number of passengers is transported by road and railway transport and the most goods by road and maritime and coastal transport. The total length of public roads in 2021 amounted to 26,412 km. The number of road vehicles has been continuously increasing. The length of railway lines in 2021 amounted to 2,617 km, of which 38 % is electrified. The Republic of Croatia has six ports open for public traffic of outstanding (international) economic importance in the cities of Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik. Inland waterway ports open to international public traffic are Osijek, Sisak, Slavonski Brod and Vukovar. Airports in public air traffic are Franjo Tuđman, Dubrovnik, Split, Zadar, Osijek, Pula, Rijeka, Brač and Lošinj. Pipeline transport includes crude oil transport through oil pipelines and gas through gas pipelines. In 2021, the length of the oil pipeline amounted to 610 km and the length of the gas pipeline amounted to 2,544 km.

Industry

According to volume indices of industrial production in the period 2017-2021 and the total sale value of industrial products, industrial production in the Republic of Croatia grew. The exception in growth was the year 2020, when the global coronavirus pandemic (COVID-19) caused a reduction of economic and social activities and mobility. The total sale value of industrial products in 2021 amounted to EUR 20,353,045,458 (provisional data). Manufacturing had the largest share in the total sale value of industrial products and had the largest independent share in the gross value added and in total employment in the Republic of Croatia. According to the sale value of industrial products, the leading place in manufacturing is manufacture of food products, followed by manufacture of coke and refined

petroleum products, manufacture of fabricated metal products (except machinery and equipment) and manufacture of other non-metallic mineral products.

Waste management

The total amount of waste generated in economic activities and in households in the Republic of Croatia grew in the period 2016-2020 and amounted to 6,003,759 t in 2020. The largest share in the total amount of generated waste had waste from construction activities (24 %) and household waste (20 %). Of the total amount of waste generated in 2020, 46.2 % was recycled, 23.8 % was disposed on landfills, 10.4 % was pre-treated before the final waste treatment, 3.3 % was used for backfilling, 1.5 % was energy recovered and 0.2 % was incinerated without energy recovery, while for 14.6 % of the total amount of waste generated there is no recorded data on waste treatment. Waste management infrastructure, facilities and systems have been developed but part of the goals determined by the regulations of the Republic of Croatia and the European Union have not been achieved.

Construction and housing

The volume indices of construction in the period 2015-2022 show the growth of construction works in the Republic of Croatia. The number of issued building permits grows. The value of completed construction works grew and amounted to EUR 2,891,910,000 in 2021. Construction of residential buildings grew in the period 2015-2021. The construction of non-residential buildings grew in the period 2015-2019, while in 2020 and 2021 it is lower compared to 2019.

Agriculture

Utilized agricultural areas decrease in the period 2015-2021 and amounted to 14,764 km² in 2021 which is 26.1% of the Republic of Croatia land area. The largest share of utilized agricultural areas have arable land and gardens (58.0%) and permanent grasslands (35.5%). The number of cattle and pigs decreased in the period 2015-2021, while the number of sheep, goats, ungulates, and poultry increased. The total catch and production of sea fish, crabs, shellfish, and molluscs in 2021 amounted to 85,341 t, of which the largest share had pelagic (blue) fish (71.5%). The total production of freshwater fish amounted to 4,149 t in 2021. Production of milt amounted to 53,123,000 pieces of freshwaters fish in 2021.

Forestry

Forest land area did not change significantly in the period 2015-2021 and amounted to 27,534 km² in 2021 which is 48.7% of the Republic of Croatia land area. Forests occupy the largest part of forest land area (91.9%), followed by other forest land (6.6%) and arid land (1.4%). According to the ownership structure, state-owned forest land dominates. The largest area is occupied by commercial forests (61.1% of the forest area), followed by protective forests (20.7%) and special purpose forests (18.2%). Commercial forests are primarily used for production of wood and non-wood forest products. In the period 2015-2019 the amount of wood cut in total (roundwood) grew, after which there was a decline in production. The share of fuel wood in roundwood grew, while the proportion of industrial roundwood decreased.

Water resources

Surface waters and groundwaters in the Republic of Croatia area are part of the Black Sea or Adriatic basin, and the Republic of Croatia area is divided into the water area of the Danube River and the Adriatic water area. The border of water areas follows natural hydrographic-hydrogeological watershed, i.e. the watershed between the Adriatic and Black Sea basins in the mountainous area of Lika and Gorski Kotar. In the Danube River water area, there is a large concentration of surface water and a branched network of streams. The largest rivers are the Danube, Sava, Drava, Kupa and Mura. In the Adriatic

water area, the density and length of surface water is significantly lower, but there are significant groundwater flows through the karst systems. The largest rivers are Lika, Zrmanja, Krka, Cetina and Neretva. There are relatively few natural lakes. According to the average water balance, the Republic of Croatia area is abundant with water, but annual distribution of water quantities is not favourable due to pronounced spatial and temporal unevenness in distribution of water wealth.

The Adriatic Sea is the northernmost part of the Mediterranean Sea. The part of the Adriatic Sea that belongs to the Republic of Croatia is the area of the eastern coast, which stretches from Prevlaka in the south to Cape Savudrija in the west, including all islands, islets and rocks along the coast and the Palagruža island. The total length of Croatian coast of the Adriatic Sea is 6,278 km. The sea border, 948 km long, extends along the outer edge of the territorial sea. The exclusive economic belt of the Republic of Croatia in the Adriatic Sea is adjacent to it. The Croatian islands (1,244 islands, islets, rocks and reefs) include almost all islands of the eastern coast of the Adriatic and its central part, forming the second largest archipelago in the Mediterranean.

Other national circumstances

Contamination with mine-explosive means and unexploded ordnance left over from war operations in the Republic of Croatia is a safety problem accompanied by economic, developmental, environmental and social disturbances. On January 1, 2021, mine-suspected area occupied 249.4 km² i.e. 0.44 % of the Republic of Croatia land area. Forest land areas occupy the largest part of mine-suspected area (98.6%). They are followed by agricultural areas (1.1%) and other areas (0.3%).

1.3. GREENHOUSE GAS EMISSIONS TREND

This report presents calculations of emissions and removals of greenhouse gases in the Republic of Croatia for the period from 1990 to 2020. The calculations include emissions which result from human activities and encompass the following direct greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons and perfluorocarbons (HFCs, PFCs) and sulphur hexafluoride (SF₆), as well as indirect greenhouse gases: carbon monoxide (CO), nitrogen oxides (NO_x), nonmethane volatile organic compounds (NMVOCs) and sulphur dioxide (SO₂). Greenhouse gases that are subject to the Montreal Protocol on substances that deplete the ozone layer (e.g. freons) and which are reported separately, are not included.

The total emission of greenhouse gases, excluding removals by sinks, in 2020 amounts to 23,758.40 million t CO₂e, which represents a reduction of emissions by 24.3% compared to the emission of greenhouse gases in 1990.

Overall decline in economic activities and energy consumption in the period from 1991 to 1994, mostly caused by the war in Croatia, directly caused a decline in total greenhouse gas emissions during that period. Since the entire national economy is in the process of transition, some energy-intensive industries have reduced their activities or even stopped production (e.g. blast furnace in Sisak, primary aluminium production in Šibenik, coking plant in Bakar), which significantly affected the reduction of greenhouse gas emissions. Emissions started to increase in 1995 with an average rate of 3% per year until 2008. Due to a decline in economic activity in the period from 2008 to 2016, emissions constantly decreased until 2014, when they began to slowly increase.

The main reason for the increase in emissions in the period from 1995 to 2008 is the energy sector (electricity and heat production; transport), industrial processes and product use (cement production; lime production; ammonia production; nitric acid production; consumption of hydrofluorocarbons) and waste. The increase in the electricity and heat production subsector is mostly caused by higher consumption of liquid fuels. In recent times, producers of cement, lime, ammonia and nitric acid have reached their maximum production capacity, which is also reflected in emission levels. Disposal of solid municipal waste and wastewater treatment and discharge have the greatest impact on the increase in emissions in the waste sector.

The main reasons for the reduction of greenhouse gas emissions in the period from 2008 to 2016 are the economic crisis and the beginning of the implementation of measures to reduce CO₂ emissions according to the National Energy Efficiency Action Plan for the period from 2014 to 2016 and the period from 2017 to 2019. Namely, due to the economic crisis there was a decrease in industrial production (primarily a decrease in the production of cement, lime and steel) and, consequently, a decrease in fuel consumption (the largest decrease in fuel consumption was in the Manufacturing industries and construction and in Transport sub-sectors), which led to a decrease in greenhouse gas emissions.

The trend of emissions and removals of greenhouse gases by sector is shown in Figure 1-1.

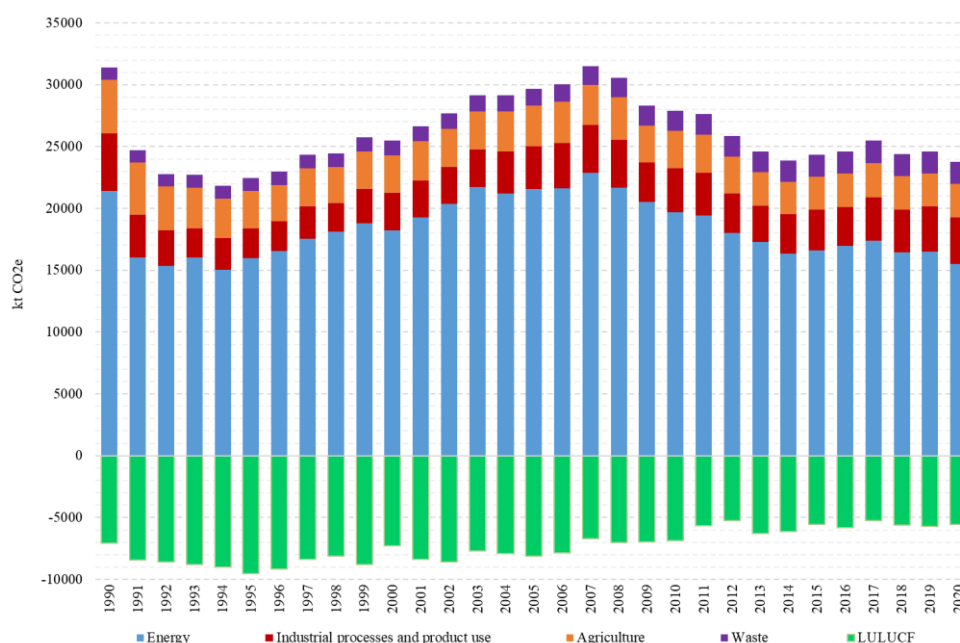


Figure 1-1: Trend of GHG emissions, by sectors

The largest contribution to greenhouse gas emissions in 2020 had the energy sector with 65.3%. In 2020, emissions from the energy sector were 5.9% lower than in 2019 and 27.6% lower than in 1990. Total energy consumption in 2020 decreased by 4.5% compared to 2019. Consumption of renewable energy sources, firewood and natural gas as well as hydropower increased, while the consumption of coal and liquid fuels decreased. Energy consumption from hydropower in 2020 increased by 0.2% compared to 2019. In the observed period from 1990 to 2020, only 14 – 32% of electricity needs in Croatia were covered by thermal power plants. Most electricity, 36 – 69%, is obtained from hydropower plants. In 2020, the import of electricity accounts for about 39% of the total electricity consumption in Croatia.

The industrial processes and product use sector contributes with 15.9% to the total national emission of greenhouse gases in 2020. Emissions in this sector in 2020 increased by 3.2% compared to 2019, which represents a decrease of 18.4% compared to 1990. Greenhouse gas emissions transformed during the reporting period with the following pattern: emissions decreased in the period 1990-1995, which is a consequence of a decline in economic activity due to the war, while in the period 1996-2008, emissions increased slightly; from 2008 onwards, due to the economic crisis there is a drop in emissions, followed by a moderate recovery since 2013.

The agriculture sector contributes with 11.3% to the total national emission of greenhouse gases in 2020. Greenhouse gas emissions from the agriculture sector have been on a downward trend since 2006, mostly due to reduction in the number of cattle. In 2020, emissions were 38.1% lower compared to 1990.

The waste sector contributes with 7.5% to the total national emission of greenhouse gases in 2020. In the period 1990-2018, emissions from the waste sector were constantly increasing, as a result of larger amounts of disposed waste, activities related to wastewater management and waste incineration. After 2018, there is a slow decline in emissions. In 2020, greenhouse gas emissions were 80.1% higher than in 1990.

The trend of greenhouse gas emissions by gases, is shown in Figure 1-2.

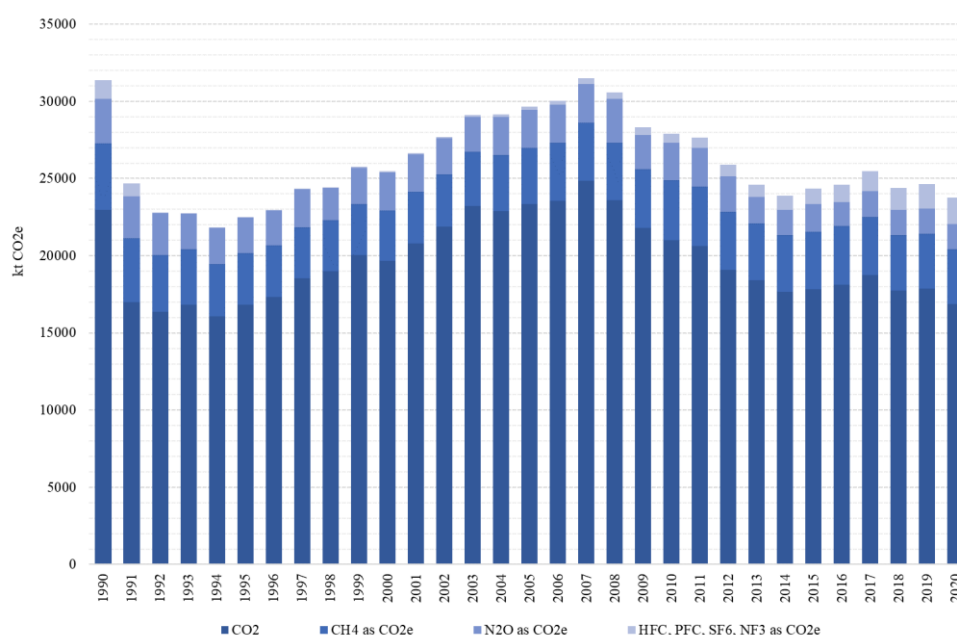


Figure 1-2: Trend of greenhouse gas emissions, by gases

During the entire observed period from 1990 to 2020, the shares of emissions of individual greenhouse gases did not change significantly. In 2020, the shares of greenhouse gas emissions were as follows: 71.0% CO₂; 15.0% CH₄; 7.6% N₂O; HFCs and SF₆ 7.1%.

1.4. POLICIES AND MEASURES

Policies and measures to reduce emissions and mitigate climate change serve to fulfil the international obligations of the Republic of Croatia under the UNFCCC and the EU acquis and are the starting point for the long-term development of the low-emission economy.

The Republic of Croatia has fulfilled its obligations under the Kyoto Protocol to reduce greenhouse gas emissions by 5% over the period 2008-2012 compared to 1990. By joining the EU, the Republic of Croatia has taken on a common European goal of reducing greenhouse gas emissions by 20% by 2020 compared to 1990. With the Paris Agreement, the EU committed to reduce greenhouse gas emissions by 40% by 2030, compared to 1990.

The obligation to reduce emissions is implemented jointly by EU Member States through the European Emission Trading System (EU ETS). A common 'cap' was established for the EU ETS system, and it includes operators of installations and aircraft operators from Croatia. For the emissions and sectors not covered by the EU ETS, the annual national allocation quotas are determined for the Member States and they must not be exceeded. These quotas are established on the basis of solidarity. Pursuant to Regulation (EU) 2018/842, the goal of reducing emissions by 7% in 2030, compared to the level of emissions from 2005, has been set for Croatia.

An important role in the implementation of policies and measures to reduce greenhouse gas emissions has the possibility to use European structural and investment funds within the Common Strategic Framework to fund programs and projects that fulfil the strategic goals of the EU, including the reduction of greenhouse gas emissions, presented in the document "Europe 2020 a Strategy for Smart, Sustainable and Inclusive Growth" (COM (2010) 2020 final). It should be emphasized that at least 20% of the total EU budget for the period 2014-2020 was allocated to the implementation of policies, measures and projects related to mitigation and adaptation to climate change, including the integration of this topic in other sectorial policies (developmental, agricultural, cohesion and so on).

Croatia adopted the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21). The Low-Carbon Development Strategy is a fundamental document in the field of climate change mitigation and an over-arching economic, development and environmental strategy. With the Low-Carbon Development Strategy, the obligations to reduce greenhouse gas emissions will be transferred to certain sectoral policies. The goal of the Low-Carbon Development Strategy is to achieve a competitive low-carbon economy by 2050, in accordance with European strategic guidelines and in accordance with the obligations of the United Nations Framework Convention on Climate Change (UNFCCC). The strategy opens up opportunities to stimulate the growth of the economy through innovation, transfer of advanced technologies and structural changes.

Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030 was adopted on the basis of Regulation (EU) 2018/1999 and in accordance with the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19). Integrated National Energy and Climate Plan for the period 2021-2030 builds on existing national strategies and plans. It provides an overview of the current energy system and the situation in the field of energy and climate policy. It also provides an overview of the national goals for each of the five dimensions of the energy union (decarbonisation, energy efficiency, energy security, internal energy market and research, innovation and competitiveness) and the appropriate policies and measures to achieve these goals, for which an analytical basis should be established. In the Integrated Energy and Climate Plan, special attention is paid to the goals until 2030, which include the reduction of greenhouse gas emissions, use of energy from renewable sources, energy efficiency and electricity interconnection.

In the Integrated National Energy and Climate Plan, approximately a hundred measures have been selected that can be applied to reduce emissions and increase removals in the following sectors: energy,

transport, industrial processes and product use, waste, agriculture, land use, land use change and forestry (LULUCF) and cross-cutting policies and measures.

Below is an overview of policies and measures for reducing greenhouse gas emissions and increasing removals in the Republic of Croatia, which are being implemented or are planned to be implemented:

Energy:

- MEN-1: Promoting nZEB construction and renovation standards
- MEN-2: Energy renovation programme for apartment buildings
- MEN-3: Energy renovation programme for single family houses
- MEN-4: Energy renovation programme for public buildings
- MEN-5: Energy renovation programme for buildings that have the status of cultural property
- MEN-6: Energy renovation programme for public lighting
- MEN-7: Energy management in the public sector
- MEN-8: Energy management in the business (service and production) sector
- MEN-9: Informational accounts
- MEN-10: Energy efficiency information
- MEN-11: Energy efficiency education
- MEN-12: Energy efficiency of the electricity transmission network
- MEN-13: Reduction of losses in the distribution network and introduction of smart grids
- MEN-14: Increasing the efficiency of the district heating systems
- MEN-15: Increasing the efficiency of the gas transport network
- MEN-16: Information, education and capacity building for RES use
- MEN-17: Spatial planning prerequisites for RES use
- MEN-18: Promoting the RES use for production of electricity and heat
- MEN-19: Development of the regulatory framework for RES use
- MEN-20: Integrated planning of security of energy and energy products supply
- MEN-21: Construction and use of energy storage
- MEN-22: Development and maintenance of centralised thermal systems
- MEN-23: LNG terminal construction
- MEN-24: Refinery modernization and transformation
- MEN-25: Measures to increase energy efficiency by improving processes and process units
- MEN-26: Methane flaring
- MEN-27: Development of the electricity transmission network
- MEN-28: Development of gas transmission system
- MEN-29: Elaboration of the regulatory framework for active participation of customers on the electricity market
- MEN-30: Introduction of advanced consumption metering systems and data management
- MEN-31: Adoption and implementation of the Programme for Energy Poverty Reduction
- MEN-32: Program for combating energy poverty, which includes the use of renewable energy sources in residential buildings in areas of special state care for the period 2021-2025
- MEN-33: Increasing energy efficiency and use of RES in manufacturing industry

Transport:

- MTR-1: Providing information to consumers on fuel economy and CO₂ emission of new passenger cars
- MTR-2: Special environmental fee for motor vehicles
- MTR-3: Special tax on motor vehicles

- MTR-4: Monitoring, reporting and verification of greenhouse gas emissions in the lifetime of fuels and energy
- MTR-5: Legislative adjustments for cleaner transport
- MTR-6: Financial incentives for the purchase of energy efficient vehicles
- MTR-7: Development of infrastructure for alternative fuels
- MTR-8: Promotion of integrated freight transport
- MTR-9: Promotion of sustainable intermodal transport at national level
- MTR-10: Promotion of integrated and intelligent transport systems and development of alternative fuels infrastructure at local and regional level
- MTR-11: Training for drivers of road vehicles for eco-driving
- MTR-12: Promotion of boat transport using alternative fuels
- MTR-13: Advanced biofuel market development plan
- MTR-14: Decarbonization of transport through the production of advanced biofuels from residues of agricultural production and energy crops with integrated carbon capture, use and storage

Industrial processes and product use:

- MIP-1: Reducing the share of clinker in cement production
- MIP-2: Limiting fluorinated greenhouse gas emissions
- MIP-3: Gradual reduction of the amount of fluorocarbons that can be placed on the market
- MIP-4: Restrictions and prohibitions on placing certain products and equipment on the market
- MIP-5: Reduction of fluorinated greenhouse gas emissions from mobile air conditioning systems

Agriculture:

- MAG-1: Change in livestock diet of and feed quality
- MAG-2: Improvement of livestock facilities and manure management systems
- MAG-3: Modification of the livestock system
- MAG-4: Anaerobic decomposition of manure and biogas production
- MAG-5: Improving the breeding and selection program, animal health and welfare
- MAG-6: Improvement and change of tillage system (reduced tillage)
- MAG-7: Expansion of crop rotation with higher share of legumes
- MAG-8: Intensification of crop rotation using intermediate crops
- MAG-9: Improving methods of applying mineral fertilizers
- MAG-10: Improving methods of applying organic fertilizers
- MAG-11: Agroforestry
- MAG-12: Hydromeliorative interventions and disaster protection systems
- MAG-13: Introduction of new cultivars, varieties and cultures
- MAG-14: Change in people's diet
- MAG-15: Collection and processing of agricultural plantations and residues for energy purposes

LULUCF:

- MLF-1: Development of the Land Management Strategy of the Republic of Croatia
- MLF-2: Carbon accumulation on the surfaces of existing forests
- MLF-3: Implementation of afforestation works
- MLF-4: Production and use of wood and wood products
- MLF-5: Cropland management
- MLF-6: Grassland management

- MLF-7: Implementation of technical projects and scientific research in the LULUCF sector

Waste:

- MWM-1: Preventing the generation and reducing the amount of solid waste
- MWM-2: Increasing the amount of separately collected and recycled solid waste
- MWM-3: Ensuring the system of treatment and use of landfill gas
- MWM-4: Reducing the amount of disposed biodegradable waste
- MWM-5: Use of biogas for biomethane production and electricity and heat generation

Other (cross-cutting) policies and measures:

- MCC-1: Committee for cross-sectoral coordination of policies and measures for mitigation and adaptation to climate change
- MCC-2: Supporting the founding of regional energy and climate agencies and capacity building
- MCC-3: Promotion of the use of innovative information and communication technologies (ICT) to reduce greenhouse gas emissions
- MCC-4: Emissions Trading System
- MCC-5: The CO₂ emission tax for the non-ETS stationary sources
- MCC-6: Covenant of Mayors for Climate and Energy in the Republic of Croatia
- MCC-7: Charter for Buildings Decarbonisation by 2050
- MCC-8: Creation of Platform for Carbon Capture, Use and Storage
- MCC-9: Improving sustainability of urban areas
- MCC-10: Foundation of the Programme for calculation and reduction of carbon footprint of business entities
- MCC-11: Foundation of the Platform for Circular Economy
- MCC-12: Foundation of the Platform for Bioeconomy
- MCC-13: Foundation of the Platform for Hydrogen Technologies
- MCC-14: Energy efficiency obligation system for suppliers
- MCC-15: Integrated information system for monitoring energy efficiency
- MCC-16: Green public procurement
- MCC-17: Determining the starting point, national goals, indicators for monitoring the achievement and establishing a system for monitoring the achievement of the set goals of research, innovation and competitiveness
- MCC-18: Co-financing of industrial research and experimental development projects aligned with the National Development Strategy
- MCC-19: Supporting low carbon entrepreneurship development
- MCC-20: Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies
- MCC-21: Supporting further work of excellence centers active in the field of natural, technical, biotechnical and biomedical sciences
- MCC-22: Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy

1.5. EMISSION PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

GHG emissions are presented for two scenarios: the ‘with existing measures’ scenario and ‘with additional measures’ scenario. The scenario ‘with existing measures’ includes the implementation of the current policy and measures whose application is already in progress, that is, the implementation of the policy and measures that have been adopted. The scenario ‘with additional measures’ is based on the implementation of the planned policy and measures.

Emission projections are based on the Greenhouse Gas Inventory (NIR 2022), which includes the inventory of greenhouse gas emissions and removals for the period from 1990 to 2020 (submission on October 14, 2022).

Figure 1-3 and Table 1-1 show historical emissions and projections of greenhouse gas emissions (not including removals) for the period from 1990 to 2040.

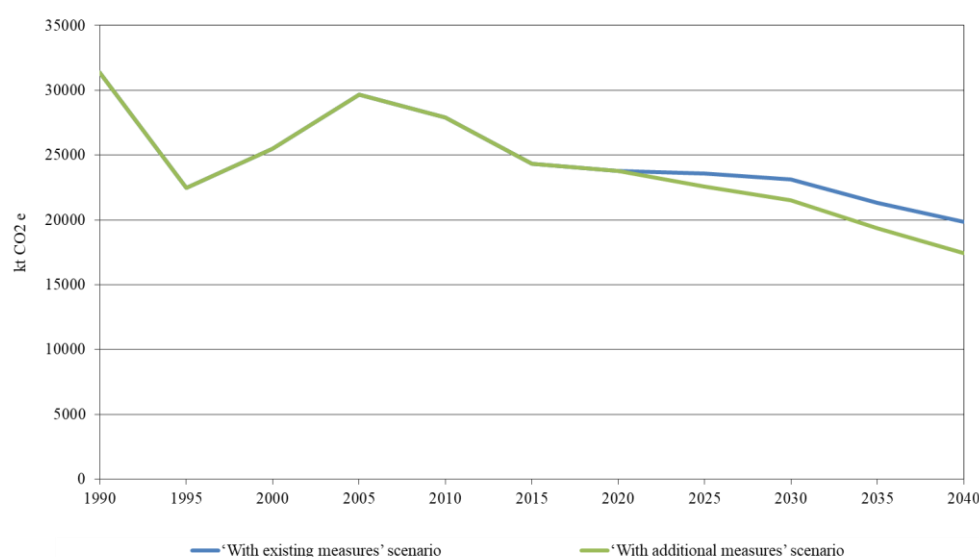


Figure 1-3: Historical emissions and projections of greenhouse gas emissions (excluding LULUCF) for the period until 2040

Table 1-1: Historical emissions and projections of greenhouse gas emissions, kt CO₂e

'With existing measures' scenario	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Energy	17,543	12,602	13,715	16,003	13,757	10,637	9,714	9,560	9,527	9,029	8,541
Transport	3,896	3,370	4,502	5,562	5,952	5,954	5,802	6,077	6,362	5,739	5,116
Industrial processes and product use	4,618	2,404	3,038	3,475	3,521	3,301	3,770	3,542	3,287	2,952	2,809
Waste	984	1,068	1,205	1,337	1,664	1,768	1,779	1,713	1,321	1,042	842
Agriculture	4,353	3,042	3,018	3,277	3,029	2,690	2,692	2,680	2,619	2,575	2,536
TOTAL	31,394	22,486	25,479	29,654	27,922	24,350	23,758	23,572	23,116	21,337	19,843

'With additional measures' scenario	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Energy	17,543	12,602	13,715	16,003	13,757	10,637	9,714	9,111	8,726	7,927	7,137
Transport	3,896	3,370	4,502	5,562	5,952	5,954	5,802	5,835	5,879	5,285	4,691
Industrial processes and product use	4,618	2,404	3,038	3,475	3,521	3,301	3,770	3,375	3,120	2,715	2,502
Waste	984	1,068	1,205	1,337	1,664	1,768	1,779	1,713	1,321	1,042	842
Agriculture	4,353	3,042	3,018	3,277	3,029	2,690	2,692	2,554	2,451	2,369	2,294
TOTAL	31,394	22,486	25,479	29,654	27,922	24,350	23,758	22,588	21,496	19,338	17,466

Projections show that compared to 1990, emissions in the 'with existing measures' scenario in 2040 will decrease by 37.7%, while in the 'with additional measures' scenario, emissions will decrease by 45.2% compared to 1990.

Projections show that in the 'with existing measures' scenario, emissions in 2040 are reduced by 16.5% compared to 2020, while in the 'with additional measures' scenario, emissions are reduced by 26.5% compared to 2020.

In the scenario 'with existing measures', projections show stagnation until 2030. After 2030, emissions show a decline in this scenario. In the scenario 'with additional measures', the projections show a constant trend of reducing emissions.

In the scenario 'with additional measures' compared to the scenario 'with existing measures' in 2040, greenhouse gas emissions are reduced by 12.0%.

Sinks in the LULUCF sector for the 'with existing measures' scenario are shown in Figure 1-4.

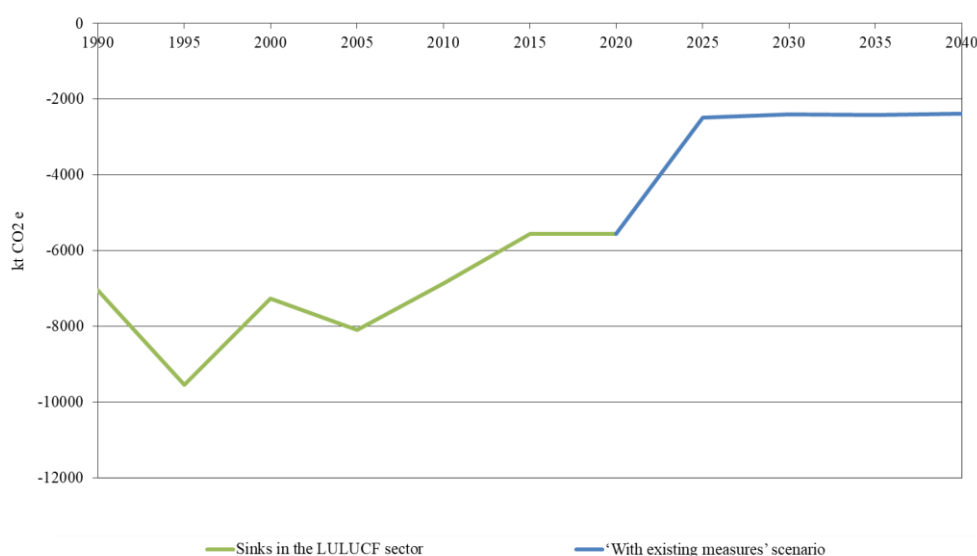


Figure 1-4: Removals by sinks in the LULUCF sector, scenario 'with existing measures'

1.6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

The Republic of Croatia is affected by climate change and since it largely belongs to the Mediterranean region, that will intensify and vulnerability to climate change is assessed as high. Climate change strongly affects the environment and exacerbates the existing environmental and nature issues. The vulnerability of certain economic sectors is almost acute, especially of agriculture, forestry, fishing, energy and tourism, because the performance of all these sectors largely depends on climate factors. Estimated economic damage from extreme weather and climate events in the Republic of Croatia in the period 1980-2020 was EUR 2.86 billion. This is an average of EUR 71.5 million per year, while in the period 1980-2013, it amounted to an average of EUR 68 million per year.

In order to respond to climate change challenges, the Strategy of Adaptation to Climate Change in Croatia until 2040 with an Outlook on 2070 (Official Gazette 46/20) (hereinafter: Climate Change Adaptation Strategy) was adopted on April 7, 2020. The Climate Change Adaptation Strategy was developed in collaboration with sectoral and cross-sectoral experts and scientists and with contribution of interested stakeholders (representatives of public authorities, representatives of scientific, educational and professional institutions, non-governmental organizations, professional chambers and other interested general public). Its goal is to raise awareness of importance and threats of climate change for society and necessity of integrating the concept of climate change adaptation into existing and new policies, to reduce the vulnerability of environment, economy and society caused by climate change effects. In addition, the desire is to encourage and direct scientific research to better understand the complexity of climate change impacts and to reduce the degree of uncertainty related to climate change effects.

Although climate change adaptation is basically a horizontal issue, the Climate Change Adaptation Strategy focuses on eight key sectors (water resources, forestry, agriculture, fishery, biodiversity, health, energy, tourism) and two cross-sectoral areas (spatial planning and development and risk management) that are relevant for adaptation due to their socioeconomic importance for the Republic of Croatia and/or are important for environment and nature. A total of 83 climate change adaptation measures with accompanying activities have been determined, which require the attention and involvement of large number of stakeholders at national, regional, and local level, as well as society and economy as a whole.

The largest number of climate change adaptation measures belong to the so-called non-structural measures (administrative, political, legislative, technical, and planning measures, measures to raise awareness of the need to adapt to climate change and measures related to data collection, monitoring, and scientific research). A relatively small number of so-called structural measures (measures that include any built structure or natural structure whose existence is aimed at reducing or avoiding possible climate change impacts) include certain technical interventions, such as construction of protective dams and walls, construction of hydrotechnical facilities, but also afforestation, green infrastructure, strengthening the absorptive capacity of land to receive excess water, etc.

The total amount of investments needed to implement the Climate Change Adaptation Strategy is estimated at around EUR 3.7 billion for the period up to 2040. It is planned to implement the Climate Change Adaptation Strategy through five-year period action plans, which should contain elaboration of specific measures and activities, i.e. for each adaptation measure and activity a description, method of implementation, sequence of activities, deadline for execution, obligors and coordinators for implementing measures and activities and sources of funding should be provided. The first action plan was not adopted, although its proposal (draft) was prepared.

Although a key document for systematic implementation and monitoring of the implementation of the Climate Change Adaptation Strategy has not been adopted, activities and projects related to climate change adaptation are carried out. Those are partly related to measures and activities determined by the Climate Change Adaptation Strategy. The topic of climate change adaptation is incorporated into public policies, national development documents and documents of regional and local self-government units. Significant number of scientific and research projects is carried out, in which cross-border cooperation is also realized. Activities have begun at the national level, enabling (co)financing of climate change adaptation projects. Awareness of the need to increase resilience to climate change has increased.

1.7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Article 4, paragraph 3 of the Convention stipulates that the Parties to the Convention which are developed, and other developed parties included in Annex II shall provide new and additional financial resources to fully meet the costs incurred by the developing country Parties in meeting their obligations under Article 12 Paragraph 1. They shall also provide financial means, including those for the transfer of technology required by developing country Parties in order to fully comply with the costs incurred for the implementation of the measures covered by Article 4, paragraph 1 of the Convention.

In this sense, Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19) stipulates the use of revenues from the greenhouse gas emissions auctioning, including the financing of measures for climate change mitigation and adaptation in third countries. By the Decision on the adoption of the Plan for the use of Financial Resources Obtained from the Sale of Emission Allowances in Auctions in Croatia by 2020 (Official Gazette 19/18, 84/19), funds for financing projects in third countries were planned, but due to a critical lack of capacity in the competent ministry, it could not be prepared and implemented an adequate program.

1.8. RESEARCH AND SYSTEMATIC OBSERVATION

Investing in research and development on the topic of climate change was highlighted for the first time in the Smart Specialization Strategy of the Republic of Croatia for the period from 2016 to 2020 (Official Gazette 32/16) (chapter Energy and sustainable environment). Investing in research and development is particularly emphasized in the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21), the Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) and the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030.

Research and development are financed through core funding, i.e. through permanent financial support, project funding and other specific calls. Project funding and other specific calls are the dominant source of funding for research and development activities in the field of climate change. The sources of project funding in the field of climate change are various financial instruments of the European Union and calls from the Croatian science foundation and the Environmental Protection and Energy Efficiency Fund.

Scientific institutions and laboratories systematically monitor number of climate parameters. Modernization of monitoring networks is underway. The observation of individual indicators is adapted to the real needs and obligations of the European and national legislative framework. Certain institutions and entities carry out specific permanent or occasional monitoring of certain climate parameters through cooperation and research projects.

1.9. EDUCATION, TRAINING AND PUBLIC AWARENESS

Main strategic documents of the Republic of Croatia in the field of climate emphasize the importance of education, training and raising awareness of the need to mitigate climate change and the necessity of strengthening resistance to climate change and adaptation to it.

In primary and secondary school education, knowledge about climate is acquired primarily in the content of regular classes in the subject of Geography and within the subjects of Nature, Nature and Society and Chemistry. Acquiring knowledge about climate is also an integral part of vocational education programs for certain professions and qualifications. The cross-curricular topic of Sustainable development should be highlighted. This cross-curricular topic made sustainable development an independent term in educational system since 2019 and is realized by connecting educational areas and continuing topics of all teaching subjects. It is carried out within framework of compulsory and optional subjects, hours class teacher, integrated teaching, as part of projects, as part of extracurricular teaching, field teaching and in extracurricular activities. In the system of science, climate and climate change are subject, independently or integrated, of a series of undergraduate, graduate and postgraduate university and professional studies at universities.

Print media and portals monitor various areas of environmental protection and write articles about climate and climate change, harmful consequences of climate change and meteorological extremes, use of renewable energy sources, and international obligations and activities of the Republic of Croatia in relation to climate change. Radio and television stations occasionally provide information on climate issues in informative and scientific-educational programs. The state administration body responsible for environmental protection¹ is also responsible for climate change and informs and works to raise awareness of different stakeholders about the need to mitigate climate change, about expected effects of climate change in Croatia, as well as ways of adapting to it. In its activities the state administration body responsible for environmental protection cooperates with and has support of other state administration bodies responsible for individual sectors. Renowned professional and expert institutions carry out activities related to information, education of professionals, as well as interested public and business entities. Professional public, including the scientific community, carry out activities of exchanging information and raising of knowledge and awareness about climate change. Importance of non-governmental organizations is especially recognized in raising knowledge about climate change and in acting at local level. Therefore, non-governmental organizations are included as partners in individual collaboration projects and research projects on climate change, but they prepare and implement their own projects in the field of climate as well.

¹ During preparation of this Eighth National Communication and the Fifth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC), the state administration body responsible for environmental protection is the Ministry of Economy and Sustainable Development.

2. NATIONAL CIRCUMSTANCES

2.1. SOCIOPOLITICAL STRUCTURE

The Republic of Croatia became an independent state on October 8, 1991, pursuant to the Croatian Parliament decision. The Croatian Constitution (hereinafter: Constitution) was adopted on December 22, 1990. The Republic of Croatia has been a member of the United Nations since May 22, 1992, and the European Union since July 1, 2013. The state government is organized on the principle of power division into legislative (the Croatian Parliament), executive (the President of the Republic, the Croatian Government) and judicial power.

The Croatian Parliament is a representative body of the Republic of Croatia citizens and is vested with legislative power. The Croatian Parliament is a unicameral representative body which may have at least 100 and no more than 160 members on the basis of universal and equal suffrage by secret ballot. Deputies are elected for four years, have no binding mandate and have immunity. Working bodies of the Parliament for specific sectorial issues are boards and committees, including the Committee for environmental and nature protection.

The Croatian President has a representative and executive function and can be elected to a maximum of two terms. He represents the Republic of Croatia at home and abroad. He is responsible for the defence of independence and territorial integrity of the Republic of Croatia, as well as stable, normal and concerted action by the state government. The President is elected through direct elections by secret ballot for a period of five years. In cooperation with the Croatian Government, the President participates in formulation and implementation of foreign policy. The President performs other duties specified by the Constitution.

The Government of the Republic of Croatia exercises the executive power in conformity with the Constitution and the law. The Government consists of the Prime Minister, Deputy Prime Ministers and Ministers and takes office when given a vote of confidence by the majority of all members of the Croatian Parliament. The organization, operation and decision-making are regulated by the Republic of Croatia Government Act and its rules of procedure. The Government proposes laws and other acts to the Croatian Parliament, state budget and final financial statement, implements laws and other decisions of the Croatian Parliament, adopts regulations for laws enforcement, conducts foreign and domestic policy, directs and controls the work of state administration, takes care of economic development of the country, directs and controls activities and development of public services and conducts other affairs as determined by the Constitution and law. Besides the aforementioned and within the framework of its authorities, the Government adopts regulations, administrative acts and decisions on appointing and releasing of officials and public servants. The Government makes a decision in case of conflict for jurisdiction of public institutions, gives answers on representatives' questions, establishes proposals of laws and other regulations, gives opinion on laws and other regulations and adopts development strategies of economic and social activities. The Government of the Republic of Croatia is responsible to the Croatian Parliament. The Prime Minister and members of the Government are responsible for decisions made by the Government and individually they are responsible for their fields of operation.

Judicial power in the Republic of Croatia is exercised by regular courts (municipal courts and county courts), specialized courts (commercial courts, administrative courts, High Misdemeanour Court of the Republic of Croatia, High Commercial Court of the Republic of Croatia, High Administrative Court of

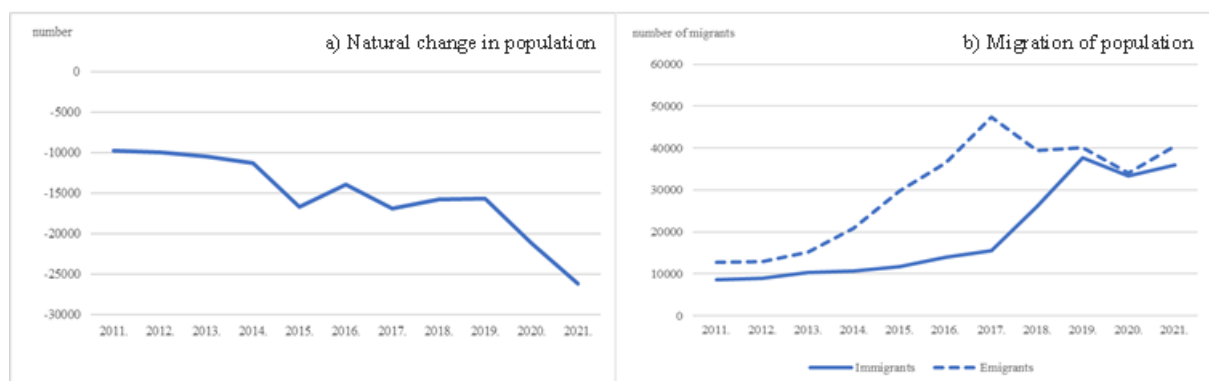
the Republic of Croatia and High Criminal Court of the Republic of Croatia) and Supreme Court of the Republic of Croatia.

The State Administration is responsible for implementation of state policy, direct enforcement of laws, carrying out administrative and inspection supervision, as well as other administrative and expert activities. The activities of State Administration are carried out by state administration bodies: ministries and state administrative organisations. Certain activities of state administration can be entrusted to the local and regional self-government units or other legal entities having public authorities.

Local and regional self-government is a citizen right guaranteed by the Constitution. Right to local and regional self-government includes right to independence in carrying out local and regional activities, own incomes, free income management, independent organization of internal structure, independent organization of scope of activities and direct election of members of representative bodies. Right to local and regional self-government is acquired by local and regional bodies comprised of members elected through direct elections by secret ballot, based on direct, equal and general voting right. Citizens are allowed to directly participate in local activities management through referendums and citizens' assembly. Local self-government units are municipalities and cities responsible for issues of local importance directly fulfilling the citizens' needs. There are 128 cities and 428 municipalities in the Republic of Croatia. Regional self-government units are counties responsible for activities of regional importance. The Republic of Croatia is divided into 21 regional self-government units: 20 counties and the City of Zagreb with the status of county. County includes physically connected municipalities and cities in its area.

2.2. POPULATION

According to the 2021 census, total number of inhabitants in the Republic of Croatia is 3,871,833, of which 2,006,704 are women and 1,865,129 are men [2-1]. Compared to the 2011 census, according to which the Republic of Croatia had 4,284,889 inhabitants, number of inhabitants decreased by 9.64 %. Demographic trends are negative. Average age of population in 2021 was 44.3, ageing index was 156.2 % and age coefficient was 29.9 % [2-2]. Natural increase is negative (Figure 2-1, a). Over a longer period, larger number of residents emigrated from the Republic of Croatia than immigrated (Figure 2-1, b).



Source: CBS: Natural change in population (statistics in line) [2-3], CBS: Migration of population (statistics in line) [2-4]

Figure 2-1: Natural increase & population migration in the Republic of Croatia in the period 2011-2021

The average population density in 2021 amounted to 68.4 inhabitants/km², with a range from 8.0 (Lika-Senj County) to 1,196.8 inhabitants/km² (City of Zagreb) showing that the territory of the Republic of Croatia is not equally populated (table 2-1).

Table 2-1: Population density per counties in 2021

County	Population per km ²	County	Population per km ²
Zagreb	98.0	Slavonski Brod-Posavina	64.2
Krapina-Zagorje	98.2	Zadar	43.8
Sisak-Moslavina	31.3	Osijek-Baranja	62.1
Karlovac	30.9	Šibenik-Knin	32.3
Varaždin	126.4	Vukovar-Sirmium	58.3
Koprivnica-Križevci	57.9	Split-Dalmatia	93.3
Bjelovar-Bilogora	38.6	Istria	69.4
Primorje-Gorski Kotar	74.0	Dubrovnik-Neretva	64.9
Lika-Senj	8.0	Međimurje	144.4
Virovitica-Podravina	34.8	City of Zagreb	1,196.8
Požega-Slavonia	35.2		

2.3. ECONOMY

During 2015, the Republic of Croatia economy started with slow growth after global financial crisis in the period 2007-2008. The growth was followed by a decline in 2020 due to global coronavirus pandemic (COVID-19). The fall in GDP rate in 2020 (-8.5%) (Table 2-2) was one of the largest in the European Union, mainly due to high dependence of the economy on tourism, a sector sensitive to unfavourable external influences such as coronavirus pandemic (COVID-19). In 2021, the economy recovered, mainly supported by export of goods and services and with the key role of tourism and personal consumption [2-5].

Table 2-2: Macroeconomic indicators of the Republic of Croatia in the period 2015-2021

Macroeconomic indicators	2015	2016	2017	2018	2019	2020	2021
GDP (million EUR, current prices)	45,734	47,331	49,516	51,933	54,784	50,477	58,244
GDP per capita (in EUR)	10,880	11,339	12,005	12,704	13,476	12,471	15,015
GDP year-on-year growth rate (%)	2.5	3.6	3.4	2.8	3.4	-8.5	13.1
Average HICP year-on-year inflation rate	-0.5	-1.1	1.1	1.5	0.8	0.1	2.6
Exports of goods and services (% GDP)	45.3	47.0	49.7	50.2	51.5	41.5	50.0
Imports of goods and services (% GDP)	45.0	45.8	49.0	51.1	51.8	48.5	52.7
External debt (million EUR, end of year)	48,622	45,050	43,879	42,809	40,589	41,285	47,213
Unemployment rate (ILO, persons above 15 years of age)	16.2	13.1	11.2	8.4	6.6	7.5	7.6

Source: HNB, website: Main macroeconomic indicators [2-6]

2.4. GEOGRAPHIC PROFILE AND LAND USE

According to its position, the Republic of Croatia belongs to the Central European, Adriatic-Mediterranean and Pannonia-Danube group of countries. Total area of the Republic of Croatia is 88,073 km². It is located between 42°22'40" and 46°33'18" of north latitude and 13°29'30" and 19°26'50" of east longitude [2-7]. The land area is 56,594 km² and the area of territorial sea and interior sea waters is 31,479 km² [2-7]. Total length of land borders towards neighbouring countries is 2,370.5 km (including river borders): 1,010.9 km towards Bosnia and Herzegovina, 355.2 km towards Hungary, 659.1 km towards Slovenia, 325.8 km towards Serbia-Vojvodina and 19.5 km towards Montenegro [2-7]. The coastline length amounts to 6,278 km (29.9% land, 70.1 % islands) [2-7]. The sea border is 948 km long and extended at outer boundary of territorial sea. The exclusive economic zone of the Republic of Croatia in the Adriatic Sea continues to the sea border [2-8].

There are three large geomorphological natural units in the Republic of Croatia: the Pannonian basin, mountain system of Dinarides and Adriatic basin. Lowland areas of up to 200 m a.s.l. represent 53% of area of the Republic of Croatia, hillies and sub-mountains from 200 up to 500 m a.s.l. represent 26%, while there is 21% of mountain areas exceeding 500 m a.s.l. [2-9]. The highest mountain top is Dinara (1,831 m a.s.l.) [2-9]. Karstic area is a relief specificity occupying about 54% of the Republic of Croatia area. Karstic forms are developed particularly in limestones in mountainous and coastal area of the Republic of Croatia and as separated form in Sava-Drava area.

According to the Corine Land Cover database for the last reference year 2018 (CLC 2018), the most represented land use classes (level 1) are Forest and seminatural areas (55.1% of the Republic of Croatia land area) and Agricultural areas (39.7% of the land area) [2-11]. Compared to CLC 2012, the area of the land use classes of Forest and semi-natural areas (-3,149 ha) and Agricultural areas (-1,317 ha) was reduced, while the area of the land use classes of Artificial surfaces (+4,064 ha) and Water bodies (+402 ha) was increased [2-10].

Protected areas of nature in the Republic of Croatia include following categories: strict nature reserve, national park, special nature reserve, nature park, regional park, natural monument, significant landscape, park-forest and park architecture monument. These areas, with their beauty, wealth and diversity represent a fundamental value and one of the most significant natural assets of the Republic of Croatia. In 2021, 408 areas are protected: strict reserve (2), national park (8), special reserve (79), nature park (12), regional park (2), nature monument (79), significant landscape (79), forest park (27) and park architecture monument (120), covering 8,172 km² i.e. 9.3% of total area of the Republic of Croatia [2-11]. Part of protected areas is a part of ecological network of the Republic of Croatia.

Ecological network of the Republic of Croatia is part of NATURA 2000 European Ecological Network. Natura 2000 is a coherent European ecological network comprising areas with natural habitat types and wild flora and fauna, which are deemed to be of European interest, and it enables the conservation or, when necessary, restoration to a favourable conservation status of certain natural habitat types and species across their entire natural range. The Republic of Croatia ecological network consists of conservation areas significant for birds, conservation areas significant for species and habitat types, potential conservation areas significant for species and habitat types and special areas of conservation significant for species and habitat types. The Republic of Croatia ecological network covers 25,956 km² which is 36.8% of the republic of Croatia land area and 9.3% of territorial sea and exclusive economic zone of the Republic of Croatia in Adriatic Sea and consists of 38 conservation areas significant for birds and 745 conservation areas significant for species and habitat types, potential conservation areas

significant for species and habitat types and special areas of conservation significant for species and habitat types [2-12], [2-13].

2.5. CLIMATE

The Republic of Croatia climate is determined by its position in the northern mid-latitudes and corresponding weather processes on a large and medium scale. The most important climate modifiers over the Republic of Croatia area are Adriatic and Mediterranean Sea, the Dinarides' orography with their form, altitude and position relative to the prevailing air flow, openness of the north-eastern parts to the Pannonian plain, and diversity of vegetation [2-14].

According to Köppen classification, the largest part of the Republic of Croatia has a moderately warm, rainy climate characterised by a mean monthly temperature ranging between -3°C and $+18^{\circ}\text{C}$ [2-9], [2-14]. The highest parts of Lika and Gorski Kotar ($> 1,200$ m a.s.l.) have snow forest climate with a mean temperature below -3°C in the coldest month [2-9], [2-14]. Islands and coastal area of the middle and southern Adriatic have a mediterranean (olive) climate [2-9], [2-14].

Mean annual air temperature in lowland area of northern Croatia ranges from 10 to 12°C and in coastal area it ranges from 12 to 17°C [2-9]. The coldest parts of the Republic of Croatia are Lika and Gorski Kotar, with the mean annual air temperature ranging between 8°C and 10°C at lower elevations and between 2°C and 4°C on the highest peaks of Dinaric massif [2-9]. Annual air temperature course has a shape of one-strand wave with a peak in summer, most often in July, more rarely in August, and with a minimum in winter, in January [2-14]. The absolute minimum air temperature of -34.6°C was measured in Gračac on January 13, 2003, and the absolute maximum air temperature of 42.8°C in Ploče on August 5, 1981 [2-15].

Mean annual precipitation quantity ranges from 300 mm to slightly above $3,500$ mm [2-14]. The lowest precipitation is on outer islands of the middle Adriatic, and the highest in Gorski Kotar, on Velebit and on the northeastern slopes of Konavosko polje [2-14]. Annual amount of precipitation in continental part decreases from west to east [2-14]. In the northern inland there are no dry periods, and annual course of precipitation has maximum in a warm part of the year and secondary maximum in late autumn [2-9]. In northern Adriatic and Lika and Gorski Kotar there are no dry periods, maximum of precipitation is in a cold part of the year and secondary maximum is in transitional period between spring and summer [2-9]. In central and southern Adriatic, annual course of precipitation is of maritime type [2-9] and in most of that area there are two precipitation maximums [2-14].

In continental part of the Republic of Croatia a weak to moderate wind with changeable direction prevails, depending significantly on the openness and form of surrounding terrain [2-14]. On the Adriatic, in a cold part of the year the dominant winds are dry, cold and gusty bora (bura) from the north-eastern quadrant and warm, humid and uniform south-east wind (jugo) from the southern quadrant, and in summer the maestral mainly from the western quadrant [2-9], [2-14].

The sunniest parts of the Republic of Croatia are outer islands of the middle Adriatic (Vis, Lastovo, Biševo and Svetac) and western shores of islands of Hvar and Korčula, with more than $2,700$ sunshine hours per year [2-9]. The middle and southern Adriatic have more sun and less clouds than the northern Adriatic [2-9]. The amount of sunshine decreases from the sea to the inland and with higher elevation above sea level [2-9]. The Dinaric massif has from $1,700$ to $1,900$ sunshine hours per year [2-10]. The

smallest insolation of 1,700 hours per year and highest cloudiness of 6 to 7 tenths is in Gorski Kotar [2-9]. In northern Croatia there are 1,800 to 2,000 hours of sunshine per year, with more of them in the eastern than in the western part, and cloudiness decreasing from west to east [2-9].

2.6. ENERGY

Production of primary energy in the Republic of Croatia in 2021 amounted to 214.52 PJ, of which 33.2 % was fuel wood and biomass, 29.8 % hydro power, 12.3 % natural gas, 12.0 % crude oil while 11.3 % belonged to other renewable sources and ambient heat (Table 2-3). Production of primary energy decreased in the period 2015-2021 at an average annual rate of 0,9 %. In production of primary energy, renewable energy production, fuelwood, biomass and heat increased, whereas production of energy from crude oil and natural gas decreased (Table 2-3). Energy production from hydro power depends on hydrological conditions.

Table 2-3: Primary energy generation in the Republic of Croatia in the period 2015-2021

Primary energy production	2015	2016	2017	2018	2019	2020	2021
	expressed in PJ						
Fuel wood and biomass	64.19	64.15	64.67	63.06	62.79	64.34	71.20
Crude oil	28.62	31.47	31.79	31.26	30.13	26.98	25.81
Natural gas	61.61	57.52	51.76	43.07	36.13	29.89	26.39
Hydro power	61.63	65.63	53.81	66.98	51.54	51.62	63.93
Heat	0.62	0.66	0.66	0.63	0.60	0.61	0.67
Renewables	10.99	12.90	16.10	16.21	19.51	22.76	23.53
TOTAL	227.65	232.32	218.78	221.21	200.71	196.20	214.52

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16], EIHP/MESD (2020): Energy in Croatia 2020 [2-17]

In the period 2015-2021, both energy import and export grew (Table 2-4 and Table 2-5). Imports of coal and coke, crude oil and electricity decreased, while imports of oil derivatives, natural gas, wood and biomass increased. Petroleum products dominated in exported energy.

Table 2-4: Energy import in the Republic of Croatia in the period 2015-2021

Energy import	2015	2016	2017	2018	2019	2020	2021
	expressed in PJ						
Coal and coke	32.11	34.49	22.57	19.69	22.82	18.75	21.09
Crude oil	99.41	107.32	120.33	126.63	85.66	83.00	75.22
Petroleum products	85.56	83.40	93.55	86.81	113.80	100.79	113.98
Natural gas	36.33	44.01	63.10	55.05	69.40	74.54	80.17
Electricity	31.93	31.43	34.16	26.66	32.97	25.53	24.12
Fuel wood and biomass	1.18	1.21	1.54	3.02	4.83	5.25	6.49
TOTAL	286.52	301.87	335.24	317.85	329.47	307.85	321.08

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16], EIHP/MESD (2020): Energy in Croatia 2020 [2-17]

Table 2-5: Energy export from the Republic of Croatia in the period 2015-2021

Energy export	2015	2016	2017	2018	2019	2020	2021
	expressed in PJ						
Coal and coke	1.21	1.13	1.00	0.58	0.74	0.29	0.23
Crude oil	-	-	-	-	5.19	23.72	20.18
Petroleum products	78.93	88.52	106.27	102.47	91.93	75.89	75.70
Natural gas	12.71	13.55	6.93	3.92	2.50	1.83	4.42
Electricity	7.49	11.52	9.12	7.26	10.89	8.82	9.86
Fuel wood and biomass	12.48	13.07	13.95	11.60	10.49	10.61	12.60
TOTAL	112.82	127.80	137.27	125.83	121.75	121.15	122.98

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16], EIHP/MESD (2020): Energy in Croatia 2020 [2-17]

The total primary energy supply in the Republic of Croatia in 2021 amounted to 412.95 PJ, of which liquid fuels accounted for 29.1%, natural gas for 24.7%, hydro power for 15.5%, fuel wood and biomass for 14.9%, other renewable sources and ambient heat for 7.5 %, coal and coke for 4.9% and electricity for 3.5% (Table 2-6). Total primary energy supply in the period 2015-2021 was increasing. The exception in growth of total primary energy supply was year 2020, when the global coronavirus pandemic (COVID-19) caused reduced economic and social activities and mobility and thus lower energy consumption. The consumption of coal and coke, liquid fuels and electricity decreased, while the consumption of energy from wood and biomass, hydro power, other renewable sources and ambient heat and natural gas increased (Table 2-6).

Table 2-6: Total primary energy supply in the Republic of Croatia in the period 2015-2021

Total primary energy supply	2015	2016	2017	2018	2019	2020	2021
	expressed in PJ						
Coal and coke	29.86	32.14	21.65	20.36	20.77	18.25	20.16
Fuel wood and biomass	52.69	52.47	52.09	53.20	54.18	55.98	61.43
Liquid fuels	130.99	130.85	139.90	134.59	133.27	112.85	120.18
Natural gas	87.16	91.08	104.67	96.43	101.22	106.10	101.99
Hydro power	61.63	65.63	53.81	66.98	51.54	51.62	63.93
Electricity	24.44	19.91	25.03	19.40	22.08	16.70	14.26
Heat	0.62	0.66	0.66	0.63	0.60	0.61	0.67
Renewables	11.36	12.90	16.11	17.32	22.12	25.50	30.33
TOTAL	398.75	405.63	413.92	408.91	405.78	387.60	412.95

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16], EIHP/MESD (2020): Energy in Croatia 2020 [2-17]

The total primary energy supply meets demand for total energy in the energy system: total final energy consumption, non-energy use, energy sector own use, energy conversion losses and energy transport and distribution losses. In the period 2015-2021, energy conversion losses, transport and distribution losses and final energy consumption were increasing (Table 2-7). Energy sector own use and non-energy consumption were reduced (Table 2-7). Final energy consumption had the largest share in total primary energy supply in 2021 (70.6 %) (Table 2-7). Other sector consumption had largest share in final energy consumption (Table 2-7).

Table 2-7: Structure of total primary energy supply in the Republic of Croatia in the period 2015-2021

Total primary energy supply	2015	2016	2017	2018	2019	2020	2021
	expressed in PJ						
Conversion losses	67.23	74.56	68.55	69.34	64.11	67.99	76.12
Energy sector own use	24.99	22.88	24.41	23.68	20.36	18.01	17.89
Transmission and distribution losses	9.21	9.20	9.01	9.29	8.76	9.07	10.10
Non energy use	22.24	21.64	22.41	20.31	23.68	22.27	17.30
Final energy consumption	275.08	277.34	289.55	286.29	288.86	270.26	291.54
Other sectors	147.42	147.36	148.02	145.11	143.06	142.09	153.53
Transport	88.66	90.96	98.37	97.82	102.17	84.87	94.27
Industry	39.00	39.03	43.16	43.35	43.62	43.29	43.74
TOTAL	398.75	405.63	413.92	408.91	405.78	387.60	412.95

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16], EIHP/MESD (2020): Energy in Croatia 2020 [2-17]

Renewable energy sources are significant in overall energy supply of the Republic of Croatia. Installed capacities for thermal and electrical energy generation from renewable sources are growing [2-16, 2-17, 2-18, 2-19, 2-20, 2-21, 2-22]. Installed capacities for energy generation from renewable sources in 2021 amounted to 604.8 MW of installed thermal power and 1,323.2 MW of installed electrical power (Table 2-8).

Table 2-8: Capacities for heat and electricity generation from renewable energy sources in 2021

Type of renewable energy source	Installed heat capacity (MW)	Installed power capacity (MW)
Solar	210.7	138.3 ⁽¹⁾
Wind	-	986.9
Biomass	275.2 ⁽²⁾	95.2
Biogas	59.3	59.1
Small hydro	-	33.7
Geothermal	59.6 ⁽³⁾	10.0
TOTAL	604.8	1,323.2

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16]

Data source states that when interpreting the data, it must be taken into account that there are no reliable statistical data on the installed capacities of solar energy and biomass production plants, and that there are two methods of data monitoring for geothermal thermal energy.

⁽¹⁾ Systems connected to the grid.

⁽²⁾ Refers only to biomass cogeneration.

⁽³⁾ Geothermal heat for space heating.

In 2021, 3,515.4 GWh of electricity and 54,784.2 TJ of thermal energy were produced from renewable energy sources [2-16]. The production of solid biofuels in 2021 included production of 344,750 t of wood pellets, 56,539 t of wood briquettes, 14,227 t of charcoal, 424,891 t of wood chips and 5,472,900 m³ of fuelwood and the production of liquid biofuels included production of 390 t of biodiesel [2-16].

Special regulations in the Republic of Croatia encourage electricity production from renewable sources and cogeneration through incentive prices. Number of incentives paid is increasing (Table 2-9). In 2021, 3,494 GWh of electricity was delivered to the grid from power plants with a valid incentive contract in the FIT system (feed-in tariff system) and EUR 442,529,873 of incentives were paid for the energy produced (Table 2-9). Most incentives were paid for electricity produced in wind power plants [2-16, 2-17, 2-18, 2-19, 2-20, 2-21, 2-22].

Table 2-9: Paid incentives to eligible producers of electricity in the period 2015-2021

	2015	2016	2017	2018	2019	2020	2021
Delivered to the grid (GWh)	1,094	1,726	2,277	2,483	2,882	3,287	3,494
Amount paid based on subsidies to eligible producers of electricity (million EUR)	137.9	205.3	253.9	288.8	354.0	403.3	442.5

Source: EIHP/MESD (2022): Energy in Croatia 2021 [2-16], EIHP/MESD (2020): Energy in Croatia 2020 [2-17], EIHP/MESD (2020): Energy in Croatia 2019 [2-18], EIHP/MESD (2019): Energy in Croatia 2018 [2-19], EIHP/MESD (2018): Energy in Croatia 2017 [2-20], EIHP/MESD (2017): Energy in Croatia 2016 [2-21], EIHP/MESD (2016): Energy in Croatia 2015 [2-22] In data sources, paid incentives are expressed in HRK. The value in EUR is calculated with a fixed conversion rate of 1 EUR = 7.53450 HRK.

The share of renewable energy sources in gross final energy consumption in the Republic of Croatia in 2021 is estimated at 31.7 % [2-16].

2.7. TRANSPORT

Transport of passenger and transport of goods in the Republic of Croatia is carried out by road transport, railway transport, maritime and coastal transport, transport by inland waterways, air transport and good transport also via pipelines. The largest number of passengers is transported by road and railway transport (Table 2-10). Although the number of passengers in railway transport is higher than number of passengers in air transport, passenger-kilometres in air transport are higher than passenger-kilometres in railway transport (Table 2-11). Most goods are transported by road and by maritime and coastal transport (Table 2-12). Although the mass of goods in road transport is higher than the mass of goods in maritime and coastal transport, tonne-kilometres in maritime and coastal transport are significantly higher than tonne-kilometres in road transport, despite the fact that it is in decline (Table 2-13).

The total length of public roads in 2021 amounted to 26,412 km, of which 1,316 km are highways, 7,180 km state, 9,422 km county and 8,494 km local roads [2-23]. Road transport is carried out by passenger vehicles, goods-carrying vehicles, buses, motorcycles and mopeds and in two cities by trams. The number of road vehicles was continuously increasing and amounted to 2,385,442 in 2021, of which largest part were passenger vehicles (75.3 %), followed by lorries (8.4 %), road tractors (0.6 %), special purpose vehicles (0.7 %), tractors (5.8 %), buses (0.2 %) and mopeds and motorcycles (6.8 %) [2-23].

Table 2-10: Transport of passengers in the Republic of Croatia in the period 2015-2021

Transport	2015	2016	2017	2018	2019	2020	2021
	expressed in thousands (000) of passengers						
Road	52,126	50,423	49,561	47,704	46,831	26,153	30,993
Railway	21,683	20,742	19,832	20,271	19,854	13,103	13,541
Maritime and coastal	13,082	13,525	14,315	14,821	15,142	8,774	12,280
Air	1,919	2,102	2,181	2,224	2,270	675	1,061
TOTAL	88,810	86,792	85,889	85,020	84,097	48,705	57,874

Source: CBS: Transport (statistic in line) [2-24]

Data source states that the data on the number of passengers transported by rail in 2015 also includes the number of refugees carried in the national transport.

Table 2-11: Passenger-kilometres in the Republic of Croatia in the period 2015-2021

Transport	2015	2016	2017	2018	2019	2020	2021
	expressed in millions (000,000) passenger-kilometres						
Road	3,377	3,802	4,150	3,843	4,022	2,076	2,394
Railway	951	836	745	756	734	449	540
Maritime and coastal	624	652	702	725	873	411	582
Air	1,438	1,649	1,676	1,713	1,788	486	924
TOTAL	6,390	6,939	7,273	7,037	7,417	3,422	4,440

Source: CBS: Transport (statistic in line) [2-24]

Data source states that the data on the number of passengers transported by rail in 2015 also includes the number of refugees carried in the national transport.

Table 2-12: Transport of goods in the Republic of Croatia in the period 2015-2021

Transport	2015	2016	2017	2018	2019	2020	2021
	expressed in thousands (000) tonnes						
Road	66,491	72,503	72,329	73,997	81,110	80,693	84,953
Railway	9,939	9,985	12,178	13,444	14,449	14,992	15,176
Pipeline	8,162	8,970	10,192	10,790	8,298	9,253	9,158
Maritime and coastal	21,376	20,951	19,579	19,435	18,296	17,400	17,809
Inland waterway	566	678	574	592	815	948	697
Air	3	3	2	2	2	1	1
TOTAL	106,537	113,090	114,854	118,260	122,970	123,288	127,794

Source: CBS: Transport (statistic in line) [2-24]

Data source states that inland waterway transport does not include transit.

Table 2-13: Tonne-kilometres in the Republic of Croatia in the period 2015-2021

Transport	2015	2016	2017	2018	2019	2020	2021
	expressed in millions (000,000) tonne-kilometres						
Road	10,439	11,337	11,833	12,635	12,477	12,254	13,629
Railway	2,183	2,160	2,592	2,743	2,911	3,279	3,172
Pipeline	1,740	1,921	2,111	2,315	1,675	1,914	2,164
Maritime and coastal	122,223	113,103	108,193	106,655	101,937	93,437	95,707
Inland waterway	40	45	34	44	51	57	34
Air	2	2	2	2	2	1	1
TOTAL	136,627	128,569	124,764	124,394	119,053	110,943	114,707

Source: CBS: Transport (statistic in line) [2-24]

Data source states that inland waterway transport does not include transit.

Total length of railway lines in 2021 amounted to 2,617 km, of which 2,342 km were single-track and 275 km double-track lines. 994 km of railways lines were electrified, i.e. 38.0 % of the total length of railways. There were a total of 558 railway stations and other official places [2-23].

The Republic of Croatia has six ports open for public traffic of outstanding (international) economic importance in the cities of Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik. Inland waterway ports open to international public traffic are Osijek, Sisak, Slavonski Brod and Vukovar. Length of navigable inland waterways amounts to 1,017 km in 2021 [2-7].

Airports in public air traffic in 2021 were Franjo Tuđman, Dubrovnik, Split, Zadar, Osijek, Pula, Rijeka, Brač and Lošinj.

Pipeline transport includes crude oil transport through oil pipelines and gas through gas pipelines. The length of the oil pipeline has not changed since 2005 and in 2021 the length of the oil pipeline amounted to 610 km [2-23], [2-25]. The length of gas pipeline in 2021 amounted to 2,549 km [2-23].

2.8. INDUSTRY

According to volume indices of industrial production in the period 2017-2021, industrial production in the Republic of Croatia grew (Table 2-14). The exception was the year 2020, when the global coronavirus pandemic (COVID-19) caused a reduction of economic and social activities and mobility. In the period 2015-2021, the total sale value of industrial products grew (Table 2-15). The only significant decrease was in 2020 due to the global coronavirus pandemic (COVID-19). The total sale value of industrial products in 2021 amounted to EUR 20,353,045,458 (provisional data), in which the value of sales of products from manufacturing dominated (Table 2-15). Manufacturing had the largest independent share in gross value added and in total employment in the Republic of Croatia [2-7, 2-27, 2-28, 2-29]. According to sale value of industrial products, the leading place in manufacturing had the manufacture of food products, followed by the manufacture of coke and refined petroleum products, the manufacture of fabricated metal products (except machinery and equipment) and the manufacture of other non-metallic mineral products [2-30].

Table 2-14: Volume indices of industrial production in the Republic of Croatia in the period 2017-2021

	2017	2018	2019	2020	2021
	indices are to be read horizontally only				
Volume indices of industrial production	<u>100</u>	99	100	97	103
	101	<u>100</u>	101	98	104
	100	99	<u>100</u>	97	103
	103	102	103	<u>100</u>	106
	97	96	97	94	<u>100</u>

Source: CBS (2022): Croatia in figures 2022 [2-26]

Table 2-15: Sale value of industrial products in the period 2015-2021

Sale value of industrial products	2015	2016	2017	2018	2019	2020	2021
TOTAL (million EUR)	16,395	15,990	17,896	19,494	18,524	17,032	20,356
Mining and quarrying (%)	4.04	3.06	2.53	2.13	1.94	1.62	1.82
Manufacturing (%)	83.51	85.23	81.12	80.17	79.83	79.31	78.19
Electricity, gas, steam and air conditioning supply (%)	11.24	10.48	15.23	16.63	17.13	17.95	19.00
Water collection, treatment and supply (%)	1.22	1.22	1.13	1.07	1.10	1.13	0.99

Source: CBS (2022): Croatia in figures 2022 [2-26], CBS (2022): Statistical information 2022 [2-7], CBS (2021): Statistical information 2021 [2-27], CBS (2019): Statistical information 2019 [2-28]

Data source [2-26] states that data for 2021 are provisional.

In data sources, total sale value of industrial products is expressed in HRK. The value in EUR is calculated with a fixed conversion rate of 1 EUR = 7.53450 HRK.

2.9. WASTE MANAGEMENT

The total amount of waste generated in economic activities and in households in the Republic of Croatia grew in the period 2016-2020 and amounted to 5,366,953 t in 2016, 5,543,310 t in 2018 and 6,003,759 t in 2020 [2-10]. This growth was related, among other things, to an increase in the amount of generated secondary waste (waste generated in waste treatment,) as result of construction and commissioning of waste treatment facilities for mixed municipal waste (mechanical biological treatment facilities), particularly from 2018 onwards. The largest share in total amount of generated waste in the period 2016-2020 have waste from construction, waste from mining and quarrying, household waste (municipal waste and other waste generated by population) and waste from water supply, sewerage, waste management and remediation activities [2-10]. In 2020, shares of individual sectors in the total amount of waste generated were 24 % (construction), 20 % (household waste), 16 % (water supply, sewerage, waste management and remediation activities), 12 % (mining and quarrying) and 28 % (all other sectors) [2-10]. Of the total amount of waste generated in 2020, 46.2 % was recycled, 23.8 % was disposed on landfills, 10.4 % was pre-treated before final waste treatment, 3.3 % was used for backfilling, 1.5 % was energy recovered and 0.2 % was incinerated without energy recovery, while for 14.6 % of the total amount of waste generated there is no recorded data on waste treatment [2-10]. Not all generated waste is treated in the Republic of Croatia.

All local self-government units have organized municipal waste collection, and this service covered 99.8 % of the population of the Republic of Croatia in 2021 [2-31]. In the period 2015-2021 total and specific amounts of generated municipal waste were increasing (Table 2-16). The exception was 2020 due to the global coronavirus pandemic (COVID-19). In 2021, 1,766,560 t of municipal waste was generated, which amounted to 454 kg/inhabitant (Table 2-16).

The quantities of separately collected municipal waste (paper and cardboard, glass, plastic, metal, biowaste, bulky waste, waste electrical and electronic equipment) grow (Table 2-16) and the share of separately collected municipal waste amounted to 43.1 % in 2021. This growth was a result of investment in infrastructure for separate collection of municipal waste (doorstep containers, recycling yards, separate collection vehicles, sorting facilities) [2-31].

Table 2-16: Municipal waste generated in the Republic of Croatia in the period 2015-2021

Municipal waste	2015	2016.	2017	2018	2019	2020	2021
Total generated (kt)	1,653.9	1,679.8	1,716.4	1,768.4	1,811.6	1,693.0	1,766.6
Total generated (kg) per capita	393	403	416	432	444	418	454
Separately collected (kt)	391.1	428.5	488.2	553.8	670.8	694.1	761.7

Source: MESD (2022): Report on municipal waste for 2021 [2-31]

The amount of recovered municipal waste is increasing (Table 2-17). In 2021, of the total amount of separately collected municipal waste, 560,129 t was recovered, while the amount of actual recycled waste was 555,320 t, and thus the municipal waste recovery rate is 32 %, and the recycling rate is 31% [2-31]. In the period 2015-2021, the share of municipal waste sent to landfills decreased (Table 2-17). In 2021, the amount of disposed municipal waste amounted to 1,029,608 t, of which 4,290 t refers to waste sent for cross-border disposal and 84,093 t to impurities and non-targeted materials that were separated before actual recycling process and sent for disposal [2-31].

Table 2-17: Share of municipal waste per treatment operations in the period 2015-2021

Municipal waste	2015	2016	2017	2018	2019	2020	2021
Sent to disposal (%)	80	77	72	66	59		
Disposed (%)						60	58
Sent to recovery (%)	18	21	24	25	30		
Recovered (%)						30	32
Other (%)	2	2	4	9	11	10	10

Source: MESD (2022): Report on municipal waste for 2021 [2-31]

Special categories of waste in the period 2015 - July 2021 were biowaste, waste textiles and footwear, packaging waste, waste tires, waste oils, waste batteries and accumulators, end-of-life vehicles, waste containing asbestos, medical waste, waste electrical and electronic equipment, waste ships, marine litter, construction waste, waste sludge from wastewater treatment plants, waste from titanium dioxide production, waste polychlorinated biphenyls and polychlorinated terphenyls.² For packaging waste, waste tires, waste oils, waste batteries and accumulators, end-of-life vehicles and waste electrical and electronic equipment, extended producer responsibility system has been set up, as compensation that is charged to producers for placing on the market of the Republic of Croatia products of which at the end of their life a special category of waste is generated.

Mariščina (Primorje-Gorski Kotar County) and Kaštijun (Istria County) waste management centres were operational in 2021 [2-10]. Another nine waste management centres were in preparation or under construction [2-10]. In 2020 there were in total 324 recycling yards [2-10]. In 2020, biological waste treatment facilities included 14 composting facilities with a total capacity of 145,500 t/year and 35 biogas plants with a total capacity of 839,808 t/year [2-10]. In 2020 five legal entities i.e. companies in Croatia had permit for waste R1 recovery operation at six different locations with a total capacity of 395,480 t/year, and additionally there were 41 energy recovery facilities that are not obliged to obtain a waste management permit but perform their activity based on registration in the register of collectors and recoverers [2-10]. Waste management facilities also include transfer stations, facilities for sorting separately collected waste, crushers and construction waste recovery plants, facilities for recycling plastic, glass and paper, recovery of waste electrical and electronic equipment, end-of-life vehicles and waste batteries, and landfills.

Since 2005, a total of 317 locations of official landfills have been recorded and monitored [2-32]. In 2021, waste was disposed at 89 landfills. Municipal waste was disposed at 81 landfills and at 8 landfills exclusively industrial waste was disposed [2-32]. In 2021, in total 1,593,329 t of waste (municipal waste, industrial waste and other types of waste) was disposed [2-32]. The amount of disposed biodegradable municipal waste in 2021 was 594,107 t [2-31, 2-32]. By the end of 2021, 232 landfills had been closed, and waste had been relocated from 95 locations where landfills were once located [2-32]. In the period 2015-2021, the number of remediated landfills increased. There are no hazardous waste landfills in the Republic of Croatia [2-33].

² In the period 2015 - July 2021, the Sustainable Waste Management Act (Official Gazette 94/13, 73/17, 14/19, 98/19).in force. In July 2021, a new Waste Management Act (Official Gazette 84/21) was adopted, according to which special categories of waste are waste textiles and footwear, packaging waste, waste tires, waste oils, waste batteries and accumulators, end-of-life vehicles, construction waste and waste containing asbestos, medical waste, waste electrical and electronic equipment, waste from titanium dioxide production, waste polychlorinated biphenyls and polychlorinated terphenyls and disposable (single-use) plastics and fishing gear containing plastics.

Despite the development of infrastructure, facilities and systems for waste management, part of the waste management goals set by the regulations of the Republic of Croatia and the European Union have not been achieved.

2.10. CONSTRUCTION AND HOUSING

According to the volume indices of construction works, construction works in the period 2015-2021 grew (Table 2-18). The number of building permits issued for buildings and civil engineering works also grew (Table 2-18). In 2021, value of construction works done with own workers amounted to EUR 2,891,910,000 (Table 2-18), of which 44.7 % refers to buildings and 55.3 % to other civil engineering works [2-33].

Table 2-18: Volume indices of construction works, issued building permits and value of construction works done with own workers in the Republic of Croatia in the period 2015-2021

	2015	2016	2017	2018	2019	2020	2021
Volume indices of construction works (Ø 2015 = 100)	100	103.3	105.1	110.3	119.5	124.7	136.3
Building permits issued (number)	6,328	8,018	9,418	9,406	9,932	9,403	10,553
Value of construction works done with own workers (million EUR)	1,778	1,863	1,904	2,061	2,379	2,541	2,892

Source: CBS: Construction (statistic in line) [2-33], CBS (2022): Croatia in figures 2022 [2-26], CBS (2020): Croatia in figures 2020 [2-34]

Construction of residential buildings grew in the period 2015-2021 (Table 2-19). The construction of non-residential buildings grew in the period 2015-2019, while in 2020 and 2021 it was lower compared to 2019 (Table 2-19).

Table 2-19: Completed buildings in the Republic of Croatia in the period 2015-2021

	2015	2016	2017	2018	2019	2020	2021
Residential buildings (number)	3,678	3,811	3,699	3,824	4,316	4,580	5,007
Non-residential buildings ⁽¹⁾ (number)	963	1,013	1,241	1,109	1,205	1,165	1,064
TOTAL	4,641	4,824	4,940	4,933	5,521	5,745	6,071
Residential buildings (thousands m ²)	979	1,012	1,041	1,302	1,430	1,524	1,632
Non-residential buildings ⁽¹⁾ (thousands m ²)	919	820	988	905	1,137	941	829
TOTAL	1,898	1,832	2,029	2,207	2,567	2,465	2,461

Source: CBS: Construction (statistic in line) [2-33]

⁽¹⁾ Non-residential buildings are Hotels and similar buildings, Office buildings, Wholesale and retail trade buildings, Traffic and communication buildings, Industrial buildings and warehouses, Public entertainment, education, hospital or institutional care buildings and Other non-residential buildings

2.11. AGRICULTURE

Agriculture in the Republic of Croatia includes crop production, animal production and fishing. Crop production is carried out on agricultural land that includes arable land and gardens, vegetable gardens, permanent grasslands (meadows and pastures), orchards, vineyards and olive groves, nurseries and osier

willows areas. Utilized agricultural areas decreased in the period 2015-2021 (Table 2-20) and amounted to 14,764 km² in 2021 which is 26.1% of the Republic of Croatia land area. The largest share of utilized agricultural areas in 2021 were arable land and gardens (58.0 %) and permanent grasslands (35.5 %) (Table 2-20).

Table 2-20: Utilized agricultural area in the Republic of Croatia in the period 2015-2021

Utilized agricultural area	2015	2016	2017	2018	2019	2020	2021
	expressed in ha						
Arable land and gardens	841,939	872,406	815,323	803,902	822,809	888,928	856,738
Vegetable gardens	2,150	1,885	1,848	1,848	1,848	1,777	1,678
Permanent grasslands	618,070	600,000	607,555	607,555	606,129	536,683	539,596
Orchards, vineyards and olive groves	74,799	71,060	71,217	71,645	72,964	77,782	77,401
Nurseries	310	342	382	357	355	576	492
Osier willows	361	326	338	338	340	459	446
TOTAL	1,537,629	1,546,019	1,496,663	1,485,645	1,504,445	1,506,205	1,476,351

Source: Ministry of Agriculture (2022): Annual report on agriculture status in 2021 [2-35], Ministry of Agriculture (2021): Annual report on agriculture status in 2020 [2-36]

The number of cattle and pigs decreased in the period 2015-2021, while the number of sheep, goats, ungulates, and poultry increased (Table 2-21).

Table 2-21: Number of livestock and poultry in the Republic of Croatia in the period 2015-2021

Number	2015	2016	2017	2018	2019	2020	2021
	expressed in thousands (000)						
Cattle	440.09	444.61	450.76	414.13	420.24	422.88	427.59
Pigs	1,195.14	1,193.29	1,152.43	1,080.46	1,054.85	1,033.05	971.31
Sheep	607.71	618.90	636.81	636.29	657.20	661.99	654.34
Goats	62.06	75.53	76.77	80.06	81.54	86.26	85.78
Horses	21.87	22.78	23.21	23.65	24.70	25.80	28.97
Donkeys and mules	2.47	2.88	3.27	3.71	4.10	4.68	
Donkeys							5.27
Poultry	10,189.79	9,856.35	10,399.40	11,412.80	12,746.69	13,056.72	12,096.17
Rabbits	84.99	84.31	84.31	84.31	84.31	84.31	

Source: Ministry of Agriculture (2022): Annual report on agriculture status in 2021 [2-35] for year 2021, MESD (2022): Croatian greenhouse gas inventory for the period 1990-2020 (National Inventory Report 2022) [2-37] for the period 2015-2020.

Maritime fishing takes place in the fishing sea of the Republic of Croatia, which includes external and internal fishing sea divided into 11 fishing zones. In 2021, maritime fishing was carried out with 7,757 vessels, of which were 329 ships (27,665 GT) and 7,428 boats (16,956 GT) [2-38]. The total catch and production of sea fish, crabs, shellfish and molluscs in 2021 amounted to 85,341 t, of which 61,574 t was caught and 23,767 t is production [2-38]. The largest share of the total catch and production was pelagic (blue) fish (71.5 %) and the rest were other types of fish, crabs, crustaceans, shellfish and molluscs (28.5 %) [2-38].

Freshwater fishing takes place in fishponds and open waters. Commercial freshwater fishing takes place in the fishing areas of the Sava River (three fishing zones) and the Danube River (two fishing zones). Sport freshwater fishing takes place in five fishing areas. In 2021, carp fishpond area in exploitation amounted to 124.84 km² and trout fishpond area in exploitation amounted to 0.045 km² [2-38]. The total production of consumable freshwater fish in 2021 amounted to 4,149 t, of which 68.1 % was carp production [2-38]. Production of milt amounted to 53,123,000 pieces of freshwaters fish in 2021 [2-38].

2.12. FORESTRY

Forest land area did not change significantly in the period 2015-2021 (Table 2-22) and amounted to 27,534 km² in 2021 which is 48.7 % of the Republic of Croatia land area. Of the total forest land area in 2021 forests covered 25,309 km² (91.9 %), other forest land 1,830 km² (6.6 %) and arid land covered 396 km² (1.4 %). According to the ownership structure, state-owned forest land dominated (Table 2-23).

Table 2-22: Forest land area in the Republic of Croatia in the period 2015-2021

Forest land area	2015	2016	2017	2018	2019	2020	2021
	expressed in km ²						
Forests	24,504	24,927	24,969	25,006	25,077	25,127	25,309
Other forest land	2,663	2,241	2,173	2,108	2,016	1,946	1,830
Arid land	422	423	411	406	409	400	396
TOTAL	27,590	27,590	27,553	27,518	27,502	27,473	27,534

Source: CBS (2022): Croatia in figures 2022 [2-26], CBS (2020): Croatia in figures 2020 [2-34], CBS (2018): Croatia in figures 2018 [2-39], CBS (2017): Croatia in figures 2017 [2-40]

Table 2-23: Ownership structure of forest land area in the period 2015 - 2021

Forest land area	2015	2016	2017	2018	2019	2020	2021
	expressed in km ²						
State-owned forests	20,973	20,973	20,953	20,930	20,904	20,879	20,850
Private forests	6,617	6,617	6,600	6,588	6,598	6,594	6,685
TOTAL	27,590	27,590	27,553	27,518	27,502	27,473	27,534

Source: CBS (2022): Croatia in figures 2022 [2-26], CBS (2020): Croatia in figures 2020 [2-34], CBS (2018): Croatia in figures 2018 [2-39], CBS (2017): Croatia in figures 2017 [2-40]

Forest Management Area Plan for the Republic of Croatia for period 2016-2025 determined growing stock of 418,618,277 m³ while its yearly increment amounts to about 10.1 million of m³. Growing stock per hectare in state-owned forests is 275 m³/ha and is 68 % higher in relation to growing stock of private forests. The most abundant deciduous trees in total growing stock are Common beech (37.2 %), Pedunculate oak (11.6 %) and Sessile oak (9.4 %) and the most abundant coniferous trees are Silver fir (7.9 %), Common spruce (2.3 %) and Black pine (1.4 %) [2-41].

According to their purpose, forests are categorized into commercial forests, protective forests, and special purpose forests. In 2021, commercial forests covered 15,456 km² (61.1% of the forest area) [2-42]. Protective forests cover 5,245 km² (20.7 % of the forest area) and special purpose forests cover 4,607 km² (18.2 % of the forest area) [2-42].

Commercial forests are primarily used for producing wood and non-wood forest products. In the period 2015-2019, the amount of wood cut in total (roundwood) grew, after which it fell in 2020 and 2021 (Table 2-24). The share of fuel wood in roundwood grows, while the proportion of industrial roundwood decreases (Table 2-24).

Table 2-24: Production of forest products in the Republic of Croatia in the period 2015-2021

Production	2015	2016	2017	2018	2019	2020	2021
	expressed in thousands (000) m ³						
Fuel wood, including wood for charcoal	1,769	1,768	1,858	2,176	2,205	2,207	2,130
Industrial roundwood (wood in the rough)	3,410	3,397	3,449	3,214	3,195	3,027	2,856
Sawlogs and veneer logs	2,451	2,402	2,392	2,675	2,628	2,469	2,394
Pulpwood	949	988	1,052	533	562	554	458
Other industrial roundwood	10	7	5	6	5	4	4
TOTAL	5,179	5,165	5,307	5,390	5,400	5,234	4,986

Source: CBS (2022): Croatia in figures 2022 [2-26], CBS (2017): Croatia in figures 2017 [2-40]

2.13. WATER RESOURCES

Spatial arrangement of surface waters (rivers, lakes, transitional and coastal waters) and groundwaters and their connection are primarily determined by morphological and hydrogeological features of the Republic of Croatia area. The Republic of Croatia area hydrographically belongs to the Black Sea basin and the Adriatic Sea basin and is divided into the Danube River water area and the Adriatic water area, whose watershed passes through the highest peaks of mountainous Croatia [2-43].

In the water area of the Danube River in the Black Sea basin, there is a large concentration of surface waters and a branched network of streams. The largest rivers are the Danube, Sava, Drava, Kupa and Mura with catchment areas of more than 10,000 km² [2-43]. The rivers Krapina, Lonja-Trebež, Česma, Ilova-Pakra, Orłjava, Biđ-Bosut and Dobra, Korana, Glin and Una in the sub-basin area of the Sava River and Karašica-Vučica, Baranjska Karašica and Vuka in the sub-basin area of the Drava and Danube rivers have catchment areas of 1,000 to 10,000 km² [2-43]. In addition, there are about 50 rivers in the sub-basin of the Sava River and about 15 rivers in the sub-basin of the Drava and Danube rivers, which have a medium-sized catchment area of 100 to 1,000 km² [2-43].

In the Adriatic water area, the density and length of surface watercourses is significantly lower, but there are significant underground flows through karst systems. Most of rainwater sinks into deeper layers, to impermeable horizons where there are underground water reserves and permanent karst springs. Watercourses occur in areas with less pronounced karst phenomena, where there are alluvial deposits and where underground circulation is not deep. There is no surface water on the islands, except for occasional torrents or rare springs, usually of small capacity. The largest river that flows into the Adriatic Sea is the Neretva, with a catchment area of 10,520 km², where most of the catchment (over 95 %) is in Bosnia and Herzegovina, and the Republic of Croatia owns only the most downstream part of the catchment, i.e. the Neretva delta [2-43]. The four large rivers of the Adriatic basin are: Lika, Zrmanja, Krka and Cetina with a catchment area of 1,000 to 10,000 km², and about 40 rivers with a catchment area of 100 to 1,000 km² are all in the Republic of Croatia, with the largest part of the Cetina basin in Bosnia and Herzegovina [2-43].

According to average water balance, the Republic of Croatia area is abundant with water (Table 2-25), but the annual distribution of water quantities is not favourable, because there is a distinct spatial and temporal unevenness in distribution of water resources.

Table 2-25: Basic characteristics of water resources of the Republic of Croatia

	Black Sea catchment area	Adriatic catchment area	The Republic of Croatia
Waters -total (10 ⁹ m ³ /year)	128.38	27.94	156.32
Water resources - total (10 ⁹ m ³ /year) ⁽¹⁾	83.72	27.94	111.66
Own waters - total (10 ⁹ m ³ /year)	11.86	14.22	26.08
Groundwater - total (10 ⁹ m ³ /year)	2.66	6.47	9.13
Independency coefficient ⁽²⁾	0.142	0.509	0.234
Freedom coefficient ⁽³⁾	0.00	1.00	0.25

Source: Water Management Strategy (Official Gazette 91/08)

⁽¹⁾ Data source states that 50 % of the waters of the Danube and Sava downstream from the mouth of the Una are included in total water resources.

⁽²⁾ Independency coefficient is share of own waters in renewable water resources.

⁽³⁾ Freedom coefficient is share of waters that do not flow into the territory of other states, i.e. that flow into the Adriatic Sea.

The Republic of Croatia has few natural lakes. The largest natural lakes are Lake Vransko near Pakoštane (30.7 km²), Lake Prokljansko (11.1 km²) and Lake Vransko on the island of Cres (5.8 km²) [2-9]. The largest artificial lakes are Lake Dubravsko (17.1 km²), Lake Peruća (13.0 km²) and Lake Varaždin (10.1 km²) [2-9]. The Plitvice Lakes are world-famous with the lake course of the Korana River with cascading lakes connected by travertine waterfalls.

There are significant wetlands in the Republic of Croatia area, especially in floodplains of the Drava, Danube, Sava and Neretva basins. On the Ramsar list of wetlands of international importance are Kopački rit on the Drava and Danube basins, Lonjsko polje and Ribnjaci Crna mlaka in the Sava basin, and the lower course of the Neretva and Lake Vrana in the Adriatic basin [2-11].

The Adriatic Sea is the northernmost part of the Mediterranean Sea. It is of closed type and has a total area of about 138,600 km² (together with islands). The total volume of the Adriatic Sea is about 35,000 km³, which is 4.6 % of the volume of the Mediterranean Sea [2-43]. The shores of the Adriatic Sea are shared by six countries: Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, and Albania. The part of the Adriatic Sea belonging to the Republic of Croatia is the eastern coast, which stretches from Prevlaka in the south to Cape Savudrija in the west, including all the islands, islets and rocks along the coast, and the Palagruža archipelago [2-43]. The area of the territorial sea and internal sea waters is 31,479 km² [2-7]. The total length of the sea coast of the Croatian part of the Adriatic Sea is 6,278 km, of which about 1,880 km is the mainland (29.9 %) and about 4,398 km (70.1%) is the island part [2-7]. The sea border, 948 km long, extends along the outer edge of the territorial sea. The exclusive economic zone of the Republic of Croatia in the Adriatic Sea is adjacent to it. [2-8].

The indented coast and long coastline are reason for abundance of coastal waters [2-43]. The coastal area of the Republic of Croatia is separated from the inland by high mountains. The Croatian islands include almost all the islands of the eastern coast of the Adriatic and its central part, making it the second largest island in the Mediterranean. There are 1,244 of them, and they are geographically divided into 79 islands, 524 islets, 642 rocks and reefs [2-44]. Considering the number of islands, islets, rocks and reefs, the Croatian Adriatic coast is extremely indented. The islands are divided into the Istrian, Kvarner,

North Dalmatian, Central Dalmatian and South Dalmatian groups, and the largest islands are: Krk (405.78 km²), Cres (405.78 km²), Brač (394.57 km²) and Hvar (299.66 km²) [2-9].

2.14. OTHER NATIONAL CIRCUMSTANCES

Contamination with mine-explosive means and unexploded ordnance left over from war operations in the Republic of Croatia is a safety problem accompanied by economic, developmental, environmental, and social disturbances. In the Republic of Croatia on January 1, 2017, mine-suspected area occupied 446.6 km². On January 1, 2021, mine-suspected area occupied 249.4 km² in the area of 44 cities and municipalities in eight counties: Lika-Senj (83.9 ha), Karlovac (42.3 ha), Sisak-Moslavina (42.2 ha), Split-Dalmatia (19.2 ha), Osijek-Baranja (17.6 ha), Šibenik-Knin (12.6 ha), Požega-Slavonia (12.6 ha) and Zadar (9.2 ha) [2-45]. Forest land areas occupy the largest part of mine-suspected area (98.6%), they are followed by agricultural areas (1.1%) and other areas (0.3 %) [2-45].

2.15. KEYNOTE

The number of inhabitants of the Republic of Croatia has been continuously decreasing for a long period of time. Emissions of greenhouse gases do not fully follow the population trend (Figure 2-2). Although the number of inhabitants is decreasing, the construction of residential areas in the period 2015 - 2020 is increasing (table 2-19).

In the period 2015-2019, most indicators of economic development had a growing trend, while in 2020 a decline was recorded. However, it should be noted that the year 2020 was marked by the global coronavirus pandemic (COVID-19), which caused a reduced scope of economic and social activities and mobility. Since 2009, the link between economic growth and greenhouse gas emissions has mostly been separated (Figure 2-3).

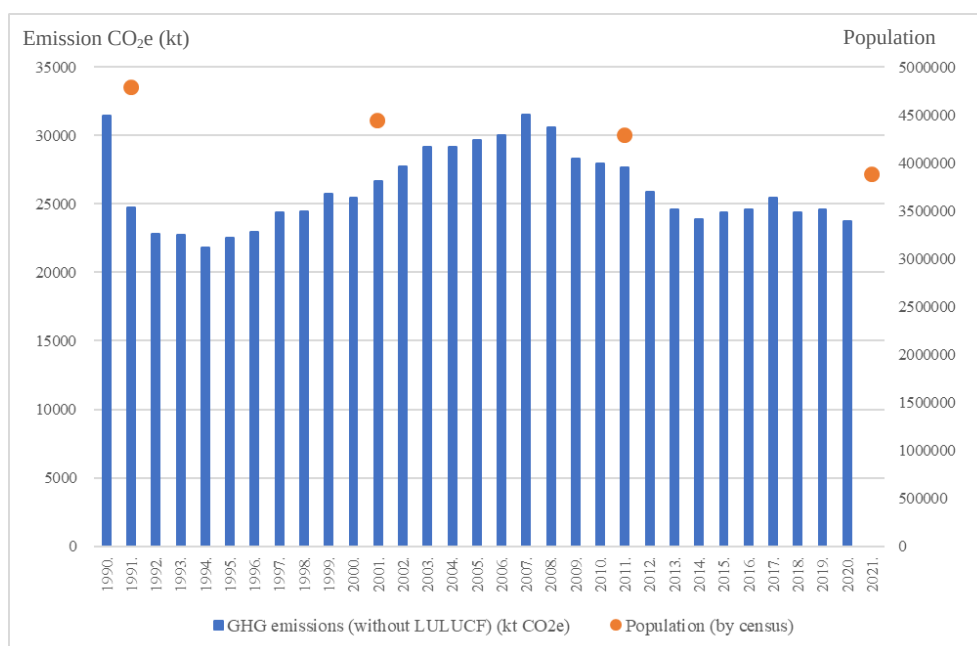


Figure 2-2: Relation of number of inhabitants according to the censuses of 1991, 2001, 2011 and 2021 and greenhouse gas emissions in the period 1990 - 2020

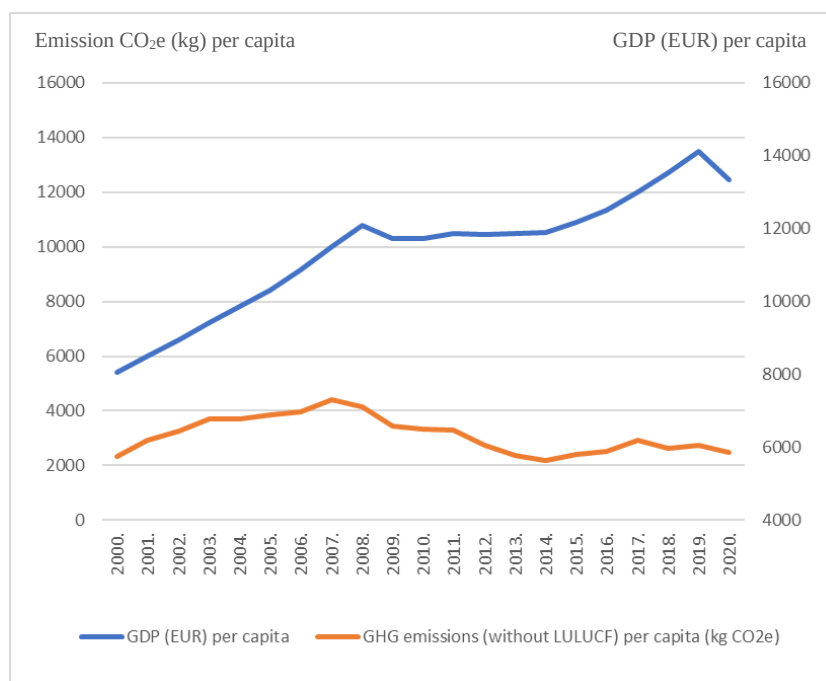


Figure 2-3: Relationship between gross domestic product and greenhouse gas emissions in the period 2000-2020

In the period 2015-2017, the total energy consumption in the Republic of Croatia and the emission of greenhouse gases (GHG) in the energy sector were increasing (Table 2-6, Table 3-2), while in the period 2018-2020 they are decreasing (Table 2-6, Table 3-2). The global coronavirus pandemic (COVID-19) marked the year 2020 with a reduced scope of economic and social activities and mobility, and already in 2021 the total energy consumption in the Republic of Croatia was higher by 4.7 % compared to 2020 (Table 2-6). As of 2010, the largest part of GHG emissions from the energy sector was a result of fuel consumption in transport [2-37], [2-46]. Road transport contributes most to GHG emissions from transport (more than 90 %) [2-37] and the number of road vehicles is continuously increasing [2-23].

Installed capacities for electricity and thermal energy generation from renewable energy sources are continuously growing, and renewable energy sources are increasingly important in total energy supply of the Republic of Croatia [2-16].

In the period 2016-2020, the total amount of waste generated in economic activities and in households in the Republic of Croatia was increasing. A significant part of the total amount of generated waste was municipal waste, and its amount was increasing (Table 2-16). Although infrastructure, facilities and systems for waste management were being developed, landfills were being remediated and closed, more and more waste was being recovered, and the amount of disposed municipal waste was decreasing, GHG emissions from waste sector did not change significantly in the period 2015-2020. In that period, it was at its highest values compared to the period since 1990 (table 3-1, table 3-2).

3. GREENHOUSE GAS EMISSION INVENTORY INFORMATION FOR THE PERIOD 1990-2020

In this chapter, the results of the greenhouse gas (GHG) emissions and removals calculation are presented for the period from 1990 to 2020, as calculated in National Inventory Report of the Republic of Croatia for the period 1990-2020 (NIR 2022) [3-1]. Summary results of the GHG emission calculation are given for the period from 1990 to 2020. Results are given as total emissions of all greenhouse gases, presented as the equivalent emission of carbon dioxide (CO₂e).

3.1. OVERVIEW OF THE GREENHOUSE GAS EMISSION AND REMOVAL ESTIMATES AND TRENDS FOR THE PERIOD 1990- 2020

Results of the GHG emission calculation are presented for the period from 1990 to 2020. Tables 3-1 and 3-2 show contribution of individual sectors to total greenhouse gas emissions and removals by sinks, while Tables 3-3 and 3-4 show contribution of individual gases to total emissions and removals.

Table 3-1: Emissions/removals of GHGs by sectors for the period from 1990 to 2010 (kt CO₂e)

Greenhouse gas source and sink categories	1990	1995	2000	2005	2010
	CO ₂ equivalent (kt)				
1. Energy	21,439.5	15,972.4	18,217.1	21,564.5	19,708.3
2. Industrial processes and product use	4,617.6	2,403.7	3,038.0	3,475.4	3,521.1
3. Agriculture	4,353.0	3,042.4	3,018.3	3,277.0	3,028.8
4. Land use, land-use change and forestry	-7,045.9	-9,537.9	-7,258.1	-8,095.1	-6,861.4
5. Waste	984.3	1,067.6	1,205.3	1,336.9	1,663.9
6. Other	NO	NO	NO	NO	NO
Total (with LULUCF)	24,348.5	12,948.1	18,220.6	21,558.8	21,060.7
Total (without LULUCF)	31,394.4	22,486.0	25,478.8	29,653.9	27,922.2

Table 3-2: Emissions/removals of GHGs by sectors for the period from 2015-2020 (kt CO₂e)

Greenhouse gas source and sink categories	2015	2016	2017	2018	2019	2020
	CO ₂ equivalent (kt)					
1. Energy	16,591.2	16,998.6	17,380.3	16,437.3	16,496.1	15,516.6
2. Industrial processes and product use	3,301.1	3,110.1	3,494.5	3,474.1	3,654.6	3,770.2
3. Agriculture	2,689.9	2,702.4	2,789.2	2,696.6	2,696.8	2,692.3
4. Land use, land-use change and forestry	-5,558.1	-5,791.4	-5,220.7	-5,609.5	-5,705.6	-5,560.9
5. Waste	1,768.3	1,800.7	1,818.0	1,794.4	1,777.2	1,779.3
6. Other	NO	NO	NO	NO	NO	NO
Total (with LULUCF)	18,792.4	18,820.4	20,261.3	18,792.9	18,919.1	18,197.5
Total (without LULUCF)	24,350.5	24,611.8	25,482.0	24,402.4	24,624.7	23,758.4

Table 3-3: Emissions/removals of GHGs by gases for the period from 1990 to 2010 (kt CO₂e)

Greenhouse gas emissions	1990	1995	2000	2005	2010
	CO ₂ equivalent (kt)				
CO ₂ emissions without net CO ₂ from LULUCF	22,979.8	16,817.7	19,662.5	23,343.9	21,016.3
CO ₂ emissions with net CO ₂ from LULUCF	15,884.6	7,225.3	12,203.0	15,178.7	14,049.0
CH ₄ emissions without CH ₄ from LULUCF	4,307.8	3,362.4	3,285.8	3,650.3	3,870.8
CH ₄ emissions with CH ₄ from LULUCF	4,309.0	3,369.9	3,382.7	3,653.0	3,872.5
N ₂ O emissions without N ₂ O from LULUCF	2,855.9	2,272.0	2,465.2	2,458.2	2,430.1
N ₂ O emissions with N ₂ O from LULUCF	2,904.0	2,319.0	2,569.7	2,525.6	2,534.2
HFCs	NO	21.8	52.9	187.2	595.1
PFCs	1,240.2	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO
SF ₆	10.7	12.1	12.3	14.3	9.8
NF ₃	NO	NO	NO	NO	NO
Total (without LULUCF)	31,394.4	22,486.0	25,478.8	29,653.9	27,922.2
Total (with LULUCF)	24,348.5	12,948.1	18,220.6	21,558.8	21,060.7
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA

Table 3-4: Emissions/removals of GHGs by gases for the for the period from 2015-2020 (kt CO₂e)

Greenhouse gas emissions	2015	2016	2017	2018	2019	2020
	CO ₂ equivalent (kt)					
CO ₂ emissions without net CO ₂ from LULUCF	17,824.7	18,109.0	18,744.0	17,724.2	17,857.4	16,870.5
CO ₂ emissions with net CO ₂ from LULUCF	12,121.8	12,181.3	13,284.2	11,991.3	12,026.0	11,133.1
CH ₄ emissions without CH ₄ from LULUCF	3,737.1	3,801.9	3,763.0	3,619.3	3,580.5	3,532.8
CH ₄ emissions with CH ₄ from LULUCF	3,751.0	3,810.8	3,832.2	3,620.6	3,583.3	3,565.4
N ₂ O emissions without N ₂ O from LULUCF	1,775.7	1,543.8	1,663.9	1,613.8	1,618.0	1,656.6
N ₂ O emissions with N ₂ O from LULUCF	1,906.5	1,671.2	1,833.8	1,735.9	1,741.0	1,800.6
HFCs	1,007.4	1,150.5	1,304.1	1,438.8	1,561.0	1,689.7
PFCs	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO
SF ₆	5.6	6.6	7.0	6.3	7.9	8.8
NF ₃	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	24,350.5	24,611.8	25,482.0	24,402.4	24,624.7	23,758.4
Total (with LULUCF)	18,792.4	18,820.4	20,261.3	18,792.9	18,919.1	18,197.5
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA

3.2. DESCRIPTIVE SUMMARY OF THE GREENHOUSE GAS INVENTORY

The NIR 2022 is reported for the period from 1990 to 2020 and it is prepared in accordance with the UNFCCC reporting guidelines on annual Inventories as adopted by the COP (Conference of Parties); Decision 24/CP.19. Methodologies used in the emission calculation are based on the following documents: 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC Good Practice Guidance) prepared by the Intergovernmental Panel on Climate Change (IPCC).

Calculation includes emissions which are a result of anthropogenic activities, and these include the following greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), halogenated carbons (HFCs, PFCs), sulphur hexafluoride (SF₆) and nitrogen fluoride (NF₃). The EMEP/EEA methodology, set up by the United Nations Convention on Long-Range Transboundary Air Pollution (LRTAP Convention), was used for the calculation of emissions of indirect greenhouse gases: carbon monoxide (CO), oxides of nitrogen (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO₂).

Since individual greenhouse gases have different properties and consequently different contribution to greenhouse effect, it is necessary to multiply the emission of every gas by the appropriate Global Warming Potential (GWP), which refer to a 100-year time horizon. Thus, the emission of greenhouse gases is presented as the equivalent emission of carbon dioxide (CO₂e). If a removal of greenhouse gases occurs (e.g. absorption of CO₂ at increase of wood stock in forests), it is referred to as a sink of greenhouse gases and the amount is presented as a negative value. Global warming potentials used to calculate CO₂ equivalent emissions are defined in Annex III to the Decision 24/CP.19 (Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention).

Greenhouse gas emission sources and sinks are divided into five main sectors: energy, industrial processes and product use, agriculture, land use, land-use change and forestry and waste. Generally, methodology for emission calculation includes multiplying activity data (e.g. fuel consumption, cement production, number of animals, increase of wood stock etc.) with corresponding emission factors. The use of specific national emission factors is recommended wherever possible and justified, while the methodology gives recommended (default) values of emission factors for all relevant activities of the particular sectors.

3.2.1. Greenhouse gas emissions by sectors

The total emission of greenhouse gases, excluding removals by sinks, in 2020 amounts to 23,758.40 mil. t CO₂e, which represents a reduction of emissions by 24.3% compared to 1990.

Overall decline of economic activities and energy consumption in the period 1991-1994, which was mainly the consequence of the war in Croatia, had directly caused decline in total emissions of greenhouse gases in that period. With the entire national economy in transition process, some energy-intensive industries reduced their activities or phased out certain productions (e.g. blast furnaces in Sisak, primary aluminium production in Šibenik, coke plant in Bakar), which was considerably reflected in GHG emissions reduction. Emissions started to increase in 1995 at an average rate of 3 % per year,

till 2008. Due to decreasing economic activity within the period 2008-2018, emission has been reducing constantly till 2014 when emission started to grow slowly.

The main impact on GHG emission increase in the period 1995-2008 had the energy sector (public electricity and heat production and transport), industrial processes and product use sector (cement production, lime production, ammonia production, nitric acid production and consumption of HFCs) and waste sector. Increase in Public electricity and Heat production sector is mostly due to higher consumption of liquid fuels. Lately, cement, lime, ammonia and nitric acid producers reached their highest production capacity, which has reflected on emission levels. Solid waste disposal, as well as wastewater treatment and discharge, have the greatest impact on emission increase in the waste sector.

The main reason for GHG emission decrease in the period from 2008 to 2016 were economic crisis as well as the implementation of measures for CO₂ emission reduction, according to the National Action Plan for Energy Efficiency for the period from 2014 to 2016 and for the period from 2017 to 2019. Namely, because of the economic crisis, there was a decrease in industrial production (primarily a decline in cement, lime and steel production) and consequently, a decrease in fuel consumption (greatest reduction in fuel consumption was in Manufacturing industries and construction sector and also in the transport sector), which led to GHG emission decrease.

Figure 3-1 shows total GHGs emissions and removals by sinks and their trend by sector in the period from 1990 to 2020.

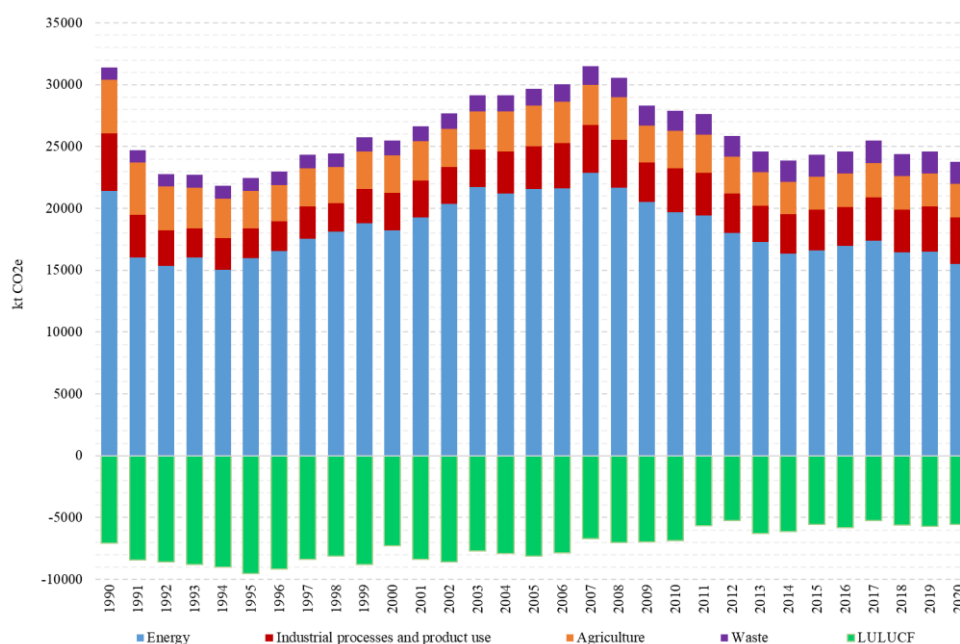


Figure 3-1: Greenhouse gases emissions trend by sector

The largest contribution to the GHGs emission in 2020 excluding LULUCF has the energy sector with 65.3 %, followed by industrial processes and product use with 15.9 %, agriculture with 11.3 % and waste with 7.5 %. This distribution is, with minor changes, consistent throughout the observed period from 1990 to 2020. In the year 2020, the total GHG emission in Croatia was 23,758.40 kt CO₂e excluding LULUCF sector, while the total emission including LULUCF was 18,197.47 kt CO₂e.

Energy sector

Energy sector is the largest contributor to GHG emissions. In 2020, the GHG emission from energy sector was 5.9 % lower in relation to 2019 and 27.6 % lower in relation to 1990. Energy sector covers all activities that involve fuel combustion from stationary and mobile sources, and fugitive emission from fuels. The energy sector is the main cause for anthropogenic emission of greenhouse gases. It accounts for approximately 70 % of the total GHG emission in Croatia.

The largest part of the emission is a consequence of fuel combustion in transport (37.4 % in 2020), in energy industries (23.8 % in 2020) and in small stationary energy sources, such as commercial/ institutional, residential and agriculture/ forestry/ fishing (20.5 % in 2020). Manufacturing industries and construction contribute to total emission from energy sector with 15.4 %, while fugitive emissions from fuels contribute with 2.9 %.

Industrial processes and product use

In industrial processes and product use sector, the key emission sources belong to sub-sectors mineral industry, chemical industry and product uses as substitutes for ODS, which together contribute with 96.8 % in total sectoral emission in 2020. Iron production in blast furnaces and aluminium production ended in 1992, and ferroalloys production ended in 2003. Generally, GHG emissions from industrial processes declined from 1990 to 1995, due to the decline in industrial activities during the war, while in the period 1996 – 2008, emissions slightly increased due to revitalization of the economy. Due to the reduction of economic activities after 2008, emissions from industrial processes have continuously decreased, followed by a moderate economic recovery since 2013, which caused the increase in emissions. The decrease in emissions from chemical industry in 2013 and onwards is due to a strong reduction of N₂O emissions from the nitric acid production after applying abatement technology. In 2020, emissions from industrial processes increased by 3.2% compared to 2019 and decreased by 18.4% compared to 1990.

Industrial processes and product use sector contributes to total GHG emissions with 15.9 % in 2020.

Agriculture

Emissions of CH₄ and N₂O in the agriculture sector are conditioned by different agricultural activities. For CH₄ emission, the most important source is livestock farming (enteric fermentation), which constitutes about 40.1% of sectoral CO₂e emission. The number of cattle showed continuous decrease in the period from 1990 to 2000. As a consequence, this led to CH₄ emission reduction. In the year 2000, the number of cattle has started increasing and this trend was mostly retained until 2006. From 2007 to 2010, cattle number decreased and remained at approximately the same level in 2013 and 2014. Compared to 2019, in 2020 CH₄ emission from enteric fermentation increased by 0.6 %. As for manure management emissions, CO₂e emission decreased by 1.0 % in 2020 compared to 2019. Emissions from agricultural soils decreased after 1990 and during the war due to specific national circumstances and limited agricultural practice at that time. Afterwards, the emission trend is mostly influenced by changes in the direct soil emissions; thus, emission increase can be noticed in 1997, 2001 and 2002 due to increase in mineral fertilizer consumption and crop production, later on also due to the increase of livestock population. CO₂e emission from agricultural soils increased in 2020 compared to 2019 by 1.9 %. Overall, in 2020 the GHG emission from agriculture sector decreased by 0.2 % in comparison to 2019.

Agriculture sector contributes 11.3% to the total national emission of greenhouse gases in 2020.

LULUCF

The Act on Forest (Official Gazette 68/18, 115/18, 98/19, 32/20, 145/20) regulates the growing, protection, usage and management of forests and forest land based on principles of sustainable management, economic and ecological acceptability and social responsibility. Forests and forest land are defined as a specific natural resource, and the beneficial and economic functions of forests require a special way of planning, management and use based on the principle of sustainable forest management. Sustainable forest management means the use of forests and forest land in a way, and to an extent, that maintains their biodiversity, productivity, capacity for regeneration, vitality and potential to fulfil current and future appropriate ecological, economic and social functions at local, national and global levels, and which does not cause damage to other ecosystems.

Pan-European criteria and criteria of the Republic of Croatia for sustainable forest management are: (1) maintenance and appropriate improvement of forest ecosystems and their contribution to the global carbon cycle, (2) maintenance of health and vitality of forest ecosystems, (3) maintenance and stimulation of productive functions of forests, (4) maintenance, preservation and appropriate improvement of biodiversity in the forest ecosystem, (5) maintenance and appropriate improvement of protective functions in forest management (especially soil and water) and (6) maintenance of other socio-economic functions and conditions.

Forest management plans are basic documents for the management and use of forests and forest land in the Republic of Croatia. They determine conditions for harmonious usage of forest and forest land and procedures in that area, necessary scope regarding cultivation and forest protection, possible utilization degree and conditions for wildlife management.

According to Forest Management Area Plan of the Republic of Croatia for the period 2016-2025 [3-2], forests and forest land covered 48.5 % of the total surface area of Croatia in 2016. The Plan determined the growing stock of 418,618,277 m³ while its yearly increment amounts to about 10.1 mil. m³. The most frequent species are common beech, pedunculate oak, sessile oak, and of coniferous species silver fir, spruce and black pine.

Forests and forest land are a specific natural resource. Preservation of biodiversity is recognized as necessary for the preservation of forest ecosystems, which is why it is an integral part of sustainable forest management. In addition to the Forest Management Area Plan of the Republic of Croatia, the other forest management plans are: basis of economic unit management, economic unit management programs with ecological network area management plan³, forest management program of private forest owners, special purpose forest management program for defence needs of the Republic of Croatia, forest seed facilities management program, program for protection, care and restoration of forests and program for management of special purpose forests managed by a legal entity.

³The Natura 2000 ecological network is a coherent European ecological network made up of areas where natural habitat types and habitats of wild species of interest to the European Union are found. It enables the conservation or, when necessary, the return to a favorable state of conservation of certain natural habitat types and habitats species in their natural distribution. The ecological network of the Republic of Croatia, established by the Regulation on the Ecological Network (Official Gazette 124/13) and amended by the Regulation on Amendments to the Regulation on the Ecological Network (Official Gazette 105/15), represents the areas of the European Union Natura 2000 ecological network. In 2019, the Regulation on the Ecological Network and The Competencies of Public Institutions for the Management of Ecological Network Areas (Official Gazette 80/19) was adopted.

The economic unit management program with ecological network area management plan prescribes operations on forests and forest lands, analysis of the condition of target species and habitat types of the ecological network area, management and conservation goals of target species and habitat types, conservation measures, activities to achieve goals and indicators of the implementation of the plan for the economic units for a period of ten years, and provides planning of sustainability of wood removal for the next ten as well as the next twenty years. The prerequisite for the approval of the program in question is the approval of the state administration body responsible for nature protection⁴. Through this prescribed administrative procedure, intersectoral cooperation in the sustainable management of biodiversity in the forest part of the ecological network is carried out. In this context, the project Development of forest management plans as ecological network management plans (Ecomanager) can be highlighted, with a planned duration January 2018 - December 2023, whose general goal is to ensure sustainable management of biodiversity in the forest part of the Natura 2000 area, through specific goals: (1) strengthening the capacity of employees of Hrvatske šume (Croatian Forests) for more efficient management of ecological network areas and (2) ensuring effective and sustainable management of the forest part of the Natura 2000 area through the integration of the planning process in forestry and nature protection and creation of Economic Unit Management Program with Ecological Network Area Management Plan [3-3].

In the context of biodiversity conservation, it should be noted that the Nature Protection Act (Official Gazette 80/13, 15/18, 14/19, 127/19) imposes the obligation to create a management plan for a protected nature area and/or ecological network. As part of the project Development of the framework for the management of the ecological network Natura 2000, with the expected duration September 2017 - November 2023, the preparation of a large number of management plans for protected nature areas and areas of the ecological network, some of which include areas of forests and forest land, valuable areas of grassland etc., was initiated [3-4]. These documents were created through a large number of workshops attended by a number of interested stakeholders, in order to find a way of sustainable and inclusive management of the most valuable parts of nature and overall area of the Republic of Croatia.

Only forest infrastructure, hunting management and hunting technical facilities, buildings for the purposes of defence and surveillance of the state border, monuments marking the places of mass graves of war victims, and buildings planned by spatial plans can be built in forests and on forest land. Spatial plans can be used to plan construction of buildings in forests and on forest land only if, due to technical and economic conditions, it is not possible to plan outside forest and forest land. The protection of forests and forest land in the spatial planning system is carried out through the opinions of state administration bodies responsible for performing administrative and other tasks in the field of forestry⁵, in the process of adopting spatial plans and special conditions, when issuing a location permit and creating the main project when a location permit is not issued.

Deforestation may only be permitted: (1) for the purpose of building forest infrastructure, (2) if forests or forest land should be used for another purpose of interest to the Republic of Croatia, (3) if it is required by the interests of security or defence, (4) to carry out operations in the area in accordance with acts for the implementation of spatial plans and (5) if necessary for construction of buildings that, according to

⁴ At the time of the preparation of Eighth National Communication and Fifth Biennial Report of the Republic of Croatia, the state administration body responsible for nature protection is the Ministry of Economy and Sustainable Development.

⁵ At the time of the preparation of Eighth National Communication and Fifth Biennial Report of the Republic of Croatia, the state administration body responsible for performing administrative and other tasks in the field of forestry is the Ministry of Agriculture.

spatial plan or special regulation, can be built outside construction area without an act for implementation of spatial plans. A land on which clearing was carried out must be brought to the purpose for which the clearing was carried out within two years. Otherwise, the land must be reforested during the next year.

The largest areas of forests and forest land in Croatia are state-owned (refer to chapter 2.12. Forestry). They are managed by Hrvatske šume (Croatian Forests), a public company for the management of forests and forest lands in Croatia. Since 2002, Hrvatske šume (Croatian Forests) has been the holder of the FSC certificate for forest management [3-5], which means that forests are managed according to strict ecological, social and economic standards.

Finally, sustainable use of all natural resources and sustainable spatial development and planning in the Republic of Croatia is the subject of a number of sectoral regulations, sustainable development and environmental protection documents and spatial plans. Special emphasis should also be placed on the strategic assessment of the impact of strategies, plans and programs on the environment, which is an environmental protection instrument that creates the basis for promoting sustainable development through the unification of conditions for environmental protection in the strategies, plans and programs of individual areas.

The estimate of emissions/removals in the LULUCF sector for the period 1990 - 2020 is a result of application of prescribed IPCC methodology and the estimate of emissions and removals carried out for LULUCF land categories, where: a) there are no land changes and b) on lands that have been converted to/from other land use categories (LUC).

In cases when the land remains in the same land category, the emission/removal estimate is carried out for the following groups: aboveground biomass, belowground biomass and harvested wood products (HWP, for the category Forest land remaining Forest land). In the categories of land subject to LUC, Croatia estimates aboveground biomass, belowground biomass, soil, litter and dead wood pools. In addition to the estimate of emissions/removals in the above-mentioned LULUCF land category pools, Croatia conducts an estimate of emissions due to fire in the Forest Land, Cropland and Grassland categories and an estimate of N₂O emissions associated with the loss/gain of organic matter in the soil resulting from a change in land use or management of mineral soils.

The area of each LULUCF land use category in the period 1990-2020 that is not subject to change, as well as the changes in each land category subject to LUC in the period 1990-2020, is the main reason for the increase and decrease in LULUCF emissions in the period 1990 - 2020.

Detailed information on the methods applied to determine each LULUCF sector land category (i.e. forest land, grassland) as well as emission/removal factors used for estimation in each pool and each type of LULUCF land category can be found in the Croatian 2022 National Inventory Report [3-1].

Waste

Waste sector includes the following categories: solid waste disposal, biological treatment of solid waste, incineration and open burning of waste and wastewater treatment and discharge. Solid waste disposal represents dominant CH₄ emission source in this sector.

In 2020, 68.3 % of sectoral emissions refer to emissions from solid waste disposal, compared to 32.6 % in 1990. During the reporting period, there is an increase in produced and disposed waste. In recent

years, the trend of the increase in produced waste has been slower, while the disposed waste has decreased, compared to the previous period, due to the application of waste avoidance/reduction and recycling measures, which are still insufficiently applied.

Emissions from wastewater management account for 30.1% of sectoral emissions in 2020, compared to 65.2% in 1990. The decrease in emissions during the reporting period is mostly caused by population decrease (domestic wastewater) as well as decrease in economic activities from 2008 onwards and the changing trend in industrial production (industrial wastewater).

Biological treatment of solid waste, incineration and open burning of waste contribute significantly less to sectoral emissions during the entire reporting period.

The waste sector contributes with 7.5% to the total national emission of greenhouse gases in 2020.

3.2.2. Greenhouse gas emissions by gases

Figure 3-2 presents total emission of greenhouse gases and their trend by individual gases in the period from 1990 to 2020.

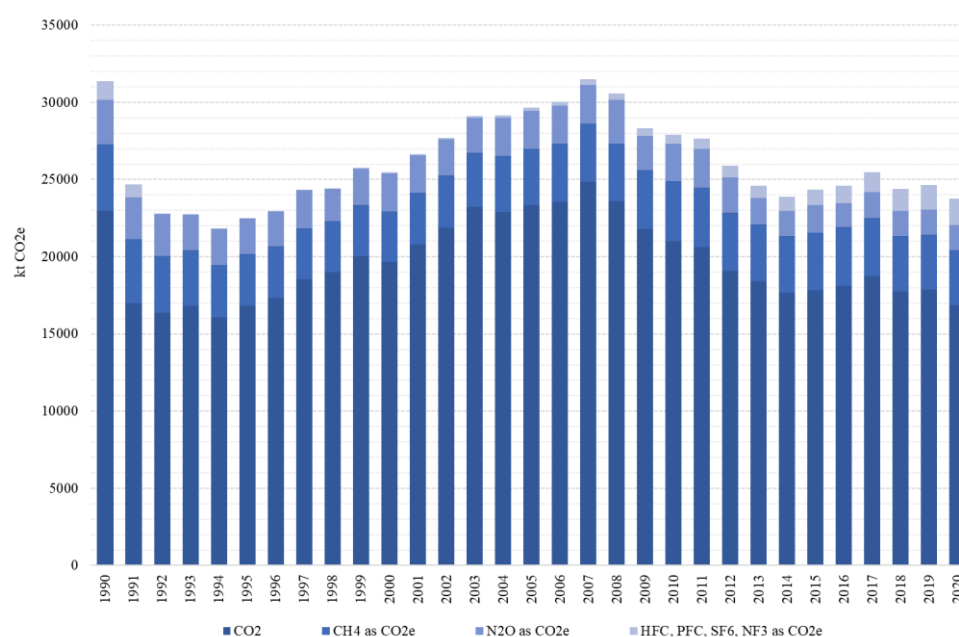


Figure 3-2: Greenhouse gas emissions trend by gases

The largest contribution to GHGs emission in 2020 excluding LULUCF comes from CO₂ emission with 71.0%, followed by CH₄ with 15.0%, N₂O with 7.6% and HFCs, PFCs and SF₆ with 7.1%.

Carbon dioxide emission (CO₂)

Carbon dioxide (CO₂) is the most significant anthropogenic GHG. As in most countries, main anthropogenic sources of CO₂ emissions in Croatia are processes of fossil fuel combustion for electricity or/and heat production, transport and industrial processes and product use (cement and ammonia production).

The energy sector is the largest source of anthropogenic carbon dioxide emissions, with a contribution of 81.3% in total carbon dioxide emissions (shown as CO₂ emissions without LULUCF).

The most energy intensive stationary sub-sector is energy industries (electricity and heat production, refineries and oil and gas field combustion). In the framework of the manufacturing Industries and construction sub-sector, predominant CO₂ emissions result from fuel combustion in industry of construction material and petrochemical production, followed by food processing industry, chemical industry, industry of pulp, paper and print, iron and steel industry and non-ferrous metal industry. Furthermore, this sub-sector includes electricity and heat production in industrial power plants.

Transport sector is also one of the significant CO₂ emission sources. This sector includes emission from road transport, civil aviation, railways and navigation. In 2020, CO₂ emission from transport sector contributed with 31.5 % to the national total CO₂ emission. The largest part of CO₂ emission from transport sector arises from road transport (96.8 % of CO₂ emission from transport sector in 2020), followed by national navigation, domestic civil aviation and railways.

Biomass combustion (fuel wood and waste wood, biodiesel, biogas) also results in greenhouse gas emissions. CO₂ emission from biomass is not included in balance, due to the assumption that the emitted CO₂ was previously absorbed in the life cycle of the plant for growth and biomass formation. Sinks or CO₂ emissions due to change in forest biomass are calculated in the LULUCF sector.

Fugitive GHG emission from coal, liquid fuels and natural gas, resulting from extraction of minerals, production, processing, transport, distribution and activities during mineral use, is also included in this sector.

Greenhouse gas emissions occur as a by-product in various industrial processes in which the input raw material is chemically transformed into the final product. Industrial processes that significantly contribute to CO₂ emissions are production of cement, lime, ammonia, and use of limestone and dehydrated soda in various industrial activities.

The most significant CO₂ industrial processes emission sources are production of cement, ammonia and lime. In 2020, mineral industry contributes to total sectoral CO₂ emission with 68.4 % and chemical industry with 26.9 %. Generally, CO₂ emissions from industrial processes declined from 1990 to 1995, due to a decline in industrial activities caused by the war in Croatia, while in the period 1996-2008 emissions increased. Production of iron and aluminium was stopped in 1992. A decrease of economic activities after 2008 influenced a reduction in cement, lime, ammonia and steel productions. In 2020, CO₂ emissions from industrial processes decreased by 1.5 % compared to 2019.

Methane emission (CH₄)

The major sources of methane (CH₄) are fugitive emissions from production, processing, transportation and activities related to fuel use in energy, agriculture and waste sectors.

In the agriculture sector, there are two significant methane emission sources: enteric fermentation in the process of digestion of ruminants (dairy cows represent the major source) and different activities related to storage and use of organic fertilizers (manure management). The total methane emission from domestic animals is being calculated as a sum of emission from enteric fermentation and emission related to manure management. The emission trend depends on the livestock population trend.

Methane emission from solid waste disposal sites (SWDSs) is a result of anaerobic decomposition of organic waste by methanogenic bacteria. The amount of methane emitted during the process of decomposition is directly proportional to the fraction of degradable organic carbon, which is defined as carbon content in different types of organic biodegradable wastes.

Of the total mass of municipal waste produced in 2020, 41% (694,160 t) is separately collected municipal waste. The largest separately collected fractions were paper and cardboard waste (29%), followed by bulky waste (19%) biowaste (17%), plastic (9.5%), glass (10%), metal (6%), electrical and electronic waste (6%), wood (5%), textiles (3%) and other waste (4%). Regarding wastewater treatment, aerobic biological processes are mostly used in Croatia. Anaerobic processes are used in the treatment of wastewater from some industries, resulting in CH₄ emissions. Disposal of domestic wastewater, particularly in rural areas where systems such as septic tanks are used, are partly anaerobic without flaring, which results in CH₄ emissions.

Nitrous oxide emission (N₂O)

The most important sources of N₂O emissions in Croatia are agricultural activities and nitric acid production, but N₂O emissions also occur in energy and waste sectors.

In the agriculture sector, three N₂O emission sources are recognised: direct N₂O emission from agricultural soils, direct N₂O emission from livestock farming and indirect N₂O emission induced by agricultural activities. According to IPCC methodology, mineral nitrogen, nitrogen from organic fertilizers, amount of nitrogen in N-fixing crops, amount of nitrogen released from crop residue mineralization, soil nitrogen mineralization due to cultivation of histosols and amount of nitrogen from the application of sewage sludge are separately analysed.

In industrial processes and product use sector, N₂O emission occurs in nitric acid production, which is used as a raw material in nitrogen mineral fertilizers. In the framework of N₂O reduction measure analysis, the possibility for application of non-selective catalytic reduction was considered, whereby nitric acid production influence on N₂O emissions would be practically eliminated.

In the energy sector, emission was calculated on the basis of fuel consumption and appropriate emission factors (IPCC). The increase in N₂O emission in the energy sector is due to the increased use of three-way catalytic converters in road transport motor vehicles.

N₂O emission from the waste sector indirectly occurs from human sewage. It is calculated on the basis of the total number of inhabitants and annual protein consumption per inhabitant. Data on the annual per capita Protein Intake Value were obtained by the FAOSTAT Statistical Database. Extrapolation method was used for data gaps estimate.

Halogenated carbons (HFC, PFC), SF₆ and NF₃ emissions

Synthetic GHGs include halogenated carbons (HFCs and PFCs) and sulphur hexafluoride (SF₆). Although on an absolute scale their emissions are not great, due to their high global warming potential (GWP), their contribution to global warming is considerable. MESD is responsible for monitoring of consumption of substitutes and mixture of substitutes for gases that deplete the ozone layer. There is no production of HFCs PFCs, SF₆ and NF₃ in Croatia; therefore, all quantities of these gases are imported. Minor quantities of some substances are exported.

Croatia is an Article 5 country, according to the Montreal protocol, and has a longer period for using CFC, HCFC and halons. Therefore, Croatia started using HFCs 10 years later than other Annex I countries.

Emission sources of PFCs CF₄ and C₂F₆ from aluminium production represent a significant source of emissions due to their high greenhouse potential. The primary production of aluminium (electrolysis) was suspended in 1991, mainly due to war activities in Croatia. After 1991, there were no PFC emissions in Croatia.

Other information (indirect GHGs)

Photochemically active gases, carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs) indirectly contribute to the greenhouse gas effect. These are generally called indirect greenhouse gases or ozone precursors because they are involved in creation and degradation of ozone, which is also one of the greenhouse gases. Sulphur dioxide (SO₂), as a precursor of sulphate and aerosols, is considered to contribute negatively to the greenhouse effect.

Emissions of indirect GHGs are taken from the document 'Republic of Croatia Informative Inventory Report for LRTAP Convention (for the period 1990-2020) Submission to the Convention on Long-range Transboundary Air Pollution (CLRTAP)' [3-6]. Emissions of indirect greenhouse gases in the period 1990-2020 are shown in Table 3-5.

Table 3-5: Emissions of indirect greenhouse gases in the period from 1990 to 2020 (kt)

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
NO_x emission	110.60	82.21	94.03	89.61	72.55	58.01	58.47	62.15	52.72	52.05	49.60
Energy	97.55	72.02	80.54	78.53	63.24	49.44	49.98	49.52	44.55	43.59	40.85
Industrial processes	2.66	2.53	2.53	2.29	1.52	1.03	0.92	1.16	0.89	0.75	0.94
Agriculture	10.35	7.43	7.91	8.67	7.70	6.87	6.54	7.26	7.08	7.12	7.12
LULUCF	0.04	0.23	3.05	0.13	0.09	0.67	1.03	4.21	0.20	0.59	0.69
CO emission	552.14	449.82	555.76	417.52	327.37	275.77	264.64	313.46	229.92	216.49	218.84
Energy	511.49	415.59	435.39	397.57	325.60	265.16	256.99	251.31	228.56	215.24	214.16
Industrial processes	39.91	27.26	30.12	17.37	0.18	0.21	0.00	0.01	0.23	0.12	0.08
LULUCF	0.74	6.96	90.24	2.58	1.59	10.40	7.65	62.13	1.13	1.12	4.60
NMVOC emission	162.03	114.46	106.57	109.39	87.84	68.90	70.05	72.19	67.06	71.80	68.35
Energy	67.22	55.81	58.95	53.42	43.65	33.97	32.72	31.49	29.60	27.86	27.21
Industrial processes	83.67	49.08	30.58	45.89	33.82	23.91	26.52	24.94	27.56	33.73	31.07
Agriculture	10.83	8.67	8.71	9.42	9.56	9.34	9.33	9.35	9.01	9.30	9.02
LULUCF	0.10	0.63	7.94	0.21	0.15	0.92	0.71	5.62	0.10	0.13	0.29
Waste	0.21	0.27	0.38	0.45	0.66	0.75	0.77	0.80	0.79	0.77	0.77
SO₂ emission	170.10	76.82	59.99	58.33	35.02	15.51	14.39	12.29	9.84	7.36	5.87
Energy	169.37	76.55	59.54	57.92	35.01	15.50	14.39	12.29	9.83	7.35	5.87
Industrial processes	0.72	0.27	0.44	0.41	0.01	0.01	NO, NE,NA	0.00	0.01	0.00	0.00

3.3. NATIONAL SYSTEM FOR PREPARATION OF GREENHOUSE GAS EMISSIONS CALCULATION

Croatian national system meets the requirements established by UNFCCC decisions (Decision 24/CP.19 and Decision 19/CMP.1) and the European Regulation on a Mechanism for Monitoring and Reporting Greenhouse Gas Emissions in the European Union and its Member States (Regulation (EU) No. 525/2013).

Functioning of the Croatian national inventory system is prescribed by the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19).

3.3.1. Institutional arrangement for inventory preparation

Institutional arrangement for inventory preparation in Croatia is regulated by Chapter II of the Regulation on the Monitoring of Greenhouse Gas Emissions, Policies and Mitigation Measures in the Republic of Croatia (Official Gazette 5/17), titled “National system for the estimation and reporting of anthropogenic greenhouse gas emissions by sources and removals by sinks”. Institutional arrangements for inventory preparation in Croatia could be characterized as decentralized and out-sourced, with clear tasks breakdown between participating institutions including Ministry of Economy and Sustainable Development (MESD) and competent governmental bodies responsible for providing of activity data. Inventory preparation is entrusted to Authorised Institution, which is chosen for three year period by public tendering. Committee for inter-sectoral coordination for national system (National System Committee) is included in the approval process. Its members provide their opinion on certain parts of the Inventory, within the frame of their speciality. Members of the National System Committee are nominated by the authorized Ministries upon the MESD’s request.

MESD is a national focal point for the UNFCCC, with overall responsibility for functioning of the National system in a sustainable manner, including:

- mediation and exchange of data on greenhouse gas emissions and removals with international organisations and Parties to the UNFCCC;
- mediation and exchange of data with competent bodies and organisations of the European Union in a manner and within the time limits laid down by legal acts of the European Union;
- control of methodology for calculation of greenhouse gas emissions and removals in line with good practices and national circumstances;
- consideration and approval of the National Inventory Report prior to its formal submission to the UNFCCC Secretariat;
- organisation of greenhouse gas inventory preparation with the aim of meeting the due deadlines from article 12. of the Regulation on the Monitoring of Greenhouse Gas Emissions;
- collection of activity data;
- development of quality assurance and quality control plan of the greenhouse gas inventory in line with the Good Practice Guidance of the Intergovernmental Panel on Climate Change;
- implementation of the quality assurance procedure of the greenhouse gas inventory in line with the quality assurance and quality control plan;
- archiving of activity data on calculation of emissions, emission factors, and of documents used for inventory planning, preparation, quality control and quality assurance;
- maintaining of records and reporting on authorised legal persons participating in the Kyoto Protocol flexible mechanisms;

- selection of Authorised Institution for preparation of the greenhouse gas inventory;
- providing insight into data and documents for the purpose of technical reviews.

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Authorised Institution is responsible for inventory preparation, which includes:

- calculation of all anthropogenic emissions from sources and removals by greenhouse gas sinks, and calculation of indirect greenhouse gas emissions, in line with the methodology outlined in the current guidelines of the UNFCCC, guidelines of the Intergovernmental Panel on Climate Change, Instructions for reporting on greenhouse gas emissions as published on the MESD's website, and on the basis of the activity data;
- quantitative estimate of the calculation uncertainty for each source category and removal of greenhouse gas emissions, as well as for the inventory as a whole, in line with the guidelines of the Intergovernmental Panel on Climate Change;
- identification of key categories of greenhouse gas emission sources and removals;
- recalculation of greenhouse gas emissions and removals by sinks in cases of improvement of methodology, emission factors or activity data, inclusion of new categories of sources and removals by sinks, or application of adjustment methods;
- calculation of greenhouse gas emissions or removals from mandatory and selected activities in the land use, land-use change and forestry sector;
- reporting on issuance, holding, transfer, acquisition, cancellation and retirement of emission reduction units, certified emission reduction units, assigned amount units and removal units, and carry-over, into the next commitment period of emission reduction units, certified emission reduction units and assigned amount units, from the Registry in line with the effective decisions and guidelines of the UNFCCC and supporting international treaties;
- implementation of and reporting on quality control procedures in line with the quality control and quality assurance plan;
- preparation of the greenhouse gas inventory report, including all additional requirements in line with the UNFCCC and supporting international treaties and decisions;
- cooperation with the UNFCCC Secretariat's expert body for the purpose of technical review and assessment of the Inventory Report submissions.

EKONERG – Energy Research and Environmental Protection Institute was selected as Authorised Institution for preparation of greenhouse gas inventory for 2022.

3.3.2. Process of planning, creating and managing the inventory

Process of inventory preparation encompasses several steps starting with activity data collection, followed by emissions estimation and recalculations in accordance with the IPCC methodology and recommendations for improvements provided by the expert review team (ERT), compilation of inventory including the National Inventory Report (NIR) and the Common Reporting Format (CRF) tables and, in parallel, implementation of general and source category specific quality control procedures.

Annual data Collection Plan (ADCP) is the main document for data collection which is the responsibility of MESD. It contains source categories, activity data, data sources and competent authorities, and it is made for each sector. This document is prepared annually in collaboration between MESD and National System Committee.

Data collection is the responsibility of MESD, which represents a link between state and public institutions responsible for ensuring the availability of data and the Authorized Institution responsible for preparing the inventory. The scope and deadline for data submission to MESD is prescribed by the Act on Climate Change and Protection of the Ozone Layer (Official Gazette 127/19). Sources of activity data for inventory preparation are presented in Table 3-6.

Table 3-6: Data sources for preparation of GHG inventory

CRF sector/sub-sector	Type of data	Data source
Energy	Energy balance	- Ministry of Economy and Sustainable Development with assistance of Energy Institute Hrvoje Požar
	Registered motor vehicles database	- Ministry of Interior
	Fuel consumption and fuel characteristic data for thermal power plants	- Pollution Emission Register MESD - Verified reports of CO ₂ emission - Voluntary survey of Power Utility Company
	Fuel characteristic data	- Voluntary survey of Oil and Gas Company
	Natural gas processed (scrubbed), CO ₂ content before scrubbing and CO ₂ emission	- Voluntary survey of Central Gas Station
Industrial Processes	Activity data on production/consumption of material for a particular industrial process	- CBS, Industry, Energy and Information Society Department - MESD - 'Republic of Croatia Informative Inventory Report for LRTAP Convention for the Year 2020 Submission to the Convention on Long-range Transboundary Air Pollution'
	Activity data on production/consumption of halogenated hydrocarbons (PFCs, HFCs) and sulphur hexafluoride (SF ₆)	- MESD
	Data on consumption and composition of natural gas in ammonia production Data on cement and lime production	- Survey of ammonia manufacturer - Survey of cement and lime manufacturers - MESD
Solvent and Other Product Use	Activity data on production for a particular source category and number of inhabitants	- 'Republic of Croatia Informative Inventory Report for LRTAP Convention for the Year 2020 Submission to the Convention on Long-range Transboundary Air Pollution'
Agriculture	Livestock number	- CBS - Ministry of Agriculture

CRF sector/sub-sector	Type of data	Data source
	Production of N-fixing crops and non N-fixing crops	- CBS
	Area of histosols	- MESD
	Activity data on mineral fertilisers applied in Croatia	- Voluntary survey of Fertilizer Companies
	Activity data on sewage sludge applied	- MESD
LULUCF	Activity data on areas of different land use categories, annual increment and annual harvest and wildfires Activity data on crop production	- Ministry of Agriculture with the assistance of public company "Hrvatske šume" - MESD - CBS
Waste	Activity data on solid waste disposal	- MESD
	Activity data on biological treatment of solid waste - composting	- Composting facilities
	Activity data on biological treatment of solid waste - anaerobic digestion at biogas facilities	- Biogas facilities
	Activity data on open-burned waste	- Ministry of Agriculture - CBS
	Activity data on wastewater treatment and discharge	- State company Croatian Water (Hrvatske vode) - CBS - FAOSTAT

3.3.3. Uncertainty assessment

Uncertainties associated with both annual estimates of emissions and emission trends over time are reported according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The uncertainties are estimated using Tier 1 and Tier 2 (Monte Carlo analysis) methods defined by the IPCC methodology, which provides estimates of uncertainties by pollutant. Uncertainties are estimated excluding LULUCF and including LULUCF, according to the Good Practice Guidance for Land Use, Land-Use Change and Forestry.

Uncertainty of emissions/removals excluding LULUCF

CO₂e emission in 2020 was estimated to be 23,758.4 kt CO₂e. CO₂e emission in 1990 was estimated to be 31,394.43 kt CO₂e. Monte Carlo analysis shows that it can be stated with a certainty of 95% that total simulated emission of all categories excluding LULUCF for the year 2020 varies between 22,973.34 kt CO₂e (2.5% percentile) and 25,986.76 kt CO₂e (97.5 % percentile). Monte Carlo analysis shows that it can be stated with a certainty of 95% that total emission excluding LULUCF for the year 1990 varies between 30,445.91 kt CO₂e (2.5% percentile) and 34,383.13 kt CO₂e (97.5% percentile).

Uncertainty of trend excluding LULUCF

The Inventory trend excluding LULUCF is -24.52%, while simulated trend is -24.45%. It can be stated with a certainty of 95% that the trend will not drop below the limit of -30.81% (2.5% percentile) to -17.62% (97.5% percentile).

Uncertainty of emissions/removals including LULUCF

CO₂e emission in 2020 was estimated to be 18,197.47 kt CO₂e. CO₂e emission in 1990 was estimated to be 24,348.5 kt CO₂e. Monte Carlo analysis shows that it can be stated with a certainty of 95 % that total emission of all categories for the year 2020 according to simulation varies between 16,466.54 kt CO₂e (2.5 % percentile) and 27,797.59 kt CO₂e (97.5 % percentile). Monte Carlo analysis shows that it

can be stated with a certainty of 95 % that total emission of all categories for the year 1990 varies between 23,623.85 kt CO₂e (2.5 % percentile) and 33,871.08 kt CO₂e (97.5 % percentile).

Uncertainty of trend excluding LULUCF

The Inventory trend excluding LULUCF is -27.49 %, while simulated trend is -22.83 %. It can be stated with a certainty of 95 % that the trend will not drop below the limit of -44.66 % (2.5% percentile) or above the limit of 3.59 % (97.5 % percentile). Uncertainty included in the trend is within the range from -18.96 % to 42.21, in relation to base year emissions.

The results of the uncertainty analysis are used to drive improvements of the inventory. Most efforts were made to collect detailed information on activity data and emission factors in order to improve accuracy of the emission calculation.

3.3.4. Key categories

According to the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, key categories are those which represent 95% (Tier 1) or 90% (Tier 2) of the total annual emissions in the last reported year or belonging to the total trend, when ranked from the largest to the smallest share in annual total emissions and trend.

Following the specified IPCC guidelines, analysis of key categories is carried out using Tier 1 and Tier 2 level and trend methods.

Level assessment

Level assessment involves identifying key categories by calculating share of emissions and removals in each category in total emissions and removals. Calculated share values are added from the category that accounts for the largest share, until the sum reaches 95% for Tier 1 or 90% for Tier 2. The Tier 1 estimate uses emissions and removals from each category directly, and the Tier 2 estimate analyses emissions and removals from each category, multiplied by the uncertainty of each category.

Trend assessment

The purpose of the trend assessment is to identify categories that may not be large enough to be identified by level assessment, but whose trend is significantly different from the overall inventory trend and therefore should be given special attention.

The difference between the rate of change of emissions and removals in the category and the rate of change of total emissions and removals is calculated. The trend estimate is calculated by multiplying this value by the ratio of the relevant category's contribution to total emissions and removals. The calculated results, which are considered trend assessment values, are added from the category whose share in the total trend assessment values is the highest, until the total amount reaches 95% for Tier 1, or 90% for Tier 2. These categories are defined as key categories. Tier 2 trend assessment is calculated by multiplying Tier 1 trend assessment by the uncertainty of each category.

Summary table with the key categories identified for the latest reporting year (by level and trend) on the basis of table 4.4 of volume 1 of the 2006 IPCC Guidelines is provided in Table 3-7.

Table 3-7: Key categories summary table for 2020

IPCC Source Categories	GHG	Criteria for Identification of key category			
1. Energy					
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO ₂	L1e L2e	T1e T2e	L1i L2i	T1i T2i
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO ₂	L1e	T1e T2e	L1i	T1i T2i
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO ₂	L1e L2e	T1e T2e	L1i	T1i
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO ₂	L1e	T1e	L1i	T1i
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO ₂	L1e	T1e T2e	L1i	T1i T2i
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO ₂	L1e	T1e	L1i	T1i
1.A.3.b Road Transportation	CO ₂	L1e	T1e T2e	L1i	T1i
1.A.3.b Road Transportation	N ₂ O	L2e	T2e		
1.A.4 Other Sectors - Biomass	CH ₄	L1e L2e	T2e	L1i L2i	
1.A.4 Other Sectors - Biomass	N ₂ O	L2e	T2e		
1.A.4 Other Sectors - Gaseous Fuels	CO ₂	L1e L2e	T1e T2e	L1i	T1i T2i
1.A.4 Other Sectors - Liquid Fuels	CO ₂	L1e L2e	T1e T2e	L1i	T1i T2i
1.A.4 Other Sectors - Liquid Fuels	N ₂ O	L2e			
1.A.4 Other Sectors - Solid Fuels	CO ₂		T1e		T1i
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CO ₂		T2e		T1i T2i
1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH ₄		T1e T2e		T1i T2i
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH ₄	L2e			
1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CO ₂	L1e L2e	T2e	L1i L2i	T1i T2i
2. Industrial Processes and Product Use					
2.A.1 Cement Production	CO ₂	L1e	T1e	L1i	T1i
2.B.1 Ammonia Production	CO ₂	L1e	T1e	L1i	
2.B.2 Nitric Acid Production	N ₂ O		T1e		T1i
2.B.8 Petrochemical and Carbon Black Production	CO ₂		T1e		T1i
2.C.2 Ferroalloys Production	CO ₂		T1e		T1i
2.C.3 Aluminium Production	CO ₂		T1e		T1i
2.C.3 Aluminium Production	PFCs		T1e		T1i
2.F.1 Refrigeration and Air conditioning - Aggregate	F-gases	L1e L2e	T1e T2e	L1i	T1i T2i
3. Agriculture					
3.A Enteric Fermentation	CH ₄	L1e L2e	T1e T2e	L1i	T1i T2i
3.B Manure Management	CH ₄	L1e		L1i	
3.B Manure Management	N ₂ O	L1e	T1e T2e		T1i
3.D.1 Direct N2O Emissions From Managed Soils	N ₂ O	L1e L2e	T2e	L1i L2i	T2i
3.D.2 Indirect N2O Emissions From Managed Soils	N ₂ O	L1e L2e		L1i L2i	T2i
4. LULUCF					
4(III).Direct N2O emissions from N mineralization /immobilization	N ₂ O				T2i
4(V) Biomass Burning	CO ₂			L1i L2i	T1i T2i
4.A.1 Forest Land Remaining Forest Land	CO ₂			L1i L2i	T1i T2i
4.A.2 Land Converted to Forest Land	CO ₂			L1i L2i	T1i T2i
4.B.1 Cropland Remaining Cropland	CO ₂			L1i L2i	T1i T2i
4.B.2 Land Converted to Cropland	CO ₂			L2i	T1i T2i
4.C.2 Land Converted to Grassland	CO ₂			L1i L2i	T1i T2i
4.D.2 Land Converted to Wetlands	CO ₂				T2i
4.E.2 Land Converted to Settlements	CO ₂			L1i L2i	T1i T2i
4.G Harvested Wood Products	CO ₂			L1i L2i	T1i T2i
5. Waste					
5.A Solid Waste Disposal	CH ₄	L1e L2e	T1e T2e	L1i L2i	T1i T2i
5.D Wastewater Treatment and Discharge	CH ₄	L1e L2e		L1i L2i	
5.D Wastewater Treatment and Discharge	N ₂ O	L2e	T2e		

L1e - Level excluding LULUCF - Tier1

L2e - Level excluding LULUCF - Tier2

L1i - Level including LULUCF - Tier1

L2i - Level including LULUCF - Tier2

T1e - Trend excluding LULUCF - Tier1

T2e - Trend excluding LULUCF - Tier2

T1i - Trend including LULUCF - Tier1

T2i - Trend including LULUCF - Tier2

3.3.5. Quality assurance, quality control and verification plan

QA/QC plan

According to Article 7. of the Regulation on the Monitoring of Greenhouse Gas Emissions, Policies and Mitigation Measures in the Republic of Croatia (Official Gazette 5/17), preparation of quality assurance and quality control plan regarding greenhouse gas inventory (hereinafter QA/QC plan), implementation of quality assurance procedures in accordance with the QA/QC plan and archiving activity data for emission calculation, emission factors and documents used for planning, preparing, controlling and assuring Inventory quality are within the competence of MESD. QA/QC plan is a part of quality assurance and quality control system (QA/QC system), stipulated by Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol. Implementation of QA/QC system is based on the following documents: Annual Data Collection Plan, QA/QC Plan, Category-specific QC checklist and Improvement Plan.

Annual data Collection Plan (ADCP) is the main document for data collection which is the responsibility of MESD. It contains source categories, activity, activity data, data source and competent authority and is made for each sector. This document is prepared annually in collaboration between MESD and National System Committee.

QA/QC plan describes overall responsibilities and roles of institutions involved in the inventory planning, preparation and management, preparation of tables for activity data collection, preparation of inventory report, inventory submission to the Convention, annual review and reporting on National GHG registry and general and specific QA/QC procedures.

Improvement Plan is a document which defines objectives related to the improvement of the National Inventory. This document considers the key category analysis and recommendations outlined in the Annual review report. The Improvement Plan incorporates recommendations listed in the annual inventory reviews with an outline of the feasible time frame for their achievement; short-term goals and long-term goals. A long-term goal implies a period longer than 2 years, needed for implementation of a specific recommendation. Tasks that were not performed in this context refer to the fact that some projects are not realized within the time frame in which they were planned, so the deadline for realization must be extended. The improvement plan is prepared annually and approved by the competent authority (MESD).

QA/QC plan prescribes the following activities and responsibilities:

Activity	Responsibility
Preparation of the QA/QC plan - Documentation revision and supplement	QA/QC coordinator (MESD)
Approval of the QA/QC plan	MESD
Implementation of QC procedures - Internal audit - Corrective and preventive activities - Reporting on performed internal audit	QA/QC coordinator (MESD) Sectoral experts (MESD), Project leader in NIR preparation (MESD) Project Coordinator (Authorized Institution) Sectoral experts (Authorized Institution) QA/QC coordinator (Authorized Institution)
Reporting on QC procedures	Authorized Institution
Implementation of QA procedures	MESD, National System Committee

Quality control activities are focused on the following elements of inventory preparation process:

- Activity data collection, import, processing and archiving;
- Preparation of GHG inventory report;
- Submission of inventory report to the UNFCCC;
- Inventory review activities;
- Reporting on the National GHG registry.

For the purpose of transparency of emission calculations and data archiving, inventory team has continued with the good practice of preparation of Inventory Data Record Sheets, which were introduced in 2001 submission and contain details of the person and/or organization responsible for emission estimates, primary or secondary sources of activity data and emission factors used, methodology applied, data gaps, cross-checking methods, suggestions for future improvements and relevant bibliographic references. The information provided in Inventory Data Record Sheets is available for each source category and for the entire time-series. All data in the form of Inventory Data Record Sheets are also archived at MESD.

During the preparation of the NIR, a number of checks were carried out by sector experts related to completeness, consistency, comparability, recalculation and uncertainty of activity data, emission factors and emission estimates. The details on these issues are elaborated in the NIR by each sector, subsector and corresponding CRF tables.

Before the Authorized Institution submits the NIR to MESD, QA/QC manager carries out an audit that covers all IPCC sectors, with the aim of checking which quality control elements (general and specific, as defined in the IPCC Good Practice Guidance) are already implemented by sector experts and which improvements and corrective actions should be included in the future submissions. CRF tables for each sector are reviewed in accordance with the Quality Management Standard and Environmental Management Standard (ISO 9001 and ISO 14001) by MESD and Authorized institution. Audit results are registered in control lists together with performed correction activities.

National System Committee is included in the approval process; its members provide their opinion on certain parts of the Inventory within the frame of their speciality. QA/QC coordinator documents all National System Committee results/findings.

Finally, MESD approves and submits Inventory to the UNFCCC.

Verification

The process of calculation verification is aimed at the improvement of the input quality and identification of the calculation reliability. The IPCC Guidelines recommend that inventories should be verified through the use of a set of simple checks for completeness and accuracy, such as checks for arithmetic errors, checks of country estimates against independently published estimates, checks of national activity data against international statistics and checks of CO₂ emissions from fuel combustion calculated using sectoral methods with the IPCC Reference Approach. Further verification checks may be done through comparison with data of other national inventories.

In the development of the Inventory, certain steps and checks were performed:

- Comparison with the national inventory data of other countries was conducted by comparing CRF tables or through a direct communication;

- Activity data were compared using different sources such as Croatian Bureau of Statistics and individual emission sources;
- The CO₂ emissions from fossil fuel combustion, within the framework of IPCC methodology, are estimated using two approaches: (1) Reference Approach and (2) Sectoral Approach (Tier 1).

3.3.6. General assessment of completeness of the inventory

The completeness is evaluated following the IPCC methodology and appropriate use of the following notation keys: NO (not occurred); NE (not estimated); NA (not applicable); IE (included elsewhere); C (confidential). Detailed description by activities and gases of the status of the emission calculation is given in corresponding CRF tables.

Generally, completeness is achieved in compliance with the capabilities of the Republic of Croatia in collecting adequate and acceptable activity data. The issues related with lack of activity data are described in sectoral chapters where necessary. The aim of the Croatian inventory is to include all anthropogenic sources of GHGs in the future.

3.3.7. Recalculations

Recalculations are carried out in accordance with the IPCC methodology, taking into account recommendations for improving the inventory.

Recalculations are performed in accordance with:

- Decisions of sectoral experts
- Suggestions of the expert review team

In the 2022 Inventory, recalculations are primarily done considering recommendations of experts review team, new emission factors and new methods given in 2006 IPCC Guidelines.

Furthermore, since the introduction of annual technical reviews of the national inventories by experts review teams (ERT), Croatia has hitherto undergone fourteen reviews, in-country review in 2004, 2007, 2008, 2012 and 2018, centralized reviews in 2005, 2006, 2009, 2010, 2011, 2013, 2014, 2016 and 2020. Recommendations given by the ERT have been included in the report to the greatest extent possible.

In addition to the revisions of the UNFCCC, since 2013 (after Croatia became one of the EU countries), the European Commission annually conducts a revision of the NIR, which is used for the purposes of recalculations.

3.3.8. Planned inventory improvements

Inventory development process, in general, encompasses inventory planning, preparation and management and each of these components have to be periodically assessed and improved. Basis for planning of inventory improvements includes: QA/QC program, QA/QC plan, recommendations identified by Committee for inter-sectoral coordination for national system and recommendations identified by the expert review teams in the course of the inventory review process.

Cross-cutting and general planned improvements

In the inventory planning phase, more attention will be given to the effectiveness of activity data collection, particularly in cases when deadlines for submission of activity data by different data providers are not fully met and/or activity data are missing in case higher IPCC methodology tiers are planned to be implemented for emission estimates.

Since inventory preparation is, according to national regulation, out-sourced to external authorized institution, it is critical to follow the timetable established by the regulatory framework and QA/QC plan and Annual data collection plan. In that respect, written protocols for activity data submission and adjustments per sectors will be prepared to envisage potential issues and actions to resolve them. Focus of the protocol will be on providing eligible and robust adjustment techniques, technical corrections and recalculations performed by the Ministry and/or authorized institution, if activity data are missing for entire time series and/or data providers are not in a position to make such adjustments.

Secondly, Committee for inter-sectoral coordination for national system was established by Government's decision in 2014 and it performs an active role in streamlining activity data collection according to the agreed timetable, provides recommendations for inventory improvement and its approval.

Still, annual review process carried out by the UNFCCC Expert Review Teams will continue to be the key driver for changes, prioritization and improvements of the inventory. In that regard, recommendations from the latest ARR are presented in the latest Inventory Report, with indication on the timeline of their implementation. The recommendations will be incorporated into the Annual Improvement Plan and approved by the competent authorities.

In the inventory preparation phase, it was decided to strengthen implementation of source-category specific QC procedures (tier 2) for key source categories and to explore possibilities to utilize bottom-up annual GHG emission reports prepared by operators or owners of installations and verified by accredited verification bodies, which fall under the EU ETS Directive, in order to harmonize GHG emissions reported under different monitoring and reporting regimes. If emission calculations prepared by bottom-up installation-specific approach (tier 3) could be reconciled with existing tier 1 or tier 2 approach, the inventory team will apply higher tier approach.

For inventory management, it was decided to improve the existing archiving system, particularly Inventory Data Record Sheets (IDRS), by means of developing a database solution for archiving information contained in IDRS in order to allow better and more user-friendly search and analysis since the amount of data have grown substantially. Better coordination among stakeholders will be applied in responding to requests for clarifying inventory information resulting from different stages of the review process of the inventory information, and information on the national system.

3.3.9. Changes in the structure of the national inventory since the submission of the last National Inventory Report

Pursuant to the Act on Amendments to the Environmental Protection Act (Official Gazette 118/18), Croatian Environment and Nature Agency (HAOP) was organizationally merged with the Ministry of Environmental Protection and Energy, since January 1, 2019, and therefore all HAOP's tasks, legal rights and obligations were taken over by the Ministry.

In 2020, the Ministry of Environmental Protection and Energy changed its name to the Ministry of Economy and Sustainable Development (MESD).

Pursuant to the Act on the Structure and Scope of State Administration Bodies (Official Gazette 85/20), the competent authority for environmental protection, which includes overall responsibility for the inventory, is the Ministry of Economy and Sustainable Development. All experts who worked on the preparation of national inventories before this change are still working on the same task within MESD.

3.4. NATIONAL REGISTRY

Initially, each EU member state had its own GHG register. Since June 2012, the GHG registries of the EU member states have been consolidated into one system - the EUCR (European Union Consolidated Registry), which is managed and maintained by the European Commission. The Union Registry is linked to the European Transaction Log (EUTL) and the International Transaction Log (ITL).

The Union Registry is a systematized and computerized database, in which accounts of greenhouse gas emission trading participants are kept. It records and monitors compliance with laws on the obligations of operators of installations and aircraft operators and records transactions and the amounts of the allocated free emission units. The registry ensures accuracy, transparency and public availability of data on the fulfilment of obligations. The functional requirements of the registry are determined by the European Commission through the Registry regulation and by the UNFCCC Secretariat through various COP/MOP decisions. All publicly available information from the Union Registry can be found on the European Transaction Log (EUTL) website. On January 1, 2013, the Croatian GHG register became part of the Union Registry, six months before Croatia became a full member of the EU. Within the unified Union Registry, each member state has its own national part of the Registry and a national administrator.

The National Administrator of the Croatian part of the Union Registry is MESD. MESD is responsible for managing the Croatian part of the Union Registry, which includes opening and managing ETS accounts, performing transactions on national accounts, producing public reports and publishing information in accordance with international and national regulations.

The registry is accessible through the Internet page:
<https://unionregistry.ec.europa.eu/euregistry/HR/index.xhtml>.

Information on changes in the National Registry, as defined in the NIR 2022, are shown in Table 3-8.

Table 3-8: Information on changes in the National Registry, NIR 2022

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No change of name or contact occurred during the reported period. National Registry administrator: Tomislav Glušac Climate Change Unit Ministry of Economy and Sustainable Development Radnička cesta 80 10000 Zagreb, Croatia e-mail: tomislav.glusac@mingor.hr
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	There was a change in the cooperation arrangement during the reported period as the United Kingdom of Great Britain and Northern Ireland no longer operate their registry in a consolidated manner within the Consolidated System of EU registries, CS EUR.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There were 6 new EUCR releases (versions 12.4, 13.0.2, 13.2.1, 13.3.3, 13.5.1 and 13.5.2) after version 11.5 (the production version at the time of the last Chapter 14 submission). No changes were applied to the database, whose model is provided in Annex A. No change was required to the application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The changes that have been introduced with versions 12.4, 13.0.2, 13.2.1, 13.3.3, 13.5.1 and 13.5.2 compared with version 11.5 of the national registry are presented in Annex B. It is to be noted that each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and are carried out prior to the relevant major release of the version to Production (see Annex B). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security were introduced.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change in the list of publicly available information with regards to confidentiality of information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reporting period.
1/CMP.8 paragraph 23 PPSR account	Previous period surplus reserve (PPSR) account will be established in the Consolidated System of European Registries (CSEUR).

Annexes A, B and H are considered to be confidential and are available upon request.

4. POLICIES AND MEASURES

4.1. PROCESS OF ADOPTION OF POLICIES

4.1.1. Legislative framework

Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19) has been in force since January 1, 2020. The Act determines the authority and responsibility for mitigation and adaptation to climate change and ozone layer protection, documents on climate change and ozone layer protection, monitoring and reporting on greenhouse gas emissions, greenhouse gas emissions trading system, sectors outside the greenhouse gas emissions trading system, ozone-depleting substances and fluorinated greenhouse gases, financing of mitigation and adaptation to climate change and ozone layer protection, information system for climate change and ozone layer protection as well as other issues related to mitigation and adaptation to climate change and ozone layer protection.

Act on Climate Change and Ozone Layer Protection is a key national legal document that regulates the framework for the implementation of European Union acts in the field of climate change and protection of the ozone layer.

In addition to the aforementioned act, the key acts relevant to the area of climate change mitigation are:

- Environmental Protection Act (Official Gazette 80/13, 153/13, 78/15, 12/18, 118/18)
- Air Protection Act (Official Gazette 127/19, 57/22)
- Energy Act (Official Gazette 120/12, 14/14, 95/15, 102/15, 68/18)
- Electricity Market Act (Official Gazette 111/21)
- Thermal Energy Market Act (Official Gazette 80/13, 14/14)
- Renewable Energy Sources and High-Efficiency Cogeneration Act (Official Gazette 138/21)
- Energy Efficiency Act (Official Gazette 127/14, 116/18, 25/20, 41/21)
- Transport Biofuels Act (Official Gazette 65/09, 145/10, 26/11, 144/12, 14/14, 94/18, 52/21)
- Act on the Deployment of Alternative Fuel Infrastructure (Official Gazette 120/16, 63/22)
- Act on the Environmental Protection and Energy Efficiency Fund (Official Gazette 107/03, 144/12)

and secondary legislation for the implementation of the mentioned acts.

4.1.2. Strategic planning documents

The key strategies in the process of adopting policies to reduce emissions and increase removals of greenhouse gases are National Development Strategy of the Republic of Croatia until 2030 (Official Gazette 13/21), Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21), Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 (Official Gazette 25/20), Long-term Strategy for the Renovation of the National Building Fund until 2050 (Official Gazette 140/20) and Agriculture Strategy until 2030 (Official Gazette 26/22).

National Development Strategy is the hierarchically highest act of strategic planning that serves to shape and implement development policies of the Republic of Croatia, and other acts of strategic planning cannot contradict it. National Development Strategy recognizes the ecological and energy transition for

climate neutrality as a strategic goal (goal 8), which will also be achieved through the reduction of emissions in the economy, transport and construction.

The preparation of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 [4-1] is an obligation under the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19). The draft of the Low-Carbon Development Strategy was prepared in 2017, when it was submitted for public debate, and refers to the energy, industry, transport, general consumption, agriculture, waste and land use sectors. The final adoption of the Low-Carbon Development Strategy Draft was postponed in order to harmonize it with the Energy Development Strategy. It was adopted by the Croatian Parliament in 2021. The Low-Carbon Development Strategy is a fundamental document in the field of climate change mitigation and an over-arching economic, development and environmental strategy. With the Low-Carbon Development Strategy, the obligations to reduce greenhouse gas emissions will be transferred to certain sectoral policies. The goal of the Low-Carbon Development Strategy is to achieve a competitive low-carbon economy by 2050, in accordance with European strategic guidelines and in accordance with the obligations of the United Nations Framework Convention on Climate Change (UNFCCC). The strategy opens up opportunities to stimulate the growth of the economy through innovation, transfer of advanced technologies and structural changes.

Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 [4-2] is an obligation under the Energy Act (Official Gazette 120/12, 14/14, 95/15, 102/15, 68/18). For the purpose of developing the Energy Development Strategy, analytical backgrounds have been prepared and presented to the professional and interested public at the end of 2018 and beginning of 2019. The analytical backgrounds contain elaborated targets for the use of renewable energy sources (RES), energy efficiency, the internal energy market and energy security. Energy Development Strategy defines the optimal energy mix and development projects with the aim of ensuring the energy independence of the Republic of Croatia, with particular emphasis on strengthening the production of energy from renewable sources. Also, special attention is paid to the security of supply, sustainability and competitiveness of the energy system. All of the above is in line with the objectives of the EU Directives in terms of reducing consumption, reducing greenhouse gas emissions, sustainability of energy development, competitiveness of the energy system and a positive investment environment.

Long-term Strategy for the Renovation of the National Building Fund until 2050 [4-3] is crucial for the use of renewable energy sources in building construction, which, through the nZEB request for new buildings and the renovation of existing buildings, includes the obligation to cover a substantial portion of primary energy for the building by using renewable energy sources at the location of the building or in its immediate vicinity. The rate of energy renovation of buildings in the period until 2020 was 0.7% per year, and the Strategy defined a gradual increase during the period 2021-2030 to 3%, with a ten-year average rate of 1.6%. An important element is the introduction of additional measurable indicators of the energy renovation, which will strengthen the process of converting the building stock into almost zero-energy, i.e. climate-neutral buildings.

The Agriculture Strategy until 2030 (Official Gazette 26/2022) synchronized the vision of agricultural development: 'to produce a larger quantity of high-quality food at competitive prices, sustainably manage natural resources while increasing resistance to climate change and contribute to improving the quality of life and increasing employment in rural areas'. The vision of agricultural development is formed in four strategic goals: 1) increasing the productivity and competitiveness of the agricultural and food sector; 2) strengthening the sustainability and resistance of agricultural production to climate

change; 3) reconstruction of the rural economy and improvement of living conditions in rural areas; and horizontal goal 4) encouraging innovation in the agricultural and food sector.

Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030 [4-4] was adopted on the basis of Regulation (EU) 2018/1999 and in accordance with the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19). Integrated National Energy and Climate Plan for the period 2021-2030 builds on existing national strategies and plans. It provides an overview of the current energy system and the situation in the field of energy and climate policy. It also provides an overview of the national goals for each of the five dimensions of the energy union (decarbonisation, energy efficiency, energy security, internal energy market and research, innovation and competitiveness) and the appropriate policies and measures to achieve these goals, for which an analytical basis should be established. In the Integrated Energy and Climate Plan, special attention is paid to the goals until 2030, which include the reduction of greenhouse gas emissions, energy from renewable sources, energy efficiency and electricity interconnection. By June 30, 2024, it is necessary to report to the EC the update of the Integrated National Energy and Climate Plan of the Republic of Croatia for the period from 2021 to 2030.

The Republic of Croatia strives to ensure that information on legislative, implementing and administrative procedures related to climate change is accessible and comprehensible to the general public in Croatia. The legislative framework (laws and secondary legislation) and strategic planning documents are publicly available through publications in the Official Gazette or through the websites of competent institutions (ministries). “Official Gazette” is the official publication of the Republic of Croatia in which laws, regulations, decisions and other official documents are published. Information on legislation, implementation measures and administrative procedures related to climate change, including relevant laws, strategies, action plans, reports and other documents, is published on the websites of competent institutions. When adopting laws, strategies or other documents related to climate change, public debates are held through which the interested professional public, non-governmental organizations, citizens and other stakeholders can provide their comments, suggestions and proposals. Also, Croatia regularly reports on its activities in the field of climate change through various reports and publications. These documents are published on the websites of competent institutions and provide details on the implementation of policies, measures and activities aimed at combating and reducing the adverse effects of climate change.

Educational and informational campaigns are conducted to educate citizens about climate change and provide them with information about the importance of legislative measures and administrative procedures that are implemented to mitigate and adapt to climate change. Various conferences, seminars and workshops are held throughout Croatia with the aim of discussing climate change and exchanging experiences. At these events, experts in the fields of climate science, policies and practice often share information about current legislative initiatives and implementation procedures.

The goals of sustainable development are integrated into the program of reforms of the Government of the Republic of Croatia and are part of the framework for monitoring the implementation of EU policies within the framework of the European Semester.

The application of the principles of sustainable development is legally binding for all levels of government and in the preparation of all types of strategic planning documents and regulations since 2013 (Environmental Protection Act). More concretely National Development Strategy of the Republic of Croatia until 2030 contains an analysis of the contribution of national development priorities to the

sustainable development goals and the UN Agenda 2030. In accordance with the Strategy, Croatia will direct investment towards the promotion of sustainability, competitiveness and innovation of the economy and society, recovery and strengthening of crisis resistance, green and digital transition and balanced regional development. In accordance with the Strategy, Croatia will direct investment towards the promotion of sustainability, competitiveness and innovation of the economy and society, recovery and strengthening of crisis resistance, green and digital transition and balanced regional development.

The goals and guidelines included in other strategic planning documents at a national, regional or sectoral level (e.g. Integrated National Energy and Climate Plan for the Republic of Croatia and other strategic planning documents listed in this chapter), as well as other development or implementation documents have to be aligned with overall strategic guidelines of the National Development Strategy of the Republic of Croatia. Therefore, the goals of sustainable development need to be taken into consideration as a horizontal principle in these documents.

4.1.3. Objectives of climate change mitigation policy

Objectives defined in the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050

Low-Carbon Development Strategy paves the way for a transition towards a sustainable, competitive economy, in which economic growth is achieved with low greenhouse gas emissions. The objectives of reducing greenhouse gas emissions by 2030 and 2050 will be implemented in the Republic of Croatia within the context of the political framework adopted by the European Union.

The general objectives of the Low-Carbon Development Strategy are the following:

- achieving sustainable development based on knowledge, a competitive low-carbon economy and efficient use of resources
- increasing the security of energy supply, sustainability of energy supply, increasing energy availability and reducing energy dependence
- solidarity by fulfilling the obligations of the Republic of Croatia under international agreements, within the framework of EU policy, as part of our historical responsibility and contribution to global goals
- reduction of air pollution and the impact on the health and quality of life of citizens.

About a hundred measures have been selected in the Low-Carbon Development Strategy that can be applied to reduce emissions (technical and non-technical), in different sectors: electricity and heat production, fuel production and processing, transport, general consumption (households and services), industry, agriculture, land use, land-use change and forestry, waste, product use and fugitive emissions. These measures have been incorporated into the three main scenarios: Reference Scenario (NUR), Gradual Transition Scenario (NU1) and Strong Transition Scenario (NU2).

The gradual transition scenario (NU1) is sized to meet the emission reduction objectives under the EU's internal commitment scheme, and the related objectives of the Paris Agreement to keep the temperature rise within 2 °C and preferably within 1.5 °C. In this scenario, emission reductions are achieved through the application of a series of cost-effective measures, strong incentives for energy efficiency and the use of renewable energy sources that could be largely market-competitive in electricity generation after 2030. The share of renewable energy sources in 2030 under this scenario is 36.4%, and in 2050 it could be 53.2%. The NU1 scenario reduces greenhouse gas emissions by 33.5% in 2030 and 56.8% in 2050, compared to 1990.

The strong transition scenario (NU2) is sized with the aim of achieving an 80% reduction in emissions in 2050, compared to 1990. In this scenario, very strong energy efficiency measures are assumed. The share of renewable energy sources in 2030 under this scenario is 36.4%, and in 2050 it could be 65.6%. In this scenario, in 2050, the dominant source of emissions remains transport, followed by agriculture and industry. By applying the measures known today, including those that are socio-economically acceptable for agriculture, an emission reduction of 73.1% could be achieved compared to 1990.

In 2030, compared to 1990 levels, in the NU1 scenario, a total reduction of 33.5% is achieved, while in the NU2 scenario, a reduction of 36.7% is achieved. The largest contribution to this decrease was made by the industry sector (43%), followed by the fuel production and processing sector (18%), the agriculture sector (15%), the electricity and heat production sector (14%) and the general consumption sector (10%). In the transport and waste sectors, emissions in 2030 are still higher than in 1990.

In 2050, in the NU1 scenario, a total decrease of 56.8% is achieved, while in the NU2 scenario, a decrease of 73.1% is achieved, compared to 1990. The largest contribution to this decrease was made by the industry sector (36%), followed by the electricity and heat production sector (15%), the fuel production and processing sector (14%), the general consumption sector (13%), the agriculture sector (11%), the transport (9%) and the waste sector (1.3%).

Objectives defined in the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030

The key objectives outlined in the Integrated Energy and Climate Plan are the reduction in greenhouse gas emissions for the Republic of Croatia for the year 2030, the share of RES in the gross final energy consumption and energy efficiency, expressed as consumption of primary energy and direct consumption of energy.

The objective of reduction in greenhouse gas emissions for the Republic of Croatia for 2030 is set by Directive (EU) 2018/410 for participants in the emissions trading system (ETS sector) and Regulation (EU) 2018/842 for non-trading sectors (non-ETS sectors):

Scope	Target for the period 2013-2020 compared to 2005	Target for the period 2021-2030 compared to 2005
ETS sector	-21 % (EU-wide target)	-43 % (EU-wide target)
Non-ETS sectors	-10 % (EU-wide target) +11 % (target for Croatia)	-30 % (EU-wide target) -7 % (target for Croatia)

Targets for the Republic of Croatia for the year 2030: share of RES in the gross final energy consumption and energy efficiency, expressed as consumption of primary energy and direct consumption of energy:

	Target for 2030
Share of RES in the gross final consumption of energy	36.6 %
Energy efficiency	
Primary energy consumption	344.4 PJ
Final energy consumption	286.9 PJ

The Republic of Croatia has a policy of supporting positive GDP growth and a pro-natalist policy, which are some of the key drivers of energy consumption, and thus of increasing greenhouse gas emissions. However, the achievement of the above-mentioned goals through the implementation of policies and measures should enable Croatia to grow economically while simultaneously reducing greenhouse gas emissions.

4.1.4. National system for reporting on policies and measures to reduce greenhouse gas emissions and emissions projections

National system for monitoring the implementation of policies and measures to reduce greenhouse gas emissions and projections of greenhouse gas emissions in the Republic of Croatia is regulated by Chapter III of the Regulation on the Monitoring of Greenhouse Gas Emissions, Policies and Mitigation Measures in the Republic of Croatia (Official Gazette 5/17). National system for policies, measures and projections is established with the aim of monitoring and reporting on the effects of policies and measures to reduce greenhouse gas emissions and enhance removals, with special emphasis on sectors not covered by the emissions trading system, reporting on emission projections and the use of financial funds from auctions. National system for policies, measures and projections ensures control and recommendations of additional measures with the aim of fulfilling the obligation to reduce greenhouse gas emissions and enhance removals, with a special emphasis on the limitations of greenhouse gas emissions from sectors not covered by the emissions trading system, up to the level of the national annual quota.

For the purpose of monitoring the fulfilment of obligations to reduce greenhouse gas emissions and enhance removals, the Report on implementation of policies and measures that reduce greenhouse gas emissions by sources or enhance removals by sinks [4-5] and the Report on projections of greenhouse gas emissions by sources and removals by sinks are prepared [4-6]. The updating of the aforementioned reports is organized in two-year cycles, in accordance with Regulation (EU) 2018/1999.

MESD is responsible for the overall national policy of environmental protection, including climate change and reporting on the implementation of policies and measures and on emission projections by sources and removals by sinks of greenhouse gases. MESD is responsible for organizing the preparation of the Inventory of greenhouse gas emissions, data collection, preparation of quality assurance and quality control plan, as well as for organizing the preparation of the Report on the implementation of policies and measures to reduce emissions and enhance sinks of greenhouse gases and Report on projections of greenhouse gas emissions by sources and their removals by sinks. It is also responsible for selection of an authorized institution for the preparation of the aforementioned reports, for a three-year period.

EKONERG - Energy Research and Environmental Protection Institute is an institution that was selected in a public tender for a three-year period to prepare reports on the Inventory of greenhouse gas emissions, Report on projections of greenhouse gas emissions by sources and their removals by sinks and Report on policies and measures to reduce emissions and enhance sinks of greenhouse gases.

In accordance with the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19), for monitoring and evaluation of the implementation and planning of policies and measures for mitigation and adaptation to climate change in the Republic of Croatia as well as participating in the review and giving opinions on Report on implementation of policies and measures that reduce greenhouse gas emissions by sources or enhance removals by sinks and Report on projections of

greenhouse gas emissions by sources and their removals by sinks, the Commission for inter-sectoral coordination of policies and measures for mitigation and adaptation to climate change was established. The Committee members include representatives of relevant central government bodies at the level of assistants to the Ministers. The composition of the Commission, tasks and functioning of the Commission is determined by the Croatian Government upon the proposal of the ministry responsible for environmental protection.

The implementation of emission reduction measures, the process of control and evaluation takes place within two systems: the emission trading system (ETS) and the system that includes sectors outside the ETS (non-ETS). Control of obligations under the ETS is carried out by checking reports by installations and aircraft operators and through reports submitted by the competent authority to the European Commission, which is prescribed by the Act on Climate Change and Ozone Layer Protection. In addition, the national inspection service is in charge for controlling the operation and fulfilling the obligations of ETS installations. Control within the non-ETS, related to maintaining the national emission of the non-ETS below the national annual quota (annual allocation of emissions), is the responsibility of MESD, and is achieved through the harmonization process within the EU primarily through the control of the national inventory report during which the European commission conducts a detailed analysis and review and check on the compliance of national emissions with the set goals.

Looking at the sector, the monitoring of the implementation of measures is realized through the system of calculating emissions in the annual national inventory of emissions by monitoring the trend of emissions.

Important internet tool is national System for Monitoring, Measurement and Verification of Energy Savings (SMiV) managed by the National Coordination Body for Energy Efficiency in accordance with the provisions of the Law on Energy Efficiency (Official Gazette 127/14, 116/18, 25/20, 41/21) and the provisions of the Ordinance on the system for monitoring, measuring and verifying energy savings (Official Gazette 98/21, 30/22). It is used to monitor, measure and verify energy efficiency measures in buildings and public lighting.

Information system for energy management (ISGE) is an online application for monitoring and analyzing energy and water consumption in public sector buildings and is an indispensable tool for systematic energy management. Systematic energy management implies strategic planning of energy and sustainable management of energy resources in buildings owned or used by cities, counties, the Government of the Republic of Croatia, as well as in buildings of other government budgetary and non-budgetary users as well as those of public authorities.

We plan to significantly improve the national system for monitoring the implementation of measures and their effect on reducing emissions. The goal is to develop an adequate management system in order to determine in a timely manner that measures from the National Integrated Energy and Climate plan are not implemented, identify and remove barriers, and achieve the required speed of the low-carbon transition, with the aim of achieving climate neutrality by 2050.

4.1.5. Changes in the national system for reporting on policies and measures to reduce greenhouse gas emissions and emissions projections

Pursuant to the Act on Amendments to the Environmental Protection Act (Official Gazette 118/18), Croatian Environment and Nature Agency (HAOP) was organizationally merged with the Ministry of

Environmental Protection and Energy, since January 1, 2019, and therefore all HAOP's tasks, legal rights and obligations were taken over by the Ministry.

In 2020, the Ministry of Environmental Protection and Energy changed its name to the Ministry of Economy and Sustainable Development (MESD).

Pursuant to the Act on the Structure and Scope of State Administration Bodies (Official Gazette 85/20), the competent authority for environmental protection is MESD. MESD is responsible for the overall national policy of environmental protection, including climate change and reporting on the implementation of policies and measures and on emission projections by sources and removals by sinks of greenhouse gases. MESD is responsible for organizing the preparation of the Inventory of greenhouse gas emissions, data collection, preparation of quality assurance and quality control plan, as well as for organizing the preparation of the Report on the implementation of policies and measures to reduce emissions and enhance sinks of greenhouse gases and Report on projections of greenhouse gas emissions by sources and their removals by sinks. It is also responsible for selection of an authorized institution for the preparation of the aforementioned reports, for a three-year period. All experts who worked on the preparation of national inventories before this change are still working on the same task within MESD.

4.2. POLICIES AND MEASURES BY SECTORS

Policies and measures that are subject of this report are included in the 'with existing measures' and 'with additional measures' scenarios given in chapter 5.

Policies and measures to reduce greenhouse gas emissions and enhance removals are shown separately for the following sectors:

- energy,
- transport,
- industrial processes and product use,
- waste,
- agriculture,
- land use, land use change and forestry (LULUCF)
- other (cross-cutting) policies and measures.

Measures described below are taken from the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030 [4-4] and the Report on implementation of policies and measures that reduce greenhouse gas emissions by sources or enhance removals by sinks [4-5].

The presented policies and measures include not only those with the most significant impact on greenhouse gas emissions, but also other measures, which could have a very low or difficult to measure impact on greenhouse gas emissions.

In Croatia, most measures are implemented at the national level, often based on EU and national legislation. However, there are also a certain number of measures that are implemented at the local level, and their implementing bodies are regional and local self-government units. Regional and local self-government units adapt the measures and their implementation to the specific needs and characteristics

of their communities. Synergy and cooperation between national and local measures is important for achieving comprehensive and effective policies and initiatives related to climate change.

4.2.1. Energy

Important currently actual strategies and plans include Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21), Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 (Official Gazette 25/20), Long-term Strategy for the Renovation of the National Building Fund until 2050 (Official Gazette 140/20) and Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030.

A number of programs in the field of energy efficiency were adopted: Program for the Development of Circular Management of Space and Buildings for the period from 2021 to 2030 (Official Gazette 143/21), Program Combating Energy Poverty, which includes the use of renewable energy sources in residential buildings in subsidized areas and areas of special state care for the period up to 2025 (Official Gazette 143/21), Program for the Development of Green Infrastructure in Urban Areas for the Period from 2021 to 2030 (Official Gazette 147/21) and programs related to energy renovation of buildings: Program for Energy Renovation of Multi-Apartment Buildings for the period until 2030 (Official Gazette 143/21), Program for Energy Renovation of Buildings that Have the status of Cultural Property for the period until 2030 (Official Gazette 143/21), Program for Energy Renovation of Public Sector Buildings for the period up to 2030 (Official Gazette 41/22).

Measures described below are taken from the Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050, Integrated Energy-Climate Plan of the Republic of Croatia for the period from 2021 to 2030 and the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 and legislative framework, and also from other legislation of the Republic of Croatia or the EU that contributes to the reduction of greenhouse gas emissions.

MEN-1: Promoting nZEB construction and renovation standards

After December 31, 2018, all public buildings in the Republic of Croatia in which reside or are owned by public bodies must be constructed according to the nZEB (Nearly Zero Energy Building) standard, and the obligation for all other newly constructed buildings occurs after December 31, 2020. These legal provisions ensure that all newly constructed buildings from 2021 onwards comply with the nZEB standard. However, in order to ensure the correct application of these directives, but also to encourage energy renovation of buildings according to the nZEB standard, in the next period it is planned to conduct a series of information and educational activities to promote construction and renovation according to the nZEB standard.

The measure has no direct effect on reducing energy consumption, but rather supports the regulatory measure for the construction of new buildings according to the nZEB standard, as well as a promotion measure for energy renovation up to the nZEB standard, which will result in measurable reduction of energy consumption, greater use of RES and avoided CO₂ emissions.

MEN-2: Energy renovation programme for apartment buildings

This program is as a continuation of the implementation of the Program of energy renovation of apartment buildings from the period from 2014 to 2020. For this purpose, it is necessary to plan funds from the ESI (European Structural and Investment) Funds for the next programming period 2021-2027 (with implementation by 2030), while implementation procedures need to be significantly simplified, especially in public procurement implementation. The technical conditions should also remain as in the

existing Program. Therefore, it is necessary to reduce the thermal needs of the building by at least 50%. It is necessary to encourage that renovation is performed according to the nZEB (Nearly Zero Energy Building) standard. In addition, establishing a special fund from which costs will be reimbursed to energy-poor households or households at risk of energy poverty should be considered, in order to remove the obstacle of securing a sufficient number of co-owners' consents for energy recovery. The implementation of the Program must be accompanied by strong promotional activities, while technical assistance should be provided to applicants. It is necessary to ensure energy consumption monitoring before and after energy renovation, for which it is necessary to create preconditions within the EMIS (Energy Management Information System). The plan includes the renovation of around 520,000 m² of apartment buildings per year.

MEN-3: Energy renovation programme for single family houses

The program should be conceived as a continuation of the implementation of the Program for energy renovation of family houses from the period from 2014 to 2020, with co-financing from the Environmental Protection and Energy Efficiency Fund. The program should leave the possibility of implementing individual measures, with respect to the order of implementation of measures (e.g. the replacement of a heating system with a more efficient system that uses RES should only be possible for those houses that have good thermal characteristics and do not need enclosure interventions). It is necessary to strongly encourage the renovation according to the nZEB standard. The implementation of the Program must be accompanied by strong promotional activities. The plan includes the renovation of around 350,000 m² of family houses per year.

MEN-4: Energy renovation programme for public buildings

The measure is based on the Programme for the Energy Renovation of Public Buildings for the Period from 2014 to 2015. For this purpose, it is necessary to plan funds from the ESI (European Structural and Investment) Funds for the next programming period 2021-2027 (with implementation by 2030). Funds need to be planned to ensure both the activation of private capital and the ESCO (Energy Service Company) market, especially for buildings that are suitable for such financing models (buildings with continuous work, such as hospitals, penitentiaries, homes for the elderly, etc.) and belonging to the category of central government buildings. Market models need to be combined with grants in order to achieve nZEB (Nearly Zero Energy Building) standards. For buildings that are not suitable for market models, it is necessary to provide grants under the same conditions as in the previous program. Renovation of public sector buildings needs to be directed towards the nZEB standard wherever technically feasible. The plan includes the renovation of around 350,000 m² of public buildings per year.

MEN-5: Energy renovation programme for buildings that have the status of cultural property

Protected buildings in terms of the Energy Renovation Programme of buildings that have the status of cultural property are those that can be classified into two categories: individually protected cultural property (individual building and construction complexes) and buildings located within the protected cultural and historical ensemble. The program does not include buildings protected as a preventively protected cultural property, or buildings registered as cultural property. Two basic approaches to energy renovation of buildings that are the subject of this Programme have been developed: a complete (integrated) approach and an approach with the application of individual energy renovation measures.

MEN-6: Energy renovation programme for public lighting

Energy renovation of public lighting in the Republic of Croatia is currently being carried out using ESI (European Structural and Investment) Funds from the European Regional Development Fund. Given the significant potential that exists in public lighting systems, it is planned to use ESI Funds in the next

programming period from 2021 to 2027. By programming a larger allocation of funds for this purpose, the existing potential could be used by the end of 2030, which is estimated at around 225-280 GWh. At the same time, the renovation of public lighting would meet the technical standards for road lighting, which means that traffic safety would be improved and light pollution would be reduced. The financing models that will be used in the next period should also enable the mobilization of private capital through energy services or public-private partnerships, in order to achieve the best possible multiplier effect. Models that are to be considered include interest rate subsidies on commercial loans/required returns to the service provider and guarantees, while it is necessary to provide grants for projects requiring investment in new public lighting infrastructure (poles, additional luminaires, etc.) to meet standard lighting requirements.

MEN-7: Energy management in the public sector

The public sector in Croatia is obliged to systematically manage energy, which is specifically regulated by the Energy Efficiency Act (Official Gazette 127/14, 116/18, 25/20, 41/21), or the Ordinance on Systematic Energy Management (Official Gazette 18/15, 6/16). The basis of this measure is an Information System for Energy Management (ISGE). The goal is to include and regularly monitor with ISGE all public sector buildings and public lighting systems by the end of 2030.

MEN-8: Energy management in the business (service and production) sector

Although large companies are obliged to conduct regular energy audits, this obligation does not ensure continuous care for energy consumption in the company, nor does it cover small and medium-sized enterprises. In order to encourage companies to introduce certified energy management systems (such as ISO 50001), a comprehensive analysis of the possibilities of using the tax system (including taxes and parafiscal levies) will be made to encourage companies to introduce such a system and thus ensure continuous care for energy consumption.

MEN-9: Informational accounts

One of the basic measures of informing consumers is the legal obligation of suppliers for submitting to consumers at least once a year information invoices, which contain information on energy billing and previous consumption of the end customer for billing meters that are the subject of the contract, which include comparison with average regular consumption or reference customer from the same category. It is desirable to reduce the frequency of application of this legal provision from the annual level to the monthly level, and it is absolutely necessary to ensure that the energy regulatory body monitors these obligations of energy suppliers. In addition, based on these regulations, it is necessary to further inform consumers about the content and meaning of bills, which is the task of the National Coordination Body for Energy Efficiency.

MEN-10: Energy efficiency information

Informing the general public and target groups will be carried out by organizing targeted info-campaigns related to specific programs to promote energy efficiency, especially energy renovation of buildings. National Coordination Body for Energy Efficiency will maintain a national energy efficiency portal and ensure continuous promotion of energy efficiency and energy services through the provision of up-to-date information. In the next period, special attention should be given to informing consumers about the duties of the supplier within the system of obligations.

MEN-11: Energy efficiency education

Training will be achieved through the continued implementation of the existing measure and the adaptation of activities to the needs and actual conditions. It is especially important to work

systematically on attracting young people to construction and other technical occupations, which will in the long run contribute to the availability of professional capacities for the implementation of energy renovation of buildings, which is the basis for achieving energy and climate goals. Through education in the field of energy efficiency, the principles of green building will be set and applied: it is necessary to encourage the promotion and implementation of green building (construction according to the principles of sustainability) as an important segment of sustainable development and the circular economy.

MEN-12: Energy efficiency of the electricity transmission network

An important characteristic of the Croatian transmission network, both in terms of plant safety and support of market activities, and in terms of losses is the extremely strong connection with neighbouring power systems (interconnections). While on the one hand this significantly increases the security of the plant, on the other hand, due to transit, the network losses increase. In the period until 2030, measures related to the management of the power system and measures related to the development of the transmission network will continue to be implemented, for optimal (safe and efficient) management of the facility.

MEN-13: Reduction of losses in the distribution network and introduction of smart grids

In the period until 2030, activities will continue to reduce technical and non-technical losses in the electricity distribution network. A detailed analysis will determine the causes of increased losses in certain parts of the network and priorities for the implementation of activities to reduce technical and non-technical losses. Based on the experience from the implementation of the pilot project of introducing advanced networks in pilot areas with the use of ESI (European Structural and Investment) Funds, it is necessary to program the continuation of the use of ESI Funds in the next programming period from 2021 to 2027 for further development of advanced networks.

MEN-14: Increasing the efficiency of the district heating systems

In the existing large centralized heating systems, a large source of losses is the deteriorated steam and hot water network, and this measure foresees the continuation of the replacement of deteriorated steel hot water pipes and steam lines with new pre-insulated pipes and a technological shift to fourth-generation district heating. In smaller systems with their own boiler room, it is necessary to enable the reconstruction of boiler rooms, in particular by replacing them with high-efficiency cogeneration systems or systems using heat pumps. The measure also envisages the development of new heating and cooling systems, which use high-efficiency cogeneration or renewable energy sources.

MEN-15: Increasing the efficiency of the gas transport network

The potential for increasing the energy efficiency of the gas transport system is largest in the consumption of natural gas, which is mostly (70%) consumed for preheating natural gas before delivery to customers, and only a small part (30%) for heating business premises and various technological reliefs, i.e. system exhaust. Activities to improve energy efficiency will be implemented in accordance with the Ten-Year Development Plan of the Gas Transport System of the Republic of Croatia 2018-2027.

MEN-16: Information, education and capacity building for RES use

Dissemination of information to the general public and target groups will be conducted through the organization of targeted informational campaigns related to investments in systems using renewable

energy sources, especially in systems for own needs. Information, education and capacity building for the use of RES will be provided at the national level.

MEN-17: Spatial planning prerequisites for RES use

Defining guidelines and criteria for the regulation of specific spatial-functional elements for the use of RES, more advanced and cross-sectoral harmonization of spatial planning conditions for determining areas suitable for the construction of RES plants at the state, county and local level. Guidelines and criteria for determining the spatial planning conditions for the use of space intended for the construction of facilities for energy recovery of RES (specific spatial-functional elements in space) and for the exploitation fields of geothermal water for energy purposes will be adopted. Conditions for determining locations and construction of RES plants will be integrated into spatial plans at the state, county and local levels.

MEN-18: Promoting the RES use for production of electricity and heat

Providing financial incentives for the development of projects for the use of RES for the production of electricity and heat. Encouraging the use of RES for electricity and heat production will be implemented at the national level.

A relatively rapid drop in the levelized costs of electricity generation from solar and wind power is expected to reach the market price level, implying their rapid integration into the operation of the system without additional incentives. The use of biomass, biogas, hydropower and geothermal energy is also expected to continue. Furthermore, it is necessary to encourage the exploitation of geothermal energy by reducing exploration risk, which can be realized with EU funds, in order to balance the price of energy obtained from geothermal water with other RES.

MEN-19: Development of the regulatory framework for RES use

It is necessary to amend the existing legal framework and develop procedures and practice for the use of RES. The goal is to fully adopt the regulatory framework and established procedures at the national level by the end of 2023.

MEN-20: Integrated planning of security of energy and energy products supply

The overarching measure to increase energy security is the integrated planning of security of supply in the context of all energy products and all energy systems. Integrated planning should be harmonized at the local, regional and national level, and in accordance with energy planning carried out by energy entities for energy infrastructure throughout the territory of the Republic of Croatia. In addition, integrated planning needs to be aligned with planning for alternative fuels and infrastructure for alternative fuels.

MEN-21: Construction and use of energy storage

In order to increase the energy storage capacity of the system and increase the regulatory capacity of the electricity system, it is planned to build additional reversible power plants with a capacity of 150 MW before 2030, development of heat storage tanks for end customers, batteries, charging stations for electric vehicles that allow energy storage, and the use of other innovative energy storage technologies.

MEN-22: Development and maintenance of centralised thermal systems

Centralised thermal systems have been identified as one of the priorities of the energy policy of the Republic of Croatia. The most significant potential for development and improvement of existing centralised thermal systems is primarily in the increase of energy efficiency of production units, infrastructure and equipment at end-users and to increase reliability and security of supply. Therefore,

this measure envisages the maintenance and upgrading of existing CTS systems, stopping the trend of disconnecting customers from the CTS systems, introducing heat storage tanks powered by electricity, and using RES for CTS as well as replacing existing CTS production with renewable sources (e.g. biofuels) and use of heat pumps.

MEN-23: LNG terminal construction

The size of the liquefied natural gas terminal depends on the interest of market. In the first phase, the construction of the FSRU vessel (Floating Storage Regasification Unit) is planned, whose maximum annual natural gas supply will amount up to 2.6 billion cubic meters. The planned maximum capacity of natural gas supply from the terminal, and indirectly its size and capacity, is conditioned by the maximum capacity of the gas pipeline system. The second phase, increasing the capacity of the terminal, depends on the additional construction of the gas pipeline.

MEN-24: Refinery modernization and transformation

Implementation of investments in modernization and improvement of production for maintaining the competitiveness of refineries. The measure includes implementation of modernization of existing infrastructure so that the techniques of extraction, transshipment and construction of a transport network with very low fugitive emissions can be applied during the oil and gas extraction process and in transshipment and transport. Also, the measure contributes to better capacity utilization of existing refineries.

MEN-25: Measures to increase energy efficiency by improving processes and process units

Increasing energy efficiency is achieved by implementing measures that contribute to reducing energy intensity through more rational use of energy and raw materials, by adding additives and by altering production processes and equipment at pumping stations and refineries, which contributes to reducing fugitive emissions.

MEN-26: Methane flaring

In Croatia, in addition to flaring in the production and processing of natural gas and oil, there is also the release of CH₄ emissions. The planned measure is to replace all venting points with flares.

In order to reduce fugitive emissions, CH₄ will be flared instead of released. In this way, methane emissions are reduced by 95-99% depending on the efficiency of the flares.

MEN-27: Development of the electricity transmission network

Croatian Transmission System Operator Ltd. is, according to the Energy Act (Official Gazette 120/12, 14/14, 95/15, 102/15, 68/18), an energy entity responsible for the management, operation and guidance, maintenance, development and construction of the transmission electricity network. According to the Electricity Market Act (Official Gazette 111/21), the Croatian Transmission System Operator, as the owner of the 110 kV to 400 kV transmission network, is obliged to develop and adopt ten-year, three-year and one-year investment plans for the development of the transmission network. Ten-year development plans are update annually. At the time of writing, the Ten-Year Transmission Network Development Plan 2019-2028 was relevant, with detailed elaboration for the initial three-year and one-year periods.

MEN-28: Development of gas transmission system

Transmission system development planning is carried out through the preparation of the Ten-Year Gas Transmission System Development Plan, the development of which is the responsibility of the gas transmission system operator pursuant to the Gas Market Act (Official Gazette 18/18, 23/20). The gas

transmission system operator is the company Plinacro Ltd. Ten-year plans for the development of the gas transmission system are update on an annual basis. At the time of preparation of this document, the Ten-Year Plan for the Development of the Gas Transport System of the Republic of Croatia 2018-2027 was relevant.

MEN-29: Elaboration of the regulatory framework for active participation of customers on the electricity market

In order to enable the active role of network users in the electricity market, it is necessary to amend the existing regulatory framework in an appropriate manner, especially through the introduction of aggregators as market participants and through enabling the launch of a pilot project to provide ancillary services. Pilot projects will analyse in detail the services that users can provide to the distribution or transmission system operator. Possible types, scope, method and period of providing ancillary services will be analysed. Barriers to the use of ancillary services will be identified and ways to remove them will be suggested. Previously, an analysis of the potential for the provision of ancillary services and flexibility services with the response of consumption by network users will be conducted, based on which the method and model of providing ancillary services and the response of consumption by network users will be defined.

MEN-30: Introduction of advanced consumption metering systems and data management

In order to enable further development of energy markets and the active role of consumers in energy markets, advanced metering devices and systems at consumption level will be introduced.

MEN-31: Adoption and implementation of the Programme for Energy Poverty Reduction

Within the Programme for Energy Poverty Reduction, capacity building will be continued through local info centres, and energy poor citizens as well as citizens at risk of energy poverty will be provided with adequate information and advice on energy efficiency measures that contribute to the reduction of energy poverty and on opportunities of cofinancing activities in this area. Furthermore, indicators necessary to monitor the energy poverty will be identified and a monitoring system will be established through the already existing system for collecting data on household consumption and habits. On the basis of data, a possible extension of criteria for gaining the status of vulnerable energy customers will be analysed. Also, the implementation of energy efficiency measures in energy poor households will be co-financed, such as replacement of household appliances by “old for new” system, upgrade or replacement of heating systems with systems that are environmentally and economically more favourable and more energy-efficient, and above all, with systems that use renewable energy sources, and the implementation of other technical energy efficiency measures will also be cofinanced.

A model to cover energy costs will be developed and implemented within the Programme. The model will determine the level of assistance needed for households facing the problem of meeting energy costs, based on the amount of energy required to meet the minimum standard of living.

MEN-32: Program for combating energy poverty, which includes the use of renewable energy sources in residential buildings in areas of special state care for the period 2021-2025

The Program for combating energy poverty, which includes the use of renewable energy sources in residential buildings in areas of special state care for the period 2021-2025 identifies 413 residential buildings. Renovation priorities were determined according to the perceived deficiencies of the buildings, and the possible savings in energy for heating and primary energy, which will be realized by the renovation of the buildings, were estimated. The total target area of renovation is 297,575 m². The total possible saving of primary energy in all buildings amounts to 27 GWh per year. The program involves the financing of reconstruction from the funds of the fund for recovery and resilience.

MEN-33: Increasing energy efficiency and use of RES in manufacturing industry

Industrial plants in Croatia have significant potential for improving energy efficiency, reducing energy consumption, as well as reducing the share of conventional (fossil) fuels in total energy consumption by introducing renewable energy sources. The aim of this measure is to ensure continued co-financing of the implementation of such measures in manufacturing industries through grants and financial instruments.

4.2.2. Transport

MTR-1: Providing information to consumers on fuel economy and CO₂ emission of new passenger cars

Pursuant to the Ordinance on Availability of Information on Fuel Economy and CO₂ Emissions from Passenger Cars (Official Gazette 7/15), each supplier of new passenger cars intended for sale shall provide consumers with information on the fuel consumption rate and specific CO₂ emission of passenger cars. Central body of state administration responsible for the road traffic safety, on the basis of the Ordinance once a year, not later than March 31 of the current year, makes a Guidelines on cost-effectiveness of fuel consumption and CO₂ emission from new passenger cars available for purchase on the market in the Republic of Croatia. The Guidelines contains required information for each model of new passenger cars available in the domestic market. Extension of information to other categories of motorized road vehicles will be implemented within the measure.

MTR-2: Special environmental fee for motor vehicles

The existing system of payment of a special environmental fee for motor vehicles is regulated by the Act on the Environmental Protection and Energy Efficiency Fund (Official Gazette 107/03, 144/12), and the Regulation on Unit Charges, Corrective Coefficients and Detailed Criteria and Standards to Determine the Special Environmental Fee for Motor Vehicles (Official Gazette 114/14, 147/14, 2/21). The special fee is charged taking into consideration the type of engine and fuel, engine operating volume, type of vehicle, CO₂ emissions and vehicle's age.

MTR-3: Special tax on motor vehicles

Based on the 'polluter pays' principle, the model's calculation is based on CO₂ emissions into the air from motor vehicles. The special tax is determined on the basis of the sales or market price of the motor vehicle, CO₂ emissions expressed in grams per kilometre, engine volume in cubic centimetres and the level of greenhouse gas emissions. This special tax encourages the purchase of energy efficient vehicles and vehicles with lower greenhouse gas emissions. The implementation of the measure is ensured through the enactment of the Act on Special Tax on Motor Vehicles (Official Gazette 15/13, 108/13, 115/16, 127/17, 121/19).

MTR-4: Monitoring, reporting and verification of greenhouse gas emissions in the lifetime of fuels and energy

In accordance with the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19) supplier that places the fuel on domestic market shall monitor greenhouse gas emissions per energy unit in the lifetime of the fuel. Suppliers have to draw up a report that has to be verified and submitted to the Ministry of Economy and Sustainable Development - the Institute for Environment and Nature.

Regulation on the Quality of Liquid Petroleum Fuels (Official Gazette 131/21) regulates the limit values of components and/or quality characteristics of liquid petroleum fuels, method of determining and monitoring the quality of liquid petroleum fuels, conditions for the operation of sampling laboratories and laboratory analysis of the quality of liquid petroleum fuels, the way of demonstrating compliance of the product, the name and marking of the product, way and deadlines for the submission of reports

on the quality of liquid petroleum fuels and emissions reports of greenhouse gases in the lifetime of fuels and energy, method of monitoring and reporting, methodology for calculation of greenhouse gas emissions in lifetime of fuels and energy, methodology for calculating the contribution of electric road vehicles to reducing greenhouse gas emissions, the format of the report, the period of the storage and the manner of transmission of data to the European Union competent bodies.

MTR-5: Legislative adjustments for cleaner transport

Through amendments to laws and bylaws, ensure the development of infrastructure for alternative fuels, raising the share of renewable sources in direct energy consumption in transport and promoting clean and energy efficient vehicles in road transport.

The objective of the measure is to increase the share of RES in traffic by 2030.

MTR-6: Financial incentives for the purchase of energy efficient vehicles

In the context of co-financing cleaner transport projects, it is necessary to define special co-financing lines for specific purposes, namely, for the purchase of electric vehicles, compressed and liquefied natural gas and hydrogen. Incentives for co-financing the purchase of vehicles will be primarily oriented towards alternative fuels for which the assessment of the existing situation has shown a minor representation in the total number of vehicles and will be time-limited until the minimum representation of vehicles is achieved. The minimum degree of market development shall be considered to be 1% of alternative fuel vehicles in the total number of vehicles registered in the country.

MTR-7: Development of infrastructure for alternative fuels

The objective of this measure is to facilitate the uptake of alternative fuels by users/consumers by strengthening the alternative fuels distribution infrastructure and implementing common technical specifications for this infrastructure. This measure will not directly affect the reduction of fuel consumption in traffic, but the development of infrastructure is certainly a necessary prerequisite for the development of the market of vehicles and vessels that use electricity, compressed and liquefied natural gas and hydrogen in Croatia.

The incentive measures for infrastructure co-financing will be primarily oriented towards alternative fuels for which an assessment of the current situation has shown that the infrastructure is underdeveloped and will be limited in time until the situation monitoring shows minimal infrastructure coverage.

MTR-8: Promotion of integrated freight transport

The measure is regulated by the Act on Combined Transport of Goods (Official Gazette 120/16) and the Ordinance on Incentives in Combined Transport of Goods (Official Gazette 5/18), which stipulates incentives for combined transport of goods by rail, inland waters or sea, and incentives for combined transport of goods on road sections.

Implementation will continue in accordance with the Act. An analysis will be made to determine the need for changes and improvements to the existing system. The possibility of including other means of road transport (except trucks) in the incentive system will be analysed as well.

MTR-9: Promotion of sustainable intermodal transport at national level

The measure follows the general and specific objectives defined in the Transport Development Strategy of the Republic of Croatia for the period from 2017 to 2030 (Official Gazette 84/17) in the context of energy efficiency of rail, road, maritime transport, inland waterway transport and urban, suburban and regional traffic. Development of rail and generally multimodal infrastructure fall behind in comparison to highway infrastructure in terms of quality and connectivity. Investments are planned to develop a sustainable, integrated trans-European climate-resilient transport network. In maritime and inland

waterway transport, the possibilities of introducing appropriate mechanisms to ensure the transition to low-carbon solutions will be analysed, especially in terms of the application of alternative energy sources for navigation. In this context, an action plan for shipping will be defined, which will, among other things, define appropriate emission standards for the coming period. Also, in air transport, the Republic of Croatia will define a plan and develop detailed guidelines for achieving a significant reduction in greenhouse gas emissions.

MTR-10: Promotion of integrated and intelligent transport systems and development of alternative fuels infrastructure at local and regional level

It is necessary to promote sustainable development of urban transport systems through the optimization of logistics of transport of goods and intelligent management of public parking spaces (ICT technologies), introduction of integrated passenger transport, introduction of car-sharing schemes in cities, introduction of low-emission zones in cities, introduction of public city bicycles system and construction of the accompanying cycling infrastructure, intelligent traffic control (upgrade, adaptation and replacement of out of date signalling devices and equipment, installation of advanced traffic equipment and intelligent traffic lights equipped with the autonomous power supply system from renewable sources, constructing and equipping central operating centres for monitoring and management of intersections with installed traffic lights). At the local level, it is necessary to continuously prepare and implement Sustainable Mobility Plans in cities, as well as strategic plans that build on the existing planning practices, and take into account integration, participation and evaluation principles to meet the citizens' mobility needs now and in the future, and ensure better quality of life in cities and their surroundings. The activities will be accompanied by appropriate information and educational campaigns.

MTR-11: Training for drivers of road vehicles for eco-driving

The aim of the measure is to raise awareness of the benefits of energy efficient driving. Education on the eco-driving elements is carried out in short trainings among the drivers who received their driver's license prior to the entry into force of the Ordinance on Training of Driver's License Candidates (Official Gazette 132/17, 6/18, 102/20), which introduced an obligation for all driving schools and instructors to carry out training on the elements of eco-driving during the standard training of candidates. Special elements of the national campaign should be devoted to eco-driving education for drivers of passenger cars, buses, commercial and heavy-duty vehicles.

MTR-12: Promotion of boat transport using alternative fuels

In accordance with the "National Coastal Shipping Service Development Plan" and considering that the Republic of Croatia is a maritime land with developed longitudinal liner traffic, and in addition has navigable river routes and lakes, this measure would co-finance the projects of gradual transition of the existing obsolete fleet to alternative and/or hybrid solutions and new construction. Ships that use alternative fuels are generally more expensive than ships that use conventional fuels, so there is no expressed interest of shipowners to invest in such ships. Therefore, in the initial period it is necessary to financially support the conversion/construction of such ships to the extent that the purchase price is equalized or puts such a shipowner in the same position as a shipowner that uses ships with conventional fuel.

MTR-13: Advanced biofuel market development plan

Increasing the share of RES in transport by 2030 through the development of the advanced fuels market and achieving the planned share of advanced fuels in direct energy consumption in transport through the criteria of the lowest cost and the largest multiplier. The implementation of the measure is based on

amendments to relevant laws and bylaws based on the Directive (EU) 2018/2001 on the Promotion of the Use of Energy from Renewable Sources, and in particular the establishment of conditions for monitoring the sustainability of biofuels and greenhouse gas savings.

MTR-14: Decarbonization of transport through the production of advanced biofuels from residues of agricultural production and energy crops with integrated carbon capture, use and storage

An industrial complex for the production of advanced bioethanol will be built based on Axens' (France) patented innovative FUTUROL™ technology with the integration of BIO-CCUS. The plant will have a capacity of 55,000 tons of advanced bioethanol per year, which will be distributed on the market through the commercial channels of INA and MOL Group. About 52,000 t/y of biogenic carbon dioxide will be captured and stored in domestic oil fields using BIO-CCUS technology. For the production of advanced bioethanol, a combination of agricultural residues, mainly cereal and corn straw, and the energy plant *Miscanthus x giganteus* will be used, in accordance with Part A of Annex IX of Directive 2018/2001 on the promotion of the use of energy from renewable sources, which lists the types of raw materials acceptable for production advanced biofuels. The industrial complex will consist of a plant for the production of advanced bioethanol, for the production of biogas, and a high-efficiency cogeneration plant.

4.2.3. Industrial processes and product use

The large emission sources within this sector - production of cement, lime and other mineral products, production of ammonia and nitric acid and production of steel, together with large energy sources, are included in the EU ETS system. Climate and energy policy framework until 2030 extends free allocation, still based on comparisons with benchmarks for products, heat, district heating and fuel. The price of emission units on the ETS market, i.e. signals related to long-term price predictability will be the main drive for industry.

Process emissions from economic activities, which are, according to the IPCC methodology, included in the industrial processes and product use sector, are estimated on the basis of detailed sectoral projections of cement industry, N₂O use for medical purposes and food industry and projected macroeconomic indicators of gross value added by industrial branches, annual growth rate of gross domestic product and population decline. Implementation of measures defined by strategic and planning sectoral documents of producers is included, which is conditioned by market requirements, laws and regulations and requirements for the application of best available techniques in production processes.

Projections also include assumptions on limiting and reducing the use of fluorinated greenhouse gases, in accordance with the provisions of Regulation (EU) 517/2014 and Directive 2006/40/EC and in accordance with the expert assessment based on the continuation of the downward trend in emissions of these pollutants.

MIP-1: Reducing the share of clinker in cement production

Measure includes gradual substitution of clinker with alternative materials in cement production which leads to reduction in clinker production. The share of used clinker substitutes depends on the composition of other raw materials used, availability of materials of appropriate composition on the market and market requirements for cements of certain composition.

MIP-2: Limiting fluorinated greenhouse gas emissions

In accordance with the Regulation (EU) 517/2014 the measure defines activities and procedures for the prevention of fluorinated greenhouse gas emissions, conducting equipment leakage checks, use of equipment with leak detection systems, keeping records of equipment on which leakage checks need to be performed, collection of fluorinated greenhouse gases to ensure their recycling, reclamation or destruction, the development of a producer responsibility system for the collection of fluorinated greenhouse gases and their recycling, reclamation or destruction, and the implementation of training and certification programs.

MIP-3: Gradual reduction of the amount of fluorocarbons that can be placed on the market

The measure concerns the gradual limitation of the amount of fluorocarbons available on the EU market by 2030 to 21% of the total amount of fluorocarbons placed on the market during the reference period 2009 to 2012, as established by Regulation (EU) 517/2014.

Regulation (EU) 517/2014 introduces a quota system for placing fluorocarbons on the market. The calculation of the benchmarks and the allocation of quotas should be based on the reported quantities of fluorocarbons placed on the market during the reference period from 2009 to 2012. Quota for placing fluorocarbons on the market shall be allocated to each manufacturer and importer for each year, starting in 2015, on the basis of benchmarks, applying defined percentages to calculate the maximum amount of fluorocarbons to be placed on the market and the allocation mechanism.

MIP-4: Restrictions and prohibitions on placing certain products and equipment on the market

The measure concerns restrictions and prohibitions on the placing on the market of certain products and equipment containing fluorinated greenhouse gases, as laid down in Regulation (EU) 517/2014.

Fluorinated greenhouse gases with high greenhouse potential are limited for use in new refrigeration and air conditioning equipment, fire extinguishing systems, foam blowing agents and aerosols.

MIP-5: Reduction of fluorinated greenhouse gas emissions from mobile air conditioning systems

Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC has been implemented in three phases. The last phase came into force on January 1, 2017, by limiting the possibility of retrofitting air conditioning equipment designed to contain fluorinated greenhouse gases with a global warming potential above 150 in motor vehicles and banning the charging of air conditioning equipment with these gases.

4.2.4. Agriculture

The positive impact of the implementation of measures on overall greenhouse gas emissions in the agriculture sector is reflected in direct reduction of methane and nitrogen compounds emissions. Measures included in the formation of scenarios of gradual transition of agriculture in relation to the referent scenario are:

MAG-1: Change in livestock diet of and feed quality

Specific sub-measures within this group of measures related to the regulation of digestive processes of livestock and their nutrition: changing the ratio of certain types of feed in the diet, the use of supplements, improving the quality of forage and improving grazing systems. These measures are largely related to the potential reduction of methane emissions from intestinal fermentation.

MAG-2: Improvement of livestock facilities and manure management systems

By improving and changing existing manure management systems and using the best available techniques, it is possible to reduce emissions.

Activities involved within this measure relate to development programs to increase the share of implementation:

- Manipulation of nutrient content and their relationship in the meal
- Changes in the manure system (type of manure) and improvement of manure collection facilities
- Measures during manure storage
- Improvements to manure management facilities

MAG-3: Modification of the livestock system

Measures that achieve effects on reducing greenhouse gas emissions refer to measures that increase the intensity of production per animal and per unit time.

In Croatia, the problem is that unused pastures and meadows cover a large area of agricultural land. In order to reduce costs, extensive fattening on pastures is becoming increasingly important. Numerous variables are included in determining the number of animals (conditional head / ha) that can be on pasture without causing damage to natural resources: soil, climate, plant composition, species and age of livestock, water availability, sensitive areas (too steep), endangered species, wetlands, etc.), general soil condition and types of livestock production.

Given the import of a large number of calves for fattening or fattened cattle and meat, the establishment of a cow-calf system imposes itself as a logical solution and source of calves that can later be fed on the same farms (pasture fattening) or fattened in specialized fattening farms. Thus, work on establishing and encouraging a cow-calf breeding system is the principal activity in this measure, with the Agricultural Census being a method on providing feedback on the rate of implementation.

MAG-4: Anaerobic decomposition of manure and biogas production

The introduction of biogas plants reduces methane emissions due to the use of litter as a renewable source for electricity production. The measure is linked to the measures in Renewable sources in the production of electricity and heat and Construction of cogeneration plants from the Energy sector. Anaerobic breakdown helps biogas plants to reduce the source of easily degradable carbon in the manure that is applied to agricultural land, but it also potentially reduces the process of nitrification and N₂O emissions (lower emissions during application, but higher during storage).

MAG-5: Improving the breeding and selection program, animal health and welfare

Main activity in this measure is research aimed at determining the variation in the predicted CH₄ emission and determining the genetic potential for reducing methane emissions in dairy cows as well as increased production intensity.

Genetic potential and type of individuals (breeding and selection work) - Intensive selection to increase productivity – higher production achieves indirect effects - fewer animals and less food consumption. Furthermore, higher food utilization results in reduced excretion of N compounds in faeces and urine, but also reduces excretion and thus their potential emission. A positive genetic correlation between PME (predicted methane emissions) and RFI (residual feed intake) shows that cows with lower RFI also have lower potential emissions. Thus, it is possible to reduce methane production in cows by selecting genetically more suitable cows with respect to methane emissions. Genetic variability assumes a reduction of 11-26% over a ten-year period but can also be increased by applying a selection program. However, there are several doubts, such as the lack of accurate methane measurements (and the main assumption is that methane produced per unit of food does not affect RFI levels), as well as predicting

the possible consequences of genetic selection. To overcome these limitations, it is necessary to collect data on feed intake and methane emissions in dairy cows, health status and mortality rate, duration of the production cycle.

MAG-6: Improvement and change of tillage system (reduced tillage)

Reduced tillage is the result of scientific research and practical audits that result in changing the conventional tillage system by reducing tillage depth, omitting one or more operations, reducing the frequency or complete omission of tillage, reducing the cultivated area and retaining crop residues. The direct impact on greenhouse gas emissions is primarily related to the significant impact on the organic carbon content in the soil and the smaller number of operating hours of machines.

MAG-7: Expansion of crop rotation with higher share of legumes

Sowing leguminous crops binds atmospheric nitrogen, reduces the risk of groundwater pollution, the soil is enriched with organic matter, which has multiple positive effects on improving and maintaining favourable physical, chemical and biological properties of the soil.

Principal activities under this measure are commencements of multi-year research on the impact of practiced crop rotations on changes in soil characteristics (expected duration > 10 years).

Measure should be implemented by encouraging producers to increase the share of leguminous crops when creating crop rotation, using incentives.

MAG-8: Intensification of crop rotation using intermediate crops

By sowing intermediate crops that can be used for livestock feeding or ploughing for green manure, the remaining nutrients will be used, prevent further evaporation of water from the soil, reduce carbon loss from the soil, prevent nitrogen leaching into groundwater and increase organic matter in the soil.

Goal of this PaM is introducing changes in organic matter content / increase in soil carbon sequestration and decrease in nitrate seepage by sowing intermediate crops. The principles of good agricultural practice in the protection of soil and water from nitrates recommend the introduction of intercrops between the harvest of the main crops.

Activities include investigations of the impact of crop application on changes in soil characteristics and encouraging the use of a typical winter or spring crop for fodder use as an intermediate crop, through incentives.

MAG-9: Improving methods of applying mineral fertilizers

Reducing the consumption of mineral fertilizers is an indirect benefit from other measures that reduce the need for their application, but with proper fertilization practice. In addition, the application of slow-release fertilizers can directly affect the total amount of mineral fertilizers applied.

Activities include introduction of information technologies, remote sensing with application in agriculture, and production of soil fertility maps, works on the establishment of systems for real monitoring of the consumption of mineral fertilizers on farms and realized yield and improving the system for calculating greenhouse gas emissions.

MAG-10: Improving methods of applying organic fertilizers

Organic fertilizers originate from organic sources such as solid manure or slurry and plant or animal residues, and strongly stimulate the activity of soil microbes compared to mineral fertilizers. Using injectors for direct injection into the soil reduces nitrogen loss due to volatilization.

Activities include introduction of information technologies, remote sensing with application in agriculture, and production of soil fertility maps, monitoring of soil changes in different ways of using

and applying organic fertilizers, encouraging investment in direct soil injection systems and consolidation of agricultural land.

MAG-11: Agroforestry

Agroforestry is a common name for land management systems in which permanent woody species are integrated with the cultivation of crops and/or animals on the same surface unit. Some agroforestry systems (e.g. Agro-silvopastoral system) are significant carbon removals. Experiments are required to determine applicability in Croatia with regard to different land use forms and different needs. It is important to point out that some elements from agroforestry were recorded throughout history in the coastal and coastal area of Croatia: cultivation and cultivation of land on terraces that were used to raise perennial plantations, olive groves, vineyards, various fruit trees and could be used for limited livestock. Activities include research of possibilities of application of agroforestry with focus on identification of suitable areas.

MAG-12: Hydromeliorative interventions and disaster protection systems

The construction of drainage, irrigation and protection systems against floods, droughts and other natural disasters can indirectly reduce nutrient losses due to seepage and leaching, resulting in a reduced need for nitrogen application. In addition to the controlled application of mineral fertilizers, controlled drainage, reuse of drained water and the use of water of appropriate quality are important for reducing nitrate emissions. Drainage has the function of draining excess water. Also, the change in soil-air ratios affects the activity of beneficial microorganisms.

Activities include research programs to improve the properties of existing hydromelioration systems, construction of irrigation systems and staff education.

MAG-13: Introduction of new cultivars, varieties and cultures

Encouraging development, education and implementation of technologies at a national and regional level, encouraging the transition and adaptation of the entire production chain to produce new crops or enabling and encouraging the implementation of cultivars and varieties that are more resistant to drought and disease and have a lower overall carbon footprint. Aimed at reducing the need for mineral nitrogen in new cultivars that have increased resistance and less need for nutrients, as well as in specific legumes that have the ability to symbiotic relationship with nodule bacteria.

MAG-14: Change in people's diet

Growing cereals for animal feed produces much more greenhouse gases than producing cereals for human consumption. By reducing the consumption of meat (especially red) in the diet in favour of foods of plant origin, significant reductions in emissions can be achieved, as well as water savings.

The first step with this PaM is research on the current eating habits of the population of the Republic of Croatia.

MAG-15: Collection and processing of agricultural plantations and residues for energy purposes

Energy utilization of post-harvest residues (with emphasis on field crops) is one of the most important ways of producing energy from biomass in the Republic of Croatia. Other possible sources are the remnants of the winter harvest of almost all horticultural species, as well as fast-growing crops for energy production that are planted/sown exclusively for the production of biomass with the aim of its conversion into energy. The establishment of collection and logistics centres for biomass with the use of existing infrastructure (utilities, competence centres, business zones) will reduce the unit cost of production of biomass products and capitalize on innovation capacity and necessary equipment for innovative biomass products for the bioeconomy. Collection and logistics centres will act as a link

between the farmer who owns biomass, processing biomass into new products with higher added value, developing new products and placing these new products on the market. The locations of the Centres will be defined with long-term development policies, in order to minimize their carbon footprint.

4.2.5. LULUCF

MLF-1: Development of the Land Management Strategy of the Republic of Croatia

The calculation of emissions/removals in the LULUCF sector, and sectoral projects (implementation activities) should form the basis for planning the use and management of LULUCF land categories for each of the repositories. The development of a Land Management Strategy is implied in order to properly define further (sub) measures that will be implemented on a particular category of land and which will reduce emissions and increase the removal of greenhouse gases in the Republic of Croatia. Proposed future measures should form an integral part of this strategy. The measure aims to increase carbon sequestration in the LULUCF sector, reduce greenhouse gas emissions, and align EU targets for increasing the share of energy from renewable sources with emission reduction requirements.

MLF-2: Carbon accumulation on the surfaces of existing forests

The measure will contribute to maintaining/increasing removals in the forestry sector and meet the provisions of Decision 529/2013/EU and Regulation 841/2018/EU. Implementation of activities that contribute to increasing the carbon stock content in forests, especially in biomass storage, and the implementation of which ensures removals in a certain period higher than those defined by the Forest Reference Level (FRL). These activities are, for example, the analysis of the current management method and suggestions for improvement, reforestation, transfer of stands to a higher form of cultivation, selection of species for filling, etc. Maintaining removals higher than those defined by the FRL also ensures an increase in emission allowances that can be transferred to non-ETS sectors.

MLF-3: Implementation of afforestation works

Changes in the sinks of greenhouse gases as a result of direct land use change caused by human activities and forestry activities, limited since 1990 to afforestation, reforestation and clearing, are allowed to be calculated in the national balance of emissions and sinks of greenhouse gases and used to fulfil obligations under the Kyoto Protocol. By analysing the costs and benefits of afforestation on the new areas, possibility of increasing greenhouse gas sinks using reforestation activities on the barren productive forest floor will be investigated. This would justify introduction of possible incentive measures, such as the afforestation of fast-growing species and natural regeneration of forests, equivalent to measures for greenhouse gas emissions reduction. Afforestation on non-forest areas (in terms of IPCC methodology) is an activity that generates removals. Due to the regulations in the field of nature protection which regulate the establishment of Natura 2000 areas, Croatia is not able to dispose of all grassland areas (according to the national regulation: non-overgrown productive forest land) for afforestation purposes. Given that in the Republic of Croatia there are agricultural areas where no production takes place and which have been neglected for many years, when drafting the Land Management Strategy, the problem of these areas must be adequately addressed.

MLF-4: Production and use of wood and wood products

It is necessary to encourage the use of wood in traditional and new products, and to take awareness of the importance of wood products as carbon storage, and their importance in terms of additionally avoided emissions when the use of these products avoids emissions from the production of for instance plastic products. Raising information on manufactured wood products leads to data harmonization, which enables the creating the basis for the adoption of strategic plans, promoting the use of wood

products, educating about the importance of wood products and their impact on climate and environment.

MLF-5: Cropland management

Agricultural production should be performed in a way that contributes to emission factor reduction, which is in the interest of family farms, given that the CAP EC regulations increase the amount of incentives if the emission factor is lower due to the way of land management. Management practices for these areas that may have an impact on emissions and removals, for example in soil storage: tillage methods, lifetime of plantation/crop (rotation period) and plantation/crop type, fertilizer application, residue management, erosion control, irrigation system application etc. It is also necessary to promote land management activities in a way suitable for the climate and the environment.

MLF-6: Grassland management

In order to reduce greenhouse gas emissions by changing and increasing removal, it is necessary to analyse the management of grassland areas in the Republic of Croatia. Implementing pasture management activities in a way that contributes to reducing the emission factor is of interest to family farms, given that the CAP EC regulations increase the amount of incentives if the emission factor is lower due to the management of these areas. It is also necessary to promote land management activities in a way suitable for the climate and the environment.

MLF-7: Implementation of technical projects and scientific research in the LULUCF sector

An analysis of the effectiveness of the implemented measures for both the sector and the measures defined in the study to meet the obligations under Article 10 of Decision 529/2013/EU on reducing/maintaining emissions and increasing/maintaining greenhouse gas removal is needed to develop new guidelines and define measures in forestry and agriculture sector. When defining priorities, Regulation 841/2018/EU and Regulation 842/2018/EU should be taken into account. This measure includes the launch of professional and scientific research to improve the management of all LULUCF land categories in order to reduce emissions and increase removals.

The implementation of several projects in the LULUCF sector is underway, which should enable better planning and monitoring of the implementation of measures in the LULUCF sector:

- LIFE CROLIS project (LIFE19 GIC/HR/001270) – Croatian land information system. The project establishes a unique national system of georeferenced data on land cover (Land Cover, LC) and land use (Land Use, LU). The existing databases of various institutions are connected, harmonized and upgraded and a more dedicated and more user-friendly system is built, using modern remote recording techniques, including the application of the EAGLE concept and products of the COPERNICUS program.
- Capacity building project for projections in the LULUCF sector. This project builds capacities in order to raise the quality of projections, starting from the analysis of the basic settings of each used scenario in order to prepare for the use of higher methodological levels of calculations and models. Within the framework of the project, the settings of the applied scenarios will be revised, and an evaluation of the scenario results will be carried out with regard to the new goals from the proposed amendments to the LULUCF Regulation 2018/841/EU.
- Project *Defining activities to increase CO₂ absorption in carbon storages in accordance with the provisions of regulation 2018/841/EU regarding sink trading that occurs in defined calculation categories of land*. The project identifies and analyses the practices and potential of the main measures to increase the LULUCF sector's sink in the forest and agricultural land categories. The project represents a forum for expert discussions and conclusions related to the challenges of harmonizing numerous factors such as: increasing the protection of biological

diversity and achieving the goals of the EU Biodiversity Strategy until 2030, initiatives on stronger restoration of nature, maintaining the general useful functions of forests, the goals of the Strategy from fields to table, the use of biomass for energy purposes.

- Project *Izdara II. National inventory of forest resources of the Republic of Croatia*. The inventory project is carried out every 15 years, and the first results of this inventory are expected at the end of 2026.
- Project - *Establishment of a reporting system for wood products (CROWOODS)*. The goal of this project is to identify the flows of wood products from production to end users, to increase the quality of information about wood products, to make concrete proposals to ensure recognition of the importance of wood product storage in the implementation of the EU's climate and energy policy and opportunities for the Republic of Croatia arising from relevant EU regulations and refer to this repository.

The above-mentioned projects are co-financed from the funds collected through the auction of emission units of the ETS system through the Environmental Protection and Energy Efficiency Fund (FZOEU). Additionally, with these funds, FZOEU finances scientific research in the field of climate for public scientific institutions and faculties, including research related to the LULUCF sector.

4.2.6. Waste

The amount of landfilled solid waste will be reduced to a minimum by preventing waste generation and using separate collection, recycling and recovery of waste. All landfills will be remediated, waste management centres will apply modern technologies that enable material recovery and chemical recycling of waste, thus obtaining various chemical compounds that can be used in industrial production (ethylene, ammonia, etc.) as well as various fuels (hydrogen, synthetic gas, liquid fuels). The new landfills will be arranged in such a way that their impact on the environment is negligible. Establishing a waste management system in accordance with the principles of the circular economy will contribute to resource efficiency with less negative impact on people and the environment.

MWM-1: Preventing the generation and reducing the amount of solid waste

It is the first in the order of priorities in the waste management, pursuant to the Sustainable Waste Management Act (Official Gazette 94/13, 73/17, 14/19, 98/19). Waste generation prevention and reduction includes municipal solid waste, industrial waste and sludge from wastewater treatment plants. Waste prevention is achieved through the process of reuse and the use of by-products and the repealing of waste status, which will directly affect the reduction of the total amount of waste. The implementation of waste prevention measures is defined by the Waste Prevention Plan and the Plan for the Prevention and Reduction of Food Waste in the Republic of Croatia 2019 - 2022 (Official Gazette 61/19, 1/22). The most important measures in terms of waste prevention are the establishment of Centres for reuse and provision of the necessary equipment for home composting as well educational activities.

This measure is achieved by cleaner production, education, economic instruments and enforcement of regulations in waste management, and by investing in modern technologies that enable material recovery and chemical recycling of waste. According to the Act, quantitative targets and deadlines for reducing the total amount of waste disposed to non-compliant landfills were defined. Disposal of waste to non-compliant landfills in Croatia was prohibited after December 31, 2017.

According to Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste, Member States should take the necessary measures to ensure that by 2035 the amount of landfilled municipal waste landfilled will be reduced to 10% or less of the total amount of municipal waste generated (by weight). Croatia was given the possibility of a delay of five years to meet the target because it is among the Member States that are in

2013 landfilled more than 60% of its municipal waste. The five-year delay is included in the projections. Accordingly, this goal will have to be met by 2040. In this case, Croatia must take the necessary measures by 2025 to reduce the amount of landfilled municipal waste to 25% or less of the total amount of municipal waste generated (by weight).

MWM-2: Increasing the amount of separately collected and recycled solid waste

Beside the Sustainable Waste Management Act, the Waste Management Plan of the Republic of Croatia for the period 2017 – 2022 (Official Gazette 3/17, 1/22) also defines the quantitative targets and deadlines for increasing the amount of separately collected and recycled waste.

Waste management objectives are prescribed to encourage the transition to a European circular economy with a high level of resource efficiency, in which the value of products, materials and resources is maintained for as long as possible, and waste generation is reduced to a minimum.

In order to contribute to the European circular economy, according to Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste, Croatia should take the necessary measures designed to achieve the following targets:

- at least 50% by weight of municipal waste and waste from other sources whose waste streams are similar to that of municipal waste, including at least paper, metal, plastic and glass, should be recovered by recycling and preparation for re-use;
- at least 70% by weight of non-hazardous construction waste, other than natural materials determined by the waste code 17 05 04 - soil and stones other than those mentioned in 17 05 03, should be recovered by recycling, preparation for re-use and other material recovery procedures, including backfilling, where waste is used as a substitute for other materials;
- by 2025, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 55% by weight;
- by 2030, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 60% by weight;
- by 2035, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 65% by weight.

Croatia was given the possibility of a delay of five years to meet the targets because it is among the Member States, which in 2013 prepared for re-use and recycled less than 20% of its municipal waste. Accordingly, Croatia must take the necessary measures designed to achieve the following targets:

- by 2025, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 50% by weight;
- by 2030, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 55% by weight;
- by 2035, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 60% by weight.

MWM-3: Ensuring the system of treatment and use of landfill gas

The Ordinance on the Methods and Conditions for the Landfill of Waste, Categories and Operational Requirements for Waste Landfills (Official Gazette 114/15, 103/18, 56/19) and Ordinance on Waste Management (Official Gazette 106/22) regulate technical requirements for landfill operation, which reduce possible adverse effects of landfills on the environment. At landfills where landfill gas occurs it is necessary to secure a gas collection system, and that gas must be treated and used. If collected landfill gases cannot be used for energy production, they should be flared in the area of the landfill and the emission of methane into the atmosphere should be prevented.

MWM-4: Reducing the amount of disposed biodegradable waste

The aim of this measure is to reduce the amount of biodegradable fraction of waste disposed at landfills, thus reducing methane emissions resulting from anaerobic decomposition of waste.

Pursuant to the Sustainable Waste Management Act, quantitative targets that relate to the reduction of biodegradable municipal waste disposed to landfills were established. Thus, by the end of 2020, the share of biodegradable municipal waste disposed of in landfills had to be reduced to 35% weight of biodegradable municipal waste generated in 1997, that is 264,661 tons of waste was allowed to dispose. To prevent the disposal of biowaste at landfills and contribute to the achievement of other goals of waste management, it is necessary to encourage citizens to compost. The goal is to achieve that households separate biowaste from other municipal waste by disposing of it in biowaste containers. This measure will cover rural areas, i.e. suburbs of urban areas with a larger number of independent housing units with infield. In the territory of the Republic of Croatia, by implementing this measure, it is possible to reduce up to 90,000 tons of biowaste per year.

MWM-5: Use of biogas for biomethane production and electricity and heat generation

The measure is associated with measures for promoting the use of renewable energy sources for electricity and heat generation and obligation to use renewable energy sources in transport and refers to the mandatory use of biowaste as a substrate in biogas plants that produce biogas to be used for the biomethane production and electricity and heat generation.

4.2.7. Other (cross-cutting) policies and measures

MCC-1: Committee for cross-sectoral coordination of policies and measures for mitigation and adaptation to climate change

In accordance with the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19) the Commission for inter-sectoral coordination of policies and measures for mitigation and adaptation to climate change was established to monitor and evaluate the implementation and planning of policies and measures for climate change mitigation and adaptation. The Commission makes recommendations to the Government of the Republic of Croatia on overall policies and measures for climate change mitigation and adaptation and provides political support in the implementation of climate change mitigation and adaptation policies and measures. The Commission also proposes to the Government of the Republic of Croatia the adoption of acts of strategic planning and regulations related to policies and measures for climate change mitigation and adaptation, proposes objectives, measures and activities of public policies and monitors their effects and outcomes in implementation and provides proposals and support in promoting interdisciplinary and synergistic public policy goals, measures and activities. Members of the Commission, the tasks and the manner of work of the Commission shall be determined by the Government of the Republic of Croatia at the proposal of the Ministry responsible for environmental protection (MESD).

MCC-2: Supporting the founding of regional energy and climate agencies and capacity building

Regional energy agencies have important roles in supporting energy decarbonisation on local level through partnership with regional and local authorities. There is an increase interest by local and regional authorities to establish them. However, there is a need to build the capacity of existing regional energy agencies to be more active in addressing climate risks and to mainstream adaptation to climate change on local level. The aim of this measure is to encourage the establishment and founding of regional energy agencies for the areas of the Republic of Croatia where they do not operate, and the transformation of existing energy agencies into energy and climate agencies.

MCC-3: Promotion of the use of innovative information and communication technologies (ICT) to reduce greenhouse gas emissions

Innovative information and communication technologies have an increasingly important role in reducing greenhouse gas emissions and increasing energy efficiency. Intensifying their use in public administration, services and manufacturing processes, will boost productivity and work efficiency and at the same time will reduce energy consumption and consequent greenhouse gas emissions. The measure is expected to intensify the use of innovative ICT and monitoring of actual energy savings and reductions of greenhouse gas emissions.

MCC-4: Emissions Trading System

ETS (Emissions Trading System) sector includes all activities listed in Annex I of the Regulation on Trading with Greenhouse Gas Emission Allowances (Official Gazette 89/20) and for the reduction of greenhouse gas emissions from these activities plant operators involved in the trading system are responsible. Through the equal distribution of emission allowances, reduction commitments have been distributed to system participants from all Member States with the aim of contributing to emission reductions at EU level by at least 43% by 2030 compared to 2005 levels.

From January 1, 2013, the Republic of Croatia is fully integrated in the EU Emission Trading System (EU ETS). Operators in Croatia - the pursuant in the EU ETS have obtained Permits for greenhouse gas emissions and have established a regime for emissions monitoring and reporting to the competent authority. Greenhouse gases covered by EU ETS are: carbon dioxide (CO₂) for all activities and additionally for certain activities nitrous oxide (N₂O).

For aircraft operators in the Republic of Croatia, emissions monitoring and reporting of CO₂ emissions started formally on July 1, 2013. However, due to certain specificities related to the responsibility for administering aviation flights prior to Croatia's accession to the European Union, aircraft operators were required to submit annual emissions reports from the aircraft starting from 2010.

MCC-5: The CO₂ emission tax for the non-ETS stationary sources

The Regulation on Unit Charges, Corrective Coefficients and Detailed Criteria and Benchmarks for Determining the Charge for Emissions of Carbon Dioxide into the Environment (Official Gazette 73/07, 48/09, 2/18, 46/21) stipulates the obligation to pay the CO₂ emission tax for all stationary sources emitting more than 450 tons of CO₂ per year. The obligated parties investing in energy efficiency, renewable energy and other measures to reduce CO₂ emissions and other GHG emissions pay a lower tax. The Environmental Protection and Energy Efficiency Fund is authorized to calculate and charge the tax. From 2013 onwards, the obligation to pay the CO₂ emission tax has applied only to non-ETS sources.

MCC-6: Covenant of Mayors for Climate and Energy in the Republic of Croatia

The signatories of the Covenant support a joint vision for 2050: accelerating decarbonisation of their territories, strengthening capacity to adapt to the inevitable impact of climate change and allowing citizens to access safe, sustainable and affordable energy. The signatory cities are committed to action that will support the reduction in greenhouse gases by 40% by 2030 and the adoption of a common approach to mitigating and adapting to climate change. In order to transfer their political engagement from theory to practical measures and projects, the signatories of the Agreement undertake to submit the Sustainable Energy and Climate Action Plan (SECAP). This initiative was accepted by 118 cities and municipalities in the Republic of Croatia, so that the Covenant of Mayors covers over 2.3 million inhabitants in the Republic of Croatia.

MCC-7: Charter for Buildings Decarbonisation by 2050

Charter on cooperation for the decarbonisation of buildings by 2050 is initiated by the Ministry of Physical Planning, Construction and State Assets, which supports the EU vision of decarbonisation of buildings by 2050. The charter was launched for better interdepartmental communication and cooperation between government and the real sector. The goal is to create a wide network of connected experts through workshops and open dialogue of partners who are ready for a joint dialogue and contribution to the decarbonisation of the building fund by 2050. The contents of the Charter relate to the achievement of energy and climate goals at national and EU level through the decarbonisation of the building stock, renovation of buildings and construction of nearly-zero energy buildings, aware of the importance of further reducing greenhouse gas emissions, increasing the share of renewable energy sources, improving energy security, and introducing innovations and smart technologies that enable buildings to support the overall decarbonisation of the economy. The signing of the charter encourages continuous cooperation in the development of the Long-Term Strategy for the Reconstruction of the National Building Fund and the transition to the standard of construction of near-zero energy buildings (nZEB). The signatories of the Charter provide support and promote the decarbonisation of buildings in their further activities, wherever possible.

MCC-8: Creation of Platform for Carbon Capture, Use and Storage

The carbon capture and storage technology for large emission sources is not yet commercially available. According to Directive 2009/31/EC on geological storage of carbon dioxide, i.e. Article 36 of Directive 2010/75/EU on industrial emissions, for power plants with a capacity of more than 300 MW that have received a building permit after the entry into force of Directive 2009/31/EC on geological storage of carbon dioxide, it is necessary to assess whether the following conditions are met: a) availability of a suitable storage location, b) technical and economic feasibility of transport facilities and c) technical and economic feasibility of upgrading the CO₂ capture and collection facility. If these conditions are met, the competent authority must provide adequate space at the installation site for equipment to capture and compress the extracted CO₂. Legislatively, this is covered by the Hydrocarbon Exploration and Exploitation Act (Official Gazette 52/18, 52/19), which enables the storage of CO₂ in the territory of the Republic of Croatia. In accordance with the above, it is planned to prepare a study of storage capacity assessment, but also to prepare a National Feasibility Study with an action plan for preparatory activities for CCUS projects. This study will cover the phases of capture at emission sources, transport, injection and storage of CO₂, and the connection of CO₂ transport systems with other EU countries.

MCC-9: Improving sustainability of urban areas

The Program for the Development of Green Infrastructure in Urban Areas for the Period from 2021 to 2030 (Official Gazette 147/21) and the Program for the Development of Circular Management of Space and Buildings for the Period from 2021 to 2030 (Official Gazette 143/21) were adopted, which achieve ecological, economic and social benefits of sustainable development. The programme for the development of green infrastructure in urban areas elaborates goals and measures for development of green infrastructure which, among other things, increase the energy efficiency of buildings, reduce CO₂ emissions and reduce temperatures in the areas of thermal islands in urban areas. The programme for the development of circular management of space and buildings elaborates goals and measures for circular management of space and buildings, which encourage, among other things, circular measures in planning new buildings, reusing abandoned and/or neglected and extending the durability of existing spaces and buildings, reducing construction waste and increasing the energy efficiency of buildings. The aim of this measure is to encourage cities and municipalities to base revitalization and development projects on new urban areas on the principles of sustainability.

MCC-10: Foundation of the Programme for calculation and reduction of carbon footprint of business entities

The aim of the measure is to establish a Programme for calculation and reduction of carbon footprint of business entities outside the ETS system (non-ETS), in order to reduce total greenhouse gas emissions for all activities for which the business entity is responsible or on which it is dependent. It is necessary to calculate direct emissions and removals of greenhouse gases at the location of the business entity, either due to fuel combustion in the thermal power plant, from the production process and/or from the company's vehicles, indirect emissions that occur outside from the location of the business entity, and are related to the supply and consumption of electricity, heat and cooling energy, but also other indirect emissions/removals related to the flows of people, materials, waste and final products. The calculation of the carbon footprint will enable business entities to get acquainted with the structure of greenhouse gas emissions, i.e. to identify activities that most significantly contribute to reducing emissions, which is a good basis for the development and implementation of the Action Plan for carbon footprint reduction. The implementation of the Action Plan would lead to the reduction of greenhouse gas emissions and the mitigation of climate change, i.e. easier realization of the obligations assumed by the Paris Agreement.

MCC-11: Foundation of the Platform for Circular Economy

It is necessary to develop a systematic approach in all value chains related to the Croatian economy related to the measures listed in the Action Plan for the Circular Economy, based on which the EC integrates the principles of the circular economy in plastic production and consumption, water management, food systems and special waste management streams. The Circular Economy Committee was established, whose goal is to speed up Croatia's transition to a circular economy and achieve EU goals related to the reduction of waste generation, as well as the reduction of pressure on the environment, and the transformation of waste into high-quality secondary raw materials, incorporated into new products. The preparation of a national action plan for the transition to a circular economy through the adjustment of the legislative framework is underway. The creation of a national digital platform for the circular economy is also planned, which would also include a user portal for monitoring progress in achieving the goals of the circular economy from European and national legislation.

MCC-12: Foundation of the Platform for Bioeconomy

In the context of bioeconomy development, it is necessary to connect three key aspects: development of new technologies and processes; market development and competitiveness of sectors based on the principles of the circular economy and the political will for cooperation between policy and stakeholders. This should ensure the transformation of existing "traditional" stakeholders of the bioeconomy (farmers, family farms, food processing, forestry, wood processing, pharmaceutical, chemical industry...) into new, modern stakeholders in low-carbon economy and sustainable development while supporting the positive impact on ecosystems, climate and carbon cycle. An in-depth analysis of stakeholders (sectors) is necessary for the transition to a bioeconomy, and that their economic activity contributes to the achievement of development goals based on low levels of emissions of carbon dioxide and other greenhouse gases. In parallel, the adjustment of the involved economic entities is needed for the use of funds from the announced EU funds intended for the transition to the bioeconomy.

MCC-13: Foundation of the Platform for Hydrogen Technologies

The role of hydrogen in the energy and transport systems of the future is expected to be more significant, even more so as the targets for reducing greenhouse gas emissions will be more ambitious. Therefore, it is necessary to identify opportunities related to the use of hydrogen in a timely manner, consider its application in the next decade and explore the possibilities of financially stimulating the production and

consumption of hydrogen. To this end, a hydrogen technology platform will be established to connect national stakeholders relevant to hydrogen technology research and application, monitor the development of hydrogen technologies at EU and international level, and serve as a link between national, EU and international levels.

MCC-14: Energy efficiency obligation system for suppliers

The system of energy efficiency obligations was established by the Energy Efficiency Act (Official Gazette 127/14, 116/18, 25/20, 41/21), and its functioning is determined in more detail by the Ordinance on the System of Energy Efficiency Obligations (Official Gazette 41/19). The obligators of the system of energy efficiency obligations are energy suppliers. The goal is to achieve a reduction in energy consumption by end consumers.

MCC-15: Integrated information system for monitoring energy efficiency

The national system for monitoring, measurement and verification of savings (SMIV) is established on the basis of the Energy Efficiency Act (Official Gazette 127/14, 116/18, 25/20, 41/21) and the Ordinance on the System for Monitoring, Measuring and Verifying Energy Savings (Official Gazette 98/21, 30/22). This system is extremely important because it monitors energy savings and the resulting reduction in greenhouse gases and the system data are used for reporting. In the next period, it is necessary to maintain and improve the functionality of the system, connect it to other systems (EMIS), and inform and educate obligated parties about the correct data entry required to calculate and verify energy savings.

MCC-16: Green public procurement

A National Commission for Green Public Procurement has been established to monitor the implementation of green public procurement through a survey questionnaire and an electronic public procurement notice. This measure represents a continuation of the initiated measures and further greening of public procurement procedures. Green public procurement will favour innovative low-carbon products and services, further encouraging their market entry, and the public sector will serve as a good example.

MCC-17: Determining the starting point, national goals, indicators for monitoring the achievement and establishing a system for monitoring the achievement of the set goals of research, innovation and competitiveness

Elaboration of goals and monitoring system and establishment of a system for monitoring achievements in the field of research and development, innovation and competitiveness related to the Energy Union; defining key technologies for low carbon transition.

Main activity is to elaborate criteria and indicators relevant to the areas of the Energy Union. It will propose relevant data sources and an indicator monitoring system. It will propose key low-carbon transition technologies, monitor the achievement of set goals, and propose corrective and other measures as needed. If necessary, thematic subgroups will be established for areas of research, innovation and competitiveness.

MCC-18: Co-financing of industrial research and experimental development projects aligned with the National Development Strategy

The measure encourages research and development of products and services relevant to low-carbon development, by co-financing research projects within priority topics.

MCC-19: Supporting low carbon entrepreneurship development

The measure encourages the development of entrepreneurship in the field of low-carbon products and services, by co-financing entrepreneurial activities in this area.

Activities include continuing to support entrepreneurs throughout the development stages of their business - from the research and development of the idea through to commercialization and marketing, all in the area of low carbon products and services. Cooperation with scientific and research institutions and increased private investment in R&D will be encouraged. One possible activity is to fund the Proof of Concept as a mechanism to support the transfer of research results from the public to the private sector to create new products and services. The number of patents applied for and granted, and the number of new products will be monitored.

Workforce needs and additional workforce qualifications will be monitored, and ongoing communication with government education and employment authorities established.

MCC-20: Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies

The measure encourages the development of established and functional technology transfer offices and science and technology parks with the aim of transferring knowledge and developing technologies that will contribute to the development of a low-carbon economy.

Activities include providing annual support to public scientific organizations for the establishment of development companies or subsidiaries resulting from the results of scientific research; providing support for cooperation between entrepreneurs and the science system, business meetings, business consulting; preparation of business plans; pre-money valuation and mentoring the preparation of high value projects and infrastructure projects; mentoring the development of business plans and pitching to investors, financing of experts on protection of intellectual property rights; financing grants for projects in the concept validation phase, etc. with a focus on sustainable technologies that contribute to low carbon development.

MCC-21: Supporting further work of excellence centers active in the field of natural, technical, biotechnical and biomedical sciences

The measure encourages the further work of established and centres of excellence, whose work was positively assessed in the periodic evaluation process with the aim of further development of the low-carbon economy.

Activities include: support for industrial and experimental research of scientific Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change, with a view of further upgrading on the results of research funded in the 2014-2020 financial period.

MCC-22: Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy

The capacities of the institutions involved in encouraging and monitoring research, innovation and competitiveness in the low-carbon economy will be built.

Representatives of all bodies involved in the implementation of measures MCC-17 to MCC-22 will be supported to participate in lectures, workshops, working group meetings, study tours with the aim of international integration and capacity building in setting goals, defining indicators and monitoring the achievement of set goals in the context research, innovation and competitiveness in the low carbon economy. Support for participation in working bodies and working groups and committees of relevant European and international organizations (IEA, etc.), programmes (SET Plan, ETIP, EERA, Horizon 2020 LIFE, Eureka, etc.), European Partnerships under the EU Framework Programme for the research and innovation in relevant Pan-European networks and consortia. If necessary, the transfer of know-

how with other EU Member States and other stakeholders within the Republic of Croatia will be organized.

This activity will also co-finance the participation of scientific organizations in public-public and public-private partnerships within the framework programme for research and technological development and with relevant Pan-European research networks and consortia in the area of low carbon economy.

4.3. POLICIES AND MEASURES AND THEIR EFFECTS

This chapter provides overview tables of policies and measures within each individual sector. Tables contain the code and title of the policy or measure, objective of implementation, identification of greenhouse gas affected by the policy or measure, type of policy instrument, status of implementation and implementing body.

The type of instrument was determined according to recommendations laid down in the Guidelines for the preparation of National Communications by parties included in Annex I to the Convention. The guidelines make a distinction between economic, fiscal, agreement, regulatory, information, research and other instruments.

The status of implementation that can be assigned to a policy or measure is: implemented, adopted or planned. Status "implemented" is assigned if national legislation is in force, voluntary agreements have been established, financial resources have been allocated or human resources have been mobilized. Status "adopted" is assigned to policies and measures for which an official government decision has been made and there is a clear commitment to proceed with implementation. For those policies and measures that are still under discussion and have a realistic chance of being adopted and implemented, status "planned" is chosen.

The initial year of application of individual measures and the effects of the measures are shown in Table 3 in Annex II: CTF tables for the biennial report (19/CP.18). The table shows the assessment of the impact of measures for the years 2025, 2030, 2035 and 2040, in relation to the year 2020, which is the base year of the projections.

Estimates of the impact of individual measures on the reduction of emissions are not available because contributions of individual measures to the reduction of emissions were not determined, and the effects of group measures were presented for the scenario 'with measures' or for the scenario 'with additional measures'.

Research that needs to be carried out with the aim of determining the potential for reducing greenhouse gas emissions for individual measures is listed below.

- Research aimed at determining the variation in the predicted CH₄ emission and determining the genetic potential for reducing methane emissions in dairy cows as well as increased production intensity (MAG-5: Improving the breeding and selection program, animal health and welfare)
- Research of soil treatment systems (MAG-6: Improvement and change of tillage system (reduced tillage))
- Research on the impact of practiced crop rotations on changes in soil characteristics (MAG-7: Expansion of crop rotation with higher share of legumes)
- Research on the impact of crop application on changes in soil characteristics (MAG-8: Intensification of crop rotation using intermediate crops)

- Remote sensing research with application in agriculture (MAG-9: Improving methods of applying mineral fertilizers; MAG-10: Improving methods of applying organic fertilizers)
- Research of possibilities of application of agroforestry with focus on identification of suitable areas (MAG-11: Agroforestry)
- Research programs to improve the properties of existing hydromelioration systems (MAG-12: Hydromeliorative interventions and disaster protection systems)
- Research programs for the application of new legumes (MAG-13: Introduction of new cultivars, varieties and cultures)
- Research on the current eating habits of the population of the Republic of Croatia (MAG-14: Change in people's diet)
- Research to improve the management of all LULUCF land categories (MLF-7: Implementation of technical projects and scientific research in the LULUCF sector)
- Industrial research of products and services relevant to low-carbon development (MCC-18: Co-financing of industrial research and experimental development projects aligned with the National Development Strategy)
- Industrial and experimental research of scientific Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change, with a view of further upgrading on the results of research funded in the 2014-2020 financial period (MCC-21: Supporting further work of excellence centers active in the field of natural, technical, biotechnical and biomedical sciences)
- Estimates of the impact of individual measures on the reduction of emissions
- Analysis and consideration of the most acceptable recycling procedures for individual streams and types of waste
- Analysis of the habits and preferences of traffic users in order to satisfy their needs, and assessment of all the costs of replacing the fleet with new, cleaner vehicles; assessment of infrastructure installation costs;
- Analysis of taxation of fossil fuel use
- Carbon sink analysis for various typologies of green infrastructure in urban areas, such as urban forests, individual trees, tree rows, parks, green facades, green roofs, etc.
- An analysis of the current fossil fuel subsidy system, the design and determination of accompanying social programs that will reduce the impact on the poorest citizens, and the definition of a plan to abolish the fossil fuel subsidy system.

Energy

Table 4-1: Overview of policies and measures in the energy sector

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MEN-1: Promoting nZEB construction and renovation standards	Efficiency improvements of buildings Increase in the number of nearly-zero energy buildings	CO ₂ , CH ₄ , N ₂ O	information, regulatory	implemented	Ministry of Physical Planning, Construction and State Assets
MEN-2: Energy renovation programme for apartment buildings	Efficiency improvements of buildings Renovation of 520,000 m ² of apartment buildings per year	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Physical Planning, Construction and State Assets Environmental Protection and Energy Efficiency Fund
MEN-3: Energy renovation programme for single family houses	Efficiency improvements of buildings Renovation of 350,000 m ² of family houses per year	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Physical Planning, Construction and State Assets Environmental Protection and Energy Efficiency Fund
MEN-4: Energy renovation programme for public buildings	Efficiency improvements of buildings Renovation of 350,000 m ² of public buildings per year	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Physical Planning, Construction and State Assets Environmental Protection and Energy Efficiency Fund Agency for Legal Affairs and Real Estate
MEN-5: Energy renovation programme for buildings that have the status of cultural property	Efficiency improvements of buildings Renovation of 8,975,943 m ² of buildings that have the status of cultural property	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Physical Planning, Construction and State Assets Environmental Protection and Energy Efficiency Fund
MEN-6: Energy renovation programme for public lighting	Efficiency improvement in services/ tertiary sector Energy savings in 2030: 0.90 PJ	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MEN-7: Energy management in the public sector	Efficiency improvement in services/ tertiary sector Energy savings in 2030: 0.20 PJ	CO ₂ , CH ₄ , N ₂ O	regulatory, information	implemented	Ministry of Physical Planning, Construction and State Assets Agency for Legal Affairs and Real Estate

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MEN-8: Energy management in the business (service and production) sector	Efficiency improvement in services/ tertiary sector Efficiency improvement in industrial end-use sectors	CO ₂ , CH ₄ , N ₂ O	fiscal	planned	Ministry of Economy and Sustainable Development Ministry of Finance
MEN-9: Informational accounts	Efficiency improvement in services/ tertiary sector Efficiency improvement in industrial end-use sectors Informing consumers about energy consumption and production	CO ₂ , CH ₄ , N ₂ O	regulatory, information	implemented	Energy Suppliers Ministry of Economy and Sustainable Development
MEN-10: Energy efficiency information	Efficiency improvements of buildings Efficiency improvement in services/ tertiary sector Efficiency improvement in industrial end-use sectors Informing the public and target groups about energy efficiency promotion programs	CO ₂ , CH ₄ , N ₂ O	information	implemented	Ministry of Physical Planning, Construction and State Assets Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MEN-11: Energy efficiency education	Efficiency improvements of buildings Educating workers on energy efficiency	CO ₂ , CH ₄ , N ₂ O	education	implemented	Agency for Vocational Education and Adult Education Croatian Employment Service
MEN-12: Energy efficiency of the electricity transmission network	Reduction of losses in the transmission network Efficiency improvement in the energy and transformation sector Energy savings in 2030: 0.9 PJ	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of Economy and Sustainable Development Croatian Transmission System Operator

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MEN-13: Reduction of losses in the distribution network and introduction of smart grids	Reduction of technical and non-technical losses in the electricity distribution network Efficiency improvement in the energy and transformation sector Cumulative energy savings in the period 2021-2030: 1.0 PJ	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of Economy and Sustainable Development HEP DSO (Distribution System Operator)
MEN-14: Increasing the efficiency of the district heating systems	Reduction of losses Efficiency improvement in the energy and transformation sector Efficiency improvement in services/ tertiary sector Efficiency improvement in industrial end-use sectors	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of Economy and Sustainable Development HEP District Heating
MEN-15: Increasing the efficiency of the gas transport network	Reduction of losses Efficiency improvement of the gas transmission system	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of Economy and Sustainable Development Plinacro Ltd.
MEN-16: Information, education and capacity building for RES use	Increase in renewable energy sources in the electricity sector Increase in renewable energy in the heating and cooling sector Promoting the use of renewable energy sources	CO ₂ , CH ₄ , N ₂ O	economic, education, information	planned	Ministry of Economy and Sustainable Development Ministry of Physical Planning, Construction and State Assets Environmental Protection and Energy Efficiency Fund
MEN-17: Spatial planning prerequisites for RES use	Increase in renewable energy sources in the electricity sector Promoting the use of renewable energy sources	CO ₂ , CH ₄ , N ₂ O	regulatory	planned	Ministry of Economy and Sustainable Development Ministry of Physical Planning, Construction and State Assets
MEN-18: Promoting the RES use for production of electricity and heat	Increase in renewable energy sources in the electricity sector Increase in renewable energy in the heating and cooling sector Promoting the use of renewable energy sources	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Economy and Sustainable Development Croatian Energy Operator (HROTE) Environmental Protection and Energy Efficiency Fund

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MEN-19: Development of the regulatory framework for RES use	Increase in renewable energy sources in the electricity sector Increase in renewable energy in the heating and cooling sector Promoting the use of renewable energy sources	CO ₂ , CH ₄ , N ₂ O	regulatory	planned	Ministry of Economy and Sustainable Development Croatian Energy Operator (HROTE) Environmental Protection and Energy Efficiency Fund
MEN-20: Integrated planning of security of energy and energy products supply	Increasing energy security including alternative fuels	CO ₂ , CH ₄ , N ₂ O	regulatory	planned	Ministry of Economy and Sustainable Development
MEN-21: Construction and use of energy storage	Increase in renewable energy sources in the electricity sector Efficiency improvement in the energy and transformation sector Increasing energy storage capacity Promoting the use of renewable energy sources	CO ₂ , CH ₄ , N ₂ O	economic	planned	Ministry of Economy and Sustainable Development
MEN-22: Development and maintenance of centralised thermal systems	Increase in renewable energy sources in the electricity sector Increase in renewable energy in the heating and cooling sector Reduction of losses Efficiency improvement in the energy and transformation sector Efficiency improvement in services/ tertiary sector Efficiency improvement in industrial end-use sectors	CO ₂ , CH ₄ , N ₂ O	economic	planned	Ministry of Economy and Sustainable Development
MEN-23: LNG terminal construction	Primary energy savings Switch to less carbon-intensive fuels	CO ₂ , CH ₄ , N ₂ O	economic	implemented	LNG Croatia LLC Ministry of Economy and Sustainable Development

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MEN-24: Refinery modernization and transformation	Efficiency improvement in the energy and transformation sector Control of fugitive emissions from energy production	CO ₂ , CH ₄ , N ₂ O	economic	planned	INA, d.d. (oil company) Ministry of Economy and Sustainable Development
MEN-25: Measures to increase energy efficiency by improving processes and process units	Efficiency improvement in the energy and transformation sector Control of fugitive emissions from energy production	CO ₂ , CH ₄	economic	planned	Ministry of Economy and Sustainable Development INA, d.d. (oil company) distributors of liquid petroleum fuels
MEN-26: Methane flaring	Control of fugitive emissions from energy production Reduction of methane emissions by 95-99%	CH ₄	economic	planned	Ministry of Economy and Sustainable Development INA, d.d. (oil company)
MEN-27: Development of the electricity transmission network	Reduction of losses Safe and reliable operation of the transmission grid Primary energy savings	CO ₂ , CH ₄ , N ₂ O	economic, regulatory	implemented	Ministry of Economy and Sustainable Development Croatian Transmission System Operator
MEN-28: Development of gas transmission system	Reduction of losses Safe and reliable operation of the gas transmission system Primary energy savings	CO ₂ , CH ₄ , N ₂ O	economic, regulatory	implemented	Ministry of Economy and Sustainable Development Plinacro Ltd.
MEN-29: Elaboration of the regulatory framework for active participation of customers on the electricity market	Primary energy savings Promoting the use of renewable energy sources	CO ₂ , CH ₄ , N ₂ O	regulatory	implemented	Ministry of Economy and Sustainable Development Croatian Energy Regulatory Agency (HERA)
MEN-30: Introduction of advanced consumption metering systems and data management	Primary energy savings	CO ₂ , CH ₄ , N ₂ O	economic	planned	Ministry of Economy and Sustainable Development
MEN-31: Adoption and implementation of the Programme for Energy Poverty Reduction	Efficiency improvements of buildings Efficiency improvement of appliances Reducing energy poverty	CO ₂ , CH ₄ , N ₂ O	economic, information	implemented	Ministry of Economy and Sustainable Development Ministry of Labour, Pension System, Family and Social Policy

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MEN-32: Program for combating energy poverty, which includes the use of renewable energy sources in residential buildings in areas of special state care for the period 2021-2025	Efficiency improvements of buildings Reducing energy poverty 413 renovated buildings	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Physical Planning, Construction and State Assets Central State Office for Housing and Reconstruction
MEN-33: Increasing energy efficiency and use of RES in manufacturing industry	Increase in renewable energy sources in the electricity sector Increase in renewable energy in the heating and cooling sector Efficiency improvement in the energy and transformation sector Efficiency improvement in services/ tertiary sector Efficiency improvement in industrial end-use sectors Installation of abatement technologies	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Economy and Sustainable Development

Transport

Table 4-2: Overview of policies and measures in transport sector

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MTR-1: Providing information to consumers on fuel economy and CO ₂ emission of new passenger cars	Efficiency improvements of vehicles Low carbon fuels/electric cars	CO ₂ , CH ₄ , N ₂ O	information	implemented	Ministry of Economy and Sustainable Development Ministry of the Interior
MTR-2: Special environmental fee for motor vehicles	Efficiency improvements of vehicles Low carbon fuels/electric cars	CO ₂ , CH ₄ , N ₂ O	economic, fiscal	implemented	Ministry of Economy and Sustainable Development Ministry of Finance Environmental Protection and Energy Efficiency Fund
MTR-3: Special tax on motor vehicles	Efficiency improvements of vehicles Low carbon fuels/electric cars	CO ₂ , CH ₄ , N ₂ O	economic, fiscal	implemented	Ministry of Economy and Sustainable Development Ministry of Finance
MTR-4: Monitoring, reporting and verification of greenhouse gas emissions in the lifetime of fuels and energy	Efficiency improvements of vehicles Low carbon fuels/electric cars	CO ₂ , CH ₄ , N ₂ O	regulatory	implemented	Ministry of Economy and Sustainable Development
MTR-5: Legislative adjustments for cleaner transport	Low carbon fuels/electric cars Improved transport infrastructure Increasing the share of RES in final energy consumption in transport Increasing the share of clean vehicles in road transport	CO ₂ , CH ₄ , N ₂ O	regulatory	planned	Ministry of the Sea, Transport and Infrastructure Ministry of Economy and Sustainable Development
MTR-6: Financial incentives for the purchase of energy efficient vehicles	Efficiency improvements of vehicles Low carbon fuels/electric cars Energy savings in 2030 0.25 PJ (decrease in consumption of gasoline and diesel fuel) and 0.1 PJ (increase in consumption of electricity)	CO ₂ , CH ₄ , N ₂ O	economic	implemented	Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MTR-7: Development of infrastructure for alternative fuels	Low carbon fuels/electric cars Improved transport infrastructure	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of the Sea, Transport and Infrastructure Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MTR-8: Promotion of integrated freight transport	Reducing CO ₂ emissions from road vehicles	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of the Sea, Transport and Infrastructure Ministry of Economy and Sustainable Development
MTR-9: Promotion of sustainable intermodal transport at national level	Modal shift to public transport or non-motorized transport Low carbon fuels/electric cars Improved transport infrastructure	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of the Sea, Transport and Infrastructure Ministry of Economy and Sustainable Development
MTR-10: Promotion of integrated and intelligent transport systems and development of alternative fuels infrastructure at local and regional level	Modal shift to public transport or non-motorized transport Low carbon fuels/electric cars Energy savings in 2030: 0.15 PJ	CO ₂ , CH ₄ , N ₂ O	economic, information	implemented	Ministry of Economy and Sustainable Development Units of regional and local self-government Environmental Protection and Energy Efficiency Fund
MTR-11: Training for drivers of road vehicles for eco-driving	Reducing CO ₂ emissions from road vehicles Energy savings in 2030: 0.03 PJ	CO ₂ , CH ₄ , N ₂ O	education	implemented	Ministry of Economy and Sustainable Development Ministry of the Interior Environmental Protection and Energy Efficiency Fund National Energy Efficiency Authority
MTR-12: Promotion of boat transport using alternative fuels	Reduce emissions from maritime transport	CO ₂ , CH ₄ , N ₂ O	voluntary agreement, economic	implemented	Ministry of the Sea, Transport and Infrastructure Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MTR-13: Advanced biofuel market development plan	Low carbon fuels/electric cars Increasing the share of RES in transport	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	planned	Ministry of Finance Ministry of Economy and Sustainable Development Ministry of Agriculture
MTR-14: Decarbonization of transport through the production of advanced biofuels from residues of agricultural production and energy crops with integrated carbon capture, use and storage	Low carbon fuels/electric cars Production of advanced biofuels of 55 kt per year	CO ₂ , CH ₄ , N ₂ O	economic	planned	INA Llc

Industrial processes and product use

Table 4-3: Overview of policies and measures in the industrial processes and product use sector

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MIP-1: Reducing the share of clinker in cement production	Reducing CO ₂ emissions Reduction in clinker production	CO ₂	economic	planned	Cement manufacturers
MIP-2: Limiting fluorinated greenhouse gas emissions	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases Replacement of fluorinated gases by other substances Reducing greenhouse gas emissions	SF ₆ , HFCs	education, regulatory	implemented	Ministry of Economy and Sustainable Development
MIP-3: Gradual reduction of the amount of fluorocarbons that can be placed on the market	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases Replacement of fluorinated gases by other substances By 2030 to 21% of the total amount of fluorocarbons placed on the market during the reference period 2009 to 2012	SF ₆ , HFCs	regulatory	implemented	Ministry of Economy and Sustainable Development
MIP-4: Restrictions and prohibitions on placing certain products and equipment on the market	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases Replacement of fluorinated gases by other substances Reducing greenhouse gas emissions	SF ₆ , HFCs	regulatory	implemented	Ministry of Economy and Sustainable Development
MIP-5: Reduction of fluorinated greenhouse gas emissions from mobile air conditioning systems	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases Replacement of fluorinated gases by other substances Reducing greenhouse gas emissions	SF ₆ , HFCs	regulatory	implemented	Ministry of Economy and Sustainable Development

Agriculture

Table 4-4: Overview of policies and measures in the agriculture sector

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MAG-1: Change in livestock diet of and feed quality	Reduction of methane emissions from intestinal fermentation	CH ₄	economic, education	implemented	Ministry of Agriculture Ministry of Economy and Sustainable Development Advisory services
MAG-2: Improvement of livestock facilities and manure management systems	Reduction of methane, nitrogen and ammonia emissions through improvements in animal nutrition and manure collection and storage systems	CH ₄ , N ₂ O	economic, education	implemented	Ministry of Agriculture Advisory services
MAG-3: Modification of the livestock system	Indirect reduction of methane and nitrous oxide emissions by increasing the share of cattle in the "cow-calf" system	CH ₄ , N ₂ O	economic	implemented	Ministry of Agriculture Advisory services
MAG-4: Anaerobic decomposition of manure and biogas production	Reduction of methane emissions from manure management systems for cattle and pigs by increasing the share of biogas plants	CH ₄	economic	implemented	Ministry of Agriculture Advisory services
MAG-5: Improving the breeding and selection program, animal health and welfare	Indirect reduction of methane and nitrous oxide emissions through breed improvements and improvements of genetic potential	CH ₄ , N ₂ O	economic, education, research	planned	Ministry of Agriculture Advisory services
MAG-6: Improvement and change of tillage system (reduced tillage)	Increasing soil carbon sequestration through improvements and modifications to tillage systems	CO ₂	research	planned	Ministry of Agriculture Ministry of Economy and Sustainable Development Advisory services
MAG-7: Expansion of crop rotation with higher share of legumes	Defining the potential for change in organic matter content / increasing soil sequestration of carbon	CO ₂ , N ₂ O	economic, education	planned	Ministry of Agriculture Advisory services
MAG-8: Intensification of crop rotation using intermediate crops	Increasing soil carbon sequestration and reducing nitrate seepage	CO ₂ , N ₂ O	economic, education	implemented	Ministry of Agriculture Advisory services

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MAG-9: Improving methods of applying mineral fertilizers	Reduction of nitrous oxide emissions from agricultural soils, increase of production, reduction of application of mineral fertilizers	N ₂ O	economic, education	implemented	Ministry of Agriculture Advisory services
MAG -10: Improving methods of applying organic fertilizers	Reducing emissions by improving the application methodology of organic fertilizers	N ₂ O	economic, education	implemented	Ministry of Agriculture Advisory services
MAG-11: Agroforestry	Defining the potential and benefits of various agroforestry technologies with the aim of increasing soil sequestration	CO ₂	research	planned	Ministry of Economy and Sustainable Development Ministry of Agriculture
MAG-12: Hydromeliorative interventions and disaster protection systems	Increasing the share of agricultural soils under irrigation, reducing the leakage of nitrates from agricultural soils	N ₂ O	economic, education, research	implemented	Ministry of Agriculture Advisory services
MAG-13: Introduction of new cultivars, varieties and cultures	Determining the potential of new cultivars, varieties and crops to increase soil carbon sequestration	CO ₂ , N ₂ O	research	planned	Ministry of Economy and Sustainable Development Ministry of Agriculture
MAG -14: Change in people's diet	Data collection and research on the potential for reducing greenhouse gas emissions due to changes in diet Developing a framework for reducing the carbon signature	CO ₂ , CH ₄ , N ₂ O	education, research	planned	Ministry of Economy and Sustainable Development Ministry of Agriculture
MAG -15: Collection and processing of agricultural plantations and residues for energy purposes	Optimization of the collection of pruned biomass of permanent crops and field biomass Production of safely available biomass, activation of poorer quality soils in the Republic of Croatia, provision of low-carbon energy during the production process of heat and/or electricity	CO ₂	regulatory, economic	planned	Ministry of Economy and Sustainable Development Ministry of Agriculture

LULUCF

Table 4-5: Overview of policies and measures in the LULUCF sector

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MLF-1: Development of the Land Management Strategy of the Republic of Croatia	Increase removal and reduction of greenhouse gas emissions from the LULUCF sector Align the EU's targets for increasing the share of energy from renewable sources with emission reduction requirements	CO ₂	economic, regulatory, information	planned	Ministry of Agriculture Ministry of Economy and Sustainable Development
MLF-2: Carbon accumulation on the surfaces of existing forests	Conservation of carbon in existing forests Enhancing production in existing forests Enhanced forest management Prevention of deforestation Strengthening protection against natural disturbances Ensuring the maintenance of a defined, reference level for forests	CO ₂	regulatory, economic	implemented	Ministry of Agriculture Ministry of Economy and Sustainable Development
MLF-3: Implementation of afforestation works	Enhanced forest management Strengthening protection against natural disturbances Restoration of degraded lands Examining the justification of measures to sinks increase	CO ₂	regulatory, economic	implemented	Ministry of Agriculture Ministry of Economy and Sustainable Development
MLF-4: Production and use of wood and wood products	Increasing the removal of carbon dioxide in Harvested Wood Products (HWP) Increasing the quality and harmonization of information on wood products	CO ₂	economic, education, information	implemented	Ministry of Agriculture Ministry of Economy and Sustainable Development

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MLF-5: Cropland management	Reducing greenhouse gas emissions by changing and improving the way cropland is managed	CO ₂ , N ₂ O	regulatory, economic	implemented	Ministry of Agriculture Ministry of Economy and Sustainable Development
MLF-6: Grassland management	Reducing greenhouse gas emissions by changing and improving the way grassland is managed	CO ₂	regulatory, economic	implemented	Ministry of Agriculture Ministry of Economy and Sustainable Development
MLF-7: Implementation of technical projects and scientific research in the LULUCF sector	Research in the LULUCF sector	CO ₂ , CH ₄ , N ₂ O	regulatory, information, research	implemented	Ministry of Science and Education Ministry of Agriculture Ministry of Economy and Sustainable Development

Waste

Table 4-6: Overview of policies and measures in the waste sector

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MWM-1: Preventing the generation and reducing the amount of solid waste	Reduced landfilling By 2040 the amount of landfilled municipal waste landfilled should be reduced to 10% or less of the total amount of municipal waste generated (by weight)	CH ₄	regulatory, economic, education	implemented	Ministry of Economy and Sustainable Development Regional self-government units Local self-government units
MWM-2: Increasing the amount of separately collected and recycled solid waste	Reduced landfilling By 2035, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 60% by weight	CH ₄	regulatory, economic	implemented	Ministry of Economy and Sustainable Development Regional self-government units Local self-government units
MWM-3: Ensuring the system of treatment and use of landfill gas	Enhanced CH ₄ collection and use Reduce methane emissions in the atmosphere	CH ₄	regulatory, economic	implemented	Ministry of Economy and Sustainable Development Regional self-government units Local self-government units
MWM-4: Reducing the amount of disposed biodegradable waste	Enhanced recycling Reduced landfilling Reduce up to 90,000 tons of biowaste per year Reduce methane emissions in the atmosphere	CH ₄	regulatory	implemented	Ministry of Economy and Sustainable Development Regional self-government units Local self-government units

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MWM-5: Use of biogas for biomethane production and electricity and heat generation	Enhanced recycling Enhanced CH ₄ collection and use Reduced landfilling Increase in renewable energy sources in the electricity sector Increase in renewable energy in the heating and cooling sector Reduce methane emissions in the atmosphere	CO ₂ , CH ₄	regulatory, economic	implemented	Ministry of Economy and Sustainable Development Regional self-government units Local self-government units

Other (cross-sectorial) policy and measures

Table 4-7: Overview of cross-cutting policies and measures

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MCC-1: Committee for cross-sectoral coordination of policies and measures for mitigation and adaptation to climate change	Monitoring the implementation of policies and measures for mitigation and adaptation to climate change	CO ₂ , CH ₄ , N ₂ O, HFCs, SF ₆	regulatory	implemented	Ministry of Economy and Sustainable Development
MCC-2: Supporting the founding of regional energy and climate agencies and capacity building	Establishment of energy and climate agencies and transformation of existing regional energy agencies into regional energy and climate agencies	CO ₂ , CH ₄ , N ₂ O	economic, regulatory	planned	Ministry of Economy and Sustainable Development
MCC-3: Promotion of the use of innovative information and communication technologies (ICT) to reduce greenhouse gas emissions	Increasing productivity and work efficiency while reducing energy consumption and consequent greenhouse gas emissions	CO ₂ , CH ₄ , N ₂ O, HFCs, SF ₆	information, voluntary agreement	implemented	Ministry of Economy and Sustainable Development Ministry of Physical Planning, Construction and State Assets
MCC-4: Emissions Trading System	Reduction of the GHG emissions by operators under EU ETS; Reduction in greenhouse gas emissions at least 2.2% per year	CO ₂ , N ₂ O	economic, regulatory	implemented	European Commission Ministry of Economy and Sustainable Development
MCC-5: The CO ₂ emission tax for the non-ETS stationary sources	Efficiency improvement in industrial end-use sectors GHG emissions reduction from non-EU ETS stationary sources	CO ₂	regulatory, fiscal	implemented	Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MCC-6: Covenant of Mayors for Climate and Energy in the Republic of Croatia	Accelerating decarbonisation of cities and municipalities	CO ₂ , CH ₄ , N ₂ O	voluntary agreement	implemented	Local government: cities and municipalities
MCC-7: Charter for Buildings Decarbonisation by 2050	Efficiency improvements of buildings Decarbonisation of the building stock by 2050	CO ₂ , CH ₄ , N ₂ O	voluntary agreement	planned	Ministry of Physical Planning, Construction and State Assets
MCC-8: Creation of Platform for Carbon Capture, Use and Storage	Preparation of bases for CCUS projects in the Republic of Croatia	CO ₂	economic, research	planned	Ministry of Economy and Sustainable Development

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MCC-9: Improving sustainability of urban areas	Accelerating decarbonisation of cities and municipalities	CO ₂ , CH ₄ , N ₂ O	economic, research, voluntary agreement	planned	Ministry of Physical Planning, Construction and State Assets
MCC-10: Foundation of the Programme for calculation and reduction of carbon footprint of business entities	Reduction of GHG emissions Reducing the carbon footprint of businesses	CO ₂ , CH ₄ , N ₂ O, HFCs, SF ₆	regulatory	planned	Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MCC-11: Foundation of the Platform for Circular Economy	Demand management/reduction Enhanced recycling Reduced landfilling Efficiency improvement in the energy and transformation sector Integration the principles of the circular economy in plastic production	CO ₂ , CH ₄ , N ₂ O	education, information, regulatory	implemented	Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MCC-12: Foundation of the Platform for Bioeconomy	Adaptation of the agriculture, forestry and waste management sectors to the transition to the bioeconomy	CO ₂ , CH ₄ , N ₂ O	education, information, regulatory	planned	Ministry of Economy and Sustainable Development Ministry of Agriculture
MCC-13: Foundation of the Platform for Hydrogen Technologies	Formed platform for hydrogen technology that will bring together national stakeholders relevant to the research and application of hydrogen technology	CO ₂ , CH ₄ , N ₂ O	education, information, regulatory	planned	Ministry of Economy and Sustainable Development Environmental Protection and Energy Efficiency Fund
MCC-14: Energy efficiency obligation system for suppliers	Energy savings in final consumption Energy savings in 2030: 16,0 PJ	CO ₂ , CH ₄ , N ₂ O	regulatory, economic	implemented	Ministry of Economy and Sustainable Development
MCC-15: Integrated information system for monitoring energy efficiency	Systematic monitoring of the implementation of energy efficiency measures	CO ₂ , CH ₄ , N ₂ O	information	implemented	Ministry of Economy and Sustainable Development

Name of PAM	Objective	Greenhouse gas	Type of instrument	Status	Implementing body
MCC-16: Green public procurement	Environmental criteria implemented in public procurement procedures	CO ₂ , CH ₄ , N ₂ O	information, regulatory	implemented	Ministry of Economy and Sustainable Development Central State Office for Central Public Procurement
MCC-17: Determining the starting point, national goals, indicators for monitoring the achievement and establishing a system for monitoring the achievement of the set goals of research, innovation and competitiveness	Defined national development goals in the context of low carbon transition, set up a system for monitoring achievement, defined key technologies	CO ₂ , CH ₄ , N ₂ O	regulatory	planned	Ministry of Economy and Sustainable Development Ministry of Science and Education
MCC-18: Co-financing of industrial research and experimental development projects aligned with the National Development Strategy	Conducting research projects of priority for the Republic of Croatia	CO ₂ , CH ₄ , N ₂ O	economic	planned	Ministry of Economy and Sustainable Development Ministry of Science and Education Croatian Science Foundation HAMAG-BICRO
MCC-19: Supporting low carbon entrepreneurship development	Low-carbon products and services placed on the market	CO ₂ , CH ₄ , N ₂ O	economic, research	planned	Ministry of Economy and Sustainable Development Ministry of Science and Education HAMAG-BICRO
MCC-20: Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies	Technology transfer Low-carbon products and services placed on the market	CO ₂ , CH ₄ , N ₂ O	economic, research	planned	Ministry of Science and Education
MCC-21: Supporting further work of excellence centers active in the field of natural, technical, biotechnical and biomedical sciences	Industrial and experimental research in the field of low carbon development	CO ₂ , CH ₄ , N ₂ O	economic, research	planned	Ministry of Science and Education
MCC-22: Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy	Research, innovation and increasing competitiveness	CO ₂ , CH ₄ , N ₂ O	information, research	planned	Ministry of Economy and Sustainable Development Ministry of Science and Education HAMAG-BICRO

4.4. POLICIES AND MEASURES THAT ARE NO LONGER IN USE

Policies and measures presented in the Fourth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change are also presented in this report. Several measures have been renamed for better understanding. In relation to the measures presented in the Fourth Biennial Report, three additional measures are included in this report.

There are no measures that are no longer in force.

Differences in measures compared to the last report:

Eighth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change	Fourth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change	Difference
MEN-24: Refinery modernization and transformation	MEN-24: Refinery modernization	Changed name of the PAM
MEN-32: Program for combating energy poverty, which includes the use of renewable energy sources in residential buildings in areas of special state care for the period 2021-2025	-	New PAM
MEN-33: Increasing energy efficiency and use of RES in manufacturing industry	-	New PAM
MTR-14: Decarbonization of transport through the production of advanced biofuels from residues of agricultural production and energy crops with integrated carbon capture, use and storage	-	New PAM
MAG-1: Change in livestock diet of and feed quality	MAG-1: Change in the diet of cattle and pigs and animal feed quality	Changed name of the PAM
MAG-2: Improvement of livestock facilities and manure management systems	MAG-2: Improving cattle facilities and system of animal waste management	Changed name of the PAM

5. PROJECTIONS OF EMISSIONS AND EFFECTS OF THE IMPLEMENTATION OF POLICIES AND MEASURES

This chapter presents historical greenhouse gas emissions for the period from 1990 to 2020 and projections of greenhouse gas emissions for the period from 2025 to 2040. The emissions are presented as total emissions of greenhouse gases by sectors and by gases.

Since individual greenhouse gases have different properties and thus different contribution to greenhouse effect, emission of each gas is multiplied by the appropriate Global Warming Potential (GWP). Thus, GHG emission is presented as the equivalent emission of carbon dioxide (CO₂e). If a removal of greenhouse gases by sinks occurs, the amount is presented as a negative value. Global warming potentials used are given below (according to Fourth Assessment Report (AR4) [5-1]).

Gas	Global Warming Potential
Carbon dioxide (CO ₂)	1
Methane (CH ₄)	25
Nitrous oxide (N ₂ O)	298
HFC-23	14,800
HFC-32	675
HFC-125	3,500
HFC-134a	1,430
HFC-143a	4,470
HFC-152a	124
HFC-227ea	3,220
HFC-236fa	9,810
CF ₄	7,390
C ₃ F ₈	8,830
C ₂ F ₆	12,200
SF ₆	22,800

Projections of greenhouse gases are presented by sectors:

- energy,
- transport,
- industrial processes and product use,
- agriculture,
- waste,
- LULUCF.

Calculation includes projections of emissions which result from human activities, and which include the following direct greenhouse gases:

- carbon dioxide (CO₂),
- methane (CH₄),
- nitrous oxide (N₂O),
- hydrofluorocarbons (HFCs),
- sulphur hexafluoride (SF₆).

Projections are presented for two scenarios: 'with existing measures' scenario and 'with additional measures' scenario. Scenario 'with existing measures' includes the application of current policies and measures whose implementation is already in progress, i.e. the application of policies and measures that have been adopted. Scenario 'with additional measures' is based on the application of planned policies and measures.

Scenario 'without measures' is not shown because the Republic of Croatia does not have the necessary data for the 'without measures' scenario.

Emission projections are based on the Inventory of Greenhouse Gas Emissions (NIR 2022), which contains the inventory of emissions and removals of greenhouse gases for the period 1990 – 2020 (submission from October 14, 2022).

Projections presented below are in accordance with the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030 [5-2] and are taken from the Report on projections of greenhouse gas emissions by sources and removals by sinks [5-3].

Projections presented in the aforementioned Report on projections of greenhouse gas emissions by sources and removals by sinks, were calculated using global warming potentials of individual gases in accordance with the Fifth Assessment Report (AR5) [5-4], while for the purposes of this report, projections were calculated using global warming potentials in accordance with the Fourth Assessment Report (AR4), for the reason of consistency with data from the National Inventory Report (NIR 2022).

The shown changes in projections compared to the previous submission refer to projections presented in the Fourth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change.

5.1. PROJECTIONS OF GREENHOUSE GAS EMISSIONS

5.1.1. Projections of greenhouse gas emissions by sectors

Historical and projected trends in greenhouse gas emissions by sectors are presented in Figures 5-1 and 5-2. Emissions are presented for 'with existing measures' scenario and 'with additional measures' scenario for the period from 1990 to 2040.

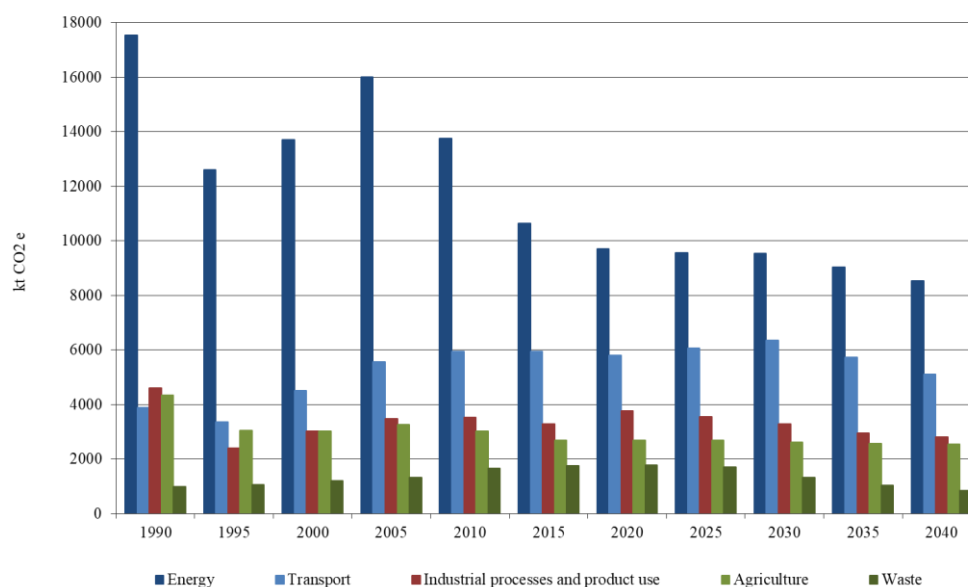


Figure 5-1: Historical and projected greenhouse emissions by sectors, 'with existing measures' scenario

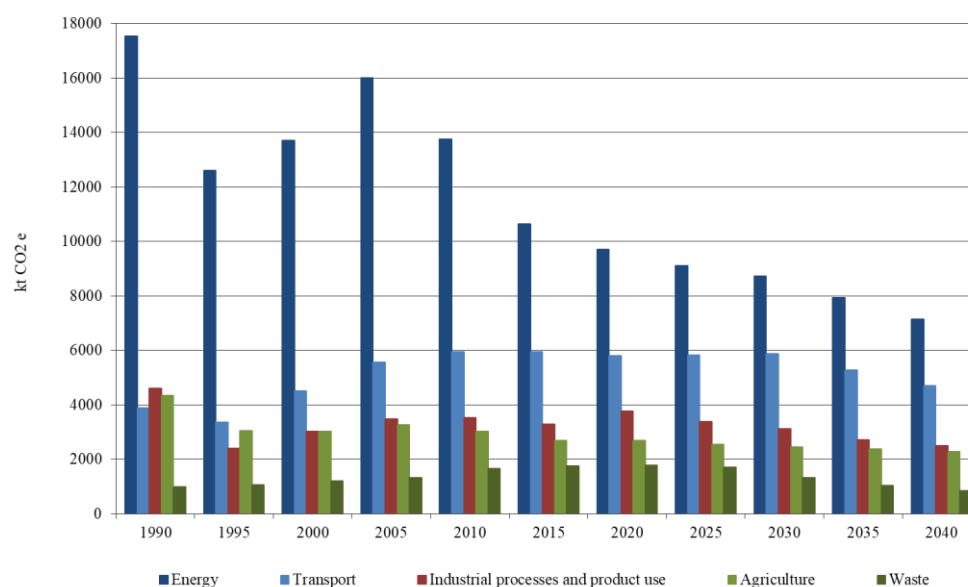


Figure 5-2: Historical and projected greenhouse emissions by sectors, 'with additional measures' scenario

Energy sector covers all activities that involve fuel combustion from stationary sources and fugitive emission from fuels. Emission from energy sector in 2020 amounted to 9,756.71 kt CO₂e and it is the main source of anthropogenic emission of greenhouse gases, with a share of 40.8 % in the total greenhouse gases emission in 2020 (excluding LULUCF).

The scenario 'with existing measures' represents the group effect of measures that are in use and for which there are implementation instruments, as well as measures resulting from the adoption of the EU acquis. A detailed list of measures with descriptions can be found in chapter 4.2.1. The scenario 'with additional measures' is based on the implementation of existing, but also additional measures, specified in chapter 4.2.1.

In the 'with existing measures' scenario, projections show a decrease in emissions in the period from 2035 onwards, because in that period it is expected that the growth of demand will be compensated primarily by the implementation of measures for the use of renewable energy sources, energy efficiency measures and due to the impact of the EU ETS. In the scenario 'with additional measures', all measures planned in the energy sector were taken into account and projections show a steady trend of emission reduction.

Changes compared to the previous submission

In the energy sector, there was a change in CH₄ emission projections compared to the previous submission. Namely, an error was observed in the model that occurred during the creation of projections for the previous submission, related to the emission factors for biofuels. The error is now corrected. Also, in the scenario 'with additional measures', larger amounts of solid biomass (1.A.2. and 1.A.4.a.) are included compared to the scenario 'with existing measures', which results in higher CH₄ emissions. In the energy sector, there was a change in CO₂ emission projections due to corrections of emission factors for coal in 1.A.1.a. and for petrol coke in 1.A.2.b.

Historical emissions and projections of greenhouse gas emissions in the energy sector are shown in Figure 5-3.

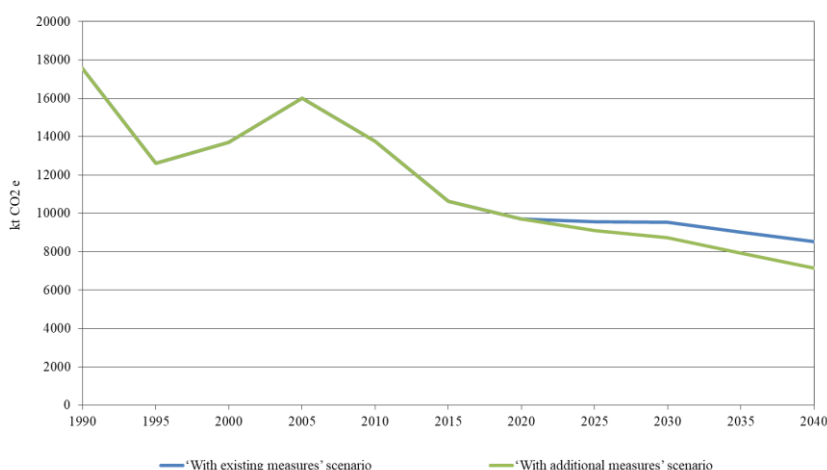


Figure 5-3: Historical and projected greenhouse emissions in the energy sector

Transport sector includes emissions from fuel combustion in road transportation, civil aviation, railways and navigation. The emission in 2020 amounted to 5,796.77 kt CO₂e, which makes about 24.3% of total Croatia's greenhouse gases emission (excluding LULUCF).

The scenario 'with existing measures' includes measures to reduce greenhouse gas emissions resulting from existing regulations and the adoption of the EU acquis. A detailed list of measures with descriptions can be found in chapter 4.2.2. The scenario 'with additional measures' is based on the implementation of existing, but also additional measures, specified in chapter 4.2.2.

In the 'with existing measures' scenario in the period up to 2030, projections show an increase in emissions. Factors that encourage the growth of emissions are the expected increase in economic activities and living standard and consequently increase in the number of fossil fuel vehicles. In the period from 2035 onwards, emission reductions are expected, which are primarily affected by measures to increase energy efficiency and the use of electricity and renewable sources in transport. In scenario 'with additional measures', projections show a continuous trend of reducing emissions by 2040, primarily due to planned additional measures to increase the share of rail transport and the development of electric vehicles, which will also be key conditions for a strong reduction of emissions in the transport sector in the long term.

Changes compared to the previous submission

In the transport sector, there was a change in CH₄ emission projections compared to the previous submission. Namely, an error was observed in the model that occurred during the creation of projections for the previous submission, related to the emission factors for biofuels. The error is now corrected. Also, in the 'with additional measures' scenario, larger amounts of biomethane (1.A.3.b.) are included compared to the 'with existing measures' scenario, which results in higher CH₄ emissions.

In sub-sector 1.A.3.d., in the period from 2035 to 2040, a higher level of domestic shipping activity is included in the scenario 'with additional measures' compared to the scenario 'with existing measures', which results in higher consumption fuel and consequently higher CO₂ emissions.

Historical emissions and projections of greenhouse gas emissions in the transport sector are shown in Figure 5-4.

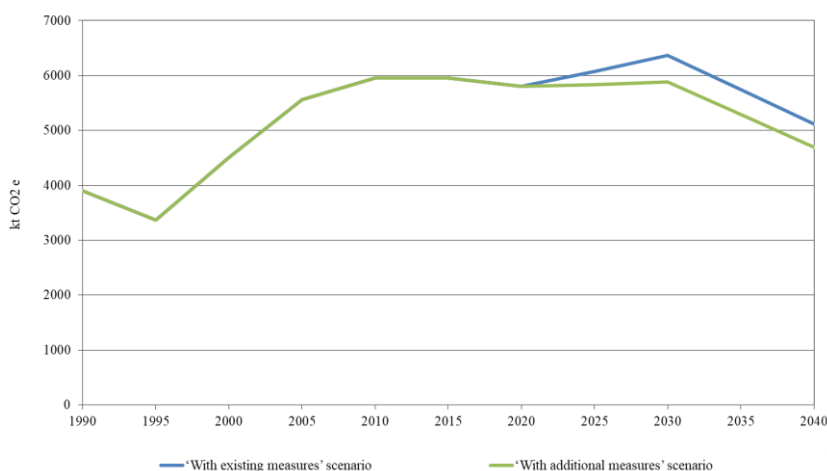


Figure 5-4: Historical and projected greenhouse emissions in the transport sector

Industrial processes and product use sector includes process emissions from industrial processes and product use, while fuel combustion emissions in industrial facilities are included in the energy sector. Emission from the industrial processes and product use sector in 2020 amounted to 3,655.04 kt CO₂e, which is 15.3% of total Croatia's greenhouse gases emission in 2020 (excluding LULUCF).

The 'with measures' scenario includes the application of measures defined by strategic and planning sector documents included in producers business policies, which are conditioned by market requirements, legislation and requirements for the implementation of the best available techniques in production processes. Measures to reduce ozone-depleting substances and fluorinated greenhouse gases are regulated by the legislation. The 'with additional measures' scenario includes the application of cost-effective measures to reduce greenhouse gas emissions in cement production and to reduce emissions of ozone-depleting substances and fluorinated greenhouse gases.

Projections of emissions indicate stagnation and a slight reduction in emissions in the 'with existing measures' scenario due to measures for ozone-depleting substances and fluorinated greenhouse gases reduction. The implementation of process measures in the 'with existing measures' scenario is prescribed by the sectoral legislation. The projections indicate a decrease in 'with additional measures' scenario due to the implementation of cost-effective measures to reduce emissions.

The 'with additional measures' scenario is based on the implementation of the planned measures specified in the Report on implementation of policies and measures that reduce greenhouse gas emissions by sources or enhance removals by sinks.

Process measures to reduce greenhouse gas emissions from the industrial processes and product use sector include:

- reducing the share of clinker in cement production;
- limiting fluorinated greenhouse gas emissions;
- gradual reduction of the amount of fluorocarbons that can be placed on the market;
- restrictions and prohibitions on placing certain products and equipment on the market;
- reduction of fluorinated greenhouse gas emissions from mobile air conditioning systems.

Changes compared to the previous submission

In the projections of fluorinated greenhouse gases, there was a significant change compared to the previous submission due to recalculations of the historical series because of the update of activity data and the emission calculation methodology.

Historical emissions and projections of greenhouse gas emissions in the industrial processes and product use sector are shown in Figure 5-5.

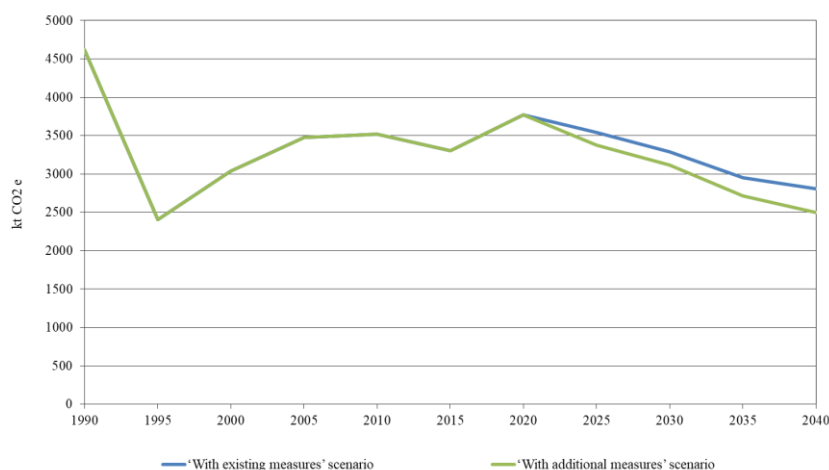


Figure 5-5: Historical and projected greenhouse emissions in the industrial processes and product use sector

Agriculture sector covers about 11.4% of total greenhouse gas emissions (excluding LULUCF) in 2020 (emission is 2,714.26 kt CO₂e). Projections indicate emission reductions in the "with existing measures" scenario due to implemented measures, while the reduction in the "with additional measures" scenario is greater due to the strengthening of additional measures, especially in emission sources of livestock and mineral fertilizers.

Changes compared to the previous submission

In the agriculture sector, there was a change in the CO₂, CH₄ and N₂O emissions projections compared to the previous submission due to recalculations of the historical series. Namely, in the NIR 2022 inventory (for the last historical year 2020), information on the rabbit population is included as a new source in 3.A. and 3.B. and information on the use of dolomite (CaMg(CO₃)₂) as a new source in 3.G. The activity data for 2020 was retained for all years of emission projections.

In addition, projections of key trends of activity data for livestock production (number of significant categories of animals) were taken from the global FAO report "The future of food and agriculture - alternative routes until 2050", using the BAU (business as usual) scenario of the mentioned report. Since 2012 was used as the base year in the FAO report, and there are no available updated trends in the number of animals, the data of the BAU scenario of the FAO report have been adjusted according to the data on the number of animals from 2020. Given that the identical trend of the future number of animals has been maintained, for some categories of animals there is a greater difference in the number of animals between the last historical year 2020 and the projected number of animals for the period from 2025 to 2040.

Historical emissions and projections of greenhouse gas emissions in the agriculture sector are shown in Figure 5-6.

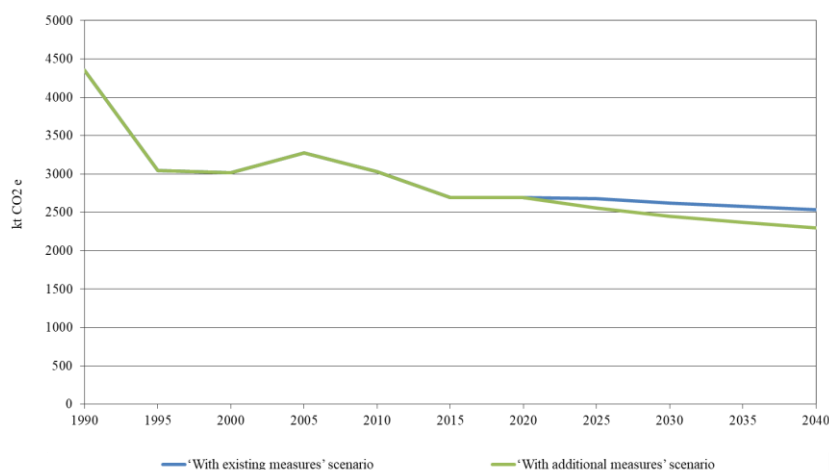


Figure 5-6: Historical and projected greenhouse emissions in the agriculture sector

Waste sector participates in the total of Croatia's greenhouse gases emission (excluding LULUCF) with 8.3% in 2020 (emission is 1,970.32 kt CO₂e). Projections of emissions of greenhouse gases from the waste sector are based on the implementation of measures prescribed by sectoral legislation, harmonized with EU legislation. The 'with existing measures' scenario includes the existing legal framework of the Republic of Croatia and the adopted EU legal framework from the waste sector for the period until 2050. Projections indicate a decrease in the 'with existing measures' scenario due to the implementation of cost-effective measures to reduce emissions. The 'with additional measures' scenario is the same as the 'with existing measures' scenario since no additional measures to reduce emissions of greenhouse gases have been identified. The potentials of CO₂ emission reduction, which can be achieved by implementing the measures included in the 'with existing measures' scenario and the 'with additional measures' scenario are estimated in the energy sector.

Changes compared to the previous submission

In the waste sector, subsector 5.B., there was a change in the greenhouse gas projections compared to the previous submission. Namely, an error was observed in the model that occurred during the creation of projections for the previous submission. The error has now been corrected and for this reason there was a change in the projections.

Historical emissions and projections of greenhouse gas emissions in the waste sector are shown in Figure 5-7.



Figure 5-7: Historical and projected greenhouse emissions in the waste sector

In 2020, removals by sinks in the **LULUCF sector** were -5,572.98 kt CO₂e. Projections are made for sectorial sub-categories 'Forest land', 'Cropland', 'Grasslands', 'Wetlands', 'Settlements', 'Other land' and 'Harvested wood products' for the scenario 'with existing measures' (Figure 5- 8).

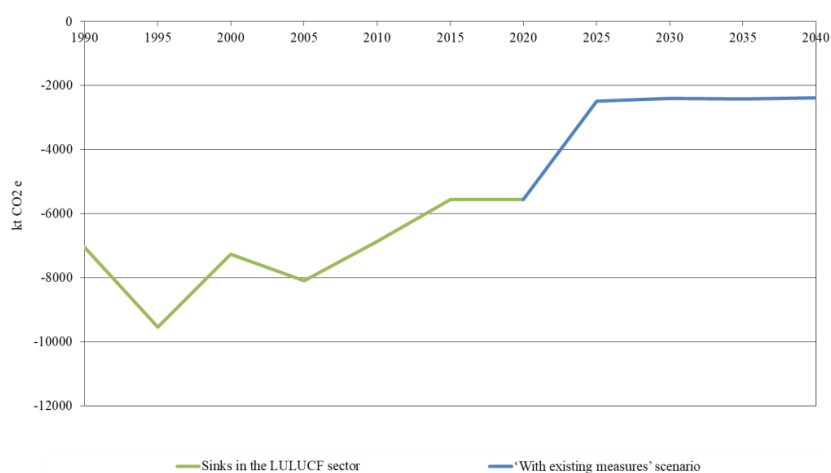


Figure 5-8: Removal by sinks in the LULUCF sector, 'with existing measures' scenario

5.1.2. Projections of greenhouse gas emissions by gases

Trends in emissions, by greenhouse gases (CO₂, CH₄, N₂O, HFCs and PFCs, SF₆), for the 'with existing measures' and 'with additional measures' scenarios, in the period 1990-2040 are shown in Figure 5-9.

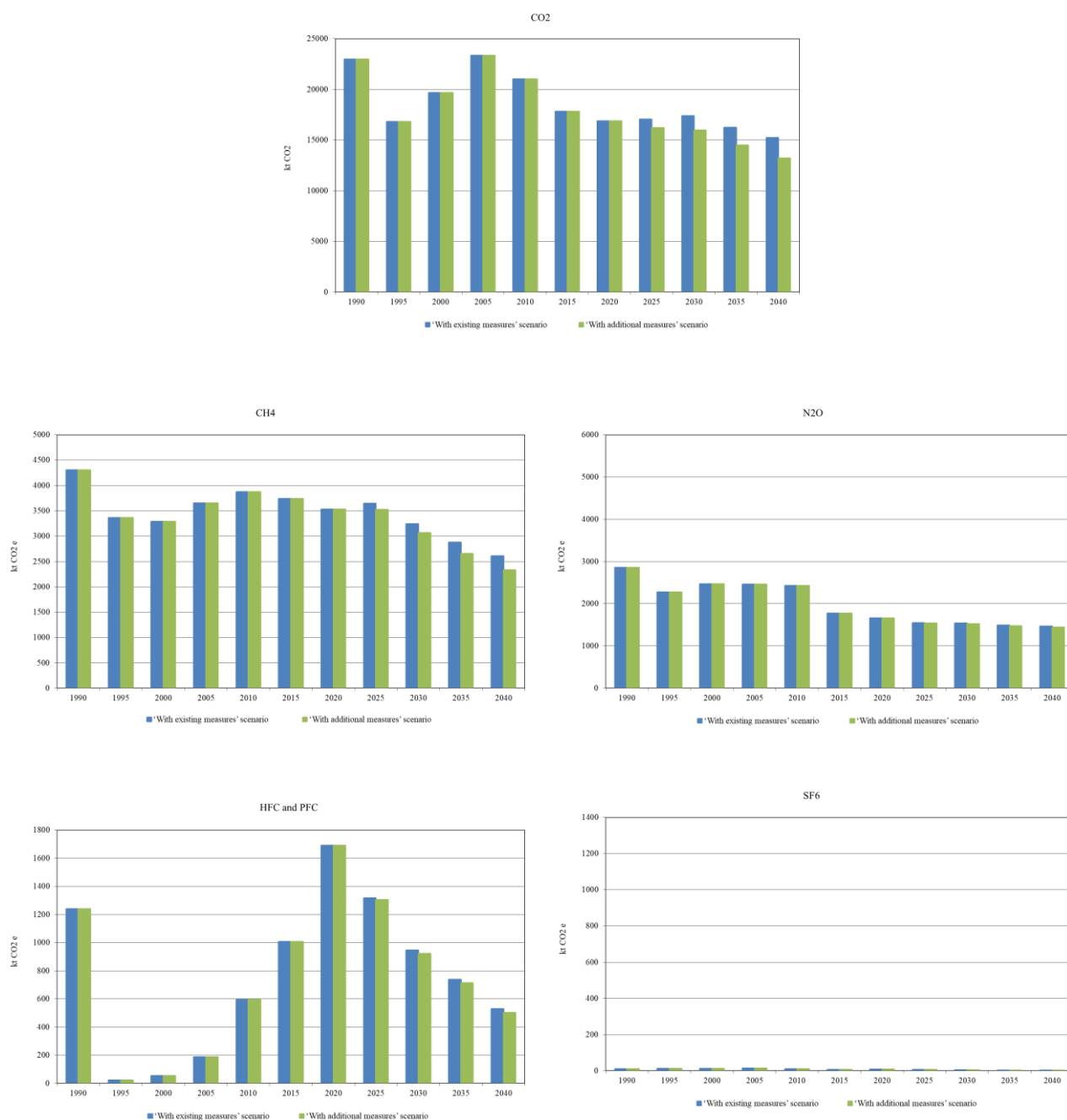


Figure 5-9: Historical and projected greenhouse emissions by gases

Historical emissions and projections of emissions of greenhouse gases CO₂, CH₄, N₂O, HFCs, PFCs and SF₆, for both scenarios, in the period 1990-2040 are shown in Table 5-1.

Table 5-1: Historical emissions and projections of emissions of greenhouse gases CO₂, CH₄, N₂O, HFCs, PFCs and SF₆, kt CO₂e

CO ₂	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	22,979.79	16,817.67	19,662.49	23,343.92	21,016.28	17,824.70	16,870.53	17,055.19	17,389.94	16,226.77	15,244.42
'With additional measures' scenario	22,979.79	16,817.67	19,662.49	23,343.92	21,016.28	17,824.70	16,870.53	16,220.17	15,983.57	14,496.91	13,191.09
CH ₄	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	4,307.79	3,362.39	3,285.82	3,650.26	3,870.76	3,737.07	3,532.83	3,642.90	3,237.69	2,880.26	2,606.28
'With additional measures' scenario	4,307.79	3,362.39	3,285.82	3,650.26	3,870.76	3,737.07	3,532.83	3,520.32	3,065.94	2,656.50	2,331.76
N ₂ O	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	2,855.88	2,272.02	2,465.23	2,458.23	2,430.14	1,775.71	1,656.56	1,549.73	1,538.61	1,489.53	1,461.55
'With additional measures' scenario	2,855.88	2,272.02	2,465.23	2,458.23	2,430.14	1,775.71	1,656.56	1,535.72	1,520.93	1,469.47	1,438.77
PFC and HFC	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	1,240.24	21.85	52.89	187.20	595.15	1,007.40	1,689.72	1,317.52	945.32	737.09	528.86
'With additional measures' scenario	1,240.24	21.85	52.89	187.20	595.15	1,007.40	1,689.72	1,305.72	921.73	712.26	502.79
SF ₆	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	10.73	12.08	12.34	14.26	9.83	5.58	8.76	6.55	4.33	3.24	2.14
'With additional measures' scenario	10.73	12.08	12.34	14.26	9.83	5.58	8.76	6.50	4.23	3.14	2.04
TOTAL	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	31,394.43	22,485.99	25,478.77	29,653.86	27,922.16	24,350.46	23,758.40	23,571.89	23,115.89	21,336.89	19,843.25
'With additional measures' scenario	31,394.43	22,485.99	25,478.77	29,653.86	27,922.16	24,350.46	23,758.40	22,588.43	21,496.40	19,338.28	17,466.46

The energy sector has the largest contribution to CO₂ emissions. Projections for 2040 show emissions of 15,244.42 kt CO₂ for the scenario 'with existing measures' and 13,191.09 kt CO₂ for the scenario 'with additional measures'. Projections show a reduction in emissions by 24.3% in 2030 compared to 1990, and by 33.7% in 2040, compared to 1990 in the 'with existing measures' scenario. In the scenario 'with additional measures', projections show a reduction in emissions by 30.4% in 2030 and by 42.6% in 2040, compared to 1990.

The main sources of CH₄ emissions are the agriculture and waste sectors. Projections show a reduction of CH₄ emissions by 39.5% in 2040, compared to 1990 in the 'with measures' scenario and by 45.9% in the 'with additional measures' scenario.

The most important source of N₂O emissions is agriculture sector. It's projections in 2040 have a maximum of 1,461.55 kt CO₂e in the 'with existing measures' scenario, and 1,438.77 kt CO₂e in the 'with additional measures' scenario.

Sources of HFCs and SF₆ emissions are industrial processes and product use. Although their emissions in absolute terms are not large, due to large global warming potentials (GWP), their contribution is significant. Projections of HFCs and SF₆ in 2040 amount to 531.01 kt CO₂e in the 'with existing measures' scenario and 504.84 ktCO₂e in the 'with additional measures' scenario.

5.1.3. Total projections of greenhouse gas emissions

Historical emissions and projections of greenhouse gas emissions (not including removals) are shown in Figure 5-10 and Table 5-2. Emissions are shown for the scenario 'with existing measures' and 'with additional measures', for the period from 1990 to 2040.

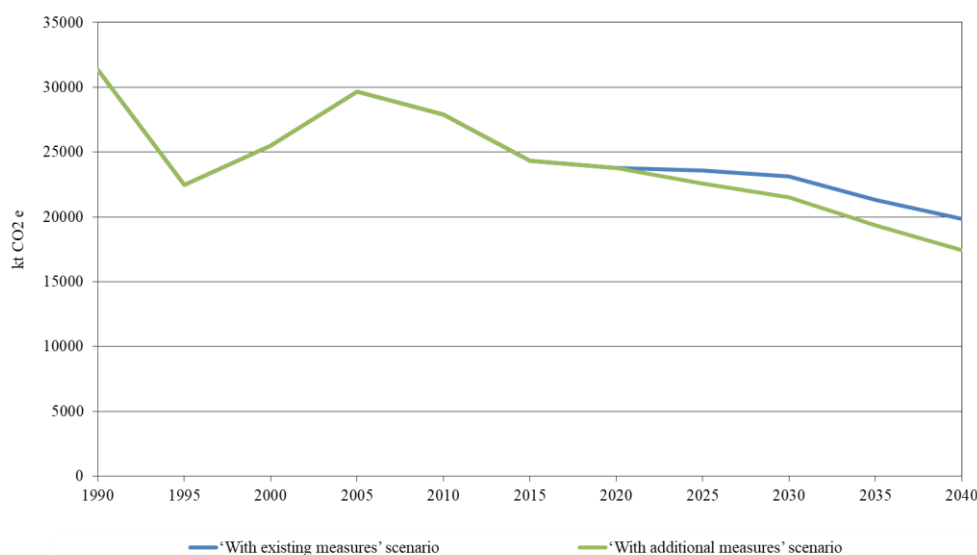


Figure 5-10: Historical emissions and projections of greenhouse gas emissions (without removals) for the period until 2040

Table 5-2: Historical emissions and projections of greenhouse gas emissions, kt CO₂e

'With existing measures' scenario	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Energy	17,543	12,602	13,715	16,003	13,757	10,637	9,714	9,560	9,527	9,029	8,541
Transport	3,896	3,370	4,502	5,562	5,952	5,954	5,802	6,077	6,362	5,739	5,116
Industrial processes and product use	4,618	2,404	3,038	3,475	3,521	3,301	3,770	3,542	3,287	2,952	2,809
Waste	984	1,068	1,205	1,337	1,664	1,768	1,779	1,713	1,321	1,042	842
Agriculture	4,353	3,042	3,018	3,277	3,029	2,690	2,692	2,680	2,619	2,575	2,536
TOTAL	31,394	22,486	25,479	29,654	27,922	24,350	23,758	23,572	23,116	21,337	19,843
'With additional measures' scenario	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Energy	17,543	12,602	13,715	16,003	13,757	10,637	9,714	9,111	8,726	7,927	7,137
Transport	3,896	3,370	4,502	5,562	5,952	5,954	5,802	5,835	5,879	5,285	4,691
Industrial processes and product use	4,618	2,404	3,038	3,475	3,521	3,301	3,770	3,375	3,120	2,715	2,502
Waste	984	1,068	1,205	1,337	1,664	1,768	1,779	1,713	1,321	1,042	842
Agriculture	4,353	3,042	3,018	3,277	3,029	2,690	2,692	2,554	2,451	2,369	2,294
TOTAL	31,394	22,486	25,479	29,654	27,922	24,350	23,758	22,588	21,496	19,338	17,466

Projections show that compared to 1990, emissions in the 'with existing measures' scenario in 2040 will decrease by 36.8%, while in the 'with additional measures' scenario, emissions will decrease by 44.4%.

Projections show that in the 'with existing measures' scenario, emissions in 2040 are reduced by 16.5% compared to 2020, while in the 'with additional measures' scenario, emissions are reduced by 26.5%.

In the scenario 'with existing measures', projections show stagnation until 2030. After 2030, emissions show a decline in this scenario. In the scenario 'with additional measures', the projections show a constant trend of reducing emissions.

In the scenario 'with additional measures' compared to the scenario 'with existing measures' in 2040, greenhouse gas emissions are reduced by 12.0%.

5.1.4. International aviation and maritime transport

Greenhouse gas emissions resulting from the consumption of fossil fuels in the international aviation and maritime transport, according to the IPCC methodology, are shown separately and are not included in the total greenhouse gas emissions of the Republic of Croatia.

The fuel consumption for international aviation and marine bunkers are shown in the Table 5-3.

Table 5-3: Fuel consumption for international aviation and marine bunkers, from 1990 to 2020, TJ

	1990	1995	2000	2005	2010	2015	2020
Aviation bunkers	6,945.7	3,428.9	2,813.4	3,604.7	4,132.2	4,884.0	2,259.5
Marine bunkers	1,936.8	1,356.8	757.4	1,047.8	255.0	144.4	852.7
Total bunkers	8,882.5	4,785.7	3,570.8	4,652.5	4,387.2	5,028.5	3,112.2

Projections of emissions from international aviation are determined for the 'with measures' scenario. The 'with additional measures' scenario is equal to the 'with measures' scenario.

Projections of emissions from international maritime transport are not available because there is no available data on fuel consumption (marine bunkers) for the period up to 2040.

Projections of fuel consumption for international aviation are presented in Table 5-4.

Table 5-4: Projections of fuel consumption for international aviation, TJ

	2025	2030	2035	2040
Jet fuel	3,899.2	5,538.9	5,559.0	5,579.0
Bio jet fuel	0	0	116.3	232.5
Total bunkers	3,899.2	5,538.9	5,675.2	5,811.5

Historical emissions and emissions projections from international aviation are presented in Table 5-5 and Figure 5-11.

Table 5-5: Historical emissions and emissions projections for international aviation transport, kt CO₂e

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
International aviation	500.8	247.3	202.9	259.9	298.0	357.1	165.2	285.1	404.9	406.5	408.0

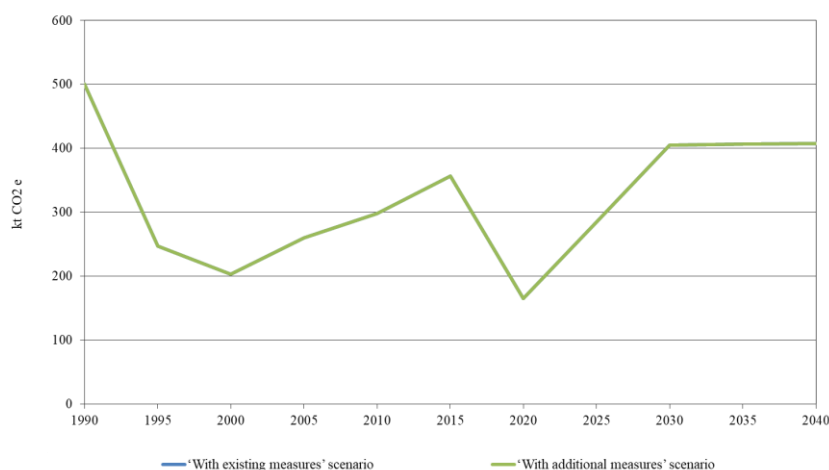


Figure 5-11: Historical emissions and projections of greenhouse gas emissions from international aviation for the period until 2040

In 2016, as an instrument for limiting greenhouse gas emissions from international aviation, the **International Civil Aviation Organization (ICAO)** adopted a global market measure for emissions from international air traffic, the so-called Carbon Offsetting and Reduction Scheme for International Aviation, CORSIA [5-5], with the aim of avoiding or neutralizing the growth of CO₂ emissions from international air traffic, i.e. limiting emissions to the 2020 levels. CORSIA complements other measures to reduce emissions such as improvements in aircraft technology, improvements in business practices and infrastructure, and the use of sustainable aviation fuel. Exceeding the emissions above the 2020 level, airlines and other aircraft operators will compensate by purchasing carbon credits. This means that airlines and aircraft operators are responsible for their emissions, and they will be able to offset emissions by investing in projects that reduce or absorb greenhouse gases.

CORSIA will be implemented in three phases: the voluntary pilot phase of the scheme from 2021 to 2023, the first phase from 2024 to 2026 and the second phase from 2027 to 2035. For the pilot phase and the first phase (from 2021 to 2026), participation is voluntary.

During the voluntary phases, CORSIA will only apply to international flights between countries that voluntarily participate in the scheme, meaning that international flights to and from countries that have not volunteered will be exempt. During the mandatory phase, starting in 2027, CORSIA will cover all international flights (including those traveling to or from countries that have not volunteered for the early phases).

All EU Member States, including the Republic of Croatia, cooperate to ensure the implementation of CORSIA and achieve the goals of reducing greenhouse gases in international aviation. The Republic of Croatia, as a Member State of the European Union, is one of the voluntary participants of the CORSIA program [5-6], [5-7].

In 2018, the **International Maritime Organization (IMO)** adopted the Initial IMO Strategy on reduction of GHG emissions from ships [5-8]. The goal of this strategy is to reduce greenhouse gas emissions from international maritime transport by at least 50% by 2050, compared to the level of emissions in 2008. The initial greenhouse gas strategy includes energy efficiency measures, promotion of alternative fuels and technologies with a low carbon footprint, and cooperation in achieving global goals for reducing emissions in maritime transport.

The IMO has established a system for collecting data on fuel consumption in maritime traffic – the Global Reporting Ship Fuel Consumption System (GRFCS), with the aim of assessing and monitoring greenhouse gas emissions and the energy efficiency of maritime transport. The system began to be implemented in 2019 and requires large ships ($\geq 5,000$ GT) to report fuel consumption data [5-9]. Large ships calling at EU ports report their fuel consumption according to both the IMO system and Regulation (EU) 2015/757. Although there is currently no carbon market instrument for international maritime transport according to the IMO, the EU plans to include greenhouse gas emissions from international maritime transport in the EU ETS [5-10].

The Republic of Croatia, as a member of the IMO, participates in the development and implementation of international standards and policies related to maritime transport, including issues such as navigation safety, environmental protection and reduction of greenhouse gas emissions.

5.1.5. Projections of indirect greenhouse gases

The National Air Pollution Control Program for the period from 2020 to 2029 (Official Gazette 90/19) contains projections of indirect greenhouse gas emissions that are inconsistent and unaligned with current strategic and planning documents, especially the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 and the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030. New projections of indirect greenhouse gas emissions are now in the process of being harmonized with these documents.

5.2. EFFECTS OF IMPLEMENTATION OF POLICIES AND MEASURES

5.2.1. Total effects of implementation of policies and measures

The effects of individual measures on the reduction of emissions have not been determined and the effects of group measures are available for the scenario 'with existing measures' and for the scenario 'with additional measures'. Group measures are defined at the sector or sub-sector level.

The effects of intersectoral measures whose impact leads to certain activities are integrally included in the projections, to the extent possible.

The overall effects of implementation of policies and measures to reduce greenhouse gas emissions are shown in Tables 5-6 and 5-7. The tables show the difference between emissions in 2020 (the reference year for projections) and emissions in 2025, 2030, 2035 and 2040.

Table 5-6: Total effects of implementation of policies and measures for the 'with existing measures' scenario, kt CO₂e

'With existing measures' scenario	2020	2025	2030	2035	2040
Energy	9,714.2	154.4	187.1	685.3	1,173.4
Transport	5,802.4	-274.5*	-559.3*	63.8	686.4
Industrial processes and product use	3,770.2	228.3	483.7	818.3	961.3
Waste	1,779.3	66.4	458.0	737.0	937.6
Agriculture	2,692.3	11.9	73.0	117.2	156.5
LULUCF	-5,560.9	-3,069.4**	-3,163.0**	-3,148.6**	-3,175.3**
TOTAL (excluding LULUCF)	23,758.4	186.5	642.5	2,421.5	3,915.2
TOTAL (including LULUCF)	18,197.5	-2,882.9***	-2,520.5***	-727.1***	739.8

* negative value indicates an increase in emissions compared to 2020

** negative value indicates a decrease in emissions compared to 2020

*** negative value indicates an increase in total emissions including LULUCF compared to 2020

Table 5-7: Total effects of implementation of policies and measures for the 'with additional measures' scenario, kt CO₂e

'With additional measures' scenario	2020	2025	2030	2035	2040
Energy	9,714.2	602.7	988.1	1,787.6	2,576.9
Transport	5,802.4	-32.8*	-76.2*	517.5	1,111.2
Industrial processes and product use	3,770.2	395.7	650.6	1,055.0	1,268.0
Waste	1,779.3	66.4	458.0	737.0	937.6
Agriculture	2,692.3	138.0	241.5	323.0	398.3
LULUCF	-5,560.9	-3,069.4**	-3,163.0**	-3,148.6**	-3,175.3**
TOTAL (excluding LULUCF)	23,758.4	1,170.0	2,262.0	4,420.1	6,291.9
TOTAL (including LULUCF)	18,197.5	-1,899.4***	-901.0***	1,271.5	3,116.6

* negative value indicates an increase in emissions compared to 2020

** negative value indicates a decrease in emissions compared to 2020

*** negative value indicates an increase in total emissions including LULUCF compared to 2020

Projections of emissions (excluding LULUCF) show a reduction in the period until 2040 compared to 2020, which is the reference year for projections. Also, in both scenarios it is evident that the transport sector is expected to increase emissions until 2030.

Projections of removals by sinks show a decrease in the period until 2040, compared to the sink levels in 2020.

The total effects of implementation of policies and measures to reduce greenhouse gas emissions shown as the difference of total emissions (excluding LULUCF) from the scenario 'with existing measures' and the scenario 'with additional measures' are shown in Table 5-8 and 5-9.

Table 5-8: Total effects of implementation of policies and measures – difference between the 'with existing measures' and 'with additional measures' scenario, kt CO₂e

	2025	2030	2035	2040
'With existing measures' scenario	23,571.9	23,115.9	21,336.9	19,843.3
'With additional measures' scenario	22,588.4	21,496.4	19,338.3	17,466.5
Difference between scenarios	983.5	1,619.5	1,998.6	2,376.8

Table 5-9: Total effects of implementation of policies and measures – difference between the 'with existing measures' and 'with additional measures' scenario by sectors, kt CO₂e

	2025	2030	2035	2040
Energy	448.3	801.1	1,102.3	1,403.5
Transport	241.6	483.0	453.7	424.8
Industrial processes and product use	167.5	166.9	236.8	306.7
Waste	0.00	0.00	0.00	0.00
Agriculture	126.1	168.5	205.8	241.8
LULUCF	0.00	0.00	0.00	0.00
TOTAL	983.5	1,619.5	1,998.6	2,376.8

5.2.2. Emissions of the ETS and non-ETS sectors

Historical emissions and projections of greenhouse gas emissions in the ETS and non-ETS sectors, according to Regulation (EU) 2018/842, for both scenarios are shown in Table 5-10.

Table 5-10: Historical emissions and projections of emissions in ETS and non-ETS sectors, kt CO₂e

	2015	2020	2025	2030	2035	2040
'With existing measures' scenario	24,350.46	23,758.40	23,571.9	23,115.9	21,336.9	19,843.3
ETS sectors	8,386.21	7,323.81	7,219.6	7,179.1	6,734.6	6,480.3
Non-ETS sectors	15,933.45	16,417.94	16,330.4	15,909.7	14,576.6	13,338.8
'With additional measures' scenario	24,350.46	23,758.40	22,588.4	21,496.4	19,338.3	17,466.5
ETS sectors	8,386.21	7,323.81	6,799.9	6,599.7	5,934.7	5,460.0
Non-ETS sectors	15,933.45	16,417.94	15,766.7	14,869.7	13,378.0	11,982.4

Emissions within the ETS sector in 2020 encompassed 30.8 % of total emissions, amounting to 7,323.8 kt CO₂e. Projections indicate that in 2030 the ETS will cover approximately 30 % of total emissions. In 2040, according to the 'with existing measures' scenario, 32.7 % of emissions will be included in the ETS, while 31.3 % of emissions will be included according to the 'with additional measures' scenario.

In the 'with existing measures' scenario, compared to 2020, projections of emissions within ETS show a decrease in emissions by 11.5 % until 2040. In the 'with additional measures' scenario, projections show a stronger downward trend. Compared to 2020, projections show a decrease in emissions by 25.1 % in 2040.

Emissions within the non-ETS sector in 2020 amounted to 16,417.9 kt CO₂e, which represents 69.1 % of total emissions.

In the 'with existing measures' scenario, a decrease in emissions is expected in the non-ETS sectors in the period from 2025 to 2040 (by 18.8 % in 2040 compared to 2020). In the 'with additional measures' scenario, further reduction of emissions is expected, which would decrease the non-ETS sectors' emissions by 27.1 % in 2040, compared to 2020.

Historical emissions and projections of greenhouse gas emissions for sectors covered by the EU ETS and non-ETS sectors, for both scenarios, are shown in Figures 5-12 and 5-13.

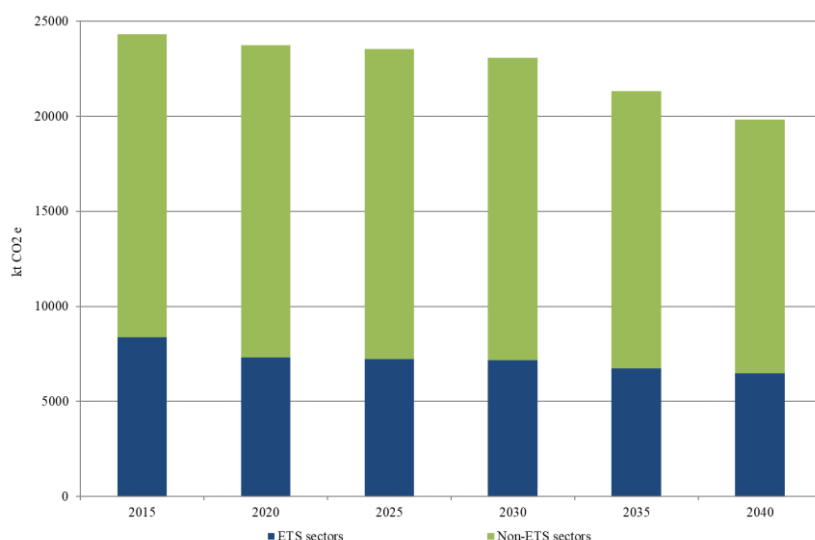


Figure 5-12: Historical emissions and projections of greenhouse gas emissions for ETS and non-ETS sectors, 'with existing measures' scenario

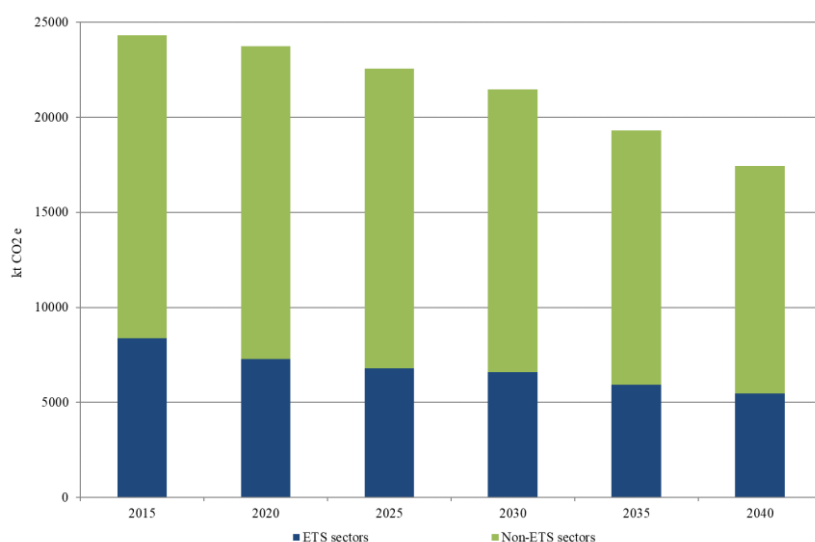


Figure 5-13: Historical emissions and projections of greenhouse gas emissions for ETS and non-ETS sectors, 'with additional measures' scenario

As part of the EU's target of reducing greenhouse gas emissions by 20% by 2020, the Republic of Croatia has set a goal for non-ETS sectors of increasing emissions by 11% compared to 2005. In addition to the target for 2020, the EC also set national annual quotas for the period 2013-2020.

The amount of the annual quota for Croatia for the period 2013-2020 and the realized emissions in the same period are presented in Annex I: Fifth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change, in chapters 3.3. and 4.

Pursuant to Regulation (EU) 2018/842, the EC set a target for the Republic of Croatia to reduce emissions by 7% until 2030, compared to 2005. National annual quotas for the period 2021-2030 have also been determined for this target. This reduction is defined as a target value in the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030. Projections of emissions in the Integrated National Energy and Climate Plan show that the Republic of Croatia can fulfill the stated obligation to reduce emissions from non-ETS sectors for 2030. Namely, reducing emissions from

non-ETS sectors would amount to 12.7% for the scenario 'with existing measures' or 18.8% for the scenario 'with additional measures' until 2030, compared to 2005.

5.2.3. Impact of the use of clean development mechanism, joint implementation and emission trading as additional measures for the GHG emission reduction

Current impact of implementation of the Kyoto Protocol mechanisms cannot be determined since the Republic of Croatia has thus far not used these mechanisms. Domestic measures were the only measures applied to reduce emissions and increase removals by sinks.

The Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19) defines that both plant operators, in the period of trading in emission units (EU ETS) from 2013 to 2020, and aircraft operators, in the period of trading in emission units from 2014 to 2020, can use the units resulting from the implementation of flexible mechanisms pursuant to Article 1, Paragraph 2 of Commission Regulation (EU) 1123/2013.

The Regulation on the Method of Trading Greenhouse Gas Emission Units (Official Gazette 89/20) prescribes the conditions for the use of units resulting from the implementation of flexible mechanisms.

Since 2013, installations in the Republic of Croatia as well as aircraft operators have been included in the EU ETS, which means that the emission trading mechanism is applied at the level of operators of electric power and industrial plants, as well as aircraft operators.

5.2.4. Limiting adverse effects in other countries

In accordance with the Kyoto Protocol, Croatia strives to implement the policies and measures listed in the Eighth National Communication in such a way that harmful social, ecological and economic impacts on other countries, especially developing countries, are minimized.

The climate policy of the Republic of Croatia follows the framework established at the EU level. The most important ongoing activity in this regard is the comprehensive impact assessment system that follows all new legislative proposals. This approach ensures that potential negative impacts on various stakeholders and third parties are identified and minimized within the legislative process. In this sense, in the decision-making process at the national level, Croatia uses a procedure that follows the provisions of the ESPOO Convention (Convention on Environmental Impact Assessment in a Transboundary Context, Espoo, 1991) and Directive 2001/42/EC of the European Parliament and the Council of June 27, 2001, on the assessment of the effects of certain plans and programs on the environment). This ensures that all decisions that could have a long-range impact are subject to both national and transboundary impacts assessment. The aforementioned process includes the participation of interested domestic public and public of the party/parties affected by the transboundary impact.

In addition to the above, the Republic of Croatia implements numerous projects of international cooperation and research, which are described in detail in chapter 8.2.

5.3. METHODOLOGY

Projections were made in accordance with the Guidelines for Preparation of National Reports by Parties Included in Annex I to the Convention.

The potential for mitigation of national greenhouse gas emissions is analysed and assessed at the sectoral level. This assessment takes into account the previous trends and the current state as well as the future projections of parameters that determine the potential for mitigating emissions. Models and methodology used in preparing the projections are described by sector, in this chapter. A detailed description of the used models is given in Annex III.

The results of all sectoral models are integrated into the LEAP (Long-Range Energy Alternatives Planning System) software package, which is recognized as a good practice approach to take into account any overlap or synergy that may exist between different policies and measures.

The added value of such integration of sectoral results is enabling scenario planning and creation of projections for pollutants, to harmonize the goals in accordance with the UNFCCC and the Convention on Long-Range Transboundary Air Pollution (LRTAP). Model results are automatically adjusted according to the UNFCCC emission inventory structure.

Eight different bottom-up models are used for modelling. This approach requires significant resources (time, staff and budget) for each scenario. In addition, the structure of some models is very complex, which can make modelling results difficult to interpret, and it is very demanding to fill in the necessary data, as a large amount of input data is required.

A list of assumptions and input data is provided in tabular form. The list contains general parameters and parameters related to the sectors and sub-sectors (energy, transport, buildings, industrial processes and product use, agriculture, waste and LULUCF), in accordance with Implementing Regulation (EU) 2020/1208.

The 'with existing measures' and 'with additional measures' scenarios include policies and measures for reduction of emissions from sources and increase greenhouse gases sinks. The emission reduction potential of individual policies and measures is aggregated at the level of individual sectors and sub-sectors.

5.3.1. Descriptions of models and methodologies for projections

Energy and transport

In preparing the projections, a software packages MAED (Model for Analysis of Energy Demand) and MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) were used, in which a model of the energy sector in Croatia was created. For the needs of detailed modelling of the power system development and optimization, the PLEXOS model was used, and its results were the inputs for the integrated energy model. Output data are structured in accordance with the structure of the inventory of the United Nations Framework Convention on Climate Change. It is the engineering simulation model in which the scenarios are simulated and certain processes and decisions are optimized, considering the assumptions and limitations. The model is detailed to the level of individual production units, present and future.

Projections were made until 2050, with a 5-year step. The model is a 'bottom-up' type because it starts from the sectoral data and individual emission sources in the power installations. Emissions of CO₂, CH₄ and N₂O are calculated.

The assumptions used in creating the projections are shown in Table 5-11. The input parameters used are presented in chapter 5.3.2.

Table 5-11: Assumptions for projections – energy and transport

Energy and transport	
Projections of greenhouse gas emissions for this report are taken from the Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030 and the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21).	
1. Final energy demand	Final energy demand is projected in different sectors - industry, transport, services, households and agriculture, fisheries and forestry. The bases for projections of activities are national macroeconomic parameters. For the projections of energy intensities, development of technology and changing of lifestyles was taken into account. The analyses were performed by sub-sectors: - industry – by industry and type of fuel used, - transport – by type of transport (road, air, marine and rail) and types of means of transport (cars, buses, motorcycles, light and heavy vans) or purpose (passenger and freight) and by type of technology and fuel used, - services – by branches (tourism, trade, education, health), climatic zone (coastal or continental Croatia), purpose (heating, water heating, cooking, cooling, electrical appliances and lighting), type of fuel used, heating demand is modelled on the level of useful and final energy, - households – by climatic zone (coastal or continental Croatia), purpose (heating, water heating, cooking, cooling, electrical appliances and lighting) and by type of fuel, heating demand is modelled on the level of useful and final energy, - agriculture, fisheries and forestry - by type of fuel.
	Demographic trends – assumes a scenario of average fertility and average migration, in accordance with the population projections made for the purposes of developing the Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 25/20).
1.1. 'With existing measures' scenario	
	In the period until 2050, development was simulated in accordance with the existing policy and measures and market development: - market-driven improvements in energy efficiency and fuel switches in the industrial sector, - renovation of buildings (renovation, replacement and new construction) at a rate of 0.75% of the area of residential buildings per year up to the nearly Zero Energy Building standard (including the use of renewable energy sources), - penetration of electric and hybrid vehicles with the share in total passenger activity in 2030 2.5% and in 2050 30%;

Energy and transport	
	- share of rail transport in the structure of cargo activity is showing a very slow increase; diesel-powered trucks will continue to dominate.
1.2. 'With additional measures' scenario	
	Continued support to energy efficiency after 2020, with the following key assumptions: - renovation of 1.3% of buildings per year to the nearly Zero Energy Building standard (including the use of renewable energy sources), - penetration of electric and hybrid vehicles whose share in total passenger activity in road traffic reaches 3.5% in 2030 and 65% in 2050 - incentive measures to co-finance the purchase of vehicles powered by alternative fuels until the minimum number of vehicles on the market is reached. The minimum degree of representation will be considered a share of 1 percent in the total number of vehicles registered in the country - an increase in the share of freight transport activities achieved by rail transport (electric locomotives) to around 30% in 2050 - in urban passenger traffic, almost 85% of all passenger activity is expected to be electrified by 2050 - improvements in energy efficiency in industry along with fuel substitution towards greater use of renewable energy sources and electricity.
2. Energy transformations and resources	The power system was analysed by the simulation of market development with the software for the hourly optimization of operation and development of the power system. The model includes part of the centralized heat system in the area of large cities, which is supplied from cogeneration, The simulation of the operation of the refineries was done to satisfy the domestic demand as possible with the existing capacities, which mean without building new refineries and reducing production in 'with existing measures' and 'with additional measures' scenarios.

Industrial processes and product use

In preparing the projections, the engineering simulation model in tabular calculation interface was used. The model is structured in accordance with the table structure of the inventory of the United Nations Framework Convention on Climate Change.

The model is detailed to the level of individual production units, the present and future ones. Projections are made until 2050, in steps of five years. The model is the 'bottom-up' type because it starts from the sectoral data and individual emission sources. Emissions of CO₂, CH₄, N₂O, HFCs and SF₆ are calculated.

Assumptions used in the preparation of projections are presented in Table 5-12. Input parameters used are presented in chapter 5.3.2.

Table 5-12: Assumptions for projections – industrial processes and product use

Industrial processes and product use
Projections were made based on the expected development of certain industries, which includes the production goals by 2050. Emission projections start from projections of macroeconomic parameters in 2020 - the projected dynamics of the annual growth rate of gross domestic product and gross value added and the decline of population, as well the results of sectoral analysis and studies (cement industry and N₂O use in food industry and medical purposes). Projections of macroeconomic parameters are in line with projections made for the purpose of the Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 25/20). <u>Assumptions for the 'with existing measures' scenario:</u> - there will be no installation of additional capacities; - production will reach the maximum value by 2040; - reduction of emissions of controlled substances and fluorinated greenhouse gases. Regulation (EU) 517/2014 on Fluorinated Greenhouse Gases, establishes a gradual reduction in the emission of F gases. From 2015 onwards, the total sum of HFC quotas allocated to producers and importers cannot exceed the maximum amount calculated for a calendar year. Projections of F gases for Croatia follow the trends of CO₂e emissions at the EU level, for the 'with existing measures' scenario. The same trend of reduction until 2030 was applied until 2050. Process emissions from economic activities, as defined by IPCC methodology, included in the sector Industrial processes and product use were estimated based on detailed sectoral projections of production of cement and the use of N₂O in industry and medical purposes and the projected macroeconomic indicators of gross value added by other industrial branches, annual increase rate in gross domestic product and decline of the population. The scenario includes the implementation of measures defined in the strategic and sectoral planning documents included in the business policy of manufacturers, conditioned by market demands, laws and regulations and the requirements of the application of best available techniques in the production process. Measures to reduce controlled substances and fluorinated greenhouse gases are provided by law. <u>Assumptions for the 'with additional measures' scenario:</u> - application of cost-effective measures to reduce process GHG emissions in cement production. - by increasing the share of mineral additives in cement, the share of clinker decreases, and thus the need for its production. It is assumed that the share of clinker in cement in 2020 is the same as in the 'with existing measures' scenario. In 2030, it is 65% and in 2050 50%. Thus, based on the planned production of cement, included in the business plans of the manufacturers, projections of the assumed production of clinker were made. - reduction of emissions of controlled substances and fluorinated greenhouse gases. Projections of F gases for the Republic of Croatia follow the trends of CO₂e emissions at the EU level for the scenario 'with additional measures'. The same trend of reduction until 2030 was applied until 2050. <u>According to good practice, the projections were made for activity data and emission factors:</u> - activity data – applying Grade of 1, 2 and 3 methods (projections of macroeconomic parameters, effects of policies and measures, sectoral analysis and studies); - emission factors – applying Grade of 1 and 2 methods (projections based on average values for the previous five-year period, effects of policies and measures, sectoral analysis and studies).

Agriculture

In preparing the projections, a model in tabular calculation interface was used. The engineering simulation model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change.

The model is detailed to the level of individual sources, the present and future ones. Projections are made by 2050, in steps of five years. The model is the 'bottom-up' type, because it starts from the sectoral data and individual emission sources, and emissions of CH₄ and N₂O are calculated.

Assumptions used in the preparation of projections are presented in Table 5-13. Input parameters used in the preparation of projections are presented chapter 5.3.2.

Table 5-13: Assumptions for projections - agriculture

Agriculture
The projections were carried out based on the expected future state of key parameters. <u>Assumptions for the scenario 'with existing measures' and 'with additional measures':</u> - to determine the key parameters for making projections (number of significant livestock species and production of significant crops) trends in livestock and crop production taken from the global FAO report "The future of food and agriculture – Alternative pathways to 2050" were used, where BAU (business as usual) scenario of the mentioned report was applied. Because there were some differences in activity data in the base year, the BAU scenario data of the FAO report were adjusted, but an identical trend was maintained. For non-significant crops, the historical data from 2020 was retained. - for mineral fertilizers, an extrapolation based on historical input data was used. <u>Assumptions for the scenario 'with additional measures':</u> - application of emission reduction potential due to: change of the ratio of certain types of feed in the diet, use of additives and fats in food, improvement of quality of voluminous feeds and improvement of grazing system, shortening of storage/disposal time of manure on the farm, covering of manure disposal site - increase in the share of cattle, pigs and poultry on anaerobic digestion of manure and production of biogas (digesters) by 30% by 2050 - reduction of consumption of mineral fertilizers due to less need for nitrogen application because of new cultivars, varieties and crops, improvement of application methods and increase of the share of slow-release fertilizers, hydro melioration interventions and disaster protection systems.

Waste

In preparing the projections, a model in tabular calculation interface was used. The model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change.

The model is detailed to the level of individual sources, the present and future ones. Projections are made until 2050, in steps of five years. The model is the 'bottom-up' type because it starts from the sectoral data and individual emission sources and calculated emissions of CO₂, CH₄ and N₂O.

Assumptions used in the preparation of projections are presented in Table 5-14. Input parameters used in the preparation of projections are presented chapter 5.3.2.

Table 5-14: Assumptions for projections - waste

Waste
Projections were made based on expected development and future state of parameters for the projections - the amount of generated and landfilled solid waste (municipal solid waste, industrial waste and sludge from wastewater treatment), the organic fraction of solid waste, the fraction of recovered/flared methane and the amount of composted organic waste. Emission projections start from the situation and projections of macroeconomic parameters in 2020 - the projected dynamics of the annual growth rate of gross domestic product and the decline of the population.
<u>Assumptions for the 'with existing measures' scenario:</u>
- Solid waste disposal – reduction of the amount of generated and landfilled solid waste due to the application of measures defined by sectoral legislation harmonized with EU legislation. On July 4, 2018, the new EU rules with legally binding targets for waste recycling and reduction of waste disposal came into force. Croatia was given the possibility of a delay of five years to meet the targets because it is among the Member States that are in 2013 prepared for re-use and recycled less than 20% of its municipal waste and landfilled more than 60% of its municipal waste. The five-year delay is included in the projections. - Composting – continuous increase in the amount of waste that is being processed by composting due to the application of measures defined by sectoral legislation harmonized with EU legislation. The increase in the amount of waste to be composted depends on the reduction of the amount of landfilled biodegradable waste and the proportion of biodegradable waste that will be treated by composting and digestion. - Waste incineration – no more incineration of clinical waste is carried out without energy recovery. - Wastewater treatment and discharge – continuous increase in the quantity of wastewater treated in industry sectors and decrease in the quantity of wastewater treated in residential/commercial sectors and decrease the population with an individual system of drainage (septic tank).
Emissions of greenhouse gases that are included in the Waste sector, according to the IPCC methodology, were estimated based on sectoral analysis and projected macroeconomic indicators on the annual increase in gross domestic product and decline of the population.
The scenario includes the existing legal framework of the Republic of Croatia and the adopted EU legal framework from the Waste sector for the period until 2050. Projections of emissions of greenhouse gases are based on the implementation of measures prescribed by sectoral legislation, harmonized with EU legislation.
<u>Assumptions for the 'with additional measures' scenario:</u>
The 'with additional measures' scenario is the same as the 'with existing measures' scenario since no additional measures to reduce emissions of greenhouse gases have been identified.
<u>According to good practice</u>, the projections were made for activity data and parameters included in the models for GHG emission calculation:
– applying Grade of 1 and 2 methods (projections of macroeconomic parameters, effects of policies and measures, sectoral analysis and studies, expert judgement).

LULUCF

In the 'with existing measures' scenario, for all sectoral components, the Projections Guide (A: General Guidelines and B: Sectoral Guide) was used. Most of the sub-categories of this sector were recognized as key sources (trend or level) in the NIR 2022. These are:

- 4(III) Direct N₂O emissions from N mineralization/immobilization
- 4.A.1 Forest Land Remaining Forest Land
- 4.A.2 Land Converted to Forest Land
- 4.B.1 Cropland Remaining Cropland
- 4.B.2 Land Converted to Cropland
- 4.C.2 Land Converted to Grassland
- 4.D.2 Land Converted to Wetlands
- 4.E.2 Land Converted to Settlements

- 4.G Harvested Wood Products.

If possible, for the aforementioned sub-categories, it is recommended to use Grade 2 or 3 when making projections. However, because of insufficient capacities in the system for making projections in the LULUCF sector at the national level, Grade 1 was applied. Emissions and removals are calculated by multiplying the projected activity data and implied emission factors based on historic trend for the period from 2009 to 2020 for each carbon pool (aboveground/belowground biomass and soil). Alternative 1 was used, where activity data for the period 2025 to 2050, in this case the area of each subcategory of land, were obtained by applying a trend extrapolation (or average values backwards, e.g. for Wetlands) over the past ten years, from 2009 to 2020. When making projections, for the carbon pool biomass under the category "Forest land remaining Forest land", increment and the planned wood removals from the official "Forest Management Plan for the period 2016-2025" were taken into account. Also, for Harvested wood products carbon stock, the reference historical period for projection estimate was from 2000 to 2009, because of large fluctuation in input data for recent years. Correction of activity data (HWP production) for the period 2012-2020 was performed to avoid non-consistency of time series data, which is in accordance with the Accounting Plan for Forestry of the Republic of Croatia and the Forest reference level (FRL). In cases where the extrapolated values took unrealistically extreme values, the arithmetic mean of data on a particular activity for the past ten years ('Land converted to grasslands') was used, i.e., expert assessment to predict the annual volume of afforestation ('Land converted to forest land'). All carbon stocks estimated in the NIR 2022 have been taken into account when making emission and removal projections. Some carbon stocks (e.g. dead wood for 'Forest land remaining Forest land') were omitted due to insufficient data (identical to the NIR 2022). Croatia is planning significant improvements in the estimation of projections of GHG emissions/removals in the future period. The main steps in this direction are the implementation of projects and activities that should be aimed at modelling the calculation of projections for key subcategories of the sector and their carbon stocks. Results should decrease uncertainty in estimation and further use of Grade 2.

Assumptions used in the preparation of projections are presented in Table 5-15. Input parameters used in the preparation of projections are presented chapter 5.3.2.

Table 5-15: Assumptions for projections - LULUCF

LULUCF
Projections were made based on the expected future state of the parameters that determine the potential for emissions mitigation. Key parameters for projections were determined based on the parameters in the relevant Guideline for projections (land area of each subcategory, emission factors assumed by carbon stock) and expert judgment for surface renovated and forest land. Assumptions: - The total area of 'Forest land' and 'Settlements' will be increased - Land conversion to forest land will remain at the annual intensity (1.88 kha/year) - Areas of 'Wetlands' will not increase - The areas of 'Grassland' and 'Agricultural land' will not change significantly - Areas of burned areas will not increase - The carbon stock in the 'Wood Products' will increase.

5.3.2. Parameters for projections

Table 5-16: Parameters for projections – general parameters

Parameter		2020	2025	2030	2035	2040
GDP	billion EUR (EC16)	46.3	51.6	57.5	62.9	68.7
Population	mil. inhabitant	3.984	3.834	3.755	3.648	3.532
Coal prices	EUR/t	6.4	7.9	8.6	9.1	9.6
Heavy Fuel Oil prices	EUR/barrel	62	83	94	103	111
Gas prices	EUR/Mbtu	70	77	80	81	82

Table 5-17: Parameters for projections – energy sector: total energy consumption, electricity generation

Parameter		2020	2025	2030	2035	2040
Total energy consumption						
Coal and coke	ktoe	361.2	307.3	253.3	149.9	46.5
Liquid petroleum fuels	ktoe	2,779.9	3,021.7	3,263.4	2,965.0	2,666.5
Gas	ktoe	2,534.0	2,490.1	2,446.2	2,571.3	2,697.0
Renewable	ktoe	3,160.6	2,953.9	2,747.2	3,008.3	3,269.5
Other	ktoe	437.9	391.4	345.2	117.9	109.9
Total	ktoe	9,273.6	9,164.4	9,055.3	8,812.4	8,569.6
Total electricity generation						
Coal	TWh	1.55	1.27	0.98	0.50	0.01
Liquid petroleum fuels	TWh	0.04	0.04	0.04	0.04	0.04
Gas	TWh	2.40	2.49	2.59	3.22	3.85
Renewable	TWh	9.20	10.98	12.76	14.49	16.22
Total	TWh	13.19	14.78	16.38	18.25	20.12

Table 5-18: Parameters for projections – energy sector: final energy consumption

Parameter		2020	2025	2030	2035	2040
Final energy consumption						
Industry	ktoe	1,193.7	1,190.5	1,187.2	1,170.2	1,153.3
Transport	ktoe	2,012.1	2,165.9	2,319.7	2,254.7	2,189.6
Households	ktoe	2,284.7	2,369.6	2,454.5	2,364.3	2,274.1
Agriculture, forestry and fisheries	ktoe	247.5	223.1	198.8	193.5	188.2
Services	ktoe	749.2	850.0	950.9	975.9	1,000.9
Other	ktoe	6,445.4	6,778.3	7,111.1	6,958.4	6,805.8

Table 5-19: Parameters for projections – weather parameters

Parameter	2020	2025	2030	2035	2040
Number of heating degree days (HDD)	2,288	2,261	2,235	2,208	2,181

Table 5-20: Parameters for projections – industrial processes and product use

Parameter		2020	2025	2030	2035	2040
Clinker production - 'with existing measures' scenario	kt	2,351	2,525	2,585	2,585	2,585
Clinker production - 'with additional measures' scenario	kt	2,351	2,223	2,308	2,174	2,041

Table 5-21: Parameters for projections – transport

Parameter		2020	2025	2030	2035	2040
Number of passenger kilometres, all modes	10 ⁹ pkm	40.0	41.4	43.2	44.0	44.5
Transport of goods	10 ⁹ tkm	11.6	11.6	11.6	11.6	11.6
Energy consumption in road transport	ktoe	2,012.1	2,165.9	2,319.7	2,254.7	2,189.6

Table 5-22: Parameters for projections – agriculture

Parameter		2020	2025	2030	2035	2040
Dairy cattle	1,000 heads	109	171	160	155	148
Non-dairy cattle	1,000 heads	313	284	288	289	296
Sheep	1,000 heads	662	639	621	607	595
Goats	1,000 heads	86	68	66	65	63
Horses	1,000 heads	26	23	24	25	26
Mules/asses	1,000 heads	5	3	3	4	4
Swine	1,000 heads	1,033	1,204	1,226	1,220	1,222
Poultry	1,000 heads	13,057	10,500	10,800	11,000	11,500
Wheat	1,000 heads	84	84	84	84	84
Wheat	t	849,656	1,028,720	1,064,901	1,046,561	1,038,850
Maize	t	2,430,598	1,466,304	1,579,681	1,601,893	1,618,633
Potatoes	t	174,279	186,121	201,028	212,581	224,869
Sugar beets	t	774,331	1,079,313	1,168,764	1,205,044	1,235,848
Tobacco	t	7,084	7,084	7,084	7,084	7,084
Sunflowers	t	120,012	120,012	120,012	120,012	120,012
Rape seed	t	119,667	119,667	119,667	119,667	119,667
Tomatoes	t	33,369	33,369	33,369	33,369	33,369
Barley	t	321,776	249,112	260,182	259,560	258,277
Oats	t	65,345	65,345	65,345	65,345	65,345
Cabbages and other brassicas	t	38,533	38,533	38,533	38,533	38,533
Garlic	t	1,972	1,972	1,972	1,972	1,972
Onions	t	16,351	16,351	16,351	16,351	16,351
Rye	t	4,367	4,367	4,367	4,367	4,367
Sorghum	t	244	244	244	244	244
Watermelons	t	15,594	15,594	15,594	15,594	15,594
Soybeans	t	266,014	105,529	111,994	112,357	111,976
Beans, dry	t	1,325	1,325	1,325	1,325	1,325
Fodder peas, dried	t	1,629	1,629	1,629	1,629	1,629
Lentils	t	52	52	52	52	52
Peas, dry	t	170	170	170	170	170
Vetches	t	0	0	0	0	0
Clover	t	60,049	60,049	60,049	60,049	60,049
Alfalfa	t	201,460	201,460	201,460	201,460	201,460
Applying nitrogen	t	98,964	98,267	95,947	93,626	91,306

Table 5-23: Parameters for projections – waste

Parameter		2020	2025	2030	2035	2040
Amount of generated solid waste	t	2,273,120	2,212,504	2,204,261	2,189,563	2178611
Amount of landfilled solid waste	t	1,459,906	553,126	440,852	328,434	217,861
Share of methane recovered/flared	%	8.6	4.2	4.5	4.6	4.1

Table 5-24: Parameters for projections – LULUCF

Parameter – Activity data (AD)		2020	2025	2030	2035	2040
4.A.1. Forest land remaining forest land	(kha)	2,312.83	2,274.67	2,236.52	2,198.36	2,160.21
4.A.2. Land converted to forest land	(kha)	67.00	76.00	85.00	94.00	103.00
4.B.1. Cropland remaining cropland	(kha)	1,468.32	1,439.42	1,410.52	1,381.62	1,352.72
4.B.2. Land converted to cropland	(kha)	48.96	51.45	53.94	56.43	58.91
4.C.1. Grassland remaining grassland	(kha)	1,079.86	1,062.02	1,044.17	1,026.33	1,008.48
4.C.2. Land converted to grassland	(kha)	57.32	55.48	55.48	55.48	55.48
4.D.1. Wetlands remaining wetlands	(kha)	74.37	75.00	75.45	75.90	76.35
4.D.2. Land converted to wetlands	(kha)	0.85	0.85	0.85	0.85	0.85
4.E.1. Settlements remaining settlements	(kha)	205.84	209.42	212.53	215.64	218.75
4.E.2. Land converted to settlements	(kha)	87.54	96.73	105.92	115.11	124.31
4.F.1. Other land remaining other land	(kha)	256.52	318.37	379.03	439.69	500.34
4.III.B Cropland	(kha)	48.96	51.45	53.94	56.43	58.91
4.III.D Wetland	(kha)	0.85	0.85	0.85	0.85	0.85
4.III.E Settlements	(kha)	87.54	96.73	105.92	115.11	124.31
4.V.A Forest land remaining forest land	(ha)	5,763.60	5,763.60	5,763.60	5,763.60	5,763.60
4.V.A Land converted to forest land	(ha)	201.36	201.36	201.36	201.36	201.36
4.V.B Cropland remaining cropland	(ha)	298.91	298.91	298.91	298.91	298.91
4.V.C Grassland remaining grassland	(ha)	7,661.57	7,869.01	7,869.01	7,869.01	7,869.01

Table 5-25: Parameters for projections – LULUCF – continued

Parameter – Emissions factors - Biomass	EF	2020	2025	2030	2035	2040
4.A.1. Forest land remaining forest land	(tC/ha)	0.50	0.40	0.40	0.40	0.40
4.A.2. Land converted to forest land	(tC/ha)	0.79	0.79	0.79	0.79	0.79
4.B.1. Cropland remaining cropland	(tC/ha)	-0.06	-0.06	-0.06	-0.06	-0.06
4.B.2. Land converted to cropland	(tC/ha)	0.47	0.48	0.48	0.48	0.49
4.C.1. Grassland remaining grassland	(tC/ha)	0.00	0.00	0.00	0.00	0.00
4.C.2. Land converted to grassland	(tC/ha)	0.12	0.12	0.12	0.12	0.12
4.D.1. Wetlands remaining wetlands	(tC/ha)	0.00	0.00	0.00	0.00	0.00
4.D.2. Land converted to wetlands	(tC/ha)	-0.80	-0.80	-0.80	-0.80	-0.80
4.E.1. Settlements remaining settlements	(tC/ha)	0.00	0.00	0.00	0.00	0.00
4.E.2. Land converted to settlements	(tC/ha)	-0.10	-0.10	-0.10	-0.10	-0.10
4.V.A Forest land remaining forest land	CO ₂ (t/AD unit)	31.07	31.07	31.07	31.07	31.07
4.V.A Forest land remaining forest land	CH ₄ (t/AD unit)	0.09	0.09	0.09	0.09	0.09
4.V.A Forest land remaining forest land	N ₂ O (t/ADunit)	0.01	0.01	0.01	0.01	0.01
4.V.A Land converted to forest land	CO ₂ (t/AD unit)	31.07	31.07	31.07	31.07	31.07
4.V.A Land converted to forest land	CH ₄ (t/AD unit)	0.09	0.09	0.09	0.09	0.09
4.V.A Land converted to forest land	N ₂ O (t/ADunit)	0.01	0.01	0.01	0.01	0.01
4.V.B Cropland remaining cropland	CO ₂ (t/AD unit)	25.51	25.51	25.51	25.51	25.51
4.V.B Cropland remaining cropland	CH ₄ (t/AD unit)	0.07	0.07	0.07	0.07	0.07
4.V.B Cropland remaining cropland	N ₂ O (t/ADunit)	0.00	0.00	0.00	0.00	0.00
4.V.C Grassland remaining grassland	CO ₂ (t/AD unit)	0.00	0.00	0.00	0.00	0.00
4.V.C Grassland remaining grassland	CH ₄ (t/AD unit)	0.01	0.01	0.01	0.01	0.01
4.V.C Grassland remaining grassland	N ₂ O (t/ADunit)	0.00	0.00	0.00	0.00	0.00

Table 5-26: Parameters for projections – LULUCF – continued

Parameter – Emissions factors - Soil	EF	2020	2025	2030	2035	2040
4.A.2. Land converted to forest land	(tC/ha)	-0.24	-0.23	-0.22	-0.21	-0.19
4.B.1. Cropland remaining cropland	(tC/ha)	-0.01	-0.02	-0.02	-0.02	-0.02
4.B.2. Land converted to cropland	(tC/ha)	-0.92	-0.92	-0.91	-0.90	-0.90
4.C.2. Land converted to grassland	(tC/ha)	1.04	1.05	1.06	1.06	1.07
4.D.2. Land converted to wetlands	(tC/ha)	-2.72	-2.72	-2.72	-2.72	-2.72
4.E.2. Land converted to settlements	(tC/ha)	-2.22	-2.22	-2.22	-2.22	-2.22
4.III.B Cropland	(kg N ₂ O–N/ha)	1.03	1.02	1.01	1.01	1.00
4.III.D Wetland	(kg N ₂ O–N/ha)	3.40	3.40	3.40	3.40	3.40
4.III.E Settlements	(kg N ₂ O–N/ha)	2.60	2.60	2.60	2.60	2.61

5.3.3. Sensitivity analysis of projections

Regulation (EU) 2018/1999 recommends that the assumptions and baselines used for joint EU projections should be used as far as possible and justified for national scenarios.

In June 2022, the European Commission drafted the document Recommended Parameters for Reporting on GHG Projections, Integrated Plans and Long-Term Strategies [5-11]. Recommended Parameters

include projections of demographic development, GDP rate, gross value added of individual industries, fuel price projections and emission units. In case of deviation, i.e. non-use of the recommended parameters, it is necessary to make a sensitivity analysis and determine changes in greenhouse gas emissions.

The key differences between the baseline data of the national scenarios presented in this report (the 'with existing measures' scenario and the 'with additional measures' scenario) and the baseline data used by the EU in the common scenarios are population and GDP projections, and the results of the sensitivity analysis are presented below, i.e. differences in greenhouse gas emissions depending on the differences of these parameters of demographic and economic development.

In total, six different scenarios were analysed. Information of scenarios are given in Table 5-27.

Table 5-27: Information of scenarios

Scenario	WEM/WAM	Parameter
Scenario 1	WEM	Population
Scenario 2	WEM	GDP
Scenario 3	WEM	Population, GDP
Scenario 4	WAM	Population
Scenario 5	WAM	GDP
Scenario 6	WAM	Population, GDP

GDP rate

In the analysed scenarios, GDP growth is assumed to average 2.2% by 2030 and 1.8% for the period 2031 – 2040.

Recommended GDP growth rates in the document Recommended Parameters for Reporting on GHG Projections, Integrated Plans and Long-Term Strategies assume GDP growth of 1.6% on average by 2040.

Using the recommended GDP growth rates, greenhouse gas emissions in 2030 are lower by 0.1% compared to the 'with existing measures' scenario and by 2.8%, compared to the 'with additional measures' scenario. Greenhouse gas emissions in 2040 are lower by 2.3% compared to the 'with existing measures' scenario and by 5.7%, compared to the 'with additional measures' scenario. The same carbon intensity of the economy is assumed for all analysed years. However, the implementation of emission reduction measures reduces and in the long run breaks the link between GDP and emissions. Thus, GDP growth contributes to reducing emissions when it comes to investments in low-carbon technologies, industry and services.

Population trends

The scenarios presented in this report were made with the assumption that the number of inhabitants in the Republic of Croatia in 2030 equals 3,755,419, and 3,531,586 in 2040. Recommended parameters of demographic development projections from the document Recommended Parameters for Reporting on GHG Projections give 1.9% more inhabitants in 2030 and 2.3% more inhabitants in 2040, compared to the assumed population in the 'with existing measures' scenario and the 'with additional measures' scenario.

Low-carbon scenarios separate GDP from greenhouse gas emissions, while emissions per capita decline. In the scenario 'with existing measures', emission in 2030 amounts to 6.15 t CO₂e per capita and in 2040 5.6 t CO₂e per capita. In the 'with additional measures' scenario in 2030, the emission is 5.69 t CO₂e per capita and 4.9 t CO₂e per capita in 2040. Variations in demographic trends have a lesser impact on emissions and cannot significantly change the trends set.

With the use of recommended parameters of demographic development from the document Recommended Parameters for Reporting on GHG Projections, greenhouse gas emissions in 2030 are 1.2% higher, compared to the scenario 'with existing measures' and 0.6% higher, compared to the scenario 'with additional measures'. In 2040, greenhouse gas emissions are 1.4% higher, compared to the scenario 'with existing measures' and 1.0% higher, compared to the scenario 'with additional measures'.

5.3.4. Changes in the used methodology and models for creating projections

Methodology used for the projections was the same as the methodology used for the preparation of the Fourth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change. Namely, the projections were made in accordance with the Guidelines for the preparation of national communications by Parties included in Annex I to the Convention.

Also, the models used to create the projections are the same as the models used to create the projections presented in the Fourth Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change.

There was a change in certain parameters that were used to create the projections shown in this report.

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

6.1. EXPECTED CLIMATE CHANGE IMPACTS

6.1.1. Global climate change

Earth's climate varies over seasons, decades and centuries as a result of natural and anthropogenic causes. Natural variability on different time scales is caused by cycles and trends of changes in the Earth's orbit, incoming solar radiation, atmospheric composition, ocean circulation, biosphere, cryosphere and other causes. Anthropogenic influence is related to greenhouse gas emissions, mostly as a result of burning fossil fuels, intensive agriculture and deforestation of tropical forests.

A detailed overview of current climate change on a global scale is given in the report of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC) (2021): Summary for Policymakers. In: Climate Change 2021: The Physical Science [6-1].

Global climate change is a result of an increase in the concentration of greenhouse gases, such as carbon dioxide, methane and nitrous oxide. The atmospheric concentration of these gases in 2019 was 410 ppm for carbon dioxide (the highest concentration in the last 2 million years), 1,866 ppb for methane and 332 ppb for nitrous oxide (the highest concentration in the last 800 thousand years).

The increase of global air temperature in the period 2011-2020 was estimated at 1.09°C with respect to the period 1850-1900, comparable to temperature anomalies 125,000 years ago. The global amount of precipitation has increased since 1950, with a more intense increase since 1980. For the mid-latitude areas where the Republic of Croatia is located, a poleward shift in the path of cyclonic systems and changes in the amount of precipitation of different sign depending on the season have been detected.

In addition to the temperature increase of the world's oceans, the continuation of sea level increase was also recorded. The average level of the world's oceans increased by 20 cm in the period 1901-2018. Reduction of the sea ice-covered Arctic area is 40% in September and 10% in March when comparing the period 2010-2019 with the period 1979-1988.

Changes in occurrence of extreme weather events in the wider Mediterranean area indicate:

- increase in hot extremes and high confidence in attributing these changes to anthropogenic influence,
- high confidence in estimates of changes in extreme amounts of precipitation and
- increase in occurrence of agricultural and ecological drought (regarding the drought in the Mediterranean area, attribution of anthropogenic influence is moderately confident but significant).

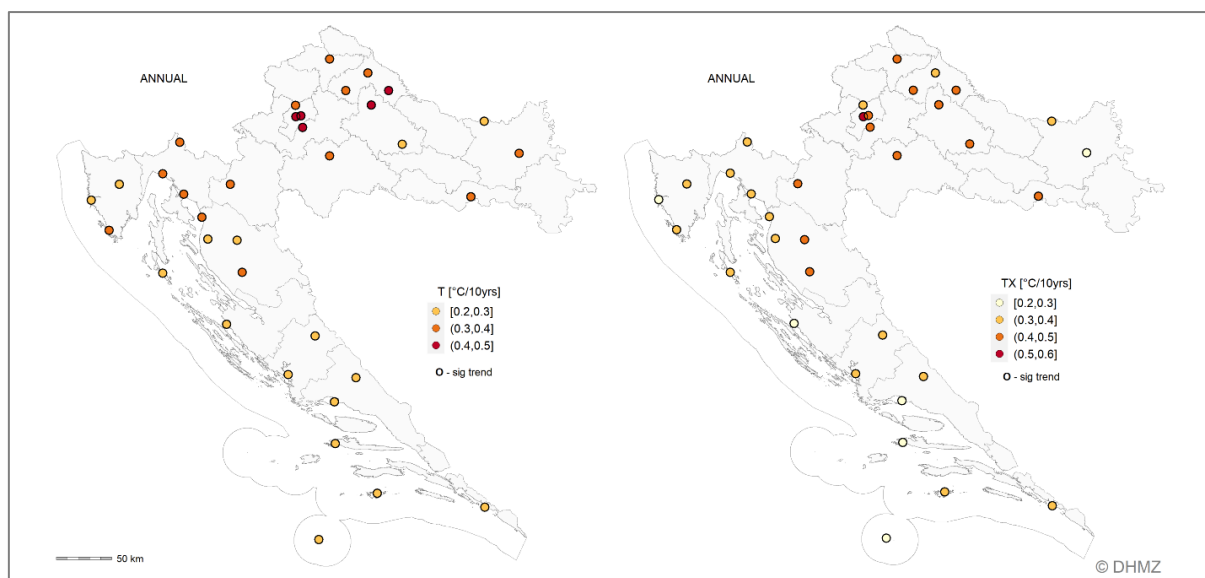
According to the projections of global climate models, an increase in air temperature in wider area of the Mediterranean and the Republic of Croatia is expected in all analysed scenarios. A reduction in annual precipitation of 10% and 20% in the Adriatic area is expected in scenarios that correspond to a global temperature increase of 2°C or 4°C by the end of the 21st century.

6.1.2. Observed climate change in Croatia

Climate change in the Republic of Croatia in the period 1961-2020 are analysed in terms of trends of annual and seasonal series of air temperature and precipitation and associated indices of extremes [6-2] based on daily data of mean and extreme air temperatures at 35 meteorological stations and of daily precipitation at 143 Croatian Meteorological and Hydrological Service stations. Trend values were estimated using Sen's slope [6-3] and expressed per 10 years. Statistical significance at 95% level is assessed using the Mann-Kendall rank test [6-4]. In addition, the monthly trend results for the Republic of Croatia area from scientific papers are presented.

Air temperature

Since the second half of the 20th century, a consistent warming has been observed in the Republic of Croatia area. Mean annual air temperature trend values range 0.2-0.3°C / 10 years along the Adriatic and up to 0.5°C / 10 years in central Croatia (Figure 6-1). The observed warming on annual scale is result of a significant increase in air temperature in all seasons, particularly in summer (0.3-0.6°C / 10 years). Significant positive trends are also observed in the mean minimum and mean maximum air temperature values in all seasons and on annual basis.



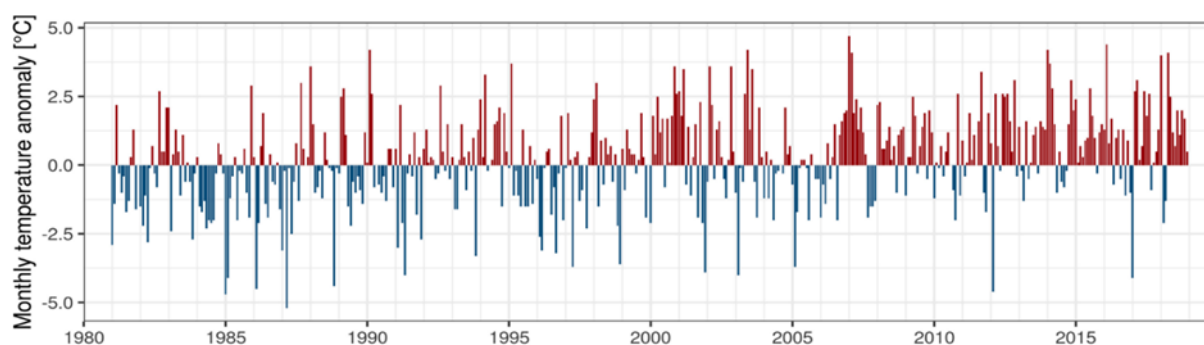
Statistically significant trend at individual meteorological station is marked with bold circle.

Annual mean air temperature (T) - left. Mean maximum air temperature (Tx) - right.

Decadal trends are expressed in °C / 10 years.

Figure 6-1: Decadal trends of annual mean and mean maximum air temperature in the period 1961-2020

Monthly air temperature trends calculated from high-resolution monthly gridded dataset (1 km) for the period 1981-2018 show a significant strong warming (0.3-1.0°C / 10 years) in April, June, July, August and November [6-5]. Annual trends of 0.3-0.7°C / 10 years are significant all over the Republic of Croatia area and are stronger in inland than on the coast. From the beginning of the 21st century, monthly anomalies averaged all over the Croatia area were often positive and up to 4.7°C warmer (January 2007) than the average of the period 1981-2010 and only occasionally negative (Figure 6-2). Positive anomalies in the 21st century prevail on annual level as well [6-5].



Taken from: Perčec Tadić M, Pasarić Z, Guijarro JA (2022:) Croatian high-resolution monthly gridded dataset of homogenised surface air temperature. Theor Appl Climatol. [6-5]. Data: Croatian Meteorological and Hydrological Service. The anomalies were calculated from monthly grids by subtracting the gridded monthly normals for the period 1981-2010. Averaged for the Republic of Croatia area.

Figure 6-2: Monthly air temperature anomalies in the period 1981-2018

Temperature extremes

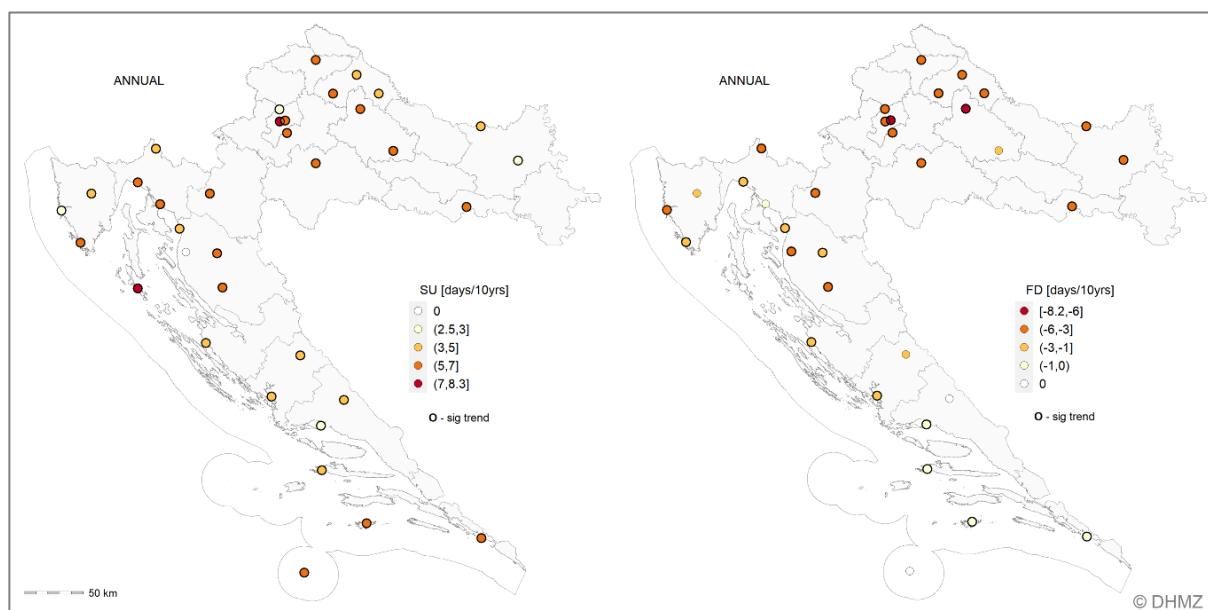
Warming in the Republic of Croatia is reflected in all indices of temperature extremes (Table 6-1). There is a significant increase in the number of warm days up to 8.3 days / 10 years (Figure 6-3). There is a significant increase of warm days in spring (up to 3 days / 10 years) and summer (up to 5 days / 10 years) and warm summer nights along the Adriatic (up to 6 days / 10 years), where trend toward longer warm spell durations is also observed. A prevalent decrease in the annual number of cold days is particularly pronounced in the inland (up to 8 days / 10 years) (Figure 6-3) and northern Adriatic. The number of cold nights is decreasing throughout Croatia (up to 10 days / 10 years). A decreasing trend in the cold spell duration (up to 2 days / 10 years) was observed along the Adriatic coast.

Strong warming in Croatia inland can be noticed in the Zagreb area (the largest settlement in the Republic of Croatia), which points to strong urban heat effect. Detailed local analysis of changes in extreme air temperatures showed stronger warming of the Zagreb city centre compared to the surroundings and mountain site [6-6]. Number of cold days ($T_{min} < 0\text{ }^{\circ}\text{C}$) decreased and the number of warm nights increased due to heating from high- built concrete surfaces. With the increase (decrease) in cooling (heating) degree days in Zagreb, the obtained results imply a potential increase in risk associated with warm, and a decrease in the risk associated with cold events, especially in cities [6-7].

Table 6-1: Temperature indices and their definitions

Indices of cold temperature extremes		
FD	Cold days (absolute threshold)	Number of days with daily minimum temperature $< 0\text{ }^{\circ}\text{C}$.
Tn10	Cold nights (percentile threshold)	Number of days with daily minimum temperature lower than threshold, determined as the calendar day 10th percentile of daily minimum temperature in the reference period 1981-2010.
Tx10	Cold days (percentile threshold)	Number of days with daily maximum temperature lower than threshold, determined as the calendar day 10th percentile of daily maximum temperature in the reference period 1981-2010.
CSDI	Cold spell duration index	Number of days in the span of at least six days with daily minimum temperature lower than Tn10.

Indices of warm temperature extremes		
Tn90	Warm nights (percentile threshold)	Number of days with daily minimum temperature higher than threshold, determined as the calendar day 90th percentile of daily minimum temperature in the reference period 1981-2010.
Tx90	Warm days (percentile threshold)	Number of days with daily maximum temperature higher than threshold, determined as the calendar day 90th percentile of daily maximum temperature in the reference period 1981-2010.
WSDI	Warm spell duration index	Number of days in the span of at least six days with daily maximum temperature higher than Tx90.
SU	Warm days (absolute threshold)	Number of days with daily maximum air temperature ≥ 25 °C.

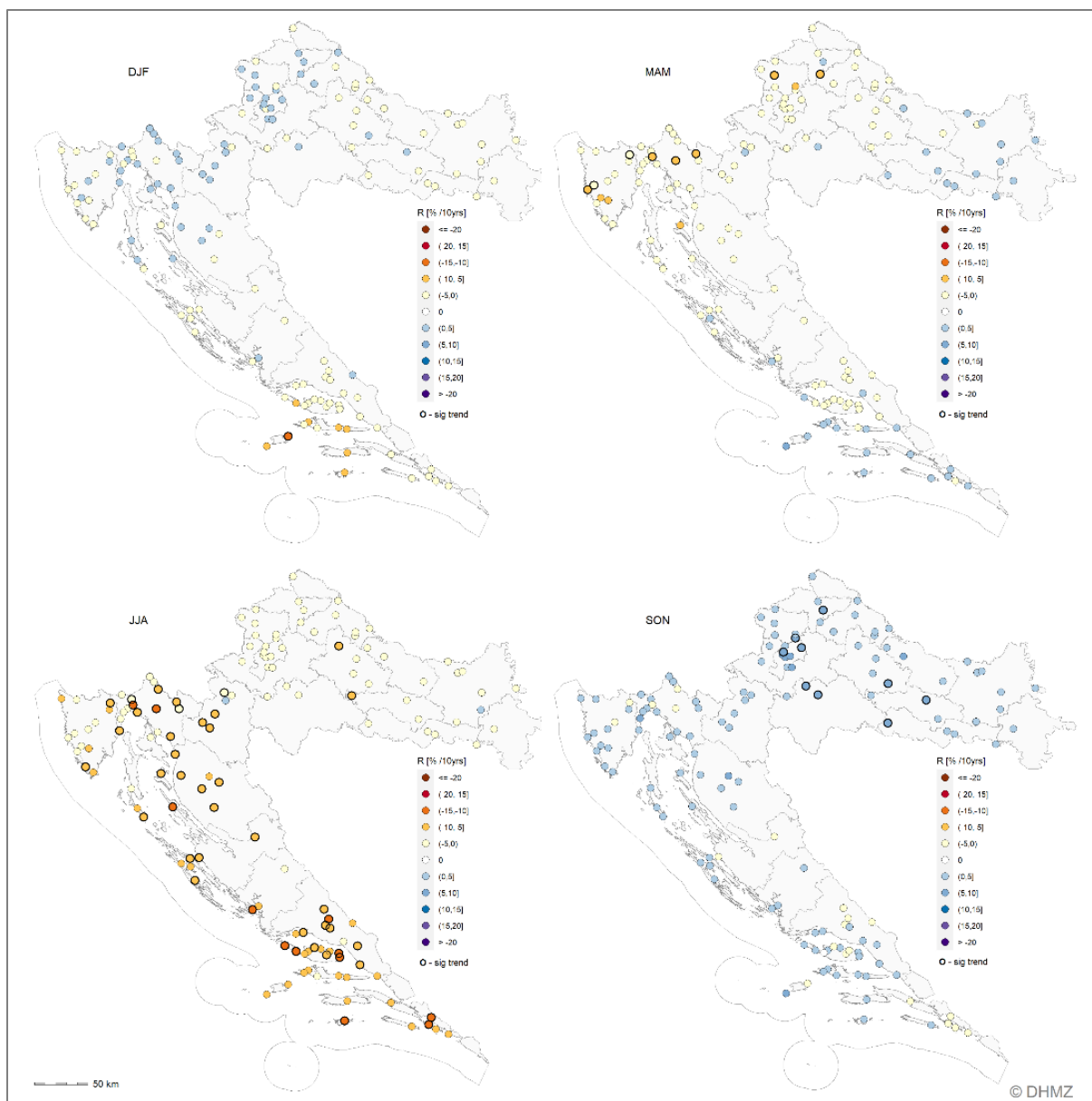


Statistically significant trend at individual meteorological station is marked with bold circle.
Number of warm days (SU) is number of days with daily maximum air temperature ≥ 25 °C.
Number of cold days (FD) is number of days with daily minimum temperature < 0 °C.
Decadal trend of warm days (SU) - left. Decadal trend of cold days (FD) - right.
Decadal trends are expressed in days / 10 years.

Figure 6-3: Decadal trends in the number of warm days and cold days in the period 1961-2020

Amount of precipitation

Precipitation trend shows distinct seasonal changes (Figure 6-4). The main trend feature is significant summer drying along the Adriatic coast and its hinterland (5-15% / 10 years compared to the period 1981-2010 average). On the other hand, a consistent increase in autumn precipitation is observed throughout the entire Republic of Croatia area and is significant in the central inland (up to 15% / 10 years). In winter a negative trend in the amount of precipitation prevails in the middle and southern Adriatic and the eastern parts of Croatia and a positive trend is observed in the rest of Croatia area. The opposite sign of the trend was observed in spring. Such seasonal distribution of the trend results in weakly expressed trend in the amount of precipitation at the annual level, both in terms of sign and amount.



Statistically significant trend at individual meteorological station is marked with bold circle.

Climatological seasons: winter (DJF), spring (MAM), summer (JJA) and autumn (SON)⁶

Decadal trends in seasonal precipitation in season winter (DJF) - first row and first column, spring (MAM) - first row and second column, summer (JJA) - second row and first column and autumn (SON) - second row and second column.

Decadal trends are expressed in % / 10 years with reference to the period 1981-2010 average.

Figure 6-4: Decadal trends in seasonal precipitation in the period 1961-2020

Precipitation extremes

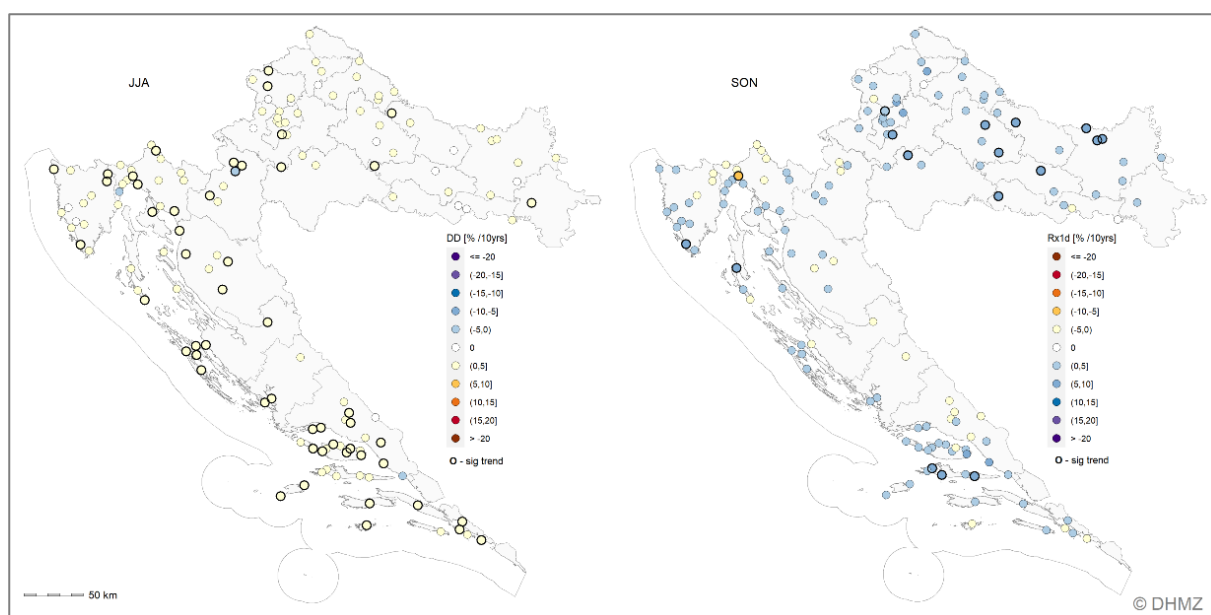
Changes in seasonal precipitation amounts are result of changes in frequency and amount of individual precipitation indices of extremes (Table 6-2). The summer drying in the Adriatic mainly contributes to a significant increase in frequency of dry days (up to 5% / 10 years) and a decrease in the number of moderately wet days (at certain stations up to 20% / 10 years compared to the period 1981-2010 average). In addition, maximum daily and multi-daily precipitation quantities are reduced (up to 10% /

⁶ Climatological season winter: December, January, February (DJF). Climatological season spring: March, April, May (MAM). Climatological season summer: June, July, August (JJA). Climatological season autumn: September, October, November (SON)

10 years). The autumn increase in precipitation amount over the past 60 years is result of an increase in the number of very wet days and the amount of maximum daily precipitation, especially in inland (Figure 6-5), as well as a decrease in duration of dry periods along the Adriatic (up to 15% / 10 years).

Table 6-2: Precipitation indices and their definitions

Dry and wet indices		
DD	Dry days	Number of days with daily precipitation amount $R_d < 1.0$ mm.
SDII	Standard daily precipitation intensity	Total annual precipitation amount divided by annual number of wet days ($R_d \geq 1.0$ mm)
R75	Moderately wet days	Number of days with amount of precipitation $R_d > R_{75\%}$, where $R_{75\%}$ is the 75th percentile of precipitation on all days in the reference period 1981-2010.
R95	Very wet days	Number of days with daily precipitation amount $R_d > R_{95\%}$, where $R_{95\%}$ is the 95th percentile of precipitation on all days in the reference period 1981-2010.
R95T	Share of precipitation on very wet days	Share of annual / seasonal precipitation SR_d / R_t , where SR_d is sum of daily precipitation greater than the 95th percentile of precipitation on very wet days ($R_{95\%}$) in the reference period 1981-2010 and R_t is total annual quantity of precipitation.
Rx1d	Maximum one-day precipitation	The highest precipitation amount in one-day period.
Rx5d	Maximum five-day precipitation	The highest precipitation amount in five-day period
CDD	Consecutive dry days	The longest period of consecutive dry days. Dry day is day with daily precipitation < 1 mm (CDD1) and < 10 mm (CDD10).
CWD	Consecutive wet days	The longest period of consecutive wet days. Wet day is day with daily precipitation ≥ 1 mm (CWD1) and ≥ 10 mm (CWD10).



Statistically significant trend at individual meteorological station is marked with bold circle.

Number of dry days (DD) is number of days with daily precipitation amount $R_d < 1.0$ mm.

Maximum one-day precipitation (Rx1d) is the highest precipitation quantity in one-day period. Climatological season: autumn (SON).

Decadal trends in number of dry days (DD) during summer season (JJA) - left.

Decadal trends of maximum daily precipitation amount in autumn season (SON) - right.

Decadal trends are expressed in % / 10 years with reference to the period 1981-2010 average.

Figure 6-5: Decadal trends in the number of dry days during summer and maximum daily precipitation amount in autumn season in the period 1961-2020

6.1.3. Climate change scenarios

The baseline for projections of future climate in previous Seventh national communication and the third biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC) was the Draft of Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 [6-8]. Future climate projections were calculated from simulations obtained by regional climate model RegCM [6-9], [6-10]. The period 1971-2000 was observed as historical climate. Climate changes were considered for two 30-year periods: 2011-2040 and 2041-2070 assuming a moderate scenario of development of greenhouse gas concentrations (RCP4.5) (Table 6-3) and a more extreme scenario (RCP8.5). As boundary and initial conditions for RegCM numerical integrations results of four global climate models were used: the model of the French meteorological service CNRM-CM5, the model of the Dutch consortium EC-Earth, the model of the German Max-Planck Institute for Meteorology MPI-ESM and the model of the British meteorological service HadGEM2. The simulations were performed at a horizontal spatial resolution of 50 km.

Table 6-3: Summary of projections of climate parameters for the period 2011-2040 and the period 2041-2070 for the Republic of Croatia in relation to the reference period 1971-2000 (RCP4.5)

Climate parameter		2011- 2040	2041-2070
Precipitation		Average annual quantity: slight decrease (except for slight increase in northwestern Croatia)	Average annual quantity: further decreasing trend (up to 5%) in almost all of Croatia, except for northwestern parts
		Seasons: different signs; winter and spring in most of Croatia slight increase of +5 to 10%, and summer and autumn decrease (mostly from -5 to 10% in southern Lika and northern Dalmatia)	Seasons: decrease in all seasons (up to 10 % in mountainous areas and northern Dalmatia) except in winter (increase of 5-10 % in northern Croatia)
		Decrease in number of rainy periods (except in central Croatia where it would slightly increase). Increase of number of dry periods.	Increase of number of dry periods
Snow cover		Decrease (highest in Gorski Kotar, up to 50 %)	Further decrease (especially in mountainous areas)
Surface runoff		There are no major changes in most regions; however, in mountainous areas and hinterland of Dalmatia there is decrease of up to 10%.	Decrease in runoff throughout Croatia (especially in spring).
Air temperature		Average: increase of 1-1.4°C (all seasons, entire Croatia)	Average: increase of 1.5-2.2°C (all seasons, entire Croatia, especially continental parts)
		Maximum: increase in all seasons 1-1.5°C	Maximum: increase up to 2.2°C in summer (up to 2.3°C on islands)
		Minimum: the highest increase in winter, 1.2-1.4°C	Minimum: the highest increase in continent in winter 2.1–2.4°C; and 1.8-2 °C in coastal areas
Extreme weather conditions	Hot days ⁽¹⁾	6 to 8 days more than reference period (reference period: 15-25 days per year)	Up to 12 days more than reference period
	Cold days ⁽²⁾	Decrease in the number of days with Tmin < -10°C and increase in Tmin values (1.2-1.4 °C)	Further decrease in number of days with Tmin < -10°C
	Warm nights ⁽³⁾	Increasing	Increasing

Climate parameter		2011- 2040	2041-2070
Wind	Average speed at 10 m	Winter and spring without change, but an increase of 20-25% in summer and particularly autumn in the Adriatic	Winter and spring mostly without change, but an increasing trend in summer and autumn in the Adriatic
	Max. speed at 10 m	Per year: without change (highest values on islands in southern Dalmatia) Per season: decrease in winter in southern Adriatic and hinterland	Per season: decrease in all seasons except in summer. The highest decrease in winter in southern Adriatic
Evapotranspiration		Increase in spring and summer 5–10% (outlying islands and western Istria >10%)	Increase of 10% for most of Croatia, up to 15% in coastal areas and hinterland, and up to 20% on outlying islands.
Air humidity		Year-round increase (most in summer in the Adriatic)	Year-round increase (most in summer in the Adriatic)
Soil humidity		Decrease in northern Croatia	Decrease throughout Croatia (most in summer and autumn)
Solar irradiance (input solar energy flux)		Increase throughout Croatia in summer and autumn, increase in northern Croatia, and decrease in western Croatia in spring; decrease throughout Croatia in winter	Increase in all seasons except in winter (highest in mountainous and central Croatia)
Mean sea level		2046-2065: 19 - 33 cm	2081-2100: 32 - 65 cm

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

(1) Number of days with $T_{max} > +30\text{ }^{\circ}\text{C}$

(2) Number of days with $T_{min} < -10\text{ }^{\circ}\text{C}$

(3) Number of days with $T_{min} \geq +20\text{ }^{\circ}\text{C}$

For purposes of the Eighth national communication and the fifth biennial report of the Republic of Croatia under the United Nations framework convention on climate change (UNFCCC), the number of individual members of the ensemble of models used in assessment of climate change in the future is increased from 4 to 12. A combination of 3 regional climate models (RCMs) is used: RegCM, RCA4 and CCLM4. For boundary and initial conditions of regional models, data from the same 4 global climate models (GCM) used in the previous Seventh national communication and the third biennial report of the Republic of Croatia under the UNFCCC are used. The used ensemble of 12 simulations better appreciates sources of uncertainties of climate projections compared to the ensemble of 4 members. Simulations integrated at a horizontal spatial resolution of 12.5 km are used, which simulated spatially variable elements in more detail, especially precipitation and precipitation extremes. Historical climate is defined for the period 1981-2010 (period P0), which includes several "warm years", which have been shown to be more frequent at the end of the 20th and in the 21st century. Projections of the future climate are analysed for one future period 2041-2070 (period P1) assuming a moderate scenario of the development of greenhouse gas concentrations (RCP4.5). Since climate projection protocol specified that simulations of the future climate start from December 2005 [6-11], the last five years in calculating historical climate were taken from simulations obtained for the RCP4.5 scenario. Assumption is that concentrations of greenhouse gases in the first few years did not change more significantly than the actual ones during the same years, and that the same simulations can be used in this way.

The change of analysed variables in the future climate (P1) compared to the historical one (P0) was obtained as the difference (absolute for temperature and number of days with a fixed threshold, and relative for precipitation and some indices) of mean values in these two periods. Difference of the ensemble means represents change of the variable in relation to the historical climate. Changes are observed for the whole year and for climatological seasons.

Air temperature (future changes in seasonal and annual air temperature)

Changes in mean air temperature at 2 m (differences between periods P1 and P0) indicate a clear signal of increase in mean annual and seasonal values over the entire Republic of Croatia area. The largest part of the Republic of Croatia will experience an increase in the mean annual air temperature in the amount of 1.5 to 1.6 °C. The mountainous area expects a slightly higher increase of 1.6 to 1.7 °C (Figure 6-6).

A clear signal of increase of minimum and maximum annual air temperatures is visible for the whole Republic of Croatia area (Figure 6-6). Except for the easternmost regions, where the projected increase is between 1.4 and 1.5 °C, the increase in minimum air temperatures in other parts of Croatia is between 1.5 and 1.6 °C. Expected increase in maximum air temperatures of 1.5 to 1.6 °C is in the Adriatic area and also in central and eastern Croatia, while projected increase in maximum temperatures over the mountains and Istria inland is between 1.6 and 1.7 °C, only over limited area 1.8 °C.

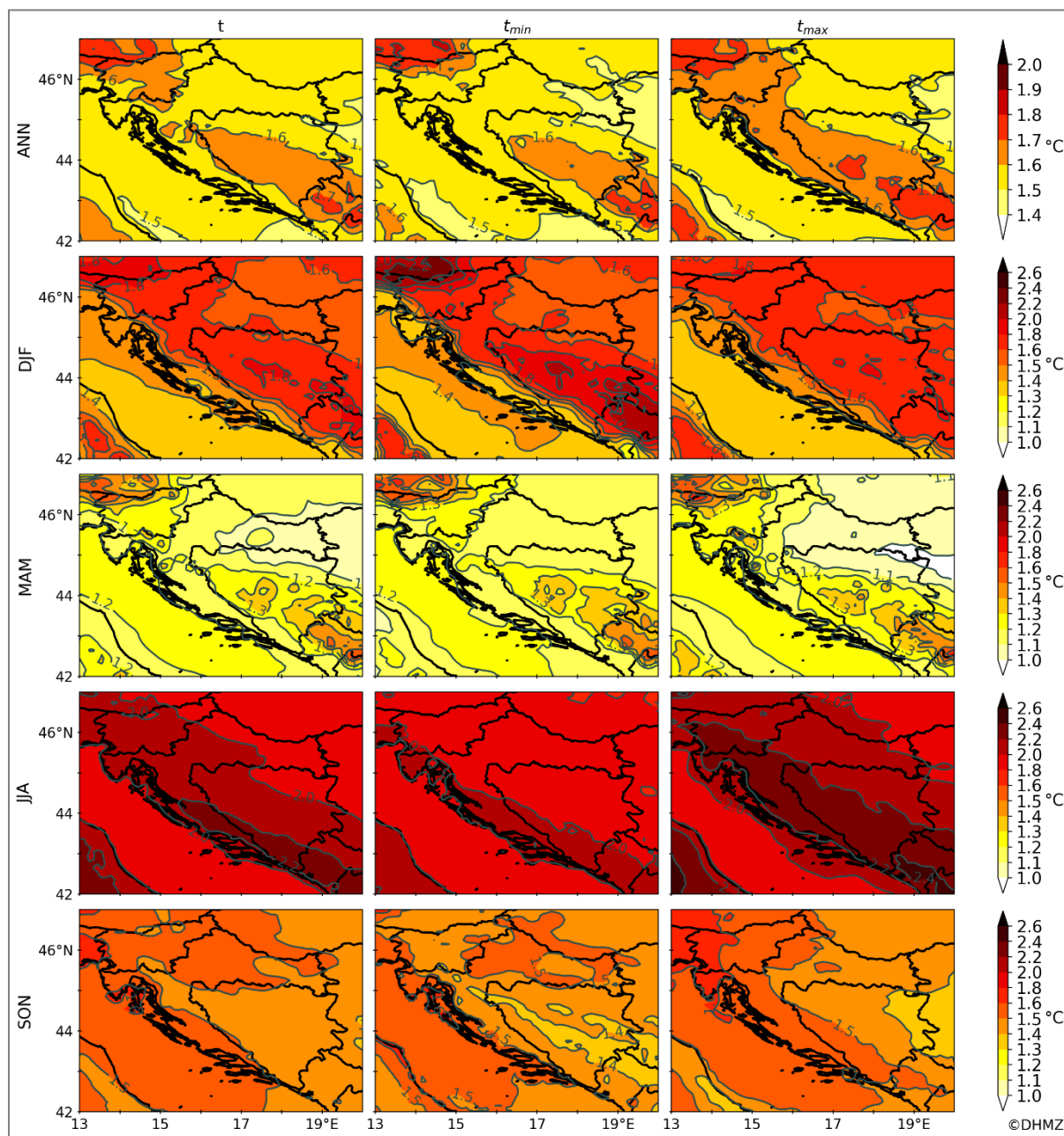
Analysing seasons (Figure 6-6), the highest increase in mean air temperature is expected in summer, when expected increase in the middle of the century amounts to at least 1.8 °C. Over the largest area of Croatia, the increase will be in the range between 2.0 and 2.2 °C, while over the Dalmatia inland temperatures may be up to 2.4 °C higher than in the period P0. Expected increase in mean winter temperatures is the highest in mountainous Croatia and the north-western parts of Croatia, ranging from 1.6 to 1.8 °C. In the eastern parts an increase of 1.5 to 1.6 °C prevails, and a bit smaller increase between 1.4 and 1.5 °C is expected over the entire coastal area. The autumn increase in the range of 1.5 to 1.6 °C is expected at the whole Republic of Croatia area, except for the mountainous area and the far east area where expected increase in the mean air temperature is of 1.4 to 1.5 °C and part of the Kvarner Bay where the increase is from 1.6 to 1.8 °C. The smallest increase in air temperature is projected for spring, when an increase in the range of 1.1 and 1.2 °C is expected for most of the Republic of Croatia area. A slightly higher increase is expected in the coastal area (between 1.2 and 1.3 °C), and a slightly lower one in the eastern Croatia (between 1.0 and 1.1 °C).

Most intense increase in minimum and maximum temperatures is projected for summer season (Figure 6-6). Spatially, the summer maximum temperature change is similar to mean air temperature change, while the changes differ in absolute terms. The area of the Adriatic, central and eastern Croatia expect an increase in summer maximum temperatures between 2.0 and 2.2 °C, while the projected increase in mountainous Croatia and the Istria inland is between 2.2 and 2.4 °C. The summer minimum temperature change in coastal area, including the inland of Istria and Dalmatia, is characterized by an increase of 2.0 to 2.2 °C. In the rest of the Republic of Croatia area expected increase in minimum summer temperatures ranges from 1.8 to 2.0 °C.

The range of increase in winter maximum temperatures in the mountainous area and Croatia inland is from 1.5 to 1.8 °C, in Istria and coastal area from 1.4 to 1.5 °C, and in the Adriatic area from 1.3 to 1.4 °C (Figure 6-6). Winter minimum temperatures have a slightly higher spatial variability, but temperature change is positive in the entire area of Croatia and ranges from 1.3 to 1.8 °C.

Autumn maximum temperatures in the coastal area of Adriatic, in Lika and Gorski Kotar, the westernmost parts of continental Croatia and the central part of Croatia will rise between 1.5 and 1.6 °C (Figure 6-6). In the Istria, the maximum autumn temperatures will be higher by 1.6 to 1.8 °C, and in most of continental Croatia by 1.4 to 1.5 °C. The increase in expected minimum autumn air temperatures (Figure 6-6) is most pronounced in the Kvarner Bay (up to 1.8 °C) and in the Adriatic and central Croatia (between 1.5 and 1.6 °C). The expected minimum temperature changes in the largest part of the mountain area and in the central part of eastern Croatia are between 1.4 and 1.5 °C.

Spring maximum air temperatures increase will also be smallest over the east and central part of Croatia (from 1.0 to 1.1 °C), and a slightly larger increase (from 1.1 to 1.2 °C) is expected in the western parts of the inland and in parts of Dalmatia. For most of the coastal area, including Istria and its inland, the increase in maximum spring temperatures ranges from 1.2 to 1.3 °C. A higher increase in maximum spring air temperatures can be expected in isolated mountain areas. Expected changes in spring minimum temperatures in the largest area of continental Croatia are between 1.1 and 1.2 °C, only in the mountainous part and most of the Adriatic Sea they are in the range of 1.2 to 1.3 °C (Figure 6-6).



Change in mean air temperature at 2 m (t) - first column. Change of minimum air temperature at 2 m (tmin) - second column. Change in maximum air temperature at 2 m (tmax) - third column. Annual (ANN) change - first row. Seasonal changes: winter (DJF) - second row, spring (MAM) - third row, summer (JJA) - fourth row and autumn (SON) - fifth row.

Figure 6-6: Change in the mean, minimum and maximum air temperature of the ensemble mean for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Temperature extremes

Changes in extreme temperature conditions are analysed considering change in annual number of days in which the condition used to define a certain event, i.e. the climate index is met (Table 6-1). Occurrence of temperature extremes strongly depends on part of the year (warm indices rarely occur in the cold part of the year and vice versa), but also on area observed (e.g. cold indices are rarer in the coastal area).

Cold temperature indices are analysed considering changes in total annual number of cold days (FD) and seasonal number of cold days in autumn, winter and spring⁷, changes in duration of cold periods (CSDI), number of cold nights (Tn10) and cold days (Tx10) for winter season and annually. A decrease in number of days with cold temperature indices is expected in the period P1 compared to the period P0.

In winter the most pronounced decrease in number of cold days (FD) is expected over central and eastern Croatia (11 to 12 days less), while over mountains decrease is mostly up to 10 days less, only in some places 8 to 9 days less (Figure 6-7). Decrease in number of cold days in autumn and spring is between 3 and 7 days in the entire Croatia area, with smaller decrease over the coast and larger decrease over the inland. Decrease in annual number of cold days is sum of seasonal contributions and for most of the Croatia area it is between 18 and 21 days. Only in the north-western parts (along the Slovenian border) and in the narrow area of western Slavonia a reduction of more than 21 days is possible. In the coastal area, the absolute amount of reduction decreases rapidly getting closer to the sea, due to small number of cold days in that area and in the period P0.

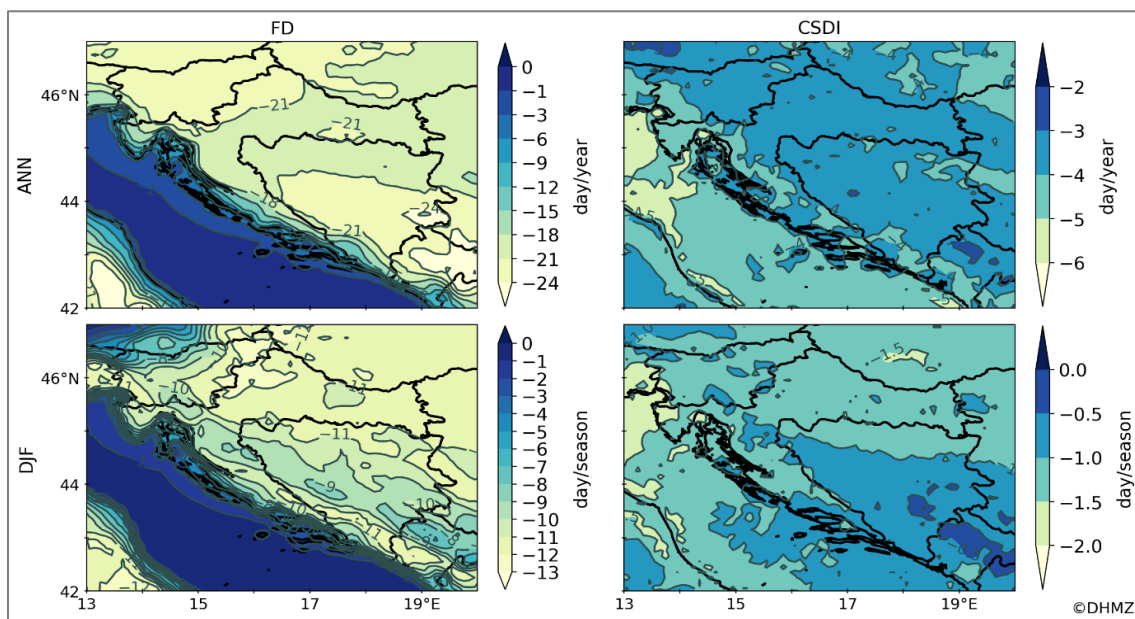
Cold spell duration (CSDI) decreases in winter season by at least 0.5 days in southern Adriatic and part of Lika and Gorski Kotar, and by maximum of 1.5 days in rest of the Republic of Croatia area (Figure 6-7). Cold spell duration is expected to decrease by 3 to 4 days on annual basis in majority of Croatia area. Greater decrease of 4 to 5 days is expected only in Istria and the mountainous coastal area.

Decrease in number of cold nights (Tn10) in winter ranges from 4.5 to 5.0 % in the majority of the inland, in Istria and part of the northern Adriatic (Figure 6-8). A slightly smaller decrease from 4.0 to 4.5 % is projected for mountainous area, and greater part of the middle and southern Adriatic. The smallest changes are expected in part of the central Adriatic area (decrease of 3.5 to 4.0 %). On annual level, a decrease in the number of cold nights is expected from 5.0 to 5.5 % in most of the Republic of Croatia area and in the north-western parts (along the Slovenian border) and in the coastal area, the decrease will be between 5.5 and 6.0 %.

Changes in number of cold days (Tx10) in winter indicate a decrease of 4.0 to 4.5 % in narrow coastal area and most of the inland (central and eastern Croatia), and slightly less (from 3.5 to 4.0 %) in mountainous Croatia, Primorje and the Dalmatia inland (Figure 6-8). Decrease in annual number of cold days is highest over the Adriatic and coastal area (6.5 %), and it gradually decreases towards the inland, where the greater part of the inland expects a decrease of 4.0 to 4.5 %.

Changes of warm extreme temperature indices are analysed based on annual changes and seasonal changes for summer, spring and autumn, except warm spell duration index which is also analysed for winter. Indices defined by absolute thresholds usually occur in the warmer part of the year, in contrast to indices and warm periods defined by percentiles on individual days, which can be recorded at any time of the year. In the future period P1, for all considered warm temperature indices an increase in number of days that meet criteria for particular index (Table 6-1) can be expected.

⁷ Figures in continuation show the annual change and the change in winter season.



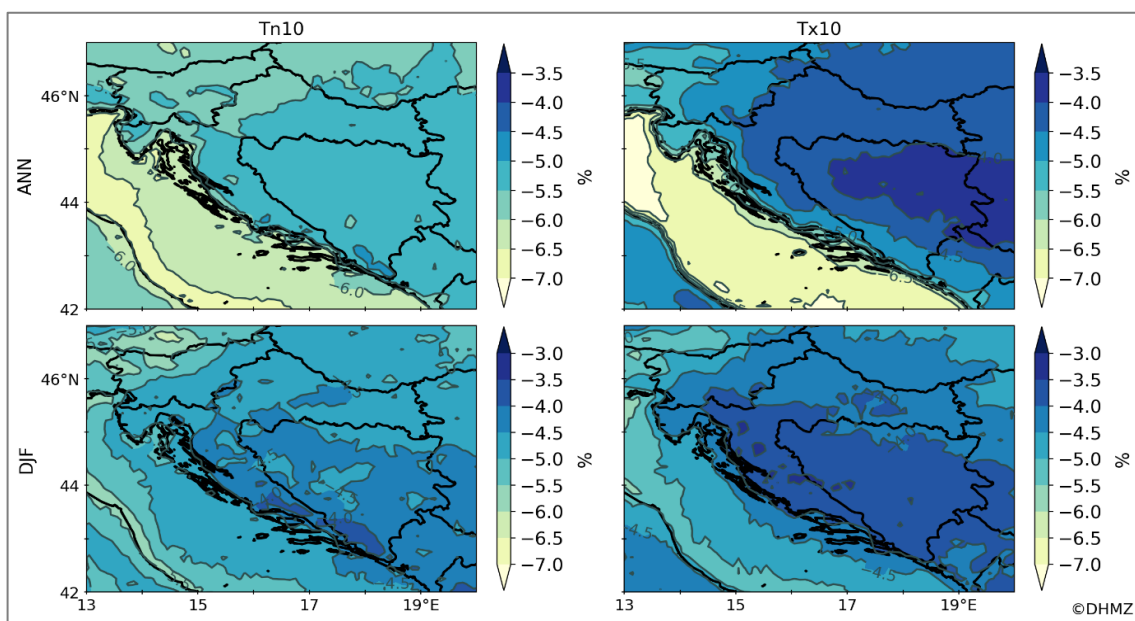
Number of cold days (FD) is number of days with daily minimum air temperature $< 0^{\circ}\text{C}$.

Cold spell duration index (CSDI) is number of at least 6 consecutive days with minimum air temperature lower than the 10th percentile of the minimum air temperature for calendar day in the period 1981-2010.

Annual (ANN) change of FD - first row and first column. Change of FD in winter (DJF) - second row and first column.

Annual (ANN) change of CSDI - first row and second column. Change of CSDI in winter - second row and second column.

Figure 6-7: Change in number of cold days and cold spell duration index of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)



Number of cold nights (Tn10) is number of days with minimum air temperature lower than the 10th percentile of minimum air temperature for calendar day in the reference period 1981-2010. Change in number of cold nights (Tn10, first column).

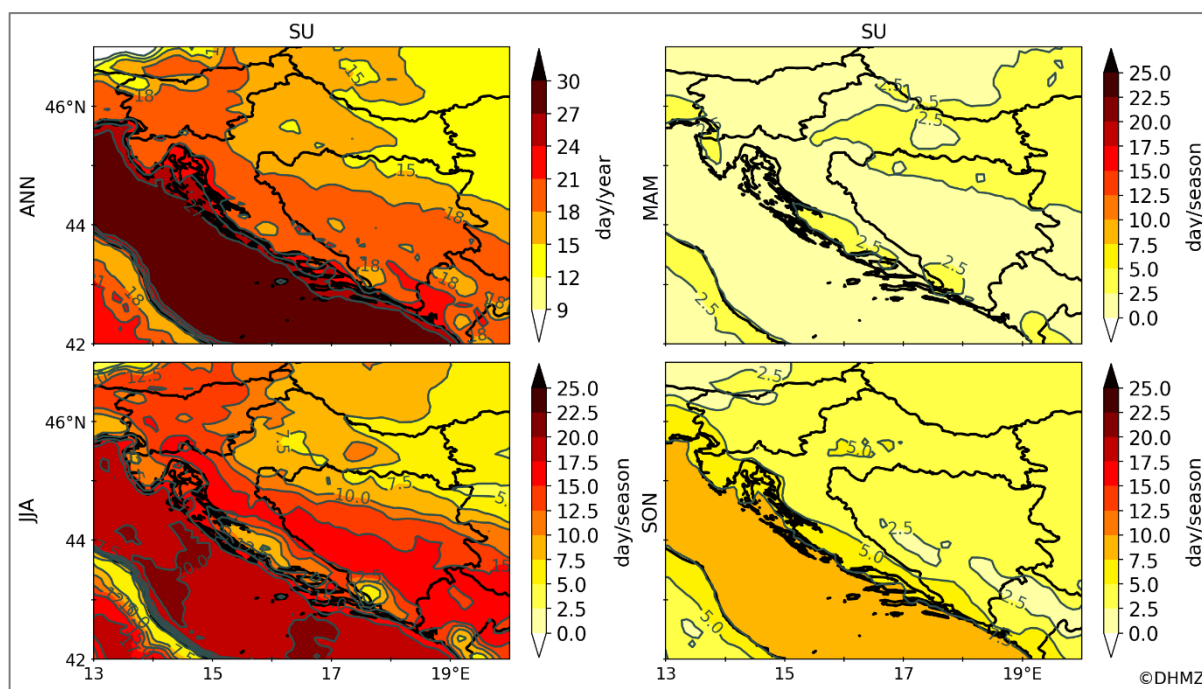
Number of cold days (Tx10) is number of days with maximum air temperature lower than the 10th percentile of maximum air temperature for calendar day in the period 1981 - 2010. Change in number of cold days (Tx10, second column).

Annual (ANN) change of Tn10 - first row and first column. Change of Tn10 in winter (DJF) - second row and first column.

Annual (ANN) change of Tx10 - first row and second column. Change of Tx10 in winter (DJF) - second row and second column.

Figure 6-8: Change in number of cold nights and cold days of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Annually, the entire Republic of Croatia area will experience in period P1 at least 12 warm days (SU) more than in period P0 (Figure 6-9). The far east expects from 12 to 15 and central Croatia from 15 to 18 warm days more. Mountainous area, Dalmatia and Istria inland will have up to 21 more warm days, while narrow coastal area will have up to 24 more warm days in the period P1 compared to the period P0. Summer contributes the most to annual increase in the number of warm days. The expected summer increase is between 5.0 and 7.5 days for eastern Croatia, 7.5 and 10.0 days for majority of central Croatia and between 10.0 and 17.5 days for the wider mountainous and coastal areas (Figure 6-9). Some coastal areas have an expected increase in number of warm days in summer of less than 10.0 but greater than 5.0. During spring, warm days can increase to a maximum of 5.0 days (Figure 6-9). The highest spring increase of 2.0 to 5.0 days is expected in areas where the increase in warm days in summer compared to the period P0 is the smallest (parts of central and eastern Croatia and areas of Dalmatia). The increase in number of warm days in the autumn is highest (between 5.0 and 7.5 days) in coastal area, and decreases towards the inland, where largest part (mountains, large parts of central and eastern Croatia) expects 2.5 to 5.0 warm days more (Figure 6-9).

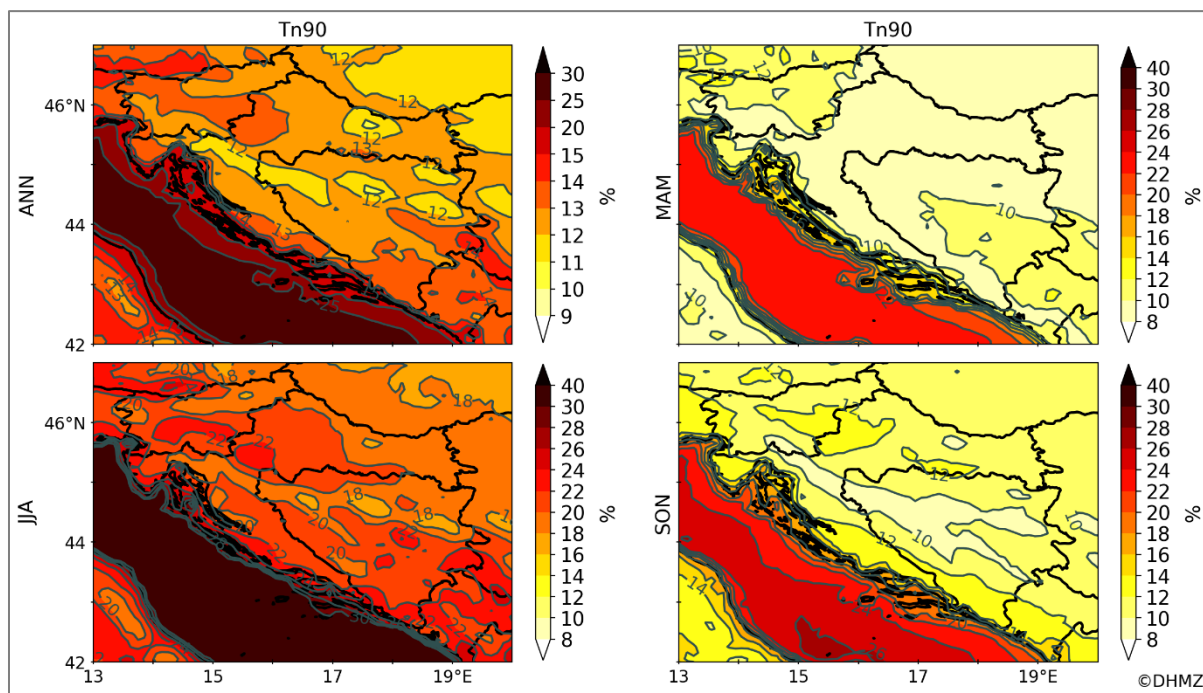


Number of warm days (SU) is number of days with daily maximum air temperature $\geq 25^{\circ}\text{C}$.

Annual (ANN) change in SU - first row and first column. SU change in spring (MAM) - first row and second column, summer (JJA) - second row and first column and autumn (SON) - second row and second column.

Figure 6-9: Change in number of warm days of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Annual change in number of warm nights (Tn90) is highest over narrow coastal area (greater than 13 %), while the expected changes over inland are between 10 and 14 % (Figure 6-10). Summer changes in number of warm nights (Figure 6-10) are also highest (greater than 22 %) over the coastal area, between 20 and 22 % in majority of central Croatia and less than 18 % over the rest of the Republic of Croatia area. Changes in number of warm nights in spring and autumn (Figure 6-10), are also highest over areas near the sea: in spring more than 10 %, in autumn more than 14 %. Spring changes over the rest of Croatia area are between 8 and 10 %, autumn changes are between 8 and 10 % over the mountains, between 12 and 14 % over western parts of central Croatia, and between 10 and 12 % over the rest of the Republic of Croatia area.

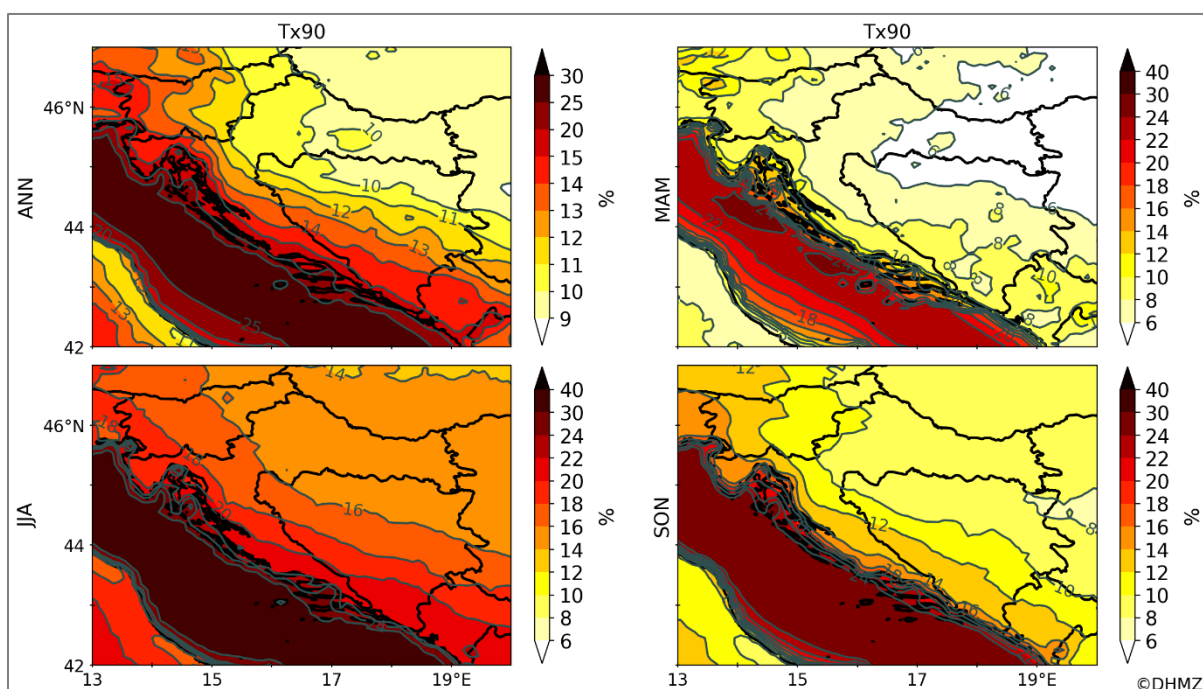


Number of warm nights (Tn90) is number of days with a minimum air temperature higher than the 90th percentile of minimum air temperature for calendar day in the period 1981-2010.

Annual (ANN) change of Tn90 - first row and first column. Change of Tn90 in spring (MAM) - first row and second column, summer (JJA) - second row and first column and autumn (SON) - second row and second column.

Figure 6-10: Change in the number of warm nights of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Annual change in number of warm days (Tx90) has an increase from far east (between 9 and 10 %) across central parts (between 10 and 11 %) and relatively rapid spatial change in mountainous area (between 11 and 15 %) to coastal areas where change greater than 15 % is expected. Spring changes in number of warm days are less than 8 % over inland and over coastal areas they increase towards more than 16n% (Figure 6-11). Autumn changes in number of warm days over inland are between 8 and 10 %, over mountain areas between 10 and 14 %, and in coastal parts they reach values of 22 % (Figure 6-11). Changes in number of warm days in summer have similar spatial distribution, the increase in number of warm days is the smallest in eastern and central Croatia (from 14 to 16 %), it grows through mountainous area (from 16 to 20 %) and reaches its maximum in coastal area (from 20 up to 24 %) (Figure 6-11).

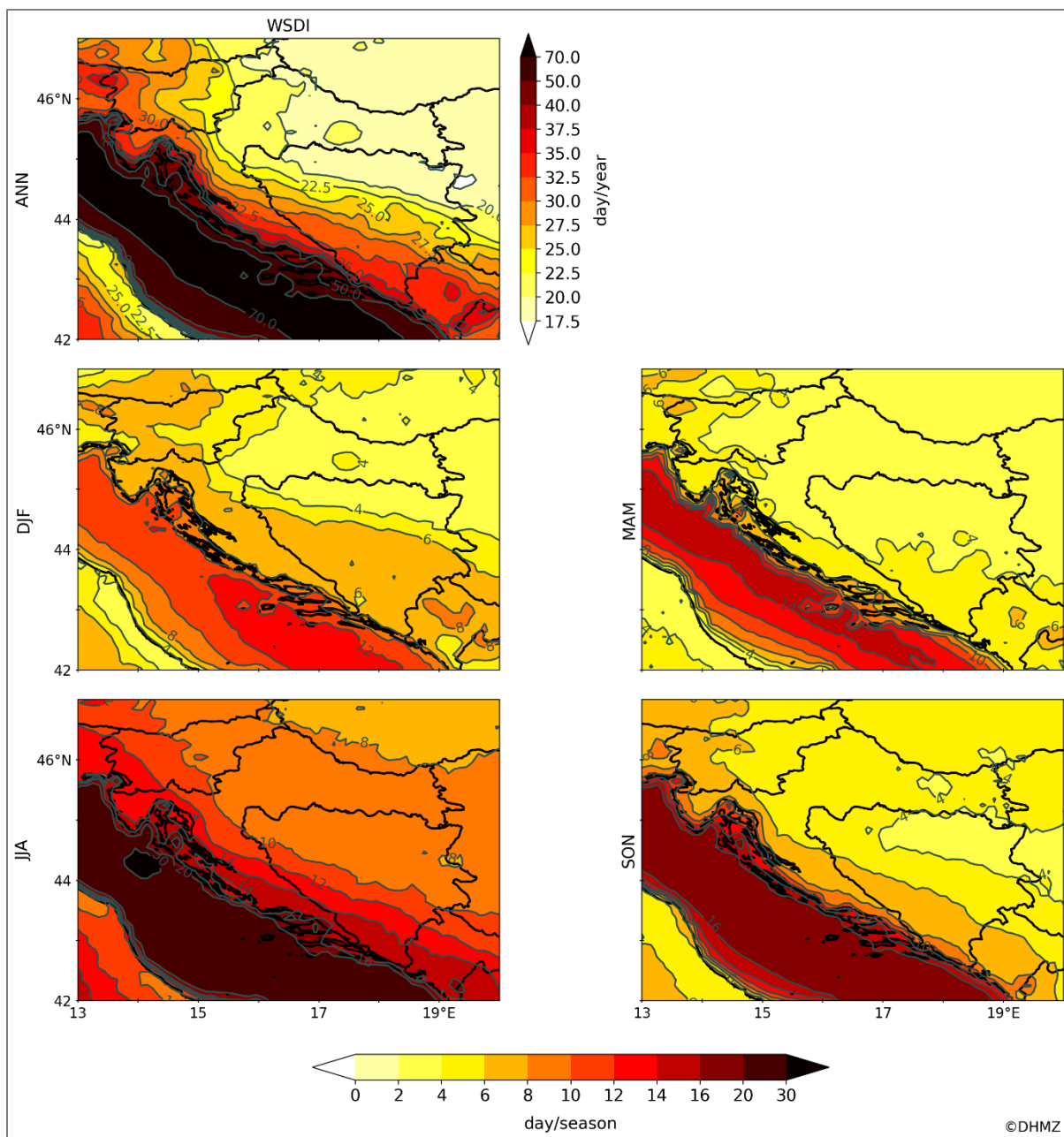


Number of warm days (Tx90) is number of days with maximum air temperature higher than threshold, determined as the 90th percentile of maximum air temperature for calendar day in the period 1981-2010.

Annual (ANN) change of Tx90 - first row and first column. Change of Tx90 in spring (MAM) - first row and second column, summer (JJA) - second row and first column and autumn (SON) - second row and second column.

Figure 6-11: Change in number of warm days of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Annual changes in warm spell duration index (WSDI) are in accordance with changes in number of warm days, gradually increase from eastern (increase from 17.5 to 20.0 days) through central and mountainous parts (20.0 to 32.5 days) and reach maximum in coastal area (up to 50.0 days) (Figure 6-12). Spatial increase from east across the central and mountainous areas towards the coast is characteristic for all four climatological seasons (Figure 6-12). It is most pronounced in the summer (from 8 to 10 days in eastern and central areas to more than 16 days over coastal area), and least pronounced in the winter (2 to 4 days in the eastern areas, 4 to 8 days in mountainous areas, 8 to 10 days over the northern Adriatic coast and 10 to 12 days over the southern Adriatic coast) (Figure 6-12). Autumn and spring changes in warm spell duration are the same for mountainous area and the area of central and eastern Croatia (in spring between 2 and 6 days, in autumn between 4 and 8 days), but over coastal area they rapidly progress to 10 or more days in both seasons (Figure 6-12).



Warm spell duration index (WSDI) is the number of days in periods of at least 6 consecutive days with maximum air temperature higher than T_{x90} (number of warm days).

Annual change of WSDI – first row. Change of WSDI in winter (DJF) - second row and first column, in spring (MAM) - second row and second column, summer (JJA) - third row and first column and autumn (SON) - third row and second column.

Figure 6-12: Change in warm spell duration index in the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Precipitation (changes in seasonal and annual precipitation)

Change in precipitation amount in the period 2041-2070 compared to the period 1981-2010 is observed with respect to relative amount $((P1-P0)/P0)$ and is expressed in percentages.

Total annual precipitation amount in the period P1 shows relatively small, spatially variable, changes compared to the period P0 (Figure 6-13). An increase in precipitation amount is expected along the Adriatic coast from 3 to 4 %. Smaller part of Lika and Gorski Kotar and Dalmatia inland will have 1 to 2 % less precipitation, while the change will be negligible over most of that area (in the range of -1 to 1%). Expected changes of precipitation amount over inland increase from west to east, and in easternmost part increase in precipitation quantity of 3 to 5 % is expected.

Expected seasonal changes in precipitation quantity are of different signs, with decrease in precipitation in the summer throughout the entire the Republic of Croatia area and prevailing, less pronounced increase in precipitation in other seasons. An increase is expected for winter over all area of the Republic of Croatia, and in autumn over majority of Croatia. In winter, the increase is most intense over eastern regions and amounts between 10 and 15 %, while over mountainous area and the Dalmatia inland it is least intense (between 1 and 5 %) (Figure 6-13). The autumn increase is from 1 to 5 % over the largest part of Croatia, and from 5 to 10 % over coastal area and isolated areas of inland (Figure 6-13). Negative changes in autumn precipitation amount are expected for narrow strip of the mountainous littoral (Velebit). Changes in spring precipitation quantities in terms of sign and spatial distribution mostly agree with changes at the annual level (Figure 6-13). The area of eastern parts of central Croatia and eastern Croatia itself, as well as coastal area show an increase in precipitation quantity, up to a maximum of 10% (eastern Slavonia). The areas of Lika and Gorski Kotar and Dalmatia inland are characterized by negative change in precipitation quantity of 1 to 5 %. The only season in which the amount of precipitation is expected to decrease throughout the Republic of Croatia area is summer (Figure 6-13). The largest decrease (between 15 and 20 %) is possible over Primorje, central Dalmatia and mountainous area, and the smallest in the northernmost and easternmost regions (between 5 and 10 %). In all other parts of the Republic of Croatia area, expected summer decrease of total precipitation quantity is between 10 and 15 %.

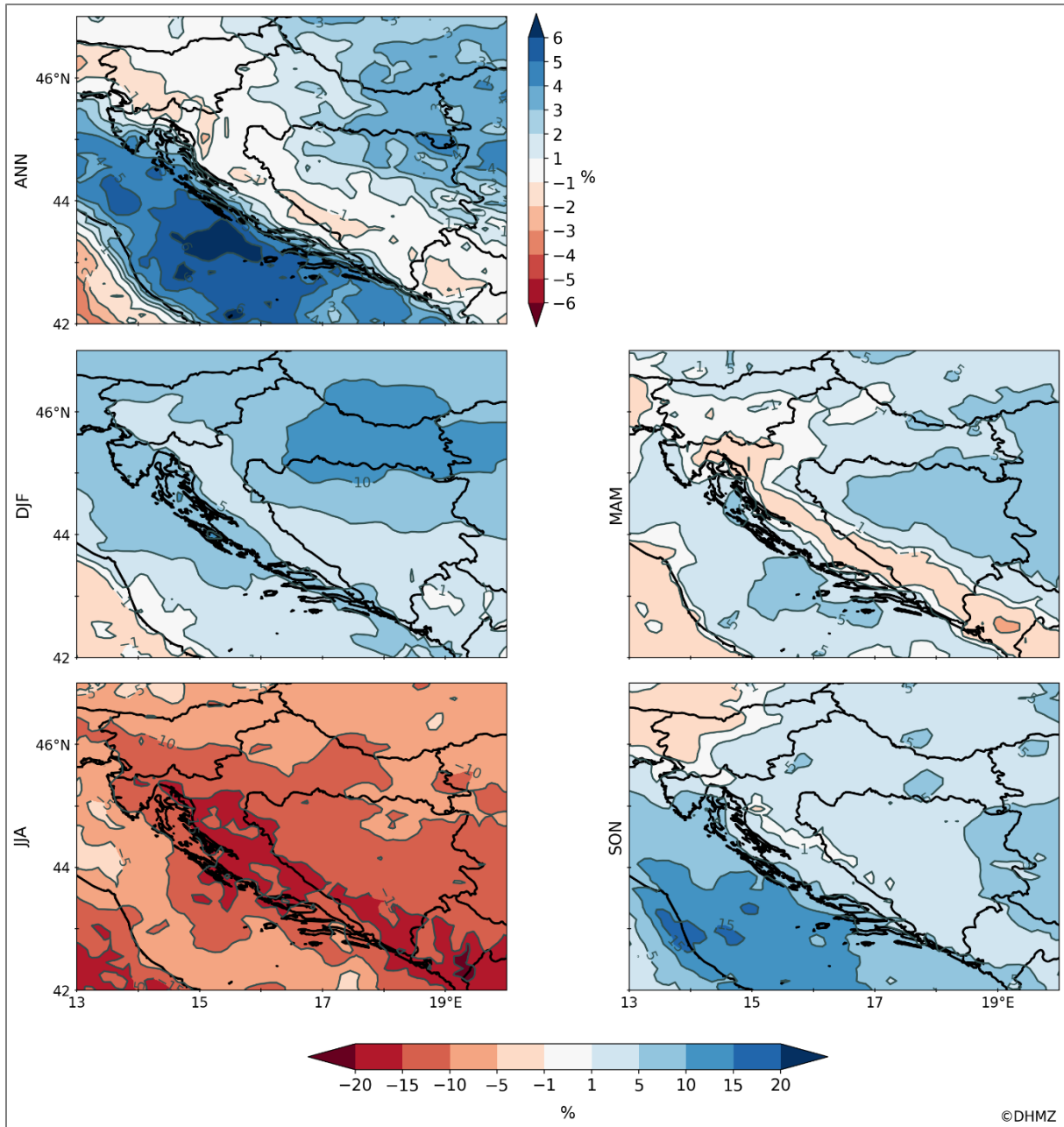
Changes in dry and wet indices

Change in precipitation indices (Table 6-2) is analysed on annual level and by all seasons.⁸ The number of dry days (DD) on annual level in period P1 will increase compared to the period P0 all over the Republic of Croatia area (Figure 6-14). The largest increase will be in the mountainous areas and Dalmatia inland (up to 5%), while for the rest of the Croatia area an increase is expected from 1 to 3 %. An increase in number of dry days is expected in all seasons throughout the Croatia area, except in winter (Figure 6-14). In winter, an increase in number of dry days is expected in the southern Adriatic, while change over other areas of Croatia is mostly negligible: in narrow area of northern areas along the border with Hungary and far east a decrease in number of dry days of 1 to 2 % is possible, elsewhere between -1 and 1 %. The increase in number of dry days is greatest in summer over the mountainous Croatia and Dalmatian hinterland (from 5 to 7.5 %).

Annual changes of both indices of consecutive dry days (CDD1, CDD10) for most of the Republic of Croatia area show that longer series of consecutive dry days can be expected, up to 20% in mountainous Croatia. Exception are consecutive dry days when precipitation is less than 10 mm (CDD10) where projections show possible shortening of series for eastern Croatia (up to 5 %). Projections for both

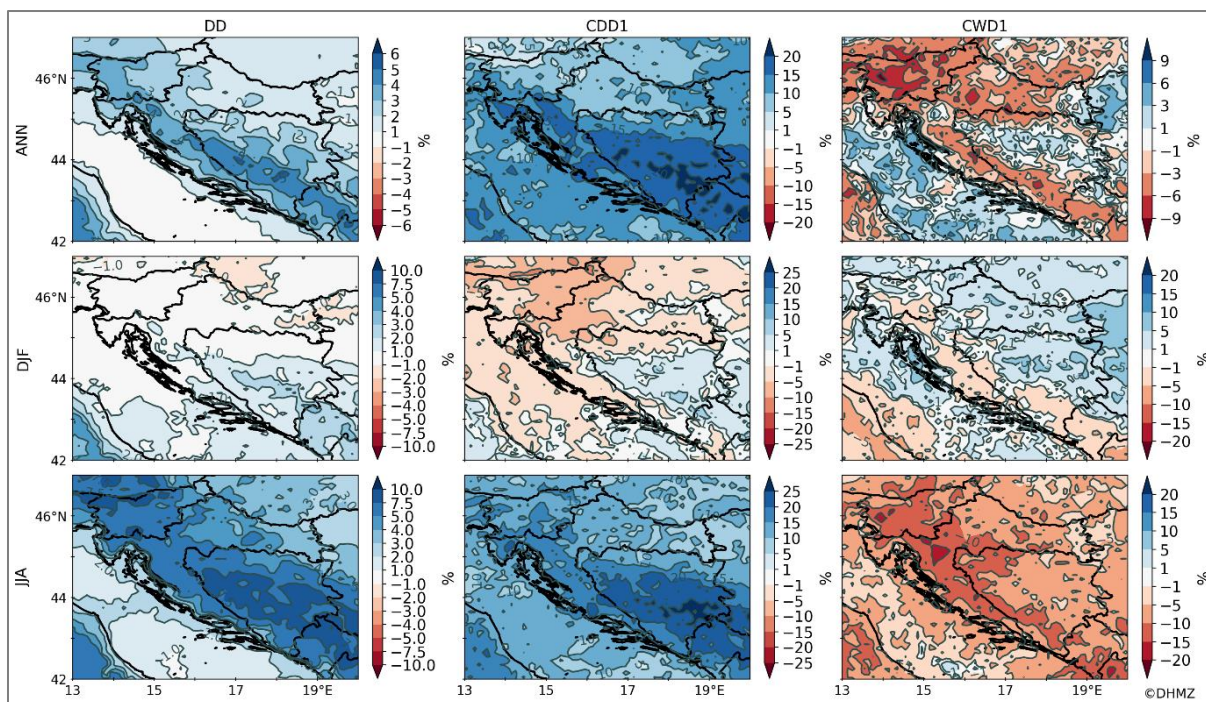
⁸ Figures in continuation show the annual change and the change in main seasons (winter and summer).

indices in summer indicate lengthening of series, while projections for winter mostly show shortening of these series. Although predominantly longer series of both indices in spring and autumn are projected, a shortening is also possible, more pronounced for the CDD10 index in the eastern and central parts of Croatia. All reductions are up to 10 % and increases up to 15 %.



Annual (ANN) change - first row and first column. Change in winter (DJF) - second row and first column, spring (MAM) - second row and second column, summer (JJA) - third row and first column and autumn (SON) - third row and second column.

Figure 6-13: Relative change in total precipitation amount of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)



Number of dry days (DD) is number of days with daily precipitation amount $R_d < 1.0$ mm. (DD, first column). Consecutive dry days (CDD1) is longest period of consecutive dry days with daily precipitation < 1 mm. (CDD1, second column). Consecutive wet days (CWD1) is longest period of consecutive wet days with daily precipitation ≥ 1 mm. (CWD1, third column). Annual (ANN) change - first row. Change in winter (DJF) - second row, summer (JJA) - third row.

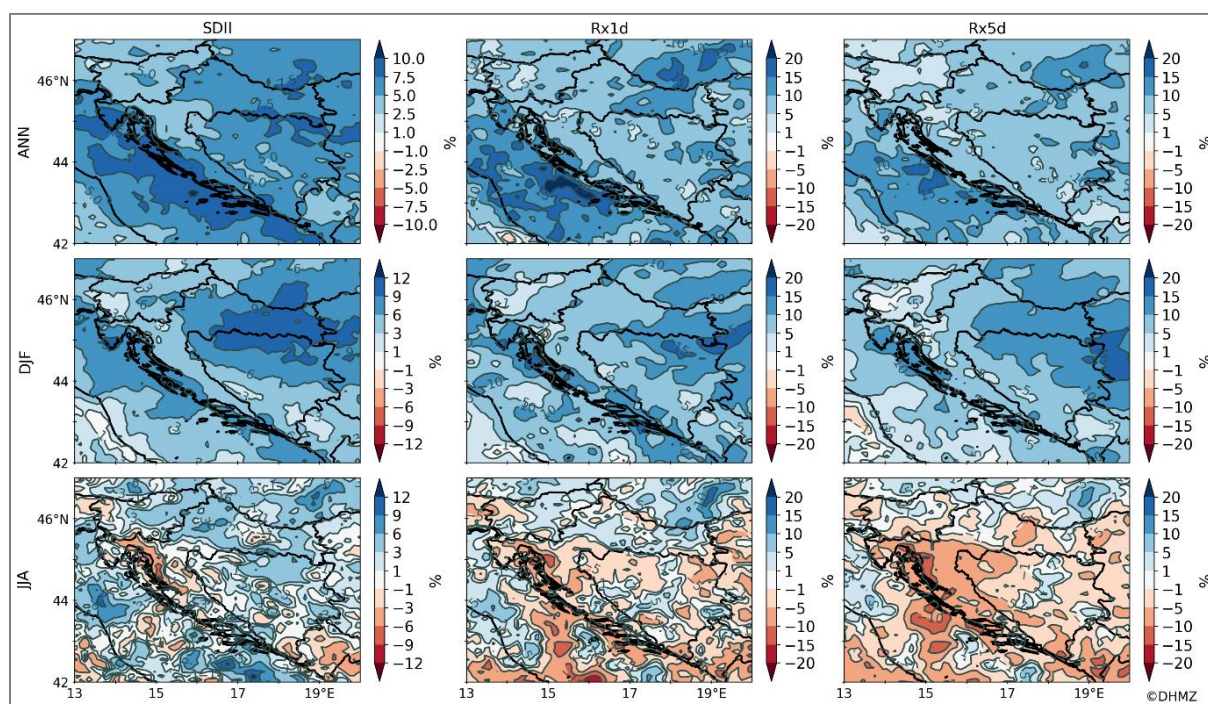
Figure 6-14: Relative change in number of dry days, consecutive series of dry and wet days in the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

Both consecutive wet days indices (CWD1, CWD10) are as expected in contrast to changes in the consecutive dry days index (CDD1, CDD10) (Figure 6-14). Over most of the Republic of Croatia area shortening of the series of consecutive wet days with precipitation greater than or equal to 1 mm (CWD1) on annual level is expected (Figure 6-14). Exception is the far east of Croatia and coastal area. The most common changes range from -6 to 3 %. Projections of number of consecutive wet days with precipitation greater or equal to 10 mm (CWD10) indicate shortening of the series in the mountains, the inland of Istria and Dalmatia, and lengthening in the rest of Croatia area. Change in the CWD1 index indicates shortening of the series of consecutive wet days during summer over the entire Croatia, and in spring and autumn almost all over the Croatia area. In winter prolongation of the series is expected for the mountainous area and the Dalmatian hinterland (up to 5%), while in other areas prolongation of the series of consecutive wet days is expected to be up to a maximum of 10 % compared to the P0 period. The largest decrease if the CWD10 index is expected in summer throughout all of Croatia area. Changes in spring and autumn will be spatially equally distributed as on annual level, while the CWD10 index is mainly expected to increase in winter.

Annual changes in standard daily intensity index (SDII) indicate the largest increase over the coastal area (between 7.5 and 10.0 %) and in narrow area of eastern Croatia along the border with Hungary and Bosnia and Herzegovina (Figure 6-15). Changes in Lika and Gorski Kotar are smallest, but also positive (between 2.5 and 5.0 %). In the rest of the Republic of Croatia area, an increase of SDII is also expected, from 5.0 to 7.5 %. A possible SDII decrease is expected only in summer and is most pronounced over coastal mountainous areas (from 3 to 9 %). In other parts of Croatia and in other seasons, changes of

SDII in the period P1 compared to the period P0 are positive and mostly pronounced over eastern areas in winter and in autumn over the Adriatic coast (between 9 and 12 %).

An increase in maximum one-day precipitation amount (Rx1d) is expected over the entire Republic of Croatia area (Figure 6-15). Increase over most of Croatia area will be between 5 and 10 %, while over the eastern part of central Croatia and the western part of eastern Croatia, as well as the Istria inland and parts of Dalmatia it will be between 10 and 15 %. The greatest contribution to the described annual increase is due to autumn changes, which are very similar to annual change both in terms of amount and spatial distribution. Spatially somewhat different and somewhat smaller in amount spring also shows positive contribution over the entire the Republic of Croatia area. Winter mainly indicates an increase of Rx1d, only a small part of Primorje area indicates possible decrease (up to 5 %). Decrease of Rx1d in summer is expected over much larger area than in winter. It covers almost entire coastal area, mountains and northern parts of the inland and it is most pronounced over the Primorje area, where it reaches a value of 10 to 15 %. However, central, and eastern Croatia are characterized by an increase in maximum one-day precipitation amount, mostly up to 5 %.



Standard daily precipitation intensity (SDII) is ratio of annual amount of precipitation and annual number of rainy days ($R_d \geq 1.0$ mm). (SDII, first column)

Maximum one-day precipitation (Rx1d) is the highest precipitation amount in one-day period (Rx1d, second column)

Maximum five-day precipitation (Rx5d) is the highest precipitation amount in five-day period (Rx5d, third column)

Annual (ANN) change - first row. Change in winter (DJF) - second row, summer (JJA) - third row.

Figure 6-15: Change in standard daily precipitation intensity index, maximum one-day precipitation and maximum five-days precipitation amount of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

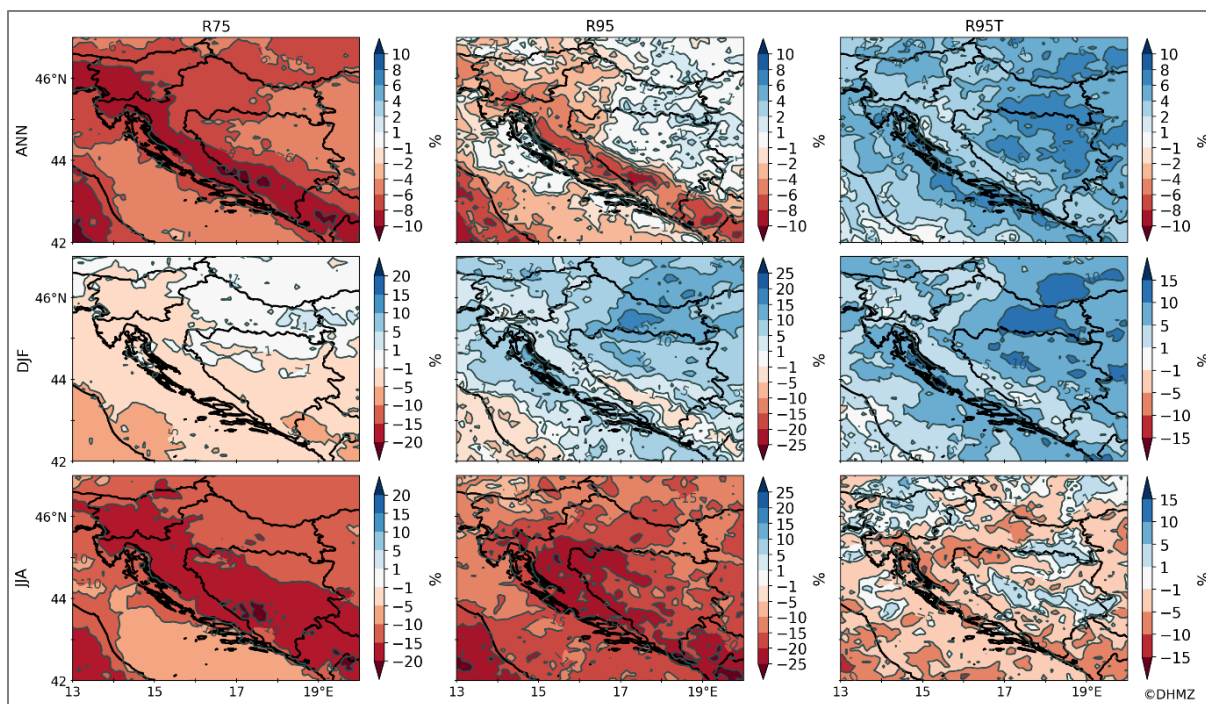
Maximum five-day precipitation amount (Rx5d) annual change is similar to changes in maximum one-day precipitation amount (Rx1d) and over the entire Republic of Croatia area it shows positive change, over the majority of area from 1 to 5 %, less in mountainous Croatia, and more over certain coastal areas (Figure 6-15). Like seasonal changes of Rx1d, changes of Rx5d in winter, spring and autumn seasons are mostly positive, and in summer mostly negative. The increase of Rx5d in spring and autumn is less

pronounced compared to changes of Rx1d. Winter changes of Rx5d are positive over the entire Republic of Croatia area. Changes of 5 to 10% in Dalmatia, Lika and the western part of central Croatia and 10 to 15% over the eastern part of Croatia will be most prevalent spatially, and less than 5% only on part of the coast and the nearby mountains. Summer decrease of maximum 5-day precipitation covers most of Croatia area and over Primorje it reaches values from 10 to 15%.

The number of moderately wet days (R75) in the period P1 will be lower than in the period P0 over the entire the Republic of Croatia area (Figure 6-16). Largest changes, decrease of 8 to 10 %, are projected for the Istria inland, Primorje, mountainous Croatia and the Dalmatia inland. For coastal area and central Croatia, the decrease is from 6 to 8%, and over eastern Croatia from 4 to 6%. Smallest changes are expected in winter, when number of moderately wet days in central and eastern Croatia may increase (up to 5% in the far east) and decrease over the rest of Croatia area (from 1 to 5 %). In all other seasons over the entire the Republic of Croatia area, number of moderately wet days decreases in the P1 period. A possible decrease is from 1 to 5 % for eastern Croatia, part of central Croatia and the coastal area of central Dalmatia in spring. A decrease of 5 to 10 % is expected for most of coastal and mountainous areas in spring, also over the entire Croatia area in autumn. A decrease of more than 10 % is projected only for the summer season, between 10 and 15 % for coastal area, central and eastern Croatia, and between 15 and 20 % for mountainous area and the inland of Istria and Dalmatia.

The change in the annual number of very wet days (R95) is spatially similarly distributed as the change in number of moderately wet days (R75). The largest difference is that the change in very wet days in the east of Croatia changes the sign from negative to positive and amounts to 2 %. The largest change (a decrease from 6 to 8 %) is expected in Primorje and Dalmatia inland. A smaller decrease (4 to 6 %) is expected in mountainous Croatia. For the central Croatia, decrease is from 1 to 4 %. In the entire of the Republic of Croatia area, a decrease in number of very wet days in summer (Figure 6-16) is expected, least in the far east and north (10 to 15 %), and most in mountainous Croatia and the Dalmatia inland, mostly between 20 and 25 %. Spring predictions give the same spatial distribution of change as annual change. A positive change (up to 10%) in spring is predicted for eastern Croatia and the western part of Istria. In the rest of Croatia the change is negative, whereas it is greatest in the mountainous areas and in Dalmatia inland (up to 10 %). Autumn changes also indicate both possible decrease and possible increase, and changes range from -5 to 5 %. In winter an increase in number of very wet days is expected, and it is the largest for the area of western Slavonia, from 15 to 20%.

Unlike change in number of moderately (R75) and very wet (R95), days which mainly indicate a decrease in the period P1 compared to the P0, projections of precipitation due to very wet days (R95T) over the entire the Republic of Croatia area indicate annual increase in the precipitation amount due to very wet days i.e. more intense extremes in the precipitation regime (Figure 6-16). The largest increase (from 6 to 8 %) is expected in Slavonia and parts of coastal area. An increase of 4 to 6 % in precipitation due to very wet days covers wider area of eastern and parts of central Croatia and the rest of the coast. Changes of less than 2 % are expected for the rest of Croatia (mountainous Croatia, Dalmatian hinterland). The winter and autumn seasons also indicate an increase in precipitation due to very wet days throughout the Croatia (highest during winter in Slavonia, between 10 and 15 %). Even though the projections indicate an increase in the precipitation due to very wet days in largest part of Croatia during spring (up to 10% in the eastern areas, Istria and in several places along the coast), for the part of the mountainous area, central Croatia, and Dalmatia hinterland a possible decrease, up to 5% is expected. The summer mainly shows a decrease in precipitation due to very wet days, at most between 5 and 10 %, while for the narrower area of Slavonia an increase of 1 to 5 % is expected.



Number of moderately wet days (R75) is number of days with precipitation greater than the 75th percentile of the distribution of daily precipitation determined from all days in the reference period 1981-2010. (R75, first column)

Number of very wet days (R95) is number of days with an amount of precipitation greater than the 95th percentile of the distribution of daily precipitation amounts determined from all days in the reference period 1981-2010. (R95, second column)

Share of precipitation on very wet days (R95T) is share of annual / seasonal precipitation (SRd / Rt). SRd is the sum of daily precipitation greater than the 95th percentile of precipitation on very wet days in the reference period 1981-2010. Rt is the total annual amount of precipitation. (R95T, third column)

Annual (ANN) change - first row. Change in season winter (DJF) - second row, summer (JJA) - third row.

Figure 6-16: Change in moderately wet days, very wet days and precipitation due to very wet days of the ensemble mean of used models for the period 2041-2070 compared to the reference period 1981-2010 (RCP4.5)

6.2. VULNERABILITY ASSESSMENT

On April 7, 2020, the Croatian Parliament adopted the Climate Change Adaptation Strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 (Official Gazette 46/20) (hereinafter: Climate Change Adaptation Strategy). It is the first strategic document providing an assessment of climate change for Croatia by the end of 2040 and 2070, possible impacts and assessments of vulnerability and, accordingly, necessary adaptation measures. The goal of the Climate Change Adaptation Strategy is to raise awareness of importance and threats of climate change for society and necessity of integrating the concept of climate change adaptation into existing and new policies, to reduce the vulnerability of environment, economy and society caused by climate change. In addition, desire is to encourage and direct scientific research in order to better understand complexity of climate change impact and to reduce the degree of uncertainty related to climate change effects. Although climate change adaptation is basically a horizontal issue, the Climate Change Adaptation Strategy focuses on eight key sectors (water resources, forestry, agriculture, fishery, biodiversity, health, energy, tourism) and two cross-sectoral areas (spatial planning and development and risk management).

The Climate Change Adaptation Strategy was developed in collaboration with sectoral and cross-sectoral experts and scientists and with contribution of interested stakeholders (representatives of public

authorities, representatives of scientific, educational, and professional institutions, non-governmental organizations, professional chambers, and other interested public).

For needs of the Climate Change Adaptation Strategy, a scientific basis was prepared. All previous research by selected sectors were analysed and a review was made of professional and scientific publications relevant to individual sectors in relation on impact, vulnerability and adaptation to climate change. Topics and findings considered important for developing the Climate Change Adaptation Strategy were selected. Comparisons were made of climate change projections for the periods 2011-2040 and 2041-2070 with the reference climate period 1971-2000. The results of climate projections for the periods 2011-2040 and 2041-2070 were obtained based on numerical integrations with regional climate model (RegCM) at two spatial resolutions of 50 km and 12.5 km, and a total of 20 climate variables were analysed. The results of the model served as basis for making sectoral scenarios in process of determining impact and vulnerability to climate change.

Below is a presentation of vulnerability assessment of eight key sectors and two cross-sectoral areas from the Climate Change Adaptation Strategy in the Republic of Croatia for the period up to 2040 with a view to 2070. Vulnerability assessment from the Climate Change Adaptation Strategy is amended for sectors of agriculture (growing season length, growing degree days, soil temperature, water in soil and viticulture), forestry (forest fire) and tourism with additional considerations compared to the assessment from the Climate Change Adaptation Strategy.

6.2.1. Water resources

The main expected impacts, which can lead to high vulnerability of water resources sector are: reduction of water quantity in watercourses and in springs; reduction of underground water reserves and lowering of groundwater levels; reduction of water levels in lakes and other lake type natural or built-up systems; rising sea levels, salinisation of coastal aquifers and aquatic systems; increase in water temperature followed by reduction in reception capability of aquatic receivers; increased frequency and intensity of flooding in vulnerable areas; increased frequency and intensity of torrents; increased frequency and intensity of rainwater floods in urban areas; rising sea levels, and thus the risk of flooding at mouths of watercourses; reduced efficiency of coastal infrastructure and intensified salinisation of river estuaries and coastal aquifers.

The Republic of Croatia is relatively rich in water, but not in water supply because of its geological structure with a large share of surface with karst structures and large spatial-temporal heterogeneity of runoffs. Namely, karst areas that occupy about half of the Republic of Croatia area generally have a small possibility of accumulating water reserves over a long period during critical dry periods. The state of water and marine resources in the Republic of Croatia area is largely dependent on transboundary impacts due to global impact of climate change on dynamics of ocean and sea level change as well as high share of cross-border and transboundary watercourses in relation to Croatia total water resources. It is expected that deterioration of hydrological conditions due to climate change will increase the frequency and duration of dry periods on the one hand, and the frequency and intensity of flood situations on the other hand.

The forecast increase in air temperature for the period up to 2070, as well as stagnation or minor reported trends of minimal change in total precipitation rates, will result in increased evapotranspiration, reduction of surface and underground runoff and, consequently, even more pronounced reduction in water resources. In such conditions, synergistic effects of negative impacts are expected due to an

increase in anthropogenic pressures, above all expressed in an increased water demand. Adverse climate change will particularly jeopardise vulnerable coastal karst aquifers and other aquatic phenomena in the coastal area (lakes, watercourses, springs) due to cumulative effect of possible changes with reduced flows and groundwater levels and more intensive sea penetration into karst coastal aquifers and lakes, as well as spreading of salinised seawater along the watercourse basins deeper into the hinterland. The results of the performed modelling show that intensity of short-term severe precipitation will increase in the future, of both rare and frequent possibilities of the phenomenon, creating preconditions for frequent occurrences of floods in flood watercourses, urban areas, and river basins.

Negative impacts of climate change are particularly expected in watercourses of coastal area due to coinciding and cumulative effect of rising sea levels and occurrence of extreme flows. With reduction of the mean annual and minimum annual flows and increase in maximum annual flows, rather pronounced changes in water temperatures are expected, which will have a negative impact on aquatic ecosystems, their diversity and reception capacity, as well as possibility of their use for other purposes. In such circumstances it is necessary to achieve the goal of preserving a good status of water in such changed climate conditions as a result of climate change and to ensure a reduction of flood and drought risks. When doing so, it is necessary to use nature-based solutions (NbS) as much as possible because, for example, natural or less modified river systems are generally more resistant to extreme climate events and return easier to their initial state than those modified by various water-technical interventions.

The expected rise of sea levels but also impact of future tides, waves and storms will also have an impact on coastal infrastructure. Most vulnerable places will be urban areas with a low coastline (e.g. settlements on the islands such as Cres, Mali and Veli Lošinj, Krk, Rab, Krpanj, Vela Luka and others, but also in coastal Croatia such as Nin, Trogir, Ston and others). A particularly negative impact of sea level rise is expected to occur at sandy shores, which will be exposed to increased erosion and other morphological changes in terms of altering their geometries, which can even lead to their complete disappearance. However, in areas where this is possible, depending on geomorphological features of the coast, urbanisation of the area and so forth, the emergence of new sandy shores is expected. Negative changes are expected for artificial parts of the coast, where built beaches will lose their functional optimums, and where structural damage can also occur.

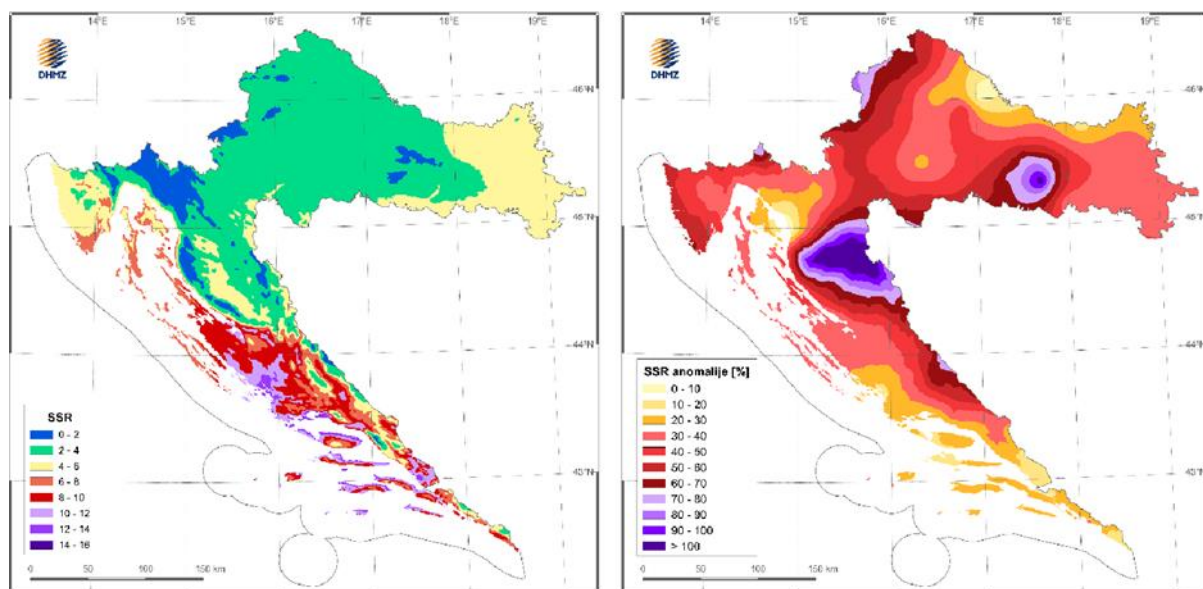
Increased vulnerability of marine environment caused by climate change will also result in risks related to weakening of thermohaline circulation of the Adriatic Sea, which can significantly affect a variety of abiotic and biotic processes and changes, especially related to ocean ventilation and changes in oxygen concentration in deeper layers, increasing the sea acidity, as well as a series of related biological processes and impacts on marine biodiversity and fishery. Changes in ocean and sea circulation are a direct result of climate change and cause drastic changes, not only in the marine environment or marine biodiversity, but also in climate of surrounding areas, which in turn affects all sectors.

6.2.2. Forestry

In forestry sector, there are several major expected impacts that cause high vulnerability. This is primarily related to higher frequency and length of forest fire season, including fires on the continent. The current trend in the number of forest fires shows that there were significantly more fires in dry years in the Mediterranean area, while forecasts show that risk of forest fires in the future will be higher for the whole of the Republic of Croatia. Furthermore, it is expected that phenological phases will shift toward an earlier start of vegetation and extended vegetation season depending on tree species and habitats. Due to change in habitat conditions, a migration of species and pests, including invasive

species, could occur. Productivity of certain forest ecosystems, such as Pedunculate oak forests, could be reduced, although it should be emphasised that it depends not only on atmospheric changes but also on forest management practices and other impacts. Due to increased frequency of forest fires and occurrence of strong winds, icing events that cause damage, floods, pest attacks and similar, higher damage to forest ecosystems are expected, such as reduction in value of wood varieties and loss of forest functions of general benefit.

During summer months, forest fires in the coastal part of Croatia frequently reach catastrophic proportions and destroy forests and agricultural lands and often pose a threat to populated areas and human lives. The Canadian Forest Fire Weather Index (FWI) [6-12], [6-13] is used globally to assess meteorological risk of forest fires. Seasonal severity rating (SSR) is an indicator of a potential seasonal meteorological risk of forest fires. Spatial distribution of average SSR during fire season (June 1 – September 30) in the period 1991-2020 indicates that Dalmatia is the most fire-prone region in the Republic of Croatia (Figure 6-17). The reasons for this are prolonged dry spells during summer months accompanied by high air temperatures and easily flammable Mediterranean vegetation cover. Conditions for occurrence and spread of forest fires are becoming more favourable due to climate change. The SSR anomaly map (Figure 6-17) indicates a significant increase in SSR in the period 1991–2020 in relation to the 1961-1990 period. The increase of SSR is more intense in the northern part of the Adriatic and in the continental part of the Republic of Croatia area, where in some places SSR has doubled during 1991-2020 period compared to the 1961-1990 period. This means that conditions for occurrence and spread of forest fires are becoming more and more favourable in areas that were not so threatened in the past, and this trend of increasing average seasonal intensity of fires is a consequence of increase in air temperature and prolongation of dry periods during summer months (refer to chapter 6.1.2. Observed climate change in Croatia).



Spatial distribution of average seasonal severity rating (SSR) during fire season (June 1 - September 30) in the period 1991-2020 - left. An anomaly of average seasonal severity rating is ratio of average SSR in the period 1991-2020 and average SSR in the period 1961-1990 - right.

Figure 6-17: Spatial distribution of average seasonal severity rating during fire season in the period 1991-2020 and anomalies of average seasonal severity rating during fire season in the period 1991–2020 compared to the 1961-1991 period

6.2.3. Agriculture

The main expected impacts of climate change that cause high vulnerability in the sector of agriculture are changes in vegetative period of arable crops with emphasis on grains and oilseeds; lower yields of all crops and higher water demand; longer vegetative period will enable cultivation of new varieties and hybrids; while more frequent flooding and stagnation of surface water will reduce or completely destroy yields. According to some predictions, agriculture is a sector that will suffer the highest damage from climate change. It is expected that due to climate change the yield of current agricultural crops in the Republic of Croatia will be reduced by 3–8 % by 2050.

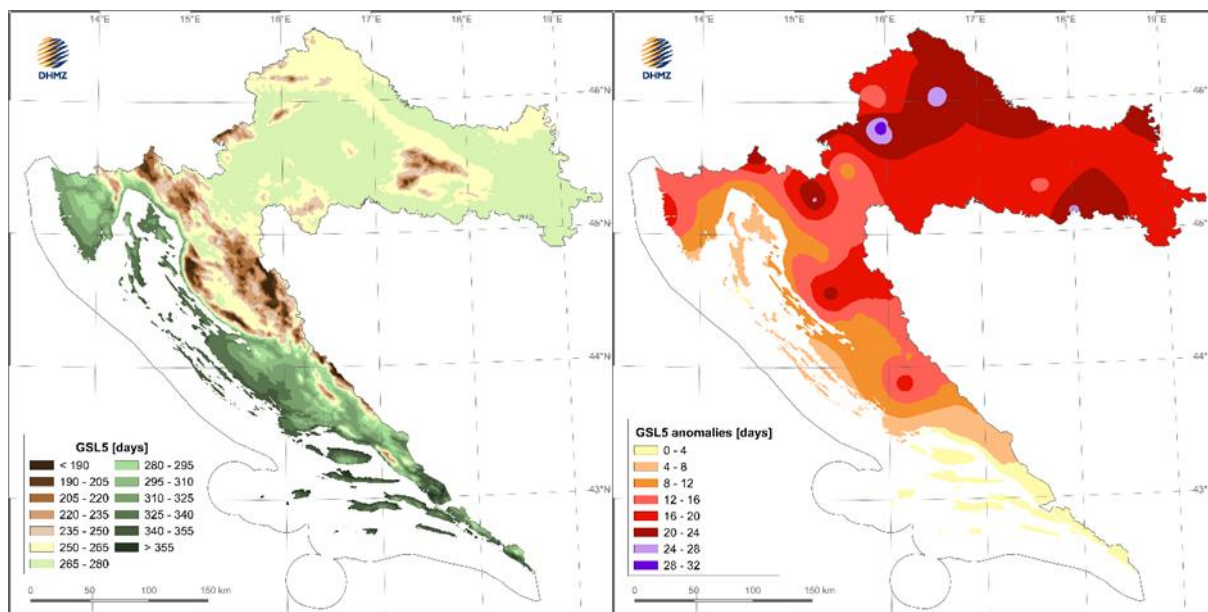
Increasingly longer and more frequent dry periods, as well as increasing threat of agricultural crops from heat stress during last decades, especially in Dalmatia, are a clear signal, above all to fruit growers, olive growers and winegrowers, to start implementing climate change adaptation measures. In the period 1980-2014, the drought in the summer months was the single largest cause of damage caused to Croatian agriculture by climate variability, while in the period from 2013-2016 it caused damage of a total of around EUR 398 million, which was equal to 43% of direct subsidies paid for agriculture in the same period.

Without increased investments, a satisfactory percentage of areas under irrigation and indoor production cannot be achieved, nor can the level of organic matter in the soil be significantly increased, which will result in reduction of agricultural production compared to current situation.

It has been observed that climate change already affects phenological phases of apple, grape, olive and corn as vegetative period begins earlier, lasts less time, and ultimately results in lower yields. The lack of water in soil (drought) and higher air temperatures in the upcoming period will be two key issues in agricultural efforts to cope with climate change. However, climate change will also have certain positive effects on agricultural sector, such as enabling cultivation of new crops and varieties in areas where that has not been possible before.

Food production is a complex process that depends on numerous factors and represents a great challenge. Numerous research carried out worldwide [6-14], [6-15] indicate reduction in the yield of wheat, corn, and other crops due to extreme heat and drought events.

Duration of growing season is a limiting factor that regulates the success of growing certain plant species in a certain area. If the vegetation period is too short certain plant species cannot complete the vegetation cycle. Criteria for estimating growing season length (GSL) is based on air temperature. The daily air temperature value of 5 °C was chosen as temperature threshold. According to the criteria, the beginning of growing season is the first day after 6 consecutive days with an average daily air temperature above 5 °C, and the last day followed by a period of 6 consecutive days with an average daily air temperature below 5 °C taken as the end [6-16]. Spatial distribution of average GSL5 in the period 1991–2020 (Figure 6-18) shows that GSL5 is shortest in mountainous areas and longest in coastal part of Dalmatia. In the lowland part of the Republic of Croatia continental area, GSL5 lasts on average from 265 to 280 days (Figure 6-18).



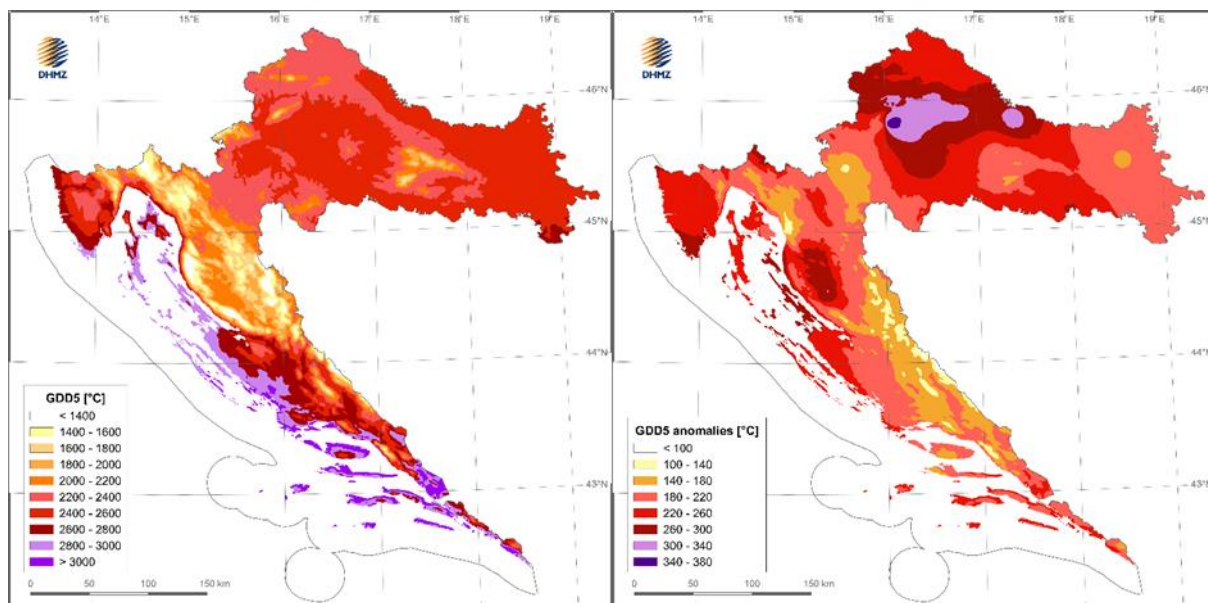
Average growing season length (GSL5) in the period 1991-2020 - left. Anomaly of average growing season length is difference between GSL5 in the period 1991-2020 and GSL5 in the period 1961-1990 - right.

Figure 6-18: Spatial distribution of average growing season length in the period 1991-2020 and anomalies of average growing season length in the period 1991-2020 compared to the period 1961-1990

GSL5 anomaly, i.e. the difference in the average of GSL5 in the period 1991-2020 and in the period 1961-1990 indicates a significant increase in GSL5 in continental part of the Republic of Croatia (Figure 6-19). The increase of GSL5 is a direct consequence of increase in air temperature months (refer to chapter 6.1.2. Observed climate change in Croatia) and can potentially lead to larger yields. However, this potential is limited by the amount of available water.

Growing degree days (GDD) are another limiting factor that regulates success of growing certain plant species in certain area. For transition from one phenological phase to another, as well as for completion of vegetation cycle, plants need a certain amount of accumulated heat which is manifested through GDD. GDD is calculated by subtracting air temperature threshold from the mean daily air temperature, and positive daily values are then summed over desired period [6-17]. Temperature threshold of 5 °C was used, while summation was performed in the warm part of the year (April 1 – September 30). The highest GDD5 are in coastal Dalmatia, and the lowest in the highlands (Figure 6-19).

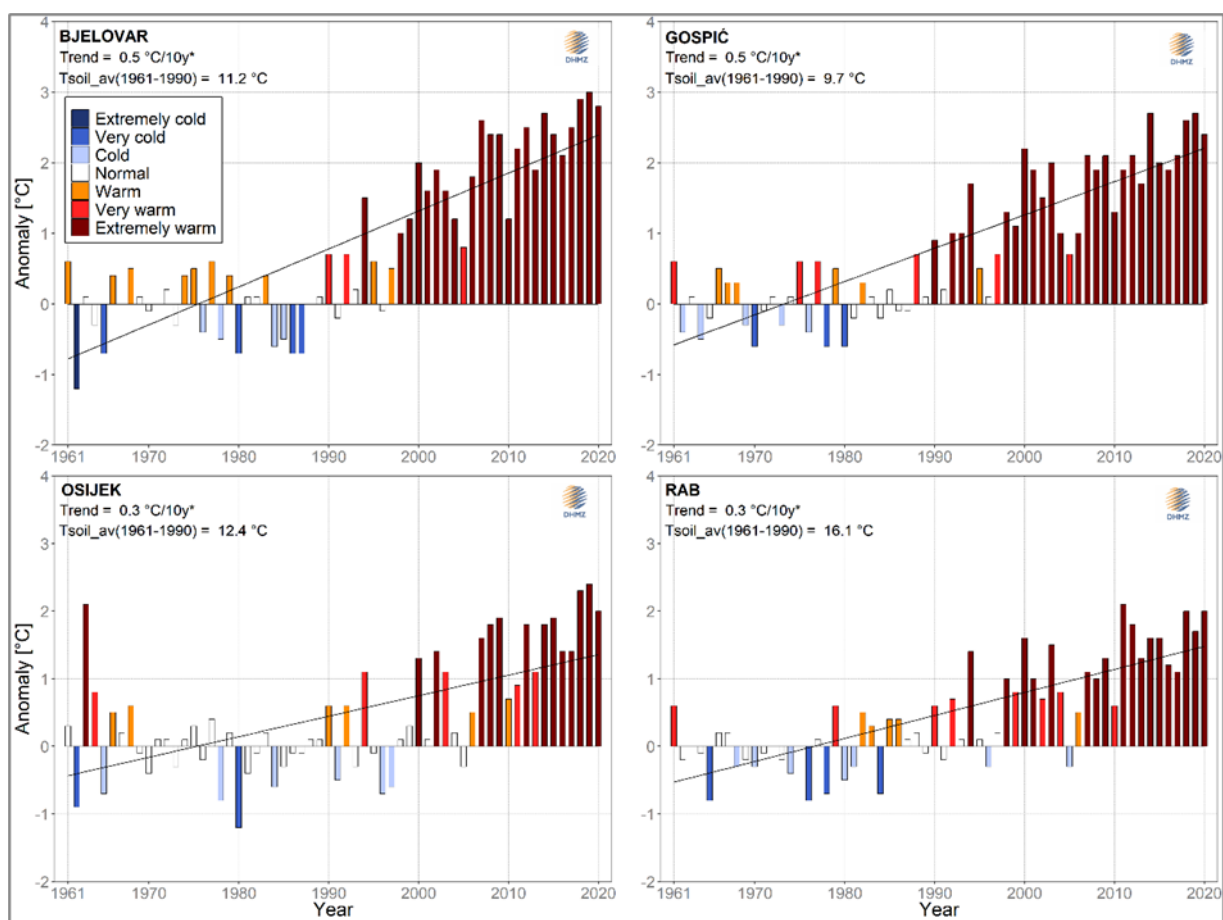
The GDD5 anomaly, i.e. difference between the average GDD5 in the period 1991-2020 and in the period 1961-1990, indicates a significant increase in GDD5 in the period 1991-2020 (Figure 6-19). This increase represents a significantly larger amount of accumulated heat during the period 1991-2020 and is a consequence of increase in air temperature. It is most pronounced in the central part of continental part of the Republic of Croatia. This means that the climate in the Republic of Croatia is getting warmer and if such trends continue in the future, it may become unsuitable for growing some plant species that are traditionally cultivated in Croatia. On the other hand, potential for growing plant species that are traditionally cultivated in more southern regions is emerging.



Average growing degree days (GDD5) in the period 1991-2020 - left. Anomaly of average growing degree days is difference between GDD5 in the period 1991-2020 and GDD5 in the period 1961-1990 - right.

Figure 6-19: Spatial distribution of average growing degree days in the period 1991-2020 and anomalies of average growing degree days in the period 1991-2020 compared to the period 1961-1990

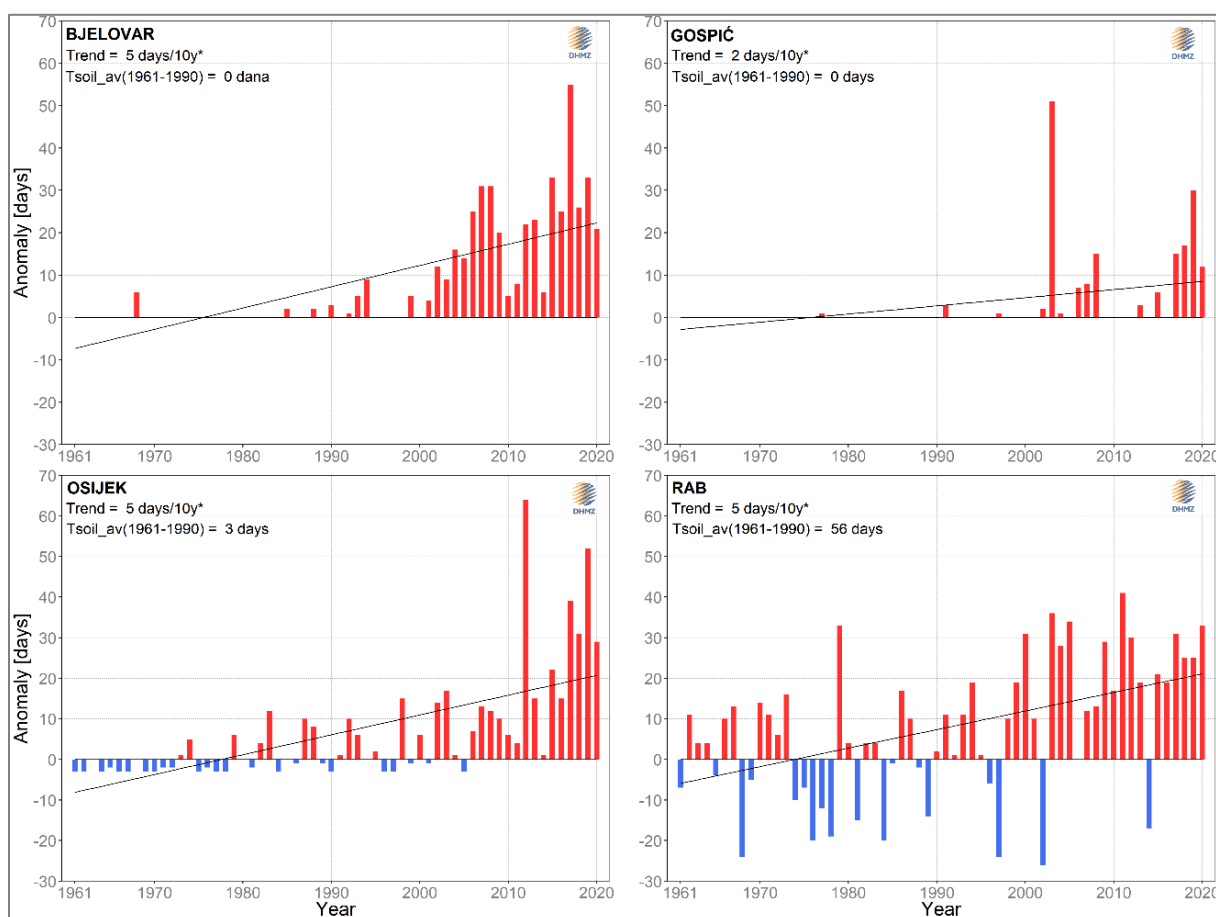
Soil temperature affects crop germination and emergence, root growth, and water and nutrients uptake from soil. Combined with humidity, it initiates and determines budding of trees as well as leaves formation [6-18]. Trend analysis of mean daily soil temperature at a depth of 10 cm at four stations in different regions of Croatia: Bjelovar, Osijek, Gospić and Rab indicates significant increase in the mean daily soil temperature at 10 cm after year 1991 at all stations (Figure 6-20). In central Croatia (station Bjelovar) and the highlands (station Gospić), this increase amounts to $0.5\text{ }^{\circ}\text{C} / 10\text{ years}$, while in eastern Croatia (station Osijek) and in the northern part of the Adriatic (station Rab) it is slightly lower and amounts to $0.3\text{ }^{\circ}\text{C} / 10\text{ year}$.



Statistically significant trends are marked with an asterisk.

Figure 6-20: Anomalies of the average annual soil temperature at a depth of 10 cm from long-term average of the period 1961–1990 and linear regression lines during the period 1961–2020 at meteorological stations Bjelovar, Gospić, Osijek and Rab

Trend analysis of annual number of days with maximum soil temperature above 30 °C at the soil depth of 10 cm shows a significant increase in the number of such days in the last two decades (Figure 6-21). In the central and eastern part of Croatia (stations Bjelovar and Osijek) and in the northern part of the Adriatic (station Rab) this increase amounts to 5 days / 10 years, while in the highlands (station Gospić) it is slightly lower and amounts to 2 days / 10 years. This means that soil in the Republic of Croatia area is becoming warmer, and a longer duration of high soil heating could threaten agricultural production. Also, due to high soil temperatures, evaporation, which loses water from the soil, is also increased.

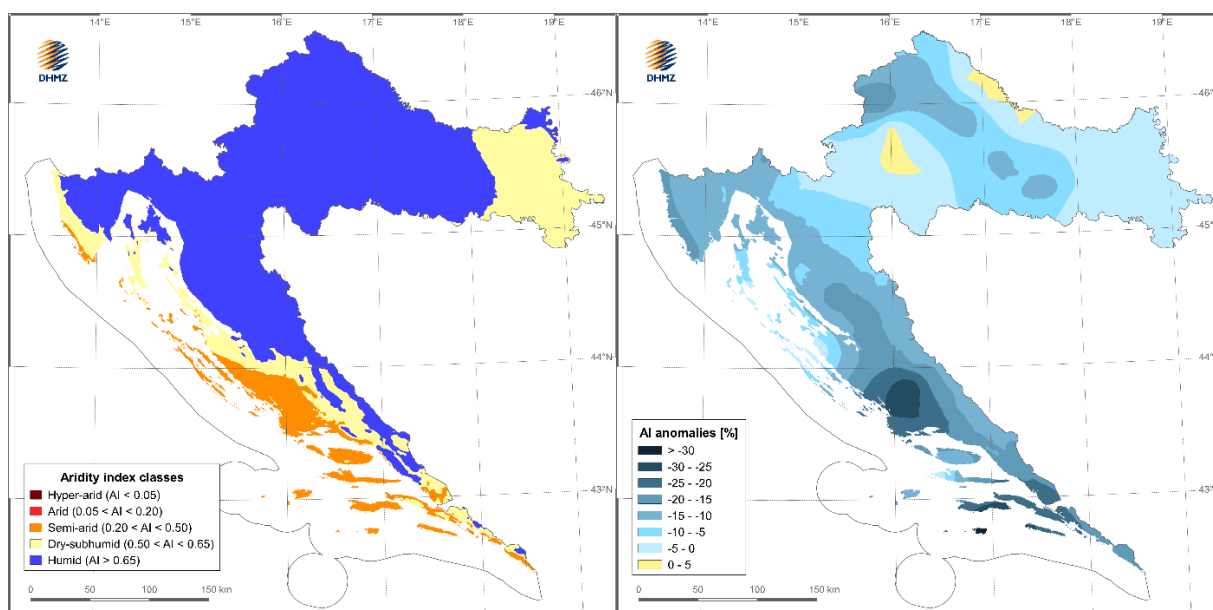


Statistically significant trends are marked with an asterisk.

Figure 6-21: Anomalies of annual number of days with maximum daily soil temperature at depth of 10 cm ≥ 30 °C from long-term average of the period 1961-1990 and linear regression lines during the period 1961-2020 at meteorological stations Bjeļovar, Gospić, Osijek and Rab

Water in soil is the most limiting abiotic factor to plant growth and productivity [6-19]. The aridity index (AI) is used as one of dryness indicators of climate [6-20] and which is calculated as ratio between precipitation and potential evapotranspiration (PET, the maximum possible evaporation that would occur if there is no shortage of water), where precipitation represents the amount of available water, while PET indicates how much water is needed. According to average AI during warm part of the year (April 1 – September 30) in the period 1991-2020, largest part of the Republic of Croatia belongs to humid zone (Figure 6-22). Part of Slavonia, the northern part of Adriatic and the continental hinterland of Dalmatia belong to the dry-subhumid zone, while coastal part of Dalmatia mainly belongs to the semi-arid zone (Figure 6-22).

AI anomalies, i.e. the ratio of the average AI during the warm part of the year in the period 1991-2020 and the period 1961-1990 indicate a decrease in aridity index during warm part of the year in the period 1991-2020 (Figure 6-22). This means that climate in the Republic of Croatia area is becoming more arid during warm part of the year when vegetation develops.



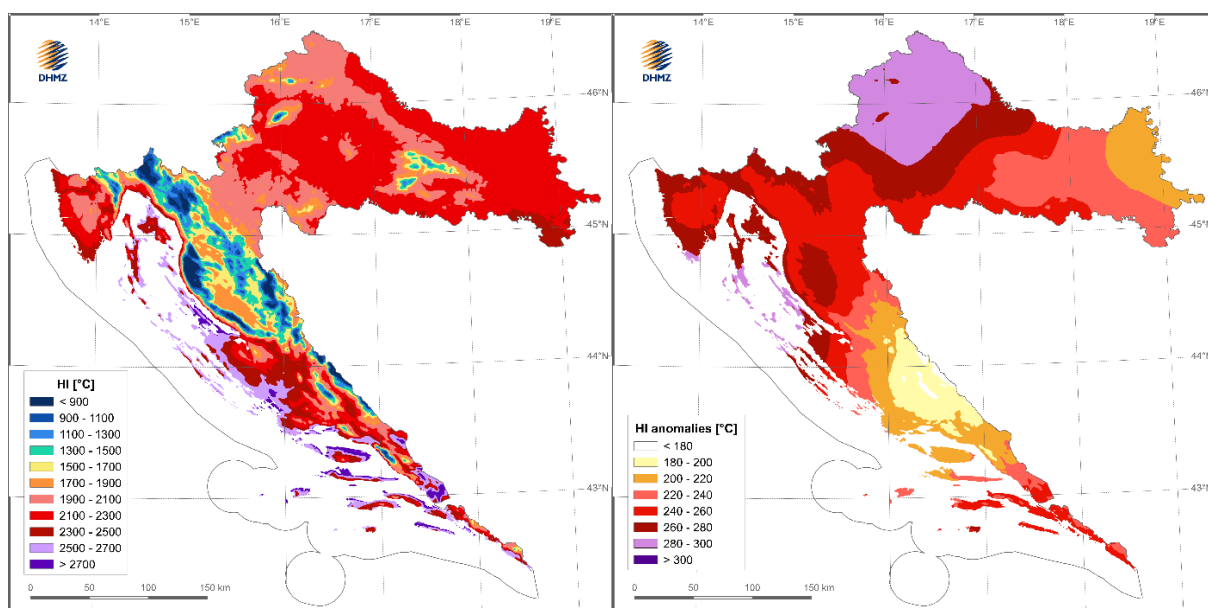
Average aridity index (AI) during warm part of the year in the period 1991-2020 - left. An anomaly of average aridity is ratio of average AI in the period 1991-2020 and in the period 1961-1990 - right.

Figure 6-22: Spatial distribution of average aridity index during warm part of the year in the period 1991-2020 and anomalies of average aridity index in the period 1991-2020 compared to the period 1961-1990

Viticulture has a rich and long tradition in the Republic of Croatia, and grapevine represents important culture for agriculture and economy. Since climatic conditions largely determine success of growing a certain grapevine variety, climate change could have a significant impact on the yield and quality of grapes [6-21]. Research have shown that increase in air temperature has a great influence on phenological stages of the grapevine as well as grapevine yield and quality [6-22], [6-23], [6-24].

Huglin heliothermal index (HI) is one of the indices used for zoning of wine-growing regions. Grapevine cultivation is not possible in regions where HI does not exceed 1,500 °C, while in regions where HI exceeds 2,400 °C heliothermal conditions are favourable for the cultivation of almost all grape varieties [6-25]. Spatial distribution of HI in the period 1991-2020 shows that the heliothermal conditions are favourable for growing grapevines in larger part of the Republic of Croatia area (Figure 6-23).

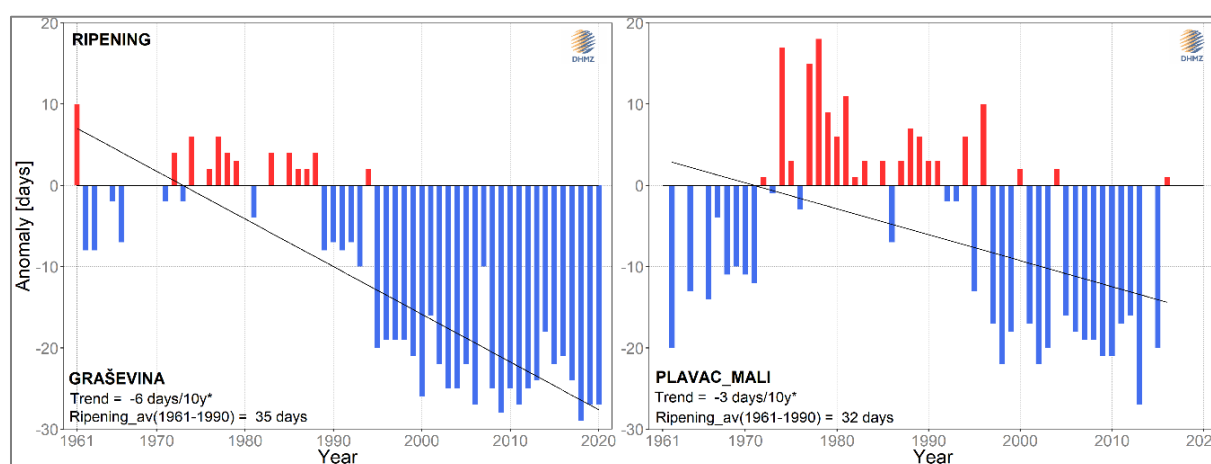
The HI anomaly, i.e. difference between the average HI in the period 1991-2020 and in the period 1961-1990, indicates a significant increase in the Huglin heliothermal index in the period 1991-2020 (Figure 6-23). This means that heliothermal conditions in some areas become favorable for cultivating vines, and in some areas where vines are already traditionally grown there is a potential for cultivating vine varieties that previously did not succeed because there was not enough heat. It is expected that climate change will introduce new challenges in viticulture, and to ensure successful grapevine cultivation in regions where the suitability for grapevine cultivation is slightly declining due to climate change [6-26], grapevine cultivation will have to be adapted to climate change [6-27].



Huglin heliothermal index (HI) in the period 1991-2020 - left. An anomaly of Huglin heliothermal index is difference between average HI in the period 1991-2020 and in period 1961-1990 - right.

Figure 6-23: Spatial distribution of average Huglin heliothermal index in the period 1991-2020 and anomalies of average Huglin heliothermal index in the period 1991-2020 compared to the period 1961-1990

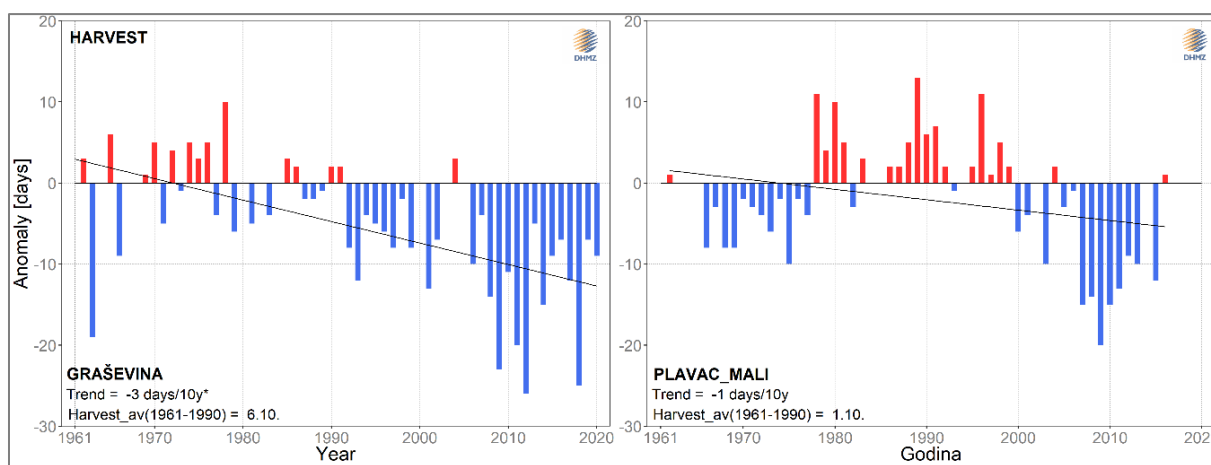
To monitor changes in the onset of certain development phases, phenological data of known grape varieties were used: Graševina (Daruvar) and Plavac mali (Hvar) in the period 1961-2020 (Graševina) and in the period 1962-2016 (Plavac mali). Duration of grape ripening was analyzed, and calculated as difference between two phenological stages - full ripening and the beginning of ripening, and the date of harvest. The analysis showed that duration of ripening of both observed varieties decreased significantly in the period 1991-2020 (Figure 6-24). The trend for Graševina is -6 days / 10 years, while trend for ripening period reduction of Plavac mali is slightly shorter and amounts to - 3 days / 10 years.



Graševina - left. Plavac mali - right

Figure 6-24: Anomalies of the duration of ripening from long-term average of the period 1961-1990 and linear regression lines for two grapevine varieties Graševina and Plavac mali

Harvesting of Graševina and Plavac mali occurs earlier (Figure 6-25). There is a significant shifting trend in the date of harvest of Graševina in the amount of -3 days / 10 years, while shifting trend of Plavac mali of -1 day / 10 years is not significant.



Graševina - left. Plavac mali - right

Figure 6-25: Anomalies of harvest date from long-term average of the period 1961-1990 and linear regression lines for two grapevine varieties Graševina and Plavac mali

The earlier onset of grapevine development stages is a direct consequence of increase in air temperature and more pronounced changes in the earlier onset of grapevine development stages of occur in continental part of the Republic of Croatia.

6.2.4. Fishery

The main expected impacts of climate change in fishery sector will be additional pressure on marine ecosystem that is already under the influence of numerous anthropogenic factors, in particular overfishing, habitat destruction and pollution. The estimated increase in temperature of the Adriatic Sea of 1.6 - 2.4 °C by 2070 could result in migration of marine organisms (especially shrimp and hake) to deeper waters and towards the north, a higher number of invasive alien species and reduction or disappearance of native fish species and change in selecting the breeding species. As one of the consequences, it is possible to expect a decrease in primary production, resulting in lower abundance of pelagic fish due to changes in water circulation caused by changes of thermohaline properties. Future climate change will affect economic viability of fishing, especially coastal and demersal fishing. In production of marine organisms, the impact will be twofold: positive for breeding of tuna and sea bream, and negative for breeding of sea bass and oysters. Acidification of seas and oceans will have major consequences for marine ecosystems based on habitat-forming species, and related ecosystem services, with potentially significant impacts on the society well-being. The acidity of Adriatic Sea is estimated to increase by 0.1 to 0.2 degree of pH, which will disrupt shellfish production in certain areas. Increased acidity could result in degradation of biogenic habitats providing a large number of services (e.g. Posidonia beds are crucial for maintaining populations of more than 400 species, among which those of economic importance; coralligenous habitats serve as shelters, feeding grounds and places for the settlement and development of numerous species, including those of economic importance, etc.). Acidification stimulates homogenisation of communities and reduction in functional diversity. The fishery sector will be particularly vulnerable to global trends in supply and price of fish flour and fish oil as a result of climate change.

A predicted increase in temperature and reduced fresh water quantities will most likely limit the availability of water for freshwater aquaculture. Positive effects of rising water temperatures will be accelerated growth and shorter breeding cycle of fish.

6.2.5. Biodiversity

Biodiversity is currently most threatened by degradation and loss of habitats, unsustainable exploitation of natural resources and pollution. The most important climate impacts in this sector are: change in average air temperatures; reduced precipitation amount and changes in spatial distribution of precipitation; occurrence of climate extremes, as well as warming, acidification and rising sea levels. The most vulnerable ecosystems are freshwater, underground, high-mountain and semi-natural grassland. As a consequence, the following is expected at habitat level: reduction in habitat size, changes in share and disappearance of certain habitats; increase of arid areas; drying out of wetland habitats; submersion of coastal habitats, salinisation of land and freshwater habitats by the sea; fragmentation; changes in structure, processes, functions and services, changes in composition of species communities.

The main expected climate impacts that cause high vulnerability of species have the following consequences: changes in phenology; termination of flowering of cryophilic and stenothermal plant species with shortening of vegetation and reduction of vigour; changes in abundance and distribution of species; spreading of ranges of thermophilic species (both positive and negative) due to increased average air temperature; drying and extinction of hygrophilic species due to reduced quantity of precipitation and changes in course of precipitation; increase areal of xerophilic species (both positive and negative) due to lower quantities of precipitation and changes in precipitation patterns; reduction in populations of forest species due to frequent fires caused by increased average air temperature and reduced quantities of precipitation; loss of species adapted to life in a narrow range of environmental conditions (particularly endemic species with limited distribution); appearance and spreading of invasive alien species and species adapted to life in a wide range of environmental conditions and suppression of native species, thus also altering the structure and function of habitats; changes in inter-species interactions (positive and negative); changes in life cycles, changes in migration periods; decrease in reproduction performance; reduced resistance to disease or predation; reduction and disappearance of freshwater species in the Adriatic basin due to salinisation of coastal habitats caused by rising sea levels; spreading of marine species to the north and appearance of thermophilic (tropical) invasive alien marine species due to sea temperature rise; potential uncontrolled growth in populations of organisms that cause disease in shellfish, fish, etc. The most vulnerable groups of species include already endangered group of pollinators, which have a significant role in ecosystem, as well as all species adapted to life in a narrow range of environmental conditions (particularly endemic species with limited distribution). Soil is exceptionally important for climate change adaptation, with particular emphasis on importance of preserving soil biodiversity.

The level of research on ecosystems, habitats and wild species at national level is still not sufficient to valorise their vulnerability to climate change and to develop predictive models, so that efficient adaptation measures could be defined.

Sectors of special importance for adapting biodiversity to climate change are water management, agriculture, forestry and spatial planning. This highlights the importance of cross-sectoral measures to strengthen the resilience of biodiversity on the basis of nature-based solutions (NbS) such as careful use of space, restoration, revitalisation, traditional knowledge and agricultural practices, etc.

6.2.6. Health

The main expected impacts that cause high vulnerability in health sector due to increased frequency and duration of extreme weather conditions as well as the impacts of other important climate parameters are: increased mortality; changes in epidemiology of chronic non-infectious diseases; changes in epidemiology of acute infectious diseases; reduction of air quality, water security and food health safety and level of possibly damaging factors in the environment.

Vulnerability in health sector will be most likely manifested by an increase in the number of people with acute and chronic illnesses, i.e. increased mortality due to extended periods with high air temperatures; increased incidence of vector diseases; increase in respiratory diseases due to increased allergenic pollen in the air, etc.

Lower health safety of water for human consumption could be expected due to lower availability and increased utilisation of resources. The impact of climate conditions is important due to indirect impacts on surface waters and waters for recreation, particularly in case of improperly designed supply or drainage systems (wastewater and drainage water). The impact of seawater on health is significant not only due to the sea temperature rise and, for example, growth of toxic algal blooms, but also because of eutrophication due to the large amount of organic matter that comes into the marine ecosystem with anthropogenic activity.

Climate change will have a significant impact on food safety, i.e. availability, distribution and consumption of food. The incidence of acute intestinal infections is expected to increase. A higher share of chronic disorders such as endocrine diseases, digestive diseases such as cancer and chronic diseases such as Crohn's disease, ulcerative colitis, etc. is also expected. A reduced level of food safety due to microbiological or chemical contamination as a result of changed macro- and microclimate conditions presents a significant vulnerability and future burden on health system.

Contrary to the negative consequences, and due to expected reduction in the period of low air temperature and snow cover, lower mortality is expected, i.e. a lower number of sudden deaths due to the impact of low temperature on health. As a reduction in the amount of snow water equivalent is predicted i.e. the amount of water that would occur in the event of instant snow melting, an impact on reducing the number of injuries and more efficient diagnosis and injury therapy due to reduction of occurrence and duration of extreme snow precipitation is possible.

6.2.7. Energy

The main expected impacts that cause vulnerability in energy sector are: reduction of electricity production in hydropower plants due to the change in temporal distribution of annual precipitation (no significant change in mean annual level was projected – with a possible smaller reduction, but there are changes in rain and dry periods, while dry seasons trends are increasing); increase in electricity consumption for cooling purposes (cooling degree days increase) due to increased average air temperature; reduction of energy production in thermal power plants due to inadequate plants cooling because of reduction in average annual precipitation; damage to power plants and infrastructure due to extreme weather events such as ice breaks and floods, and reduction of electricity production in hydropower plants due to droughts.

Climate parameters directly affect energy sector in a form of increased or reduced energy resource needs at certain time periods. Climate extremes and natural disasters will significantly disrupt safe energy supply. Global temperature rise in all seasons will increase the cooling energy consumption in summer and reduce the energy needed for heating in winter. Extreme climate events will negatively affect the production, transmission and distribution of energy. Decreasing precipitation levels in summer period will lead to a reduction in hydro power plant contribution, while increasing the need for electricity in summer months. Lower precipitation levels will lead to an issue with thermal power plant cooling flow system, which will also negatively affect the production.

6.2.8. Tourism

In tourism sector, the main expected impacts of climate change are: reduction of tourism demand in summer months due to high temperatures, increased UV radiation, higher frequency and severity of extreme weather events; reduction or loss of attractiveness of ecosystems and biodiversity as elements of attraction in tourism; reduction of water availability and damage to different infrastructure systems (wastewater drainage, solid waste disposal, beach infrastructure, accommodation infrastructure, horticulture of hotel complexes, etc.) and/or their reduced functionality.

Changes in climate parameters will have different implications for individual tourist destinations, but they can be both positive and negative. Due to climate change (but also because of the proximity to western and northern European guests), the further north parts of Europe could become attractive enough for vacation during summer months, and the Mediterranean and the Republic of Croatia could remain attractive (only) in rest of the year. The tourism sector will be compelled to enrich its offer and to include higher quality products, which can positively affect competitiveness and guest composition. Favourable climate conditions in coastal part of the Republic of Croatia in post season and pre-season can positively affect the reduction of seasonal influences on financial efficiency of tourism in a form of extension of the season. Opportunities for tourism development in mountains and continental areas will increase.

Expected changes in temperature and precipitation (refer to chapter 6.1.3 Climate change scenarios) show that tourism will have to adapt to the upcoming changes. This mostly applies to coastal tourism in summer. High air temperatures with extended warm periods and more frequent heat waves, less precipitation and consequently a lack of water for human consumption, increased risk of fire will not be suitable for coastal tourism in a form as it is today. However, the temperature increase in spring and autumn, with smaller changes in precipitation regime than in summer, is an opportunity to extend today's summer activities on these two seasons. Mountain tourism, hiking and green continental tourism will be enabled in all seasons (to a lesser extent in summer compared to the remaining seasons). Ski tourism will weaken due to the lack of snow, but with adequate adaptation to other contents, winter tourism will be possible.

6.2.9. Spatial planning and development

Spatial planning and development have an integrative function in planning of spatial development and use of land and marine areas, and climate change presents a threat to the management of spatial development. Spatial planning and development also have a function in environmental protection and climate change adaptation which, in the context of intensifying climate change, should be further enhanced. At the same time, spatial planning plays an extremely important role in reducing the impacts of climate change, as changes in land use (for example, from agricultural or forest land into construction land or change of forests into agricultural land) are considered to be among the most important causes

of increase in greenhouse gas emissions. This cross-sectoral activity also includes islands, which represent a particular geographic and problem area in terms of climate change.

Vulnerability of built-up environment as a result of climate change impact includes: flooding in settlements due to a rise in sea level and extreme sea level as a result of extreme weather conditions and general rise of the mean sea level; the occurrence of heat islands in settlements due to influence of extreme temperatures, in particular the increase in hot days and days with temperatures above 35 °C and flooding in settlements as a consequence of the higher incidence and intensity of extreme weather conditions characterised by large amounts of precipitation in a short term.

The estimates of average rise in sea level on the Croatian coast range from 0.32 m to 0.65 m by 2100, with recent estimates increasing this value up to 1.1 m. When the effects of occasional extreme sea levels in the range of 0.84 m to 1.15 m are added to them, intermittent extreme sea levels occurring at the end of the century will be in the range of 1.4 m to 2.2 m. Temperature rise is the most probable aspect of climate change which, among other things, is manifested by an increase in a number of days with temperatures higher than 35 °C. The largest increase (3 to 5 days by 2040) is expected in most of northern Croatia, in part of northern Primorje and in part of middle Dalmatia, where this increase is locally more than 100 % compared to the climate of the period 1971-2000. In the period 2041-2070, a further increase in the subject parameter is expected from 7 to 10 days in the same areas. Such extended periods of extreme temperatures exacerbate the heat island effect in urban environments. The forecast change in total precipitation varies for different regions and different seasons. A slight increase is expected in a number of days with extreme precipitation in autumn and winter in southern regions, particularly in the middle and southern Adriatic. Larger quantities and irregular incidence of heavy precipitation affects the existing and planned infrastructure for precipitation collection and drainage.

The basis of spatial planning is a multi-sectoral, interdisciplinary approach that considers, aligns and regulates the spatial requirements of all other sectors. Integrating of climate adaptation measures into physical plans divides the responsibility of many professions that physical planners use in two ways. The first one concerns direct planning solutions that are the primary responsibility of physical planners, e.g. planning the development of settlements by defining land use or urban planning of settlements themselves (street network, built structures, grey and green infrastructure, etc.). The second way is indirect, that is, in spatial planning process sectors submit their requests and inputs that planners, after alignment and resolution of possible conflicts, include in spatial planning solutions. Accordingly, each sector is expected, based on their respective analyses and monitoring, sectoral strategic documents, plans and other expert backgrounds, to define and substantiate their interests, requirements and needs and to further participate in spatial planning process. In order to reduce the number of potential conflicts, it is necessary to follow the guidelines of the Spatial Development Strategy of the Republic of Croatia, and it is good practice for sectors to consult physical plans and planners in advance while preparing their sectoral documents and to anticipate possible problems that may arise in interaction of their needs with requirements and expectations of other sectors. Furthermore, another important instrument is integrated coastal area management, which introduces new management concept to reduce pollution and anthropogenic pressures in coastal areas and marine environment and which should be used in the context of expected climate change impacts and climate change adaptation options.

6.2.10. Risk management

Climate change can increase the likelihood of disaster events and exacerbate their intensity. The main expected impacts that could cause high or medium vulnerability in this sector are: landslides; floods;

open fires due to extended periods of high solar irradiance and extended periods of high air temperatures; extreme temperatures due to extended periods of high solar irradiance and extended periods of high air temperatures; pandemics due to the impact on diseases transmission pathways or pathogen characteristics resulting from changes in precipitation, humidity and evaporation rates; and complex risks, particularly in urban areas.

6.3. CLIMATE CHANGE ADAPTATION MEASURES

The Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined in total 83 climate change adaptation measures with accompanying activities: measures for eight key sectors (water resources, forestry, agriculture, fishery, biodiversity, health, energy, tourism), measures for two cross-sectoral areas (spatial planning and development and risk management) and general measures.

Climate change adaptation measures are grouped into three categories: measures of very high importance, measures of high importance and measures of medium importance of implementation, according to five priorities: Ensuring sustainable regional and urban development; Ensuring preconditions for economic development of rural areas, coastal areas and islands; Ensuring sustainable energy development; Strengthening of management capacities through a networked monitoring and early warning system and Ensuring continuity of research activities.

Most of the climate change adaptation measures belongs to the so-called non-structural measures (administrative, political, legislative, technical and planning measures, measures to raise awareness of the need to adapt to climate change and measures related to data collection, monitoring and scientific research). A relatively small number of so-called structural measures (measures that include any built structure or natural structure which existence is aimed at reducing or avoiding possible climate change impacts) includes certain technical interventions, such as construction of protective dams and walls, construction of hydrotechnical facilities, but also afforestation, green infrastructure, strengthening the absorptive capacity of land to receive excess water, etc.

6.3.1. Water resources

Main impacts and challenges that can cause high vulnerability in the water resources sector:

- reduction of water quantity in watercourses and in springs,
- reduction of underground water reserves and lowering of groundwater levels,
- reduction of water levels in lakes and other lake-type natural or built-up systems,
- rise of sea level and changes in its thermohaline properties,
- salinisation of coastal aquifers and aquatic systems,
- rise of water temperature followed by a reduction of reception capability of aquatic receivers,
- increased frequency and intensity of flooding in vulnerable areas,
- increased frequency and intensity of torrents and
- increased frequency and intensity of rainwater flooding in urban areas.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 10 climate change adaptation measures (HM-01 - HM-10) for the water resources sector and activities for their implementation are determined as well (Table 6-4).

Table 6-4: Climate change adaptation measures in the water resources sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
HM-01 Implementation of non-structural measures for protection against harmful effects of water and for water protection in cases of extreme hydrological conditions which increase in intensity and frequency is conditioned by climate change	HM-01-01 Development of models for the prediction of extreme precipitation in the broader catchment areas and their local occurrence
	HM-01-02 Development of models for simulating high water levels in the larger catchment areas and small torrential streams
	HM-01-03 Preparation of projection studies on flood propagation, determination of flood zones and risks and opportunities for the provision of natural flood retention areas, prioritisation of flood zones (probability of flooding and socioeconomic and environmental impacts) and their inclusion in physical planning documents
	HM-01-04 Preparation of new and revision of existing projects for protection against harmful effects of water and high sea levels (assessment of efficiency, sustainability and performance)
	HM-01-05 Development of models, studies and analyses related to low water levels, environmentally acceptable flow and sustainability of the water management balance in the context of expected climate change
HM-02 Support to planning, construction, reconstruction and upgrading the system for protection against harmful effects of water and related hydrotechnical systems (structural measures) and lowland natural floodplains flooded in a controlled fashion, as well as other water protection measures, giving priority to applying the "room for the river" approach and use of natural retention areas	HM-02-01 Preparation of project and planning documents for the construction, reconstruction and upgrading of water infrastructure intended for the protection against harmful effects of water (e.g. protective embankments, dikes and similar facilities and other systems), giving priority to the concept of "room for the river" and use of natural retention areas
	HM-02-02 Construction, reconstruction and upgrading of protective embankments, dikes and similar facilities related to the protection against harmful effects of water while giving priority to the concept of "room for the river" and use of natural retention areas
	HM-02-03 Development of "green and blue infrastructure" - restoration of watercourse sections in line with their natural flow characteristics or with ecological remediation principles of river restoration, and provision of natural lowland areas for controlled flooding and retention/reduction of high water levels - "flood adaptation" measures
	HM-02-04 Enhancing water status improvement measures to respond to deteriorated hydrological conditions caused by climate change
	HM-02-05 Enhancing measures of control and release of treated wastewater to maintain good water status in case of deteriorated hydrological conditions caused by climate change
HM-03 Strengthening professional, research and management capacities to assess the occurrence and risk of adverse impacts of climate change and adaptation of freshwater and marine water systems in current and future climate conditions	HM-03-01 Provision of education for selected target groups in the form of thematic workshops for experts and interested public as well as for elementary, high-school and university students
	HM-03-02 Promoting research related to analysing possible climate change scenarios at national and regional level (for the needs of research and management institutions) aimed at identifying climate change impacts, analysing their impact on water and marine resources and also the impacts of these changes on the environment, urban areas, infrastructural amenities, protected areas and human activities largely related to water (water supply, water protection, agriculture, hydropower, etc.)
	HM-03-03 Improvement of a system for monitoring the ecological and chemical status of surface inland water, the quantitative and chemical status of groundwater and the status of the Adriatic Sea, and of the public

Climate change adaptation measure	Activities for the implementation of adaptation measures
	availability of their results (measurement, information, updating of the climate change risk analysis, report on adaptation options)
	HM-03-04 Development of international cooperation in the implementation of monitoring the state of transnational watercourses and the Adriatic Sea aimed at sustainable management and protection
	HM-03-05 Implementation of initial activities necessary for the realisation of measures whose implementation is planned in the next stages of realisation in the area of water use, protection of water and marine resources and protection from harmful effects of water
HM-04 Strengthening capacities of responsible institutions to act in cases of occurrence of extreme hydrological conditions	HM-04-01 Development of scenarios for extreme situations (floods, droughts, etc.) at different spatial and temporal scales for areas where there is an increased risk of adverse consequences of climate extremes
	HM-04-02 Revision of existing management systems in critical hydrological conditions caused by climate extremes
	HM-04-03 Updating, modifying and improving management and coordination systems of responsible institutions according to new (possible) scenarios and preparing management responses to minimise adverse consequences
HM-05 Reducing adverse effects on the coastal water and municipal infrastructure and coastal water resources caused by rising sea levels brought about by climate change (non-structural measures)	HM-05-01 Developing a forecasting model for rising sea levels depending on global climate change and local coastal conditions
	HM-05-02 Creating a preliminary map of the vulnerability of coastal infrastructure, particularly valuable natural sites (natural strands, transitional waters) and coastal karst water resources
	HM-05-03 Detailed analysis of the most vulnerable components of the water sector
	HM-05-04 Proposal of the solution (protection measure)
HM-06 Strengthening the resilience of urban areas to anthropogenic pressures conditioned by climate change	HM-06-01 Education of employees related to the management of urban water phenomena and urban water infrastructure and education of spatial planners and water infrastructure designers related to new tendencies and project solutions for adaptation of urban water systems to climate change and increased anthropogenic pressures
	HM-06-02 Developing a plan for rationalisation of water use in cases of increased demand caused by adverse hydrological conditions due to climate change
	HM-06-03 Analysis of the possibilities of reusing treated wastewater and rainwater
	HM-06-04 Analysis of using water supply systems of lower quality for secondary water use and reduction of the pressure on drinking water resources
	HM-06-05 Analysis of the possibilities of constructing projects to increase the use of rainwater
	HM-06-06 Analysis of the possibilities of constructing desalination equipment for salinised water (brackish water and exceptionally sea water)
	HM-06-07 Local containment, retention and infiltration of rainwater and reduction of the pressure on channel or pipe drainage systems
	HM-06-08 Formation of green areas within urban areas intended for temporary or permanent retention and treatment of rainwater and recreational amenities, and development of blue infrastructure by environmental restoration and revitalisation of watercourses in urban and rural areas at both local and regional level

Climate change adaptation measure	Activities for the implementation of adaptation measures
HM-07 Strengthening capacities for exploration and sustainable management of groundwater	HM-07-01 Supplementing groundwater monitoring in the Danube river basin district with the aim of more reliable monitoring of climate change impacts on the quantitative and chemical status of groundwater
	HM-07-02 Supplementing groundwater monitoring in the Adriatic river basin district with the aim of more reliable monitoring of climate change impacts on the quantitative and chemical status of groundwater
	HM-07-03 Modelling of interdependencies between climate and hydrological conditions concerning the ecological and chemical status of surface water and the quantitative and chemical status of groundwater
	HM-07-04 Modelling of interdependencies between the groundwater status and rise in sea levels
	HM-07-05 Creating groundwater vulnerability maps in situations of reduced natural inflows due to climate change impacts
	HM-07-06 Developing proposals for methods of protection and sustainable use of groundwater in changed climate conditions
HM-08 Strengthening the resilience of the coastal water and municipal infrastructure and coastal water resources (structural measures)	HM-08-01 Reconstruction and rehabilitation of water and municipal infrastructure and other abstractions of water resources
	HM-08-02 Relocation of water intakes outside the influence of the sea
	HM-08-03 Artificial replenishment of coastal aquifers
	HM-08-04 Construction of controlled mobile barriers at the mouths of watercourses and the like while taking into account the longitudinal continuity of watercourses (ecological corridors for migratory species)
HM-09 Strengthening professional, research and management capacities for the protection of particularly valuable aquatic ecosystems	HM-09-01 Evaluation of existing anthropogenic pressures on the ecological and chemical status of water, the status of aquatic water systems in protected areas and ecological network areas and the risk of exacerbating adverse impacts under changed climate conditions, and the development of solutions for reducing pressures (e.g. relocation of water intakes outside of protected areas, solution for precipitation drainage, etc.)
	HM-09-02 Carrying out an analysis of climate change impacts on changes in abiotic and biotic features of aquatic ecosystems in protected areas and ecological network areas (e.g. changes in indicators for hydromorphological quality elements of the ecological status of water, change in water quantity and temperature and related biogenic changes, change in water volume in surface and groundwater, change in water velocity and the like)
	HM-09-03 Planning of structural and non-structural solutions for reducing climate change impacts on aquatic water systems and their implementation and/or construction
HM-10 Mapping of water sources outside the public water supply system	HM-10-01 Mapping of water sources outside the public water supply system (natural springs, private wells, water captures, etc.)
	HM-10-02 Water testing and initial health risk assessment and their application to the mapped water sources outside the public water supply system
	HM-10-03 Comprehensive health risk assessment and its application based on results of field inspections, documentation, and laboratory analyses

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures HM-01- HM-03 and HM-10 are determined as measures of very high importance. Measures HM-04 - HM-06 are determined as measures of high importance, and measures HM-07 - HM-9 as measures of medium importance. Measures HM-01, HM-02 and HM-05 - HM-09 are determined as measures within the priority Ensuring sustainable regional and urban development. Measure HM-03 is determined as part of the priority Ensuring sustainable regional and urban development, the priority Strengthening of management capacities through a networked monitoring and early warning system, and the priority Ensuring continuity of research activities. Measures HM-04 and HM-10 are determined as measures within the priority Strengthening of management capacities through a networked monitoring and early warning system.

6.3.2. Forestry

Main impacts and challenges that can cause high vulnerability in the forestry sector:

- increased incidence of forest fires including the occurrence of fires in the continental part of Croatia due to increased temperature and decreased precipitation,
- decreased productivity of some forest ecosystems,
- migration of harmful organisms,
- shift in phenological phases of forest tree species,
- increased sensitivity of tree species to changed climate conditions,
- increased extinction rate of tree species due to climate change,
- damage to forest ecosystems due to increased intensity and frequency of extreme weather events (natural disasters) and
- reduced forest functions of general benefit, i.e. reduced capacity of forest ecosystems to provide services.

Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 12 climate change adaptation measures (ŠU-01 - ŠU-12) for the forestry sector as well as the activities for their implementation (Table 6-5).

Table 6-5: Climate change adaptation measures in the forestry sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
ŠU-01 Incorporation of adaptation measures into key documents pertaining to forests and forestry sectors	ŠU-01-01 Incorporating climate change adaptation measures into the Forestry sector strategy, the Forest act and other legislation concerning forests and the forestry sector, including implementation indicators.
ŠU-02 Increasing knowledge on the vulnerability of forests to climate change and possible response measures	ŠU-02-01 Vulnerability analysis of forest tree species and research of possible responses through the provenance of forest trees that are more adaptable to the expected climate change
	ŠU-02-02 Elaboration of forest growth and dynamics models depending on climate change alongside the integration of risk assessment, and elaboration of forest management adaptation scenarios and options
ŠU-03 Strengthening capacities for systematic monitoring and reporting on the state of forest ecosystems as a prerequisite for informed planning and implementation of climate change adaptation	ŠU-03-01 Evaluation of the existing forest ecosystem monitoring system with identification of strengths and weaknesses and development of guidelines for its improvement
	ŠU-03-02 Creating a register of monitoring, experiments, and research conducted by state institutions that are not part of systematic monitoring, their evaluation, and proposal for inclusion of selected items in the monitoring system

Climate change adaptation measure	Activities for the implementation of adaptation measures
	ŠU-03-03 Upgrading and integration of selected existing monitoring/experimentation/research into the forest ecosystem monitoring system and enabling the availability of results in compliance with the INSPIRE Directive
ŠU-04 Strengthening capacities for fire protection	ŠU-04-01 Improving the early warning system for forest fires
	ŠU-04-02 Developing forest fire spread models and agricultural and forest fire prediction models entailing all elements of fire spread prediction and relevant risks
	ŠU-04-03 Preparing a plan and raising public awareness on the importance of implementing preventive measures to prevent agricultural and forest fires
	ŠU-04-04 Maintenance of existing fire roads in the Mediterranean and SubMediterranean zone and construction of new ones
ŠU-05 Implementation of the green infrastructure concept aimed at strengthening climate resilience in urban and rural areas	ŠU-05-01. Analysis of the existing network of green areas and water surfaces in urban and rural areas (forests, forest parks, parks and other urban green areas, streams, rivers and lakes) and options to improve linkages between individual elements of green and blue infrastructure of local and regional importance (e.g. linear infrastructure, watercourses, rivers and lakes)
	ŠU-05-02 Strategic planting of trees and other tree species in order to achieve physical and/or functional linkages between individual elements of green infrastructure, including the establishment of park and/or forest areas along the surface flow beds, and environmental restoration and revitalisation of watercourses in urban and rural areas at both regional and local level
	ŠU-05-03 Strengthening capacities of state administration bodies at all levels for the implementation of participatory planning
	ŠU-05-04 Implementation of research on the impact of trees and other green areas as well as natural watercourses and water surfaces on the mitigation of climate change impacts in urban environments (reduction of heat island effects)
	ŠU-05-05 When planning new green areas, giving priority to tree species before grass that requires large amounts of water for maintenance, while trees have a better impact on reducing the heat island effect
ŠU-06 Prediction (forecast) of change in the distribution of harmful organisms	ŠU-06-01 Implementation of research on the distribution of harmful organisms in forests
ŠU-07 Afforestation and reforestation to strengthen resilience to climate change	ŠU-07-01 Development of a plan for afforestation with suitable tree species
	ŠU-07-02 Afforestation with suitable tree species
ŠU-08 Raising awareness of stakeholders in the forestry sector regarding climate change and adaptation measures	ŠU-08-01 Education of licensed and other forestry engineers, forestry technicians, employees of public institutions for the management of protected natural areas in the context of climate change risks
ŠU-09 Raising awareness and sensitisation of private forest owners for sustainable forest management as a prerequisite for adapting to climate change	ŠU-09-01 Developing education and awareness-raising programmes for private forest owners on climate change and adaptation to climate change
ŠU-10 Risk assessment and development of tools that ensure continuous adaptation of agricultural land and forest	ŠU-10-01 Preparing analyses of climate change impacts on the method of agricultural land and forest management (for the needs of research and management institutions) aimed at identifying quality planning in

Climate change adaptation measure	Activities for the implementation of adaptation measures
management to reduce damage from natural and weather-related disasters	agriculture and forestry and defining the national agriculture and forestry policy
	ŠU-10-02 Developing new tools (remote research, forest growth and dynamics modelling, etc.) that enable continuous adaptation of the method of managing forests, their restoration and protection aimed at ensuring sustainable forest management
	ŠU-10-03 Informing relevant stakeholders on the analyses and developed tools
ŠU-11 Identifying capacities and options for implementing adaptation measures and reducing the threat to populations of large wild animals	ŠU-11-01 Creating analytical backgrounds and defining indicators of the impact of climate parameters on the stability of populations of large wild animals in changed habitat conditions
	ŠU-11-02 Preparing adaptation models aimed at controlling the number, growth rate and health condition of large wild animals to ensure uniform habitat conditions
	ŠU-11-03 Informing relevant stakeholders on the analyses and developed models
ŠU-12 Defining communities and forest areas that are most susceptible to potential changes and defining measures to reduce the threat to the most vulnerable areas and communities	ŠU-12-01 Developing climate change risk assessment index maps for agricultural and forest communities of high economic value by applying GIS, ICT and digital technologies
	ŠU-12-02 Developing adaptation maps for the most vulnerable agricultural and forest areas of high economic value

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures ŠU-01 - ŠU-04 are determined as measures of very high importance. Measures ŠU-05, ŠU-06, ŠU-10 and ŠU-11 are determined as measures of high importance, while measures ŠU-07 - ŠU-09 and ŠU-12 as measures of medium importance. Measures ŠU-01, ŠU-07, ŠU-10 - ŠU-12 are determined as measures within the priority Ensuring sustainable regional and urban development. Measures ŠU-03, ŠU-08 and ŠU-09 are determined as measures within the priority Ensuring preconditions for - economic development of rural areas, coastal areas and islands. Measure ŠU-04 is determined as measure within the priority Strengthening of management capacities through a networked monitoring and early warning system. Measures ŠU-02 and ŠU-06 are determined as measures within the priority Ensuring continuity of research activities. Measure ŠU-05 is determined as measures within the priority Ensuring sustainable regional and urban development and the priority Ensuring continuity of research activities.

6.3.3. Agriculture

Main impacts and challenges that can cause high vulnerability in the agriculture sector:

- change in duration/length of vegetative period of agricultural crops and lower yields,
- higher demand for irrigation water due to frequent droughts,
- longer vegetative period will enable the cultivation of new varieties and hybrids,
- more frequent flooding and stagnation of surface water - which will reduce or completely destroy yields and
- reduced growth rate and quality of animal products, reproduction disturbances, new diseases.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 8 climate change adaptation measures (P-01 - P-08) for the agriculture sector as well as the activities for their implementation (Table 6-6).

Table 6-6: Climate change adaptation measures in the agriculture sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
P-01 Implementation of the climate change adaptation experimental-research programme in agriculture	P-01-01 Preparation of the climate change adaptation research programme in agriculture
	P-01-02 Implementation of the climate change adaptation research programme in agriculture
	P-01-03 Transferring and promoting the achievements of the climate change adaptation research programme in agriculture
P-02 Increasing the water absorption capacity of agricultural soil	P-02-01 Development of activities to increase the water absorption capacity of agricultural soil
	P-02-02 Design and implementation of a promotional and educational programme for popularising the implementation of activities to increase the water absorption capacity of agricultural soil among farmers
	P-02-03 Implementation of activities to increase the water absorption capacity of agricultural soil
P-03 Application of appropriate soil tillage methods (e.g. soil conservation tillage and other methods of reduced soil tillage)	P-03-01 Design and implementation of a promotional and educational programme for popularising the use of appropriate soil tillage methods (e.g. soil conservation tillage and other methods of reduced soil tillage) as well as integrated pest management (IPM) methods among farmers
	P-03-02 Implementation of appropriate soil tillage methods (e.g. soil conservation tillage and other methods of reduced soil tillage) as well as integrated pest management (IPM) methods
P-04 Cultivation of species and varieties of agricultural crops for food and non-food supply chain and breeds of domestic animals that are more resilient to climate change	P-04-01 Identification of varieties, species and breeds resilient to climate change for individual agrotechnical regions
	P-04-02 Development and implementation of a promotional and educational programme for popularising activities of cultivating species and varieties of agricultural crops for food and other types of use and breeds of domestic animals that are more resilient to climate change among farmers and the general public
	P-04-03 Implementing activities of cultivating species and varieties of agricultural crops and breeds of domestic animals that are more resilient to climate change
P-05 Integration of climate change risks into the development of irrigation systems	P-05-01 Implementation of a promotional and educational programme for popularising water-saving irrigation methods and other methods of securing water for agricultural purposes (e.g. green infrastructure) among farmers
	P-05-02 Analysis of the possibilities of constructing innovative irrigation systems
	P-05-03 Continuing and extending the implementation of the National Project for Irrigation and Management of Agricultural Land and Water in the Republic of Croatia (NAPNAV): elaboration of conceptual solutions, preparation of pre-investment studies and project documentation, rehabilitation and reconstruction of existing systems and construction of new irrigation systems
	P-05-04 Ensuring sufficient funds for irrigation of at least 100 000 ha
	P-05-05 Establishing a system for monitoring and evaluation of the implementation of irrigation systems
P-06 Application of anti-erosion measures	P-06-01 Defining soil erosion prevention activities
	P-06-02 Implementation of a promotional and educational programme for popularising the use of anti-erosion measures among farmers
	P-06-03 Implementation of soil erosion prevention activities

Climate change adaptation measure	Activities for the implementation of adaptation measures
P-07 Reconstruction and construction of amelioration drainage structures	P-07-01 Defining needs for reconstruction of existing and construction of new drainage systems
	P-07-02 Ensuring sufficient funds to implement the measure on at least 100 000 ha
P-08 Insurance of agricultural production from production losses caused by adverse climate conditions	P-08-01 Definition of preventive activities and continuing the implementation of activities related to the restoration of agricultural land and production potential, under which aid is granted for the restoration of production potential damaged by natural disasters and catastrophic events and for the introduction of appropriate preventive activities
	P-08-02 Continuing to grant aid for co-financing a part of the crop, animal and plant insurance premium; the subject of aid is plant and livestock production entered in appropriate registers of agricultural land and domestic animals

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures P-01 - P-05 are determined as measures of very high importance. Measures P-06 - P-07 are determined as measures of high importance, while measure P-08 as measure of medium importance. Measure P-01 is determined as measure of the priority Ensuring continuity of research activities. Measures P-02 - P-08 are determined as measures within the priority Ensuring preconditions for economic development of rural areas, coastal areas and islands.

6.3.4. Fishery

Main impacts and challenges that can cause high vulnerability in the fishery sector:

- migration to the northern Adriatic Sea or to the deeper sea of cold-water species due to rising sea temperatures,
- increase in the number of alien species and impact on domestic species due to rising sea temperatures,
- decrease in the primary production, resulting in lower numbers of pelagic fish due to changes in water circulation caused by changes in thermohaline properties,
- slower growth rate and higher mortality of shellfish due to increased sea acidity,
- impaired habitat capacity to provide ecosystem services essential for maintaining species of economic importance and
- impaired socio-economic stability of the fisheries sector.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 10 climate change adaptation measures (RR-01 - RR-10) for the fishery sector as well as the activities for their implementation (Table 6-7).

Table 6-7: Climate change adaptation measures in the fishery sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
RR-01 Strengthening the sector by investing in the development of new markets and expanding the range of products offered	RR-01-01 Implementation of research on the acceptability of new types of cultivated organisms and products by consumers

Climate change adaptation measure	Activities for the implementation of adaptation measures
RR-02 Strengthening capacities to assess the future state of the sector due to climate change impacts	RR-02-01 Encouraging the development of application models for predicting future trends in fish biomass
RR-03 Strengthening the resilience of natural resources through adaptive fisheries management	RR-03-01 Developing a system for monitoring the state of bioresources in marine and fresh water that also includes monitoring of the food chain of marine organisms
RR-04 Increasing the involvement of fishermen in the tourism sector	RR-04-01 Educating fishermen to carry out tourism activities
	RR-04-02 Supporting fishermen to reconstruct vessels for the purpose of carrying out tourism activities
RR-05 Strengthening aquaculture capacities by greater breeding of organisms at lower trophic levels and new forms of breeding	RR-05-01 Implementation of a programme for encouraging shellfish farming
	RR-05-02 Implementation of a programme for encouraging controlled farming of juvenile shellfish in hatcheries instead of collecting them in nature
	RR-05-03 Preparation of a study on the feasibility of farming aquatic plants and their acceptance on the market
	RR-05-04 Design and implementation of an educational programme for breeders on the advantages and benefits of integrated breeding of aquatic organisms
	RR-05-05 Raising awareness of the general public on the benefits of consuming shellfish, aquatic plants and non-carnivorous fish species
RR-06 Strengthening aquaculture capacities through breeding in recirculation systems	RR-06-01 Analysis of the possibilities of using recirculation breeding systems in fisheries
	RR-06-02 Design and implementation of an educational programme for breeders on the benefits of recirculation breeding systems
	RR-06-03 Implementation of research related to the use of recirculation systems only for certain breeding stages and on the breeding of new fish species in recirculation systems
RR-07 Strengthening aquaculture capacities by breeding new species of fish	RR-07-01 Preparation of a study on the possibilities of farming new (alien) fish species adapted to climate change
	RR-07-02 Market research to determine the possibility of consumers accepting new (alien) fish species
RR-08 Popularising the use of new fish species	RR-08-01 Investigate the acceptability of potential new (alien) species among consumers
	RR-08-02 Selecting techniques and tools for harvesting new (alien) species
	RR-08-03 Exploring all possibilities of exploiting new (alien) species for different purposes and popularising their use
RR-09 Strengthening aquaculture capacities by selective breeding	RR-09-01 Educating staff that will be involved in selective breeding at all levels
	RR-09-02 Developing models for predicting future trends in fish biomass
	RR-09-03 Preparation of a study on the possibilities of selective fish breeding; determining fish species to be subjected to selective breeding; determining the characteristics of fish to be selected
	RR-09-04 Encouraging breeders to participate in selective breeding
RR-10 Development of aquaculture by adapting the quantity and quality of food to changed climate conditions	RR-10-01 Researching the influence of elevated water temperature on fish metabolism
	RR-10-02 Researching the influence of eating habits, the amount and composition of meals on the intensity of fish growth in elevated water temperature conditions

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures RR-01 - RR-07 are determined as measures of very high importance. Measures RR-08 and RR-09 are determined as measures of high importance, and measure RR-10 as measures of medium importance. Measures RR-01 - RR-10 are determined as measures within the priority Ensuring preconditions for economic development of rural areas, coastal areas and islands.

6.3.5. Biodiversity

Main impacts and challenges that can cause high vulnerability of biodiversity:

- reduction in habitat size, changes in their share and disappearance of some habitats,
- habitat fragmentation,
- changes in structure, processes, functions and services,
- changes in the composition of species communities,
- changes in phenology,
- termination of flowering of cryophilic and stenothermal plant species with shortening of vegetation and reduction of vigour,
- damage, degradation and extinction due to climate extremes (long-lasting droughts, excessive short time precipitation, stormy winds, excessive sunlight, etc.),
- changes in abundance and distribution of species,
- loss of species adapted to life in a narrow range of environmental conditions (particularly endemic species with limited distribution),
- appearance and spreading of invasive alien species and species adapted to life in a wide range of environmental conditions and suppression of native species,
- changes in inter-species interactions (positive and negative),
- changes in life cycles,
- changes in migration periods,
- reduction in populations of forest species due to frequent fires caused by increased average air temperature and reduced and unevenly distributed precipitation,
- reduction and disappearance of freshwater species in the Adriatic basin due to the salinisation of coastal habitats caused by rising sea levels and
- spreading of marine species to the north and appearance of thermophilic (tropical) invasive alien marine species due to sea temperature rise.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 9 climate change adaptation measures (B-01 - B-09) for biodiversity as well as the activities for their implementation (Table 6-8).

Table 6-8: Climate change adaptation measures for biodiversity and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
B-01 Improvement of knowledge and creation of databases to assess the vulnerability of (semi-)natural ecosystems, habitats, wild species, protected areas and ecological network areas for the purpose of improving predictive models	B-01-01 Assessing the vulnerability of habitats through the systematic updating of the map of terrestrial nonforest and forest habitats as well as marine habitats along with upgrading databases and monitoring systems with climate change vulnerability elements
	B-01-02 Assessing the vulnerability of (semi-)natural ecosystems through systematic mapping along with upgrading databases and monitoring systems with climate change vulnerability elements
	B-01-03 Assessing the vulnerability of wild species through systematic inventory and mapping along with upgrading databases and monitoring systems with climate change vulnerability elements

Climate change adaptation measure	Activities for the implementation of adaptation measures
	B-01-04 Assessing the impact of invasive alien species that are particularly aggressive in the climate change process through systematic monitoring along with the development and implementation of suppression and adaptive management measures and upgrading databases and monitoring systems
	B-01-05 Assessing the vulnerability of underground habitats through the systematic data collection and updating of the Cadastre of Speleological Objects along with upgrading databases and monitoring systems with climate change vulnerability elements
B-02 Establishment of a climate monitoring and early warning system for protected areas and ecological network areas and monitoring of ecosystems, habitats and wild species	B-02-01 Establishment of a climate impact monitoring and early warning system for all protected areas and ecological network areas for the purpose of adaptive management
	B-02-02 Preparation and inclusion of climate change adaptation measures into the adaptive management of protected areas and ecological network areas
	B-02-03 Establishment of expert monitoring of ecosystems, habitats and wild species for monitoring climate change impacts and consequences to assess the vulnerability and strengthen the resilience for the purpose of adapting to climate change
B-03 Development and implementation of measures for strengthening the resilience of vulnerable ecosystems, habitats and species	B-03-01 Strengthening the resilience of vulnerable habitats, e.g.: revitalisation, restoration, inclusion in protected areas, maintenance by using traditional knowledge, ensuring the connectivity of habitats, removing of invasive alien species
	B-03-02 Strengthening the resilience of vulnerable species: propagation of plant species, introduction, reintroduction, translocation, provision of optimal corridors and resting areas for migratory species, genetic diversity conservation in situ and ex situ (including gene banks)
B-04 Integrated management of (freshwater, marine and land) resources for the preservation and revitalisation of natural ecosystems and biodiversity	B-04-01 Preserving and revitalising natural floodplains important for maintaining biodiversity by implementing protection measures against extreme climate events (e.g. flood, drought), including the use of nature-based solutions
	B-04-02 Defining and implementing the measures for ensuring favourable hydrological conditions to preserve and restore freshwater, stagnant water, wetland and hygrophilic ecosystems, including the use of nature-based solutions
	B-04-03 Preserve coastal sources and wetland habitats from salinisation and other threats by establishing dams, embankments and other measures, including the use of nature-based solutions
	B-04-04 Developing predictive models of change in the distribution of wild species, habitats and ecosystems to be used for sustainable spatial planning and land use and adaptive management
B-05 Incorporation of climate change adaptation measures into key documents for the protection of nature and its components and management of areas, species and habitats	B-05-01 Incorporating climate change adaptation measures into the Nature protection strategy, laws and subordinate regulations, management and preservation documents and guidelines concerning nature protection, including implementation indicators
B-06 Preservation and application of traditional agricultural practices and knowledge to strengthen the resilience of	B-06-01 Identification of traditional varieties and breeds that are environmentally and genetically best adapted to climate change impacts for the purpose of strengthening the resilience of vulnerable ecosystems, habitats and wild species

Climate change adaptation measure	Activities for the implementation of adaptation measures
(semi-)natural ecosystems, habitats and wild species	B-06-02 Design and implementation of models for restoring traditional agriculture in vulnerable (semi-)natural ecosystem
	B-06-03 Strengthening capacities of local communities to upgrade systems for monitoring (semi-) natural ecosystems, habitats and wild species by using elements of traditional knowledge
	B-06-04 Establishment of systematic monitoring of (semi-) natural ecosystems covered through models for restoring traditional agriculture in view of climate change adaptation
	B-06-05 Valorisation and promotion of traditional agricultural practices that strengthen climate resilience of ecosystems, habitats and species
B-07 Improving sustainable management and reducing anthropogenic impacts on (semi-)natural ecosystems, habitats and wild species primarily via sustainable development measures by applying nature-based solutions (NbS)	B-07-01 Development of guidelines for the preservation of ecosystems, habitats and wild species with respect to climate change adaptation based on predictive models, and align sectoral documents related to spatial use
	B-07-02 Enhancing (semi-)natural and anthropogenic ecosystems to increase biodiversity for better adaptation to climate change (encouraging green architecture and green and blue infrastructure by selecting native plant species, green belts, flower strips, shelters for birds, bats, insects)
B-08 Strengthening professional and financial capacities of the nature protection system	B-08-01 Educating, specialising and strengthening capacities of expert teams
	B-08-02 Ensuring the financing of adaptation and resilience building measures for ecosystems, habitats and species and the nature protection system through structural and other EU funds, EU programmes, etc
B-09 Transferring knowledge on the importance of ecosystems, habitats, wild species, protected areas and ecological network areas and the importance of preserving ecosystem services when adapting to climate change	B-09-01 Carrying out professional communication and informative educational activities (professional and scientific conferences, workshops and the like)
	B-09-02 Establishing a wider public information and education system by developing communication and interpretation programmes

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures B-01, B-02 and B-04 are determined as measures of very high importance. Measures B-03, B-05 and B-06 are determined as measures of high importance, while measures B-07 - B-09 as measures of medium importance. Measures B-01 and B-02 are determined as measures within the priority Strengthening of management capacities through a networked monitoring and early warning system. Measures B-03 - B-05 and B-07 - B-09 are determined as measures within the priority Ensuring sustainable regional and urban development. Measure B-06 is determined as measure within the priority Ensuring preconditions for economic development of rural areas, coastal areas and islands.

6.3.6. Health

Main impacts and challenges that can cause high vulnerability in the health sector:

- increased mortality of population,
- change in the epidemiology of chronic non-infectious diseases,
- change in the epidemiology of acute infectious diseases,
- reduced quality of outdoor and indoor air due to extremely high and low temperatures and precipitation,
- more frequent and longer periods of unavailability of water safe for human consumption,

- increased levels of contaminants and pollutants in the environment and
- impact on the epidemiology of diseases related to climate factors.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 9 climate change adaptation measures (ZD-01 - ZD-09) for the health sector as well as the activities for their implementation (Table 6-9).

Table 6-9: Climate change adaptation measures in the health sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
ZD-01 Establishment of a system for calculating health-economic indicators for climate change related conditions	ZD-01-01 Development of a system for calculating health-economic indicators by selecting priority diagnoses according to the International Classification of Diseases and Related Health Problems that can be associated with the impact of meteorological or climate parameters
	ZD-01-02 Establishment of a network of persons conducting health and economic analyses
	ZD-01-03 Establishment of an automated calculation within the central information healthcare system / health-ecological / public health subsystem
	ZD-01-04 Establishment of a networked database and of authorised stakeholders in the evaluation and monitoring of health and economic indicators associated with climate change
ZD-02 Integration of various information systems within healthcare to monitor indicators associated with climate change	ZD-02-01 Defining and positioning key stakeholders within the network of public health institutes, primary healthcare system, hospital system, emergency reception system, veterinary supervision system and others
	ZD-02-02 Expansion of the knowledge base through scientific and expert definition of health indicators associated with climate change
	ZD-02-03 Networking of meteorological information systems and air quality monitoring systems with preventive, hospital, and primary health care systems
ZD-03 Establishment of a framework for the implementation of human biomonitoring for tracking environmental factors related to climate change	ZD-03-01 Selection of authorised stakeholders for human biomonitoring
	ZD-03-02 Collecting epidemiological/descriptive population data and analysing environmental factors related to climate change amongst people
	ZD-03-03 Publishing research results and creating a national knowledge base
ZD-04 Implementation of health impact assessments and health risk assessments related to climate change	ZD-04-01 Amendments to the legislative framework related to the obligation to prepare and adopt an ordinance on the minimum content of the Health Impact Assessment Study (HIA) and the Health Risk Assessment Study (HRA); defining a list of strategic projects; defining the minimum composition of the multidisciplinary team according to the types of risk and content of the studies
	ZD-04-02 Creating an analytical background and defining the minimum content of the Health Impact Assessment Study (HIA) and the Health Risk Assessment Study (HRA)
	ZD-04-03 Education of key stakeholders on the methodology for implementing and using tools for health risk assessment and health impact assessment studies (temporal-spatial modelling, mandatory statistical data processing programmes in public health institutes, etc.)
	ZD-04-04 Implementation of experimental health impact assessment and health risk assessment studies at the local level

Climate change adaptation measure	Activities for the implementation of adaptation measures
ZD-05 Networking and upgrading of the system of monitoring environmental indicators related to climate change	ZD-05-01 Linking systems of all existing monitoring indicators by developing the GIS system, cross-sectoral cooperation in the preparation and adoption of plans, revising monitoring plans and increasing/decreasing the number of parameters (indicators of environmental factors harmful for human health) based on the results of research and risk assessment
	ZD-05-02 Definition of health impact indicators for meteorological/climate parameters via environmental media
	ZD-05-03 Evaluation of the success of implementation of health risk assessments related to climate change
ZD-06 Increasing the number of secure points in case of extreme meteorological conditions	ZD-06-01 Definition of the priority points proposal by the multidisciplinary team with an optimal solution in relation to the spatial plan, microclimate conditions and architectural microenvironment and at least one public water site with water safe for human consumption in urban and rural areas (points of public mass gatherings, recreational and sports areas, construction sites, agricultural areas)
	ZD-06-02 Planning and construction of secure points in case of extreme meteorological conditions (such as heat waves) in public areas at the local level
	ZD-06-03 Establishment of a system and assessment of the compliance of monthly laboratory controls of water for human consumption at public water sites or aerosol dispensers
	ZD-06-04 Establishment of a system for monthly laboratory controls of water for human consumption at public water sites or aerosol dispensers
ZD-07 Strengthening the allergenic species monitoring system	ZD-07-01 Amendments to legislative provisions and the management plan for planting nonallergen plants in public areas for the prevention and control of spreading of aeroallergenic species
	ZD-07-02 Establishment of the legally mandatory monitoring of allergenic pollen species within the network of public health institutes, development of a tool for assessing the temporal-spatial expansion and appearance of new species and the influence of allergenic pollen on outdoor air quality indicators and indicators within the health system
	ZD-07-03 Multidisciplinary planning of planting non-allergenic species at the local and regional self-organization level
	ZD-07-04 Planning of public awareness-raising actions and capacity building in the health and other sectors (municipal management, spatial planning, etc.) based on the results of monitoring and modelling the movement of aeroallergens
ZD-08 Raising awareness of the public and key stakeholders in health and other priority professions (e.g. educational institutions, etc.)	ZD-08-01 Preparation of annual plans for media activities and public education plans (educational materials and tools) on climate change impacts and adaptation
	ZD-08-02 Planning of knowledge transfer work packages tailored to the roles of key stakeholders for the promotion of proper procedures, identification and monitoring of health consequences associated with meteorological and climate influences
	ZD-08-03 Preparation, promotion and implementation of educational workshops for key stakeholders with international experience and exchange of experience at regional and national level
ZD-09 Integration of the climate change topic into the national curriculums	ZD-09-01 Defining priority groups for introducing a customised intersubject topic of health, safety and environmental protection
	ZD-09-02 Identification and education of educators within the school system

Climate change adaptation measure	Activities for the implementation of adaptation measures
	ZD-09-03 Preparation, promotion and implementation of workshops for stakeholders in the school system by educated educators

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures ZD-01 - ZD-03 are determined as measures of very high importance. Measures ZD-04 – ZD-06 are determined as measures of high importance, while measures ZD-07 - ZD-09 as measures of medium importance. Measures ZD-01 - ZD-07 are determined as measures within the priority Strengthening of management capacities through a networked monitoring and early warning system. Measures ZD-08 and ZD-09 are determined as measures within the priority Ensuring sustainable regional and urban development.

6.3.7. Energy

Main impacts and challenges that can cause high vulnerability in the energy sector:

- decrease in the production of electricity in hydropower plants due to reduced precipitation in all seasons except winter, and consequentially lowered flow rate, numerous dry periods and increased evapotranspiration,
- increase in electricity consumption for cooling purposes (higher number of cooling degree days) due to increased average air temperature,
- reduction of heat production in thermal power plants due to increased average air temperature in winter months,
- reduction of electric and heat production in thermal power plants due to insufficient cooling of the plants due to flow reduction and
- damage to power plants and infrastructure due to extreme weather events – ice breaking and floods.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 7 climate change adaptation measures (E-01 - E-07) for the energy sector as well as the activities for their implementation (Table 6-10).

Table 6-10: Climate change adaptation measures in the energy sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
E-01 Strengthening the resilience of production facilities through the storage of electrical energy	E-01-01 Conducting a vulnerability analysis of more important existing production plants to the adverse impacts of climate change to define the most vulnerable ones and create a priority list
	E-01-02 Analysis of the possibilities of constructing energy storage facilities
	E-01-03 Preparation of project documentation for the construction of an energy storage test facility
	E-01-04 Construction of an energy storage test facility
	E-01-05 Preparation of a study on the possibilities of constructing small autonomous RES-based energy systems and battery energy storage systems on islands and in rural areas
	E-01-06 Preparation of project documentation for the installation of small autonomous RES-based energy systems and battery energy storage systems on islands and in rural areas

Climate change adaptation measure	Activities for the implementation of adaptation measures
	E-01-07 Construction of small autonomous RES-based energy systems and battery energy storage systems on islands and in rural areas
E-02 Strengthening capacities and ensuring an enabling legal framework to increase the capacity of renewable energy sources and distributed sources	E-02-01 Creating a map of the climate potential (positive and negative) of Croatian regions for the production of energy from alternative sources in different climate scenarios
	E-02-02 Preparation of a study on the possibilities of developing diversified energy sources with an emphasis on the exploitation of alternative (renewable) energy sources in the territory of the Republic of Croatia
	E-02-03 Preparation of a study on the possibilities of using renewable energy sources in rural areas such as agricultural micro-installations
E-03 Strengthening the resilience of the existing capacities for electricity and heat production	E-03-01 Conducting a vulnerability analysis of existing thermal power plants to extreme weather and climate hazards and reduced precipitation to define the most vulnerable thermal power plants and create a priority list
	E-03-02 Conducting a detailed vulnerability analysis of the most vulnerable thermal power plants and proposing measures that will include a technical and economic analysis
	E-03-03 Conducting a preliminary vulnerability analysis of existing hydropower plants to extreme weather and climate hazards, particularly the impact of reduced precipitation to define the most vulnerable hydropower plants and create a priority list.
	E-03-04 Conducting a detailed vulnerability analysis of the most vulnerable hydropower plants and proposing measures that will include a technical and economic analysis
	E-03-05 Preparation of project documentation for the revitalisation of parts of settlements in urban areas connected to the district heating system (DHS) by introducing a low-temperature regime in heating pipes, thus increasing cost-effectiveness of the DHS
	E-03-06 Revitalisation of parts of settlements in urban areas connected to the district heating system (DHS) by introducing a low-temperature regime in heating pipes, thus increasing cost-effectiveness of the DHS
E-04 Development of capacities for monitoring and rapid elimination of negative effects of climate impacts on the power system	E-04-01 Establishing a working group for crisis situations in the energy system, which will be composed of stakeholders from the energy sector (institutional representatives and representatives of larger power companies) and other relevant sectors (climatology, protection and rescue, internal affairs, etc.) and independent experts as needed
	E-04-02 Conducting a detailed analysis of the identified vulnerabilities of the existing power system (power plants and infrastructure) (detailed analysis should target the most vulnerable parts of the power system for which the adverse impact of climate change is expected); considering the need to establish a national centre for crisis situations in the energy sector, as well as a list of stakeholders that should be involved in the work of the national centre and intervention teams, including their roles and responsibilities during and after emergencies (crisis situations)
	E-04-03 If a decision on the establishment is made, taking all the steps necessary to establish a national centre for crisis situations in the energy sector and intervention teams
	E-04-04 Developing emergency action plans

Climate change adaptation measure	Activities for the implementation of adaptation measures
	E-04-05 Strengthening capacities of all stakeholders, particularly of newly established intervention teams through a continuous training system
E-05 Strengthening the resilience of the power system	E-05-01 Developing detailed maps (mapping) of the existing power system and seasonal climate modelling results according to parameters important for the energy sector
	E-05-02 Developing and introducing advanced IT tools and solutions for the management of power systems, for the prediction of weather conditions and hazards as well as favourable/unfavourable climate conditions for the production, transmission, distribution and consumption of energy
	E-05-03 Strengthening capacities of all stakeholders involved in the power system
E-06 Strengthening the resilience of the distribution grid	E-06-01 When preparing new plans for developing the distribution grid, taking into account the expected climate change and the identified vulnerabilities of the power system
	E-06-02 Determining the most vulnerable parts of the existing distribution grid with regard to the identified vulnerabilities and making a list of priority parts of the grid when exposed to adverse weather and climate hazards
	E-06-03 Conducting a detailed vulnerability analysis of the most vulnerable parts of the existing distribution grid and proposing measures that will include a technical and economic analysis
	E-06-04 Taking the results of the conducted analyses into account when preparing sectoral strategies, plans and development programmes
E-07 Strengthening the resilience of the transmission grid	E-07-01 When preparing new plans for the development of the Croatian transmission grid, taking into account the expected climate change and the identified vulnerabilities of the power system
	E-07-02 Determining the most vulnerable parts of the existing transmission grid with regard to the identified vulnerabilities and making a list of priority parts of the grid when exposed to adverse weather and climate hazards
	E-07-03 Conducting a detailed vulnerability analysis of the most vulnerable parts of the existing transmission grid and proposing measures that will include a technical and economic analysis
	E-07-04 Taking the results of the conducted analyses into account when preparing sectoral strategies, plans and development programmes

Source: Climate Change Adaptation Strategy in the Republic of Croatia was adopted for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures E-01 - E-03 are determined as measures of very high importance. Measures E-04 and E-05 are determined as measures of high importance, while measures E-06 and E-07 as measures of medium importance. Measures E-01 - E-07 are determined as measures within the priority Ensuring sustainable energy development.

6.3.8. Tourism

Main impacts and challenges that can cause high vulnerability in the tourism sector:

- misalignment between the tourist offer and projected climate change (high temperatures, increased solar irradiance, frequency of extreme weather events, etc.)

- changing attractiveness of coastal parts and inland areas of the Republic of Croatia
- damage to and/or reduced functionality of various infrastructure systems (water supply, drainage, beach infrastructure, horticulture, etc.) and
- deterioration of ecosystems, biodiversity and cultural heritage important for tourism due to indirect and direct effects of climate change.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 5 climate change adaptation measures (T-01 - T-05) for the tourism sector as well as the activities for their implementation (Table 6-11).

Table 6-11: Climate change adaptation measures in the tourism sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
T-01 Integration of climate change into the tourism development strategy	T-01-01 Enhancing knowledge on the impact of climate change on tourism
	T-01-02 Development of guidelines for implementing adaptation measures aimed at achieving, inter alia, sustainable development of tourism by monitoring the impact of tourism on components of the natural environment
	T-01-03 Development of plans for protecting tourism infrastructure against climate change impacts and weather extremes
	T-01-04 Development of plans for constructing future tourism infrastructure to be more resilient to weather extremes
	T-01-05 Continuous monitoring of the state of tourism infrastructure, evaluation of the efficacy and practicality of implementing adaptation measures
T-02 Raising awareness of persons involved in the tourism sector on climate change impacts, risks and adaptation options	T-02-01 Organisation of workshops for relevant tourism experts aimed at learning about specific climate change impacts, likelihood of their occurrence, and adaptation options
	T-02-02 Preparation of educational materials to spread awareness of the impacts and risks of climate change and adaptation options intended for management structures in the tourism sector
T-03 Promoting the education of high school and university students on climate change	T-03-01 Training programmes on climate change, its impacts and risks, and adaptation measures in the tourism sector
	T-03-02 Development of a subject/course in secondary schools and colleges for tourism on the impacts and risks of climate change and adaptation measures in the tourism sector
T-04 Strengthening the resilience of tourism infrastructure to different weather extremes	T-04-01 Development and implementation of specific destination offers adapted to climate and spatial characteristics
	T-04-02 Construction of tourism infrastructure adapted to climate change
T-05 Strengthening the resilience of local communities in the tourism sector	T-05-01 Assessment of tourism development at local level under the impact of climate change
	T-05-02 Proposing adaptation measures and their implementation at local levels

Source: Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures T-01 - T-04 are determined as measures of very high importance, while measure T-05 as measure of medium importance. Measures T-01 - T-05 are determined as measures within the priority Ensuring sustainable regional and urban development.]

6.3.9. Spatial planning and development

Main impacts and challenges that can cause high vulnerability in the area of spatial planning and development:

- heat islands in settlements due to increased average temperatures in summer months,
- sea floods caused by rising sea levels and
- floods in settlements due to extreme amounts of precipitation.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 5 climate change adaptation measures (PP-01 - PP-05) for the spatial planning and development sector as well as the activities for their implementation (Table 6-12).

Table 6-12: Climate change adaptation measures for the spatial planning and development sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
PP-01 Strengthening knowledge bases as well as monitoring and evaluation systems	PP-01-01 Implementation of targeted research on the impact of rising sea levels on the most vulnerable parts of the coast as a basis for the preparation of priority intervention plans
	PP-01-02 Implementing an integrated multidisciplinary assessment of the vulnerability of coastal areas to extreme sea levels, including socio-economic aspects and cost estimates as well as benefits of adaptation options
	PP-01-03 Implementation of targeted research on climate change impacts related to spatial planning decisions in the function of tourism development
	PP-01-04 Implementation of an assessment of vulnerability to the occurrence of heat islands and extreme precipitation in settlements focusing on their connection with spatial planning solutions
	PP-01-05 Ensuring the availability of research results through existing information systems for spatial planning, environmental protection and water protection or the Open Data Portal or Geoportal of the National Spatial Data Infrastructure
PP-02 Strengthening professional and institutional capacities of expert stakeholders in the spatial planning system	PP-02-01 Strengthening of continuing professional development programmes for spatial planners related to the implementation of climate change adaptation measures
PP-03 Integration of adaptation measures into the spatial planning system	PP-03-01 Amendments to the legal framework to develop the implementation of climate change adaptation measures in spatial planning
	PP-03-02 Development and strengthening of the integrated spatial planning methodology and Strategic Environmental Assessment (SEA) with an emphasis on the implementation of climate change adaptation measures
	PP-03-03 Development of programmes and guidelines for strengthening cross-sectoral coordination in the spatial planning process, with an emphasis on the planning of climate change adaptation measures by taking into account: – renaturalisation and regeneration of the urban fabric by using nature based solutions

Climate change adaptation measure	Activities for the implementation of adaptation measures
	– definition of zones and guidelines for climate-neutral and climate positive urban districts – integration of optimal decarbonisation, energy transition and climate change adaptation solutions to protect the health of the population and increase air quality and life quality of the population
	PP-03-04 Analysis and elaboration of methods of monitoring and evaluating the efficiency and effectiveness of spatial plans in the implementation of climate change adaptation measures
PP-04 Raising awareness and sensitisation of the public and decision-makers at all levels	PP-04-01 Design and implementation of public information and education programmes focusing on targeted groups in vulnerable areas
	PP-04-02 Design and implementation of information programmes for decision-makers at all levels of government
	PP-04-03 Raising awareness of social responsibility in the banking and insurance sectors regarding climate change
PP-05 Preparation of rehabilitation programmes and projects	PP-05-01 Development of good and sustainable practice guidelines for the design of rehabilitation projects for typical situations of exposure and vulnerability to sea flooding of different physical structures on the coast, especially those identified as priorities, with an emphasis on spatial planning aspects
	PP-05-02 Provision of technical and financial support for the design of rehabilitation projects and the plan for financing the realisation of these projects
	PP-05-03 Establishing a national programme for the rehabilitation of cultural heritage threatened by extreme sea levels and other climate change risks
	PP-05-04. Encouraging and stimulating cooperation between local and regional self-organization on joint and coordinated planning of adaptation measure

Source: Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures PP-01 - PP-04 are determined as measures of very high importance, while measure PP-05 as measure of high importance. Measures PP-01 - PP-05 are determined as measures within the priority Ensuring sustainable regional and urban development.

6.3.10. Risk management

Main impacts and challenges that can cause high vulnerability in the risk management sector:

- open-type fires due to extended periods of high solar irradiance and extended periods of high air temperatures,
- epidemics and pandemics due to impact on diseases transmission pathways or pathogen characteristics resulting from changes in precipitation, humidity and evaporation rates and
- increased health and socio-economic burden on community due to food contamination and environmental pollution after events such as flooding or landslides.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) determined 5 climate change adaptation measures (UR-01 - UR-05) for the risk management sector as well as the activities for their implementation (Table 6-13).

Table 6-13: Climate change adaptation measures in the risk management sector and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
UR-01 Strengthening the function and importance of the Croatian Platform for Disaster Risk Reduction (SROK) in the area of climate change	UR-01-01 Increasing the intensity of activities of the Croatian Platform for Disaster Risk Reduction on the inclusion of climate change adaptation measures in the Disaster Risk Reduction Strategy
	UR-01-02 Encouraging cooperation of environmental sectors with other sectors represented in activities of the Croatian Platform for Disaster Risk Reduction to raise awareness and provide education on the common objectives of disaster risk reduction and climate change adaptation, and integration of disaster risk reduction and climate change adaptation measures into regulations and documents at national and local levels
UR-02 Multi-sectoral and sectoral risk assessment for various threat/risk scenarios related to climate change	UR-02-01 Conducting sectoral risk assessments based on scientific research
	UR-02-02 Conducting sectoral capacity assessments based on scientific research
	UR-02-03 Expansion of relevant working groups and persons responsible for certain types of threats/risks related to climate change
	UR-02-04 Further elaboration of algorithms and action guidelines for different disaster and major accident scenarios
	UR-02-05 Amendments to the legislative framework related to decentralisation and centralisation of management functions depending on the type of disaster, major accident, emergency and incident/crisis situation
	UR-02-06 Interconnectivity of information systems of key stakeholders
	UR-02-07 Connecting civil, security, and defence services during interventions
	UR-02-08 Establishment of vertical and horizontal data and information exchange systems
	UR-02-09 Appointment of key stakeholders with regard to complex risks associated with climate change
UR-03 Strengthening the sector's capacities for the prevention and response to disasters and major accidents associated with climate change	UR-03-01 Defining events related to meteorological and climate variations in accordance with the area/region/county determinants
	UR-03-02 Defining subgroups/processes/locations sensitive to climate change-related risks
	UR-03-03 Education of stakeholders exposed to specific risks
	UR-03-04 Raising awareness of events related to climate change in the local community
	UR-03-05 Appointment and training of key stakeholders in response to complex risks associated with climate change (e.g. flooding or landslides in areas of previously contaminated and polluted sites, contamination of areas affected by climate or meteorological disasters, etc.)
	UR-03-06 Ensuring continuous preparedness of key stakeholders
	UR-03-07 Establishment of a system for issuing requests, monitoring and refunding the costs of laboratory and expert analyses for the purpose of assessing a disaster, major accident, state of emergency or incident/crisis situations related to climate change
UR-04 Creation of an integrated and standardised cross-sectoral database of threats, measures, damages and losses	UR-04-01 Establishment of an integrated database of climate change-related threats
	UR-04-02 Development of an integrated database of key stakeholders

Climate change adaptation measure	Activities for the implementation of adaptation measures
	UR-04-03 Integration of the results of health-environmental and social databases – number of vegetation and forest fires, areas prone to flooding or rising sea levels, the condition of crops or soil determinants and other threats at the site of disasters and major accidents
UR-05 Expanding capacities and models for the coverage of risks related to climate change and catastrophic damages	UR-05-01 Multidisciplinary analysis/development of proposals for the improvement of legislative regulations related to mandatory insurance models for the purpose of more efficient planning and maintenance of public and private facilities or high risk processes (such as those within the agricultural or construction sector) due to climate change
	UR-05-02 Expanding the types of services and insurance models
	UR-05-03 Raising public awareness and promoting the use of different insurance models

Source: Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures UR-01 and UR-02 are determined as measures of very high importance, while measure UR-03 - UR-05 as measures of high importance. Measures UR-01 - UR-05 are determined as measures within the priority Strengthening of management capacities through a networked monitoring and early warning system.

6.3.11. General measures

In addition to measures for eight key sectors (water resources, forestry, agriculture, fishery, biodiversity, health, energy, tourism), measures for two cross-sectoral areas (spatial planning and development and risk management) in the Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20), general measures of adaptation to climate change were determined as well as activities for their implementation (Table 6-14).

Table 6-14: General climate change adaptation measures and activities for implementation of climate change adaptation measures

Climate change adaptation measure	Activities for the implementation of adaptation measures
KM-01 Strengthening the professional and technical capacities for implementing research and applied activities and operational activities that include the area of climate modelling and predictive technologies for predicting weather and environmental conditions and related warnings of dangerous weather and environmental conditions, as well as analyses and interpretation of observed and expected climate change and dangerous weather phenomena caused by them	KM-01-01 Development of climate models at spatial resolutions of 1–4 km and preparation of climate scenarios for the wider area of Croatia
	KM-01-02 Development of combined climate models (atmosphere-ocean/soil) and preparation of climate scenarios for the Adriatic and Mediterranean area
	KM-01-03 Supporting the development of applied sector models and strengthening capacities for using these models
	KM-01-04 Involvement of new professional capacities in the development of predictive technologies for high-reliability prediction of weather and technological conditions
	KM-01-05 Supporting the development of combined multi- sectoral models for predicting the occurrence and impact of climate change and extreme weather events on different economic sectors and strengthening capacities for applying these models
OM-01 Increasing the level of knowledge and capacities for monitoring climate change impacts, risk assessment and climate change adaptation	OM-01-01 Development of programmes for awareness-raising, information and education of the public, decision-makers, experts, business sector and other stakeholders on climate change impacts and adaptation options

Climate change adaptation measure	Activities for the implementation of adaptation measures
	OM-01-02 Programme for funding research and development of innovative climate change adaptation solutions
	OM-01-03 Establishment and development of a national professional, research and education centre for climate change adaptation and ecosystem preservation
RP-01 Development of implementation impact indicators for the Adaptation Strategy	RP-01-01 Defining the best dataset required for monitoring the impact of implementing the Adaptation Strategy
	RP-01-02 Development of a protocol for monitoring climate change adaptation indicators

Source: Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20)

Measures KM-01, OM-01 and RP-01 are determined as measures of very high importance. Measures KM-01 and RP-01 are determined as measures within the priority Strengthening of management capacities through a networked monitoring and early warning system. Measure OM-1 is determined as measures within the priority Ensuring the continuity of research activities.

6.4. IMPLEMENTATION OF CLIMATE CHANGE ADAPTATION MEASURES AND ADAPTATION ACTIVITIES AND PROJECTS

On April 7, 2020, the Croatian Parliament adopted the Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) (hereinafter: Climate Change Adaptation Strategy). It defined a total of 83 climate change adaptation measures: measures for eight key sectors (water resources, forestry, agriculture, fishery, biodiversity, health, energy, tourism), measures for two cross-sectoral areas (spatial planning and development and risk management) and general measures. In addition, key stakeholders for implementation of climate change adaptation measures and activities were defined. Total amount of investments required for implementation of the Climate change adaptation strategy is estimated at around EUR 3.7 billion for the period up to 2040.

Pursuant to the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19), on the basis of the Climate change adaptation strategy, action plans for implementation of the Climate change adaptation strategy for a five-year period should be prepared. Action plans should contain elaboration of specific measures and activities, i.e. for each measure and activity they should provide a description, method of implementation, sequence of activities, deadline for execution, obligors and coordinators for implementing measures and activities and sources of funding [6-28].

Action plans for implementation of the Climate Change Adaptation Strategy propose the state administration body responsible for environmental protection⁹ and adopt the Government of the Republic of Croatia. Although the Draft action plan for implementation of the Climate Change Adaptation Strategy in the Republic of Croatia for the period from 2019 to 2023 was prepared [6-29] as part of the project "Strengthening the capacity of the Ministry of Environmental Protection and Energy

⁹ During the preparation of this Eighth national communication and the fifth biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC), the state administration body responsible for environmental protection is the Ministry of Economy and Sustainable Development.

for climate change adaptation and preparation of the Draft Climate Change Adaptation Strategy"¹⁰, it was not adopted.

Although a key document for systematic implementation and monitoring of implementation of the Climate change adaptation strategy has not been adopted, activities and projects related to climate change adaptation are carried out, which is briefly described below.

Integration of climate change adaptation into public policies and national development documents

On December 13, 2019, the Croatian Parliament voted the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19), which entered into force on January 1, 2020, except for Articles 22 and 24, which entered into force on January 1, 2021. Climate change was separated from the previous framework of regulations governing air protection, and the Act on Climate Change and Ozone Layer Protection became a key national legal document that reduces impact of climate change and regulates the framework for implementation of European Union acts in the field of climate change and ozone layer protection.

Climate change and thus adaptation to climate change are included in national development documents. The National Development Strategy of the Republic of Croatia until 2030 (Official Gazette 13/21) is a fundamental document and comprehensive strategic planning document that directs a development of society and economy in all important issues for the Republic of Croatia until 2030. It emphasizes that the Republic of Croatia area is exposed to high risks from climate change, which will be one of the challenges that will mark the period until 2030, and recognizes the need for risk prevention, promotion of resilience and adaptation to climate change. This particularly applies to sectors that are particularly sensitive to climate change: water management, agriculture, forestry, energy and tourism, and it also emphasizes that biodiversity, natural terrestrial and marine ecosystems, coastal and urban areas and human health are also at risk. The National Development Strategy of the Republic of Croatia until 2030 supports implementation of the Climate Change Adaptation Strategy.

Development documents of the water management sector include planning of activities and projects for adaptation of water sector to climate change. The River Basin Management Plan for a six-year period is the basic instrument for managing water conditions and flood risks in the Republic of Croatia. An integral part of the River Basin Management Plan 2016-2021 (Official Gazette 66/16) and the Draft River Basin Management Plan 2022-2027 [6-30] is the flood risk management. Draft River Basin Management Plan 2022-2027 emphasizes that negative consequences of climate change make water resources particularly vulnerable and additionally complicate the management of water conditions and management of flood risks. The climate change impact is considered in the context of increased risk of achieving water environment protection goals and increased risk of floods, thus measures are proposed in the area of water management and in the area of flood risk management. A Multi-year Program for Construction of public Utility Water Structures for the period until 2030 (Official Gazette 147/21) is a framework investment program for development of public water supply and public sewage. Its implementation supports the implementation of the Climate Change Adaptation Strategy, namely measure HM-06 and HM-08 - activities HM-08-1 and HM-08-02 (refer to chapter 6.3.1. Water resources). The Draft of the Multi-year Program for the Construction of Regulatory and Protective Water

¹⁰ Project implemented in the period 2015 - 2017 for the Ministry of Environment and Energy to draft the Climate Change Adaptation Strategy of the Republic of Croatia for the period up to 2040 with a view to 2070 and the draft Action Plan. The value of the project was EUR 770 000, and the project was funded through the Transitional Instrument of the European Union for Croatia fund.

Structures and Reclamation Structures for the period until 2030 [6-31] also provides support for implementation of the Climate Change Adaptation Strategy, namely measure HM-02 - activities HM-02-03, HM-02 -04 and H-02-05 (refer to chapter 6.3.1. Water resources) and P-05 - activities P-05-02 and P-05-03 (refer to chapter 6.3.3. Agriculture).

The Agriculture Strategy until 2030 (Official Gazette 26/22) is a fundamental document of the strategic planning of the agriculture sector. Among other things, it takes into account the goals, priorities and measures of the Climate Change Adaptation Strategy, and it was emphasized that climate change is expected to increasingly affect the agricultural and food sector. Therefore, through the development needs, strategic goals and priorities and implementation mechanisms of the Agriculture Strategy until 2030, the need to strengthen the sustainability and resistance of agricultural production to climate change was emphasized. Strategic environmental assessment emphasized the need for all infrastructure projects arising from the Agriculture Strategy until 2030 to be planned to consider potential climate phenomena in the area of their implementation.

Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21) establishes guidelines for long-term economic and social development of the Republic of Croatia towards society with low greenhouse gas emissions. It was emphasized that climate change is the biggest challenge the world is facing and that it causes great damage to the economy, society, and ecosystems. Therefore, it is important to work simultaneously with mitigation to strengthen resistance to climate change and implement climate adaptation measures.

The Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 25/20) leads towards a period of low-carbon energy policy. Adaptation to climate change is emphasized in the context of energy development research and links between mitigation and adaptation to climate change as well as interactions with other environmental components. Through strategic environmental assessment, the need to strengthen the resistance of power system to climate change was emphasized, with an emphasis on power plants for electricity and heat production as well as transmission network. The need to make a study on climate change impact with vulnerability analysis and proposal for climate adaptation measures for the existing large hydropower systems in the Adriatic basin and analysis of reducing a negative impact of climate change adaptation (in terms of energy production), on other water users and on the state water (in terms of climate change).

The Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030 [6-32] is based on five key dimensions of the Energy Union: decarbonization, energy efficiency, energy security, internal energy market and research, innovation, and competitiveness. Key goals for 2030 and measures to achieve key goals were determined. For most of the measures, correlation with climate change adaptation was considered.

The Program for Green Infrastructure Development in Urban Areas for the period from 2021 to 2030 (Official Gazette 147/21) was prepared to establish sustainable, resilient, safe, liveable, and orderly cities and municipalities. Green infrastructure is an important instrument in adapting to climate change. Solutions based on green infrastructure are recognized as cost-effective nature-based solutions with multiple benefits, and the application of green infrastructure represents a sustainable approach to adapting to climate change and managing risks associated with climate change.

The Disaster Risk Management Strategy until 2030 (Official Gazette 122/22) determines long-term disaster-resistant development vision of the Republic of Croatia and the approach to disaster risk

management. It directs activities and investments in the field of risk management, from prevention, preparedness to disaster response. Challenges of changes in climate parameters (extreme temperatures, snow and ice) as well as dangers associated with climate change (floods, droughts, open fires, landslides, soil salinization) are highlighted, and development potentials and needs are determined for them, while respecting other national development documents. and competences for the management of certain groups of risks.

Integration of climate change adaptation into regional and local self-government documents

Pursuant to the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19), units of local (regional) self-government and large cities are obliged to create programs for mitigation of climate change, adaptation to climate change and protection of the ozone layer¹¹.

In the context of climate change adaptation, the widely recognized initiative of the Covenant of Mayors for Climate and Energy can be highlighted. It is one of the voluntary instruments of implementing climate and energy policy of the European Union (EU) by which local administration is actively involved in energy transition to achieve climate and energy goals of the EU. The signatories of the Covenant of mayors for climate and energy undertake: (1) to reduce emissions of carbon dioxide (and, if possible, other greenhouse gases) in the area of their cities or municipalities by at least 40% by 2030 through more efficient use of energy and greater use of renewable energy sources, (2) increase climate change resilience and (3) share their vision, results, experience and knowledge with other local and regional authorities inside and outside the EU through direct cooperation and exchange, especially in the context of the Global compact of mayors. The signatories of the Covenant of mayors for climate and energy are obliged to create and implement the Sustainable energy and climate action plan (SECAP), in which measures for sustainable energy development are determined in accordance with local specificities and in accordance with the assessment of risk and vulnerability to climate change, they also determine adaptation measures to climate change.

Based on regulations and national development documents related to climate change, the Environmental protection and energy efficiency fund published on July 23, 2021, a Public call (JP ZO-6/2021) for direct co-financing of work bases for developing mitigation, adaptation programs for climate change and protection of the ozone layer or bases for preparing energy sustainable development and adaptation to climate change action plans (SECAP) and/or reports on their implementation [6-33]. The right to use funds was available to local and regional (regional) self-government units (working bases for preparing SECAP or reports on its implementation), that is, regional (regional) self-government units and large cities (working bases for creating mitigation programs, adaptation to climate change and the ozone layer protection). The purpose of the call was to encourage and provide support to regional and local self-government to accept the climate goals of reducing greenhouse gas emissions and the goal of adaptation to climate change, and to encourage stakeholders at the local and regional level to consider the impact of climate change on their territory, to assess vulnerability degree and risk of climate change for key sectors in their area so that they can then determine priority measures at the level of local and regional self-government units. Co-financing of working foundations was approved for 50 units of regional and local self-government.

¹¹ Prior to adopting the Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19), local (regional) self-government units and large cities were obliged in accordance with regulations governing air protection to prepare programs for air protection, ozone layer mitigation, climate change mitigation and climate changes adaptation.

Pursuant to the National Development Strategy of the Republic of Croatia until 2030 (Official Gazette 13/21), regional self-government units draw up their own development plans. Development directions, strategic goals and priorities from national level are taken over and elaborated in development plans. This means that development plans of regional self-government units include consideration of risk prevention, increasing resilience and adaptation to climate change.

Integration of climate change mitigation and adaptation in environmental impact assessment of projects

In accordance with regulations governing the environmental impact assessment, climate change is analysed in environmental impact assessment studies i.e. in the procedures for environmental impact assessment of projects and in environmental protection elaborates i.e. in procedures for assessing the need to assess the environmental impact of projects (screening). Mitigation and adaptation to climate change are both analysed in accordance with the guidelines of the European Commission Technical guidance on the climate proofing of infrastructure in the period 2021-2027. (2021/C 373/01) [6-34], Guidance on integrating climate change and biodiversity into environmental impact assessment [6-35] and Guidance for project managers: How to increase the resilience of vulnerable investments to climate change (informal document) [6-36]. In this way at an early stage of planning project investors are given information about possible risks related to climate change, so that activities to increase resilience to climate change could be planned in time.

Integration of climate change mitigation and adaptation into strategic environmental assessment

In accordance with regulations governing strategic impact assessment of strategies, plans and programs on the environment, environmental reports consider climate change through mitigation and adaptation according to the rules of the profession and in accordance with the guidelines of the European Commission for integrating climate change and biodiversity into strategic environmental assessments impact [6-37].

Collaboration projects and research projects

The Ministry of Economy and Sustainable Development as the coordination authority for climate policy implemented a program to strengthen applied research for climate change adaptation measures with the aim of greater involvement of scientists in Croatia in providing solutions for climate change adaptation. Based on this public call, 25 projects in the total amount of about 12 million euros were contracted (2020 - 2023), and a national conference was organized where solutions for adapting to climate change were presented (June 2023). Above this, there are more and more projects addressing climate change risks and adaptation issues lead by different stakeholders and financed from different funds, national and EU.

Knowledge exchange

The website prilagodba-klimi.hr [6-38] is a comprehensive interactive platform on climate change adaptation in the Republic of Croatia. It is intended for the public with different backgrounds and levels of knowledge, public and private sector, government and private institutions and scientific institutions. The site is run by the state administration body responsible for environmental protection¹².

The website prilagodba-klimi.hr is the central place for information and education about climate change adaptation in the Republic of Croatia, and there is possible to find information about: climate and climate

¹² During the preparation of this Eighth national communication and the fifth biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC), the state administration body responsible for environmental protection is the Ministry of Economy and Sustainable Development.

change, future climate scenarios, observed and expected impacts of climate change, sectors and cross-sectoral topics vulnerable to climate change, and examples of good practice and projects that test diverse options for adapting to climate change.

The latest news in the field of climate change and adaptation from Europe and the world is published on the website prilagodba-klimi.hr. Expert texts, interviews, video presentations, etc. on topic of climate change are published in cooperation with scientists, as well as basic information on scientific and research projects on topic of climate change (which includes projects listed in the Cooperation projects and research projects section). Regional and local self-government documents on strengthening resilience to climate change are also available, examples are: Plan for Integral Management of the Coastal Area of Šibenik-Knin County - Coastal plan (2015)¹³, Strategy for applying natural solutions in Climate Change Adaptation of the City of Zadar (2018.), Study and Strategy for Developing Green Infrastructure of the City of Sisak (2021) and others.

Calls for financing climate change adaptation projects

The National Recovery and Resilience Plan for the period 2021-2026 [6-39] (hereinafter: NPOO) is the fundamental document for using funds available to the Republic of Croatia within the Recovery and resilience mechanism. Total estimated value of investments from NPOO for the period 2021 - 2026 in the economy; public administration, judiciary and state property; education, science and research, labour market and social protection; healthcare and building renovation amounts to EUR 6.4 billion¹⁴. In accordance with requirements of binding framework of the Recovery and resilience mechanism, at least 37 % of NPOO funds for the period 2021-2026 should be directed to green transition and fight against climate change.

On September 30, 2022, the Ministry of Spatial Planning, Construction and State Property published call for local self-government units for allocation of grants for developing green urban renewal strategies based on the NPOO for the period 2021-2026 [6-40]. The aim of the call was to provide support to local self-government units in the preparation of green urban renewal strategies in order to encourage the development of green infrastructure in urban areas and the circular management of space and buildings, in order to ensure the foundations of sustainable space development with an emphasis on the development of green infrastructure and the integration of nature-based solutions, integration of the model of circular management of space and buildings, strengthening resistance to risks and climate change, all in support of general sustainable development.

The Environmental Protection and Energy Efficiency Fund is the central place for collecting and investing extrabudgetary funds in programs and projects of environmental and nature protection, energy efficiency and the use of renewable energy sources. The activities of the Environmental Protection and Energy Efficiency Fund related to adaptation to climate change were public calls: JP ZO-6/2021 for direct co-financing of work bases for the creation of mitigation programs, adaptation to climate change and protection of the ozone layer or work bases for the preparation of sustainable energy and climate action plans (SECAP) and/or reports on their implementation (see section Inclusion of climate change adaptation in regional and local self-government documents) and JP ZO 10/2022 for direct co-financing

¹³ In 2019, Šibenik-Knin County received main award "Mediterranean Climate Change Adaptation Awards" for exceptional contribution in the field of climate change adaptation for the Plan for the Integrated Management of the Coastal Area of Šibenik-Knin County - Coastal Plan.

¹⁴ In data source, value is expressed in HRK. The value in EUR is calculated with a fixed conversion rate of 1 EUR = 7.53450 HRK

of the implementation of climate change adaptation measures from national and local planning and strategic documents.

Based on regulations and national development documents related to climate change, the Environmental Protection and Energy Efficiency Fund published on September 21, 2022, a Public call (JP ZO 10/2022) for direct co-financing of implementing climate change adaptation measures from national and local planning and strategic documents [6-33]. Local and regional self-government units had the right to use the funds. The subject of the call was the allocation of funds for the co-financing of works, equipment and services for the implementation of adaptation measures defined in national and local strategic and planning documents, in order to increase resilience of local and regional communities to climate change, i.e. to reduce vulnerability of natural systems and society to negative impacts of climate change and in order to thereby contribute to construction of green and climate-neutral Croatia. Eligible projects and costs were: development of green infrastructure in urban and peri-urban areas, making green and blue infrastructure plan, investments in the preservation and restoration of habitats and strengthening the resistance of urban areas to anthropogenic pressures caused by climate change), projects for exchange of knowledge and experience in applying adaptation measures to climate change (learning from examples of successful cities) and other climate change adaptation measures from adopted climate change mitigation, climate change adaptation and ozone layer protection and SECAP programs.

Based on the Operational program Competitiveness and Cohesion 2014-2020. and in the competence of the state administration body for environmental protection¹⁵, in the period September 23, 2019 - March 31, 2020, a call was opened for submitting project proposals of Scheme for strengthening applied research for climate change adaptation measures - KK.05.1.1.02, for awarding grants to projects that carry out applied research for adaptation measures to climate change. The aim of the call was to support implementation of applied research for climate change adaptation measures in vulnerable sectors (water resources, forestry, agriculture, fisheries, biodiversity, health, energy, tourism) and/or cross-sectoral areas (spatial planning and management and risk management), and in order to encourage improvement of quality and availability of climate data, by strengthening scientific research on possibilities of adapting to climate change in the Republic of Croatia. Based on the call to bid, funds were approved for 25 projects of research organizations [6-41].

¹⁵ During call period state administration body responsible for environmental protection was the Ministry of Environmental Protection and Energy.

7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Article 4, paragraph 3 of the Convention stipulates that the Parties to the Convention which are developed, and other developed parties included in Annex II shall provide new and additional financial resources to fully meet the costs incurred by the developing country Parties in meeting their obligations under Article 12 Paragraph 1. They shall also provide financial means, including those for the transfer of technology required by developing country Parties in order to fully comply with the costs incurred for the implementation of the measures covered by Article 4, paragraph 1 of the Convention.

In this sense, Act on Climate Change and Ozone Layer Protection (Official Gazette 127/19) stipulates the use of revenues from the greenhouse gas emissions auctioning, including the financing of climate change mitigation and adaptation measures in third countries. By the Decision on the adoption of the Plan for the use of Financial Resources Obtained from the Sale of Emission Allowances in Auctions in Croatia by 2020 (Official Gazette 19/18, 84/19), funds for financing projects in third countries were planned, but due to a critical lack of capacity in the competent ministry, it could not be prepared and implemented an adequate program.

7.1. FINANCIAL RESOURCES

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7.2. KNOWLEDGE AND TECHNOLOGY TRANSFER

As an Annex I country, the Republic of Croatia has so far not pursued separate activities related to the financing of transfer of knowledge and technology in the field of environmental protection to developing countries.

It is important to note that as the most recent EU member state with recent experience in the transposition and implementation of EU environmental legislation, the Republic of Croatia is participating in the TAIEX assistance program, with which Croatia is involved in the transfer of knowledge and experience to potential candidate countries for membership in the EU, which are also non-Annex I states (e.g. Bosnia and Herzegovina, Montenegro, Serbia, Albania).

Data on the use of financial resources for 2019 and 2020 are presented in tables 7, 7 (a) and 7 (b) in Annex II: CTF tables for the Biennial Report (19/CP.18).

Table 8 and table 9 in Annex II: CTF tables for the Biennial Report (19/CP.18) remain blank because the Republic of Croatia did not contribute to a program specifically focused on capacity building or technology transfer in developing countries.

8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1. GENERAL POLICY OF RESEARCH AND SYSTEMATIC MONITORING

Research and development

Total expenditures for research and development in the Republic of Croatia GDP for a long period were at a level lower than 1% of the gross domestic product (GDP) [8-1], [8-2], [8-3]. They crossed that limit only in 2019 and continued to grow slightly up to 1.27% of GDP in 2021 [8-1], [8-3]. Most funds are spent in business enterprise sector, then in higher education, and the least in government and private non-profit sector [8-3], [8-4], [8-5]. Thus, in 2021, of total funds spent on research and development activities in the Republic of Croatia in the amount of around EUR 0.72 billion¹⁶, the most was spent in business enterprise sector (46.5 %), followed by higher education (32.3 %) and government and private non-profit sector (21.1 %) [8-3]. The largest part of expenditures for research and development refers to labour costs and employee compensation costs, then to other current costs, and the least to capital expenditures [8-3], [8-4], [8-5] and that distribution in 2021 amounts to: labour costs and employee compensation costs (62.5 %), other current costs (22.8 %) and capital expenditures (14.7 %) [8-3]. Companies mostly finance research and development with their own funds, while the state and private non-profit sector and higher education are mostly financed by the state and local government [8-3], [8-4], [8-5]. Total number of employees in research and development is growing [8-2], [8-3], [8-4], [8-5] and in 2021 it amounts to 27,424 employees [8-3].

The National development strategy of the Republic of Croatia until 2030 (Official Gazette 13/21) highlighted the need to change the approach to research and development, and through several strategic goals, a need to encourage research, development of science, technology and innovative capacities, as well as a better connection of academic, research and business sector was highlighted. In the area of climate change, the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21) emphasizes that it is necessary to integrate low-carbon development into programs to encourage innovation, research and development of high technologies in the private and public sector and makes suggestions of specific measures and topics related to low-carbon technological development, innovation and research. The Climate Change Adaptation Strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 (Official Gazette 46/20) emphasizes a need for research and development in the field of climate change adaptation through a series of measures and their accompanying activities. The importance of investing in research and projects of mitigating and adapting to climate change is also highlighted in the draft proposal of the Smart specialization strategy until 2029¹⁷ [8-6], and it is also mentioned in the development documents of individual sectors.

Research projects and development are financed in addition to core funding, i.e. through permanent financial support and through project funding and other specific calls. Project funding and other specific calls are the dominant source of funding for research and development activities in the field of climate change. The sources of project funding in the field of climate change are various financial instruments

¹⁶ In data sources, total funds spent on research and development are expressed in HRK. The value in EUR is calculated with a fixed conversion rate of 1 EUR = 7.53450 HRK.

¹⁷ The goal of the Smart Specialization Strategy is to strategically define priority areas for encouraging investment in research, development and innovation of public funds, and will represent a key document for directing funds from European Union funds intended for this purpose.

of the European Union and calls and tenders from the Croatian science foundation and the Environmental Protection and Energy Efficiency Fund (refer to chapter 8.2. Research).

Systematic monitoring

The Croatian Meteorological and Hydrological Service (hereinafter: DHMZ) is a state administrative and scientific organization founded in year 1947. DHMZ provides professional tasks related to: monitoring of meteorological and hydrological processes, collection, processing and publication of hydrometeorological data; atmospheric and water resources research; application of meteorology and hydrology in the fields of climatology, marine meteorology, agrometeorology, artificial influence on weather, aviation meteorology, spatial planning and design and other applications; performing international tasks in the field of hydrology and meteorology of interest to the Republic of Croatia [8-10]. Meteorological and hydrological activity is of interest to the Republic of Croatia and DHMZ as a state administration body is responsible for its work to the Republic of Croatia Government [8-7], [8-8]. For the purpose of monitoring meteorological and hydrological elements, phenomena and processes of interest to the Republic of Croatia, a meteorological and hydrological monitoring system was established, which includes a national network of meteorological, hydrological, meteorological-oceanographic and phenological stations that are public goods and infrastructure of interest to the Republic of Croatia [8-8]. The monitoring system is financed from the Republic of Croatia state budget [8-8]. DHMZ manages the work of the national network for continuous air quality monitoring, while the implementation of the program for measuring air pollution levels in the national network is financed by the Environmental Protection and Energy Efficiency Fund [8-9].

Systematic monitoring of a series of data in the field of climatology is monitored by national databases in the field of meteorology, hydrology and air quality, and DHMZ participates in international exchange of meteorological, hydrological and related data through global communication and information system within the framework of the World Meteorological Organization (WMO) and other international systems.

DHMZ represents the Republic of Croatia in international meteorological and hydrological and other related organizations: World Meteorological Organization (WMO), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), European Centre for Medium-Range Weather Forecasts (ECMWF), European Association of Meteorological and Hydrological Services (EUMETNET), the Joint Technical Commission for Oceanography and Maritime Meteorology and the ALADIN consortium and the Earth Observation Group, and actively participates in the work of a number of other international organizations and associations.

Other institutions and organizations also carry out systematic monitoring of individual data for climate change monitoring as part of their work. Hrvatske vode carried out systematic monitoring of the state of surface waters and groundwaters, which was taken over by the Josip Juraj Strossmayer water institute¹⁸ upon its establishment. The source of funds for monitoring the state of water is an income from water fees. The Reference centre for the sea has been designated for the period 2018 - 2024, a community consisting of the Institute of oceanography and fisheries (leader) and the Ruđer Bošković institute (partner) [8-10]. The Reference centre for the sea systematically monitors data and indicators of the state of marine environment, mariculture and fisheries. Funds for the work of the Reference centre for the sea are provided in the Republic of Croatia state budget. The Hydrographic institute of the

¹⁸ The Josip Juraj Strossmayer water institute is a public institution established by the Government of the Republic of Croatia on 23 December 2021. The Water institute was registered in the court register on 23 February 2022.

Republic of Croatia monitors a series of data within the scope of its hydrographic activity, which includes fluctuations in sea level. Funds for carrying out the activities of the Hydrographic institute of the Republic of Croatia, are provided from the state budget, special fees and other sources of funding. The Hydrographic institute of the Republic of Croatia monitors sea levels at six tidal stations, and one station is run by the Geophysics department of the Faculty of science of the University of Zagreb. The Institute for medical research and occupational health participates in air quality monitoring at the stations of the state network for permanent monitoring of air quality [8-9].

The results of systematic monitoring to a certain extent are available on the website and in the publications of DHMZ [8-11], in the information system of environmental protection [8-12], on the Croatian marine spatial data portal [8-13], in the reports of Hrvatske vode [8-14], a number of scientific and professional publications and in other data sources.

In addition to the aforementioned institutions that carry out systematic monitoring, various institutions and entities carry out their own systematic or sporadic monitoring in the field of climatology, and the same one are also carried out as part of individual collaboration projects and research projects (refer to chapter 8.2. Research).

8.2. RESEARCH

Selected completed and active research and similar projects in the field of climate change are listed below.

Croatian Climate Variability and Change – From Global Impacts to Local Green Solutions (CroClimGoGreen) [8-15]

Funding: Croatian Science Foundation and Faculty of Science of the University of Zagreb

Planned implementation period: February 2018 - August 2023

Participants: Faculty of Science of the University of Zagreb and Croatian Meteorological and Hydrological Service

The main goal is investigating urban heat island of Zagreb based on observed data and by performing numerical simulations for the current and future climate conditions, as well as consideration of possibility of implementing green and blue infrastructure and their efficiency with regard to passive cooling. To a certain extent, the project also covers other cities in Croatia. Contribution of large-scale climate variability and teleconnections is investigated, as well as synergistic interaction between large-scale climate variability and urban micro-climate with a purpose to study potential urban heat island amplifying.

Viticulture and Climate Change in Croatia (VITCLIC) [8-16]

Funding: Environmental Protection and Energy Efficiency Fund through Croatian science foundation

Implementation period: April 2017 - March 2019

Participants: Faculty of Science of the University of Zagreb, Croatian Meteorological and Hydrological Service, Faculty of Agriculture of the University of Zagreb, Croatian Centre for Agriculture, Food and Rural Affairs, Institute for Agriculture and Tourism Poreč and Institute of Economics, Zagreb

The main goal was the analysis of current situation in viticulture and assessment and preparation of recommendations of specific climate change adaptation measures. The following was carried out: (1) preparation of spatial-time characteristics of hail in Istria and links with economic and financial aspects of wine and grape production, (2) analysis of phenological phases of grapevine during growing season and basic quality parameters of grapes and wine, (3) determination of relationship between climatic and

phenological data for the current and future climate with reference to the adequacy of existing zoning in Croatia and (4) evaluation of Croatian grapevine native species with regard to their ability to adapt to observed climate change.

The Adriatic Decadal and Interannual Oscillations: Observations, Modelling and Consequences (ADIOS) [8-17]

Funding: Croatian Science Foundation

Implementation period: March 2017 - March 2021

Participants (international collaboration): Institute of Oceanography and Fisheries (Croatia), Ruđer Bošković Institute (Croatia), Faculty of Science of the University of Split (Croatia), Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (Italy) and Centre National de Recherches Météorologiques (France)

The main goal was to investigate and to quantify processes driving interannual to decadal thermohaline variations in the Adriatic-Ionian basin, through: documenting interannual to decadal variability from long-term oceanographic series and existing climate models; investigating short- and long-time processes that drive the Adriatic-Ionian thermohaline circulation, primarily the Adriatic dense water formation and BIOS (Adriatic-Ionian Bimodal Oscillating System); and assessing past and future Adriatic climate and variability from the Adriatic-adopted high-resolution atmosphere/ocean climate model runs.

Life SEC Adapt - Upgrading Sustainable Energy Communities in Mayor Adapt Initiative by Planning Climate Change Adaptation Strategies [8-18]

Funding: LIFE Programme 2014-2020

Implementation period: May 2015 - December 2018

Participants (international collaboration): Partners from Italy, Croatia, Spain and Greece

The goal was to contribute to increasing the capacity of resistance to climate change and to facilitate the transition towards a low-carbon and efficient resource economy in European urban areas. Numerous partners from Italy, Croatia, Spain and Greece participated in the project. Partners from Croatia were the County of Istria, the Istrian development agency and local self-government units: City of Pula - Pola, City of Rovinj - Rovigno, City of Poreč - Parenzo, City of Buzet, City of Labin and City of Pazin. Proposals of strategies and plans for adapting to climate change have been prepared for the aforementioned local self-government units.

AdriAdapt, A Resilience Information Platform for Adriatic Cities and Towns [8-19]

Funding: Interreg Italy Croatia Cross-Border Cooperation Programme 2014-2020

Implementation period: January 2019 - June 2021

Participants (international collaboration): Euro-Mediterranean Center on Climate Change (Italy) and partners: Priority Actions Programme / Regional Activity Centre (PAP/RAC), Croatian Meteorological and Hydrological Service (Croatia), Šibenik-Knin County (Croatia), City of Vodice (Croatia), Society for Sustainable Development Design (Društvo za oblikovanje održivog razvoja - DOOR) (Croatia), IUAV University of Venice (Italy), Union of the Municipalities of Savio valley (Italy), Regional Agency for Prevention, Environment and Energy of Emilia Romagna (ARPAE) (Italy), Municipality of Udine (Italy) and Municipality of Cervia (Italy)

The goal was to support the building of local and regional resilience by developing the knowledge base for identification and planning of appropriate climate change adaptation options, in order to strengthen resilience to climate change of selected settlements on the Adriatic coast. To achieve this goal, numerous activities were carried out: high-resolution climate projections with detailed information on climate parameters for the Adriatic region were created, an overview of various options for adaptation to climate

change was prepared, examples from practice, guidelines and guides and other useful materials on climate change adaptation were created, which are available for interested experts and the general public. Workshops and conferences were held with the aim of exchanging knowledge. The platform was tested in selected Italian and Croatian pilot cities and extended urban areas.

Climate Vulnerability of Croatia and Possibilities for Adaptation in Urban and Natural Environments (Klima-4HR) [8-20]

Funding: Operational Programme Competitiveness and Cohesion 2014-2020

Implementation period: June 2020 - December 2022

Participants: Faculty of Science of the University of Zagreb (Department of biology and Department of geophysics) and Ruđer Bošković Institute

The goal was to investigate the vulnerability of urban and natural environments to climate change and their ability to adapt. The project activities were aimed at identifying and analyzing phenomena with extremely negative ecological, economic and social consequences, which will represent an even greater threat in the conditions of expected climate change. The project includes elements of the environment that are extremely important for the Republic of Croatia, and at the same time are particularly vulnerable to the impact of climate change: Dubrovnik and its coastal area and the Mljet national park. The project included the detection and analysis of extreme heat loads, extreme meteorological phenomena accompanied by convective storms with hail and lightning, prolonged heat waves and dry periods, and the response of target freshwater and marine species to stress caused by climate change. For the area of Dubrovnik, a heat map and a map of vegetation indices were created, which enabled an insight into the link between the type of substrate material and surface temperature and the influence of green areas on the urban climate.

Strategies to Adapt to Climate Change in Adriatic Regions (RESPONSe) [8-21]

Funding: Interreg Italy Croatia cross-border cooperation programme 2014-2020

Implementation period: January 2019 - April 2022

Participants (international collaboration): Informest (Italy) and partners: Croatian Meteorological and Hydrological Service (Croatia), Energy Institute Hrvoje Požar (Croatia), Institute of Oceanography and Fisheries (Croatia), Energy management Agency of Friuli Venezia Giulia (Italy), Regional Agency for Environmental Protection and Prevention of Veneto (Italy), University Polytechnic of Marche (Italy) and Apulia Region (Italy)

The goal was to strengthen the resilience of local communities to climate change and harmonization of access and data exchange for implementation of climate change adaptation measures. Historical climate data in the Adriatic regions were analyzed and it was concluded that most temperature-related variables and indices, including sea surface temperature, show increasing and statistically significant changes, while changes in precipitation variables and indices are more locally specific. Adaptation and mitigation strategies and methods are combined in the Climate Menu tool, which contains 160 climate change mitigation and adaptation measures. Pilot areas for the development of sustainable energy and climate action plans (SECAP) included 6 coastal cities and municipalities, 3 from Croatia (City of Cres, City of Šibenik and City of Ploče) and 3 from Italy. A methodology for risk and vulnerability analysis was standardized and involved both local decision makers and local population. The inclusion of local stakeholders enabled a better identification of the main risks and vulnerabilities of the observed areas and the analysis of mitigation and adaptation measures.

Carstic Coastal Water Management Endangered by Climate Change (UKV) [8-22]

Funding: Operational Programme Competitiveness and Cohesion 2014-2020

Planned implementation period: May 2020 - January 2023

Participants: Faculty of Geotechnical Engineering of the University of Zagreb, Faculty of civil Engineering of the University of Rijeka, Croatian Meteorological and Hydrological Service, Croatian Geological Survey in collaboration with other stakeholders

Project is oriented on research of unwanted consequences of climate change in coastal karst aquifers: salinity and water temperature increase, water quality deterioration, and identification of measures to adapt to them in water resources, tourism, agriculture and health sectors. The main research activities are related to development of climate and hydrological models, analysis of surface and underground water monitoring results, analysis of surface and underground water quality and risk management in conditions of climate change in three pilot areas: Bokanjac - Poličnik basin near Zadar, Blatsko polje on the island of Korčula and Vrana lake on the island of Cres. Preparation of proposals for adaptation measures for the water supply sector and agriculture, health and tourism sectors is planned.

Adaptability Assessment of Maze and Soybean Cultivars of Croatia in the Function of Breeding for Drought Tolerance (AGRO-DROUGHT-ADAPT) [8-23]

Funding: Croatian Science Foundation

Implementation period: April 2017 – March 2019

Participants: Faculty of Agriculture of the University of Zagreb, Faculty of Agriculture of J. J. Strossmayer University in Osijek, Agricultural Institute Osijek, Croatian Centre for Agriculture, Food and Rural Affairs, Croatian Meteorological and Hydrological Service, BC institute Zagreb, Križevci University of Applied Sciences, Institute for agriculture and tourism Poreč and Institute for Adriatic cultures and karst reclamation

The goal was to investigate during two successive years and throughout Croatia (continental and coastal areas) genetic adaptability of the most important sorts of corn and soybean in terms of drought tolerance in order to identify superior germplasms and optimum selection method for the purpose of plant breeding.

Vitality of Common Beech (*Fagus sylvatica* L.) in Changing Climate Conditions (VitaClim) [8-24]

Funding: Croatian Science Foundation

Implementation period: November 2018 – October 2022

Participants: Croatian Forest Research Institute and Croatian Meteorological and Hydrological Service
Changed climate conditions are considered critical for the conditions of trees, as they determine the availability of water in terms of its absorption and transport in trees, and water deficit causes insufficient plant nutrition and consequent loss of vitality. The main goal of this project was to research impact of changed climate conditions on various indicators of tree vitality (crown defoliation, nutrition, photosynthesis, radial growth), as well as their potential interrelations, in order to provide basis for various decision-making processes related to forest management, forest ecosystem services, reporting on the state of forests as well as planning to mitigate consequences of climate change.

Climate Change Adaptation Measures for Sustainable Management of Natural Resources (MEMORIE) [8-25]

Funding: European Fund for Regional Development

Planned implementation period: January 2020 - January 2023

Participants: Faculty of Forestry and Wood Technology of the University of Zagreb, Faculty of Agriculture of the University of Zagreb, Faculty of Science of the University of Zagreb in collaboration with other stakeholders

The goal is to contribute to solving the problem of lack of data and research papers on impact, vulnerability, resilience and possibility of adaptation to climate change in vulnerable sectors based on natural resources: forestry, natural ecosystems and biodiversity and agriculture. Knowledge and

databases are the basis for the analyses of vulnerability and resilience of forests, nature and biological diversity, and agriculture in relation to predicted climate change models. On the basis of the analyses carried out and in the multi-sector consideration, the creation of a manual with guidelines and adaptation measures is planned.

I-STORMS - Integrated Sea sTORM Management Strategies [8-26]

Funding: European Fund for Regional Development

Implementation period: January 2018 - March 2020

Participants (international collaboration): Collaboration of numerous organizations, including weather services, civil protection and emergency services and scientific organizations, in Albania, Greece, Croatia, Italy and Slovenia (Adriatic-Ionian region)

The goal was to improve transnational cooperation in the exchange of knowledge, data and forecasts through common infrastructure and a joint strategy for managing the risks of sea flooding and at the same time improving the capacities of data interoperability, early warning systems and strengthening the application of the European Union civil protection and rescue mechanisms. Among other things, Sea storm atlas was developed, an online data mapping tool that includes emergency procedures and information on past coastal disasters to identify sensitive areas. An application for smartphones and tablets that provides easier access to information and warnings about potential flooding of the coast of Adriatic-Ionian region was developed as well.

Climate Change Information, Monitoring and Management Tools for Adaptation Strategies in Adriatic Coastal Areas (AdriaClim) [8-27]

Funding: Interreg Italy Croatia Cross-Border Cooperation Programme 2014-2020

Planned implementation period: January 2020 - June 2023

Participants (international collaboration): Environment and Energy of Emilia Romagna (ARPAE) (Italy) in collaboration with numerous partners from Italy and Croatia. Partners from Croatia: Zadar County Development Agency ZADRA NOVA, Dubrovnik-Neretva County, Ruđer Bošković Institute, Institute of Oceanography and Fisheries, Public Institution RERA SD for Coordination and Development of Split-Dalmatia County and Istria County

The goals are: (1) increasing the climate change adaptation capacity of the coastal area by improved monitoring (measurement systems with integrated models) (2) improving knowledge, capacity and cooperation on climate change observing and modelling systems in the program area and (3) developing advanced information systems, tools and indicators for optimal planning of adaptation to climate change and mitigating its consequences.

Production of Food, Biocomposites and Biofuels from Cereals in the Circular Bioeconomy (KLIMA project) [8-28]

Funding: European Fund for Regional Development

Planned implementation period: September 2019 - June 2023

Participants: University of Zadar, Faculty of Agriculture of the University of Zagreb, Faculty of Textile Technology of the University of Zagreb

The project includes applied research on correct agrotechnical measures for old and new wheat and barley varieties and corn hybrids in order to determine the optimal ratios between grain and biomass as well as the presence of mycotoxins. In addition to the quantity, the quality of grains for food and nutrition is planned to be determined, as well as carbon sequestration in soil and plants, as well as the quality of biomass for biocomposites, biofilters, second-generation bioethanol and solid biofuels from production residues. By utilizing the remains, potential waste becomes raw material and closes the circular

bioeconomy process. New knowledge is intended for stakeholders of vulnerable sectors and for raising the awareness of general public about the possibilities of mitigating negative impacts of climate change.

Improvement of Non-Structural Measures of Flood Risk Management in the Republic of Croatia (VEPAR project, Water-Ecological Monitoring, Analyses and Solutions)

Funding: European Fund for Regional Development

Planned implementation period: September 2019 - 2023

Participants: Croatian Waters and Croatian Meteorological and Hydrological service

The goal is to establish improved flood risk management throughout the Republic of Croatia, by implementing non-construction measures that should result in a reduction of flood risk, through improvements in monitoring, analyses and finding optimal solutions for integral and sustainable management of water, water environment and flood risks in the Republic Croatia.

Assessment of Adriatic Algae Potential in Cogeneration Production of 3rd Generation Biofuel (A3-PICO-3G) [8-30]

Funding: Croatian Science Foundation

Implementation period: April 2017 - March 2019

Participants: Ruđer Bošković Institute and INA d.d.

The main goal was to create a scientific basis for cultivation of Adriatic microalgae in industrial wastewater and to conduct a preliminary feasibility study to assess the conditions of wastewater from INA d.d. oil refinery plant as the basis for cogeneration production of 3rd generation biofuels. The project results are intended to ensure a better exchange of information and knowledge between the business sector and scientific community in development of green energy sources, significantly increase the competitiveness of the Croatian petrochemical industry, and contribute to development of the Croatian blue bioeconomy. This contributes to the global search for ecologically and economically sustainable alternative production of green (biological) fuels and to the reduction of wastewater emission loaded with nutrients and organic substances in the sea.

Energy-Independent Croatia Based on a High Share of Renewable Energy Sources and Various Rapid Response Technologies (RESFLEX) [8-31]

Funding: Croatian Science Foundation

Implementation period: April 2017 - March 2019

Participants: Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb

The goal was to support the reduction of carbon dioxide emissions by 2050 with the help of economic instruments for defining climate protection policy, increasing the use of renewable sources and energy efficiency.

ESCOM – Evaluation System for CO₂ Mitigation [8-32]

Funding: Croatian Science Foundation

Implementation period: April 2017 - March 2019

Participants: Faculty of Mining, Geology and Petroleum Engineering of the University of Zagreb

The main goal was to raise awareness of possibilities of oil and gas industry for reducing emissions, through a website and an online tool for rough assessments of implementation of various methods for estimating lower energy consumption, CO₂ emissions, CO₂ storage potential, etc.

Sustainable Concept for Integration of Distributed Energy Storage Systems (SUCCESS) [8-33]

Funding: Croatian Science Foundation

Implementation period: April 2017 - March 2019

Participants: Faculty of Electrical Engineering and Computing of the University of Zagreb (FER) and HEP Operator distribucijskog sustava Ltd (HEP-ODS)

An increasing integration of renewable energy sources, their variability and uncertainty, requires new ways of planning and managing the energy system compared to the "fit and forget" approach. Installing energy storage systems near the point of consumption significantly changes the concept of distribution networks, which are traditionally passive networks with one-way power flows. Energy storage systems increase the flexibility and efficiency of distribution network, reduce operating costs, increase the security of supply to customers, stabilize the price of electricity and enable the interaction of end users with the power system. Implementation of the project was designed in phases: (1) Detailed analysis of regulatory and market frameworks in Europe and the USA in order to identify best practices in the development of distribution systems and markets, as a basis for proposals for changes in national regulations and management and planning of distribution networks. (2) Development of new algorithms for management and operation of distribution systems, whereby energy storage technologies will play a key role in providing flexibility services to the system operator and end users. (3) Development of a laboratory for testing the ability of battery systems to provide the required flexibility services within the Smart Grid laboratory of FER.

8.3. SYSTEMATIC OBSERVATIONS

Meteorological observation network

Meteorological observations include two types of data: visual observations of weather phenomena and instrumental measurements.

The Republic of Croatia has a long tradition in monitoring segments of the climate system, including meteorological data. The first official meteorological station was established in 1,851 in Dubrovnik, but it later had interruptions in its work. Stations all over Croatia followed, and by year 1900, 160 stations were established. The oldest station with continuous meteorological observations is Zagreb-Grič, where observations began on December 1, 1861, and are carried out to this day without a single day's interruption. Stations with hundreds of years of meteorological data are: Osijek, Požega, Gospić, Crikvenica and Hvar.

In Croatian Meteorological and Hydrological service (hereinafter: DHMZ), mostly manual observations are still carried out by observers at 40 synoptic stations (34 DHMZ + 6 locations of the Croatian air traffic control), 98 climatological stations, 325 rain gauge stations and 22 totalizer rain gauges (Figure 8-1). Existing automated weather stations (AMP) are co-located with 34 synoptic stations, while there are 30 independent AMPs in other locations. The standard time resolution of AMP data is 10 minutes. Furthermore, at individual meteorological stations, monitoring of soil conditions and measurements of soil temperature and humidity, solar radiation and evaporation from the water surface are carried out. In order to obtain the vertical profile of atmosphere, radiosonde measurements are performed in Zagreb and Zadar two times per day (00 and 12 UTC). Remote measurements of the atmosphere include 6 C-band meteorological radars (5 meteorological radars are in function since the beginning of 2023), 2 wind profilers (Dubrovnik and Monte Kope in Istria), one LIDAR in Slavonski Brod and one microwave radiometer (Monte Kope). In order to determine physical characteristics of the sea, 5 moored buoys were installed in the eastern part of Adriatic Sea, they include AMPs for measuring atmospheric parameters at buoys locations.

Modernization of more than 400 meteorological stations in the Republic of Croatia began on October 1, 2017, through the project Modernization of the national weather observation network in Croatia (METMONIC), which is one of the strategic projects of DHMZ and state administration body for environmental protection¹⁹ in the European Union thematic goal of adapting to climate change in the financial period 2014-2020 from which the METMONIC project is co-financed with the amount of 85 %, while the Republic of Croatia contribution is 15 %. It is planned to complete the METMONIC project in 2023.

The modernized network data of meteorological stations will serve for many purposes: for continuous monitoring of weather, climate and climate change and model calibration; for warnings of dangerous weather conditions as support to climate change adaptation systems and action in case of natural disasters; for development of policies for climate change adaptation and mitigation; for environmental planning and management for example, for better monitoring and assessment of long-distance cross-border pollution, analysis and application of modelling techniques for geographic distribution of pollutant concentrations; for planning sustainable activities in the economy; for the purpose of producing renewable energy, etc.

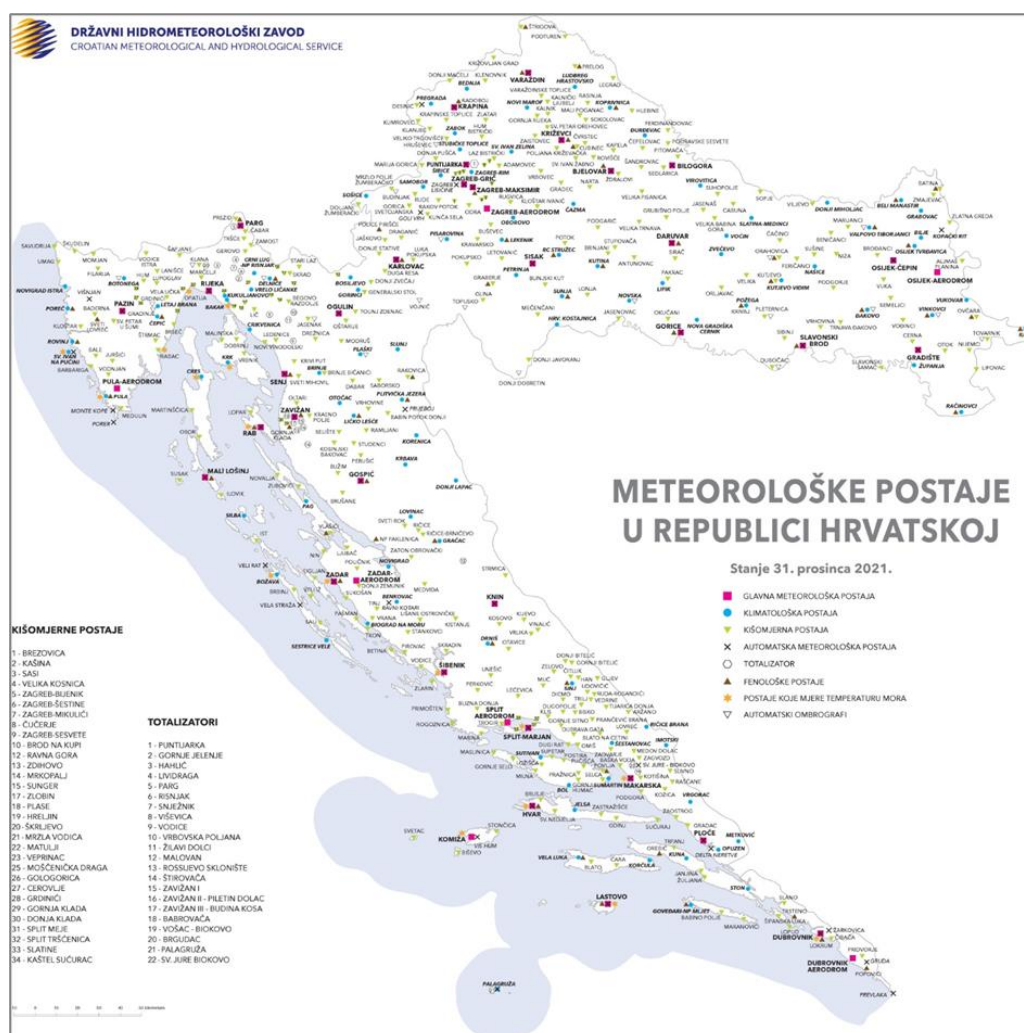


Figure 8-1: Meteorological stations of the Croatian Meteorological and Hydrological Service

¹⁹ During the preparation of this Eighth national communication and the fifth biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC), the state administration body responsible for environmental protection is the Ministry of Economy and Sustainable Development.

Hydrological observation network

Monitoring of hydrological data in the Republic of Croatia also has a long tradition. The first notes on the water level height in Croatia date from the 17th century. The first hydrological station on the Sava river near Stara Gradiška was established in 1817. Not long after, several more hydrological stations were established on the Sava, Drava, Danube and Kupa rivers. The first flow measurements in Croatia on the Sava River were carried out in the period 1840-1844. Flow measurement service within the construction department of the Royal Croatian-Slavonian-Dalmatian land government was established in 1866 and by year 1918, 181 measurements were made.

Today, the hydrological monitoring network of DHMZ includes surface water monitoring network and groundwater monitoring network.

Basic network of hydrological stations has the function of determining water balance and statistical data analysis of continuous and long-term monitoring. In addition to the standard field collection of hydrological data in a form of direct field measurements of flow, profile recording, field observations and controls, there is also a system of automatic data collection from telemetry hydrological stations.

Measurement of the surface streams flow in 2021 was carried out at 292 hydrological stations (Figure 8-2). DHMZ participates in various data exchange programs including sending flow data to international data centers: GRDC 1 station, WISE-SoE 19 stations and EFAS 48 stations.

Modernization of the surface water monitoring network, which includes renovation of existing and installation of new stations, began in 2021 through the Project for improvement of non-structural flood risk management measures in the Republic of Croatia (VEPAR, water ecological monitoring, analysis and solutions). It is planned to complete the VEPAR project in 2023.

Groundwater level monitoring by DHMZ in the Pannonian part of Croatia is carried out as part of the national monitoring network. Monitoring is established at hundreds of piezometers in the western part of the Drava and Sava basins (Figure 8-2). The network of stations monitoring the groundwater level consists of nearly 700 stations, of which 44 limnigraphic stations and 306 piezometers are in the Drava and Danube basins, and 52 limnigraphic stations and 294 piezometers are in the Sava basin. Limnigraphic stations provide groundwater level data every hour, and piezometer stations are monitored twice a week. Data from 15 stations are sent to the WISE-SoE database of the European environment agency.

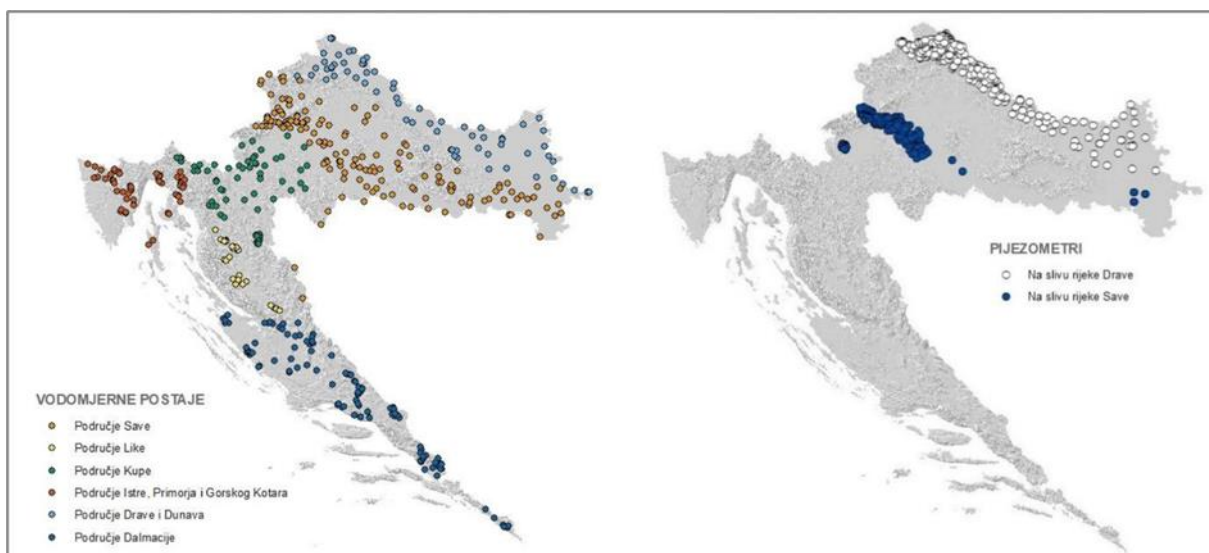


Figure 8-2: Hydrological monitoring network of the Croatian Meteorological and Hydrological Service

National network for continuous air quality monitoring

Air quality in the Republic of Croatia is monitored within the national network for continuous air quality monitoring and within local air quality monitoring networks in counties and cities, which also include special purpose measuring stations where the impact of individual pollutants on air quality is monitored.

DHMZ manages national network for continuous air quality monitoring, ensures the establishment of new stations in the national network; ensures and implements air quality monitoring and is responsible for implementing the air quality measurement program at national network stations. In addition to the DHMZ, the Institute for medical research and occupational health (hereinafter: IMI) participates in monitoring the air quality at the national network stations.

The number of stations, as well as the measurement program at them is periodically changed and continuously improved. Locations of measuring stations of the national network for continuous air quality monitoring and the range of measurements are determined by special regulations governing air protection. DHMZ and IMI submit to the state administrative body responsible for environmental protection the annual implementation plan of the Air pollution level measurement program in the national network by September 30 of the current year for the next calendar year.

Implementation of the Expansion and modernisation of the national network for continuous air quality monitoring (AIRQ) project started in May 2017, with aim to improve air quality management and monitoring in order to achieve effective control and management of air quality in urban areas, zones and agglomerations and to fulfil obligations of the European and national legislative framework governing the protection of air quality. The AIRQ project also improves the program for monitoring short-lived climate forcers (SLCF). The AIRQ project is financed through the Operational program Competitiveness and cohesion 2014-2020 (85 %) with co-financing from the Environmental Protection and Energy Efficiency Fund (15 %). It is planned to complete the AIRQ project in 2023.

Monitoring of surface waters and groundwater status

Control over surface waters, including coastal waters, and underground waters is carried out by systematic monitoring of the water state (hereinafter: monitoring). Monitoring is carried out by Hrvatske

vode until it is taken over by the newly established Josip Juraj Strossmayer water institute. Monitoring is carried out on the basis of the annual monitoring plan.

Monitoring is carried out as supervisory monitoring (determining long-term changes), operational monitoring (determining changes due to the implementation of measures in areas that have been determined not to meet the conditions for good condition) and research monitoring (determining unknown relationships). Monitoring includes indicators necessary to determine: volume, level, flow, speed, hydromorphological features, ecological and chemical condition and ecological potential for surface waters, chemical condition for waters of territorial sea and quantitative and chemical condition for underground waters, and may also include others indicators for protected areas - areas of special water protection.

Monitoring of data and indicators of marine environment, mariculture and fisheries

Reference center for the sea: association of the Institute of oceanography and fisheries (leader) and the Ruđer Bošković institute (partner) in the period 2018 - 2024 systematically monitors data and indicators of marine environment, mariculture and fisheries with the goal of monitoring and observing the state of Adriatic Sea and performing other professional tasks related to sea protection. The Reference center for the sea monitors data and indicators of marine environment, mariculture and fisheries on the basis of annual work program through which the regulations governing the sea protection are respected, the Action Program of the Marine Environment and Coastal Area Management Strategy - Monitoring and Observation System for Continuous Assessment of the Adriatic Sea (Official Gazette 28/21) and others.

The Hydrographic institute of the Republic of Croatia monitors sea levels at six permanent tide gauge stations (Rovinj, Zadar, Split, Ploče, Dubrovnik and Rijeka). The oldest maroeographic station Bakar, founded in 1929, is run by the Geophysics Department of the Faculty of science of the University of Zagreb.

National contribution to observation of the surface and upper-air atmospheric essential climate variables, atmospheric composition, oceanic and terrestrial domain essential climate variables

Table 8-1 presents all stations in the Republic of Croatia for monitoring segments of the climate system, including national contribution to observation of the surface and upper-air atmospheric essential climate variables, atmospheric composition, oceanic and terrestrial domain essential climate variables.

Table 8-1: National contributions to observation of the surface and upper-air atmospheric essential climate variables, atmospheric composition, oceanic and terrestrial domain essential climate variables

Contributing networks specified in the GCOS implementation plan	Essential climate variables (ECVs)	Number of stations or platforms in operation	Number of stations or platforms operating in accordance with the GCMP (Global Climate Monitoring Principles)	Number of stations or platforms expected to be operational in 2020	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS surface network (GSN)	Air temperature	140	140	138	40	40
	Precipitation	466	466	450	40	40

Contributing networks specified in the GCOS implementation plan	Essential climate variables (ECVs)	Number of stations or platforms in operation	Number of stations or platforms operating in accordance with the GCMP (Global Climate Monitoring Principles)	Number of stations or platforms expected to be operational in 2020	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Weather Watch / Global Observing System (WWW/GOS) of surface network	Air temperature and pressure, wind speed and direction, water vapour, precipitation	40	40	40	40	40
Baseline surface radiation network (BSRN)	Sunshine duration	40	40	40	40	40
Sun irradiation and balance of radiation	Surface radiation	10	10	10	5	5
Drafting sea buoys	Air temperature and pressure	0	0	0	0	0
Fixed buoys	Air temperature and pressure	0	0	0	0	0
Voluntary observing ship climate project (VOSclim)	Air temperature, air pressure, wind speed and direction, precipitation	0	0	0	0	0
Ocean reference mooring network and sites on small, isolated islands	Air temperature, air pressure, wind speed and direction, precipitation	0	0	0	0	0
GCOS upper air network (GUAN)	Upper-air temperature, wind speed and direction, water vapour	1	1	1	1	1
Full WWW/GCOS upper air network	Upper-air temperature, wind speed and direction, water vapour	2	2	2	2	2
World Meteorological Organization / Global Atmosphere Watch (WMO/GAW), Network for atmospheric CO ₂ & CH ₄ and other greenhouse gaseous	Carbon dioxide	1	1	1	0	0
	Methane	0	0	0	0	0
	Other greenhouse gaseous	5	5	10	5	5
WMO/GAW ozone-sonde network	Ozone	0	0	0	0	0
WMO/GAW aerosol network	Optical depth of the aerosols	0	0	0	0	0
	Other properties of the aerosols	15	15	20	5	5

Contributing networks specified in the GCOS implementation plan	Essential climate variables (ECVs)	Number of stations or platforms in operation	Number of stations or platforms operating in accordance with the GCMP (Global Climate Monitoring Principles)	Number of stations or platforms expected to be operational in 2020	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global sea level observing system (GLOSS)	Sea level	0	0	0	0	0
Argo network	Temperature, Salinity, Currents	0	0	0	0	0
GCOS baseline river flow network	River flow	300	300	350	50	50
WWW/GOS Synoptic Network	Snow cover	40	40	40	40	40

9. EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1. GENERAL POLICY ON EDUCATION, TRAINING AND PUBLIC AWARENESS

The Environmental Protection Act (Official Gazette 80/13, 153/13, 78/15, 12/18, 118/18) stipulates that the Republic of Croatia ensure implementation of education for environmental protection and sustainable development in educational system and encourages development of the environmental protection system as well as environmental protection improvement.

The Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21) (hereinafter: Low-Carbon Strategy) highlights that education system should become a leader in promoting principles of low-carbon development. Systematic raising of knowledge about sustainable development and climate change should take place through:

- continuous improvement of education level on sustainable development and climate change issues in education system (primary school, secondary school, higher schools, colleges, and universities),
- adaptation of high school and higher education learning programs to master knowledge and skills related to low-carbon economy and smart specialization,
- lifelong learning through the media (newspapers, television, and the Internet), which will educate all people, including those who are no longer in the process of institutional education about low-carbon development,
- development of application tools for calculating and monitoring ecological footprint and carbon footprint for young people, for their activities, for educational institutions, households, transport and
- support for developing centres of educational excellence, support for developing technological demonstration parks, laboratories, "life laboratories" such as university campuses.

Transition process towards a low-carbon economy is continuous and long-term and affects the entire society and economy. Among other things, it is necessary to change the way of understanding and behaviour patterns and to incorporate low-carbon solutions into social life organization, production, consumption, and development management in direction of increasing sustainability. To incorporate low-carbon development into key aspects of society and economy, continuous activities to raise awareness and knowledge about the importance of low-carbon development are necessary. In this context, it can be emphasized that the Low-Carbon Strategy was developed in an inclusive and transparent manner, with cooperation of numerous stakeholders (representatives of public authorities, representatives of scientific, educational and professional institutions, non-governmental organizations, professional chambers and other interested public) through workshops, public presentations, e-counseling and information publication on websites, which contributed to raising awareness and knowledge about the need to mitigate climate change.

The Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) (hereinafter: Climate Change Adaptation Strategy) was also developed in an inclusive manner, in collaboration with sectoral and cross-sectoral experts and scientists and with contribution of interested stakeholders (representatives of public authorities, representatives of scientific, educational and professional institutions, non-governmental organizations, professional chambers and other interested public) through workshops, public presentations, e-counseling and

information publication on websites. The Climate Change Adaptation Strategy through numerous of measures and activities emphasizes the need to raise awareness and knowledge about necessity of strengthening resistance to climate change and adapting to it. Considering that frequency of meteorological extremes is increasing and that consequences of climate change can be seen in everyday life, climate change adaptation is an increasingly common topic in the public space and thus in the general public.

9.2. PRIMARY, SECONDARY AND HIGHER EDUCATION

The fundamental values of the National Curriculum for Early and Preschool Education (Official Gazette 5/15) derive from commitment of Croatian education policy to a complete personal development of the child, to preservation and development of the national, material, natural and spiritual heritage of the Republic of Croatia, to European coexistence and to creating societies of knowledge and values that will enable progress and sustainable development. Therefore, upbringing and education of preschool children encourages their active participation in social life and promotes their responsibility towards the general social good, nature and towards themselves and others.

According to national curricula of subjects in primary and secondary education, knowledge about climate is acquired primarily by primary school and high school students in the contents of regular classes in the subject of Geography and within the subjects of Nature, Nature and Society and Chemistry. Acquiring knowledge about climate is also an integral part of vocational education programs for certain professions and qualifications. An example is the education program for the profession of Energy technician, which includes an optional subject of Renewable energy sources.

The importance of sustainable development has been recognized for a long time in Croatian education system, but only in 2019, with adoption of the Curriculum for the Cross-Curricular Topic of Sustainable Development (Official Gazette 7/19), sustainable development became an independent term in the education system. The cross-curricular topic of Sustainable development encompasses all three dimensions of sustainability: environmental, social and economic and their interdependence, and provides students with knowledge about the needs of the modern age on a global and local level, as well as knowledge about diversity of nature, necessity of sustainable management of natural resources, load limit, human potential, personal and shared responsibilities and rights. The cross-curricular topic of Sustainable development is achieved by connecting educational areas and teaching topics of all subjects and is carried out within the framework of compulsory and optional subjects, class teacher hours, integrated teaching, as part of projects, as part of extracurricular teaching, field teaching and in extracurricular activities.

In the science system, topics of climate and climate change are the subject, independently or integrated, of a series of undergraduate, graduate, and postgraduate university and professional studies at universities [9-1].

In addition to institutional system of upbringing and education, one can highlight projects and programs with topic of environmental protection and sustainable development of GLOBE and SEMEP, the Eco-school project, the national program Young guardians of nature, which provide a thematic and substantive framework for environmental education activities, enable networking of institutions with similar interests and ensure mutual support and exchange of experiences.

The GLOBE program - Global Learning and Observation for Benefit of the Environment was launched in 1995 in the United States of America. The GLOBE program envisages regular and continuous measurements and observations performed by students in the immediate environment of the school. Measurements and observations are carried out in the atmosphere, water, soil and cover, and the results of research complement each other and are connected, thus making a program of complete monitoring of the state of the environment. A large number primary and secondary schools in the Republic of Croatia and several kindergartens are included in the GLOBE program [9-2].

The international Eco-School program was developed by the Foundation for Environmental Education (FEE). The Eco-school program has been implemented since 1994 and is recognized as one of the most successful models of environmental education in the world. The national coordinator and manager of the Eco-school program is the association of Lijepa naša. In the Republic of Croatia, large number of educational institutions have active status of Ecoschools and Ecofaculties [9-3].

9.3. PUBLIC INFORMATION CAMPAIGNS

The Republic of Croatia has been a member of the Aarhus Convention since June 2007. The principles of the Aarhus Convention are integrated into the Environmental Protection Act as well as into other national regulations. Croatia reports on this periodically and constantly improves the system in order to enable public access to environmental data, the participation of the public and associations in the drafting and adoption of regulations and other environmental issues, and to enable access to judiciary in environmental matters.

Print media and portals monitor various areas of environmental protection and write articles about climate and climate change, harmful consequences of climate change and meteorological extremes (drought, heat, floods, storms), use of renewable energy sources, and about international obligations and activities of the Republic of Croatia in relation to climate change. Radio and television stations occasionally provide information on climate issues in informative and scientific-educational programs.

The state administration body responsible for environmental protection²⁰ is also responsible for climate change and informs and works to raise awareness of different stakeholders about the need to mitigate climate change, about expected effects of climate change in Croatia, as well as ways of adapting to it. In its activities, the state administration body responsible for environmental protection cooperates with and has the support of other state administration bodies responsible for individual sectors, which in their areas also work to increase awareness of the need to mitigate and adapt to climate change.

Examples of state administration's work with professionals and the public:

- Consultations of the Ministry of Economy and Sustainable Development in the period October 2020 - May 2021 on climate ambitions of the European Union and scenario for the Republic of Croatia to achieve greater emission reductions by 2030 and climate neutrality by 2050 [9-4].
- Conference on the Future of Europe - Croatia's transition towards climate neutrality [9-5], as part of which the Directorate for climate activities of the Ministry of Economy and Sustainable Development held in the period September 20 – October 11, 2021, eight panel discussions for

²⁰ During the preparation of this Eighth national communication and the fifth biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC), the state administration body responsible for environmental protection is the Ministry of Economy and Sustainable Development.

decision makers, business sector, scientists, media, education, trade unions, civil society and youth in order to hear the thoughts of these groups regarding the challenges and opportunities for a fair and efficient transition of Croatia towards climate neutrality.

- Website of the Ministry of Economy and Sustainable Development prilagodba-klimi.hr [9-6] is an interactive platform and a central place for information and education about adaptation to climate change in the Republic of Croatia. It is intended for the public with different backgrounds and levels of knowledge, public and private sectors, governmental and private institutions and scientific institutions (refer to chapter 6.4. Implementation of climate change adaptation measures and adaptation activities and projects).
- Website of the Institute for Environmental and Nature Protection of the Ministry of Economy and Sustainable Development [9-7] contains, among other things, the National inventory report (NIR) of greenhouse gas emissions.
- The National Energy Efficiency Portal [9-8] of the National Coordination Body for Energy Efficiency is the central place for coordinating energy efficiency activities.
- Website of the Ministry of Spatial Planning, Construction and State Property which, among other things, contains information on green transition and energy renovation of buildings [9-9] and energy efficiency in buildings [9-10].
- Conferences and seminars held as part of the Energy and Climate Change Program [9-11], which is led by the Ministry of Regional Development and European Union Funds in cooperation with the Energy Institute Hrvoje Požar and the Norwegian Water Resources and Energy Administration with the aim of introducing and applying technologies with lower carbon emissions, improving energy efficiency and increasing the security of energy supply.
- Croatian Meteorological and Hydrological Service (DHMZ) monthly, seasonally, and annually informs the public, users and experts about climate assessment via the website [9-12] and press releases.

Seminars, round tables, workshops, thematic events on climate change for professionals and the public are organized and conducted by professional institutions and scientific institutions (refer to chapter 9.4. Training programmes) and non-governmental associations.

Examples of activities in which non-governmental organizations participate:

- The METAR Project for Better Climate (Education, Transition, Adaptation and development Network) [9-13] whose goal is to establish a permanent thematic network of capacitated civil society organizations, local self-government units and scientific research institutions that, by including them in all phases of public policy development, will contribute to transition to a low-carbon society adapted to climate change without energy poverty. Participants in the project: Society for Sustainable Development Design (Društvo za oblikovanje održivog razvoja - DOOR) (lead partner) and partners: City of Zagreb, Faculty of Electrical Engineering and Computer Science, University of Zagreb, Institute for Social Research in Zagreb, Terra Hub, Eko-Zadar, Brodsko ekološko društvo, Institute for Political Ecology, Zelena akcija, Zelena Istra and Forum for Freedom of Education. Estimated duration of the project is October 2020 - October 2023.
- The JEDRO Project - Public Policies for Sustainable Social Development: Water, Energy, Waste [9-14] whose goal is to collect and analyse data and contribute to the improvement of the management system in three key thematic areas (water, energy and waste) as a contribution to solving the ecological crisis and climate change. Participants in the project: Zelena akcija (lead partner) and partners: Faculty of Political Science of the University of Zagreb, Society for Sustainable Development Design (Društvo za oblikovanje održivog razvoja - DOOR), Zeleni

Osijek, Association for Nature, Environment and Sustainable Development Sunce, Green Energy Cooperative, Brodsko ekološko društvo, Ecological Association Krka Knin, PAN - Association for Protection of Environment and Nature and ZMAG - Green Network of Activist Groups. The project started in October 2020.

- The Climate change Mitigation Program for Sustainable Slavonia and Baranja project of the Association for protection of nature and environment Zeleni Osijek [9-15] implemented in the period July 2021 - February 2022. Project included following activities: (1) Action plan for mitigating climate change - research into impact of climate on biodiversity and flood protection and development of revitalization concepts, (2) raising awareness of climate change, (3) the Drava and Danube visitor centre and (4) development of educational program Mitigation of climate change in Eastern Croatia. Zeleni Osijek also implements the project Youth and the climate future of Eastern Croatia.

9.4. TRAINING PROGRAMMES

There are several renowned professional and expert institutions in the Republic of Croatia that carry out activities related to information, education of professionals, as well as interested general public and business entities about climate change: Croatian chamber of economy (HGK), International Institute for Climate Activities (IICA), Croatian employers' association (HUP), Croatian green building council **Zgradonačelnik**, TERRA HUB, Zelena energetska zadruga (ZEZ) and others.

Examples of activities of professional institutions:

- In just ten days, with the support of 93 new and 15 existing members, ZEZ Sunce collected EUR 140,000 in necessary investments for the construction of a solar power plant owned by citizens at the City Market in Križevci.
- IICA – ESG in agreement with world-renowned partners, it establishes and implements education that is aligned with the highest global, professional and ethical standards with the aim of educating experts who contribute to the organization's progress in development while preserving the environment
- HGK_COR AKCELERATOR [9-16] platform promotes partnership between the business sector, state institutions and the civil sector in achieving goals of sustainable development. In section Role of the business sector in achieving the 13th Sustainable development goal, it contains examples from domestic practice of the business sector as response to climate change.
- Workshop Impact of weather, climate and climate change on agricultural production held on February 18, 2020, in cooperation with HGK and Croatian Meteorological and Hydrological Service (DHMZ).
- Conference Climate change in Croatia: What can and must we do? held on May 25, 2019, organized by HGK and Podravka d.d.
- Conference: Restoration of buildings that have the status of cultural property in the age of climate crisis, held on September 15, 2021, and organized by the Croatian green building council.
- Two-day online education How to design according to nZEB (December 2, 2020) organized by the Croatian green building council.
- Online panel discussion Adaptation to climate change - necessary transformations in key systems - energy and mobility held on July 7, 2020, organized by the Croatian green building council and Hrvoje Požar energy institute.

Professional public, including the scientific community, carries out activities to exchange information and raise knowledge and awareness about climate change. This most often takes place within the framework of cooperation and research projects (refer to chapter 8.2. Research) through workshops and conferences where knowledge and acquired experience are exchanged. Knowledge is also exchanged through scientific articles and professional publications.

Within professional institutions and the professional public, national and regional energy agencies can be highlighted, as well as associations and companies whose work is focused on climate change.

The National coordinating body for energy efficiency is a main authority in charge of systematic planning, coordination and implementation of energy efficiency policy and has the role of a national agency for energy efficiency. There are five regional energy agencies in the Republic of Croatia. They provide regional and local self-government units that established with professional assistance in sustainable development in the field of energy and environmental protection by using renewable sources, introducing energy efficiency measures, introducing good energy management practices, promoting sustainable development, providing information, etc.

Among numerous associations dealing with environmental protection, the International Institute for climate activities (formerly the Croatian association for carbon footprint reduction) can be highlighted as the first association of experts in the Republic of Croatia in the field of climate change and policies. The goal of the [International Institute for Climate Action](#) (IICA) work is primarily to assist business sector in combating climate change, reducing carbon dioxide emissions, and introducing national and European strategic documents on climate change into business plans and processes of the business sector.

Assistance to state administration bodies, regional (regional) and local self-governments, and business sector in the field of climate change is provided on a commercial basis by private and public companies with a long tradition of work in the field of energy and climate protection.

9.5. RESOURCE OR INFORMATION CENTRES

The website prilagodba-klimi.hr [9-6] is a comprehensive interactive platform on climate change adaptation in the Republic of Croatia. It is a central place for information and education about adaptation to climate change in the Republic of Croatia, and following information are available: what is climate and climate change, future climate scenarios, observed and expected impacts of climate change, sectors and cross-sectoral topics vulnerable to climate change and examples of good practice and projects that test diverse options for adapting to climate change. The latest news from Europe and the world on climate change are published as well. In cooperation with scientists, expert articles, interviews, video presentations, etc. on the topic of climate change are published, as well as basic information on scientific and research projects on mitigation and adaptation to climate change. The website prilagodba-klimi.hr is managed by state administration body responsible for environmental protection²¹.

The website [Nacionalni portal energetske učinkovitosti](#) (National energy efficiency portal) [9-8] is a central place for coordinating energy efficiency activities. It contains educational materials, advice,

²¹ During the preparation of this Eighth national communication and the fifth biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC), the state administration body responsible for environmental protection is the Ministry of Economy and Sustainable Development.

examples of good energy efficiency practices, etc. for citizens, public sector and business sector. The National energy efficiency portal is managed by the National coordinating body for energy efficiency.

The [OIE Hrvatska](#) website [9-17] includes information on renewable energy sources, news from Croatia and the world on renewable sources and energy, studies and educational materials, etc. The OIE Hrvatska website is managed by the economic- interest association The renewable energy sources of Croatia, which gathers energy companies with a total of 80 % of the installed capacity for the production of electricity from renewable sources in Croatia, as well as the other renewable energy industry.

The Croatian Meteorological and Hydrological Service (DHMZ) website [9-12] contains numerous of data from the DHMZ scope of work, including information on climate and climate change, future climate scenarios, data and climate monitoring, and a description of the climate of the Republic of Croatia area. Professional publications and scientific works of DHMZ employees are available, as well as basic information about cooperation and research in which DHMZ participates.

Besides previously mentioned information centres, websites of individual research projects can also be highlighted as sources of information about climate and climate change (refer to chapter 8.2. Research).

9.6. INVOLVEMENT OF THE PUBLIC AND NON-GOVERNMENTAL ORGANIZATIONS

The Act on the System of Strategic Planning and Development Management of the Republic of Croatia (Official Gazette 123/17, 151/22) obliges the body in charge of drafting and implementing the strategic planning act²² to ensure in strategic planning processes partnership with main stakeholders and competent authorities of the local and regional self-government units, as well as to ensure inclusion of business sector / economy associations, social partners, scientific community, civil society organizations and interested public.

The Environmental Protection Act (Official Gazette 80/13, 153/13, 78/15, 12/18, 118/18) stipulates that the public has the right to participate in determining the starting point, preparing and adopting strategies, plans and programs, preparing and adopting regulations and general acts related to environmental protection, as well as in other special procedures²³. Principles and provisions of the Environmental Protection Act on public participation are further elaborated by special regulations.

In accordance with legal framework and principles of good practice, strategic documents in the field of climate change: Low-Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21), Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with a view to 2070 (Official Gazette 46/20) and Integrated National Energy and Climate Plan for the period 2021-2030 [9-18] were prepared in an inclusive manner, with cooperation

²² Acts of strategic planning are National Development Strategy, multi-sector and sectoral strategies, national plans, local and regional self-government units' development plans, Government of the Republic of Croatia program, convergence program, National program of reforms, state administration bodies and local and regional self-governments units implementation programs.

²³ Strategic environmental assessment, environmental impact assessment, assessment of the need for an environmental impact assessment (screening), instructions on the content of the environmental impact study (scoping), environmental permit, consent to the major accident prevention policy, consent on safety report, and consent on remediation program,

of numerous stakeholders (public authorities, representatives of scientific, educational and professional institutions, non-governmental organizations, professional chambers) through a series of workshops, public presentations, publication of information on webpages and web portals, and participation of the general public was made possible through the e-counselling application [9-19].

Importance of non-governmental organizations is especially recognized in raising knowledge about climate change and in acting at the local level. Therefore, NGOs are included as partners in cooperation projects and research projects on climate change and they also independently design and implement thematic projects on climate (refer to chapter 9.3. Public information campaigns). Non-governmental organizations participated in preparation of strategic documents on climate change.

9.7. PARTICIPATION IN INTERNATIONAL ACTIVITIES

The Republic of Croatia participates in activities of the European Commission and the Council of the European Union regarding the European Union environmental and climate policy. The Republic of Croatia participates independently and as part of the European Union in United Nations climate conferences (COP).

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ANNEX I. FIFTH BIENNIAL REPORT OF THE REPUBLIC OF CROATIA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

1. SUMMARY

The summary contains additional information that is presented in the Fifth Biennial Report. Most of the information required in the biennial report is already contained in the Eighth National Communication, which is referred to in individual chapters of the biennial report.

The EU and its member states are committed to achieving a common quantified economy-wide target of reducing greenhouse gas emissions by 20% below 1990 levels by 2020, excluding LULUCF. It is therefore a joint pledge without separate targets for member states under the UNFCCC.

The EU is jointly committed to its UNFCCC goal and is implementing it internally through EU legislation, in the 2020 EU Climate and Energy Package²⁴. In this package, the EU introduced a clear approach to achieving a 20% reduction in total greenhouse gas emissions compared to 1990 levels, by dividing efforts between ETS and non-ETS sectors. Non-ETS sectors (ESD) are covered by Decision No. 406/2009/EC – Effort Sharing Decision. Binding national targets are set for Member States in accordance with the Effort Sharing Decision. Achieving the internal EU compliance under the 2020 Climate and Energy Package, including national targets in the non-ETS sectors, is not subject to the UNFCCC assessment of the EU's joint commitment under the UNFCCC.

Operators of installations in the Republic of Croatia included in the EU ETS must fulfil their obligations within the EU ETS scheme, while the reduction of emissions from non-ETS sectors is shared among member states through individual national targets. According to the Effort Sharing Decision, the defined limit of greenhouse gas emissions in 2020 in relation to the 2005 levels for the Republic of Croatia is 11%.

The EU has significantly exceeded its reduction target under the UNFCCC, meaning that its Member States and the UK have also met their emission reduction commitments. As reported in the 2022 EU GHG inventory submission to the UNFCCC, total GHG emissions, excluding LULUCF and including international aviation, decreased by 34% in the EU-27 + UK compared to the 1990 baseline or 1.94 billion tons of CO₂e.

In the period from 2013 to 2020, each year the Republic of Croatia achieved lower emissions than the annual allocated emissions (quotas) established on the basis of the Effort Sharing Decision. The total realized emission for the entire period amounted to 131.0 Mt CO₂e, while the annual allocated quota was cumulatively 155.6 Mt CO₂e.

²⁴ <https://eur-lex.europa.eu/EN/legal-content/summary/2020-climate-and-energy-package.html>

2. INFORMATION ON GREENHOUSE GAS EMISSIONS AND TRENDS

Relevant information is provided in Chapter 3 of the Eighth National Communication of the Republic of Croatia under the UNFCCC.

3. QUANTIFIED EMISSION REDUCTION TARGETS

3.1. EU TARGETS WITHIN THE UNFCCC FRAMEWORK

This chapter explains the EU 2020 emission reduction target under the UNFCCC and the target compliance architecture set up within the EU in order to meet that target. This chapter also gives an overview of the emission reduction targets of the Republic of Croatia in the context of the EU emission target.

The EU and its member states are committed to achieving a common quantified economy-wide target of reducing greenhouse gas emissions by 20% below 1990 levels by 2020, excluding LULUCF. It is therefore a joint pledge without separate targets for member states under the UNFCCC.

The EU is jointly committed to its UNFCCC goal and is implementing it internally through EU legislation, in the 2020 EU Climate and Energy Package. In this package, the EU introduced a clear approach to achieving a 20% reduction in total greenhouse gas emissions compared to 1990 levels, by dividing efforts between ETS and non-ETS sectors. Non-ETS sectors (ESD) are covered by Decision No. 406/2009/EC - Effort Sharing Decision. Binding national targets are set for Member States in accordance with the Effort Sharing Decision. Achieving the internal EU compliance under the 2020 Climate and Energy Package, including national targets in the non-ETS sectors, is not subject to the UNFCCC assessment of the EU's joint commitment under the UNFCCC.

The definition of the UNFCCC target for 2020 is documented in the revised note provided by the UNFCCC Secretariat on the 'Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention' (FCCC/SB/2011/INF.1/Rev.1 of June 7, 2011). The EU provided additional information relating to its quantified economy-wide emission reduction target in a submission as part of the process of clarifying the developed country Parties' targets in 2012 (FCCC/AWGLCA/2012/MISC.1).

The EU rules for the target under the UNFCCC are more ambitious than the rules under the Kyoto Protocol. Accordingly, the following assumptions and conditions apply to the EU's 20 % emission reduction target under the UNFCCC:

- Emissions/removals from land use, land-use change and forestry (LULUCF) sector are not included, and it is estimated to be a net sink over the relevant period. EU inventory also includes information on emissions and removals by sinks from LULUCF in accordance with the UNFCCC. Accounting for LULUCF activities is only relevant under the Kyoto Protocol.
- The target covers the gases CO₂, CH₄, N₂O, HFCs, PFCs and SF₆.
- The target refers to 1990 as a single base year for all gases and all Member States.
- Emissions from international aviation to the extent it is included in the EU ETS are included in the target.
- A limited number of CER and ERU units from new market-based mechanisms may be used to achieve the target: in the EU ETS, the use of international credits is capped (up to 50% reduction of emissions required within the EU ETS by 2020). Quality standards also apply to the use of international credits in the EU ETS, including a ban on credits from LULUCF projects and certain industrial gas projects. In the ESD sectors, the use of international credits is limited to up to 3 % of each Member State's ESD emissions in 2005.

- Global Warming Potentials (GWPs) used to aggregate GHG emissions up to 2020 under EU legislation were based on the Second Assessment Report of the IPCC when the target was submitted. For the implementation until 2020, GWPs from the Fourth Assessment Report (AR4) will be used in accordance with the UNFCCC reporting guidelines for GHG inventories.

Key facts about the EU target under the Convention are summarized in Table I3-1.

Table I3-1: Key facts about the EU-28 target under the Convention

Parameter	Target
Base Year	1990
Target Year	2020
Emission Reduction target	-20% in 2020 compared to 1990
Gases covered	CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SF ₆
Global Warming Potential	AR4
Sectors Covered	All IPCC sources and sectors except LULUCF, as measured by the full annual inventory and international aviation to the extent it is included in the EU ETS.
Land Use, Land-Use Change, and Forestry (LULUCF)	Accounted for under Kyoto Protocol, reported in EU inventories under the UNFCCC. Assumed to produce net removals.
Use of international credits (JI and CDM)	Possible subject to quantitative and qualitative limits.

As this target under the UNFCCC has only been defined for EU-28 and not for each of its Member States, there are no specified targets for individual Member States. Due to this, Croatia, as part of the EU-28, takes on a quantified economy-wide emission reduction target jointly with all Member States.

3.2. ARCHITECTURE OF COMPLIANCE WITH EU TARGETS

3.2.1. 2020 EU Climate and Energy Package

In 2009, the EU established internal rules under its “2020 Climate and Energy Package” to support the EU implementation of the target under the UNFCCC. The Package introduced a clear approach to achieving the 20 % reduction of total GHG emissions from 1990 levels, which is equivalent to a 14 % reduction compared to 2005 levels. This 14 % reduction objective is divided between the ETS and ESD sectors. Based on this, two sub-targets are defined:

- a 21 % reduction target compared to 2005 for emissions covered by the ETS (including domestic and international aviation);
- a 10 % reduction target compared to 2005 for non-ETS sectors, shared between the 28 Member States through individual national emission reduction targets.

The distribution of the total target across the ETS and non-ETS sectors is shown in the Figure I3-1.

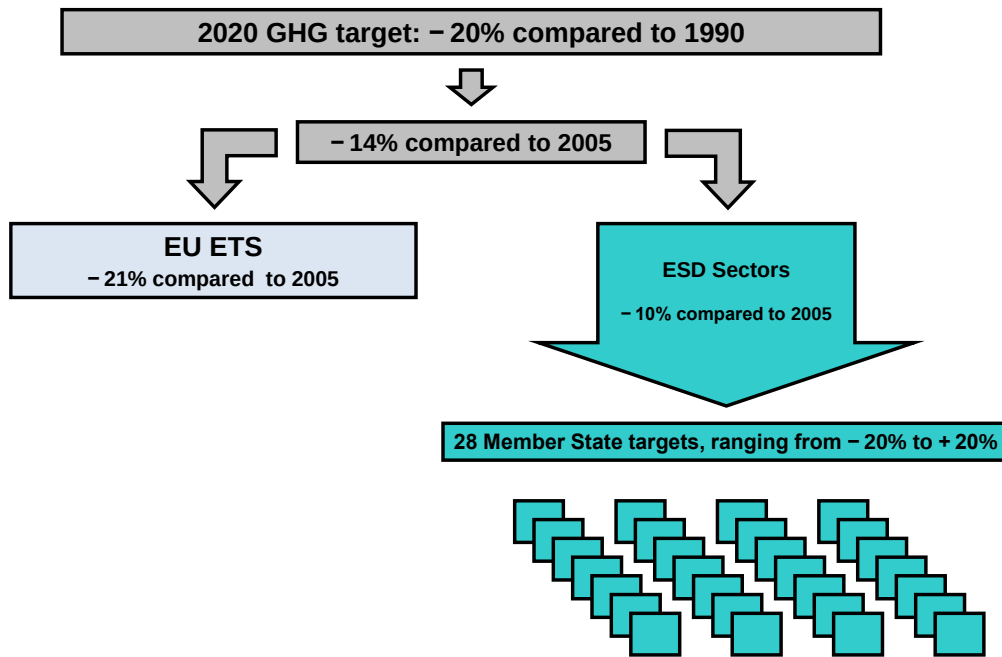


Figure I3-1: GHG emission reduction targets under the 2020 EU Climate and Energy Package

Under the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), i.e. there are no further individual caps by country. Allowances allocated in the EU ETS from 2013 to 2020 decrease by 1.74 % annually, starting from the average level of allowances issued by Member States for the second trading period (2008–2012).

The vast majority of emissions within the EU which fall outside the scope of the EU ETS are addressed under the Effort Sharing Decision (ESD) (Decision No 406/2009/EC). The ESD covers emissions from all sources outside the EU ETS, except for emissions from domestic and international aviation (which were included in the EU ETS from January 1, 2012), international maritime transport, and emissions and removals from LULUCF. Non-ETS sectors include a diverse range of small-scale emitters: transport, buildings, services, small industrial installations, fugitive emissions from the energy sector, emissions of fluorinated gases, agriculture and waste. Such sources account for about 60 % of total GHG emissions in the EU.

The EU ETS target is to be achieved by the EU as a whole, while the ESD target was divided into national targets to be achieved individually by each Member State. Under the Effort Sharing Decision, national emission targets for 2020 are set, expressed as percentage changes from 2005 levels. These changes have been transferred into binding quantified annual reduction targets for the period from 2013 to 2020 (Commission Decisions 2013/162/EU, Commission Implementing Decision 2013/634/EU and Commission Decisions 2017/1417/EU), denominated in Annual Emission Allocations (AEAs). At country level, 2020 targets under the ESD range from -20 % to +20 %, compared to 2005 levels. ESD targets for 2020 for each EU Member State are shown in Figure I3-2. The target levels have been set on the basis of Member States' relative Gross Domestic Product per capita. In addition, different levels of development in the EU-28 are taken into account by the provision of several flexibility options.

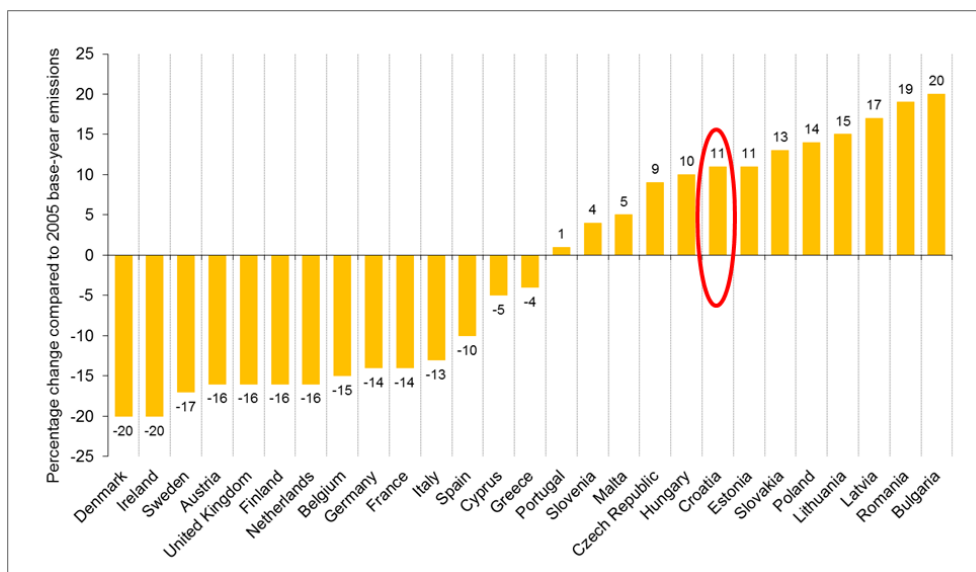


Figure I3-2: National 2020 GHG emission limits under the ESD, relative to 2005 emissions levels

3.2.2. Monitoring progress towards the 2020 targets for non-ETS sectors

Monitoring, reporting and verification of the achievement of targets for non-ETS sectors are mainly carried out by the submission of national greenhouse gas inventories by Member States. Chapter III of the Commission Implementing Regulation 749/2014 establishes strict criteria on the basis of which national greenhouse gas inventories and greenhouse gas emissions of member states are reviewed annually at the EU level. Based on that review, the European Commission issues an enforcement decision on emissions for the Member States' non-ETS sectors in a given year, which may result in Member States facing fines or other consequences.

The Effort Sharing Decision and the Monitoring Mechanism Regulation (MMR) introduced an annual compliance cycle, requiring a review of Member States' greenhouse gas inventories to ensure compliance with their obligations under the Effort Sharing Decision for the period 2013-2020. These reviews are conducted in a shorter timeframe than the UNFCCC inventory review to allow flexibility provisions to be used and corrective action to be taken, as appropriate, at the end of each relevant year. The following review progress has been made:

- a comprehensive review was completed in 2016 to determine greenhouse gas emission levels for the 2013 and 2014 compliance years.
- a further review was completed in 2017 to determine emission levels for the compliance year 2015.
- since 2018, annual review cycles continue.
- in 2022, a final audit was carried out to determine the emission levels for the last compliance year 2020.

3.3. CROATIAN EMISSION REDUCTION TARGETS

3.3.1. Targets for ETS sectors

Within the framework of the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), i.e. there are no further individual caps by country. Therefore, there is no specific Croatian reduction target in the ETS.

More information on the EU ETS target can be found in the EU Fifth Biennial Report.

3.3.2. Targets for non-ETS sectors

The Republic of Croatia is committed to achieving a common economy-wide target of reducing emissions under the UNFCCC.

According to the Effort Sharing Decision, the defined limit of greenhouse gas emissions in 2020 in relation to the 2005 levels for the Republic of Croatia is 11%.

Table I3-2 shows the limit of greenhouse gas emissions under the Effort Sharing Decision (national annual quota) in the period 2013-2020, using the Global Warming Potential (GWP) values from the Fourth Assessment Report (AR4).

Table I3-2: Annual quota amount for Croatia for the period 2013 – 2020, kt CO₂e

	2013	2014	2015	2016	2017	2018	2019	2020
Annual allowance allocation	19,614	19,805	19,997	20,188	18,681	18,893	19,106	19,318

Further information can be found in tables 2 (a) - (f) in Annex II: CTF for Biennial Report (19/CP.18).

4. PROGRESS IN ACHIEVEMENT OF QUANTIFIED EMISSION REDUCTION TARGETS AND RELEVANT INFORMATION

4.1. INTRODUCTION

This chapter describes the progress and achievement of quantified emission reduction targets for the entire economy in the Republic of Croatia for the period from 2013 to 2020. The reduction of greenhouse gas emissions in the non-ETS sectors is reported, and information is provided on the reduction of emissions by the operators of facilities included in the ETS.

A description of the policies and measures that have had and will have an impact on reducing greenhouse gas emissions and increasing removals by sinks in Croatia is given in Chapter 4 of the Eighth National Communication of the Republic of Croatia under the UNFCCC. A summary of information on policies and measures and the effects of the measures are presented in Table 3 in Annex II: CTF tables for the Biennial Report (19/CP.18).

The EU has significantly exceeded its reduction target under the UNFCCC, meaning that its Member States and the UK have also met their emission reduction commitments. As reported in the 2022 EU GHG inventory submission under the UNFCCC, total GHG emissions, excluding LULUCF and including international aviation, decreased by 34% in the EU-27 + UK compared to the 1990 base year, or 1.94 billion tons of CO₂e.

4.2. PROGRESS IN ACHIEVING QUANTIFIED ECONOMY-WIDE TARGETS OF REDUCING EMISSIONS IN NON-ETS SECTORS

As stated in chapter 3.3. of this biennial report, the quantified annual emission reduction targets for non-ETS sectors, for EU Member States, including the Republic of Croatia until 2020, have been set by EU decisions. For the Republic of Croatia, this target results in a cumulative amount of 155.6 Mt CO₂e for the period 2013-2020. Emissions from the non-ETS sectors in the period 2013-2020 amounted to 131.0 Mt CO₂e.

Realized emissions in non-ETS sectors were below annual allocated emissions every year in the period 2013-2020 (Table I4-1 and Figure I4-1).

Table I4-1: Greenhouse gas emissions in non-ETS sectors and allocated annual quota, kt CO₂e

Year	Emission in non-ETS sectors (kt CO ₂ e)	Annual allocated emission (kt CO ₂ e)
2013	15,791.89	19,613.81
2014	15,455.77	19,805.26
2015	15,933.45	19,996.71
2016	16,313.57	20,188.16
2017	17,082.80	18,681.01
2018	16,926.05	18,893.32
2019	17,077.97	19,105.63
2020	16,417.94	19,317.94
Cumulative	130,999.44	155,601.83

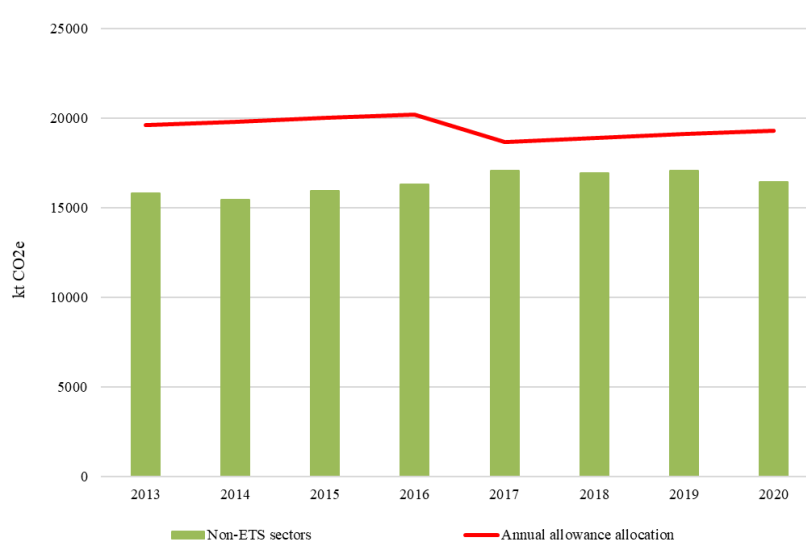


Figure I4-1: Greenhouse gas emissions in non-ETS sectors and allocated annual quota, kt CO₂e

4.3. EMISSIONS OF OPERATORS OF INSTALLATIONS INCLUDED IN THE ETS

As previously stated in this Biennial Report, the ETS target needs to be achieved at the EU level, a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein), i.e. there are no further individual caps by country.

In 2013, emission from sectors included in the ETS amounted to 8,785.8 kt CO₂e. By 2020, the emission has decreased to 7,323.8 kt CO₂e (Figure I4-3).

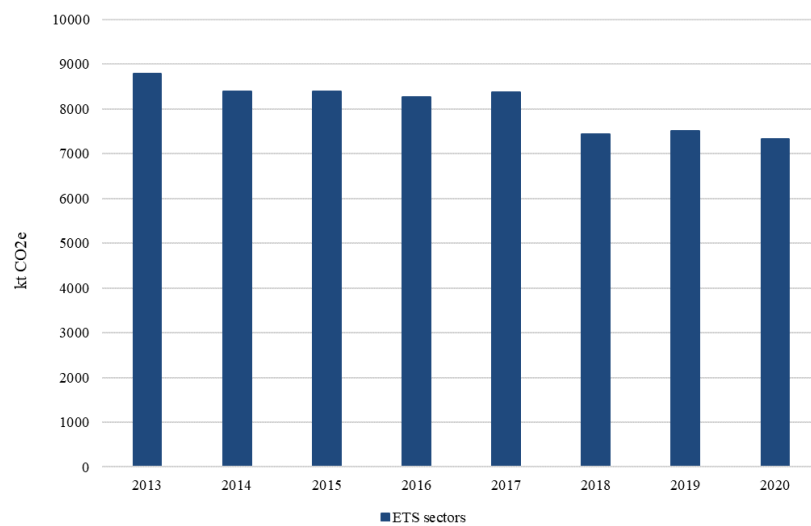


Figure I4-2: Greenhouse gas emissions of operators of installations included in the ETS, kt CO₂e

5. PROJECTIONS

Relevant information is provided in Chapter 5 of the Eighth National Communication of the Republic of Croatia under the UNFCCC.

6. PROVISION OF FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING SUPPORT TO DEVELOPING COUNTRIES

Relevant information is provided in Chapter 7 of the Eighth National Communication of the Republic of Croatia under the UNFCCC.

Data on the use of financial resources for 2019 and 2020 are presented in tables 7, 7 (a) and 7 (b) in Annex II: CTF tables for the biennial report (19/CP.18).

Table 8 and table 9 in Annex II: CTF tables for the biennial report (19/CP.18) remain blank because the Republic of Croatia did not contribute to a program specifically focused on capacity building or technology transfer in developing countries.

ANNEX II. CTF TABLES FOR THE BIENNIAL REPORT (19/CP.18)

CTF Table 1: Emission trends (Summary), sheet 1/3

<i>GREENHOUSE GAS EMISSIONS</i>	Base year ^a	1990	1991	1992	1993	1994	1995	1996	1997	1998
	<i>kt CO₂ eq</i>									
CO ₂ emissions without net CO ₂ from LULUCF	22,979.79	22,979.79	16,987.51	16,372.59	16,809.18	16,054.02	16,817.67	17,344.87	18,558.62	19,013.42
CO ₂ emissions with net CO ₂ from LULUCF	15,884.57	15,884.57	8,503.09	7,729.03	7,938.10	6,984.52	7,225.26	8,126.04	10,107.24	10,799.96
CH ₄ emissions without CH ₄ from LULUCF	4,307.79	4,307.79	4,152.17	3,686.11	3,597.27	3,410.91	3,362.39	3,323.88	3,298.43	3,274.87
CH ₄ emissions with CH ₄ from LULUCF	4,309.02	4,309.02	4,155.35	3,701.25	3,631.66	3,422.41	3,369.94	3,340.42	3,316.06	3,319.98
N ₂ O emissions without N ₂ O from LULUCF	2,855.88	2,855.88	2,697.91	2,709.09	2,310.83	2,349.94	2,272.02	2,270.95	2,465.62	2,113.77
N ₂ O emissions with N ₂ O from LULUCF	2,903.97	2,903.97	2,746.24	2,764.79	2,378.17	2,400.77	2,319.02	2,323.18	2,517.45	2,184.32
HFCs	NO	NO	NO	NO	NO	NO	21.85	25.18	29.69	35.89
PFCs	1,240.24	1,240.24	850.75	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF ₆	10.73	10.73	10.61	10.69	10.81	11.60	12.08	12.51	12.15	13.00
NF ₃	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	31,394.43	31,394.43	24,698.95	22,778.48	22,728.09	21,826.47	22,486.00	22,977.40	24,364.50	24,450.96
Total (with LULUCF)	24,348.53	24,348.53	16,266.04	14,205.77	13,958.75	12,819.31	12,948.15	13,827.32	15,982.58	16,353.15
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	Base year ^a	1990	1991	1992	1993	1994	1995	1996	1997	1998
	<i>kt CO₂ eq</i>									
1. Energy	21,439.51	21,439.51	16,009.94	15,353.13	16,031.06	15,024.26	15,972.40	16,573.52	17,572.87	18,117.53
2. Industrial processes and product use	4,617.63	4,617.63	3,487.73	2,879.73	2,345.27	2,587.09	2,403.66	2,363.16	2,563.24	2,308.69
3. Agriculture	4,353.02	4,353.02	4,206.20	3,535.63	3,326.63	3,166.61	3,042.35	2,963.35	3,121.31	2,898.87
4. Land Use, Land-Use Change and Forestry ^b	-7,045.89	-7,045.89	-8,432.91	-8,572.71	-8,769.34	-9,007.16	-9,537.85	-9,150.08	-8,381.92	-8,097.80
5. Waste	984.27	984.27	995.08	1,010.00	1,025.13	1,048.51	1,067.59	1,077.38	1,107.08	1,125.87
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	24,348.53	24,348.53	16,266.04	14,205.77	13,958.75	12,819.31	12,948.15	13,827.32	15,982.58	16,353.15

CTF Table 1: Emission trends (Summary), sheet 2/3

<i>GREENHOUSE GAS EMISSIONS</i>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CO ₂ emissions without net CO ₂ from LULUCF	20,024.75	19,662.49	20,785.30	21,889.46	23,215.26	22,887.89	23,343.92	23,549.95	24,862.86	23,594.99	21,804.45
CO ₂ emissions with net CO ₂ from LULUCF	11,167.44	12,203.01	12,308.04	13,226.97	15,409.02	14,896.63	15,178.68	15,637.51	18,031.30	16,456.65	14,737.24
CH ₄ emissions without CH ₄ from LULUCF	3,328.98	3,285.82	3,357.78	3,366.05	3,534.09	3,627.23	3,650.26	3,754.82	3,758.67	3,734.59	3,809.35
CH ₄ emissions with CH ₄ from LULUCF	3,334.89	3,382.73	3,376.78	3,372.44	3,573.64	3,630.15	3,652.99	3,760.88	3,790.44	3,744.17	3,814.45
N ₂ O emissions without N ₂ O from LULUCF	2,345.30	2,465.23	2,431.47	2,346.43	2,254.89	2,495.45	2,458.23	2,468.32	2,520.14	2,824.53	2,186.89
N ₂ O emissions with N ₂ O from LULUCF	2,387.35	2,569.68	2,487.41	2,398.92	2,336.28	2,557.35	2,525.63	2,543.72	2,621.10	2,918.24	2,285.27
HFCs	43.62	52.89	64.80	86.16	114.37	137.14	187.20	247.18	329.67	405.91	494.27
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF ₆	12.95	12.34	12.42	12.75	13.09	13.54	14.26	14.13	14.15	12.99	9.34
NF ₃	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	25,755.59	25,478.76	26,651.77	27,700.85	29,131.71	29,161.26	29,653.87	30,034.40	31,485.49	30,573.01	28,304.30
Total (with LULUCF)	16,946.25	18,220.64	18,249.44	19,097.25	21,446.41	21,234.81	21,558.76	22,203.41	24,786.66	23,537.96	21,340.56
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	18,800.93	18,217.13	19,249.55	20,352.96	21,722.89	21,201.17	21,564.49	21,625.22	22,861.30	21,681.52	20,519.83
2. Industrial processes and product use	2,761.80	3,038.00	3,026.57	2,997.16	3,026.75	3,378.11	3,475.41	3,661.49	3,879.07	3,856.33	3,212.08
3. Agriculture	3,026.38	3,018.30	3,154.46	3,092.10	3,089.45	3,241.50	3,277.04	3,329.52	3,252.34	3,464.66	2,952.00
4. Land Use, Land-Use Change and Forestry ^b	-8,809.34	-7,258.12	-8,402.33	-8,603.60	-7,685.30	-7,926.45	-8,095.11	-7,830.98	-6,698.83	-7,035.05	-6,963.74
5. Waste	1,166.47	1,205.33	1,221.19	1,258.64	1,292.61	1,340.47	1,336.93	1,418.17	1,492.78	1,570.50	1,620.39
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	16,946.25	18,220.64	18,249.44	19,097.25	21,446.41	21,234.81	21,558.76	22,203.41	24,786.66	23,537.96	21,340.56

CTF Table 1: Emission trends (Summary), sheet 3/3

GREENHOUSE GAS EMISSIONS	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
	(%)											
CO ₂ emissions without net CO ₂ from LULUCF	21,016.28	20,649.62	19,087.40	18,432.19	17,681.57	17,824.70	18,109.01	18,744.00	17,724.15	17,857.45	16,870.53	-26.59
CO ₂ emissions with net CO ₂ from LULUCF	14,049.02	14,822.91	13,636.95	11,996.85	11,423.23	12,121.84	12,181.30	13,284.23	11,991.27	12,026.00	11,133.05	-29.91
CH ₄ emissions without CH ₄ from LULUCF	3,870.76	3,823.78	3,777.47	3,678.59	3,642.27	3,737.07	3,801.91	3,762.97	3,619.32	3,580.52	3,532.83	-17.99
CH ₄ emissions with CH ₄ from LULUCF	3,872.52	3,842.41	3,816.35	3,680.52	3,642.59	3,751.04	3,810.82	3,832.20	3,620.62	3,583.30	3,565.36	-17.26
N ₂ O emissions without N ₂ O from LULUCF	2,430.14	2,490.46	2,260.98	1,676.55	1,636.73	1,775.71	1,543.78	1,663.93	1,613.83	1,617.97	1,656.56	-41.99
N ₂ O emissions with N ₂ O from LULUCF	2,534.20	2,616.09	2,408.71	1,798.92	1,757.87	1,906.52	1,671.23	1,833.80	1,735.88	1,741.01	1,800.57	-38.00
HFCs	595.15	663.84	741.43	814.57	905.47	1,007.40	1,150.49	1,304.09	1,438.84	1,560.96	1,689.72	100.00
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF ₆	9.83	10.26	10.96	7.18	7.67	5.58	6.60	7.02	6.27	7.85	8.76	-18.30
NF ₃	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (without LULUCF)	27,922.16	27,637.95	25,878.24	24,609.08	23,873.71	24,350.46	24,611.79	25,482.00	24,402.41	24,624.75	23,758.40	-24.32
Total (with LULUCF)	21,060.72	21,955.51	20,614.40	18,298.04	17,736.83	18,792.37	18,820.43	20,261.34	18,792.88	18,919.12	18,197.47	-25.26
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
	(%)											
1. Energy	19,708.33	19,453.04	18,035.18	17,286.72	16,343.96	16,591.19	16,998.58	17,380.27	16,437.31	16,496.14	15,516.58	-27.63
2. Industrial processes and product use	3,521.14	3,405.50	3,190.68	2,949.71	3,190.60	3,301.12	3,110.05	3,494.54	3,474.12	3,654.62	3,770.25	-18.35
3. Agriculture	3,028.76	3,082.21	2,959.11	2,693.42	2,617.91	2,689.85	2,702.44	2,789.22	2,696.62	2,696.79	2,692.31	-38.15
4. Land Use, Land-Use Change and Forestry ^b	-6,861.44	-5,682.44	-5,263.84	-6,311.04	-6,136.87	-5,558.09	-5,791.36	-5,220.66	-5,609.53	-5,705.63	-5,560.93	-21.08
5. Waste	1,663.93	1,697.20	1,693.27	1,679.24	1,721.24	1,768.30	1,800.71	1,817.97	1,794.35	1,777.19	1,779.26	80.77
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)	21,060.72	21,955.51	20,614.40	18,298.04	17,736.83	18,792.37	18,820.43	20,261.34	18,792.88	18,919.12	18,197.47	-25.26

CTF Table 1(a): Emission trends (CO₂), sheet 1/3

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	<i>Base year^a</i> <i>kt</i>	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. Energy	20,362.90	20,362.90	15,017.89	14,347.02	15,117.22	14,179.93	15,121.53	15,640.05	16,674.29	17,247.97
A. Fuel combustion (sectoral approach)	19,780.38	19,780.38	14,440.98	13,759.23	14,330.95	13,474.85	14,285.75	14,829.75	15,911.94	16,570.51
1. Energy industries	7,065.79	7,065.79	4,742.10	5,342.75	5,940.22	4,658.42	5,261.60	5,085.53	5,557.16	6,238.88
2. Manufacturing industries and construction	5,208.58	5,208.58	3,769.57	3,079.37	2,917.23	3,077.51	2,874.38	2,866.98	3,080.25	3,065.07
3. Transport	3,787.06	3,787.06	2,866.99	2,776.79	2,925.16	3,102.93	3,292.91	3,620.22	3,966.11	4,098.78
4. Other sectors	3,718.95	3,718.95	3,062.32	2,560.33	2,548.34	2,635.99	2,856.86	3,257.02	3,308.41	3,167.79
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE
B. Fugitive emissions from fuels	582.52	582.52	576.92	587.79	786.27	705.07	835.78	810.30	762.35	677.45
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	582.52	582.52	576.92	587.79	786.27	705.07	835.78	810.30	762.35	677.45
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	2,566.34	2,566.34	1,918.14	1,959.52	1,639.29	1,825.99	1,649.30	1,651.84	1,814.12	1,717.51
A. Mineral industry	1,302.67	1,302.67	863.03	933.89	797.34	957.92	741.72	827.96	950.81	1,016.67
B. Chemical industry	751.10	751.10	665.95	832.68	715.96	715.58	756.00	701.63	743.07	592.72
C. Metal industry	336.40	336.40	270.10	121.11	57.46	81.17	40.32	19.17	40.82	29.65
D. Non-energy products from fuels and solvent use	176.17	176.17	119.06	71.85	68.52	71.31	111.27	103.08	79.41	78.46
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	50.02	50.02	50.95	65.51	52.14	47.57	46.29	52.44	68.39	44.25
A. Enteric fermentation										
B. Manure management										
C. Rice cultivation										
D. Agricultural soils										
E. Prescribed burning of savannas										
F. Field burning of agricultural residues										
G. Liming	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Urea application	50.02	50.02	50.95	65.51	52.14	47.57	46.29	52.44	68.39	44.25
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land Use, Land-Use Change and Forestry	-7,095.21	-7,095.21	-8,484.42	-8,643.56	-8,871.08	-9,069.50	-9,592.40	-9,218.83	-8,451.38	-8,213.47
A. Forest land	-7,200.60	-7,200.60	-9,074.26	-9,298.12	-9,328.49	-9,402.68	-9,904.36	-9,562.29	-8,913.20	-8,549.77
B. Cropland	114.91	114.91	127.70	129.64	131.57	133.50	135.43	137.37	139.30	141.23
C. Grassland	-7.88	-7.88	3.98	-0.24	-3.30	-7.89	-11.98	-15.71	-20.57	-24.06
D. Wetlands	78.26	78.26	67.64	64.60	61.56	58.51	55.47	52.43	49.39	46.34
E. Settlements	237.96	237.96	214.28	207.73	201.19	194.55	188.12	181.64	173.73	169.12
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products	-317.85	-317.85	176.24	252.83	66.40	-45.49	-55.09	-12.27	119.97	3.68
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	1.82	3.70
A. Solid waste disposal	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Biological treatment of solid waste										
C. Incineration and open burning of waste	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	1.82	3.70
D. Waste water treatment and discharge										
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:										
International bunkers	643.85	643.85	94.29	72.29	182.30	403.81	348.25	339.28	310.14	336.44
Aviation	496.62	496.62	94.29	72.29	182.30	264.02	245.16	223.16	235.74	254.59
Navigation	147.23	147.23	NO	NO	NO	139.78	103.08	116.12	74.41	81.85
Multilateral operations	C	C	C	C	C	C	C	C	C	C
CO2 emissions from biomass	5,237.84	5,237.84	6,091.91	5,308.28	5,583.98	4,999.29	5,288.54	5,877.64	5,526.07	5,535.75
CO2 captured	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Long-term storage of C in waste disposal sites	194.62	194.62	203.06	211.54	220.08	228.77	237.66	246.64	255.77	265.00
Indirect N2O										
Indirect CO2 (3)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Total CO2 equivalent emissions without land use, land-use change	22,979.79	22,979.79	16,987.51	16,372.59	16,809.18	16,054.02	16,817.67	17,344.87	18,558.62	19,013.42
Total CO2 equivalent emissions with land use, land-use change and	15,884.57	15,884.57	8,503.09	7,729.03	7,938.10	6,984.52	7,225.26	8,126.04	10,107.24	10,799.96
Total CO2 equivalent emissions, including indirect CO2, without	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 equivalent emissions, including indirect CO2, with land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

CTF Table 1(a): Emission trends (CO₂), sheet 2/3

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	17,896.52	17,356.75	18,358.84	19,511.40	20,816.14	20,272.16	20,656.65	20,732.16	21,965.25	20,802.16	19,642.09
A. Fuel combustion (sectoral approach)	17,234.65	16,645.33	17,596.69	18,735.04	20,087.34	19,494.24	19,899.91	19,966.19	21,237.66	20,165.34	19,068.23
1. Energy industries	6,459.12	5,810.87	6,343.85	7,225.52	7,871.16	6,784.01	6,810.03	6,631.42	7,815.15	6,771.62	6,365.42
2. Manufacturing industries and construction	2,867.36	3,061.67	3,196.99	3,057.13	3,136.78	3,583.00	3,724.02	3,855.12	3,853.05	3,872.78	3,157.36
3. Transport	4,329.18	4,354.38	4,420.07	4,729.32	5,126.76	5,262.21	5,467.69	5,820.94	6,242.17	6,079.11	6,091.06
4. Other sectors	3,578.99	3,418.41	3,635.78	3,723.08	3,952.65	3,865.02	3,898.16	3,658.71	3,327.29	3,441.83	3,454.39
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE
B. Fugitive emissions from fuels	661.86	711.42	762.15	776.36	728.80	777.92	756.74	765.97	727.60	636.82	573.86
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	661.86	711.42	762.15	776.36	728.80	777.92	756.74	765.97	727.60	636.82	573.86
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	2,073.36	2,238.72	2,327.69	2,293.52	2,326.52	2,539.44	2,601.65	2,736.38	2,807.63	2,695.57	2,085.24
A. Mineral industry	1,270.90	1,428.93	1,647.58	1,647.57	1,654.26	1,751.18	1,813.79	1,941.92	1,969.85	1,868.94	1,454.55
B. Chemical industry	701.41	704.40	595.81	550.89	574.42	665.57	663.60	657.88	696.32	676.64	529.27
C. Metal industry	27.67	29.68	7.15	4.72	6.62	13.72	12.71	13.31	13.69	23.41	4.84
D. Non-energy products from fuels and solvent use	73.38	75.71	77.15	90.34	91.23	108.97	111.55	123.26	127.77	126.57	96.57
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	50.49	60.87	92.09	80.76	71.79	75.94	85.46	80.67	89.32	96.60	76.96
A. Enteric fermentation											
B. Manure management											
C. Rice cultivation											
D. Agricultural soils											
E. Prescribed burning of savannas											
F. Field burning of agricultural residues											
G. Liming	NO	NO	NO	NO	NO	NO	14.49	17.48	16.60	20.78	11.92
H. Urea application	50.49	60.87	92.09	80.76	71.79	75.94	70.97	63.19	72.72	75.83	65.04
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land Use, Land-Use Change and Forestry	-8,857.31	-7,459.47	-8,477.26	-8,662.49	-7,806.24	-7,991.26	-8,165.24	-7,912.44	-6,831.56	-7,138.34	-7,067.22
A. Forest land	-9,120.82	-7,701.45	-8,637.24	-8,857.31	-8,139.59	-8,369.10	-8,407.71	-8,192.90	-7,371.85	-7,688.29	-7,886.98
B. Cropland	143.17	145.10	147.03	148.96	150.90	154.03	155.54	157.35	366.86	387.42	422.21
C. Grassland	-27.56	-32.63	-26.55	-37.52	-49.14	-59.71	-60.56	-83.61	-101.08	-131.78	-129.26
D. Wetlands	43.30	40.26	36.42	33.15	29.88	26.61	23.34	20.07	17.68	14.66	11.65
E. Settlements	162.87	158.91	309.20	352.56	392.54	437.21	472.87	509.61	566.18	604.97	694.13
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products	-58.26	-69.66	-306.12	-302.33	-190.82	-180.30	-348.72	-322.96	-309.35	-325.34	-178.97
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	4.38	6.15	6.68	3.78	0.80	0.35	0.16	0.74	0.65	0.67	0.16
A. Solid waste disposal	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Biological treatment of solid waste											
C. Incineration and open burning of waste	4.38	6.15	6.68	3.78	0.80	0.35	0.16	0.74	0.65	0.67	0.16
D. Waste water treatment and discharge											
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:											
International bunkers	311.54	258.78	291.47	262.60	251.70	284.43	337.55	325.65	353.05	384.96	292.16
Aviation	245.16	201.16	201.16	188.59	182.30	210.59	257.74	264.02	276.60	317.46	270.31
Navigation	66.37	57.62	90.31	74.01	69.39	73.83	79.82	61.63	76.45	67.50	21.85
Multilateral operations	C	C	C	C	C	C	C	C	C	C	C
CO2 emissions from biomass	5,328.01	4,771.83	5,187.98	4,975.57	5,755.73	5,660.22	5,908.79	5,497.41	5,322.60	5,298.65	5,576.02
CO2 captured	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO
Long-term storage of C in waste disposal sites	274.55	284.87	295.61	306.73	318.20	329.99	342.08	354.51	367.63	381.18	395.03
Indirect N2O											
Indirect CO2 (3)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Total CO2 equivalent emissions without land use, land-use change	20,024.75	19,662.49	20,785.30	21,889.46	23,215.26	22,887.89	23,343.92	23,549.95	24,862.86	23,594.99	21,804.45
Total CO2 equivalent emissions with land use, land-use change and	11,167.44	12,203.01	12,308.04	13,226.97	15,409.02	14,896.63	15,178.68	15,637.51	18,031.30	16,456.65	14,737.24
Total CO2 equivalent emissions, including indirect CO2, without	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 equivalent emissions, including indirect CO2, with land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

CTF Table 1(a): Emission trends (CO₂), sheet 3/3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
	%											
1. Energy	18,806.64	18,595.12	17,224.34	16,492.03	15,620.71	15,798.65	16,208.64	16,597.78	15,691.36	15,764.28	14,788.60	-27.37
A. Fuel combustion (sectoral approach)	18,265.12	18,036.24	16,751.09	16,039.24	15,179.55	15,549.11	15,971.92	16,286.19	15,406.72	15,477.34	14,500.42	-26.69
1. Energy industries	5,877.34	6,247.86	5,849.20	5,238.07	4,743.91	4,718.82	4,846.79	4,464.77	3,907.81	3,880.44	3,659.32	-48.21
2. Manufacturing industries and construction	3,015.80	2,779.55	2,409.07	2,384.92	2,324.33	2,222.70	2,228.67	2,429.58	2,411.05	2,421.11	2,381.74	-54.27
3. Transport	5,865.78	5,726.93	5,551.16	5,636.55	5,580.73	5,887.78	6,106.38	6,570.29	6,340.78	6,516.87	5,732.11	51.36
4. Other sectors	3,506.21	3,281.90	2,941.67	2,779.70	2,530.59	2,719.81	2,790.08	2,821.56	2,747.08	2,658.92	2,727.25	-26.67
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
B. Fugitive emissions from fuels	541.52	558.89	473.24	452.80	441.16	249.53	236.72	311.59	284.63	286.94	288.18	-50.53
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy	541.52	558.89	473.24	452.80	441.16	249.53	236.72	311.59	284.63	286.94	288.18	-50.53
C. CO2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial processes	2,121.55	1,949.26	1,761.75	1,865.50	1,991.34	1,956.67	1,824.16	2,065.09	1,960.55	2,017.51	1,986.75	-22.58
A. Mineral industry	1,401.83	1,255.01	1,179.39	1,271.22	1,354.11	1,306.35	1,201.30	1,425.61	1,358.42	1,324.94	1,359.34	4.35
B. Chemical industry	615.36	593.19	502.01	509.33	559.83	572.27	547.86	566.79	513.06	594.60	535.32	-28.73
C. Metal industry	14.68	16.64	1.43	13.93	10.11	9.30	1.05	1.87	8.99	4.91	4.93	-98.54
D. Non-energy products from fuels and solvent use	89.69	84.43	78.92	71.02	67.29	68.74	73.94	70.82	80.09	93.05	87.16	-50.53
E. Electronic industry												
F. Product uses as ODS substitutes												
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Agriculture	88.04	105.18	101.23	74.61	69.47	69.34	76.17	81.13	72.24	75.66	95.18	90.28
A. Enteric fermentation												
B. Manure management												
C. Rice cultivation												
D. Agricultural soils												
E. Prescribed burning of savannas												
F. Field burning of agricultural residues												
G. Liming	21.46	21.32	14.38	14.23	19.99	12.09	11.20	10.92	4.62	2.07	6.89	100.00
H. Urea application	66.58	83.86	86.85	60.39	49.47	57.25	64.96	70.21	67.62	73.59	88.29	76.51
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land Use, Land-Use Change and Forestry	-6,967.26	-5,826.71	-5,450.45	-6,435.34	-6,258.34	-5,702.87	-5,927.72	-5,459.77	-5,732.89	-5,831.44	-5,737.47	-19.14
A. Forest land	-7,702.24	-6,599.08	-6,198.38	-6,752.14	-6,438.76	-5,686.43	-5,792.16	-4,831.08	-5,584.52	-5,795.42	-5,803.73	-19.40
B. Cropland	437.24	462.50	481.36	294.00	286.85	335.60	282.50	281.71	271.85	268.96	265.32	130.91
C. Grassland	-149.40	-160.97	-190.72	-219.28	-233.89	-269.89	-308.16	-294.94	-321.61	-314.92	-311.36	3,850.01
D. Wetlands	8.63	8.66	8.68	9.62	9.91	10.19	10.48	10.77	11.06	11.34	11.63	-85.14
E. Settlements	687.66	730.95	768.44	658.64	656.17	671.80	659.70	663.20	666.43	670.35	673.34	182.97
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Harvested wood products	-249.16	-268.76	-319.83	-426.18	-538.61	-764.15	-780.07	-1,289.42	-776.10	-671.76	-572.68	80.17
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.05	0.05	0.08	0.04	0.04	0.05	0.05	NO, NA	NO, NA	NO, NA	NO, NA	0.00
A. Solid waste disposal	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
B. Biological treatment of solid waste												
C. Incineration and open burning of waste	0.05	0.05	0.08	0.04	0.04	0.05	0.05	NO	NO	NO	NO	
D. Waste water treatment and discharge												
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Memo items:												
International bunkers	315.09	387.14	342.53	379.01	383.77	365.05	388.96	469.17	624.92	683.77	227.53	-64.66
Aviation	295.46	311.17	330.03	366.52	368.10	354.08	375.75	449.06	559.65	605.86	163.82	-67.01
Navigation	19.64	75.97	12.50	12.50	15.66	10.97	13.21	20.11	65.27	77.91	63.71	-56.73
Multilateral operations	C	C	C	C	C	C	C	C	C	C	C	0.00
CO2 emissions from biomass	5,940.55	5,834.09	6,011.36	5,975.40	5,245.05	6,006.75	5,970.35	5,906.57	6,057.52	6,228.14	6,383.96	21.88
CO2 captured	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Long-term storage of C in waste disposal sites	406.14	418.97	434.33	450.11	464.39	481.32	495.68	508.48	521.07	536.49	551.48	183.37
Indirect N2O												
Indirect CO2 (3)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
Total CO2 equivalent emissions without land use, land-use	21,016.28	20,649.62	19,087.40	18,432.19	17,681.57	17,824.70	18,109.01	18,744.00	17,724.15	17,857.45	16,870.53	-26.59
Total CO2 equivalent emissions with land use, land-use	14,049.02	14,822.91	13,636.95	11,996.85	11,423.23	12,121.84	12,181.30	13,284.23	11,991.27	12,026.00	11,133.05	-29.91
Total CO2 equivalent emissions, including indirect CO2,	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total CO2 equivalent emissions, including indirect CO2, with	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

CTF Table 1(b): Emission trends (CH₄), sheet 1/3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year ^a	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt									
1. Energy	33.33	33.33	31.36	32.78	28.75	26.18	26.82	28.11	26.80	26.32
A. Fuel combustion (sectoral approach)	16.57	16.57	17.71	15.10	15.77	14.43	15.23	16.95	15.87	16.01
1. Energy industries	0.22	0.22	0.16	0.18	0.20	0.13	0.16	0.16	0.18	0.21
2. Manufacturing industries and construction	0.37	0.37	0.28	0.22	0.21	0.19	0.19	0.18	0.21	0.20
3. Transport	1.68	1.68	1.27	1.13	1.12	1.22	1.28	1.38	1.46	1.50
4. Other sectors	14.31	14.31	16.01	13.57	14.25	12.89	13.60	15.22	14.02	14.11
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE
B. Fugitive emissions from fuels	16.76	16.76	13.65	17.68	12.97	11.74	11.59	11.16	10.93	10.30
1. Solid fuels	2.39	2.39	2.13	1.65	1.58	1.42	1.13	0.91	0.67	0.70
2. Oil and natural gas and other emissions from energy production	14.38	14.38	11.53	16.03	11.39	10.33	10.46	10.25	10.26	9.60
C. CO2 transport and storage										
2. Industrial processes	0.37	0.37	0.35	0.30	0.25	0.26	0.23	0.21	0.22	0.20
A. Mineral industry										
B. Chemical industry	0.22	0.22	0.20	0.20	0.21	0.20	0.20	0.19	0.19	0.18
C. Metal industry	0.16	0.16	0.15	0.10	0.04	0.07	0.03	0.01	0.03	0.02
D. Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	101.93	101.93	97.12	76.53	76.46	70.75	67.66	64.33	63.50	62.31
A. Enteric fermentation	84.85	84.85	79.69	62.52	61.62	55.71	53.20	49.83	48.79	47.42
B. Manure management	17.08	17.08	17.43	14.02	14.84	15.04	14.46	14.50	14.71	14.89
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming										
H. Urea application										
I. Other carbon-containing fertilizers										
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	0.05	0.05	0.13	0.61	1.38	0.46	0.30	0.66	0.71	1.80
A. Forest land	0.04	0.04	0.12	0.55	1.31	0.43	0.28	0.61	0.65	1.59
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	0.00	0.00	0.01	0.06	0.06	0.03	0.02	0.06	0.05	0.21
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	36.67	36.67	37.25	37.83	38.43	39.25	39.79	40.31	41.42	42.17
A. Solid waste disposal	13.12	13.12	13.87	14.58	15.27	15.99	16.78	17.71	18.73	19.86
B. Biological treatment of solid waste	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.02	0.02	0.02	0.02	0.02
C. Incineration and open burning of waste	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA
D. Waste water treatment and discharge	23.56	23.56	23.38	23.25	23.16	23.24	22.99	22.58	22.67	22.29
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH4 emissions without CH4 from LULUCF	172.31	172.31	166.09	147.44	143.89	136.44	134.50	132.96	131.94	130.99
Total CH4 emissions with CH4 from LULUCF	172.36	172.36	166.21	148.05	145.27	136.90	134.80	133.62	132.64	132.80
Memo items:										
International bunkers	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	0.01	0.01	NO	NO	NO	0.01	0.01	0.01	0.01	0.01
Multilateral operations	C	C	C	C	C	C	C	C	C	C
CO2 emissions from biomass										
CO2 captured										
Long-term storage of C in waste disposal sites										
Indirect N2O										
Indirect CO2 (3)										

CTF Table 1(b): Emission trends (CH₄), sheet 2/3

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	25.38	23.38	24.94	24.56	26.58	26.05	26.82	26.17	26.04	25.53	25.72
A. Fuel combustion (sectoral approach)	15.80	14.16	15.16	14.59	16.57	16.12	16.87	15.56	15.02	14.96	15.46
1. Energy industries	0.22	0.16	0.18	0.20	0.23	0.19	0.18	0.19	0.22	0.19	0.19
2. Manufacturing industries and construction	0.17	0.18	0.18	0.17	0.20	0.24	0.22	0.23	0.23	0.22	0.21
3. Transport	1.52	1.47	1.26	1.22	1.18	1.11	1.02	0.97	0.94	0.86	0.82
4. Other sectors	13.89	12.36	13.55	13.00	14.96	14.58	15.45	14.16	13.63	13.68	14.24
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE
B. Fugitive emissions from fuels	9.57	9.21	9.78	9.96	10.01	9.93	9.95	10.61	11.02	10.58	10.26
1. Solid fuels	0.21	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	9.36	9.21	9.78	9.96	10.01	9.93	9.95	10.61	11.02	10.58	10.26
C. CO2 transport and storage											
2. Industrial processes	0.20	0.14	0.14	0.13	0.12	0.15	0.15	0.15	0.14	0.13	0.12
A. Mineral industry											
B. Chemical industry	0.18	0.12	0.14	0.13	0.12	0.15	0.15	0.15	0.14	0.13	0.12
C. Metal industry	0.02	0.02	0.00	0.00	0.00	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
D. Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	64.02	62.77	63.66	62.92	66.12	68.40	68.83	70.53	67.90	64.43	65.33
A. Enteric fermentation	47.63	46.76	47.13	45.96	47.94	49.14	50.84	50.08	48.17	46.24	45.84
B. Manure management	16.39	16.02	16.53	16.96	18.18	19.26	17.98	20.45	19.72	18.19	19.49
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming											
H. Urea application											
I. Other carbon-containing fertilizers											
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	0.24	3.88	0.76	0.26	1.58	0.12	0.11	0.24	1.27	0.38	0.20
A. Forest land	0.17	3.48	0.64	0.22	1.44	0.08	0.09	0.22	1.18	0.35	0.19
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Grassland	0.07	0.39	0.12	0.03	0.14	0.04	0.02	0.02	0.09	0.04	0.01
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	43.56	45.15	45.58	47.03	48.54	50.48	50.21	53.35	56.27	59.29	61.21
A. Solid waste disposal	21.04	22.40	23.74	25.29	27.03	28.72	28.55	31.52	34.20	37.42	40.65
B. Biological treatment of solid waste	0.02	0.03	0.02	0.03	0.02	0.02	0.04	0.03	0.07	0.13	0.18
C. Incineration and open burning of waste	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA
D. Waste water treatment and discharge	22.49	22.72	21.81	21.71	21.49	21.74	21.62	21.80	22.01	21.74	20.39
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH4 emissions without CH4 from LULUCF	133.16	131.43	134.31	134.64	141.36	145.09	146.01	150.19	150.35	149.38	152.37
Total CH4 emissions with CH4 from LULUCF	133.40	135.31	135.07	134.90	142.95	145.21	146.12	150.44	151.62	149.77	152.58
Memo items:											
International bunkers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navigation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Multilateral operations	C	C	C	C	C	C	C	C	C	C	C
CO2 emissions from biomass											
CO2 captured											
Long-term storage of C in waste disposal sites											
Indirect N2O											
Indirect CO2 (3)											

CTF Table 1(b): Emission trends (CH₄), sheet 3/3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
	%											
1. Energy	26.72	25.46	24.02	23.48	21.11	23.44	23.11	22.71	21.44	20.67	20.37	-38.88
A. Fuel combustion (sectoral approach)	16.43	15.98	15.79	15.65	13.80	15.70	15.31	14.98	14.34	14.02	14.23	-14.13
1. Energy industries	0.17	0.20	0.20	0.17	0.13	0.17	0.22	0.28	0.31	0.39	0.42	94.81
2. Manufacturing industries and construction	0.21	0.18	0.19	0.18	0.15	0.13	0.12	0.14	0.15	0.16	0.18	-51.05
3. Transport	0.73	0.67	0.54	0.54	0.50	0.48	0.48	0.47	0.42	0.39	0.37	-77.96
4. Other sectors	15.32	14.92	14.86	14.77	13.01	14.92	14.50	14.09	13.46	13.07	13.25	-7.35
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
B. Fugitive emissions from fuels	10.29	9.48	8.23	7.83	7.31	7.74	7.80	7.74	7.10	6.65	6.14	-63.35
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
2. Oil and natural gas and other emissions from energy production	10.29	9.48	8.23	7.83	7.31	7.74	7.80	7.74	7.10	6.65	6.14	-57.27
C. CO2 transport and storage												
2. Industrial processes	0.11	0.07	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	
A. Mineral industry												
B. Chemical industry	0.11	0.07	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	
C. Metal industry	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	
D. Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Electronic industry												
F. Product uses as ODS substitutes												
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Agriculture	64.86	63.00	62.88	60.06	59.31	58.95	60.67	58.79	55.25	55.24	53.66	-47.35
A. Enteric fermentation	45.37	44.25	44.55	42.69	41.97	41.57	43.64	42.09	39.55	39.79	39.02	-54.01
B. Manure management	19.49	18.75	18.33	17.36	17.34	17.39	17.03	16.70	15.70	15.45	14.64	-14.29
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Liming												
H. Urea application												
I. Other carbon-containing fertilizers												
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	0.07	0.75	1.56	0.08	0.01	0.56	0.36	2.77	0.05	0.11	1.30	2,543.87
A. Forest land	0.07	0.61	1.44	0.06	0.01	0.39	0.30	2.45	0.03	0.09	1.16	2,485.99
B. Cropland	NO	NO	NO	NO	0.00	0.10	0.00	0.02	0.00	0.00	0.00	100.00
C. Grassland	0.00	0.14	0.11	0.02	0.00	0.06	0.06	0.30	0.02	0.02	0.14	3,130.13
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Harvested wood products												
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	63.14	64.42	64.20	63.61	65.28	67.09	68.30	69.02	68.08	67.31	67.28	83.45
A. Solid waste disposal	41.62	42.97	44.15	43.94	45.64	47.46	48.45	50.19	49.87	48.89	48.81	272.04
B. Biological treatment of solid waste	0.15	0.17	0.18	0.21	0.22	0.21	0.30	0.31	0.36	0.45	0.59	100.00
C. Incineration and open burning of waste	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	0.00
D. Waste water treatment and discharge	21.38	21.27	19.88	19.46	19.43	19.42	19.54	18.52	17.85	17.97	17.88	-24.10
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CH4 emissions without CH4 from LULUCF	154.83	152.95	151.10	147.14	145.69	149.48	152.08	150.52	144.77	143.22	141.31	-17.99
Total CH4 emissions with CH4 from LULUCF	154.90	153.70	152.65	147.22	145.70	150.04	152.43	153.29	144.82	143.33	142.61	-17.26
Memo items:												
International bunkers	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	-58.32
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-67.47
Navigation	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	-55.98
Multilateral operations	C	C	C	C	C	C	C	C	C	C	C	0.00
CO2 emissions from biomass												
CO2 captured												
Long-term storage of C in waste disposal sites												
Indirect N2O												
Indirect CO2 (3)												

CTF Table 1(c): Emission trends (N₂O), sheet 1/3

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	<i>Base year^a</i> <i>kt</i>	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. Energy	0.82	0.82	0.70	0.63	0.65	0.64	0.61	0.77	0.77	0.71
A. Fuel combustion (sectoral approach)	0.81	0.81	0.70	0.63	0.65	0.64	0.60	0.77	0.77	0.71
1. Energy industries	0.06	0.06	0.04	0.05	0.06	0.04	0.04	0.04	0.05	0.06
2. Manufacturing industries and construction	0.06	0.06	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
3. Transport	0.23	0.23	0.18	0.15	0.16	0.17	0.15	0.25	0.29	0.20
4. Other sectors	0.47	0.47	0.44	0.39	0.40	0.40	0.38	0.46	0.40	0.42
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO2 transport and storage										
2. Industrial processes	2.65	2.65	2.35	3.03	2.31	2.49	2.40	2.24	2.35	1.80
A. Mineral industry										
B. Chemical industry	2.53	2.53	2.22	2.90	2.19	2.37	2.27	2.12	2.23	1.68
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	5.89	5.89	5.80	5.22	4.57	4.53	4.38	4.37	4.92	4.35
A. Enteric fermentation										
B. Manure management	1.10	1.10	1.05	0.82	0.82	0.77	0.72	0.68	0.67	0.65
C. Rice cultivation										
D. Agricultural soils	4.78	4.78	4.74	4.40	3.76	3.76	3.65	3.69	4.25	3.70
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming										
H. Urea application										
I. Other carbon containing fertilizers										
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	0.16	0.16	0.16	0.19	0.23	0.17	0.16	0.18	0.17	0.24
A. Forest land	0.00	0.00	0.01	0.03	0.07	0.02	0.02	0.03	0.04	0.09
B. Cropland	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
C. Grassland	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.02
D. Wetlands	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02
E. Settlements	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.22	0.22	0.21	0.21	0.21	0.22	0.24	0.23	0.23	0.23
A. Solid waste disposal										
B. Biological treatment of solid waste	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00	0.00	0.00	0.00	0.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Waste water treatment and discharge	0.22	0.22	0.21	0.21	0.21	0.22	0.24	0.23	0.23	0.23
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N2O emissions without N2O from LULUCF	9.58	9.58	9.05	9.09	7.75	7.89	7.62	7.62	8.27	7.09
Total direct N2O emissions with N2O from LULUCF	9.74	9.74	9.22	9.28	7.98	8.06	7.78	7.80	8.45	7.33
Memo items:										
International bunkers	0.02	0.02	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Aviation	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Navigation	0.00	0.00	NO	NO	NO	0.00	0.00	0.00	0.00	0.00
Multilateral operations	C	C	C	C	C	C	C	C	C	C
CO2 emissions from biomass										
CO2 captured										
Long-term storage of C in waste disposal sites										
Indirect N2O	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Indirect CO2 (3)										

CTF Table 1(c): Emission trends (N₂O), sheet 2/3

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	0.91	0.93	0.90	0.76	0.81	0.93	0.80	0.80	0.82	0.81	0.79
A. Fuel combustion (sectoral approach)	0.90	0.93	0.90	0.76	0.81	0.93	0.80	0.80	0.82	0.81	0.79
1. Energy industries	0.06	0.06	0.07	0.08	0.09	0.08	0.08	0.08	0.09	0.08	0.07
2. Manufacturing industries and construction	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.03	0.03
3. Transport	0.37	0.37	0.34	0.22	0.23	0.37	0.23	0.24	0.26	0.24	0.24
4. Other sectors	0.45	0.46	0.46	0.43	0.47	0.44	0.46	0.45	0.44	0.45	0.45
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO2 transport and storage											
2. Industrial processes	2.10	2.45	2.07	2.02	1.91	2.30	2.24	2.22	2.43	2.48	2.08
A. Mineral industry											
B. Chemical industry	1.98	2.33	1.95	1.90	1.80	2.19	2.14	2.11	2.33	2.38	1.99
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Electronic industry											
F. Product uses as ODS substitutes											
G. Other product manufacture and use	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.09
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	4.62	4.66	4.94	4.83	4.58	4.88	4.94	4.99	4.92	5.90	4.17
A. Enteric fermentation											
B. Manure management	0.67	0.64	0.65	0.64	0.65	0.67	0.63	0.65	0.62	0.58	0.59
C. Rice cultivation											
D. Agricultural soils	3.94	4.01	4.29	4.19	3.93	4.21	4.30	4.33	4.30	5.32	3.58
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming											
H. Urea application											
I. Other carbon containing fertilizers											
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	0.14	0.35	0.19	0.18	0.27	0.21	0.23	0.25	0.34	0.31	0.33
A. Forest land	0.01	0.19	0.04	0.01	0.08	0.00	0.00	0.01	0.07	0.02	0.01
B. Cropland	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.06
C. Grassland	0.01	0.04	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
D. Wetlands	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
E. Settlements	0.08	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23	0.25
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products											
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.25	0.24	0.25	0.27	0.26	0.26	0.27	0.28	0.29	0.29	0.30
A. Solid waste disposal											
B. Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
C. Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO, NE, IE, NA
D. Waste water treatment and discharge	0.24	0.23	0.25	0.26	0.26	0.26	0.27	0.28	0.28	0.29	0.29
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N2O emissions without N2O from LULUCF	7.87	8.27	8.16	7.87	7.57	8.37	8.25	8.28	8.46	9.48	7.34
Total direct N2O emissions with N2O from LULUCF	8.01	8.62	8.35	8.05	7.84	8.58	8.48	8.54	8.80	9.79	7.67
Memo items:											
International bunkers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Navigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Multilateral operations	C	C	C	C	C	C	C	C	C	C	C
CO2 emissions from biomass											
CO2 captured											
Long-term storage of C in waste disposal sites											
Indirect N2O	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Indirect CO2 (3)											

CTF Table 1(c): Emission trends (N₂O), sheet 3/3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
	%											
1. Energy	0.78	0.74	0.71	0.70	0.66	0.69	0.71	0.72	0.70	0.72	0.73	-10.12
A. Fuel combustion (sectoral approach)	0.78	0.74	0.71	0.70	0.66	0.69	0.71	0.72	0.70	0.72	0.73	-9.92
1. Energy industries	0.07	0.08	0.07	0.07	0.06	0.07	0.08	0.07	0.07	0.09	0.09	49.09
2. Manufacturing industries and construction	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	-53.79
3. Transport	0.23	0.19	0.18	0.18	0.17	0.18	0.20	0.21	0.20	0.21	0.20	-8.93
4. Other sectors	0.45	0.45	0.43	0.42	0.40	0.43	0.42	0.41	0.41	0.40	0.42	-12.46
5. Other	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-76.88
1. Solid fuels	NO, NA	NO, NA	NO, NA	NO, NA	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
2. Oil and natural gas and other emissions from energy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-76.88
C. CO2 transport and storage												
2. Industrial processes	2.66	2.62	2.27	0.88	0.96	1.11	0.43	0.40	0.23	0.23	0.29	-89.25
A. Mineral industry												
B. Chemical industry	2.57	2.53	2.19	0.81	0.89	1.04	0.37	0.33	0.17	0.17	0.22	-91.37
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Electronic industry												
F. Product uses as ODS substitutes												
G. Other product manufacture and use	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.07	-45.69
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Agriculture	4.43	4.70	4.32	3.75	3.58	3.85	3.72	4.16	4.17	4.16	4.21	-28.45
A. Enteric fermentation												
B. Manure management	0.57	0.54	0.53	0.50	0.51	0.50	0.53	0.52	0.49	0.49	0.48	-56.84
C. Rice cultivation												
D. Agricultural soils	3.86	4.17	3.79	3.25	3.07	3.35	3.20	3.63	3.68	3.67	3.74	-21.89
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Liming												
H. Urea application												
I. Other carbon containing fertilizers												
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	0.35	0.42	0.50	0.41	0.41	0.44	0.43	0.57	0.41	0.41	0.48	199.46
A. Forest land	0.00	0.03	0.08	0.00	0.00	0.02	0.02	0.14	0.00	0.01	0.06	2,485.99
B. Cropland	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	412.41
C. Grassland	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.00	0.00	0.01	3,130.13
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	-85.88
E. Settlements	0.27	0.30	0.32	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.33	208.48
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Harvested wood products												
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Waste	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.31	0.31	0.32	0.33	45.43
A. Solid waste disposal												
B. Biological treatment of solid waste	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	100.00
C. Incineration and open burning of waste	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, IE,	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	
D. Waste water treatment and discharge	0.28	0.28	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.30	34.96
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total direct N2O emissions without N2O from LULUCF	8.15	8.36	7.59	5.63	5.49	5.96	5.18	5.58	5.42	5.43	5.56	-41.99
Total direct N2O emissions with N2O from LULUCF	8.50	8.78	8.08	6.04	5.90	6.40	5.61	6.15	5.83	5.84	6.04	-38.00
Memo items:												
International bunkers	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	-64.96
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.00	-67.47
Navigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-55.98
Multilateral operations	C	C	C	C	C	C	C	C	C	C	C	0.00
CO2 emissions from biomass												
CO2 captured												
Long-term storage of C in waste disposal sites												
Indirect N2O	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
Indirect CO2 (3)												

CTF Table 1(d): Emission trends (HFCs, PFCs and SF₆), sheet 1/3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year ^a	1990	1991	1992	1993	1994	1995	1996	1997	1998
	kt									
Emissions of HFCs and PFCs - (kt CO2 equivalent)	1,240.24	1,240.24	850.75	NO	NO	NO	21.85	25.18	29.69	35.89
Emissions of HFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	21.85	25.18	29.69	35.89
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	NO	NO	NO	NO	0.00	0.00	0.01	0.01
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs - (kt CO2 equivalent)	1,240.24	1,240.24	850.75	NO	NO	NO	NO	NO	NO	NO
CF ₄	0.12	0.12	0.08	NO	NO	NO	NO	NO	NO	NO
C ₂ F ₆	0.03	0.03	0.02	NO	NO	NO	NO	NO	NO	NO
C ₃ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₄ F ₁₀	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C ₄ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₅ F ₁₂	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₆ F ₁₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF6 - (kt CO2 equivalent)	10.73	10.73	10.61	10.69	10.81	11.60	12.08	12.51	12.15	13.00
SF ₆	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions of NF3 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

CTF Table 1(d): Emission trends (HFCs, PFCs and SF₆), sheet 2/3

<i>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</i>	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Emissions of HFCs and PFCs - (kt CO2 equivalent)	43.62	52.89	64.80	86.16	114.37	137.14	187.20	247.18	329.67	405.91	494.27
Emissions of HFCs - (kt CO2 equivalent)	43.62	52.89	64.80	86.16	114.37	137.14	187.20	247.18	329.67	405.91	494.27
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.06
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.08	0.10	0.12	0.14
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	NO	NO	NO	NO	NO	NO	NO	0.00	0.00	NO	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified mix of HFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CF ₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₂ F ₆	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₃ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₄ F ₁₀	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C ₄ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₅ F ₁₂	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₆ F ₁₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF6 - (kt CO2 equivalent)	12.95	12.34	12.42	12.75	13.09	13.54	14.26	14.13	14.15	12.99	9.34
SF ₆	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions of NF3 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

CTF Table 1(d): Emission trends (HFCs, PFCs and SF₆), sheet 3/3

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Change from base to latest reported year
	%											
Emissions of HFCs and PFCs - (kt CO2 equivalent)	595.15	663.84	741.43	814.57	905.47	1,007.40	1,150.49	1,304.09	1,438.84	1,560.96	1,689.72	36.24
Emissions of HFCs - (kt CO2 equivalent)	595.15	663.84	741.43	814.57	905.47	1,007.40	1,150.49	1,304.09	1,438.84	1,560.96	1,689.72	100.00
HFC-23	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-32	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.13	0.17	0.20	0.24	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	0.07	0.08	0.09	0.10	0.11	0.13	0.15	0.17	0.19	0.20	0.22	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.17	0.18	0.19	0.21	0.22	0.24	0.27	0.29	0.32	0.36	0.38	100.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.05	100.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.04	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-365mfc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Unspecified mix of HFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
CF ₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
C ₂ F ₆	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
C ₃ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C ₄ F ₁₀	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C ₄ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C ₅ F ₁₂	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C ₆ F ₁₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of SF6 - (kt CO2 equivalent)	9.83	10.26	10.96	7.18	7.67	5.58	6.60	7.02	6.27	7.85	8.76	-18.30
SF ₆	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-18.30
Emissions of NF3 - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

Table 2(a): Description of quantified economy-wide emission reduction target: base year^a

<i>Party</i>	<i>Croatia</i>	
Base year /base period	1990	
Emission reduction target	% of base year/base period	% of 1990 ^b
	20.00	20.00
Period for reaching target	BY-2020	

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Optional.

Table 2(b): Description of quantified economy-wide emission reduction target: gases and sectors covered^a

<i>Gases covered</i>		<i>Base year for each gas (year):</i>
CO ₂		1990
CH ₄		1990
N ₂ O		1990
HFCs		1990
PFCs		1990
SF ₆		1990
NF ₃		
Other Gases (specify)		
Sectors covered ^b	Energy	Yes
	Transport ^f	Yes
	Industrial processes ^g	Yes
	Agriculture	Yes
	LULUCF	No
	Waste	Yes
	Other Sectors (specify)	

Abbreviations: LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b More than one selection will be allowed. If Parties use sectors other than those indicated above, the explanation of how these sectors relate to the sectors defined by the IPCC should be provided.

^f Transport is reported as a subsector of the energy sector.

^g Industrial processes refer to the industrial processes and solvent and other product use sectors.

Table 2(c): Description of quantified economy-wide emission reduction target: global warming potential values (GWP)^a

<i>Gases</i>	<i>GWP values^b</i>
CO ₂	4th AR
CH ₄	4th AR
N ₂ O	4th AR
HFCs	4th AR
PFCs	4th AR
SF ₆	4th AR
NF ₃	4th AR
Other Gases (specify)	

Abbreviations: GWP = global warming potential

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Please specify the reference for the GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

Table 2(d): Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF^a

Role of LULUCF	LULUCF in base year level and target	Excluded
	Contribution of LULUCF is calculated using	

Abbreviation: LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Table 2(e)I: Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention and other market-based mechanisms^a

<i>Market-based mechanisms</i>	<i>Possible scale of contributions</i>
<i>under the Convention</i>	<i>(estimated kt CO₂ eq)</i>
Possible scale of contributions of market-based mechanisms under the convention	
CERs	
ERUs	
AAUs ⁱ	
Carry-over units ^j	
Other mechanism units under the Convention (specify) ^d	

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^d As indicated in paragraph 5(e) of the guidelines contained in annex I of decision 2/CP.17 .

ⁱ AAUs issued to or purchased by a Party.

^j Units carried over from the first to the second commitment periods of the Kyoto Protocol, as described in decision 13/CMP.1 and consistent with decision 1/CMP.8.

Table 2(e)II: Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention and other market-based mechanisms^a

<i>Other market-based mechanisms</i>	<i>Possible scale of contributions</i>
<i>(Specify)</i>	<i>(estimated kt CO₂ eq)</i>

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Table 2(f): Description of quantified economy-wide emission reduction target: any other information^{a,b}

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emission reduction target of 20 per cent below the 1990 level by 2020 (“the Cancun pledge”). It is therefore a joint pledge with no separate targets for Member States under the Convention.

The EU has jointly committed to its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package. In this package, the EU introduced a clear approach to achieving the 20% reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (ESD).

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b This information could include information on the domestic legal status of the target or the total assigned amount of emission units for the period for reaching a target. Some of this information is presented in the narrative part of the biennial report.

Custom Footnotes

CTF Table 3. Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
MEN-1: Promoting nZEB construction and renovation standards*	Energy	CH ₄ , CO ₂ , N ₂ O	Efficiency improvements of buildings; Increase in the number of nearly-zero energy buildings	Information, Regulatory	Implemented	After December 31, 2018, all public buildings in the Republic of Croatia in which they reside or are owned by public bodies must be constructed according to the nZEB (Nearly Zero Energy Building) standard, and the obligation for all other newly constructed buildings occurs after December 31, 2020. These legal provisions ensure that all newly constructed buildings from 2021 onwards are according to the nZEB standard. However, in order to ensure the correct application of these directives, but also to encourage energy renovation of buildings according to the nZEB standard, in the next period it is planned to conduct a series of information and educational activities to promote construction and renovation according to the nZEB standard. The measure has no direct effect on reducing energy consumption, but rather supports the regulatory measure for the construction of new buildings according to the nZEB standard, as well as a promotion measure for energy renovation up to the nZEB standard, which will result in measurable reduction of energy consumption, greater use of RES and avoided CO ₂ emissions.	2019	Ministry of Physical Planning; Construction and State Assets	NE	NE	NE	NE	NE
MEN-2: Energy renovation programme for apartment buildings*	Energy	CH ₄ , CO ₂ , N ₂ O	Efficiency improvements of buildings; Renovation of 520,000 m ² of apartment buildings per year	Economic	Implemented	This program is as a continuation of the implementation of the Program of energy renovation of apartment buildings from the period from 2014 to 2020. For this purpose, it is necessary to plan funds from the ESI (European Structural and Investment) Funds for the next programming period 2021-2027 (with implementation by 2030), while implementation procedures need to be significantly simplified, especially in public procurement implementation. The technical conditions should also remain as in the existing Program. Therefore, it is necessary to reduce the thermal needs of the building by at least 50%. It is necessary to encourage that renovation is performed according to the nZEB (Nearly Zero Energy Building) standard. In addition, establishing a special fund from which costs will be reimbursed to energy-poor households or households at risk of energy poverty should be considered, in order to remove the obstacle of securing a sufficient number of co-owners' consents for energy recovery. The implementation of the Program must be accompanied by strong promotional activities, while technical assistance should be provided to applicants. It is necessary to ensure energy consumption monitoring before and after energy	2014	Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning, Construction and State Assets	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						renovation, for which it is necessary to create preconditions within the EMIS (Energy Management Information System). The plan includes the renovation of around 520,000 m2 of apartment buildings per year.							
MEN-3: Energy renovation programme for single family houses*	Energy	CO2, CH4, N2O	Efficiency improvements of buildings; Renovation of 350,000 m2 of family houses per year	Economic	Implemented	The program should be conceived as a continuation of the implementation of the Program for energy renovation of family houses from the period from 2014 to 2020, with co-financing from the Environmental Protection and Energy Efficiency Fund. The program should leave the possibility of implementing individual measures, with respect to the order of implementation of measures (e.g. the replacement of a heating system with a more efficient system that uses RES should only be possible for those houses that have good thermal characteristics and do not need enclosure interventions). It is necessary to strongly encourage the renovation according to the nZEB standard. The implementation of the Program must be accompanied by strong promotional activities. The plan includes the renovation of around 350,000 m2 of family houses per year.	2017	Ministry of Physical Planning, Construction and State Assets; Environmental Protection and Energy Efficiency Fund	NE	NE	NE	NE	NE
MEN-4: Energy renovation programme for public buildings*	Energy	CO2, CH4, N2O	Efficiency improvements of buildings; Renovation of 350,000 m2 of public buildings per year	Economic	Implemented	The measure is based on the Programme for the Energy Renovation of Public Buildings for the Period from 2016 to 2020. For this purpose, it is necessary to plan funds from the ESI (European Structural and Investment) Funds for the next programming period 2021-2027 (with implementation by 2030). Funds need to be planned to ensure both the activation of private capital and the ESCO (Energy Service Company) market, especially for buildings that are suitable for such financing models (buildings with continuous work, such as hospitals, penitentiaries, homes for the elderly, etc.) and belonging to the category of central government buildings. Market models need to be combined with grants in order to achieve nZEB (Nearly Zero Energy Building) standards. For buildings that are not suitable for market models, it is necessary to provide grants under the same conditions as in the previous program. Renovation of public sector buildings needs to be directed towards the nZEB standard wherever technically feasible. The plan includes the renovation of around 350,000 m2 of public buildings per year.	2014	Ministry of Physical Planning, Construction and State Assets; Agency for Legal Affairs and Real Estate; Environmental Protection and Energy Efficiency Fund	NE	NE	NE	NE	NE
MEN-5: Energy renovation programme for buildings that have the status of cultural property*	Energy	CO2, CH4, N2O	Efficiency improvements of buildings; Renovation of 8.975.943 m2 of buildings that	Economic	Implemented	Protected buildings in terms of the Energy Renovation Programme of buildings that have the status of cultural property are those that can be classified into two categories: individually protected cultural property (individual building and construction complexes) and buildings	2021	Ministry of Physical Planning, Construction and State Assets; Environmental	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
			have the status of cultural property			located within the protected cultural and historical ensemble. The program does not include buildings protected as a preventively protected cultural property, or buildings registered as cultural property. Two basic approaches to energy renovation of buildings that are the subject of this Programme have been developed: a complete (integrated) approach and an approach with the application of individual energy renovation measures.		Protection and Energy Efficiency Fund					
MEN-6: Energy renovation programme for public lighting*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in services/ tertiary sector; Energy savings in 2030: 0.90 PJ	Economic	Implemented	Energy renovation of public lighting in the Republic of Croatia is currently being carried out using ESI (European Structural and Investment) Funds from the European Regional Development Fund. Given the significant potential that exists in public lighting systems, it is planned to use ESI Funds in the next programming period from 2021 to 2027. By programming a larger allocation of funds for this purpose, the existing potential could be used by the end of 2030, which is estimated at around 225-280 GWh. At the same time, the renovation of public lighting would meet the technical standards for road lighting, which means that traffic safety would be improved and light pollution would be reduced. The financing models that will be used in the next period should also enable the mobilization of private capital through energy services or public-private partnerships, in order to achieve the best possible multiplier effect. Models that are to be considered include interest rate subsidies on commercial loans/required returns to the service provider and guarantees, while it is necessary to provide grants for projects requiring investment in new public lighting infrastructure (poles, additional luminaires, etc.) to meet standard lighting requirements.	2014	Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-7: Energy management in the public sector**	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in services/ tertiary sector; Energy savings in 2030: 0.20 PJ	Information, Regulatory	Implemented	The public sector in Croatia is obliged to systematically manage energy, which is specifically regulated by the Energy Efficiency Act (OG 127/14, 116/18, 25/20, 41/21), or the Ordinance on Systematic Energy Management (OG 18/15, 6/16). The basis of this measure is an Information System for Energy Management (ISGE). The goal is to include and regularly monitor with ISGE all public sector buildings and public lighting systems by the end of 2030.	2014	Ministry of Physical Planning, Construction and State Assets; Agency for Legal Affairs and Real Estate	NE	NE	NE	NE	NE
MEN-8: Energy management in the business (service and production) sector	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors	Fiscal	Planned	Although large companies are obliged to conduct regular energy audits, this obligation does not ensure continuous care for energy consumption in the company nor does it cover small and medium-sized enterprises. In order to encourage companies to introduce certified energy management systems (such as ISO	2023	Ministry of Economy and Sustainable Development; Ministry of Finance	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						50001), a comprehensive analysis of the possibilities of using the tax system (including taxes and parafiscal levies) will be made to encourage companies to introduce such a system and thus ensure continuous care for energy consumption.							
MEN-9: Informational accounts*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Informing consumers about energy consumption and production	Information, Regulatory	Implemented	One of the basic measures of informing consumers is the legal obligation of suppliers for submitting to consumers at least once a year information invoices, which contain information on energy billing and previous consumption of the end customer for billing meters that are the subject of the contract, which include comparison with average regular consumption or reference customer from the same category. It is desirable to reduce the frequency of application of this legal provision from the annual level to the monthly level, and it is absolutely necessary to ensure that the energy regulatory body monitors these obligations of energy suppliers. In addition, based on these regulations, it is necessary to further inform consumers about the content and meaning of bills, which is the task of the National Coordination Body for Energy Efficiency.	2014	Energy Suppliers; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-10: Energy efficiency information*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of buildings; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Informing the general public and target groups about energy efficiency promotion programs	Information	Implemented	Informing the general public and target groups will be carried out by organizing targeted info-campaigns related to specific programs to promote energy efficiency, especially energy renovation of buildings. National Coordination Body for Energy Efficiency will maintain a national energy efficiency portal and ensure continuous promotion of energy efficiency and energy services through the provision of up-to-date information. In the next period, special attention should be given to informing consumers about the duties of the supplier within the system of obligations.	2014	Ministry of Physical Planning, Construction and State Assets; Ministry of Economy and Sustainable Development; Environmental Protection and Energy Efficiency Fund and EU funds	NE	NE	NE	NE	NE
MEN-11: Energy efficiency education*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of buildings; Educating workers on energy efficiency	Education	Implemented	Training will be achieved through the continued implementation of the existing measure and the adaptation of activities to the needs and the real situation. It is especially important to work systematically on attracting young people to construction and other technical occupations, which will in the long run contribute to the availability of professional capacities for the implementation of energy renovation of buildings, which is the basis for achieving energy and climate goals. Through education in the field of energy efficiency, the principles of green building will be set and applied: it is necessary to encourage the promotion and	2017	Agency for Vocational Education and Adult Education; Croatian Employment Service	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						implementation of green building (construction according to the principles of sustainability) as an important segment of sustainable development and the circular economy.							
MEN-12: Energy efficiency of the electricity transmission network*	Energy	CO ₂ , CH ₄ , N ₂ O	Reduction of losses in the transmission network; Efficiency improvement in the energy and transformation sector; Energy savings in 2030: 0.9 PJ	Economic, Regulatory	Implemented	An important characteristic of the Croatian transmission network, both in terms of plant safety and support of market activities, and in terms of losses is the extremely strong connection with neighbouring power systems (interconnections). While on the one hand this significantly increases the security of the plant, on the other hand due to transit the network losses increase. In the period until 2030, measures related to the management of the power system and measures related to the development of the transmission network will continue to be implemented, for optimal (safe and efficient) management of the facility.	2016	Croatian Transmission System Operator; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-13: Reduction of losses in the distribution network and introduction of smart grids*	Energy	CO ₂ , CH ₄ , N ₂ O	Reduction of technical and non-technical losses in the electricity distribution network; Efficiency improvement in the energy and transformation sector; Cumulative energy savings in the period 2021-2030: 1.0 PJ	Economic, Regulatory	Implemented	In the period until 2030, activities will continue to reduce technical and non-technical losses in the electricity distribution network. A detailed analysis will determine the causes of increased losses in certain parts of the network and priorities for the implementation of activities to reduce technical and non-technical losses. Based on the experience from the implementation of the pilot project of introducing advanced networks in pilot areas with the use of ESI (European Structural and Investment) Funds, it is necessary to program the continuation of the use of ESI Funds in the next programming period from 2021 to 2027 for further development of advanced networks.	2016	HEP DSO (Distribution System Operator); Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-14: Increasing the efficiency of the district heating systems*	Energy	CO ₂ , CH ₄ , N ₂ O	Reduction of losses; Efficiency improvement in the energy and transformation sector; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors	Economic, Regulatory	Implemented	In the existing large centralized heating systems, a large source of losses is the deteriorated steam and hot water network, and this measure foresees the continuation of the replacement of deteriorated steel hot water pipes and steam lines with new pre-insulated pipes and a technological shift to fourth-generation district heating. In smaller systems with their own boiler room, it is necessary to enable the reconstruction of boiler rooms, in particular by replacing them with high-efficiency cogeneration systems or systems using heat pumps. The measure also envisages the development of new heating and cooling systems, which use high-efficiency cogeneration or renewable energy sources.	2016	Ministry of Economy and Sustainable Development; HEP District Heating	NE	NE	NE	NE	NE
MEN-15: Increasing the efficiency of the gas transport network*	Energy	CO ₂ , CH ₄ , N ₂ O	Reduction of losses; Efficiency improvement of the gas transmission system	Economic, Regulatory	Implemented	The potential for increasing the energy efficiency of the gas transport system is largest in the consumption of natural gas, which is mostly (70%) consumed for preheating natural gas before delivery to customers, and only a small part (30%) for heating business premises and various technological reliefs, i.e. system	2016	Ministry of Economy and Sustainable Development; Plinacro Ltd.	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						exhaust. Activities to improve energy efficiency will be implemented in accordance with the Ten-Year Development Plan of the Gas Transport System of the Republic of Croatia 2018-2027.							
MEN-16: Information, education and capacity building for RES use	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector ; Increase in renewable energy in the heating and cooling sector; Promoting the use of renewable energy sources	Economic, Education, Information	Planned	Dissemination of information to the general public and target groups will be conducted through the organization of targeted informational campaigns related to investments in systems using renewable energy sources, especially in systems for own needs. Information, education and capacity building for the use of RES will be provided at the national level.	2023	Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning, Construction and State Assets; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-17: Spatial planning prerequisites for RES use	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Promoting the use of renewable energy sources	Regulatory	Planned	Defining guidelines and criteria for the regulation of specific spatial-functional elements for the use of RES, more advanced and cross-sectoral harmonization of spatial planning conditions for determining areas suitable for the construction of RES plants at the state, county and local level. Guidelines and criteria for determining the spatial planning conditions for the use of space intended for the construction of facilities for energy recovery of RES (specific spatial-functional elements in space) and for the exploitation fields of geothermal water for energy purposes will be adopted. Conditions for determining locations and construction of RES plants will be integrated into spatial plans at the state, county and local levels.	2023	Ministry of Economy and Sustainable Development; Ministry of Physical Planning, Construction and State Assets	NE	NE	NE	NE	NE
MEN-18: Promoting the RES use for production of electricity and heat*	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Promoting the use of renewable energy sources	Economic	Implemented	Providing financial incentives for the development of projects for the use of RES for the production of electricity and heat. Encouraging the use of RES for electricity and heat production will be implemented at the national level.	2014	Ministry of Economy and Sustainable Development; Croatian Energy Operator (HROTE); Environmental Protection and Energy Efficiency Fund	NE	NE	NE	NE	NE
MEN-19: Development of the regulatory framework for RES use	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Promoting the use of renewable energy sources	Regulatory	Planned	The existing legal framework needs to be amended and procedures and practices developed. The goal is to fully adopt the regulatory framework and established procedures at the national level by the end of 2023.	2023	Croatian Energy Regulatory Agency; Ministry of Physical Planning, Construction and State Assets; Ministry of Economy and	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
								Sustainable Development					
MEN-20: Integrated planning of security of energy and energy products supply	Energy	CO ₂ , CH ₄ , N ₂ O	Increasing energy security including alternative fuels	Regulatory	Planned	The overarching measure to increase energy security is the integrated planning of security of supply in the context of all energy products and all energy systems. Integrated planning should be harmonized at the local, regional and national level, and in accordance with energy planning carried out by energy entities for energy infrastructure throughout the territory of the Republic of Croatia. In addition, integrated planning needs to be aligned with planning for alternative fuels and infrastructure for alternative fuels.	2023	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-21: Construction and use of energy storage	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Efficiency improvement in the energy and transformation sector; Increasing energy storage capacity; Promoting the use of renewable energy sources	Economic	Planned	In order to increase the energy storage capacity of the system and increase the regulatory capacity of the electricity system, it is planned to build additional reversible power plants with a capacity of 150 MW before 2030, development of heat storage tanks for end customers, batteries, charging stations for electric vehicles that allow energy storage, and the use of other innovative energy storage technologies.	2023	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-22: Development and maintenance of centralised thermal systems	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Reduction of losses; Efficiency improvement in the energy and transformation sector; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors	Economic	Planned	Centralised thermal systems have been identified as one of the priorities of the energy policy of the Republic of Croatia. The most significant potential for the development and improvement of existing centralised thermal systems is primarily to increase the energy efficiency of production units, infrastructure and equipment at end-users and to increase reliability and security of supply. Therefore, this measure envisages the maintenance and upgrading of existing CTS systems, stopping the trend of disconnecting customers from the CTS systems, introducing heat storage tanks powered by electricity, and using RES for CTS as well as replacing existing CTS production with renewable sources (e.g. biofuels) and use of heat pumps.	2023	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-23: LNG terminal construction*	Energy	CO ₂ , CH ₄ , N ₂ O	Primary energy savings; Switch to less carbon-intensive fuels	Economic	Implemented	The size of the liquefied natural gas terminal depends on the interest of market. In the first phase, the construction of the FSRU vessel (Floating Storage Regasification Unit) is planned, whose maximum annual natural gas supply will amount up to 2.6 billion cubic meters. The planned maximum capacity of	2021	LNG Croatia LLC; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						natural gas supply from the terminal, and indirectly its size and capacity, is conditioned by the maximum capacity of the gas pipeline system.							
MEN-24: Refinery modernization and transformation	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in the energy and transformation sector; Control of fugitive emissions from energy production	Economic	Planned	Implementation of investments in modernization and improvement of production for maintaining the competitiveness of refineries. The measure includes the implementation of the modernization of the existing infrastructure so that the techniques of extraction, transshipment and construction of a transport network with very low fugitive emissions can be applied during the oil and gas extraction process and in transshipment and transport. Also, the measure contributes to better capacity utilization of existing refineries.	2023	INA, d.d. (oil company); Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-25: Measures to increase energy efficiency by improving processes and process units	Energy	CO ₂ , CH ₄	Efficiency improvement in the energy and transformation sector; Control of fugitive emissions from energy production	Economic	Planned	Increasing energy efficiency is achieved by implementing measures that contribute to reducing energy intensity through more rational use of energy and raw materials, by adding additives and by altering production processes and equipment at pumping stations and refineries, which contributes to reducing fugitive emissions.	2023	Ministry of Economy and Sustainable Development; INA, d.d. (oil company); distributors of liquid petroleum fuels	NE	NE	NE	NE	NE
MEN-26: Methane flaring	Energy	CH ₄	Control of fugitive emissions from energy production; Reduction of methane emissions by 95-99%	Economic	Planned	In Croatia except of flaring in natural gas and oil production and processing venting of CH ₄ emissions exists as well. Planned measure is that all places for venting should be replaced with torches. In that way CH ₄ will be flared not released in atmosphere as CH ₄ and methane emissions will be reduced by 95-99% depending on the efficiency of the torches.	2023	Ministry of Economy and Sustainable Development; INA, d.d. (oil company)	NE	NE	NE	NE	NE
MEN-27: Development of the electricity transmission network*	Energy	CO ₂ , CH ₄ , N ₂ O	Reduction of losses; Safe and reliable operation of the transmission grid; Primary energy savings	Economic, Regulatory	Implemented	Croatian Transmission System Operator Ltd. is, according to the Energy Act (OG 120/12, 14/14, 95/15, 102/15, 68/18), an energy entity responsible for the management, operation and guidance, maintenance, development and construction of the transmission electricity network. According to the Electricity Market Act (OG 111/21), the Croatian Transmission System Operator, as the owner of the 110 kV to 400 kV transmission network, is obliged to develop and adopt ten-year, three-year and one-year investment plans for the development of the transmission network. Ten-year development plans are update annually. At the time of writing, the Ten-Year Transmission Network Development Plan 2019-2028 was relevant, with detailed elaboration for the initial three-year and one-year periods.	2019	Ministry of Economy and Sustainable Development; Croatian Transmission System Operator	NE	NE	NE	NE	NE
MEN-28: Development of gas transmission system*	Energy	CO ₂ , CH ₄ , N ₂ O	Reduction of losses; Safe and reliable operation of the gas	Economic, Regulatory	Implemented	Transmission system development planning is carried out through the preparation of the Ten-Year Gas Transmission System Development Plan, the development of which is the	2018	Ministry of Economy and Sustainable	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
			transmission system; Primary energy savings			responsibility of the gas transmission system operator pursuant to the Gas Market Act (OG 18/18, 23/20). The gas transmission system operator is the company Plinacro Ltd. Ten-year plans for the development of the gas transmission system are update on an annual basis. At the time of writing, the Ten-Year Plan for the Development of the Gas Transport System of the Republic of Croatia 2018-2027 was relevant.		Development; Plinacro Ltd.					
MEN-29: Elaboration of the regulatory framework for active participation of customers on the electricity market*	Energy	CO ₂ , CH ₄ , N ₂ O	Primary energy savings; Promoting the use of renewable energy sources	Regulatory	Implemented	In order to enable the active role of network users in the electricity market, it is necessary to amend the existing regulatory framework in an appropriate manner, especially through the introduction of aggregators as market participants and through enabling the launch of a pilot project to provide ancillary services. Pilot projects will analyse in detail the services that users can provide to the distribution or transmission system operator. Possible types, scope, method and period of providing ancillary services will be analysed. Barriers to the use of ancillary services will be identified and ways to remove them will be suggested. Previously, an analysis of the potential for the provision of ancillary services and flexibility services with the response of consumption by network users will be conducted, based on which the method and model of providing ancillary services and the response of consumption by network users will be defined.	2020	Croatian Energy Regulatory Agency (HERA); Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-30: Introduction of advanced consumption metering systems and data management	Energy	CO ₂ , CH ₄ , N ₂ O	Primary energy savings	Economic	Planned	In order to enable further development of energy markets and the active role of consumers in energy markets, advanced metering devices and systems at consumption level will be introduced.	2025	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MEN-31: Adoption and implementation of the Programme for Energy Poverty Reduction*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of buildings; Efficiency improvement of appliances; Reducing energy poverty	Economic, Information	Implemented	Within the Programme for Energy Poverty Reduction, capacity building will be continued through local info centres, and energy poor citizens as well as citizens at risk of energy poverty will be provided with adequate information and advice on energy efficiency measures that contribute to the reduction of energy poverty and on opportunities of cofinancing activities in this area. Furthermore, indicators necessary to monitor the energy poverty will be identified and a monitoring system will be established through the already existing system for collecting data on household consumption and habits. On the basis of data, a possible extension of criteria for gaining the status of vulnerable energy customers will be analysed. Also, the implementation of energy	2021	Ministry of Economy and Sustainable Development; Ministry of Labour, Pension System, Family and Social Policy	NE	NE	NE	NE	NE

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						efficiency measures in energy poor households will be co-financed, such as replacement of household appliances by “old for new” system, upgrade or replacement of heating systems with systems that are environmentally and economically more favourable and more energy-efficient, and above all, with systems that use renewable energy sources, and the implementation of other technical energy efficiency measures will also be cofinanced. A model to cover energy costs will be developed and implemented within the Programme. The model will determine the level of assistance needed for households facing the problem of meeting energy costs, based on the amount of energy required to meet the minimum standard of living.							
MEN-32: Program for combating energy poverty, which includes the use of renewable energy sources in residential buildings in areas of special state care for the period 2021-2025*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of buildings; Reducing energy poverty; 413 renovated buildings	Economic	Implemented	The program includes 413 residential buildings that need to be renovated. The total target area of renovation is 297,575 m ² . The total possible saving of primary energy in all buildings amounts to 27 GWh per year. The program involves the financing of reconstruction from the funds of the fund for recovery and resilience.	2021	Ministry of Physical Planning, Construction and State Assets; Central State Office for Housing and Reconstruction	NE	NE	NE	NE	NE
MEN-33: Increasing energy efficiency and use of RES in manufacturing industry*	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Efficiency improvement in the energy and transformation sector; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Installation of abatement technologies	Economic	Implemented	Industrial plants in Croatia have significant potential for improving energy efficiency, reducing energy consumption, as well as reducing the share of conventional (fossil) fuels in total energy consumption by introducing renewable energy sources. The aim of this measure is to ensure continued co-financing of the implementation of such measures in manufacturing industries through grants and financial instruments.	2021	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MTR-1: Providing information to consumers on fuel economy and CO ₂ emission of new passenger cars *	Transport	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of vehicles; Low carbon fuels/electric cars	Information	Implemented	Pursuant to the Ordinance on Availability of Information on Fuel Economy and CO ₂ Emissions from Passenger Cars (OG 7/15) each supplier of new passenger cars intended for sale shall provide consumers with information on the fuel consumption rate and specific CO ₂	2015	Ministry of Economy and Sustainable Development; Ministry of the Interior	NE	NE	NE	NE	NE

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						emission of passenger cars. Central body of state administration responsible for the road traffic safety, on the basis of the Ordinance once a year, not later than March 31 of the current year, makes a Guidelines on cost-effectiveness of fuel consumption and CO ₂ emission from new passenger cars available for purchase on the market in the Republic of Croatia. The Guidelines contains required information for each model of new passenger cars available in the domestic market. Extension of information to other categories of motorized road vehicles will be implemented within the measure.							
MTR-2: Special environmental fee for motor vehicles*	Transport	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of vehicles; Low carbon fuels/electric cars	Economic, Fiscal	Implemented	The existing system of payment of a special environmental fee for motor vehicles is regulated by the Act on the Environmental Protection and Energy Efficiency Fund (OG 107/03, 144/12), and the Regulation on unit charges, corrective coefficients and detailed criteria and standards to determine the special environmental fee for motor vehicles (OG 114/14, 147/14, 2/21). The special fee is charged taking into consideration the type of engine and fuel, engine operating volume, type of vehicle, CO ₂ emissions and vehicle's age.	2014	Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development; Ministry of Finances	NE	NE	NE	NE	NE
MTR-3: Special tax on motor vehicles*	Transport	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of vehicles; Low carbon fuels/electric cars	Economic, Fiscal	Implemented	Based on the 'polluter pays' principle, the model's calculation is based on CO ₂ emissions into the air from motor vehicles. The special tax is determined on the basis of the sales or market price of the motor vehicle, CO ₂ emissions expressed in grams per kilometre, engine volume in cubic centimetres and the level of greenhouse gas emissions. This special tax encourages the purchase of energy efficient vehicles and vehicles with lower greenhouse gas emissions. The implementation of the measure is ensured through the enactment of the Act on Special Tax on Motor Vehicles (OG 15/13, 108/13, 115/16, 127/17, 121/19).	2014	Ministry of Economy and Sustainable Development; Ministry of Finances	NE	NE	NE	NE	NE
MTR-4: Monitoring, reporting and verification of greenhouse gas emissions in the lifetime of fuels and energy*	Transport	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of vehicles; Low carbon fuels/electric cars	Regulatory	Implemented	In accordance with the Act on Climate Change and Ozone Layer Protection (OG 127/19) supplier that places the fuel on domestic market shall monitor greenhouse gas emissions per energy unit in the lifetime of the fuel. Suppliers have to draw up a report that has to be verified and submitted to the Ministry of Economy and Sustainable Development - the Institute for Environment and Nature. The Croatian Government's Regulation on the quality of liquid petroleum fuels (OG 131/21) regulates the limit values of components and/or quality characteristics of liquid petroleum fuels, method of determining and monitoring the quality of liquid petroleum fuels, conditions for the operation of sampling laboratories and	2017	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

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						laboratory analysis of the quality of liquid petroleum fuels, the way of demonstrating compliance of the product, the name and marking of the product, way and deadlines for the submission of reports on the quality of liquid petroleum fuels and emissions reports of greenhouse gases in the lifetime of fuels and energy, method of monitoring and reporting, methodology for calculation of greenhouse gas emissions in lifetime of fuels and energy, methodology for calculating the contribution of electric road vehicles to reducing greenhouse gas emissions, the format of the report, the period of the storage and the manner of transmission of data to the European Union competent bodies.							
MTR-5: Legislative adjustments for cleaner transport	Transport	CO ₂ , CH ₄ , N ₂ O	Low carbon fuels/electric cars; Improved transport infrastructure; Increasing the share of RES in final energy consumption in transport; Increasing the share of clean vehicles in road transport	Regulatory	Planned	Through amendments to laws and bylaws, ensure the development of infrastructure for alternative fuels, raising the share of renewable sources in direct energy consumption in transport and promoting clean and energy efficient vehicles in road transport.	2023	Ministry of the Sea, Transport and Infrastructure; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MTR-6: Financial incentives for the purchase of energy efficient vehicles*	Transport	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of vehicles; Low carbon fuels/electric cars; Energy savings in 2030 0.25 PJ (decrease in consumption of gasoline and diesel fuel) and 0.1 PJ (increase in consumption of electricity)	Economic	Implemented	In the context of co-financing cleaner transport projects, it is necessary to define special co-financing lines for specific purposes, namely, for the purchase of electric vehicles, compressed and liquefied natural gas and hydrogen. Incentives for co-financing the purchase of vehicles will be primarily oriented towards alternative fuels for which the assessment of the existing situation has shown a minor representation in the total number of vehicles and will be time-limited until the minimum representation of vehicles is achieved. The minimum degree of market development shall be considered to be 1% of alternative fuel vehicles in the total number of vehicles registered in the country.	2014	Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MTR-7: Development of infrastructure for alternative fuels*	Transport	CO ₂ , CH ₄ , N ₂ O	Low carbon fuels/electric cars; Improved transport infrastructure	Regulatory, Economic	Implemented	The objective of this measure is to facilitate the uptake of alternative fuels by users/consumers by strengthening the alternative fuels distribution infrastructure and implementing common technical specifications for this infrastructure. This measure will not directly affect the reduction of fuel consumption in traffic, but the development of infrastructure is certainly a necessary prerequisite for the development of the market of vehicles and vessels that use	2019	Ministry of the Sea, Transport and Infrastructure; Ministry of Economy and Sustainable Development; Environmental Protection and	NE	NE	NE	NE	NE

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						electricity, compressed and liquefied natural gas and hydrogen in Croatia. The incentive measures for infrastructure co-financing will be primarily oriented towards alternative fuels for which an assessment of the current situation has shown that the infrastructure is underdeveloped and will be limited in time until the situation monitoring shows minimal infrastructure coverage.		Energy Efficiency Fund					
MTR-8: Promotion of integrated freight transport*	Transport	CO ₂ , CH ₄ , N ₂ O	Reducing CO ₂ emissions from road vehicles	Regulatory, Economic	Implemented	The measure is regulated by the Act on Combined Transport of Goods (OG 120/16) and the Ordinance on Incentives in Combined Transport of Goods (OG 5/18), which stipulates incentives for combined transport of goods by rail, inland waters or sea, and incentives for combined transport of goods on road sections.	2016	Ministry of the Sea, Transport and Infrastructure; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MTR-9: Promotion of sustainable intermodal transport at national level*	Transport	CO ₂ , CH ₄ , N ₂ O	Modal shift to public transport or non-motorized transport; Low carbon fuels/electric cars; Improved transport infrastructure	Regulatory, Economic	Implemented	The measure follows the general and specific objectives defined in the Transport Development Strategy of the Republic of Croatia for the period from 2017 to 2030 (OG 84/17) in the context of energy efficiency of rail, road, maritime transport, inland waterway transport and urban, suburban and regional traffic. Development of rail and generally multimodal infrastructure fall behind in comparison to highway infrastructure in terms of quality and connectivity. Investments are planned to develop a sustainable, integrated trans-European climate-resilient transport network. In maritime and inland waterway transport, the possibilities of introducing appropriate mechanisms to ensure the transition to low-carbon solutions will be analysed, especially in terms of the application of alternative energy sources for navigation. In this context, an action plan for shipping will be defined, which will, among other things, define appropriate emission standards for the coming period. Also, in air transport, the Republic of Croatia will define a plan and develop detailed guidelines for achieving a significant reduction in greenhouse gas emissions.	2019	Ministry of the Sea, Transport and Infrastructure; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MTR-10: Promotion of integrated and intelligent transport systems and development of alternative fuels infrastructure at local and regional level*	Transport	CO ₂ , CH ₄ , N ₂ O	Modal shift to public transport or non-motorized transport; Low carbon fuels/electric cars; Energy savings in 2030: 0.15 PJ	Economic, Information	Implemented	It is necessary to promote sustainable development of urban transport systems through the optimization of logistics of transport of goods and intelligent management of public parking spaces (ICT technologies), introduction of integrated passenger transport, introduction of car-sharing schemes in cities, introduction of low-emission zones in cities, introduction of public city bicycles system and construction of the accompanying cycling infrastructure, intelligent traffic control (upgrade, adaptation and replacement of out of date signalling devices and equipment, installation of advanced traffic	2019	Ministry of Economy and Sustainable Development; Units of regional and local self-government; Environmental Protection and Energy Efficiency Fund	NE	NE	NE	NE	NE

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						equipment and intelligent traffic lights equipped with the autonomous power supply system from renewable sources, constructing and equipping central operating centers for monitoring and management of intersections with installed traffic lights). At the local level, it is necessary to continuously prepare and implement Sustainable Mobility Plans in cities, as well as strategic plans that build on the existing planning practices, and take into account integration, participation and evaluation principles to meet the citizens' mobility needs now and in the future, and ensure better quality of life in cities and their surroundings. The activities will be accompanied by appropriate information and educational campaigns.							
MTR-11: Training for drivers of road vehicles for eco-driving*	Transport	CO ₂ , CH ₄ , N ₂ O	Reducing CO ₂ emissions from road vehicles; Energy savings in 2030: 0.03 PJ	Education	Implemented	The aim of the measure is to raise awareness of the benefits of energy efficient driving. Education on the eco-driving elements is carried out in short trainings among the drivers who received their driver's license prior to the entry into force of the Ordinance on Training of Driver's License Candidates (OG 132/17, 6/18, 102/20), which introduced an obligation for all driving schools and instructors to carry out training on the elements of eco-driving during the standard training of candidates. Special elements of the national campaign should be devoted to eco-driving education for drivers of passenger cars, buses, commercial and heavy-duty vehicles.	2011	National Energy Efficiency Authority; Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development; Ministry of the Interior	NE	NE	NE	NE	NE
MTR-12: Promotion of boat transport using alternative fuels*	Transport	CO ₂ , CH ₄ , N ₂ O	Low carbon fuels/electric cars; Reduce emissions from maritime transport	Voluntary Agreement, Economic	Implemented	In accordance with the "National Coastal Shipping Service Development Plan" and considering that the Republic of Croatia is a maritime land with developed longitudinal liner traffic, and in addition has navigable river routes and lakes, this measure would co-finance the projects of gradual transition of the existing obsolete fleet to alternative and/or hybrid solutions and new construction. Ships that use alternative fuels are generally more expensive than ships that use conventional fuels, so there is no expressed interest of shipowners to invest in such ships. Therefore, in the initial period it is necessary to financially support the conversion/construction of such ships to the extent that the purchase price is equalized or puts such a shipowner in the same position as a shipowner that uses ships with conventional fuel.	2019	Environmental Protection and Energy Efficiency Fund; Ministry of the Sea, Transport and Infrastructure; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MTR-13: Advanced biofuel market development plan	Transport	CO ₂ , CH ₄ , N ₂ O	Low carbon fuels/electric cars; Increasing the share of RES in transport	Regulatory, Economic	Planned	Increasing the share of RES in transport by 2030 through the development of the advanced fuels market and achieving the planned share of advanced fuels in direct energy consumption in transport through the criteria of the lowest cost and the largest multiplier. The implementation of	2023	Ministry of Finance; Ministry of Economy and Sustainable Development;	NE	NE	NE	NE	NE

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						the measure is based on amendments to relevant laws and bylaws based on the Directive on the Promotion of the Use of Energy from Renewable Sources, and in particular the establishment of conditions for monitoring the sustainability of biofuels and greenhouse gas savings.		Ministry of Agriculture					
MTR-14: Decarbonization of transport through the production of advanced biofuels from residues of agricultural production and energy crops with integrated carbon capture, use and storage	Transport	CO ₂ , CH ₄ , N ₂ O	Low carbon fuels/electric cars; Production of advanced biofuels of 55 kt per year	Economic	Planned	An industrial complex for the production of advanced bioethanol will be built based on Axens' (France) patented innovative FUTUROL™ technology with the integration of BIO-CCUS. The plant will have a capacity of 55,000 tons of advanced bioethanol per year, which will be distributed on the market through the commercial channels of INA and MOL Group. About 52,000 t/y of biogenic carbon dioxide will be captured and stored in domestic oil fields using BIO-CCUS technology. For the production of advanced bioethanol, a combination of agricultural residues, mainly cereal and corn straw, and the energy plant Miscanthus x giganteus will be used, in accordance with Part A of Annex IX of Directive 2018/2001 on the promotion of the use of energy from renewable sources, which lists the types of raw materials acceptable for production advanced biofuels. The industrial complex will consist of a plant for the production of advanced bioethanol, for the production of biogas, and a high-efficiency cogeneration plant.	2023	INA Llc	NE	NE	NE	NE	NE
MIP-1: Reducing the share of clinker in cement production	Industry/industrial processes	CO ₂	Reducing CO ₂ emissions; Reduction in clinker production	Economic	Planned	Measure includes gradual substitution of clinker with alternative materials in cement production which leads to reduction in clinker production. The share of used clinker substitutes depends on the composition of other raw materials used, availability of materials of appropriate composition on the market and market requirements for cements of certain composition.	2023	Cement manufacturers	NE	NE	NE	NE	NE
MIP-2: Limiting fluorinated greenhouse gas emissions*	Industry/industrial processes	HFCs, SF ₆	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases; Replacement of fluorinated gases by other substances; Reducing greenhouse gas emissions	Education, Regulatory	Implemented	In accordance with the Regulation (EU) 517/14 the measure defines activities and procedures for the prevention of fluorinated greenhouse gas emissions, conducting equipment leakage checks, use of equipment with leak detection systems, keeping records of equipment on which leakage checks need to be performed, collection of fluorinated greenhouse gases to ensure their recycling, reclamation or destruction, the development of a producer responsibility system for the collection of fluorinated greenhouse gases and their recycling, reclamation or destruction, and the implementation of training and certification programs.	2014	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MIP-3: Gradual reduction of the amount of	Industry/industrial processes	HFCs, SF ₆	Improved control of manufacturing, fugitive and	Regulatory	Implemented	The measure concerns the gradual limitation of the amount of fluorocarbons available on the EU market by 2030 to 21% of the total amount of	2014	Ministry of Economy and	NE	NE	NE	NE	NE

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fluorocarbons that can be placed on the market*			disposal emissions of fluorinated gases; Replacement of fluorinated gases by other substances; By 2030 to 21% of the total amount of fluorocarbons placed on the market during the reference period 2009 to 2012			fluorocarbons placed on the market during the reference period 2009 to 2012, as established by Regulation (EU) 517/2014. Regulation (EU) 517/2014 introduces a quota system for placing fluorocarbons on the market. The calculation of the benchmarks and the allocation of quotas should be based on the reported quantities of fluorocarbons placed on the market during the reference period from 2009 to 2012. Quota for placing fluorocarbons on the market shall be allocated to each manufacturer and importer for each year, starting in 2015, on the basis of benchmarks, applying defined percentages to calculate the maximum amount of fluorocarbons to be placed on the market and the allocation mechanism.		Sustainable Development					
MIP-4: Restrictions and prohibitions on placing certain products and equipment on the market*	Industry/industrial processes	HFCs, SF6	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases; Replacement of fluorinated gases by other substances; Reducing greenhouse gas emissions	Regulatory	Implemented	The measure concerns restrictions and prohibitions on the placing on the market of certain products and equipment containing fluorinated greenhouse gases, as laid down in Regulation (EU) 517/2014. Fluorinated greenhouse gases with high greenhouse potential are limited for use in new refrigeration and air conditioning equipment, fire extinguishing systems, foam blowing agents and aerosols.	2014	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MIP-5: Reduction of fluorinated greenhouse gas emissions from mobile air conditioning systems*	Industry/industrial processes	HFCs, SF6	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases; Replacement of fluorinated gases by other substances; Reducing greenhouse gas emissions	Regulatory	Implemented	Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC has been implemented in three phases. The last phase came into force on January 1, 2017, by limiting the possibility of retrofitting air conditioning equipment designed to contain fluorinated greenhouse gases with a global warming potential above 150 in motor vehicles and banning the charging of air conditioning equipment with these gases.	2014	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MWM-1: Preventing the generation and reducing the amount of solid waste*	Waste management/waste	CH4	Reduced landfilling; By 2040 the amount of landfilled municipal waste landfilled should be reduced to 10% or less of the total amount of municipal waste generated (by weight)	Regulatory, Economic, Education	Implemented	Waste prevention is achieved through the process of reuse and the use of by-products and the repealing of waste status, which will directly affect the reduction of the total amount of waste. The implementation of waste prevention measures is defined by the Waste Prevention Plan and the Plan for the Prevention and Reduction of Food Waste in the Republic of Croatia 2019 - 2022 (OG 61/19). The most important measures in terms of waste prevention are the establishment of Centres for reuse and provision of the necessary equipment for home composting as well educational activities.	2018	Ministry of Economy and Sustainable Development; Regional self-government units; Local self-government units	NE	NE	NE	NE	NE

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						This measure is achieved by cleaner production, education, economic instruments and enforcement of regulations in waste management, and by investing in modern technologies that enable material recovery and chemical recycling of waste. According to the Act, quantitative targets and deadlines for reducing the total amount of waste disposed to non-compliant landfills were defined. Disposal of waste to non-compliant landfills in Croatia was prohibited after December 31, 2017.							
MWM-2: Increasing the amount of separately collected and recycled solid waste*	Waste management/waste	CH4	Reduced landfilling; By 2035, the preparing for re-use and the recycling of municipal waste should be increased to a minimum of 60% by weight	Regulatory, Economic	Implemented	Beside the Sustainable Waste Management Act, the Waste Management Plan of the Republic of Croatia for the period 2017 – 2022 (OG 3/17, 1/22) also defines the quantitative targets and deadlines for increasing the amount of separately collected and recycled waste. Waste management objectives are prescribed to encourage the transition to a European circular economy with a high level of resource efficiency, in which the value of products, materials and resources is maintained for as long as possible, and waste generation is reduced to a minimum.	2018	Regional self-government units; Local self-government units; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MWM-3: Ensuring the system of treatment and use of landfill gas*	Waste management/waste	CH4	Enhanced CH4 collection and use; Reduce methane emissions in the atmosphere	Regulatory, Economic	Implemented	The Ordinance on the Methods and Conditions for the Landfill of Waste, Categories and Operational Requirements for Waste Landfills (OG 114/15, 103/18, 56/19) and Ordinance on Waste Management (OG 106/22) regulate technical requirements for landfill operation, which reduce possible adverse effects of landfills on the environment. At landfills where landfill gas occurs it is necessary to secure a gas collection system, and that gas must be treated and used. If collected landfill gases cannot be used for energy production, they should be flared in the area of the landfill and the emission of methane into the atmosphere should be prevented.	2004	Regional self-government units; Local self-government units; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MWM-4: Reducing the amount of disposed biodegradable waste*	Waste management/waste	CH4	Enhanced recycling; Reduced landfilling; Reduce up to 90,000 tons of biowaste per year; Reduce methane emissions in the atmosphere	Regulatory	Implemented	The aim of this measure is to reduce the amount of biodegradable fraction of waste disposed at landfills, thus reducing methane emissions resulting from anaerobic decomposition of waste. Pursuant to the Sustainable Waste Management Act, quantitative targets that relate to the reduction of biodegradable municipal waste disposed to landfills were established. Thus, by the end of 2020, the share of biodegradable municipal waste disposed of in landfills had to be reduced to 35% weight of biodegradable municipal waste generated in 1997, that is 264,661 tons of waste was allowed to dispose. To prevent the disposal of biowaste at landfills and contribute to the achievement of other goals	2018	Regional self-government units; Local self-government units; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						of waste management, it is necessary to encourage citizens to compost. The goal is to achieve that households separate biowaste from other municipal waste by disposing of it in biowaste containers. This measure will cover rural areas, i.e. suburbs of urban areas with a larger number of independent housing units with infield. In the territory of the Republic of Croatia, by implementing this measure, it is possible to reduce up to 90,000 tons of biowaste per year.							
MWM-5: Use of biogas for biomethane production and electricity and heat generation*	Waste management/waste	CO ₂ , CH ₄	Enhanced recycling; Enhanced CH ₄ collection and use; Reduced landfilling; Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Reduce methane emissions in the atmosphere	Regulatory, Economic	Implemented	The measure is associated with measures for promoting the use of renewable energy sources for electricity and heat generation and obligation to use renewable energy sources in transport and refers to the mandatory use of biowaste as a substrate in biogas plants that produce biogas to be used for the biomethane production and electricity and heat generation.	2018	Regional self-government units; Ministry of Economy and Sustainable Development ; Local self-government units	NE	NE	NE	NE	NE
MAG-1: Change in livestock diet of and feed quality*	Agriculture	CH ₄	Reduction of methane emissions from intestinal fermentation	Economic, Education	Implemented	Specific sub-measures within this group of measures related to the regulation of digestive processes of livestock and their nutrition: changing the ratio of certain types of feed in the diet, the use of supplements, improving the quality of forage and improving grazing systems. These measures are largely related to the potential reduction of methane emissions from intestinal fermentation.	2014	Advisory services; Ministry of Agriculture; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MAG-2: Improvement of livestock facilities and manure management systems*	Agriculture	CH ₄ , N ₂ O	Reduction of methane, nitrogen and ammonia emissions through improvements in animal nutrition and manure collection and storage systems	Economic, Education	Implemented	By improving and changing existing manure management systems and using the best available techniques, it is possible to reduce emissions. Activities involved within this measure relate to development programs to increase the share of implementation: 1) Manipulation of nutrient content and their relationship in the meal: - reduction of protein content in the meal - A high-fiber meal - reduction of grazing intensity 2) Changes in the manure system (type of manure) and improvement of manure collection facilities: - Application of a manure system in pig breeding, which is characterized by a short time from the moment of defecation or urination to	2014	Ministry of Agriculture; Advisory services	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						the moment of removal of feces and urine from buildings 3) Measures during manure storage: - Reduction of storage / disposal time on manure 4) Improvements to manure management facilities: - Manure tanks must be watertight and meet the size of the manure collection for a six-month period. - Increasing the energy efficiency of housing - Project for improvement of the system for calculation of greenhouse gas emissions (development of nationally specific emission factors and parameters)							
MAG-3: Modification of the livestock system*	Agriculture	CH ₄ , N ₂ O	Indirect reduction of methane and nitrous oxide emissions by increasing the share of cattle in the "cow-calf" system	Economic	Implemented	Measures that achieve effects on reducing greenhouse gas emissions refer to measures that increase the intensity of production per animal and per unit time. In Croatia, the problem is that unused pastures and meadows cover a large area of agricultural land. In order to reduce costs, extensive fattening on pastures is becoming increasingly important. Numerous variables are included in determining the number of animals (conditional head / ha) that can be on pasture without causing damage to natural resources: soil, climate, plant composition, species and age of livestock, water availability, sensitive areas (too steep) , endangered species, wetlands, etc.), general soil condition and types of livestock production. Given the import of a large number of calves for fattening or fattened cattle and meat, the establishment of a cow-calf system imposes itself as a logical solution and source of calves that can later be fed on the same farms (pasture fattening) or fattened in specialized fattening farms. Thus, work on establishing and encouraging a cow-calf breeding system is the principal activity in this measure, with the Agricultural Census being a method on providing feedback on the rate of implementation.	2014	Ministry of Agriculture; Advisory services	NE	NE	NE	NE	NE
MAG-4: Anaerobic decomposition of manure and biogas production*	Agriculture	CH ₄	Reduction of methane emissions from manure management systems for cattle and pigs by increasing the share of biogas plants	Economic	Implemented	The introduction of biogas plants reduces methane emissions due to the use of litter as a renewable source for electricity production. The measure is linked to the measures in Renewable sources in the production of electricity and heat and Construction of cogeneration plants from the Energy sector. Anaerobic breakdown help biogas plants to reduce the source of easily degradable carbon in the manure that is applied to agricultural land, but it also potentially reduces the process of nitrification and N ₂ O emissions.	2018	Ministry of Agriculture; Advisory services	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
MAG-5: Improving the breeding and selection program, animal health and welfare	Agriculture	CH ₄ , N ₂ O	Indirect reduction of methane and nitrous oxide emissions through breed improvements and improvement of genetic potential	Economic, Education, Research	Planned	Main activity in this measure is research aimed at determining the variation in the predicted CH ₄ emission and determining the genetic potential for reducing methane emissions in dairy cows as well as increased production intensity. Genetic potential and type of individuals (breeding and selection work) - Intensive selection to increase productivity - higher production achieves indirect effects - fewer animals and less food consumption . Furthermore, higher food utilization results in reduced excretion of N compounds in faeces and urine, but also reduces excretion and thus their potential emission. A positive genetic correlation between PME (predicted methane emissions) and RFI (residual feed intake) shows that cows with lower RFI also have lower potential emissions. Thus, it is possible to reduce methane production in cows by selecting genetically more suitable cows with respect to methane emissions. Genetic variability assumes a reduction of 11-26% over a ten-year period, but can also be increased by applying a selection program. However, there are several doubts, such as the lack of accurate methane measurements (and the main assumption is that methane produced per unit of food does not affect RFI levels), as well as predicting the possible consequences of genetic selection. To overcome these limitations, it is necessary to collect data on feed intake and methane emissions in dairy cows, health status and mortality rate, duration of the production cycle.	2023	Advisory services; Ministry of Agriculture	NE	NE	NE	NE	NE
MAG-6: Improvement and change of tillage system (reduced tillage)	Agriculture	CO ₂	Increasing soil carbon sequestration through improvements and modifications to tillage systems	Research	Planned	Reduced tillage is the result of scientific research and practical audits that result in changing the conventional tillage system by reducing tillage depth, omitting one or more operations, reducing the frequency or complete omission of tillage, reducing the cultivated area and retaining crop residues. The direct impact on greenhouse gas emissions is primarily related to the significant impact on the organic carbon content in the soil and the smaller number of operating hours of machines.	2023	Ministry of Economy and Sustainable Development; Advisory services; Ministry of Agriculture	NE	NE	NE	NE	NE
MAG-7: Expansion of crop rotation with higher share of legumes	Agriculture	CO ₂ , N ₂ O	Defining the potential for change in organic matter content / increasing soil sequestration of carbon	Economic, Education	Planned	Sowing leguminous crops binds atmospheric nitrogen, reduces the risk of groundwater pollution, the soil is enriched with organic matter, which has multiple positive effects on improving and maintaining favorable physical, chemical and biological properties of the soil. Principal activities under this measure are commencements of multi-year research on the impact of practiced crop rotations on changes in soil characteristics (expected duration> 10 years).	2023	Ministry of Agriculture; Advisory services	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						Measure should be implemented by encouraging producers to increase the share of leguminous crops when creating crop rotation, using incentives.							
MAG-8: Intensification of crop rotation using intermediate crops*	Agriculture	CO ₂ , N ₂ O	Increasing soil carbon sequestration and reducing nitrate seepage	Economic, Education	Implemented	By sowing intermediate crops that can be used for livestock feeding or plowing for green manure, the remaining nutrients will be used, prevent further evaporation of water from the soil, reduce carbon loss from the soil, prevent nitrogen leaching into groundwater and increase organic matter in the soil. Goal of this PaM is introducing changes in organic matter content / increase in soil carbon sequestration and decrease in nitrate seepage by sowing intermediate crops . The principles of good agricultural practice in the protection of soil and water from nitrates recommend the introduction of intercrops (intercropping crops) between the harvest of the main crops. Activities include: -investigations of the impact of crop application on changes in soil characteristics. - Encouraging the use of a typical winter or spring crop for fodder use as an intermediate crop, through incentives.	2014	Advisory services; Ministry of Agriculture	NE	NE	NE	NE	NE
MAG-9: Improving methods of applying mineral fertilizers*	Agriculture	N ₂ O	Reduction of nitrous oxide emissions from agricultural soils, increase of production, reduction of application of mineral fertilizers	Economic, Education	Implemented	Reducing the consumption of mineral fertilizers is an indirect benefit from other measures that reduce the need for their application, but with proper fertilization practice. In addition, the application of slow-release fertilizers can directly affect the total amount of mineral fertilizers applied. Activities include: - Introduction of information technologies, remote sensing with application in agriculture, and production of soil fertility maps - Works on the establishment of systems for real monitoring of the consumption of mineral fertilizers on farms and realized yields - Improving the system for calculating greenhouse gas emissions	2014	Advisory services; Ministry of Agriculture	NE	NE	NE	NE	NE
MAG -10: Improving methods of applying organic fertilizers*	Agriculture	N ₂ O	Reducing emissions by improving the application methodology of organic fertilizers	Economic, Education	Implemented	Organic fertilizers originate from organic sources such as solid manure or slurry and plant or animal residues, and strongly stimulate the activity of soil microbes compared to mineral fertilizers. Using injectors for direct injection into the soil reduces nitrogen loss due to volatilization. Activities include: - Introduction of information technologies, remote sensing with application in agriculture, and production of soil fertility maps - Monitoring of soil changes in different ways of using and applying organic fertilizers - Encouraging investment in direct soil injection	2014	Advisory services; Ministry of Agriculture	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						systems - Consolidation of agricultural land							
MAG-11: Agroforestry	Agriculture	CO2	Defining the potential and benefits of various agroforestry technologies with the aim of increasing soil sequestration	Research	Planned	Agroforestry is a common name for land management systems in which permanent woody species are integrated with the cultivation of crops and/or animals on the same surface unit. Some agroforestry systems (e.g. Agro-silvopastoral system) are significant carbon removals. Experiments are required to determine applicability in Croatia with regard to different land use forms and different needs. It is important to point out that some elements from agroforestry were recorded throughout history in the coastal and coastal area of Croatia: cultivation and cultivation of land on terraces that were used to raise perennial plantations, olive groves, vineyards, various fruit trees and could be used for limited livestock. Activities include: - Research of possibilities of application of agroforestry with focus on identification of suitable areas	2023	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE
MAG-12: Hydromeliorative interventions and disaster protection systems*	Agriculture	N2O	Increasing the share of agricultural soils under irrigation, reducing the leakage of nitrates from agricultural soils	Economic, Education, Research	Implemented	The construction of drainage, irrigation and protection systems against floods, droughts and other natural disasters can indirectly reduce nutrient losses due to seepage and leaching, resulting in a reduced need for nitrogen application. In addition to the controlled application of mineral fertilizers, controlled drainage, reuse of drained water and the use of water of appropriate quality are important for reducing nitrate emissions. Drainage has the function of draining excess water. Also, the change in soil-air ratios affects the activity of beneficial microorganisms. Activities include: - research programs to improve the properties of existing hydromelioration systems - construction of irrigation systems - staff education	2014	Ministry of Agriculture; Advisory services	NE	NE	NE	NE	NE
MAG-13: Introduction of new cultivars, varieties and cultures	Agriculture	CO2, N2O	Determining the potential of new cultivars, varieties and crops to increase soil carbon sequestration	Research	Planned	Encouraging development, education and implementation of technologies at a national and regional level, encouraging the transition and adaptation of the entire production chain to produce new crops or enabling and encouraging the implementation of cultivars and varieties that are more resistant to drought and disease and have a lower overall carbon footprint. Aimed at reducing the need for mineral nitrogen in new cultivars that have increased resistance and less need for nutrients, as well as in specific legumes that have the ability to symbiotic relationship with nodule bacteria.	2023	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
MAG -14: Change in people's diet	Agriculture	CO ₂ , CH ₄ , N ₂ O	Data collection and research on the potential for reducing greenhouse gas emissions due to changes in diet; Developing a framework for reducing the carbon signature	Education, Research	Planned	Growing cereals for animal feed produces much more greenhouse gases than producing cereals for human consumption. By reducing the consumption of meat (especially red) in the diet in favor of foods of plant origin, significant reductions in emissions can be achieved, as well as water savings. The first step with this PaM is research on the current eating habits of the population of the Republic of Croatia. Activity: - Statistical and nutritional research of eating habits of the population of the Republic of Croatia by regions	2030	Ministry of Agriculture; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MAG -15: Collection and processing of agricultural plantations and residues for energy purposes	Agriculture	CO ₂	Optimization of the collection of pruned biomass of permanent crops and field biomass; production of safely available biomass, activation of poorer quality soils in the Republic of Croatia, provision of low-carbon energy during the production process of heat and/or electricity	Economic, Regulatory	Planned	Energy utilization of post-harvest residues (with emphasis on field crops) is one of the most important ways of producing energy from biomass in the Republic of Croatia. Other possible sources are the remnants of the winter harvest of almost all horticultural species, as well as fast-growing crops for energy production that are planted/sown exclusively for the production of biomass with the aim of its conversion into energy. The establishment of collection and logistics centers for biomass with the use of existing infrastructure (utilities, competence centers, business zones) will reduce the unit cost of production of biomass products and capitalize on innovation capacity and necessary equipment for innovative biomass products for the bioeconomy. Collection and logistics centers will act as a link between the farmer who owns biomass, processing biomass into new products with higher added value, developing new products and placing these new products on the market. The locations of the Centers will be defined with long-term development policies, in order to minimize their carbon footprint.	2023	Ministry of Agriculture; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MLF-1: Development of the Land Management Strategy of the Republic of Croatia	Forestry/LULUCF	CO ₂	Increase removal and reduction of greenhouse gas emissions from the LULUCF sector; Align the EU's targets for increasing the share of energy from renewable sources with emission reduction requirements	Economic, Regulatory, Information	Planned	The calculation of emissions/removals in the LULUCF sector, and sectoral projects (implementation activities) should form the basis for planning the use and management of LULUCF land categories for each of the repositories. The development of a Land Management Strategy is implied in order to properly define further (sub) measures that will be implemented on a particular category of land and which will reduce emissions and increase the removal of greenhouse gases in the Republic of Croatia. Proposed future measures should form an integral part of this strategy. The measure aims to increase carbon sequestration in the LULUCF sector, reduce greenhouse gas emissions, and align EU targets for increasing	2025	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						the share of energy from renewable sources with emission reduction requirements.							
MLF-2: Carbon accumulation on the surfaces of existing forests*	Forestry/LULUCF	CO2	Conservation of carbon in existing forests; Enhancing production in existing forests; Enhanced forest management; Prevention of deforestation; Strengthening protection against natural disturbances; Ensuring the maintenance of a defined, reference level for forests	Regulatory, Economic	Implemented	The measure will contribute to maintaining/increasing removals in the forestry sector and meet the provisions of Decision 529/2013/EU and Regulation 841/2018/EU. Implementation of activities that contribute to increasing the carbon stock content in forests, especially in biomass storage, and the implementation of which ensures removals in a certain period higher than those defined by the Forest Reference Level (FRL). These activities are, for example, the analysis of the current management method and suggestions for improvement, reforestation, transfer of stands to a higher form of cultivation, selection of species for filling, etc. Maintaining removals higher than those defined by the FRL also ensures an increase in emission allowances that can be transferred to sectors outside the ETS.	2021	Ministry of Agriculture; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MLF-3: Implementation of afforestation works*	Forestry/LULUCF	CO2	Enhanced forest management; Strengthening protection against natural disturbances; Restoration of degraded lands; Examining the justification of measures to sinks increase	Regulatory, Economic	Implemented	Changes in the sinks of greenhouse gases as a result of direct land use change caused by human activities and forestry activities, limited since 1990 to afforestation, reforestation and clearing, are allowed to be calculated in the national balance of emissions and sinks of greenhouse gases and used to fulfil obligations under the Kyoto Protocol. By analysing the costs and benefits of afforestation on the new areas, possibility of increasing greenhouse gas sinks using reforestation activities on the barren productive forest floor will be investigated. This would justify introduction of possible incentive measures, such as the afforestation of fast-growing species and natural regeneration of forests, equivalent to measures for greenhouse gas emissions reduction. Due to the regulations in the field of nature protection which regulate the establishment of Natura 2000 areas, Croatia is not able to dispose of all grassland areas (according to the national regulation: non-overgrown productive forest land) for afforestation purposes. Given that in the Republic of Croatia there are agricultural areas where no production takes place and which have been neglected for many years, when drafting the Land Management Strategy, the problem of these areas must be adequately addressed.	2021	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE
MLF-4: Production and use of wood and wood products*	Forestry/LULUCF	CO2	Increasing the removal of carbon dioxide in Harvested Wood Products (HWP); Increasing the quality and	Economic, Education, Information	Implemented	It is necessary to encourage the use of wood in traditional and new products, and to take awareness of the importance of wood products as carbon storage, and their importance in terms of additionally avoided emissions when the use of these products avoids emissions from the production of for instance plastic products.	2021	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE

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			harmonization of information on wood products			Raising information on manufactured wood products leads to data harmonization, which enables the creating the basis for the adoption of strategic plans, promoting the use of wood products, educating about the importance of wood products and their impact on climate and environment.							
MLF-5: Cropland management*	Forestry/L ULUCF, Agriculture	CO ₂ , N ₂ O	Reducing greenhouse gas emissions by changing and improving the way cropland is managed	Regulatory, Economic	Implemented	Agricultural production should be performed in a way that contributes to emission factor reduction, which is in the interest of family farms, given that the CAP EC regulations increase the amount of incentives if the emission factor is lower due to the way of land management. Management practices for these areas that may have an impact on emissions and removals, for example in soil storage: tillage methods, lifetime of plantation/crop (rotation period) and plantation/crop type, fertilizer application, residue management, erosion control, irrigation system application etc. It is also necessary to promote land management activities in a way suitable for the climate and the environment.	2021	Ministry of Agriculture; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MLF-6: Grassland management*	Forestry/L ULUCF	CO ₂	Reducing greenhouse gas emissions by changing and improving the way grassland is managed	Regulatory, Economic	Implemented	In order to reduce greenhouse gas emissions by changing and increasing removal, it is necessary to analyse the management of grassland areas in the Republic of Croatia. Implementing pasture management activities in a way that contributes to reducing the emission factor is of interest to family farms, given that the CAP EC regulations increase the amount of incentives if the emission factor is lower due to the management of these areas. It is also necessary to promote land management activities in a way suitable for the climate and the environment.	2021	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE
MLF-7: Implementation of technical projects and scientific research in the LULUCF sector*	Forestry/L ULUCF	CO ₂ , CH ₄ , N ₂ O	Research in the LULUCF sector	Regulatory, Information, Research	Implemented	An analysis of the effectiveness of the implemented measures for both the sector and the measures defined in the study to meet the obligations under Article 10 of Decision 529/2013/EU on reducing/maintaining emissions and increasing/maintaining greenhouse gas removal is needed to develop new guidelines and define measures in forestry and agriculture sector. When defining priorities, Regulation 841/2018/EU and Regulation 842/2018/EU should be taken into account. This measure includes the launch of professional and scientific research to improve the management of all LULUCF land categories in order to reduce emissions and increase removals.	2021	Ministry of Science and Education; Ministry of Agriculture; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-1: Committee for cross-sectoral coordination of policies and measures for	Cross-cutting	CO ₂ , HFCs, CH ₄ , N ₂ O, SF ₆	Monitoring the implementation of policies and measures for mitigation and	Regulatory	Implemented	In accordance with the Act on Climate Change and Ozone Layer Protection (OG 127/19) the Commission for inter-sectoral coordination of policies and measures for mitigation and adaptation to climate change was established to	2017	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

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mitigation and adaptation to climate change*			adaptation to climate change			monitor and evaluate the implementation and planning of policies and measures for climate change mitigation and adaptation. The Commission makes recommendations to the Government of the Republic of Croatia on overall policies and measures for climate change mitigation and adaptation and provides political support in the implementation of climate change mitigation and adaptation policies and measures. The Commission also proposes to the Government of the Republic of Croatia the adoption of acts of strategic planning and regulations related to policies and measures for climate change mitigation and adaptation, proposes objectives, measures and activities of public policies and monitors their effects and outcomes in implementation and provides proposals and support in promoting interdisciplinary and synergistic public policy goals, measures and activities. Members of the Commission, the tasks and the manner of work of the Commission shall be determined by the Government of the Republic of Croatia at the proposal of the Ministry responsible for environmental protection.							
MCC-2: Supporting the founding of regional energy and climate agencies and capacity building	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Establishment of energy and climate agencies and transformation of existing regional energy agencies into regional energy and climate agencies	Economic, Regulatory	Planned	Regional energy agencies do not currently operate in the entire Republic of Croatia, and it is necessary to build the capacity of existing regional energy agencies in the field of climate change and their transformation into energy and climate agencies. The aim of this measure is to encourage the establishment and founding of regional energy agencies for the areas of the Republic of Croatia where they do not operate, and the transformation of existing energy agencies into energy and climate agencies.	2023	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-3: Promotion of the use of innovative information and communication technologies (ICT) to reduce greenhouse gas emissions*	Cross-cutting	CO ₂ , HFCs, CH ₄ , N ₂ O, SF ₆	Increasing productivity and work efficiency while reducing energy consumption and consequent greenhouse gas emissions	Information, Voluntary Agreement	Implemented	Innovative information and communication technologies have an increasingly important role in reducing greenhouse gas emissions and increasing energy efficiency. Intensifying their use in public administration, services and manufacturing processes, will boost productivity and work efficiency and at the same time will reduce energy consumption and consequent greenhouse gas emissions. The measure is expected to intensify the use of innovative ICT and monitoring of actual energy savings and reductions of greenhouse gas emissions.	2016	Ministry of Economy and Sustainable Development; Ministry of Physical Planning, Construction and State Assets	NE	NE	NE	NE	NE
MCC-4: Emissions Trading System *	Cross-cutting	CO ₂ , N ₂ O	Reduction of the GHG emissions by operators under EU ETS; Reduction in greenhouse gas	Economic, Regulatory	Implemented	ETS (Emissions Trading System) sector includes all activities listed in Annex I of the Regulation on trading with greenhouse gas emission allowances (OG 89/20) and for the reduction of greenhouse gas emissions from these activities plant operators involved in the trading system are responsible. Through the equal distribution	2013	European Commission; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
			emissions at least 2.2% per year			of emission allowances, reduction commitments have been distributed to system participants from all Member States with the aim of contributing to emission reductions at EU level by at least 43% by 2030 compared to 2005 levels. From January 1, 2013, the Republic of Croatia is fully integrated in the EU Emission Trading System (EU ETS). Operators in Croatia - the pursuant in the EU ETS have obtained Permits for greenhouse gas emissions and have established a regime for emissions monitoring and reporting to the competent authority. Greenhouse gases covered by EU ETS are: carbon dioxide (CO₂) for all activities and additionally for certain activities nitrous oxide (N₂O). For aircraft operators in the Republic of Croatia, emissions monitoring and reporting of CO₂ emissions started formally on July 1, 2013. However, due to certain specificities related to the responsibility for administering aviation flights prior to Croatia's accession to the European Union, aircraft operators were required to submit annual emissions reports from the aircraft starting from 2010.							
MCC-5: The CO ₂ emission tax for the non-ETS stationary sources*	Cross-cutting	CO ₂	Efficiency improvement in industrial end-use sectors; GHG emissions reduction from non-EU ETS stationary sources	Regulatory, Fiscal	Implemented	The Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon dioxide into the environment (OG 73/07, 48/09, 2/18, 46/21) stipulates the obligation to pay the CO ₂ emission tax for all stationary sources emitting more than 450 tons of CO ₂ per year. The obligated parties investing in energy efficiency, renewable energy and other measures to reduce CO ₂ emissions and other GHG emissions pay a lower tax. The Environmental Protection and Energy Efficiency Fund is authorized to calculate and charge the tax. From 2013 onwards, the obligation to pay the CO ₂ emission tax has applied only to non-ETS sources.	2016	Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-6: Covenant of Mayors for Climate and Energy in the Republic of Croatia*	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Accelerating decarbonisation of cities and municipalities	Voluntary Agreement	Implemented	The signatories of the Covenant support a joint vision for 2050: accelerating decarbonisation of their territories, strengthening capacity to adapt to the inevitable impact of climate change and allowing citizens to access safe, sustainable and affordable energy. The signatory cities are committed to action that will support the reduction in greenhouse gases by 40% by 2030 and the adoption of a common approach to mitigating and adapting to climate change. In order to transfer their political engagement from theory to practical measures and projects, the signatories of the Agreement undertake to	2009	Local government: cities and municipalities	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						submit the Sustainable Energy and Climate Action Plan (SECAP). This initiative was accepted by 118 cities and municipalities in the Republic of Croatia, so that the Covenant of Mayors covers over 2.3 million inhabitants in the Republic of Croatia.							
MCC-7: Charter for Buildings Decarbonisation by 2050	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of buildings; Decarbonisation of the building stock by 2050	Voluntary Agreement	Planned	Charter on cooperation for the decarbonisation of buildings by 2050 is initiated by the Ministry of Physical Planning, Construction and State Assets, which supports the EU vision of decarbonisation of buildings by 2050. The charter was launched for better interdepartmental communication and cooperation between government and the real sector. The goal is to create a wide network of connected experts through workshops and open dialogue of partners who are ready for a joint dialogue and contribution to the decarbonisation of the building fund by 2050. The contents of the Charter relate to the achievement of energy and climate goals at national and EU level through the decarbonisation of the building stock, renovation of buildings and construction of nearly-zero energy buildings, aware of the importance of further reducing greenhouse gas emissions, increasing the share of renewable energy sources, improving energy security, and introducing innovations and smart technologies that enable buildings to support the overall decarbonisation of the economy. The signing of the charter encourages continuous cooperation in the development of the Long-Term Strategy for the Reconstruction of the National Building Fund and the transition to the standard of construction of near-zero energy buildings (nZEB). The signatories of the Charter provide support and promote the decarbonisation of buildings in their further activities, wherever possible.	2023	Ministry of Physical Planning, Construction and State Assets	NE	NE	NE	NE	NE
MCC-8: Creation of Platform for Carbon Capture, Use and Storage	Cross-cutting	CO ₂	Preparation of bases for CCUS projects in the Republic of Croatia	Economic, Research	Planned	The carbon capture and storage technology for large emission sources is not yet commercially available. According to Directive 2009/31/EC on geological storage of carbon dioxide, i.e. Article 36 of Directive 2010/75/EU on industrial emissions, for power plants with a capacity of more than 300 MW that have received a building permit after the entry into force of Directive 2009/31/EC on geological storage of carbon dioxide, it is necessary to assess whether the following conditions are met: a) availability of a suitable storage location, b) technical and economic feasibility of transport facilities and c) technical and economic feasibility of upgrading the CO ₂ capture and collection facility. If these conditions are met, the competent authority must	2023	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						provide adequate space at the installation site for equipment to capture and compress the extracted CO ₂ . Legislatively, this is covered by the Hydrocarbon Exploration and Exploitation Act (OG 52/18, 52/19), which enables the storage of CO ₂ in the territory of the Republic of Croatia. In accordance with the above, it is planned to prepare a study of storage capacity assessment, but also to prepare a National Feasibility Study with an action plan for preparatory activities for CCUS projects. This study will cover the phases of capture at emission sources, transport, injection and storage of CO ₂ , and the connection of CO ₂ transport systems with other EU countries.							
MCC-9: Improving sustainability of urban areas	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Accelerating decarbonisation of cities and municipalities	Economic, Research, Voluntary Agreement	Planned	The Program for the Development of Green Infrastructure in Urban Areas for the Period from 2021 to 2030 (OG 147/21) and the Program for the Development of Circular Management of Space and Buildings for the Period from 2021 to 2030 (OG 143/21) were adopted, which achieve ecological, economic and social benefits of sustainable development. The programme for the development of green infrastructure in urban areas elaborates goals and measures for the development of green infrastructure which, among other things, increase the energy efficiency of buildings, reduce CO ₂ emissions and reduce temperatures in the areas of thermal islands in urban areas. The programme for the development of circular management of space and buildings elaborates goals and measures for circular management of space and buildings, which encourage, among other things, circular measures in planning new buildings, reusing abandoned and/or neglected and extending the durability of existing spaces and buildings, reducing construction waste and increasing the energy efficiency of buildings. The aim of this measure is to encourage cities and municipalities to base revitalization and development projects on new urban areas on the principles of sustainability.	2023	Ministry of Physical Planning, Construction and State Assets	NE	NE	NE	NE	NE
MCC-10: Foundation of the Programme for calculation and reduction of carbon footprint of business entities	Cross-cutting	CO ₂ , CH ₄ , N ₂ O, HFCs, SF ₆	Reduction of GHG emissions; Reducing the carbon footprint of businesses	Regulatory	Planned	The aim of the measure is to establish a Programme for calculation and reduction of carbon footprint of business entities outside the ETS system, in order to reduce total greenhouse gas emissions for all activities for which the business entity is responsible or on which it is dependent. It is necessary to calculate direct emissions and removals of greenhouse gases at the location of the business entity, either due to fuel combustion in the thermal power plant, from the production process and/or from the company's vehicles, indirect emissions that	2023	Ministry of Economy and Sustainable Development; Environmental Protection and Energy Efficiency Fund	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						occur outside from the location of the business entity, and are related to the supply and consumption of electricity, heat and cooling energy, but also other indirect emissions/removals related to the flows of people, materials, waste and final products. The calculation of the carbon footprint will enable business entities to get acquainted with the structure of greenhouse gas emissions, i.e. to identify activities that most significantly contribute to reducing emissions, which is a good basis for the development and implementation of the Action Plan for carbon footprint reduction. The implementation of the Action Plan would lead to the reduction of greenhouse gas emissions and the mitigation of climate change, i.e. easier realization of the obligations assumed by the Paris Agreement.							
MCC-11: Foundation of the Platform for Circular Economy*	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Demand management/reduction; Enhanced recycling; Reduced landfilling; Efficiency improvement in the energy and transformation sector; Integration the principles of the circular economy in plastic production	Education, Information, Regulatory	Implemented	It is necessary to develop a systematic approach in all value chains related to the Croatian economy related to the measures listed in the Action Plan for the Circular Economy, based on which the EC integrates the principles of the circular economy in plastic production and consumption, water management, food systems and special waste management streams. The Circular Economy Committee was established, whose goal is to speed up Croatia's transition to a circular economy and achieve EU goals related to the reduction of waste generation, as well as the reduction of pressure on the environment, and the transformation of waste into high-quality secondary raw materials, incorporated into new products. The preparation of a national action plan for the transition to a circular economy through the adjustment of the legislative framework is underway. The creation of a national digital platform for the circular economy is also planned, which would also include a user portal for monitoring progress in achieving the goals of the circular economy from European and national legislation.	2021	Ministry of Economy and Sustainable Development; Environmental Protection and Energy Efficiency Fund	NE	NE	NE	NE	NE
MCC-12: Foundation of the Platform for Bioeconomy	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Adaptation of the agriculture, forestry and waste management sectors to the transition to the bioeconomy	Education, Information, Regulatory	Planned	In the context of bioeconomy development, it is necessary to connect three key aspects: development of new technologies and processes; market development and competitiveness of sectors based on the principles of the circular economy and the political will for cooperation between policy and stakeholders. This should ensure the transformation of existing "traditional" stakeholders of the bioeconomy (farmers, family farms, food processing, forestry, wood processing, pharmaceutical, chemical industry...) into new, modern stakeholders in low-carbon economy and	2023	Ministry of Economy and Sustainable Development; Ministry of Agriculture	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						sustainable development while supporting the positive impact on ecosystems, climate and carbon cycle. An in-depth analysis of stakeholders (sectors) is necessary for the transition to a bioeconomy, and that their economic activity contributes to the achievement of development goals based on low levels of emissions of carbon dioxide and other greenhouse gases. In parallel, the adjustment of the involved economic entities is needed for the use of funds from the announced EU funds intended for the transition to the bioeconomy.							
MCC-13: Foundation of the Platform for Hydrogen Technologies	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Formed platform for hydrogen technology that will bring together national stakeholders relevant to the research and application of hydrogen technology	Education, Information, Regulatory	Planned	The role of hydrogen in the energy and transport systems of the future is expected to be more significant, even more so as the targets for reducing greenhouse gas emissions will be more ambitious. Therefore, it is necessary to identify opportunities related to the use of hydrogen in a timely manner, consider its application in the next decade and explore the possibilities of financially stimulating the production and consumption of hydrogen. To this end, a hydrogen technology platform will be established to connect national stakeholders relevant to hydrogen technology research and application, monitor the development of hydrogen technologies at EU and international level, and serve as a link between national, EU and international levels.	2023	Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-14: Energy efficiency obligation system for suppliers *	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Energy savings in final consumption; Energy savings in 2030: 16,0 PJ	Regulatory, Economic	Implemented	The system of energy efficiency obligations was established by the Energy Efficiency Act (OG 127/14, 116/18, 25/20), and its functioning is determined in more detail by the Ordinance on the System of Energy Efficiency Obligations (OG 41/19). The obligators of the system of energy efficiency obligations are energy suppliers. The goal is to achieve a reduction in energy consumption by end consumers.	2019	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-15: Integrated information system for monitoring energy efficiency*	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Systematic monitoring of the implementation of energy efficiency measures	Information	Implemented	The national system for monitoring, measurement and verification of savings (SMIV) is established on the basis of the Energy Efficiency Act (OG 127/14, 116/18, 25/20, 41/21) and the Ordinance on the System for Monitoring, Measuring and Verifying Energy Savings (OG 98/21, 30/22). This system is extremely important because it monitors energy savings and the resulting reduction in greenhouse gases and the system data are used for reporting. In the next period, it is necessary to maintain and improve the functionality of the system, connect it to other systems (EMIS), and inform and educate obligated parties about the correct data entry required to calculate and verify energy savings.	2015	Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
MCC-16: Green public procurement*	Cross-cutting	CO ₂ , CH ₄	Environmental criteria implemented in public procurement procedures	Information, Regulatory	Implemented	A National Commission for Green Public Procurement has been established to monitor the implementation of green public procurement through a survey questionnaire and an electronic public procurement notice. This measure represents a continuation of the initiated measures and further greening of public procurement procedures. Green public procurement will favour innovative low-carbon products and services, further encouraging their market entry, and the public sector will serve as a good example.	2014	Central State Office for Central Public Procurement; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-17: Determining the starting point, national goals, indicators for monitoring the achievement and establishing a system for monitoring the achievement of the set goals of research, innovation and competitiveness	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Defined national development goals in the context of low carbon transition, set up a system for monitoring achievement, defined key technologies	Regulatory	Planned	Elaboration of goals and monitoring system and establishment of a system for monitoring achievements in the field of research and development, innovation and competitiveness related to the Energy Union; defining key technologies for low carbon transition. Main activity is to elaborate criteria and indicators relevant to the areas of the Energy Union. It will propose relevant data sources and an indicator monitoring system. It will propose key low-carbon transition technologies, monitor the achievement of set goals, and propose corrective and other measures as needed. If necessary, thematic subgroups will be established for areas of research, innovation and competitiveness.	2023	Ministry of Science and Education; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-18: Co-financing of industrial research and experimental development projects aligned with the National Development Strategy	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Conducting research projects of priority for the Republic of Croatia	Economic	Planned	The measure encourages research and development of products and services relevant to low-carbon development, by co-financing research projects within priority topics.	2023	HAMAG-BICRO; Ministry of Science and Education; Croatian Science Foundation; Ministry of Economy and Sustainable Development	NE	NE	NE	NE	NE
MCC-19: Supporting low carbon entrepreneurship development	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Low-carbon products and services placed on the market	Economic, Research	Planned	The measure encourages the development of entrepreneurship in the field of low-carbon products and services, by co-financing entrepreneurial activities in this area. Activities: It will continue to support entrepreneurs throughout the development stages of their business - from the research and development of the idea through to commercialization and marketing, all in the area of low carbon products and services. Cooperation with scientific and research institutions and increased private investment in R&D will be encouraged. One possible activity is to fund the Proof of Concept as a mechanism to support the transfer of research results from the public to the private sector to create new	2023	Ministry of Science and Education; Ministry of Economy and Sustainable Development; HAMAG-BICRO	NE	NE	NE	NE	NE

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
						products and services. The number of patents applied for and granted and the number of new products will be monitored. Workforce needs and additional workforce qualifications will be monitored, and ongoing communication with government education and employment authorities established.							
MCC-20: Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Technology transfer; Low-carbon products and services placed on the market	Economic, Research	Planned	The measure encourages the development of established and functional technology transfer offices and science and technology parks with the aim of transferring knowledge and developing technologies that will contribute to the development of a low-carbon economy. Activities: Providing annual support to public scientific organizations for the establishment of development companies or subsidiaries resulting from the results of scientific research; providing support for cooperation between entrepreneurs and the science system, business meetings, business consulting; preparation of business plans; pre-money valuation and mentoring the preparation of high value projects and infrastructure projects; mentoring the development of business plans and pitching to investors, financing of experts on protection of intellectual property rights; financing grants for projects in the concept validation phase, etc. with a focus on sustainable technologies that contribute to low carbon development.	2023	Ministry of Science and Education	NE	NE	NE	NE	NE
MCC-21: Supporting further work of excellence centers active in the field of natural, technical, biotechnical and biomedical sciences	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Industrial and experimental research in the field of low carbon development	Economic, Research	Planned	The measure encourages the further work of established and centers of excellence, whose work was positively assessed in the periodic evaluation process with the aim of further development of the low-carbon economy. Activities: Support for industrial and experimental research of scientific Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change, with a view of further upgrading on the results of research funded in the 2014-2020 financial period.	2023	Ministry of Science and Education	NE	NE	NE	NE	NE
MCC-22: Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy	Cross-cutting	CO ₂ , CH ₄ , N ₂ O	Research, innovation and increasing competitiveness	Information, Research	Planned	The capacities of the institutions involved in encouraging and monitoring research, innovation and competitiveness in the low-carbon economy will be built. Representatives of all bodies involved in the implementation of measures IIK 1-5 will be supported to participate in lectures, workshops, working group meetings, study tours with the aim of international integration and capacity building in setting goals, defining indicators and monitoring the achievement of set goals in the context research, innovation and competitiveness in the low carbon economy. Support for participation in working bodies and working	2023	HAMAG-BICRO; Ministry of Economy and Sustainable Development; Ministry of Science and Education	NE	NE	NE	NE	NE

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						groups and committees of relevant European and international organizations (IEA, etc.), programmes (SET Plan, ETIP, EERA, Horizon 2020 LIFE, Eureka, etc.), European Partnerships under the EU Framework Programme for the research and innovation in relevant Pan-European networks and consortia. If necessary, the transfer of know-how with other EU Member States and other stakeholders within the Republic of Croatia will be organized. This activity will also co-finance the participation of scientific organizations in public-public and public-private partnerships within the framework programme for research and technological development and with relevant Pan-European research networks and consortia in the area of low carbon economy.							
Energy transformation (WEM)*	Energy	CO ₂ , CH ₄ , N ₂ O, HFCs, SF ₆	Reduction of losses; Efficiency improvement in the energy and transformation sector; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Safe and reliable operation of the gas transmission system; Multi-sectoral policy	Regulatory, Information, Voluntary Agreement, Economic	Implemented	Incorporates estimated mitigation potential of measures in the energy transformation sector in WEM scenario. Description is given for each measure separately.		Croatian Transmission System Operator; Ministry of Economy and Sustainable Development; HEP DSO (Distribution System Operator); Ministry of Economy and Sustainable Development; HEP District Heating; Croatian Energy Operator (HROTE); Environmental Protection and Energy Efficiency Fund; Plinacro Ltd.; Ministry of Physical Planning, Construction and State Assets	NA	204.62	282.78	526.57	770.35
Energy transformation (WAM)	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and	Economic, Education, Information, Regulatory	Planned	Incorporates estimated mitigation potential of measures in the energy transformation sector in WAM scenario. Description is given for each measure separately.		Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning,	NA	452.98	683.91	1,045.63	1,407.34

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
			cooling sector; Demand management/reduction; Efficiency improvement in the energy and transformation sector; Increasing energy storage capacity					Construction and State Assets; Ministry of Economy and Sustainable Development; Ministry of Economy and Sustainable Development; Croatian Energy Regulatory Agency					
Manufacturing industries (WEM)*	Energy	CO ₂ , CH ₄ , N ₂ O, HFCs, SF ₆	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Multi-sectoral policy; Installation of abatement technologies; Switch to less carbon-intensive fuels; Efficiency improvement in the energy and transformation sector; Carbon capture and storage; Reduce emissions from international air or maritime transport	Economic, Information, Voluntary Agreement, Regulatory	Implemented	Incorporates estimated mitigation potential of measures in the manufacturing industries sector in WEM scenario. Description is given for each measure separately.		Ministry of Economy and Sustainable Development; Croatian Energy Operator (HROTE); Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning, Construction and State Assets; European Commission; Ministry of Economy and Sustainable Development	NA	35.26	108.28	197.69	287.09
Manufacturing industries (WAM)	Energy	CO ₂ , CH ₄ , N ₂ O	Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Demand management/reduction	Economic, Education, Information, Regulatory	Planned	Incorporates estimated mitigation potential of measures in the manufacturing industries sector in WAM scenario. Description is given for each measure separately.		Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning, Construction and State Assets; Ministry of Economy and Sustainable Development; Ministry of Economy and Sustainable Development; Croatian Energy	NA	69.45	176.66	315.14	453.63

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
								Regulatory Agency					
General consumption (WEM) (1)*	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of buildings; Efficiency improvement in services/ tertiary sector; Demand management/reduction; Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector; Efficiency improvement in industrial end-use sectors	Regulatory, Economic, Information, Fiscal	Implemented	Incorporates estimated mitigation potential of measures in the general consumption sector in WEM scenario. Description is given for each measure separately.		Ministry of Physical Planning, Construction and State Assets; Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning, Construction and State Assets; Environmental Protection and Energy Efficiency Fund; Agency for Legal Affairs and Real Estate; Ministry of Economy and Sustainable Development; Agency for Legal Affairs and Real Estate; Ministry of Economy and Sustainable Development; Croatian Energy Operator (HROTE)	NA	-42.77	-85.94	-4.04	77.88
General consumption (WAM)	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in services/ tertiary sector; Efficiency improvement in industrial end-use sectors; Demand management/reduction; Increase in renewable energy sources in the electricity sector; Increase in renewable energy in the heating and cooling sector	Economic, Education, Fiscal, Information, Regulatory	Planned	Incorporates estimated mitigation potential of measures in the general consumption sector in WAM scenario. Description is given for each measure separately.		Ministry of Economy and Sustainable Development; Ministry of Finance; Environmental Protection and Energy Efficiency Fund; Ministry of Physical Planning, Construction and State Assets; Ministry of Economy and	NA	119.78	239.18	451.29	663.36

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
								Sustainable Development					
Fugitive emissions (WAM)	Energy	CO ₂ , CH ₄ , N ₂ O	Efficiency improvement in the energy and transformation sector; Control of fugitive emissions from energy production	Economic	Planned	Incorporates estimated mitigation potential of measures in the fugitive emissions sector in WAM scenario. Description is given for each measure separately.		INA, d.d. (oil company); Ministry of Economy and Sustainable Development; Ministry of Economy and Sustainable Development; INA, d.d. (oil company); distributors of liquid petroleum fuels	NA	3.22	6.44	10.45	14.46
Transport (WEM) (2)*	Transport	CO ₂ , CH ₄ , N ₂ O	Efficiency improvements of vehicles; Low carbon fuels/electric cars; Electric road transport; Improved transport infrastructure; Demand management/reduction; Reducing CO ₂ emissions from road vehicles; Reducing greenhouse gas emissions; Reducing the carbon signature; Research in the LULUCF sector; Modal shift to public transport or non-motorized transport; Improved behaviour; Reduce emissions from maritime transport	Economic, Education, Information, Fiscal, Regulatory, Voluntary Agreement	Implemented	Incorporates estimated mitigation potential of measures in the transport sector in WEM scenario. Description is given for each measure separately.		Ministry of Economy and Sustainable Development; Ministry of the Interior; Environmental Protection and Energy Efficiency Fund; Ministry of Economy and Sustainable Development; Ministry of Finances; Ministry of the Sea, Transport and Infrastructure; Environmental Protection and Energy Efficiency Fund; Units of regional and local self-government; National Energy Efficiency Authority; Ministry of the Sea, Transport and Infrastructure	NA	-274.46	-559.25	63.78	686.41
Transport (WAM) (3)	Transport	CO ₂ , CH ₄ , N ₂ O	Demand management/reduction; Low carbon	Regulatory, Economic	Planned	Incorporates estimated mitigation potential of measures in the transport sector in WAM		Ministry of the Sea, Transport and	NA	-32.84	-76.20	517.48	1,111.23

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									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
			fuels/electric cars; Improved transport infrastructure; Increasing the share of RES in transport			scenario. Description is given for each measure separately.		Infrastructure; Ministry of Economy and Sustainable Development; Ministry of Finance; Ministry of Agriculture					
Industrial processes (WEM)*	Industry/industrial processes	HFCs, SF6	Improved control of manufacturing, fugitive and disposal emissions of fluorinated gases; Replacement of fluorinated gases by other substances	Education, Regulatory	Implemented	Incorporates estimated mitigation potential of measures in the industrial processes and product use sector in WEM scenario. Description is given for each measure separately.		Ministry of Economy and Sustainable Development	NA	228.28	483.70	818.25	961.29
Industrial processes (WAM)	Industry/industrial processes	CO2	Installation of abatement technologies; Reduction in clinker production	Economic	Planned	Incorporates estimated mitigation potential of measures in the industrial processes and product use sector in WAM scenario. Description is given for each measure separately.		Cement manufacturers	NA	65.66	22.25	90.94	159.64
Waste *	Waste management/waste	CH4, CO2	Demand management/reduction (Waste management/waste); Reduced landfilling (Waste management/waste); Improved treatment technologies (Waste management/waste); Enhanced CH4 collection and use (Waste management/waste); Enhanced recycling (Waste management/waste); Increase in renewable energy sources in the electricity sector (Energy Supply); Increase in renewable energy in the heating and cooling sector (Energy Supply)	Economic, Education, Research	Implemented	Incorporates estimated mitigation potential of measures in the waste sector. WEM scenario is the same as WAM scenario. Description is given for each measure separately.		Ministry of Economy and Sustainable Development; Regional self-government units; Local self-government units; Regional self-government units; Ministry of Economy and Sustainable Development; Ministry of Economy and Sustainable Development	NA	66.36	458.03	736.99	937.55

Name of mitigation action ^a	Sector(s) affected ^b	GHG(s) affected	Objective and/or activity affected	Type of instrument ^c	Status of implementation ^d	Brief description ^e	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)				
									2020	2025 ^f	2030 ^f	2035 ^f	2040 ^f
Agriculture (WEM)*	Agriculture	CH ₄ , CO ₂ , N ₂ O		Economic, Education, Research	Implemented	Incorporates estimated mitigation potential of measures in the agriculture sector in WEM scenario. Description is given for each measure separately.		Advisory services; Ministry of Agriculture; Ministry of Economy and Sustainable Development; Ministry of Agriculture; Advisory services	NA	11.94	72.96	117.20	156.47
Agriculture (WAM)	Agriculture	CH ₄ , N ₂ O, CO ₂	Reduction of fertilizer/manure use on cropland	Economic, Education, Research, Regulatory	Planned	Incorporates estimated mitigation potential of measures in the agriculture sector in WAM scenario. Description is given for each measure separately.		Advisory services; Ministry of Agriculture; Ministry of Economy and Sustainable Development; Advisory services; Ministry of Agriculture; Ministry of Economy and Sustainable Development	NA	138.00	241.49	323.04	398.25
LULUCF (4)*	Forestry/LULUCF	CO ₂ , N ₂ O, CH ₄		Regulatory, Economic, Information, Education, Research	Implemented	Incorporates estimated mitigation potential of measures in LULUCF sector. WEM scenario is the same as WAM scenario. Description is given for each measure separately.		Ministry of Economy and Sustainable Development; Ministry of Agriculture; Ministry of Agriculture; Ministry of Economy and Sustainable Development; Ministry of Science and Education	NA	- 3,069.38	-3,162.99	-3,148.58	-3,175.34

Table 4: Reporting on progress^{a,b}

	<i>Total emissions excluding LULUCF</i>	<i>Contribution from LULUCF^d</i>	<i>Quantity of units from market based mechanisms under the Convention</i>		<i>Quantity of units from other market based mechanisms</i>	
<i>Year^c</i>	<i>(kt CO₂ eq)</i>	<i>(kt CO₂ eq)</i>	<i>(number of units)</i>	<i>(kt CO₂ eq)</i>	<i>(number of units)</i>	<i>(kt CO₂ eq)</i>
Base year/period (1990)	31,394.43	NA	NA	NA	NA	NA
2010	27,922.16	NA	NA	NA	NA	NA
2011	27,637.95	NA	NA	NA	NA	NA
2012	25,878.24	NA	NA	NA	NA	NA
2013	24,609.08	NA	NA	NA	NA	NA
2014	23,873.71	NA	NA	NA	NA	NA
2015	24,350.46	NA	NA	NA	NA	NA
2016	24,611.79	NA	NA	NA	NA	NA
2017	25,482.00	NA	NA	NA	NA	NA
2018	24,402.41	NA	NA	NA	NA	NA
2019	24,624.75	NA	NA	NA	NA	NA
2020	23,758.40	NA	NA	NA	NA	NA

Abbreviation: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b For the base year, information reported on the emission reduction target shall include the following: (a) total GHG emissions, excluding emissions and removals from the LULUCF sector; (b) emissions and/or removals from the LULUCF sector based on the accounting approach applied taking into consideration any relevant decisions of the Conference of the Parties and the activities and/or land that will be accounted for; (c) total GHG emissions, including emissions and removals from the LULUCF sector. For each reported year, information reported on progress made towards the emission reduction targets shall include, in addition to the information noted in paragraphs 9(a–c) of the UNFCCC biennial reporting guidelines for developed country Parties, information on the use of units from market-based mechanisms.

^c Parties may add additional rows for years other than those specified below.

^d Information in this column should be consistent with the information reported in table 4(a)I or 4(a)II, as appropriate. The Parties for which all relevant information on the LULUCF contribution is reported in table 1 of this common tabular format can refer to table 1.

Since the LULUCF is excluded from the economy-wide emission reduction target of the Republic of Croatia, following optional tables are not needed:

- Table 4(a): Progress in achieving the quantified economy-wide emission reduction targets -- further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2019 and 2020
- Table 4(a): Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol^{a,b}

Table 4: Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2019 a,b

	<i>Net GHG</i>	<i>Base year/period or</i>	<i>Contribution from</i>	<i>Cumulative</i>	<i>Accounting approach^f</i>
	<i>(kt CO₂ eq)</i>				
Total LULUCF					
A. Forest land					
1. Forest land remaining forest land					
2. Land converted to forest land					
3. Other ^g					
B. Cropland					
1. Cropland remaining cropland					
2. Land converted to cropland					
3. Other ^g					
C. Grassland					
1. Grassland remaining grassland					
2. Land converted to grassland					
3. Other ^g					
D. Wetlands					
1. Wetland remaining wetland					
2. Land converted to wetland					
3. Other ^g					
E. Settlements					
1. Settlements remaining settlements					
2. Land converted to settlements					
3. Other ^g					
F. Other land					
1. Other land remaining other land					
2. Land converted to other land					
3. Other ^g					
G. Other					
Harvested wood products					

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

^c For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

^d Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

^e If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

^f Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

^g Specify what was used for the category “other”. Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Table 4: Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2020 a,b

	<i>Net GHG</i>	<i>Base year/period or</i>	<i>Contribution from</i>	<i>Cumulative</i>	<i>Accounting</i>
	<i>(kt CO₂ eq)</i>				<i>approach^f</i>
Total LULUCF					
A. Forest land					
1. Forest land remaining forest land					
2. Land converted to forest land					
3. Other ^g					
B. Cropland					
1. Cropland remaining cropland					
2. Land converted to cropland					
3. Other ^g					
C. Grassland					
1. Grassland remaining grassland					
2. Land converted to grassland					
3. Other ^g					
D. Wetlands					
1. Wetland remaining wetland					

	<i>Net GHG</i>	<i>Base year/period or</i>	<i>Contribution from</i>	<i>Cumulative</i>	<i>Accounting approach^f</i>
	<i>(kt CO₂ eq)</i>				
2. Land converted to wetland					
3. Other ^g					
E. Settlements					
1. Settlements remaining settlements					
2. Land converted to settlements					
3. Other ^g					
F. Other land					
1. Other land remaining other land					
2. Land converted to other land					
3. Other ^g					
G. Other					
Harvested wood products					

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

^c For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

^d Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

^e If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

^f Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

^g Specify what was used for the category “other”. Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Table 4(a)II: Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol^{a,b, c}

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Base year ^d	Net emissions/removals ^e									Account ing paramet ers ^h	Accounting quantity ⁱ	
		2013	2014	2015	2016	2017	2018	2019	2020	Total ^g			
	(kt CO ₂ eq)												
A. Article 3.3 activities													
A.1. Afforestation/reforestation		-173.27	-196.20	-240.94	-340.65	-298.74	-372.73	-386.95	-395.93	-2,405.41		-2405.41	
Excluded emissions from natural disturbances(5)		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
Excluded subsequent removals from land subject to natural disturbances(6)		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
A.2. Deforestation		38.03	20.60	49.13	20.86	15.18	14.27	19.62	16.20	193.90		193.90	
B. Article 3.4 activities													
B.1. Forest management										-56,686.15		-7146.71	
Net emissions/removals ^e		-8,131.97	-7,767.46	-7,319.42	-7,030.92	-6,201.02	-6,665.69	-6,838.73	-6,730.93	-56,686.15			
Excluded emissions from natural disturbances(5)		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
Excluded subsequent removals from land subject to natural disturbances(6)		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
Any debits from newly established forest (CEF-ne)(7),(8)		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
Forest management reference level (FMRL)(9)											-6289.00		
Technical corrections to FMRL(10)											96.57		
Forest management cap ^l											8737.00	-7146.71	

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Base year ^d	Net emissions/removals ^e									Account ing paramet ers ^h	Accounting quantity ⁱ	
		2013	2014	2015	2016	2017	2018	2019	2020	Total ^g			
		(kt CO ₂ eq)											
	B.2. Cropland management (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA
B.3. Grazing land management (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
B.4. Revegetation (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	
B.5. Wetland drainage and rewetting (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	

Note: 1 kt CO₂ eq equals 1 Gg CO₂ eq.

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

^c Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the biennial reports.

^d Net emissions and removals in the Party's base year, as established by decision 9/CP.2.

^e All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

^f Additional columns for relevant years should be added, if applicable.

^g Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

^h The values in the cells "3.3 offset" and "Forest management cap" are absolute values.

ⁱ The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

^j In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

^k In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

^l In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

Table 4(b): Reporting on progress^{a,b,c}

Units of market based mechanisms			Year	
			2019	2020
Kyoto Protocol units ^d	Kyoto Protocol units	(number of units)		
		(kt CO ₂ eq)		
	AAUs	(number of units)		
		(kt CO ₂ eq)		
	ERUs	(number of units)		
		(kt CO ₂ eq)		
	CERs	(number of units)		
		(kt CO ₂ eq)		
	tCERs	(number of units)		
		(kt CO ₂ eq)		
	lCERs	(number of units)		
		(kt CO ₂ eq)		
Other units ^{d,e}	Units from market-based mechanisms under the Convention	(number of units)		
		(kt CO ₂ eq)		
	Units from other market-based mechanisms	(number of units)		
		(kt CO ₂ eq)		
Total		(number of units)		
		(kt CO ₂ eq)		

Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, lCERs = long-term certified emission reductions, tCERs = temporary certified emission reductions.

Note: 2011 is the latest reporting year.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.

^c Parties may include this information, as appropriate and if relevant to their target.

^d Units surrendered by that Party for that year that have not been previously surrendered by that or any other Party.

^e Additional rows for each market-based mechanism should be added, if applicable.

Table 5: Summary of key variables and assumptions used in the projections analysis^a

Key underlying assumptions		Historical ^b											Projected			
Assumption	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2025	2030	2035	2040
Population	thousands	4,777.37	4,620.03	4,468.30	4,312.49	4,289.86	4,131.12	4,078.77	4,014.34	3,968.68	3,933.51	3,983.70	3,833.53	3,755.42	3,647.91	3,531.59
GDP growth rate	%	NE	NE	2.90	4.30	-1.20	2.50	3.60	3.40	2.80	3.40	-8.50	2.20	2.20	1.80	1.80
International oil price	USD / boe	NE	NE	38.00	NE	86.00	NE	41.00	NE	NE	NE	62.00	83.00	94.00	103.00	111.00
International gas price	USD / Mbtu	NE	NE	46.00	NE	101.00	NE	63.00	NE	NE	NE	70.00	77.00	80.00	81.00	82.00
International coal price	USD / tonne	NE	NE	3.80	NE	8.20	NE	4.90	NE	NE	NE	6.40	7.90	8.60	9.10	9.60
Emission unit price	EUR / tCO _{2e}	NA	NA	NA	NE	NE	NE	NE	NE	NE	NE	25.60	29.90	34.30	43.00	51.10

Table 6(a): Information on updated greenhouse gas projections under a ‘with measures’ scenario^a

	<i>GHG emissions and removals^b</i>								GHG emission projections	
	<i>(kt CO₂ eq)</i>								<i>(kt CO₂ eq)</i>	
	<i>Base year (1990)</i>	1990	1995	2000	2005	2010	2015	2019	2020	2030
Sector^{d,e}										
Energy	17,543.49	17,543.49	12,602.30	13,714.85	16,002.71	13,756.82	10,637.41	9,907.12	9,714.15	9,527.09
Transport	3,896.02	3,896.02	3,370.09	4,502.29	5,561.77	5,951.51	5,953.78	6,589.02	5,802.43	6,361.68
Industry/industrial processes	4,617.63	4,617.63	2,403.66	3,038.00	3,475.41	3,521.14	3,301.12	3,654.62	3,770.25	3,286.55
Agriculture	4,353.02	4,353.02	3,042.35	3,018.30	3,277.04	3,028.76	2,689.85	2,696.79	2,692.31	2,619.35
Forestry/LULUCF	-7,045.89	-7,045.89	-9,537.85	-7,258.12	-8,095.11	-6,861.44	-5,558.09	-5,705.63	-5,560.93	-2,397.95
Waste management/waste	984.27	984.27	1,067.59	1,205.33	1,336.93	1,663.93	1,768.30	1,777.19	1,779.26	1,321.23
Other (specify)										
Gas										
CO ₂ emissions including net CO ₂ from LULUCF	15,884.57	15,884.57	7,225.26	12,203.01	15,178.68	14,049.02	12,121.84	12,026.00	11,133.05	14,808.02
CO ₂ emissions excluding net CO ₂ from LULUCF	22,979.79	22,979.79	16,817.67	19,662.49	23,343.92	21,016.28	17,824.70	17,857.45	16,870.53	17,389.94
CH ₄ emissions including CH ₄ from LULUCF	4,309.02	4,309.02	3,369.94	3,382.73	3,652.99	3,872.52	3,751.04	3,583.30	3,565.36	3,253.97
CH ₄ emissions excluding CH ₄ from LULUCF	4,307.79	4,307.79	3,362.39	3,285.82	3,650.26	3,870.76	3,737.07	3,580.52	3,532.83	3,237.69
N ₂ O emissions including N ₂ O from LULUCF	2,903.97	2,903.97	2,319.02	2,569.68	2,525.63	2,534.20	1,906.52	1,741.01	1,800.57	1,706.30
N ₂ O emissions excluding N ₂ O from LULUCF	2,855.88	2,855.88	2,272.02	2,465.23	2,458.23	2,430.14	1,775.71	1,617.97	1,656.56	1,538.61
HFCs	NO	NO	21.85	52.89	187.20	595.15	1,007.40	1,560.96	1,689.72	945.32
PFCs	1,240.24	1,240.24	NO	NO	NO	NO	NO	NO	NO	NO
SF ₆	10.73	10.73	12.08	12.34	14.26	9.83	5.58	7.85	8.76	4.33
NF ₃	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (specify)										
Total with LULUCF^f	24,348.53	24,348.53	12,948.15	18,220.65	21,558.76	21,060.72	18,792.38	18,919.12	18,197.46	20,717.94
Total without LULUCF	31,394.43	31,394.43	22,486.01	25,478.77	29,653.87	27,922.16	24,350.46	24,624.75	23,758.40	23,115.89

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

- ^a In accordance with the “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications”, at a minimum Parties shall report a ‘with measures’ scenario, and may report ‘without measures’ and ‘with additional measures’ scenarios. If a Party chooses to report ‘without measures’ and/or ‘with additional measures’ scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report ‘without measures’ or ‘with additional measures’ scenarios then it should not include tables 6(b) or 6(c) in the biennial report.
- ^b Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.
- ^c 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).
- ^d In accordance with paragraph 34 of the “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications”, projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.
- ^e To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.
- ^f Parties may choose to report total emissions with or without LULUCF, as appropriate.

Table 6(c): Information on updated greenhouse gas projections under a ‘with additional measures’ scenario

	<i>GHG emissions and removals^b</i>								GHG emission projections	
	<i>(kt CO₂ eq)</i>								<i>(kt CO₂ eq)</i>	
	<i>Base year (1990)</i>	1990	1995	2000	2005	2010	2015	2019	2020	2030
<i>Sector^{d,e}</i>										
Energy	17,543.49	17,543.49	12,602.30	13,714.85	16,002.71	13,756.82	10,637.41	9,907.12	9,714.15	8,726.03
Transport	3,896.02	3,896.02	3,370.09	4,502.29	5,561.77	5,951.51	5,953.78	6,589.02	5,802.43	5,878.62
Industry/industrial processes	4,617.63	4,617.63	2,403.66	3,038.00	3,475.41	3,521.14	3,301.12	3,654.62	3,770.25	3,119.70
Agriculture	4,353.02	4,353.02	3,042.35	3,018.30	3,277.04	3,028.76	2,689.85	2,696.79	2,692.31	2,450.83
Forestry/LULUCF	-7,045.89	-7,045.89	-9,537.85	-7,258.12	-8,095.11	-6,861.44	-5,558.09	-5,705.63	-5,560.93	-2,397.95
Waste management/waste	984.27	984.27	1,067.59	1,205.33	1,336.93	1,663.93	1,768.30	1,777.19	1,779.26	1,321.23
Other (specify)										
<i>Gas</i>										
CO ₂ emissions including net CO ₂ from LULUCF	15,884.57	15,884.57	7,225.26	12,203.01	15,178.68	14,049.02	12,121.84	12,026.00	11,133.05	13,401.65
CO ₂ emissions excluding net CO ₂ from LULUCF	22,979.79	22,979.79	16,817.67	19,662.49	23,343.92	21,016.28	17,824.70	17,857.45	16,870.53	15,983.57
CH ₄ emissions including CH ₄ from LULUCF	4,309.02	4,309.02	3,369.94	3,382.73	3,652.99	3,872.52	3,751.04	3,583.30	3,565.36	3,082.23
CH ₄ emissions excluding CH ₄ from LULUCF	4,307.79	4,307.79	3,362.39	3,285.82	3,650.26	3,870.76	3,737.07	3,580.52	3,532.83	3,065.94
N ₂ O emissions including N ₂ O from LULUCF	2,903.97	2,903.97	2,319.02	2,569.68	2,525.63	2,534.20	1,906.52	1,741.01	1,800.57	1,688.62
N ₂ O emissions excluding N ₂ O from LULUCF	2,855.88	2,855.88	2,272.02	2,465.23	2,458.23	2,430.14	1,775.71	1,617.97	1,656.56	1,520.93
HFCs	NO	NO	21.85	52.89	187.20	595.15	1,007.40	1,560.96	1,689.72	921.73
PFCs	1,240.24	1,240.24	NO	NO	NO	NO	NO	NO	NO	NO
SF ₆	10.73	10.73	12.08	12.34	14.26	9.83	5.58	7.85	8.76	4.23
NF ₃	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other (specify)										
Total with LULUCF^f	24,348.53	24,348.53	12,948.15	18,220.65	21,558.76	21,060.72	18,792.38	18,919.12	18,197.46	19,098.46
Total without LULUCF	31,394.43	31,394.43	22,486.01	25,478.77	29,653.87	27,922.16	24,350.46	24,624.75	23,758.40	21,496.40

Table 7: Provision of public financial support: summary information in 2019-2020

Allocation channels	Year 2019									
	European euro - EUR					USD ^b				
	Core/ general ^c	Climate-specific ^d				Core/ general ^c	Climate-specific ^d			
		Mitigation	Adaptation	Cross-cutting ^e	Other ^f		Mitigation	Adaptation	Cross-cutting ^e	Other ^f
2019										
Total contributions through multilateral channels:	27,798.00					31,119.00				
Multilateral climate change funds ^g										
Other multilateral climate change funds ^h										
Multilateral financial institutions, including regional development banks										
Specialized United Nations bodies	27,798.00					31,119.00				
Total contributions through bilateral, regional and other channels										
Total	27,798.00					31,119.00				
2020										
Total contributions through multilateral channels:	16,418.00					18,709.00				
Multilateral climate change funds ^g										
Other multilateral climate change funds ^h										
Multilateral financial institutions, including regional development banks										
Specialized United Nations bodies	16,418.00					18,709.00				
Total contributions through bilateral, regional and other channels										
Total	16,418.00					18,709.00				

Note: Explanation of numerical footnotes is provided in the documentation box after tables 7, 7(a) and 7(b).

Abbreviation: USD = United States dollars.

^a Parties should fill in a separate table for each year, namely 2015 and 2016, where 2018 is the reporting year.

^b Parties should provide an explanation of the methodology used for currency exchange for the information provided in tables 7, 7(a) and 7(b) in the documentation box.

^c This refers to support to multilateral institutions that Parties cannot specify as being climate-specific.

^d Parties should explain in their biennial reports how they define funds as being climate-specific.

^e This refers to funding for activities that are cross-cutting across mitigation and adaptation.

^f Please specify.

^g Multilateral climate change funds listed in paragraph 17(a) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

^h Other multilateral climate change funds as referred in paragraph 17(b) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

Table 7(a): Provision of public financial support: contribution through multilateral channels in 2019

Donor funding	Total amount				Status ^{b, 3}	Funding source ^{f, 4}	Financial instrument ^{f, 5}	Type of support ^{f, 9, 6}	Sector ^{c, f, 7}
	Core/general ^{d, 1}		Climate-specific ^{e, 2}						
	European euro - EUR	USD	European euro - EUR	USD					
Total contributions through multilateral channels	27,798.00	31,119.00							
Multilateral climate change funds									
1. Global Environment Facility									
2. Least Developed Countries Fund									
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds									
Multilateral financial institutions, including regional development banks									
1. World Bank									
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. European Bank for Reconstruction and Development									
6. Inter-American Development Bank									
7. Other									
Specialized United Nations bodies	27,798.00	31,119.00							
1. United Nations Development Programme									
2. United Nations Environment Programme	27,798.00	31,119.00							
Core budget of UNFCCC	27,798.00	31,119.00						Other ()	
3. Other									

Abbreviations: ODA = official development assistance, OOF = other official flows, USD = United States dollars.

^a Parties should fill in a separate table for each year, namely 2015 and 2016, where 2018 is the reporting year.

^b Parties should explain, in their biennial reports, the methodologies used to specify the funds as disbursed and committed. Parties will provide the information for as many status categories as appropriate in the following order of priority: disbursed and committed.

^c Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

^d This refers to support to multilateral institutions that Parties cannot specify as being climate-specific.

^e Parties should explain in their biennial reports how they define funds as being climate-specific.

^f Please specify.

^g This refers to funding for activities that are cross-cutting across mitigation and adaptation.

Table 7(a): Provision of public financial support: contribution through multilateral channels in 2020

Donor funding	Total amount				Status ^{b, 3}	Funding source ^{f, 4}	Financial instrument ^{f, 5}	Type of support ^{f, 9, 6}	Sector ^{c, f, 7}
	Core/general ^{d, 1}		Climate-specific ^{e, 2}						
	European euro - EUR	USD	European euro - EUR	USD					
Total contributions through multilateral channels	16,418.00	18,709.00							
Multilateral climate change funds									
1. Global Environment Facility									
2. Least Developed Countries Fund									
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds									
Multilateral financial institutions, including regional development banks									
1. World Bank									
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. European Bank for Reconstruction and Development									
6. Inter-American Development Bank									
7. Other									
Specialized United Nations bodies	16,418.00	18,709.00							
1. United Nations Development Programme									
2. United Nations Environment Programme	16,418.00	18,709.00							
Core budget of UNFCCC	16,418.00	18,709.00						Other ()	
3. Other									

Abbreviations: ODA = official development assistance, OOF = other official flows, USD = United States dollars.

^a Parties should fill in a separate table for each year, namely 2015 and 2016, where 2018 is the reporting year.

^b Parties should explain, in their biennial reports, the methodologies used to specify the funds as disbursed and committed. Parties will provide the information for as many status categories as appropriate in the following order of priority: disbursed and committed.

^c Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

^d This refers to support to multilateral institutions that Parties cannot specify as being climate-specific.

^e Parties should explain in their biennial reports how they define funds as being climate-specific.

^f Please specify.

^g This refers to funding for activities that are cross-cutting across mitigation and adaptation.

Table 7(b): Provision of public financial support: contribution through bi-lateral, regional and other channels in 2019

Recipient country/ region/project/programme ^b	Total amount		Status ^{c, 3}	Funding source ^{g, 4}	Financial instrument ^{g, 5}	Type of support ^{g, h, 6}	Sector ^{d, g, 7}	Additional information ^e
	Climate-specific ^{f, 2}							
	European euro - EUR	USD						
Total contributions through bilateral, regional and other channels								

Abbreviations: ODA = official development assistance, OOF = other official flows; USD = United States dollars.

^a Parties should fill in a separate table for each year, namely 2015 and 2016, where 2018 is the reporting year.

^b Parties should report, to the extent possible, on details contained in this table.

^c Parties should explain, in their biennial reports, the methodologies used to specify the funds as disbursed and committed. Parties will provide the information for as many status categories as appropriate in the following order of priority: disbursed and committed.

^d Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

^e Parties should report, as appropriate, on project details and the implementing agency.

^f Parties should explain in their biennial reports how they define funds as being climate-specific.

^g Please specify.

^h This refers to funding for activities that are cross-cutting across mitigation and adaptation.

Table 7(b): Provision of public financial support: contribution through bi-lateral, regional and other channels in 2020

Recipient country/ region/project/programme ^b	Total amount		Status ^{c, 3}	Funding source ^{g, 4}	Financial instrument ^{g, 5}	Type of support ^{g, h, 6}	Sector ^{d, g, 7}	Additional information ^e
	Climate-specific ^{f, 2}							
	European euro - EUR	USD						
Total contributions through bilateral, regional and other channels								

Abbreviations: ODA = official development assistance, OOF = other official flows; USD = United States dollars.

^a Parties should fill in a separate table for each year, namely 2015 and 2016, where 2018 is the reporting year.

^b Parties should report, to the extent possible, on details contained in this table.

^c Parties should explain, in their biennial reports, the methodologies used to specify the funds as disbursed and committed. Parties will provide the information for as many status categories as appropriate in the following order of priority: disbursed and committed.

^d Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

^e Parties should report, as appropriate, on project details and the implementing agency.

^f Parties should explain in their biennial reports how they define funds as being climate-specific.

^g Please specify.

^h This refers to funding for activities that are cross-cutting across mitigation and adaptation.

Table 8: Provision of technology development and transfer support

<i>Recipient country and/or region</i>	<i>Targeted area</i>	<i>Measures and activities related to technology transfer</i>	<i>Sector^c</i>	<i>Source of the funding for technology transfer</i>	<i>Activities undertaken by</i>	<i>Status</i>	<i>Additional information^d</i>

^a To be reported to the extent possible.

^b The tables should include measures and activities since the last national communication or biennial report.

^c Parties may report sectoral disaggregation, as appropriate.

^d Additional information may include, for example, funding for technology development and transfer provided, a short description of the measure or activity and co-financing arrangements.

Table 9: Provision of capacity-building support

<i>Recipient country/region</i>	<i>Targeted area</i>	<i>Programme or project title</i>	<i>Description of programme or project^{b,c}</i>

^a To be reported to the extent possible.

^b Each Party included in Annex II to the Convention shall provide information, to the extent possible, on how it has provided capacity-building support that responds to the existing and emerging capacity-building needs identified by Parties not included in Annex I to the Convention in the areas of mitigation, adaptation and technology development and transfer.

^c Additional information may be provided on, for example, the measure or activity and co-financing arrangements.

ANNEX III. OTHER

1. SUMMARY OF EMISSION TABLES 1990-2020

1990	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	15884.57	4309.02	2903.97	1250.9	24348.53	
1. Energy	20362.90	833.35	243.27		21439.51	68.29%
A. Fuel combustion (sectoral approach)	19780.38	414.23	242.57		20437.19	65.10%
1. Energy industries	7065.79	5.43	17.40		7088.62	22.58%
2. Manufacturing industries and construction	5208.58	9.24	16.75		5234.57	16.67%
3. Transport	3787.06	41.90	67.07		3896.02	12.41%
4. Other sectors	3718.95	357.67	141.35		4217.97	13.44%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	582.52	419.11	0.69		1002.32	3.19%
1. Solid fuels	NO	59.64	NO,NA		59.64	0.19%
2. Oil and natural gas	582.52	359.47	0.69		942.68	3.00%
C. CO ₂ transport and storage	NO				NO	NA
2. Industrial processes and product use	2566.34	9.35	790.98	1250.9	4617.63	14.71%
A. Mineral industry	1302.67				1302.67	4.15%
B. Chemical industry	751.10	5.45	754.27		1510.81	4.81%
C. Metal industry	336.40	3.90	NO	1240.2	1580.54	5.03%
D. Non-energy products from fuels and solvent use	176.17	NA	NA		176.17	0.56%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes					NO	NO
G. Other product manufacture and use	NO	NO	36.71	10.73	47.44	0.15%
3. Agriculture	50.02	2548.26	1754.74		4353.02	13.87%
A. Enteric fermentation		2121.15			2121.15	6.76%
B. Manure management		427.11	329.05		756.16	2.41%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1425.69		1425.69	4.54%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	50.02				50.02	0.16%
I. Other carbon-containing fertilizers	NA				NA	NO
4. Land use, land-use change and forestry⁽¹⁾	-7095.21	1.23	48.09		-7045.89	-22.44%
A. Forest land	-7200.60	1.12	0.74		-7198.74	-22.93%
B. Cropland	114.91	NO	3.95		118.86	0.38%
C. Grassland	-7.88	0.11	0.12		-7.66	-0.02%
D. Wetlands	78.26	NO	11.11		89.37	0.28%
E. Settlements	237.96	NO	32.17		270.12	0.86%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-317.85				-317.85	-1.01%
5. Waste	0.54	916.84	66.89		984.27	3.14%
A. Solid waste disposal	NA,NO	327.97			327.97	1.04%
B. Biological treatment of solid waste		NO,IE	NO,IE		NO,IE	NO,IE
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		588.88	66.88		655.76	2.09%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	643.85	0.43	5.29		649.57	
Aviation	496.62	0.09	4.14		500.84	
Navigation	147.23	0.34	1.15		148.72	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5237.84				5237.84	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	194.62				194.62	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					31394.43	
Total CO₂ equivalent emissions with land use, land-use change and forestry					24348.53	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1991	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	8503.09	4155.35	2746.24	861.36	16266.04	
1. Energy	15017.89	784.08	207.97		16009.94	64.82%
A. Fuel combustion (sectoral approach)	14440.98	442.74	207.46		15091.18	61.10%
1. Energy industries	4742.10	3.98	11.99		4758.07	19.26%
2. Manufacturing industries and construction	3769.57	6.88	12.20		3788.65	15.34%
3. Transport	2866.99	31.74	52.72		2951.45	11.95%
4. Other sectors	3062.32	400.14	130.55		3593.01	14.55%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	576.92	341.34	0.50		918.76	3.72%
1. Solid fuels	NO	53.15	NO,NA		53.15	0.22%
2. Oil and natural gas	576.92	288.19	0.50		865.61	3.50%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1918.14	8.74	699.50	861.36	3487.73	14.12%
A. Mineral industry	863.03				863.03	3.49%
B. Chemical industry	665.95	5.02	662.78		1333.74	5.40%
C. Metal industry	270.10	3.73	NO	850.75	1124.58	4.55%
D. Non-energy products from fuels and solvent use	119.06	NA	NA		119.06	0.48%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes					NO	NO
G. Other product manufacture and use	NO	NO	36.71	10.61	47.32	0.19%
3. Agriculture	50.95	2428.07	1727.18		4206.20	17.03%
A. Enteric fermentation		1992.20			1992.20	8.07%
B. Manure management		435.87	313.75		749.63	3.04%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1413.42		1413.42	5.72%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	50.95				50.95	0.21%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8484.42	3.18	48.32		-8432.91	-34.14%
A. Forest land	-9074.26	3.00	1.98		-9069.27	-36.72%
B. Cropland	127.70	NO	4.36		132.06	0.53%
C. Grassland	3.98	0.18	0.19		4.35	0.02%
D. Wetlands	67.64	NO	10.63		78.27	0.32%
E. Settlements	214.28	NO	31.17		245.45	0.99%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	176.24				176.24	0.71%
5. Waste	0.54	931.27	63.27		995.08	4.03%
A. Solid waste disposal	NA,NO	346.76			346.76	1.40%
B. Biological treatment of solid waste		NO,IE	NO,IE		NO,IE	NO,IE
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		584.52	63.27		647.78	2.62%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	94.29	0.02	0.79		95.10	
Aviation	94.29	0.02	0.79		95.10	
Navigation	NO	NO	NO		NO	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	6091.91				6091.91	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	203.06				203.06	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24698.95	
Total CO₂ equivalent emissions with land use, land-use change and forestry					16266.04	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1992	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	7729.03	3701.25	2764.79	10.69	14205.77	
1. Energy	14347.02	819.38	186.72		15353.13	67.40%
A. Fuel combustion (sectoral approach)	13759.23	377.44	186.27		14322.94	62.88%
1. Energy industries	5342.75	4.51	15.27		5362.52	23.54%
2. Manufacturing industries and construction	3079.37	5.43	9.59		3094.39	13.58%
3. Transport	2776.79	28.16	45.29		2850.24	12.51%
4. Other sectors	2560.33	339.34	116.12		3015.79	13.24%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	587.79	441.94	0.46		1030.18	4.52%
1. Solid fuels	NO	41.30	NO,NA		41.30	0.18%
2. Oil and natural gas	587.79	400.64	0.46		988.89	4.34%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1959.52	7.57	901.94	10.69	2879.73	12.64%
A. Mineral industry	933.89				933.89	4.10%
B. Chemical industry	832.68	5.12	865.22		1703.03	7.48%
C. Metal industry	121.11	2.45	NO		123.56	0.54%
D. Non-energy products from fuels and solvent use	71.85	NA	NA		71.85	0.32%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes					NO	NO
G. Other product manufacture and use	NO	NO	36.71	10.69	47.41	0.21%
3. Agriculture	65.51	1913.34	1556.78		3535.63	15.52%
A. Enteric fermentation		1562.96			1562.96	6.86%
B. Manure management		350.38	245.46		595.84	2.62%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1311.32		1311.32	5.76%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	65.51				65.51	0.29%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8643.56	15.15	55.70		-8572.71	-37.64%
A. Forest land	-9298.12	13.64	9.00		-9275.48	-40.72%
B. Cropland	129.64	NO	4.76		134.39	0.59%
C. Grassland	-0.24	1.51	1.64		2.91	0.01%
D. Wetlands	64.60	NO	10.14		74.74	0.33%
E. Settlements	207.73	NO	30.17		237.90	1.04%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	252.83				252.83	1.11%
5. Waste	0.54	945.81	63.65		101	4.43%
A. Solid waste disposal	NA,NO	364.58			364.58	1.60%
B. Biological treatment of solid waste		NO,IE	NO,IE		NO,IE	NO,IE
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		581.23	63.64		644.87	2.83%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	72.29	0.01	0.60		72.91	
Aviation	72.29	0.01	0.60		72.91	
Navigation	NO	NO	NO		NO	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5308.28				5308.28	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	211.54				211.54	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					22778.48	
Total CO₂ equivalent emissions with land use, land-use change and forestry					14205.77	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1993	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	7938.10	3631.66	2378.17	10.81	13958.75	
1. Energy	15117.22	718.71	195.14		16031.06	70.53%
A. Fuel combustion (sectoral approach)	14330.95	394.33	194.68		14919.97	65.65%
1. Energy industries	5940.22	4.89	17.15		5962.26	26.23%
2. Manufacturing industries and construction	2917.23	5.13	9.03		2931.39	12.90%
3. Transport	2925.16	28.09	48.05		3001.30	13.21%
4. Other sectors	2548.34	356.21	120.46		3025.01	13.31%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	786.27	324.37	0.46		1111.10	4.89%
1. Solid fuels	NO	39.52	NO,NA		39.52	0.17%
2. Oil and natural gas	786.27	284.85	0.46		1071.58	4.71%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1639.29	6.25	688.93	10.81	2345.27	10.32%
A. Mineral industry	797.34				797.34	3.51%
B. Chemical industry	715.96	5.15	652.21		1373.32	6.04%
C. Metal industry	57.46	1.10	NO		58.56	0.26%
D. Non-energy products from fuels and solvent use	68.52	NA	NA		68.52	0.30%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes					NO	NO
G. Other product manufacture and use	NO	NO	36.71	10.81	47.52	0.21%
3. Agriculture	52.14	1911.58	1362.90		3326.63	14.64%
A. Enteric fermentation		1540.48			1540.48	6.78%
B. Manure management		371.10	243.74		614.84	2.71%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1119.17		1119.17	4.92%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	52.14				52.14	0.23%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8871.08	34.39	67.34		-8769.34	-38.58%
A. Forest land	-9328.49	32.81	21.64		-9274.05	-40.80%
B. Cropland	131.57	NO	5.16		136.73	0.60%
C. Grassland	-3.30	1.58	1.72			%
D. Wetlands	61.56	NO	9.65		71.21	0.31%
E. Settlements	201.19	NO	29.17		230.36	1.01%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	66.40				66.40	0.29%
5. Waste	0.54	960.73	63.86		1025.13	4.51%
A. Solid waste disposal	NA,NO	381.84			381.84	1.68%
B. Biological treatment of solid waste		NO,IE	NO,IE		NO,IE	NO,IE
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		578.89	63.86		642.75	2.83%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	182.30	0.03	1.52		183.85	
Aviation	182.30	0.03	1.52		183.85	
Navigation	NO	NO	NO		NO	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5583.98				5583.98	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	220.08				220.08	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					22728.09	
Total CO₂ equivalent emissions with land use, land-use change and forestry					13958.75	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1994	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	6984.52	3422.41	2400.77	11.60	12819.31	
1. Energy	14179.93	654.42	189.91		15024.26	68.84%
A. Fuel combustion (sectoral approach)	13474.85	360.84	189.50		14025.19	64.26%
1. Energy industries	4658.42	3.29	12.07		4673.79	21.41%
2. Manufacturing industries and construction	3077.51	4.76	8.47		3090.74	14.16%
3. Transport	3102.93	30.57	50.43		3183.94	14.59%
4. Other sectors	2635.99	322.22	118.52		3076.73	14.10%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	705.07	293.58	0.42		999.07	4.58%
1. Solid fuels	NO	35.44	NO,NA		35.44	0.16%
2. Oil and natural gas	705.07	258.14	0.42		963.63	4.41%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1825.99	6.53	742.97	11.60	2587.09	11.85%
A. Mineral industry	957.92				957.92	4.39%
B. Chemical industry	715.58	4.90	706.26		1426.74	6.54%
C. Metal industry	81.17	1.63	NO		82.80	0.38%
D. Non-energy products from fuels and solvent use	71.31	NA	NA		71.31	0.33%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes					NO	NO
G. Other product manufacture and use	NO	NO	36.71	11.60	48.31	0.22%
3. Agriculture	47.57	1768.71	1350.33		3166.61	14.51%
A. Enteric fermentation		1392.68			1392.68	6.38%
B. Manure management		376.03	230.65		606.68	2.78%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1119.68		1119.68	5.13%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	47.57				47.57	0.22%
I. Other carbon-containing fertilizers	NA				NA	NO
4. Land use, land-use change and forestry⁽¹⁾	-9069.50	11.51	50.83		-9007.16	-41.27%
A. Forest land	-9402.68	10.68	7.04		-9384.95	-43.00%
B. Cropland	133.50	NO	5.56		139.06	0.64%
C. Grassland	-7.89	0.82	0.90		-6.17	-0.03%
D. Wetlands	58.51	NO	9.17		67.68	0.31%
E. Settlements	194.55	NO	28.16		222.71	1.02%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-45.49				-45.49	-0.21%
5. Waste	0.54	981.26	66.72		1048.51	4.80%
A. Solid waste disposal	NA,NO	399.87			399.87	1.83%
B. Biological treatment of solid waste		0.46	0.33		0.79	%
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		580.93	66.38		647.31	2.97%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	403.81	0.37	3.29		407.47	
Aviation	264.02	0.05	2.20		266.27	
Navigation	139.78	0.32	1.09		141.20	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	4999.29				4999.29	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	228.77				228.77	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					21826.47	
Total CO₂ equivalent emissions with land use, land-use change and forestry					12819.31	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1995	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	7225.26	3369.94	2319.02	33.93	12948.15	
1. Energy	15121.53	670.44	180.42		15972.40	71.03%
A. Fuel combustion (sectoral approach)	14285.75	380.65	180.02		14846.42	66.03%
1. Energy industries	5261.60	4.06	12.37		5278.03	23.47%
2. Manufacturing industries and construction	2874.38	4.69	8.36		2887.43	12.84%
3. Transport	3292.91	31.89	45.29		3370.09	14.99%
4. Other sectors	2856.86	340.01	114.00		3310.87	14.72%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	835.78	289.79	0.40		1125.98	5.01%
1. Solid fuels	NO	28.23	NO,NA		28.23	0.13%
2. Oil and natural gas	835.78	261.57	0.40		1097.75	4.88%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1649.30	5.85	714.59	33.93	2403.66	10.69%
A. Mineral industry	741.72				741.72	3.30%
B. Chemical industry	756.00	5.07	677.87		1438.94	6.40%
C. Metal industry	40.32	0.78	NO		41.10	0.18%
D. Non-energy products from fuels and solvent use	111.27	NA	NA		111.27	0.49%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				21.85	21.85	0.10%
G. Other product manufacture and use	NO	NO	36.71	12.08	48.79	0.22%
3. Agriculture	46.29	1691.46	1304.60		3042.35	13.53%
A. Enteric fermentation		1330.03			1330.03	5.91%
B. Manure management		361.43	215.90		577.33	2.57%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1088.70		1088.70	4.84%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	46.29				46.29	0.21%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-9592.40	7.54	47.00		-9537.85	-42.42%
A. Forest land	-9904.36	7.03	4.63		-9892.69	-43.99%
B. Cropland	135.43	NO	5.96		141.40	0.63%
C. Grassland	-11.98	0.52	0.56		-10.90	-0.05%
D. Wetlands	55.47	NO	8.68		64.15	0.29%
E. Settlements	188.12	NO	27.16		215.29	0.96%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-55.09				-55.09	-0.25%
5. Waste	0.54	994.64	72.41		1067.59	4.75%
A. Solid waste disposal	NA,NO	419.50			419.50	1.87%
B. Biological treatment of solid waste		0.49	0.35		0.84	%
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		574.65	72.05		646.70	2.88%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	348.25	0.28	2.85		351.38	
Aviation	245.16	0.04	2.04		247.25	
Navigation	103.08	0.24	0.81		104.13	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5288.54				5288.54	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	237.66				237.66	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					22486.00	
Total CO₂ equivalent emissions with land use, land-use change and forestry					12948.15	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1996	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	8126.04	3340.42	2323.18	37.69	13827.32	
1. Energy	15640.05	702.69	230.78		16573.52	72.13%
A. Fuel combustion (sectoral approach)	14829.75	423.63	230.39		15483.77	67.39%
1. Energy industries	5085.53	4.08	12.94		5102.55	22.21%
2. Manufacturing industries and construction	2866.98	4.60	8.19		2879.77	12.53%
3. Transport	3620.22	34.50	73.49		3728.21	16.23%
4. Other sectors	3257.02	380.45	135.78		3773.25	16.42%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	810.30	279.06	0.39		1089.75	4.74%
1. Solid fuels	NO	22.77	NO,NA		22.77	0.10%
2. Oil and natural gas	810.30	256.30	0.39		1066.99	4.64%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1651.84	5.18	668.45	37.69	2363.16	10.28%
A. Mineral industry	827.96				827.96	3.60%
B. Chemical industry	701.63	4.86	631.73		1338.22	5.82%
C. Metal industry	19.17	0.32	NO		19.49	0.08%
D. Non-energy products from fuels and solvent use	103.08	NA	NA		103.08	0.45%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				25.18	25.18	0.11%
G. Other product manufacture and use	NO	NO	36.71	12.51	49.22	0.21%
3. Agriculture	52.44	1608.30	1302.60		2963.35	12.90%
A. Enteric fermentation		1245.87			1245.87	5.42%
B. Manure management		362.44	203.95		566.39	2.46%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1098.65		1098.65	4.78%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	52.44				52.44	0.23%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-9218.83	16.53	52.22		-9150.08	-39.82%
A. Forest land	-9562.29	15.14	9.99		-9537.16	-41.51%
B. Cropland	137.37	NO	6.36		143.73	0.63%
C. Grassland	-15.71	1.39	1.51		-12.81	-0.06%
D. Wetlands	52.43	NO	8.20		60.62	0.26%
E. Settlements	181.64	NO	26.17		207.80	0.90%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-12.27				-12.27	-0.05%
5. Waste	0.54	1007.71	69.13		1077.38	4.69%
A. Solid waste disposal	NA,NO	442.77			442.77	1.93%
B. Biological treatment of solid waste		0.52	0.37		0.88	%
C. Incineration and open burning of waste	0.54	NO,NE,N	0.01		0.54	%
D. Waste water treatment and discharge		564.43	68.75		633.18	2.76%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	339.28	0.31	2.77		342.36	
Aviation	223.16	0.04	1.86		225.06	
Navigation	116.12	0.27	0.91		117.30	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5877.64				5877.64	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	246.64				246.64	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					22977.40	
Total CO₂ equivalent emissions with land use, land-use change and forestry					13827.32	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1997	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	10107.24	3316.06	2517.45	41.84	15982.58	
1. Energy	16674.29	669.93	228.66		17572.87	72.12%
A. Fuel combustion (sectoral approach)	15911.94	396.69	228.26		16536.89	67.87%
1. Energy industries	5557.16	4.46	15.10		5576.72	22.89%
2. Manufacturing industries and construction	3080.25	5.20	9.17		3094.62	12.70%
3. Transport	3966.11	36.61	85.39		4088.11	16.78%
4. Other sectors	3308.41	350.42	118.60		3777.43	15.50%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	762.35	273.24	0.39		1035.98	4.25%
1. Solid fuels	NO	16.65	NO,NA		16.65	0.07%
2. Oil and natural gas	762.35	256.58	0.39		1019.33	4.18%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1814.12	5.51	701.78	41.84	2563.24	10.52%
A. Mineral industry	950.81				950.81	3.90%
B. Chemical industry	743.07	4.77	665.06		1412.90	5.80%
C. Metal industry	40.82	0.74	NO		41.56	0.17%
D. Non-energy products from fuels and solvent use	79.41	NA	NA		79.41	0.33%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				29.69	29.69	0.12%
G. Other product manufacture and use	NO	NO	36.71	12.15	48.86	0.20%
3. Agriculture	68.39	1587.46	1465.46		3121.31	12.81%
A. Enteric fermentation		1219.73			1219.73	5.01%
B. Manure management		367.74	199.91		567.65	2.33%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1265.55		1265.55	5.19%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	68.39				68.39	0.28%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8451.38	17.63	51.83		-8381.92	-34.40%
A. Forest land	-8913.20	16.28	10.73		-8886.19	-36.47%
B. Cropland	139.30	NO	6.76		146.06	0.60%
C. Grassland	-20.57	1.35	1.47		-17.74	-0.07%
D. Wetlands	49.39	NO	7.71		57.10	0.23%
E. Settlements	173.73	NO	25.16		198.89	0.82%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	119.97				119.97	0.49%
5. Waste	1.82	1035.54	69.72		1107.08	4.54%
A. Solid waste disposal	NA,NO	468.13			468.13	1.92%
B. Biological treatment of solid waste		0.54	0.39		0.93	%
C. Incineration and open burning of waste	1.82	NO,NE,N	0.03		1.86	0.01%
D. Waste water treatment and discharge		566.86	69.30		636.17	2.61%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	310.14	0.21	2.55		312.90	
Aviation	235.74	0.04	1.97		237.74	
Navigation	74.41	0.17	0.58		75.16	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5526.07				5526.07	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	255.77				255.77	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24364.50	
Total CO₂ equivalent emissions with land use, land-use change and forestry					15982.58	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1998	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	10799.96	3319.98	2184.32	48.90	16353.15	
1. Energy	17247.97	657.91	211.66		18117.53	74.10%
A. Fuel combustion (sectoral approach)	16570.51	400.36	211.29		17182.17	70.27%
1. Energy industries	6238.88	5.20	16.84		6260.92	25.61%
2. Manufacturing industries and construction	3065.07	5.00	8.93		3078.99	12.59%
3. Transport	4098.78	37.46	60.42		4196.66	17.16%
4. Other sectors	3167.79	352.70	125.11		3645.59	14.91%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	677.45	257.54	0.37		935.36	3.83%
1. Solid fuels	NO	17.44	NO,NA		17.44	0.07%
2. Oil and natural gas	677.45	240.10	0.37		917.92	3.75%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1717.51	4.89	537.40	48.90	2308.69	9.44%
A. Mineral industry	1016.67				1016.67	4.16%
B. Chemical industry	592.72	4.51	500.68		1097.92	4.49%
C. Metal industry	29.65	0.38	NO		30.03	0.12%
D. Non-energy products from fuels and solvent use	78.46	NA	NA		78.46	0.32%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				35.89	35.89	0.15%
G. Other product manufacture and use	NO	NO	36.71	13.00	49.72	0.20%
3. Agriculture	44.25	1557.76	1296.86		2898.87	11.86%
A. Enteric fermentation		1185.49			1185.49	4.85%
B. Manure management		372.27	193.35		565.63	2.31%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1103.51		1103.51	4.51%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	44.25				44.25	0.18%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8213.47	45.11	70.55		-8097.80	-33.12%
A. Forest land	-8549.77	39.83	26.26		-8483.69	-34.70%
B. Cropland	141.23	NO	7.16		148.40	0.61%
C. Grassland	-24.06	5.29	5.75		-13.02	-0.05%
D. Wetlands	46.34	NO	7.22		53.57	0.22%
E. Settlements	169.12	NO	24.15		193.26	0.79%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	3.68				3.68	0.02%
5. Waste	3.70	1054.31	67.85		1125.87	4.60%
A. Solid waste disposal	NA,NO	496.59			496.59	2.03%
B. Biological treatment of solid waste		0.57	0.41		0.98	%
C. Incineration and open burning of waste	3.70	NO,NE,N	0.06		3.76	0.02%
D. Waste water treatment and discharge		557.15	67.38		624.53	2.55%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	336.44	0.23	2.77		339.44	
Aviation	254.59	0.04	2.12		256.76	
Navigation	81.85	0.19	0.64		82.68	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5535.75				5535.75	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	265.00				265.00	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24450.96	
Total CO₂ equivalent emissions with land use, land-use change and forestry					16353.15	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

1999	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	11167.44	3334.89	2387.35	56.57	16946.25	
1. Energy	17896.52	634.39	270.02		18800.93	73.00%
A. Fuel combustion (sectoral approach)	17234.65	395.08	269.68		17899.42	69.50%
1. Energy industries	6459.12	5.47	17.41		6482.00	25.17%
2. Manufacturing industries and construction	2867.36	4.18	7.52		2879.06	11.18%
3. Transport	4329.18	38.11	109.53		4476.81	17.38%
4. Other sectors	3578.99	347.33	135.23		4061.55	15.77%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	661.86	239.31	0.34		901.52	3.50%
1. Solid fuels	NO	5.25	NO,NA		5.25	0.02%
2. Oil and natural gas	661.86	234.06	0.34		896.26	3.48%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2073.36	4.95	626.93	56.57	2761.80	10.72%
A. Mineral industry	1270.90				1270.90	4.93%
B. Chemical industry	701.41	4.52	590.21		1296.14	5.03%
C. Metal industry	27.67	0.42	NO		28.10	0.11%
D. Non-energy products from fuels and solvent use	73.38	NA	NA		73.38	0.28%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				43.62	43.62	0.17%
G. Other product manufacture and use	NO	NO	36.71	12.95	49.66	0.19%
3. Agriculture	50.49	1600.60	1375.30		3026.38	11.75%
A. Enteric fermentation		1190.78			1190.78	4.62%
B. Manure management		409.81	200.90		610.71	2.37%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1174.40		1174.40	4.56%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	50.49				50.49	0.20%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8857.31	5.91	42.06		-8809.34	-34.20%
A. Forest land	-9120.82	4.26	2.81		-9113.76	-35.39%
B. Cropland	143.17	NO	7.57		150.73	0.59%
C. Grassland	-27.56	1.65	1.80		-24.11	-0.09%
D. Wetlands	43.30	NO	6.74		50.04	0.19%
E. Settlements	162.87	NO	23.14		186.01	0.72%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-58.26				-58.26	-0.23%
5. Waste	4.38	1089.04	73.05		1166.47	4.53%
A. Solid waste disposal	NA,NO	526.11			526.11	2.04%
B. Biological treatment of solid waste		0.60	0.43		1.02	%
C. Incineration and open burning of waste	4.38	NO,NE,N	0.08		4.46	0.02%
D. Waste water treatment and discharge		562.34	72.54		634.88	2.47%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	311.54	0.20	2.57		314.30	
Aviation	245.16	0.04	2.04		247.25	
Navigation	66.37	0.15	0.53		67.05	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5328.01				5328.01	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	274.55				274.55	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					25755.59	
Total CO₂ equivalent emissions with land use, land-use change and forestry					16946.25	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2000	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	12203.01	3382.73	2569.68	65.23	18220.64	
1. Energy	17356.75	584.39	275.99		18217.13	71.50%
A. Fuel combustion (sectoral approach)	16645.33	354.10	275.67		17275.10	67.80%
1. Energy industries	5810.87	3.95	18.59		5833.41	22.90%
2. Manufacturing industries and construction	3061.67	4.47	8.11		3074.25	12.07%
3. Transport	4354.38	36.77	111.14		4502.29	17.67%
4. Other sectors	3418.41	308.91	137.84		3865.16	15.17%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	711.42	230.29	0.32		942.03	3.70%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	711.42	230.29	0.32		942.03	3.70%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2238.72	3.40	730.66	65.23	3038.00	11.92%
A. Mineral industry	1428.93				1428.93	5.61%
B. Chemical industry	704.40	2.92	693.94		1401.26	5.50%
C. Metal industry	29.68	0.48	NO		30.17	0.12%
D. Non-energy products from fuels and solvent use	75.71	NA	NA		75.71	0.30%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				52.89	52.89	0.21%
G. Other product manufacture and use	NO	NO	36.71	12.34	49.05	0.19%
3. Agriculture	60.87	1569.36	1388.07		3018.30	11.85%
A. Enteric fermentation		1168.97			1168.97	4.59%
B. Manure management		400.39	191.86		592.25	2.32%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1196.21		1196.21	4.69%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	60.87				60.87	0.24%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-7459.47	96.91	104.45		-7258.12	-28.49%
A. Forest land	-7701.45	87.11	57.44		-7556.90	-29.66%
B. Cropland	145.10	NO	7.97		153.07	0.60%
C. Grassland	-32.63	9.80	10.67		-12.16	-0.05%
D. Wetlands	40.26	NO	6.25		46.51	0.18%
E. Settlements	158.91	NO	22.12		181.04	0.71%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-69.66				-69.66	-0.27%
5. Waste	6.15	1128.67	70.51		1205.33	4.73%
A. Solid waste disposal	NA,NO	559.98			559.98	2.20%
B. Biological treatment of solid waste		0.68	0.48		1.16	%
C. Incineration and open burning of waste	6.15	NO,NE,N	0.11		6.26	0.02%
D. Waste water treatment and discharge		568.02	69.91		637.93	2.50%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	258.78	0.17	2.13		261.08	
Aviation	201.16	0.04	1.68		202.87	
Navigation	57.62	0.13	0.45		58.21	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	4771.83				4771.83	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	284.87				284.87	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					25478.76	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18220.64	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2001	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	12308.04	3376.78	2487.41	77.22	18249.44	
1. Energy	18358.84	623.39	267.33		19249.55	72.23%
A. Fuel combustion (sectoral approach)	17596.69	378.99	267.02		18242.70	68.45%
1. Energy industries	6343.85	4.46	20.96		6369.27	23.90%
2. Manufacturing industries and construction	3196.99	4.39	8.06		3209.43	12.04%
3. Transport	4420.07	31.40	100.39		4551.85	17.08%
4. Other sectors	3635.78	338.75	137.61		4112.14	15.43%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	762.15	244.40	0.31		1006.85	3.78%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	762.15	244.40	0.31		1006.85	3.78%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2327.69	3.52	618.14	77.22	3026.57	11.36%
A. Mineral industry	1647.58				1647.58	6.18%
B. Chemical industry	595.81	3.50	582.41		1181.71	4.43%
C. Metal industry	7.15	0.02	NO		7.17	0.03%
D. Non-energy products from fuels and solvent use	77.15	NA	NA		77.15	0.29%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				64.80	64.80	0.24%
G. Other product manufacture and use	NO	NO	35.73	12.42	48.15	0.18%
3. Agriculture	92.09	1591.40	1470.97		3154.46	11.84%
A. Enteric fermentation		1178.20			1178.20	4.42%
B. Manure management		413.21	192.76		605.97	2.27%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1278.21		1278.21	4.80%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	92.09				92.09	0.35%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8477.26	19.00	55.94		-8402.33	-31.53%
A. Forest land	-8637.24	16.02	10.56		-8610.66	-32.31%
B. Cropland	147.03	NO	8.37		155.40	0.58%
C. Grassland	-26.55	2.98	3.24		-20.34	-0.08%
D. Wetlands	36.42	NO	5.73		42.15	0.16%
E. Settlements	309.20	NO	28.04		337.24	1.27%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-306.12				-306.12	-1.15%
5. Waste	6.68	1139.47	75.04		1221.19	4.58%
A. Solid waste disposal	NA,NO	593.61			593.61	2.23%
B. Biological treatment of solid waste		0.54	0.39		0.93	%
C. Incineration and open burning of waste	6.68	NO,NE,N	0.12		6.80	0.03%
D. Waste water treatment and discharge		545.32	74.53		619.85	2.33%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	291.47	0.24	2.39		294.10	
Aviation	201.16	0.04	1.68		202.87	
Navigation	90.31	0.21	0.71		91.23	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5187.98				5187.98	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	295.61				295.61	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					26651.77	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18249.44	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2002	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	13226.97	3372.44	2398.92	98.91	19097.25	
1. Energy	19511.40	613.97	227.59		20352.96	73.47%
A. Fuel combustion (sectoral approach)	18735.04	364.86	227.28		19327.19	69.77%
1. Energy industries	7225.52	4.90	24.91		7255.33	26.19%
2. Manufacturing industries and construction	3057.13	4.32	7.93		3069.38	11.08%
3. Transport	4729.32	30.51	64.96		4824.79	17.42%
4. Other sectors	3723.08	325.12	129.48		4177.68	15.08%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	776.36	249.11	0.31		1025.77	3.70%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	776.36	249.11	0.31		1025.77	3.70%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2293.52	3.27	601.45	98.91	2997.16	10.82%
A. Mineral industry	1647.57				1647.57	5.95%
B. Chemical industry	550.89	3.27	566.71		1120.86	4.05%
C. Metal industry	4.72	0.01	NO		4.73	0.02%
D. Non-energy products from fuels and solvent use	90.34	NA	NA		90.34	0.33%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				86.16	86.16	0.31%
G. Other product manufacture and use	NO	NO	34.75	12.75	47.50	0.17%
3. Agriculture	80.76	1573.02	1438.32		3092.10	11.16%
A. Enteric fermentation		1149.05			1149.05	4.15%
B. Manure management		423.98	189.46		613.44	2.21%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1248.86		1248.86	4.51%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	80.76				80.76	0.29%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8662.49	6.39	52.49		-8603.60	-31.06%
A. Forest land	-8857.31	5.62	3.70		-8847.99	-31.94%
B. Cropland	148.96	NO	8.77		157.73	0.57%
C. Grassland	-37.52	0.78	0.85		-35.89	-0.13%
D. Wetlands	33.15	NO	5.21		38.36	0.14%
E. Settlements	352.56	NO	33.96		386.52	1.40%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-302.33				-302.33	-1.09%
5. Waste	3.78	1175.79	79.07		1258.64	4.54%
A. Solid waste disposal	NA,NO	632.29			632.29	2.28%
B. Biological treatment of solid waste		0.73	0.52		1.25	%
C. Incineration and open burning of waste	3.78	NO,NE,N	0.07		3.85	0.01%
D. Waste water treatment and discharge		542.77	78.48		621.26	2.24%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	262.60	0.20	2.15		264.95	
Aviation	188.59	0.03	1.57		190.19	
Navigation	74.01	0.17	0.58		74.76	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	4975.57				4975.57	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	306.73				306.73	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					27700.85	
Total CO₂ equivalent emissions with land use, land-use change and forestry					19097.25	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2003	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	15409.02	3573.64	2336.28	127.46	21446.41	
1. Energy	20816.14	664.52	242.23		21722.89	74.57%
A. Fuel combustion (sectoral approach)	20087.34	414.37	241.94		20743.65	71.21%
1. Energy industries	7871.16	5.83	25.89		7902.88	27.13%
2. Manufacturing industries and construction	3136.78	4.94	8.93		3150.65	10.82%
3. Transport	5126.76	29.57	67.37		5223.70	17.93%
4. Other sectors	3952.65	374.04	139.74		4466.43	15.33%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	728.80	250.14	0.29		979.24	3.36%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	728.80	250.14	0.29		979.24	3.36%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2326.52	3.12	569.66	127.46	3026.75	10.39%
A. Mineral industry	1654.26				1654.26	5.68%
B. Chemical industry	574.42	3.09	535.89		1113.41	3.82%
C. Metal industry	6.62	0.02	NO		6.64	0.02%
D. Non-energy products from fuels and solvent use	91.23	NA	NA		91.23	0.31%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				114.37	114.37	0.39%
G. Other product manufacture and use	NO	NO	33.76	13.09	46.86	0.16%
3. Agriculture	71.79	1652.98	1364.68		3089.45	10.61%
A. Enteric fermentation		1198.59			1198.59	4.11%
B. Manure management		454.38	194.58		648.96	2.23%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1170.10		1170.10	4.02%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	71.79				71.79	0.25%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-7806.24	39.55	81.39		-7685.30	-26.38%
A. Forest land	-8139.59	35.95	23.70		-8079.94	-27.74%
B. Cropland	150.90	NO	9.17		160.07	0.55%
C. Grassland	-49.14	3.60	3.92		-41.62	-0.14%
D. Wetlands	29.88	NO	4.69		34.57	0.12%
E. Settlements	392.54	NO	39.90		432.44	1.48%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-190.82				-190.82	-0.66%
5. Waste	0.80	1213.48	78.33		1292.61	4.44%
A. Solid waste disposal	NA,NO	675.69			675.69	2.32%
B. Biological treatment of solid waste		0.52	0.37		0.89	%
C. Incineration and open burning of waste	0.80	NO,NE,N	0.01		0.82	%
D. Waste water treatment and discharge		537.27	77.94		615.21	2.11%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	251.70	0.19	2.06		253.95	
Aviation	182.30	0.03	1.52		183.85	
Navigation	69.39	0.16	0.54		70.09	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5755.73				5755.73	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	318.20				318.20	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					29131.71	
Total CO₂ equivalent emissions with land use, land-use change and forestry					21446.41	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2004	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	14896.63	3630.15	2557.35	150.68	21234.81	
1. Energy	20272.16	651.33	277.68		21201.17	72.70%
A. Fuel combustion (sectoral approach)	19494.24	402.98	277.39		20174.62	69.18%
1. Energy industries	6784.01	4.86	23.51		6812.38	23.36%
2. Manufacturing industries and construction	3583.00	5.99	10.74		3599.72	12.34%
3. Transport	5262.21	27.73	110.58		5400.53	18.52%
4. Other sectors	3865.02	364.40	132.57		4361.99	14.96%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	777.92	248.35	0.28		1026.55	3.52%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	777.92	248.35	0.28		1026.55	3.52%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2539.44	3.74	684.25	150.68	3378.11	11.58%
A. Mineral industry	1751.18				1751.18	6.01%
B. Chemical industry	665.57	3.74	651.47		1320.78	4.53%
C. Metal industry	13.72	NA,NO	NO		13.72	0.05%
D. Non-energy products from fuels and solvent use	108.97	NA	NA		108.97	0.37%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				137.14	137.14	0.47%
G. Other product manufacture and use	NO	NO	32.78	13.54	46.32	0.16%
3. Agriculture	75.94	1710.09	1455.47		3241.50	11.12%
A. Enteric fermentation		1228.58			1228.58	4.21%
B. Manure management		481.52	200.29		681.81	2.34%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1255.18		1255.18	4.30%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	NO				NO	NO
H. Urea application	75.94				75.94	0.26%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-7991.26	2.92	61.90		-7926.45	-27.18%
A. Forest land	-8369.10	1.95	1.29		-8365.86	-28.69%
B. Cropland	154.03	NO	9.57		163.61	0.56%
C. Grassland	-59.71	0.97	1.05		-57.69	-0.20%
D. Wetlands	26.61	NO	4.16		30.77	0.11%
E. Settlements	437.21	NO	45.82		483.03	1.66%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-180.30				-180.30	-0.62%
5. Waste	0.35	1262.06	78.06		1340.47	4.60%
A. Solid waste disposal	NA,NO	717.97			717.97	2.46%
B. Biological treatment of solid waste		0.62	0.44		1.06	%
C. Incineration and open burning of waste	0.35	NO,NE,N			0.35	%
D. Waste water treatment and discharge		543.47	77.61		621.09	2.13%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	284.43	0.21	2.33		286.96	
Aviation	210.59	0.04	1.76		212.38	
Navigation	73.83	0.17	0.58		74.58	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5660.22				5660.22	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	329.99				329.99	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					29161.26	
Total CO₂ equivalent emissions with land use, land-use change and forestry					21234.81	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2005	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	15178.68	3652.99	2525.63	201.46	21558.76	
1. Energy	20656.65	670.45	237.39		21564.49	72.72%
A. Fuel combustion (sectoral approach)	19899.91	421.70	237.12		20558.73	69.33%
1. Energy industries	6810.03	4.61	22.86		6837.50	23.06%
2. Manufacturing industries and construction	3724.02	5.41	9.91		3739.34	12.61%
3. Transport	5467.69	25.45	68.63		5561.77	18.76%
4. Other sectors	3898.16	386.23	135.72		4420.11	14.91%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	756.74	248.75	0.27		1005.76	3.39%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	756.74	248.75	0.27		1005.76	3.39%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2601.65	3.77	668.54	201.46	3475.41	11.72%
A. Mineral industry	1813.79				1813.79	6.12%
B. Chemical industry	663.60	3.77	636.74		1304.11	4.40%
C. Metal industry	12.71	NA,NO	NO		12.71	0.04%
D. Non-energy products from fuels and solvent use	111.55	NA	NA		111.55	0.38%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				187.20	187.20	0.63%
G. Other product manufacture and use	NO	NO	31.80	14.26	46.06	0.16%
3. Agriculture	85.46	1720.70	1470.88		3277.04	11.05%
A. Enteric fermentation		1271.09			1271.09	4.29%
B. Manure management		449.61	189.20		638.80	2.15%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1281.68		1281.68	4.32%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	14.49				14.49	0.05%
H. Urea application	70.97				70.97	0.24%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-8165.24	2.74	67.40		-8095.11	-27.30%
A. Forest land	-8407.71	2.16	1.43		-8404.12	-28.34%
B. Cropland	155.54	NO	9.97		165.52	0.56%
C. Grassland	-60.56	0.57	0.62		-59.36	-0.20%
D. Wetlands	23.34	NO	3.64		26.98	0.09%
E. Settlements	472.87	NO	51.74		524.60	1.77%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-348.72				-348.72	-1.18%
5. Waste	0.16	1255.34	81.42		1336.93	4.51%
A. Solid waste disposal	NA,NO	713.70			713.70	2.41%
B. Biological treatment of solid waste		1.12	0.80		1.91	0.01%
C. Incineration and open burning of waste	0.16	NO,NE,N			0.16	%
D. Waste water treatment and discharge		540.53	80.63		621.15	2.09%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	337.55	0.23	2.77		340.55	
Aviation	257.74	0.05	2.15		259.93	
Navigation	79.82	0.18	0.62		80.62	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5908.79				5908.79	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	342.08				342.08	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					29653.87	
Total CO₂ equivalent emissions with land use, land-use change and forestry					21558.76	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2006	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	15637.51	3760.88	2543.72	261.31	22203.41	
1. Energy	20732.16	654.31	238.75		21625.22	72.00%
A. Fuel combustion (sectoral approach)	19966.19	388.98	238.48		20593.65	68.57%
1. Energy industries	6631.42	4.82	22.56		6658.79	22.17%
2. Manufacturing industries and construction	3855.12	5.75	10.53		3871.40	12.89%
3. Transport	5820.94	24.31	72.76		5918.01	19.70%
4. Other sectors	3658.71	354.11	132.63		4145.45	13.80%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	765.97	265.33	0.27		1031.57	3.43%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	765.97	265.33	0.27		1031.57	3.43%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2736.38	3.66	660.14	261.31	3661.49	12.19%
A. Mineral industry	1941.92				1941.92	6.47%
B. Chemical industry	657.88	3.66	629.32		1290.87	4.30%
C. Metal industry	13.31	NA,NO	NO		13.31	0.04%
D. Non-energy products from fuels and solvent use	123.26	NA	NA		123.26	0.41%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				247.18	247.18	0.82%
G. Other product manufacture and use	NO	NO	30.81	14.13	44.95	0.15%
3. Agriculture	80.67	1763.13	1485.72		3329.52	11.09%
A. Enteric fermentation		1252.01			1252.01	4.17%
B. Manure management		511.13	194.90		706.03	2.35%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1290.82		1290.82	4.30%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	17.48				17.48	0.06%
H. Urea application	63.19				63.19	0.21%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-7912.44	6.06	75.40		-7830.98	-26.07%
A. Forest land	-8192.90	5.46	3.60		-8183.83	-27.25%
B. Cropland	157.35	NO	10.38		167.73	0.56%
C. Grassland	-83.61	0.60	0.65		-82.37	-0.27%
D. Wetlands	20.07	NO	3.12		23.19	0.08%
E. Settlements	509.61	NO	57.65		567.26	1.89%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-322.96				-322.96	-1.08%
5. Waste	0.74	1333.71	83.71		1418.17	4.72%
A. Solid waste disposal	NA,NO	787.97			787.97	2.62%
B. Biological treatment of solid waste		0.86	0.62		1.48	%
C. Incineration and open burning of waste	0.74	NO,NE,N	0.01		0.75	%
D. Waste water treatment and discharge		544.88	83.08		627.96	2.09%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	325.65	0.19	2.68		328.52	
Aviation	264.02	0.05	2.20		266.27	
Navigation	61.63	0.14	0.48		62.25	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5497.41				5497.41	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	354.51				354.51	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					30034.40	
Total CO₂ equivalent emissions with land use, land-use change and forestry					22203.41	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2007	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	18031.30	3790.44	2621.10	343.82	24786.66	
1. Energy	21965.25	651.04	245.01		22861.30	72.61%
A. Fuel combustion (sectoral approach)	21237.66	375.55	244.74		21857.94	69.42%
1. Energy industries	7815.15	5.57	27.11		7847.84	24.93%
2. Manufacturing industries and construction	3853.05	5.80	10.51		3869.36	12.29%
3. Transport	6242.17	23.46	76.62		6342.25	20.14%
4. Other sectors	3327.29	340.71	130.51		3798.51	12.06%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	727.60	275.50	0.26		1003.36	3.19%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	727.60	275.50	0.26		1003.36	3.19%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2807.63	3.41	724.21	343.82	3879.07	12.32%
A. Mineral industry	1969.85				1969.85	6.26%
B. Chemical industry	696.32	3.41	694.38		1394.11	4.43%
C. Metal industry	13.69	NA,NO	NO		13.69	0.04%
D. Non-energy products from fuels and solvent use	127.77	NA	NA		127.77	0.41%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				329.67	329.67	1.05%
G. Other product manufacture and use	NO	NO	29.83	14.15	43.98	0.14%
3. Agriculture	89.32	1697.42	1465.60		3252.34	10.33%
A. Enteric fermentation		1204.31			1204.31	3.82%
B. Manure management		493.11	185.29		678.40	2.15%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1280.31		1280.31	4.07%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	16.60				16.60	0.05%
H. Urea application	72.72				72.72	0.23%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-6831.56	31.76	100.96		-6698.83	-21.28%
A. Forest land	-7371.85	29.59	19.51		-7322.74	-23.26%
B. Cropland	366.86	NO	12.89		379.74	1.21%
C. Grassland	-101.08	2.17	2.37		-96.54	-0.31%
D. Wetlands	17.68	NO	2.64		20.32	0.06%
E. Settlements	566.18	NO	63.56		629.74	2.00%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-309.35				-309.35	-0.98%
5. Waste	0.65	1406.80	85.32		1492.78	4.74%
A. Solid waste disposal	NA,NO	854.97			854.97	2.72%
B. Biological treatment of solid waste		1.65	1.18		2.83	0.01%
C. Incineration and open burning of waste	0.65	NO,NE,N	0.01		0.66	%
D. Waste water treatment and discharge		550.18	84.14		634.32	2.01%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	353.05	0.22	2.90		356.17	
Aviation	276.60	0.05	2.31		278.95	
Navigation	76.45	0.17	0.59		77.22	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5322.60				5322.60	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	367.63				367.63	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					31485.49	
Total CO₂ equivalent emissions with land use, land-use change and forestry					24786.66	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2008	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	16456.65	3744.17	2918.24	418.90	23537.96	
1. Energy	20802.16	638.31	241.05		21681.52	70.92%
A. Fuel combustion (sectoral approach)	20165.34	373.91	240.81		20780.05	67.97%
1. Energy industries	6771.62	4.79	24.21		6800.63	22.24%
2. Manufacturing industries and construction	3872.78	5.59	10.17		3888.55	12.72%
3. Transport	6079.11	21.57	71.52		6172.20	20.19%
4. Other sectors	3441.83	341.95	134.90		3918.68	12.82%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	636.82	264.40	0.25		901.47	2.95%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	636.82	264.40	0.25		901.47	2.95%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2695.57	3.23	738.63	418.90	3856.33	12.61%
A. Mineral industry	1868.94				1868.94	6.11%
B. Chemical industry	676.64	3.23	709.79		1389.66	4.55%
C. Metal industry	23.41	NA,NO	NO		23.41	0.08%
D. Non-energy products from fuels and solvent use	126.57	NA	NA		126.57	0.41%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				405.91	405.91	1.33%
G. Other product manufacture and use	NO	NO	28.85	12.99	41.84	0.14%
3. Agriculture	96.60	1610.80	1757.26		3464.66	11.33%
A. Enteric fermentation		1155.97			1155.97	3.78%
B. Manure management		454.83	172.82		627.65	2.05%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1584.44		1584.44	5.18%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	20.78				20.78	0.07%
H. Urea application	75.83				75.83	0.25%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-7138.34	9.58	93.72		-7035.05	-23.01%
A. Forest land	-7688.29	8.64	5.70		-7673.96	-25.10%
B. Cropland	387.42	NO	15.39		402.82	1.32%
C. Grassland	-131.78	0.94	1.02		-129.81	-0.42%
D. Wetlands	14.66	NO	2.16		16.82	0.06%
E. Settlements	604.97	NO	69.44		674.42	2.21%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-325.34				-325.34	-1.06%
5. Waste	0.67	1482.25	87.58		1570.50	5.14%
A. Solid waste disposal	NA,NO	935.44			935.44	3.06%
B. Biological treatment of solid waste		3.31	2.36		5.67	0.02%
C. Incineration and open burning of waste	0.67	NO,NE,N	0.01		0.68	%
D. Waste water treatment and discharge		543.51	85.21		628.71	2.06%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	384.96	0.21	3.17		388.33	
Aviation	317.46	0.06	2.65		320.16	
Navigation	67.50	0.15	0.52		68.17	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5298.65				5298.65	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	381.18				381.18	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					30573.01	
Total CO₂ equivalent emissions with land use, land-use change and forestry					23537.96	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2009	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	14737.24	3814.45	2285.27	503.61	21340.56	
1. Energy	19642.09	642.91	234.82		20519.83	72.50%
A. Fuel combustion (sectoral approach)	19068.23	386.44	234.59		19689.26	69.56%
1. Energy industries	6365.42	4.77	21.01		6391.20	22.58%
2. Manufacturing industries and construction	3157.36	5.28	9.34		3171.98	11.21%
3. Transport	6091.06	20.39	70.57		6182.01	21.84%
4. Other sectors	3454.39	356.00	133.68		3944.07	13.93%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	573.86	256.47	0.23		830.57	2.93%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	573.86	256.47	0.23		830.57	2.93%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2085.24	2.91	620.32	503.61	3212.08	11.35%
A. Mineral industry	1454.55				1454.55	5.14%
B. Chemical industry	529.27	2.91	593.20		1125.38	3.98%
C. Metal industry	4.84	NA,NO	NO		4.84	0.02%
D. Non-energy products from fuels and solvent use	96.57	NA	NA		96.57	0.34%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				494.27	494.27	1.75%
G. Other product manufacture and use	NO	NO	27.12	9.34	36.46	0.13%
3. Agriculture	76.96	1633.18	1241.86		2952.00	10.43%
A. Enteric fermentation		1146.02			1146.02	4.05%
B. Manure management		487.16	174.81		661.97	2.34%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1067.06		1067.06	3.77%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	11.92				11.92	0.04%
H. Urea application	65.04				65.04	0.23%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-7067.22	5.10	98.38		-6963.74	-24.60%
A. Forest land	-7886.98	4.87	3.21		-7878.89	-27.84%
B. Cropland	422.21	NO	17.90		440.12	1.55%
C. Grassland	-129.26	0.22	0.24		-128.80	-0.46%
D. Wetlands	11.65	NO	1.68		13.32	0.05%
E. Settlements	694.13	NO	75.35		769.48	2.72%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-178.97				-178.97	-0.63%
5. Waste	0.16	1530.35	89.88		1620.39	5.72%
A. Solid waste disposal	NA,NO	1016.16			1016.16	3.59%
B. Biological treatment of solid waste		4.55	3.21		7.77	0.03%
C. Incineration and open burning of waste	0.16	NO,NE,N	NO,NE,I		0.16	%
D. Waste water treatment and discharge		509.64	86.67		596.30	2.11%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	292.16	0.10	2.42		294.68	
Aviation	270.31	0.05	2.25		272.61	
Navigation	21.85	0.05	0.17		22.07	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5576.02				5576.02	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	395.03				395.03	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					28304.30	
Total CO₂ equivalent emissions with land use, land-use change and forestry					21340.56	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2010	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	14049.02	3872.52	2534.20	604.98	21060.72	
1. Energy	18806.64	668.04	233.65		19708.33	70.58%
A. Fuel combustion (sectoral approach)	18265.12	410.87	233.43		18909.42	67.72%
1. Energy industries	5877.34	4.34	21.72		5903.40	21.14%
2. Manufacturing industries and construction	3015.80	5.21	9.09		3030.11	10.85%
3. Transport	5865.78	18.33	67.41		5951.51	21.31%
4. Other sectors	3506.21	382.98	135.21		4024.40	14.41%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	541.52	257.16	0.22		798.91	2.86%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	541.52	257.16	0.22		798.91	2.86%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2121.55	2.72	791.89	604.98	3521.14	12.61%
A. Mineral industry	1401.83				1401.83	5.02%
B. Chemical industry	615.36	2.72	765.00		1383.07	4.95%
C. Metal industry	14.68	NA,NO	NO		14.68	0.05%
D. Non-energy products from fuels and solvent use	89.69	NA	NA		89.69	0.32%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				595.15	595.15	2.13%
G. Other product manufacture and use	NO	NO	26.89	9.83	36.72	0.13%
3. Agriculture	88.04	1621.48	1319.24		3028.76	10.85%
A. Enteric fermentation		1134.14			1134.14	4.06%
B. Manure management		487.33	168.49		655.82	2.35%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1150.76		1150.76	4.12%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	21.46				21.46	0.08%
H. Urea application	66.58				66.58	0.24%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-6967.26	1.76	104.06		-6861.44	-24.57%
A. Forest land	-7702.24	1.64	1.08		-7699.51	-27.57%
B. Cropland	437.24	NO	20.41		457.65	1.64%
C. Grassland	-149.40	0.12	0.13		-149.15	-0.53%
D. Wetlands	8.63	NO	1.19		9.82	0.04%
E. Settlements	687.66	NO	81.24		768.91	2.75%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-249.16				-249.16	-0.89%
5. Waste	0.05	1578.52	85.35		1663.93	5.96%
A. Solid waste disposal	NA,NO	1040.40			1040.40	3.73%
B. Biological treatment of solid waste		3.72	2.54		6.27	0.02%
C. Incineration and open burning of waste	0.05	NO,NE,N	NO,NE,I		0.05	%
D. Waste water treatment and discharge		534.40	82.81		617.21	2.21%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	315.09	0.10	2.61		317.80	
Aviation	295.46	0.05	2.46		297.97	
Navigation	19.64	0.04	0.15		19.83	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5940.55				5940.55	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	406.14				406.14	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					27922.16	
Total CO₂ equivalent emissions with land use, land-use change and forestry					21060.72	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2011	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	14822.91	3842.41	2616.09	674.10	21955.51	
1. Energy	18595.12	636.56	221.36		19453.04	70.39%
A. Fuel combustion (sectoral approach)	18036.24	399.44	221.16		18656.83	67.50%
1. Energy industries	6247.86	5.02	23.00		6275.88	22.71%
2. Manufacturing industries and construction	2779.55	4.57	8.00		2792.12	10.10%
3. Transport	5726.93	16.80	56.59		5800.32	20.99%
4. Other sectors	3281.90	373.05	133.57		3788.51	13.71%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	558.89	237.12	0.20		796.21	2.88%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	558.89	237.12	0.20		796.21	2.88%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1949.26	1.75	780.39	674.10	3405.50	12.32%
A. Mineral industry	1255.01				1255.01	4.54%
B. Chemical industry	593.19	1.75	753.93		1348.87	4.88%
C. Metal industry	16.64	NA,NO	NO		16.64	0.06%
D. Non-energy products from fuels and solvent use	84.43	NA	NA		84.43	0.31%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				663.84	663.84	2.40%
G. Other product manufacture and use	NO	NO	26.46	10.26	36.72	0.13%
3. Agriculture	105.18	1574.97	1402.06		3082.21	11.15%
A. Enteric fermentation		1106.27			1106.27	4.00%
B. Manure management		468.70	159.97		628.67	2.27%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1242.10		1242.10	4.49%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	21.32				21.32	0.08%
H. Urea application	83.86				83.86	0.30%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5826.71	18.63	125.63		-5682.44	-20.56%
A. Forest land	-6599.08	15.20	10.02		-6573.86	-23.79%
B. Cropland	462.50	NO	22.52		485.02	1.75%
C. Grassland	-160.97	3.43	3.74		-153.80	-0.56%
D. Wetlands	8.66	NO	1.20		9.85	0.04%
E. Settlements	730.95	NO	88.16		819.11	2.96%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-268.76				-268.76	-0.97%
5. Waste	0.05	1610.51	86.65		1697.20	6.14%
A. Solid waste disposal	NA,NO	1074.29			1074.29	3.89%
B. Biological treatment of solid waste		4.36	2.95		7.31	0.03%
C. Incineration and open burning of waste	0.05	NO,NE,N	NO,NE,I		0.05	%
D. Waste water treatment and discharge		531.86	83.70		615.56	2.23%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	387.14	0.23	3.18		390.55	
Aviation	311.17	0.05	2.59		313.82	
Navigation	75.97	0.17	0.59		76.73	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5834.09				5834.09	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	418.97				418.97	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					27637.95	
Total CO₂ equivalent emissions with land use, land-use change and forestry					21955.51	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2012	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	13636.95	3816.35	2408.71	752.39	20614.40	
1. Energy	17224.34	600.46	210.39		18035.18	69.69%
A. Fuel combustion (sectoral approach)	16751.09	394.70	210.21		17356.00	67.07%
1. Energy industries	5849.20	4.88	21.78		5875.87	22.71%
2. Manufacturing industries and construction	2409.07	4.69	8.12		2421.88	9.36%
3. Transport	5551.16	13.58	52.28		5617.01	21.71%
4. Other sectors	2941.67	371.55	128.03		3441.25	13.30%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	473.24	205.76	0.18		679.18	2.62%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	473.24	205.76	0.18		679.18	2.62%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1761.75	NO,NE,IE,	676.54	752.39	3190.68	12.33%
A. Mineral industry	1179.39				1179.39	4.56%
B. Chemical industry	502.01	NO,NE,IE	652.37		1154.37	4.46%
C. Metal industry	1.43	NA,NO	NO		1.43	0.01%
D. Non-energy products from fuels and solvent use	78.92	NA	NA		78.92	0.30%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				741.43	741.43	2.87%
G. Other product manufacture and use	NO	NO	24.17	10.96	35.13	0.14%
3. Agriculture	101.23	1571.95	1285.92		2959.11	11.43%
A. Enteric fermentation		1113.63			1113.63	4.30%
B. Manure management		458.32	157.85		616.17	2.38%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1128.08		1128.08	4.36%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	14.38				14.38	0.06%
H. Urea application	86.85				86.85	0.34%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5450.45	38.88	147.73		-5263.84	-20.34%
A. Forest land	-6198.38	36.09	23.80		-6138.50	-23.72%
B. Cropland	481.36	NO	24.63		505.99	1.96%
C. Grassland	-190.72	2.79	3.04		-184.89	-0.71%
D. Wetlands	8.68	NO	1.20		9.88	0.04%
E. Settlements	768.44	NO	95.06		863.50	3.34%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-319.83				-319.83	-1.24%
5. Waste	0.08	1605.06	88.13		1693.27	6.54%
A. Solid waste disposal	NA,NO	1103.67			1103.67	4.26%
B. Biological treatment of solid waste		4.43	2.83		7.26	0.03%
C. Incineration and open burning of waste	0.08	NO,NE,N	NO,NE,I		0.08	%
D. Waste water treatment and discharge		496.96	85.30		582.26	2.25%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	342.53	0.09	2.85		345.46	
Aviation	330.03	0.06	2.75		332.84	
Navigation	12.50	0.03	0.10		12.62	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	6011.36				6011.36	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	434.33				434.33	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					25878.24	
Total CO₂ equivalent emissions with land use, land-use change and forestry					20614.40	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2013	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	11996.85	3680.52	1798.92	821.75	18298.04	
1. Energy	16492.03	587.01	207.67		17286.72	70.25%
A. Fuel combustion (sectoral approach)	16039.24	391.29	207.49		16638.03	67.61%
1. Energy industries	5238.07	4.16	20.92		5263.15	21.39%
2. Manufacturing industries and construction	2384.92	4.50	7.87		2397.29	9.74%
3. Transport	5636.55	13.40	52.82		5702.77	23.17%
4. Other sectors	2779.70	369.23	125.88		3274.81	13.31%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	452.80	195.72	0.18		648.69	2.64%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	452.80	195.72	0.18		648.69	2.64%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1865.50	NO,NE,IE,	262.46	821.75	2949.71	11.99%
A. Mineral industry	1271.22				1271.22	5.17%
B. Chemical industry	509.33	NO,NE,IE	240.27		749.60	3.05%
C. Metal industry	13.93	NA,NO	NO		13.93	0.06%
D. Non-energy products from fuels and solvent use	71.02	NA	NA		71.02	0.29%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				814.57	814.57	3.31%
G. Other product manufacture and use	NO	NO	22.19	7.18	29.37	0.12%
3. Agriculture	74.61	1501.44	1117.37		2693.42	10.94%
A. Enteric fermentation		1067.35			1067.35	4.34%
B. Manure management		434.08	149.83		583.91	2.37%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	967.54		967.54	3.93%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	14.23				14.23	0.06%
H. Urea application	60.39				60.39	0.25%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-6435.34	1.93	122.37		-6311.04	-25.65%
A. Forest land	-6752.14	1.46	0.96		-6749.72	-27.43%
B. Cropland	294.00	NO	24.08		318.08	1.29%
C. Grassland	-219.28	0.47	0.51		-218.29	-0.89%
D. Wetlands	9.62	NO	1.25		10.87	0.04%
E. Settlements	658.64	NO	95.57		754.20	3.06%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-426.18				-426.18	-1.73%
5. Waste	0.04	1590.14	89.05		1679.24	6.82%
A. Solid waste disposal	NA,NO	1098.44			1098.44	4.46%
B. Biological treatment of solid waste		5.13	3.15		8.28	0.03%
C. Incineration and open burning of waste	0.04	NO,NE,N	NO,NE,I		0.04	%
D. Waste water treatment and discharge		486.57	85.90		572.47	2.33%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	379.01	0.09	3.11		382.22	
Aviation	366.52	0.06	3.01		369.59	
Navigation	12.50	0.03	0.10		12.62	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5975.40				5975.40	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	450.11				450.11	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24609.08	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18298.04	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2014	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	11423.23	3642.59	1757.87	913.14	17736.83	
1. Energy	15620.71	527.66	195.58		16343.96	68.46%
A. Fuel combustion (sectoral approach)	15179.55	344.92	195.41		15719.87	65.85%
1. Energy industries	4743.91	3.23	17.95		4765.09	19.96%
2. Manufacturing industries and construction	2324.33	3.84	6.79		2334.97	9.78%
3. Transport	5580.73	12.52	51.91		5645.16	23.65%
4. Other sectors	2530.59	325.33	118.76		2974.67	12.46%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	441.16	182.74	0.17		624.08	2.61%
1. Solid fuels	NO	NO	NA,NO		NO,NA	NO,NA
2. Oil and natural gas	441.16	182.74	0.17		624.08	2.61%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1991.34	NO,NE,IE,	286.11	913.14	3190.60	13.36%
A. Mineral industry	1354.11				1354.11	5.67%
B. Chemical industry	559.83	NO,NE,IE	266.19		826.03	3.46%
C. Metal industry	10.11	NA,NO	NO		10.11	0.04%
D. Non-energy products from fuels and solvent use	67.29	NA	NA		67.29	0.28%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				905.47	905.47	3.79%
G. Other product manufacture and use	NO	NO	19.92	7.67	27.59	0.12%
3. Agriculture	69.47	1482.63	1065.81		2617.91	10.97%
A. Enteric fermentation		1049.14			1049.14	4.39%
B. Manure management		433.49	150.70		584.18	2.45%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	915.11		915.11	3.83%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	19.99				19.99	0.08%
H. Urea application	49.47				49.47	0.21%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-6258.34	0.32	121.14		-6136.87	-25.71%
A. Forest land	-6438.76	0.22	0.14		-6438.40	-26.97%
B. Cropland	286.85	0.08	23.59		310.51	1.30%
C. Grassland	-233.89	0.03	0.03		-233.84	-0.98%
D. Wetlands	9.91	NO	1.29		11.20	0.05%
E. Settlements	656.17	NO	96.09		752.26	3.15%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-538.61				-538.61	-2.26%
5. Waste	0.04	1631.98	89.22		1721.24	7.21%
A. Solid waste disposal	NA,NO	1140.94			1140.94	4.78%
B. Biological treatment of solid waste		5.40	3.23		8.63	0.04%
C. Incineration and open burning of waste	0.04	NO,NE,N	NO,NE,I		0.04	%
D. Waste water treatment and discharge		485.64	86.00		571.63	2.39%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	383.77	0.10	3.15		387.01	
Aviation	368.10	0.06	3.03		371.19	
Navigation	15.66	0.04	0.12		15.82	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5245.05				5245.05	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	464.39				464.39	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					23873.71	
Total CO₂ equivalent emissions with land use, land-use change and forestry					17736.83	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2015	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	12121.84	3751.04	1906.52	1012.9	18792.37	
1. Energy	15798.65	586.10	206.44		16591.19	68.14%
A. Fuel combustion (sectoral approach)	15549.11	392.57	206.25		16147.93	66.31%
1. Energy industries	4718.82	4.13	19.62		4742.57	19.48%
2. Manufacturing industries and construction	2222.70	3.33	5.98		2232.02	9.17%
3. Transport	5887.78	12.07	53.93		5953.78	24.45%
4. Other sectors	2719.81	373.03	126.72		3219.56	13.22%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	249.53	193.53	0.19		443.26	1.82%
1. Solid fuels	NO	NO	NA,NO		NO,NA	NO,NA
2. Oil and natural gas	249.53	193.53	0.19		443.26	1.82%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1956.67	NO,NE,IE,	331.47	1012.9	3301.12	13.56%
A. Mineral industry	1306.35				1306.35	5.36%
B. Chemical industry	572.27	NO,NE,IE	311.35		883.62	3.63%
C. Metal industry	9.30	NA,NO	NO		9.30	0.04%
D. Non-energy products from fuels and solvent use	68.74	NA	NA		68.74	0.28%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				1007.4	1007.40	4.14%
G. Other product manufacture and use	NO	NO	20.13	5.58	25.70	0.11%
3. Agriculture	69.34	1473.78	1146.73		2689.85	11.05%
A. Enteric fermentation		1039.13			1039.13	4.27%
B. Manure management		434.65	149.66		584.31	2.40%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	997.08		997.08	4.09%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	12.09				12.09	0.05%
H. Urea application	57.25				57.25	0.24%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5702.87	13.96	130.81		-5558.09	-22.83%
A. Forest land	-5686.43	9.82	6.48		-5670.14	-23.29%
B. Cropland	335.60	2.58	24.69		362.87	1.49%
C. Grassland	-269.89	1.57	1.70		-266.62	-1.09%
D. Wetlands	10.19	NO	1.34		11.53	0.05%
E. Settlements	671.80	NO	96.60		768.41	3.16%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-764.15				-764.15	-3.14%
5. Waste	0.05	1677.19	91.06		1768.30	7.26%
A. Solid waste disposal	NA,NO	1186.57			1186.57	4.87%
B. Biological treatment of solid waste		5.25	2.73		7.98	0.03%
C. Incineration and open burning of waste	0.05	NO,NE,N	NO,NE,I		0.05	%
D. Waste water treatment and discharge		485.38	88.33		573.70	2.36%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	365.05	0.09	3.00		368.13	
Aviation	354.08	0.06	2.91		357.05	
Navigation	10.97	0.03	0.09		11.08	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	6006.75				6006.75	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	481.32				481.32	
Indirect N₂O			NA,NO			
Indirect CO₂⁽³⁾	NA,NO					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24350.46	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18792.37	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2016	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	12181.30	3810.82	1671.23	1157.0	18820.43	
1. Energy	16208.64	577.77	212.17		16998.58	69.07%
A. Fuel combustion (sectoral approach)	15971.92	382.78	211.97		16566.66	67.31%
1. Energy industries	4846.79	5.45	23.03		4875.27	19.81%
2. Manufacturing industries and construction	2228.67	2.89	5.25		2236.81	9.09%
3. Transport	6106.38	12.02	59.29		6177.69	25.10%
4. Other sectors	2790.08	362.42	124.40		3276.89	13.31%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	236.72	194.99	0.21		431.92	1.75%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	236.72	194.99	0.21		431.92	1.75%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1824.16	NO,NE,IE,	128.81	1157.0	3110.05	12.64%
A. Mineral industry	1201.30				1201.30	4.88%
B. Chemical industry	547.86	NO,NE,IE	109.36		657.22	2.67%
C. Metal industry	1.05	NO,NA	NO		1.05	%
D. Non-energy products from fuels and solvent use	73.94	NA	NA		73.94	0.30%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				1150.4	1150.49	4.67%
G. Other product manufacture and use	NO	NO	19.45	6.60	26.05	0.11%
3. Agriculture	76.17	1516.75	1109.52		2702.44	10.98%
A. Enteric fermentation		1091.03			1091.03	4.43%
B. Manure management		425.72	156.72		582.44	2.37%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	952.80		952.80	3.87%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	11.20				11.20	0.05%
H. Urea application	64.96				64.96	0.26%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5927.72	8.92	127.44		-5791.36	-23.53%
A. Forest land	-5792.16	7.42	4.89		-5779.85	-23.48%
B. Cropland	282.50	0.05	22.48		305.03	1.24%
C. Grassland	-308.16	1.44	1.57		-305.15	-1.24%
D. Wetlands	10.48	NO	1.39		11.87	0.05%
E. Settlements	659.70	NO	97.12		756.82	3.08%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-780.07				-780.07	-3.17%
5. Waste	0.05	1707.39	93.28		1800.71	7.32%
A. Solid waste disposal	NO,NA	1211.21			1211.21	4.92%
B. Biological treatment of solid waste		7.59	3.56		11.15	0.05%
C. Incineration and open burning of waste	0.05	NO,NE,N	NO,NE,I		0.05	%
D. Waste water treatment and discharge		488.58	89.72		578.30	2.35%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	388.96	0.10	3.19		392.25	
Aviation	375.75	0.06	3.09		378.91	
Navigation	13.21	0.03	0.10		13.35	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5970.35				5970.35	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	495.68				495.68	
Indirect N₂O			NO,NA			
Indirect CO₂⁽³⁾	NO,NA					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24611.79	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18820.43	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2017	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	13284.23	3832.20	1833.80	1311.1	20261.34	
1. Energy	16597.78	567.87	214.61		17380.27	68.21%
A. Fuel combustion (sectoral approach)	16286.19	374.42	214.41		16875.01	66.22%
1. Energy industries	4464.77	6.91	21.55		4493.22	17.63%
2. Manufacturing industries and construction	2429.58	3.52	6.29		2439.39	9.57%
3. Transport	6570.29	11.67	63.80		6645.76	26.08%
4. Other sectors	2821.56	352.31	122.76		3296.63	12.94%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	311.59	193.45	0.21		505.25	1.98%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	311.59	193.45	0.21		505.25	1.98%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2065.09	NO,NE,IE,	118.35	1311.1	3494.54	13.71%
A. Mineral industry	1425.61				1425.61	5.59%
B. Chemical industry	566.79	NO,NE,IE	98.60		665.39	2.61%
C. Metal industry	1.87	NO,NA	NO		1.87	0.01%
D. Non-energy products from fuels and solvent use	70.82	NA	NA		70.82	0.28%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				1304.0	1304.09	5.12%
G. Other product manufacture and use	NO	NO	19.75	7.02	26.77	0.11%
3. Agriculture	81.13	1469.71	1238.38		2789.22	10.95%
A. Enteric fermentation		1052.18			1052.18	4.13%
B. Manure management		417.53	155.36		572.88	2.25%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1083.02		1083.02	4.25%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	10.92				10.92	0.04%
H. Urea application	70.21				70.21	0.28%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5459.77	69.23	169.87		-5220.66	-20.49%
A. Forest land	-4831.08	61.21	40.36		-4729.50	-18.56%
B. Cropland	281.71	0.48	22.22		304.41	1.19%
C. Grassland	-294.94	7.54	8.21		-279.19	-1.10%
D. Wetlands	10.77	NO	1.43		12.20	0.05%
E. Settlements	663.20	NO	97.65		760.85	2.99%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-1289.42				-1289.42	-5.06%
5. Waste	NO,NA	1725.39	92.59		1817.97	7.13%
A. Solid waste disposal	NO,NA	1254.71			1254.71	4.92%
B. Biological treatment of solid waste		7.64	3.08		10.72	0.04%
C. Incineration and open burning of waste	NO	NO,NE,N	NO,NE,		NO,NE,N	NO,NE,NA
D. Waste water treatment and discharge		463.03	89.51		552.54	2.17%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	469.17	0.12	3.85		473.14	
Aviation	449.06	0.08	3.69		452.82	
Navigation	20.11	0.05	0.16		20.32	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	5906.57				5906.57	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	508.48				508.48	
Indirect N₂O			NO,NA			
Indirect CO₂⁽³⁾	NO,NA					
Total CO₂ equivalent emissions without land use, land-use change and forestry					25482.00	
Total CO₂ equivalent emissions with land use, land-use change and forestry					20261.34	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2018	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	11991.27	3620.62	1735.88	1445.1	18792.88	
1. Energy	15691.36	535.98	209.98		16437.31	67.36%
A. Fuel combustion (sectoral approach)	15406.72	358.43	209.79		15974.95	65.46%
1. Energy industries	3907.81	7.84	22.22		3937.87	16.14%
2. Manufacturing industries and construction	2411.05	3.74	6.63		2421.41	9.92%
3. Transport	6340.78	10.47	59.00		6410.25	26.27%
4. Other sectors	2747.08	336.38	121.94		3205.41	13.14%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	284.63	177.54	0.19		462.37	1.89%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	284.63	177.54	0.19		462.37	1.89%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1960.55	NO,NE,IE,	68.46	1445.1	3474.12	14.24%
A. Mineral industry	1358.42				1358.42	5.57%
B. Chemical industry	513.06	NO,NE,IE	50.11		563.17	2.31%
C. Metal industry	8.99	NO,NA	NO		8.99	0.04%
D. Non-energy products from fuels and solvent use	80.09	NA	NA		80.09	0.33%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				1438.8	1438.84	5.90%
G. Other product manufacture and use	NO	NO	18.35	6.27	24.62	0.10%
3. Agriculture	72.24	1381.32	1243.06		2696.62	11.05%
A. Enteric fermentation		988.79			988.79	4.05%
B. Manure management		392.53	146.12		538.64	2.21%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1096.94		1096.94	4.50%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	4.62				4.62	0.02%
H. Urea application	67.62				67.62	0.28%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5732.89	1.30	122.05		-5609.53	-22.99%
A. Forest land	-5584.52	0.84	0.56		-5583.12	-22.88%
B. Cropland	271.85	0.01	21.35		293.21	1.20%
C. Grassland	-321.61	0.45	0.49		-320.67	-1.31%
D. Wetlands	11.06	NO	1.48		12.53	0.05%
E. Settlements	666.43	NO	98.18		764.61	3.13%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-776.10				-776.10	-3.18%
5. Waste	NO,NA	1702.02	92.33		1794.35	7.35%
A. Solid waste disposal	NO,NA	1246.74			1246.74	5.11%
B. Biological treatment of solid waste		9.08	3.71		12.79	0.05%
C. Incineration and open burning of waste	NO	NO,NE,N	NO,NE,		NO,NE,N	NO,NE,NA
D. Waste water treatment and discharge		446.20	88.62		534.83	2.19%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	624.92	0.25	5.12		630.29	
Aviation	559.65	0.10	4.60		564.35	
Navigation	65.27	0.15	0.52		65.94	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	6057.52				6057.52	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	521.07				521.07	
Indirect N₂O			NO,NA			
Indirect CO₂⁽³⁾	NO,NA					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24402.41	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18792.88	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2019	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	12026.00	3583.30	1741.01	1568.8	18919.12	
1. Energy	15764.28	516.84	215.03		16496.14	66.99%
A. Fuel combustion (sectoral approach)	15477.34	350.48	214.85		16042.67	65.15%
1. Energy industries	3880.44	9.84	25.53		3915.81	15.90%
2. Manufacturing industries and construction	2421.11	4.01	7.00		2432.12	9.88%
3. Transport	6516.87	9.85	62.31		6589.02	26.76%
4. Other sectors	2658.92	326.78	120.01		3105.71	12.61%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	286.94	166.36	0.18		453.47	1.84%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	286.94	166.36	0.18		453.47	1.84%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	2017.51	NO,NE,IE,	68.30	1568.8	3654.62	14.84%
A. Mineral industry	1324.94				1324.94	5.38%
B. Chemical industry	594.60	NO,NE,IE	50.10		644.70	2.62%
C. Metal industry	4.91	NO,NA	NO		4.91	0.02%
D. Non-energy products from fuels and solvent use	93.05	NA	NA		93.05	0.38%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				1560.9	1560.96	6.34%
G. Other product manufacture and use	NO	NO	18.20	7.85	26.05	0.11%
3. Agriculture	75.66	1380.89	1240.24		2696.79	10.95%
A. Enteric fermentation		994.69			994.69	4.04%
B. Manure management		386.19	147.16		533.35	2.17%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1093.08		1093.08	4.44%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	2.07				2.07	0.01%
H. Urea application	73.59				73.59	0.30%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5831.44	2.78	123.04		-5705.63	-23.17%
A. Forest land	-5795.42	2.30	1.52		-5791.60	-23.52%
B. Cropland	268.96	0.04	20.83		289.83	1.18%
C. Grassland	-314.92	0.43	0.47		-314.01	-1.28%
D. Wetlands	11.34	NO	1.52		12.87	0.05%
E. Settlements	670.35	NO	98.70		769.04	3.12%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-671.76				-671.76	-2.73%
5. Waste	NO,NA	1682.80	94.40		1777.19	7.22%
A. Solid waste disposal	NO,NA	1222.18			1222.18	4.96%
B. Biological treatment of solid waste		11.24	4.64		15.88	0.06%
C. Incineration and open burning of waste	NO	NO,NE,N	NO,NE,		NO,NE,N	NO,NE,NA
D. Waste water treatment and discharge		449.37	89.76		539.13	2.19%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	683.77	0.29	5.60		689.66	
Aviation	605.86	0.10	4.98		610.95	
Navigation	77.91	0.18	0.62		78.72	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	6228.14				6228.14	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	536.49				536.49	
Indirect N₂O			NO,NA			
Indirect CO₂⁽³⁾	NO,NA					
Total CO₂ equivalent emissions without land use, land-use change and forestry					24624.75	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18919.12	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2020	CO ₂ ⁽¹⁾	CH ₄	N ₂ O	Total F-gas, ¹	Total	% without LULUCF
	CO ₂ equivalent (kt)					
Total (net emissions)⁽¹⁾	11133.05	3565.36	1800.57	1698.4	18197.47	
1. Energy	14788.60	509.31	218.66		15516.58	65.31%
A. Fuel combustion (sectoral approach)	14500.42	355.70	218.50		15074.62	63.45%
1. Energy industries	3659.32	10.57	25.95		3695.84	15.56%
2. Manufacturing industries and construction	2381.74	4.52	7.74		2394.01	10.08%
3. Transport	5732.11	9.24	61.08		5802.43	24.42%
4. Other sectors	2727.25	331.37	123.73		3182.35	13.39%
5. Other	NO,IE	NO,IE	NO,IE		NO,IE	NO,IE
B. Fugitive emissions from fuels	288.18	153.61	0.16		441.95	1.86%
1. Solid fuels	NO	NO	NO,NA		NO,NA	NO,NA
2. Oil and natural gas	288.18	153.61	0.16		441.95	1.86%
C. CO ₂ transport and storage	NO				NO	NO
2. Industrial processes and product use	1986.75	NO,NE,IE,	85.02	1698.4	3770.25	15.87%
A. Mineral industry	1359.34				1359.34	5.72%
B. Chemical industry	535.32	NO,NE,IE	65.08		600.40	2.53%
C. Metal industry	4.93	NO,NA	NO		4.93	0.02%
D. Non-energy products from fuels and solvent use	87.16	NA	NA		87.16	0.37%
E. Electronic Industry					NO	NO
F. Product uses as ODS substitutes				1689.7	1689.72	7.11%
G. Other product manufacture and use	NO	NO	19.94	8.76	28.70	0.12%
3. Agriculture	95.18	1341.54	1255.60		2692.31	11.33%
A. Enteric fermentation		975.46			975.46	4.11%
B. Manure management		366.08	142.00		508.09	2.14%
C. Rice cultivation		NO			NO	NO
D. Agricultural soils		NE	1113.59		1113.59	4.69%
E. Prescribed burning of savannas		NO	NO		NO	NO
F. Field burning of agricultural residues		NO	NO		NO	NO
G. Liming	6.89				6.89	0.03%
H. Urea application	88.29				88.29	0.37%
I. Other carbon-containing fertilizers	NA				NA	NA
4. Land use, land-use change and forestry⁽¹⁾	-5737.47	32.53	144.01		-5560.93	-23.41%
A. Forest land	-5803.73	29.01	19.13		-5755.60	-24.23%
B. Cropland	265.32	0.01	20.26		285.60	1.20%
C. Grassland	-311.36	3.51	3.82		-304.02	-1.28%
D. Wetlands	11.63	NO	1.57		13.20	0.06%
E. Settlements	673.34	NO	99.23		772.57	3.25%
F. Other land	NO	NO	NO		NO	NO
G. Harvested wood products	-572.68				-572.68	-2.41%
5. Waste	NO,NA	1681.98	97.28		1779.26	7.49%
A. Solid waste disposal	NO,NA	1220.17			1220.17	5.14%
B. Biological treatment of solid waste		14.86	7.01		21.87	0.09%
C. Incineration and open burning of waste	NO	NO,NE,N	NO,NE,		NO,NE,N	NO,NE,NA
D. Waste water treatment and discharge		446.95	90.27		537.21	2.26%
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO
Memo items:⁽²⁾						
International bunkers	227.53	0.18	1.85		229.56	
Aviation	163.82	0.03	1.35		165.19	
Navigation	63.71	0.15	0.51		64.37	
Multilateral operations	C	C	C		C	
CO₂ emissions from biomass	6383.96				6383.96	
CO₂ captured	NO				NO	
Long-term storage of C in waste disposal sites	551.48				551.48	
Indirect N₂O			NO,NA			
Indirect CO₂⁽³⁾	NO,NA					
Total CO₂ equivalent emissions without land use, land-use change and forestry					23758.40	
Total CO₂ equivalent emissions with land use, land-use change and forestry					18197.47	
Total CO₂ equivalent emissions, including indirect CO₂, without land use, land-use change and forestry					NA	
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry					NA	

2. SUMMARY OF REPORTING SUPPLEMENTARY INFORMATION UNDER ARTICLE 7, PARAGRAPH 2 OF THE KYOTO PROTOCOL

Supplementary information under Article 7, paragraph 2 of the Kyoto Protocol	Chapter in the Eighth National Communication
National systems in accordance with Article 5, paragraph 1	3.3.
Nacional registries	3.4.
Supplementary relating to the Mechanisms pursuant to Articles 6, 12, 17	5.2.3.
Policies and measures in accordance with Article 2	
Promote sustainable development	4.1.2.
Reduce emissions from international aviation and maritime transport	5.1.4.
Minimize adverse effects	5.2.4.
Domestic and regional programmes and/or legislative arrangements and enforcements and administrative procedures	4.1.
Implementation of Article 3.3. and 3.4 and contribution to the preservation of biological diversity and natural resources	3.2.1.
Information under Article 10:	
Article 10.a	3.3.
Article 10.b	4.1., 4.2.
Article 10.c	7.2.
Article 10.d	8.
Article 10.e	9.
Financial resources	7.1.

3. DESCRIPTION OF MODELS USED FOR PREPARING PROJECTIONS

Model name	MAED
Full model name	Model for Analysis of Energy Demand
URL to model description	https://www.iaea.org/topics/energy-planning/energy-modelling-tools
Model type	Simulation
Model description	MAED evaluates future energy demands based on medium- to long-term scenarios of socioeconomic, technological and demographic development. Energy demand is disaggregated into a large number of end-use categories corresponding to different goods and services. The influences of social, economic and technological driving factors from a given scenario are estimated. These are combined for an overall picture of future energy demand growth.
Summary	Model for Analysis of Energy Demand
Intended field of application	Future energy demand
Description of main input data categories and data sources	Final energy consumption projections for all forms of energy (e.g. fossil fuels, biomass, solar energy, electricity, etc.) were made using a bottom-up approach that allows for the analysis of structural changes on the energy use side in different sectors (e.g. industry, household, service sector, transport). Final energy efficiency measures are important for the achievement of climate change mitigation goals. The Model for Analysis of Energy Demand (MAED) was used to analyse the final energy consumption.
Validation and evaluation	The final energy consumption scenarios consider the necessary reduction of greenhouse gas emissions by 2030/2050 year, in all energy consuming sectors, as well as feedback of expected climate change on the ways and dynamics of consumption of various forms of energy (e.g. changes in seasonal mode of energy use, changes in heating and cooling requirements etc.).
Output quantities	Energy consumption and driving parameters (e.g. number and structure of population, structure of GDP, etc.) were analysed for two geographical and climate zones of Croatia - Continental Croatia and Adriatic Croatia (also official statistical regions).
GHG covered	CO ₂ , CH ₄ , N ₂ O
Sectoral coverage	Energy consumption
Geographical coverage	National level - Croatia
Temporal coverage	Until 2050, yearly time steps with seasonal and daily variations
Input from other models	-

Model name	MESSAGE
Full model name	Model for Energy Supply Strategy Alternatives and their General Environmental Impact
URL to model description	https://www.iaea.org/topics/energy-planning/energy-modelling-tools
Model type	Simulation and optimization
Model description	MESSAGE combines technologies and fuels to construct so-called "energy chains", making it possible to map energy flows from supply (resource extraction) to demand (energy services). The model can help design long term strategies by analysing cost optimal energy mixes, investment needs and other costs for new infrastructure,

	energy supply security, energy resource utilization, rate of introduction of new technologies (technology learning), environmental constraints.
Summary	Model for Energy Supply Strategy Alternatives and their General Environmental Impact
Intended field of application	Model for Energy Supply Strategy Alternatives and their General Environmental Impact
Description of main input data categories and data sources	For each of the selected scenarios, based on the availability of local resources and sources of primary forms of energy, the possibilities of meeting the needs for all forms of energy (e.g. thermal, electrical, natural gas, biomass, etc.) have been analysed.
Validation and evaluation	The MESSAGE model for the optimization of the power system and centralized heat systems (in the part of heat production) was used, as well as the PLEXOS model for analysing / confirming the feasibility of the operation of the electric power system at the hourly level in selected characteristic years.
Output quantities	Possibilities of meeting the needs for all forms of energy (e.g. thermal, electrical, natural gas, biomass, etc.).
GHG covered	CO ₂ , CH ₄ , N ₂ O
Sectoral coverage	Energy sector
Geographical coverage	National level - Croatia
Temporal coverage	Until 2050, yearly time steps with seasonal and daily variations
Input from other models	Energy consumption from MAED model

Model name	PLEXOS
Full model name	PLEXOS Energy Simulation Software
URL to model description	https://energyexemplar.com/software/#features
Model type	Optimization
Model description	Robust simulation capabilities across electric, water and gas systems focusing on full user control, transparency and accuracy across numerous constraints and uncertainties.
Summary	Simulation and optimization of the electricity, water and gas system operation and development
Intended field of application	Electricity, water and gas system operation and development
Description of main input data categories and data sources	Techno-economic data on facilities goals and constraints
Validation and evaluation	The MESSAGE model for the optimization of the power system and centralized heat systems (in the part of heat production) was used, as well as the PLEXOS model for analysing / confirming the feasibility of the operation of the electric power system at the hourly level in selected characteristic years.
Output quantities	Analysing / confirming the feasibility of the operation of the electric power system at the hourly level in selected characteristic years.
GHG covered	CO ₂ , CH ₄ , N ₂ O
Sectoral coverage	Electricity sector
Geographical coverage	National level - Croatia
Temporal coverage	Hourly resolution, for some years
Input from other models	Input data from MAED and MESSAGE models
Model structure	Based on the structure of the power system

Model name	LEAP
Full model name	Long-range Energy Alternatives Planning System
Model version and status	LEAP 2020.1.24
Latest date of revision	February 2021
URL to model description	https://www.energycommunity.org/default.asp?action=introduction
Model type	Simulation/optimization/accounting
Model description	LEAP is a tool that can be used to create models of different energy systems, where each requires its own unique data structures. LEAP supports a wide range of different modelling methodologies: on the demand side these range from bottom-up, end-use accounting techniques to top-down macroeconomic modelling. LEAP also includes a range of optional specialized methodologies including stock-turnover modelling for areas such as transport planning. On the supply side, LEAP provides a range of accounting and simulation methodologies that are powerful enough for modelling electric sector generation and capacity expansion planning, but which are also sufficiently flexible and transparent to allow LEAP to easily incorporate data and results from other more specialized models.
Summary	LEAP is an integrated modelling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy.
Intended field of application	It can be used to account for both energy sector and non-energy sector greenhouse gas (GHG) emission sources and sinks.
Description of main input data categories and data sources	The main “Analysis View” is the place where users create data structures and scenarios and enter all of the data describing both historical years and forward-looking scenarios. In the Analysis View a hierarchical tree displays the main data structure for the analysis. Data structure is based on the national energy balance data structure corrected to accommodate the structure of IPCC Energy sectors. Data sources are from National Energy Balance, National Bureau of Statistics, EK recommendation on use of parameters etc.
Validation and evaluation	Studies include both a historical period known as the Current Accounts, in which the model is run to test its ability to replicate known statistical data, as well as multiple forward looking scenarios.
Output quantities	Energy balance, GHG emissions, emissions of pollutants
GHG covered	CO ₂ , N ₂ O, CH ₄
Sectoral coverage	Energy and transport
Geographical coverage	National level - Croatia
Temporal coverage	LEAP is intended as a medium to long-term modelling tool. Most of its calculations occur on an annual time-step, and the time horizon can extend for an unlimited number of years. The hourly simulation and optimization of the power system was done outside of the LEAP.
Input from other models	From the analysis done outside of the LEAP (based on the energy demand calculated in the LEAP) done on an hourly basis with the software for hourly optimization of the power system development in the market environment. Additional calculations were done by the software: MAED, MESSAGE, PLEXOS. Additionally, LEAP was used as a framework for the integration of the sectorial projections and thus included the inputs from other sectorial models.

Model name	IPPU Model
Full model name	Industrial Processes and Product Use Model
Model version and status	Engineering simulation model (in own development), Microsoft Excel based
Latest date of revision	Microsoft Excel 2013
URL to model description	http://products.office.com
Model type	Bottom up type
Model description	Model derived in tabular calculation interface was used. The model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change (2006 IPCC Guidelines).
Summary	Calculations of all anthropogenic emissions from this sector are included. 2006 IPCC Guidelines provides a number of different possible methodologies or variations for calculating a given emission. In most cases these represent calculations of the same form but the differences are in the level of detail at which the original calculations are carried out. Wherever possible the methodology provides a "tiered" structure of calculations which describes and connects the various levels of detail at which national experts can work depending on the importance of the source category, availability of data, and other capabilities.
Intended field of application	GHG reporting from IPPU sector
Description of main input data categories and data sources	Projections are based on expected development of different industries, which includes production goals by 2050 and projections of macroeconomic parameters in 2020 - projected dynamics of the annual growth rate of gross domestic product and gross value added and the decline of population. Main assumptions for 'with measures' scenario: - no installation of additional capacity - production will reach the maximum value by 2040. The scenario includes implementation of measures defined in business plans and policies of manufacturers, conditioned by market demands, laws and regulations and the requirements of the application of best available techniques in the production process. Main assumptions for 'with additional measures' scenario: - application of cost- effective measures to reduce greenhouse gas emissions in the production of cement, and reduction of emissions of F gases. According to good practice, projections were made for activity data and emission factors: - activity data – applying grade of 1, 2 and 3 methods (projections of macroeconomic parameters, effects of policies and measures, sectoral analysis and studies) - emission factors – applying grade of 1 and 2 methods (projections based on average values for the previous five-year period, effects of policies and measures, sectoral analysis and studies).
Validation and evaluation	Model incorporates QA/QC procedures
Output quantities	Gg
GHG covered	CO ₂ , N ₂ O, CH ₄ , HFC, SF ₆
Sectoral coverage	Industrial Processes and Product Use
Geographical coverage	National level - Croatia

Temporal coverage	Yearly
Input from other models	-

Model name	Agriculture Model
Full model name	IPCC Guidelines for National Greenhouse Gas Inventories
Model version and status	The IPCC Guidelines were first accepted in 1994 and published in 1995. UNFCCC COP3 held in 1997 in Kyoto reaffirmed that the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories should be used as "methodologies for estimating anthropogenic emissions by sources and removals by sinks of greenhouse gases" in calculation of legally-binding targets during the first commitment period. The 1996 guidelines comprised the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories together with the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the Good Practice Guidance for Land Use, Land-Use Change and Forestry. The 2006 Guidelines have built upon this body of work in an evolutionary manner to ensure that the transition from the previous guidelines to these new ones will be as straightforward as possible. These new guidelines cover new sources and gases as well as updates to previously published methods where technical and scientific knowledge have improved.
Latest date of revision	9th Corrigenda for the 2006 IPCC Guidelines, July 2015
URL to model description	http://www.ipcc-nggip.iges.or.jp/public/2006gl/
Model type	Bottom-up reference-based Excel model
Model description	The methodologies used in the calculation of emissions are based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC Good Practice Guidance) prepared by IPCC. As recommended by the IPCC Guidelines country specific methods have been used where appropriate and where they provide more accurate emission data.
Summary	All anthropogenic emissions from this sector, except for fuel combustion emissions and sewage emissions, which are covered in Energy and Waste modules The Reference Manual frequently provides a number of different possible methodologies or variations for calculating a given emission. In most cases these represent calculations of the same form but the differences are in the level of detail at which the original calculations are carried out. Wherever possible the methodology provides a "tiered" structure of calculations which describes and connects the various levels of detail at which national experts can work depending on the importance of the source category, availability of data, and other capabilities.
Intended field of application	GHG reporting from Agriculture sector
Description of main input data categories and data sources	Emissions from domestic livestock DATA SOURCE for existing years: AD provided by Ministry of Economy and Sustainable Development: Number of heads for each livestock type Other years: extrapolation based on trend Emissions from agricultural soils DATA SOURCE for existing years: AD provided by Ministry of Economy and Sustainable Development: Number of heads for each livestock type

	Other years: extrapolation based on trend Crop production: non N-fixing, N-fixing Production of mineral fertilizers within the country for domestic use and import of mineral fertilizers for domestic use (in tonnes) which relates to urea, KAN, NPK, ammonium nitrate and urea ammonium nitrate Total production of NPK by each formulation within the country (in tonnes) Area of cultivated organic soils within the country (ha) Sewage sludge applied (tonnes dry matter)
Validation and evaluation	Model incorporates QA/QC procedure
Output quantities	Gg, kg
GHG covered	CH ₄ , N ₂ O
Sectoral coverage	Agriculture
Geographical coverage	National level - Croatia
Temporal coverage	Yearly
Input from other models	-

Model name	Waste Model
Full model name	Waste Model
Model version and status	Engineering simulation model (in own development), Microsoft Excel based
Latest date of revision	Microsoft Excel 2013
URL to model description	http://products.office.com
Model type	Bottom-up type
Model description	Model derived in tabular calculation interface was used. The model is structured in accordance with the table structure of the inventory of United Nations Framework Convention on Climate Change (2006 IPCC Guidelines).
Summary	Calculations of all anthropogenic emissions from this sector are included. 2006 IPCC Guidelines provides a number of different possible methodologies or variations for calculating a given emission. In most cases these represent calculations of the same form but the differences are in the level of detail at which the original calculations are carried out. Wherever possible the methodology provides a "tiered" structure of calculations which describes and connects the various levels of detail at which national experts can work depending on the importance of the source category, availability of data, and other capabilities.
Intended field of application	GHG reporting from Waste sector
Description of main input data categories and data sources	The projections were carried out on the basis of expected development and future state of parameters for the projections - the amount of generated and landfilled solid waste (municipal solid waste, industrial waste and sludge from wastewater treatment), the organic fraction of solid waste, the fraction of recovered/flared methane and the amount of composted organic waste. Emission projections start from the situation and projections of macroeconomic parameters in 2020 - the projected dynamics of the annual growth rate of gross domestic product and the decline of population. Assumptions for the 'with measures' scenario:

	- Solid waste disposal – reduction of the amount of generated and landfilled solid waste due to the application of measures defined by sectoral legislation harmonized with EU legislation. 4 July 2018 came into force the new EU rules with legally binding targets for waste recycling and reduction of waste disposal. Croatia was given the possibility of a delay of five years to meet the targets because it is among the Member States that are in 2013 prepared for re-use and recycled less than 20% of its municipal waste and landfilled more than 60% of its municipal waste. The five-year delay is included in the projections. - Composting – continuous increase in the amount of waste that is being processed by composting due to the application of measures defined by sectoral legislation harmonized with EU legislation. The increase in the amount of waste to be composted depends on the reduction of the amount of landfilled biodegradable waste and the proportion of biodegradable waste that will be treated by composting and digestion. - Anaerobic digest biogas facilities – the trend follows the future trend of biogas production in the Republic of Croatia. - Waste incineration – no more incineration of clinical waste is carried out without energy recovery. - Wastewater treatment and discharge – continuous increase in the quantity of wastewater treated in industry sectors and decrease in the quantity of wastewater treated in residential/commercial sectors and decrease the population with individual system of drainage (septic tank). Emissions of greenhouse gases that are included in the Waste sector, according to the IPCC methodology, were estimated based on sectoral analysis and projected macroeconomic indicators on the annual increase in gross domestic product and decline of population. The scenario includes the existing legal framework of the Republic of Croatia and the adopted EU legal framework from the Waste sector for the period until 2035. Projections of emissions of greenhouse gases are based on the implementation of measures prescribed by sectoral legislation, harmonized with EU legislation. Assumptions for the 'with additional measures' scenario: - the 'with additional measures' scenario is the same as the 'with measures' scenario since no additional measures to reduce emissions of greenhouse gases have been identified. According to good practice, the projections were made for activity data and parameters included in the models for GHG emission calculation: - applying grade of 1 and 2 methods (projections of macroeconomic parameters, effects of policies and measures, sectoral analysis and studies, expert judgement).
Validation and evaluation	Model incorporates QA/QC procedures
Output quantities	Gg
GHG covered	CO ₂ , N ₂ O, CH ₄
Sectoral coverage	Waste
Geographical coverage	National level - Croatia
Temporal coverage	Yearly
Input from other models	-

Model name	LULUCF
Full model name	IPCC 2006 Guidelines for National Greenhouse Gas Inventories - LULUCF sector
Model version and status	Model is based on the "2006 IPCC Guidelines", which are built upon work in an evolutionary manner to ensure that the transition from the previous guidelines to these new ones will be as straightforward as possible. These new guidelines include new sources and gases as well as updates to the previously published. The IPCC Guidelines should be used as "methodologies for estimating anthropogenic emissions by sources and removals by sinks of greenhouse gases".
Latest date of revision	July 2015
URL to model description	http://www.ipcc-nggip.iges.or.jp/public/gl/invs6c.html
Model type	Bottom-up reference based Excel model
Model description	The methodologies used in the calculation of emissions are based on the IPCC 2006 IPCC Guidelines for National Greenhouse Gas Inventories prepared by IPCC. As recommended by the IPCC Guidelines country specific methods have been used where appropriate and where they provide more accurate emission data. Because of insufficient capacities in the system for making projections in the LULUCF sector at the national level, Grade 1 was applied. Emissions and removals are calculated by multiplying the projected activity data on and implied emission factor for the period 2009-2020 for each carbon pool. Alternative 1 was used, whereat the activity data for the period from 2025 to 2050, in this case the size of the sub-categories of land, were estimated using the linear extrapolation within the past ten years, from 2009 to 2020. For Harvested wood products pool, reference period was 2000- 2009, because of large fluctuation in input data. In cases where the extrapolation had unrealistic extreme values (for example, negative values on areas in "Land converted to wetlands"), the arithmetic means of information on specific activity or implied emission factor for the past years were used. Expert assessment was used to predict the annual area of afforestation ("Land converted to forest land").
Summary	The IPCC 2006 Guidelines provides a number of different possible methodologies or variations for calculating a given emission. In most cases these represent calculations of the same form. For calculation of the past emissions and removals gain-loss method was used. The level of details in calculations depends on key category and uncertainty analyses. For projections Grade 1 approach was used.
Intended field of application	GHG reporting from LULUCF sector
Description of main input data categories and data sources	Activity Data are provided by Ministry of Economy and Sustainable Development. Input parameters needed for calculation of Emission factors per subcategories and pool are taken either from IPCC 2006 Guidelines or national based values.
Validation and evaluation	Model incorporates QA/QC procedure
Output quantities	kha, ha
GHG covered	CO ₂ , CH ₄ , N ₂ O
Sectoral coverage	LULUCF
Geographical coverage	National level - Croatia
Temporal coverage	Yearly
Input from other models	-