REPUBLIC OF CROATIA
Ministry of Economy

# INTEGRATED NATIONAL ENERGY AND CLIMATE PLAN FOR THE REPUBLIC OF CROATIA FOR THE PERIOD 2021-2030

March 2025

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# INTRODUCTION

In a Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy, COM(2015)80 final of 25th February 2015, it has been noted that integrated management is needed to ensure that all energy-related activities at the Union, regional, national and local level contribute to the objectives of the Energy Union. The objectives should be achieved through five key dimensions of the Energy Union: *1. decarbonisation, 2. energy efficiency, 3. energy security, 4. an internal energy market and 5. research, innovation and competitiveness.*

The Conclusions of the European Council on the Governance of the Energy Union of 26th November 2015 recognized that the governance system of the Energy Union is an essential tool for the efficient and effective construction of the Energy Union and for achieving its objectives. The Conclusions stressed that the governance system should be based on the principles of integration of strategic planning and reporting on the implementation of climate and energy policy and coordination between actors responsible for climate and energy policy at the EU, regional and national levels.

Therefore, on 11th December 2018, Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No. 663/2009 and (EC) No. 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No. 525/2013 of the European Parliament and of the Council (text relevant for EEA) (OJ L 328, December 21st, 2018) has been adopted (hereinafter referred to as the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action). This Regulation stipulates the development of **integrated national energy and climate plans** for a ten-year period. The first Integrated Energy and Climate Plan should be drawn up for the period from 2021 to 2030.

National and European energy and climate objectives by 2030 and achieving climate neutrality by 2050 is intended to be achieved through a combination of Union initiatives and consistent national policies in integrated national energy and climate plans.

The Integrated National Energy and Climate Plan for Republic of Croatia for 2021-2030 (hereinafter referred to as NECP, Plan, Integrated Energy and Climate Plan) builds on the existing national strategies and plans and will enable the implementation of the long-term Low-Carbon Development Strategy of the Republic of Croatia until 2030, with an outlook to 2050 („Official Gazette“, No. 63/21.) and also put Croatia on the path to a strong reduction of greenhouse gas emissions in accordance with the energy and climate legislative framework "Fit for 55".

It provides an overview of the current energy system and the energy and climate policy. It also provides an overview of the national targets for each of the five key dimensions of the Energy Union and the appropriate policies and measures to achieve those targets, for which an analytical basis should be established. In the Integrated Energy and Climate Plan, particular

attention should be paid to the targets to be achieved by 2030, including **reducing greenhouse gas emissions, increasing production and consumption of energy from renewable sources**, **energy efficiency** and **electricity interconnection** with the comprehensive strengthening of resistance to climate change. It should be ensured that the Integrated Energy and Climate Plan is consistent with and contributes to sustainable development goals.

According to Article 14. of the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, by June 30th, 2023, each Member State shall submit to the Commission a draft update of the last disclosed integrated national energy and climate plan and by June 30th, 2024, report to the Commission an update of its previous disclosed integrated national energy and climate plan. The main reasons for the update are the increase of climate ambitions by 2030 within the European Union and the achievement of carbon neutrality by 2050. Accordingly, the Republic of Croatia adopted more ambitious goals regarding the reduction of greenhouse gas emissions, both in the sectors within the emission unit trading system and in the sectors outside the emission unit trading system, and increased the goals related to the share of renewable energy sources in energy consumption and energy efficiency.

The table below includes the most important targets that the NECP sets for 2030:

| Indicator | Goal |
|---|---|
| Reduction in greenhouse gas emissions in the ETS sector, compared to 2005 | -62% |
| Reduction in greenhouse gas emissions in the sectors outside the ETS sector, compared to 2005 | -16.7% |
| The value of the net removal of greenhouse gases in 2030 | -5,527 kt $CO_2$-eq |
| Share of renewable energy sources (RES) in gross final energy consumption | 42.5% |
| Share of renewable energy sources (RES) in final energy consumption in transport | 24.6% |
| Primary energy consumption (total energy consumption without non-energy consumption) | 336.9 PJ (8.05 Mtoe) |
| Final energy consumption | 246.2 PJ (5.88 Mtoe) |

In accordance to Article 18. Act on Climate Change and Ozone Layer Protection („Official Gazette“, No. 127/19) Integrated National Energy and Climate Plan for the period 2021-2030, shall be adopted by the Government of the Republic of Croatia at the proposal of the state administration body responsible for energy, with the prior consent of the state administration body responsible for environmental protection.

# SECTION A: NATIONAL PLAN

# 1 PLAN OVERVIEW AND ADOPTION PROCEDURE

## 1.1 Summary

### i. The political, economic, environmental and social context of the plan

The Republic of Croatia has been a member state of the European Union (EU) since 1st July 2013, and its energy and climate legislation is aligned with the relevant acquis Communautaire. The Republic of Croatia is also a party to the United Nations Framework Convention on Climate Change (hereinafter: UNFCCC), the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the Paris Agreement, and regularly submits reports on the greenhouse gas inventory to the UNFCCC Secretariat as well as national reports.

The 8th National Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change with the appendix Fifth Biennial Report was submitted in 2024. In addition to information on greenhouse gas emissions, this document also contains conclusions on the current situation and trends of environmental, economic, and social developments, as well as recommendations for improving the implementation of environmental protection and sustainable development policies [1]. Emissions of major pollutants into the air ($SO_2$, $NH_3$, $NO_X$, NMHOS) compared to the baseline year 1990 show a general downward trend. Greenhouse gas emissions tend to decrease compared to the base year 1990, whereby this decrease must be intensified given the new climate goals until 2030. According to the number of different pollutants in the water and/or the sea and their discharge and transfer rates, the water area of the Sava basin is the most stressed. Minefields ("mine-suspected areas") remain in Croatia's territory.

Regarding the social context of the plan, the development of the regions of Croatia and the population of the areas are uneven, with growing pressure on larger cities. The trend of departure from rural areas continues. Due to the emigration of a share of the working-age population and the economy's recovery, the dynamics of a decrease in the unemployment rate are considerably faster than the dynamics foreseen in European estimates. The number of inhabitants of the Republic of Croatia is continuously decreasing, whereby the share of the population in the age group above 65 is increasing, and the share of working age groups is decreasing.

Croatia has considerably lower economic activity per capita than most EU countries. Its energy balance significantly depends on oil, gas, and electricity imports.

The impact of climate change in Croatia increases the risk of disasters in various ways by changing the frequency and intensity of natural threats, affecting vulnerability, and changing areas of exposure. The risk of disasters has increased under the influence of climate change, while at the same time, the intensity of natural threats increases, and the resilience of communities decreases.

## ii. Strategies that address the five dimensions of the Energy Union

The five dimensions of the Energy Union are decarbonisation, energy efficiency, energy security, the internal energy market and research, innovation, and competitiveness.

Five key strategies address the **dimension of decarbonisation**. **The Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050** („Official Gazette", No. 25/20, hereinafter referred to as the Energy Development Strategy) [3] is an obligation under the Energy Act („Official Gazette" Nos. 120/12, 14/14, 95/15, 102/15, 68/18). Analytical backgrounds have been prepared (the so-called Green Paper [2] and White Paper [4]) and presented to the professional and interested public at the end of 2018 and the beginning of 2019 to develop the Energy Development Strategy. The analytical backgrounds contain elaborated targets for using renewable energy sources (RES), energy efficiency, the internal energy market and energy security. The Energy Development Strategy defines the optimal energy mix and development projects to ensure the energy independence of the Republic of Croatia, with particular emphasis on strengthening energy production from renewable sources. Also, special attention is paid to the security of supply, sustainability, and competitiveness of the energy system. All of the above aligns with the EU Directives' objectives in reducing consumption, greenhouse gas emissions, sustainability of energy development, the competitiveness of the energy system and a favourable investment environment. **The Long-Term Strategy of the Renovation of the National Building Stock of the Republic of Croatia by 2050**[1] is crucial for using renewable energy sources in building construction. This strategy seeks to increase the number of buildings with almost zero energy (nZEB) by requiring new buildings and renovating existing buildings. It includes the obligation to cover a significant part of the primary energy for the building by using renewable energy sources at the building's location or in its immediate vicinity.

The third strategic document for decarbonisation is **the Low-Carbon Development Strategy of the Republic of Croatia until 2030, with an outlook to 2050** [5] (hereinafter referred to as the Low-Carbon Development Strategy). Drafting the Low-Carbon Development Strategy is an obligation arising from the Act on Climate Change and Protection of the Ozone Layer („Official Gazette", No. 127/19). Also, a strategic document important for decarbonization and strengthening resistance to climate change is the Spatial Development Strategy of the Republic of Croatia, which ensures the conditions for the use, protection and management of the territory of the Republic of Croatia as a particularly valuable national asset[2].

One of the objectives within the decarbonisation dimension is also adaptation to climate change, which is elaborated in the **Climate Change Adaptation Strategy in the Republic of Croatia until 2040 with an outlook to 2070** with the action plan (hereinafter referred to as the Adaptation Strategy [6] which envisages action in the direction of strengthening resistance

[1] https://mpgi.gov.hr/o-ministarstvu/djelokrug-50/energetska-ucinkovitost-u-zgradarstvu/strateski-dokumenti-programi-i-projekti/dugorocna-strategija-obnove-nacionalnog-fonda-zgrada-do-2050-godine/9055

[2] https://narodne-novine.nn.hr/clanci/sluzbeni/17_10_106_2423.html

to climate change and reducing the risk of disasters potentiated by climate change. The Adaptation Strategy was adopted by the Croatian Parliament in 2020.

The key document for the energy efficiency dimension is **the Long-Term Strategy of the Renovation of the National Building Stock of the Republic of Croatia by 2050** [15], which promotes the need for investment in the building stock. The long-term strategy was adopted by the Government of the Republic of Croatia in December 2020, and it aligns the objectives of reconstruction with the Integrated energy and climate plan, considering demographic trends and the activities of the construction sector. At the same time, trends of accelerated abandonment of the existing stock of buildings with poorer properties were observed, along with the gradual growth of new construction. The energy renovation rate of buildings until 2020 was 0.7% per year, and the Strategy defined a gradual increase of this value to 3% from 2021-2030, with a ten-year average rate of 1.6%. An important element is the introduction of additional measurable indicators of energy renovation of buildings, which will strengthen the process of conversion of the building stock into buildings with almost zero energy (nZEB) and buildings with zero emissions (carbon-neutral buildings).

The dimensions of energy security and the internal energy market have been elaborated within the framework of the Energy Development Strategy.

National strategies relevant to the dimension of research, innovation and competitiveness are the Strategy of Education, Science and Technology [7] and the Strategy of Smart Specialization until 2029, adopted at the end of 2023 [8]. As a follow-up to these strategies, this Integrated Energy and Climate Plan highlights and systematises measures expected to contribute to the Croatian economy's research, innovation and competitiveness in sectors relevant to the energy transition.

### iii. Tabular representation of key objectives and policies

The key objectives outlined in the Integrated Energy and Climate Plan are reducing greenhouse gas emissions in the Republic of Croatia by 2030, increasing the share of renewable energy sources (RES) in gross final energy consumption, and increasing energy efficiency, expressed as primary energy and final energy consumption.

The goal of reducing greenhouse gas emissions in the Republic of Croatia by 2030 is set by Directive (EU) 2023/959 of the European Parliament and of the Council of May 10$^{th}$, 2023 on amending Directive 2003/87/EC on the establishment of a system of trading greenhouse gas emission units within the Union and Decision (EU) 2015/1814 on the establishment and functioning of the market stability reserve for the Union's greenhouse gas emissions trading system and Regulation (EU) 2018/842 of the European Parliament and of the Council of May 30$^{th}$, 2018 on the binding annual reduction of greenhouse gas emissions in the member states from 2021 to 2030, which contributes to climate measures to fulfill obligations in within the framework of the Paris Agreement and amendments to Regulation (EU) no. 525/13 (Text with EEA relevance) (OJ L 156, June 19$^{th}$, 2018) separately for participants in the EU emissions trading system (sectors in the EU ETS) and for sectors that do not participate in emissions trading (sectors outside the EU ETS). The targets for reducing greenhouse gas emissions are shown in Table 1-1.

**Table 1-1 Targets of reduced greenhouse gas emissions**

| | Targets for 2030 compared to 2005 | Targets for 2030 compared to 2005 according to WAM scenario |
|---|---|---|
| **Sectors in the EU ETS** | -62%<br>(target for the entire EU) | -62% |
| **Sectors outside the EU ETS** | -40% (target for the entire EU)<br>-16.7% (target for Croatia) | -16.7% |

At the EU level, the goal is to increase the sink to at least -310 Mt $CO_2$-eq by 2030, which stems from the goals of the "Fit for 55" package. It is by Regulation (EU) 2023/839 of the European Parliament and the Council of April 19th, 2023, amending Regulation (EU) 2018/841 as regards the scope, simplification of the rules on reporting and compliance and establishing the objectives of the Member States for 2030 and Regulation (EU) 2018/1999 as regards the improvement of monitoring, reporting, monitoring of progress and reviews (text with EEA relevance) (OJ L 107 April 19th, 2023) determined the increase of the sink in the LULUCF sector for each member state. The target value of net removal in 2030 for the Republic of Croatia is -5,527 kt$CO_2$-eq.

**Table 1-2 The target of increasing the net removal of greenhouse gas sinks in the LULUCF sector**

| Average data from the greenhouse gas inventory for 2016, 2017 and 2018 (kt of $CO_2$ equivalent), data submitted in 2020 | Goal for the Republic of Croatia for 2030 (kt of $CO_2$ equivalent) | Value of net removal in kt of $CO_2$ equivalent in 2030, data provided in 2020 |
|---|---|---|
| -4,933 | -593 | -5,527 |

Table 1-3 shows the target share of RES in gross direct consumption and energy efficiency goals for 2030.

**Table 1-3 Value projections of key indicators**

| | Goal for 2030 |
|---|---|
| Share of RES in gross final energy consumption | 42.5 % |
| *Energy efficiency* | |
| Primary energy consumption[3] | 336.9 PJ |
| Final energy consumption | 246.2 PJ |

Measures relevant to individual dimensions of the Energy Union are shown in Table 1-4.

Most of the measures are also relevant to reporting on policies and measures to reduce emissions and on greenhouse gas estimates to the European Commission under Regulation

[3] Primary energy consumption, according to EUROSTAT guidelines, is defined as total energy consumption less non-energy consumption.

(EU) 2018/899 on the Governance of the Energy Union and action in the field of climate to UNFCCC within the framework of preparing national and biennial reports of the Republic of Croatia. Hence, the table specifies both the abbreviation indicating the dimension of the Energy Union to which the measure primarily refers and the abbreviation used within the framework of the said reporting. Impacts on other dimensions of the Energy Union, adaptation to climate change and the circular economy are listed along with the description of each measure.

In the planning and implementation of all measures, the application of the DNSH-principle 'Do not cause significant harm', which aims to ensure that projects do not cause significant harm to the six environmental goals defined in the Regulation (EU) 2020/852 of the European Parliament and of the Council of June 18th, 2020, on establishing a framework for facilitating sustainable investments and amending Regulation (EU) 2019/2088 (Text with EEA relevance) (OJ L 198, June 22nd, 2020) (hereinafter: Sustainable Investment Regulation) has an imperative. Infrastructural projects whose service life is longer than five (5) years will be prepared by applying the Commission Notice - Technical Guidelines for the preparation of infrastructure for climate change in the period 2021 - 2027 (OJ C, C/373, September 16th, 2021), i.e. the climate proofing process will be applied.

All measures under the Plan for which one of the EU funds is listed as a potential source of financing also include the possibility of financing from the EEA Financial Mechanism, the Norwegian Financial Mechanism, and the Swiss Croatian Cooperation Programme, provided that, under the legal framework of the said financial mechanisms, the costs financed under the said measures represent eligible costs.

## iv. Tabular representation of measures of the plan

**Table 1-4 Overview of measures**

| Abbreviation 1[4] | Abbreviation 2[5] | Name | Impact on other dimensions |
|---|---|---|---|
| **Decarbonisation** | | | |
| MS-1 | MCC-1 | Strengthening governance to achieve climate goals | 2,3,4,5 |
| MS-2 | MCC-2 | Establishment of regional energy and climate agencies and capacity building | 2,3,4,5 |
| MS-3 | MCC-4 | The EU emissions trading system | 2,4 |
| MS-4 | MCC-6 | Strategic planning at the regional and local level | 2,3,4,5 |
| MS-5 | MCC-8 | Development and implementation of $CO_2$ collection, transport and storage projects (CCS) | 5 |
| MS-6 | MCC-9 | Improving the sustainability of urban environments | 2,3,5 |
| MS-7 | MCC-10 | Greening of the public and private sector | 2,3,4,5 |
| MS-8 | MCC-11 | Improvement of the IT platform for waste management | 2,3,4,5 |
| MS-9 | MCC-12 | Transformation of the bioeconomy sector | 2,3,5 |
| MS-10 | MCC-13 | Legal adjustments and technical bases for the introduction of hydrogen into the energy system | 3,5 |
| MS-11 | | Reducing an individual's carbon footprint by changing lifestyle habits | 2,3 |
| MS-12 | | Collecting and processing of biomass from agriculture, forestry, fishing and aquaculture | 5 |
| MS-13 | | Elimination of fossil fuels subsidies | 3,5 |
| MS-14 | | Carbon removal certification | 4 |
| MS-15 | | Creation and implementation of the Social Plan for climate policy | 2,3,5 |
| MS-16 | | Green budget planning | 2,3,4,5 |
| IP-1 | MIP-1 | Reduction of the share of clinker in cement production | |
| IP-2 | MIP-2 | Limiting fluorinated greenhouse gas emissions | |
| GO-1 | MWM-1 | Prevention and reduction of waste generation | 5 |
| GO-2 | MWM-2 | Increasing the amount of separately collected and recycled waste | 5 |
| GO-3 | MWM-4 | Reduction of the amount of disposed biodegradable waste | 5 |
| GO-4 | MWM-3 | Ensuring the system for the treatment and use of landfill gas | 5 |
| GO-5 | | Reduction of food waste generation | 5 |

[4] According to the dimensions of the energy union

[5] According to the sectoral division in accordance with the IPCC methodology

| | | | |
|---|---|---|---|
| GO-6 | | Circular economy measures to increase resource efficiency and business application models based on repair, recycling and recovery | 5 |
| POLJ-1 | MAG-2 | Improving storage capacity and practices when handling manure | 5 |
| POLJ-2 | MAG-4 | Anaerobic manure decomposition and biogas production | |
| POLJ-3 | MAG-6 | Improvement and changing the soil tillage system (reduced tillage) | 5 |
| POLJ-4 | MAG-7 | Extension of crop rotation with a higher share of legumes | 5 |
| POLJ-5 | MAG-8 | Intensification of crop rotation by using intercropping | 5 |
| POLJ-6 | MAG-10 | Improvement of organic fertilizer application methods | 5 |
| POLJ-7 | MAG-11 | Agroforestry | 5 |
| POLJ-8 | MAG-12 | Hydro-amelioration interventions and systems of protection against natural disasters | 5 |
| POLJ-9 | MAG-13 | Introduction of new cultivars, varieties and crops | 5 |
| LUF-1 | MLF-1 | Establishment, maintenance and upgrading of the National Information System for land in the Republic of Croatia | 3,4 |
| LUF-2 | MLF-2 | Carbon sequestration on the areas of existing forests | 3,4 |
| LUF-3 | MLF-3 | Implementation of afforestation works | 5 |
| LUF-4 | MLF-4 | Manufacture and use of wood and wood products | |
| LUF-5 | MLF-5 | Management of agricultural land | |
| LUF-6 | MLF-6 | Pasture management | |
| LUF-7 | MLF-7 | Implementation of technical projects and scientific research in the LULUCF sector | 5 |
| LUF-8 | MLF-8 | Activities to build the WAM scenario | 3 |
| FUG-1 | MEN-24 | Modernization and transformation of refineries | 2,3 |
| FUG-2 | MEN-25 | Measures to increase energy efficiency by improving processes and process units | 2,3 |
| OIE-1 | MEN-16 | Information, education and capacity building for the use of RES | 2,3,4 |
| OIE-2 | MEN-17 | Spatial planning requirements for the use of RES | 3,4 |
| OIE-3 | MEN-19 | Elaboration of the regulatory framework for the use of RES | 3,4 |
| OIE-4 | | The use of RES for electricity production | 3,4,5 |
| OIE-5 | | The use of RES for thermal purposes | 3,4,5 |
| OIE-6 | | The use of RES in centralised and closed district heating systems | 3,4,5 |
| OIE-7 | | Energy sharing and Energy communities | 2,4 |
| OIE-8 | | Use of hydrogen and new technologies | 3,5 |
| TR-1 | MTR-5 | Regulatory instruments for promoting a cleaner transport system | 2 |
| TR-2 | MTR-6 | Programme for co-financing the purchase of new alternative fuel vehicles and the development of alternative fuel infrastructure in road transport | 2 |

| | | | |
|---|---|---|---|
| TR-3 | MTR-9 | Improving the public transport system and promoting sustainable integrated transport | 2 |
| TR-4 | MTR-12 | Development of energy-efficient maritime transport and inland navigation | 2,3,5 |
| TR-5 | | Development of energy-efficient rail transport | 2,3,5 |
| TR-6 | | Development of energy-efficient air transport | 2,3,5 |
| TR-7 | MTR-13 | Development of the low-carbon fuel market | 2,3,5 |
| **Energy efficiency** | | | |
| ENU-1 | MCC-14 | Energy efficiency obligation system for suppliers | 4 |
| ENU-2 | MEN-1 | Promoting the decarbonisation and application of the "energy efficiency first" principle in buildings | 1,4 |
| ENU-3 | MEN-2 | Energy renovation programme for apartment buildings | 1 |
| ENU-4 | MEN-3 | Energy renovation program for family houses | 1 |
| ENU-5 | MEN-4 | Energy renovation program for public sector buildings | 1 |
| ENU-6 | MEN-5 | Energy renovation program for buildings that have the status of cultural property | 1 |
| ENU-7 | MEN-7 | Systematic energy management in the public sector | 4 |
| ENU-8 | MEN-6 | Public lighting energy renovation program | 1 |
| ENU-9 | MCC-15 | Green public procurement | 1,5 |
| ENU-10 | MEN-8 | Systematic energy management in the business (service & production) sector | 1,4 |
| ENU-11 | MEN-10 | Information on energy efficiency | 1,5 |
| ENU-12 | MEN-11 | Development of a framework to ensure adequate skills in the context of green jobs required for building renovation | 1 |
| ENU-13 | MEN-12 | Energy efficiency of the power transmission system | 1,3,4 |
| ENU-14 | MEN-13 | Reduction of losses in the distribution power grid and introduction of smart grids | 1,3,4 |
| ENU-15 | MEN-14 | Increasing the efficiency of the district heating system | 1,3,4 |
| ENU-16 | MEN-15 | Increasing the efficiency of the gas system | 1,3,4 |
| ENU-17 | | Increasing energy efficiency and use of RES in manufacturing industries | 1 |
| ENU-18 | | Increasing the energy efficiency of public water supply, drainage and wastewater treatment systems | 1 |
| **Energy security** | | | |
| ES-1 | MEN-21 | Construction and use of energy storage facilities | 1,2,4,5 |
| ES-2 | | Improvement of the electricity system management | 1,2,4,5 |
| ES-3 | MEN-22 | Development and maintenance of the district heating systems | 1,2,4 |
| ES-4 | MEN-23 | LNG terminal capacity increase | 3,4 |
| ES-5 | | Security of natural gas supply for EU countries | 3,4 |
| ES-6 | | Security of natural gas supply for the Western Balkans | 3,4 |
| ES-7 | | Construction and improvement of gas transmission system management | 1,3,4 |
| ES-8 | | Exploration of potential hydrocarbon deposits | 3 |
| ES-9 | | Reduction in fossil fuel usage for heating needs in individual heating systems | 1,3,4 |

| | | | |
|---|---|---|---|
| ES-10 | | Cybersecurity | 3,4 |
| ES-11 | | Establishment of a hydrogen-based economy | 1 |
| **Internal energy market** | | | |
| UET-1 | MEN-27 | Development of the electricity transmission grid | 1,2,3,5 |
| UET-2 | MEN-28 | Development of the gas transmission system | 1,2,3,5 |
| UET-3 | | Equipping the gas transmission system for the future possibility of transmitting up to 100% hydrogen | 1,2,3 |
| UET-4 | | Analysis of the impact of pilot projects management of consumption on the distribution network | 2,5 |
| UET-5 | | Co-financing the implementation of consumption management projects | 1,2,3,5 |
| UET-6 | | Development of the national balancing market | 2 |
| UET-7 | MEN-29 | Elaboration of the regulatory framework for the active participation of grid users in the electricity market | 1,3 |
| UET-8 | MEN-30 | Introduction of advanced consumption measurement systems and measurement data management | 1,2,3 |
| UET-9 | MEN-31 | Implementation of the Programme for the reduction of energy poverty and Programme for combating poverty in terms of mobility | 1,2,3 |
| UET-10 | | Implementation of the Programme for Combating Energy Poverty, which includes the use of renewable energy sources in residential buildings in assisted areas and areas of special state care for the period up to 2025 | 1,2,3 |
| **Research, innovation and competitiveness** | | | |
| IIK-1 | MCC-17 | Establishment of a system for identifying and monitoring the achievement of research,innovation and competitiveness objectives | 1,2,3,4 |
| IIK-2 | MCC-18 | Establishment of systematic financing of research and development projects | 1,2,3,4 |
| IIK-3 | MCC-19 | Strengthening competitiveness of low-carbon economy | 1,2,3,4 |
| IIK-4 | MCC-20 | Transfer of knowledge and technologies from science to the economy system with an emphasis on low-carbon technologies | 1,2,3,4 |
| IIK-5 | MCC-21 | Strengthening of scientific centres of excellence established in the field of natural, technical, biotechnical and biomedical sciences | 1,2,3,4 |
| IIK-6 | MCC-22 | Strengthening research and innovation and increasing the competitiveness of the low-carbon economy | 1,2,3,4 |
| IIK-7 | | Analytical bases for the green transition | 1,2,3,4 |

## 1.2 Overview of the current state of policies

### i. The National Energy System and the context of the national plan policies

The basic indicators of the development of energy consumption and economic indicators such as:

- GDP - Gross Domestic Product
- TPES - Total Primary Energy Supply
- TFC - Total Final Energy Consumption
- GEC - Gross Electricity Consumption
- NEC - Net Electricity Consumption
- TPES/GDP - energy intensity of total primary energy consumed;
- GEC/GDP - energy intensity of gross electricity consumption;
- NEC/GDP - energy intensity of net electricity consumption;

for the Republic of Croatia from 2017 to 2022 are shown in Figure 1-1.

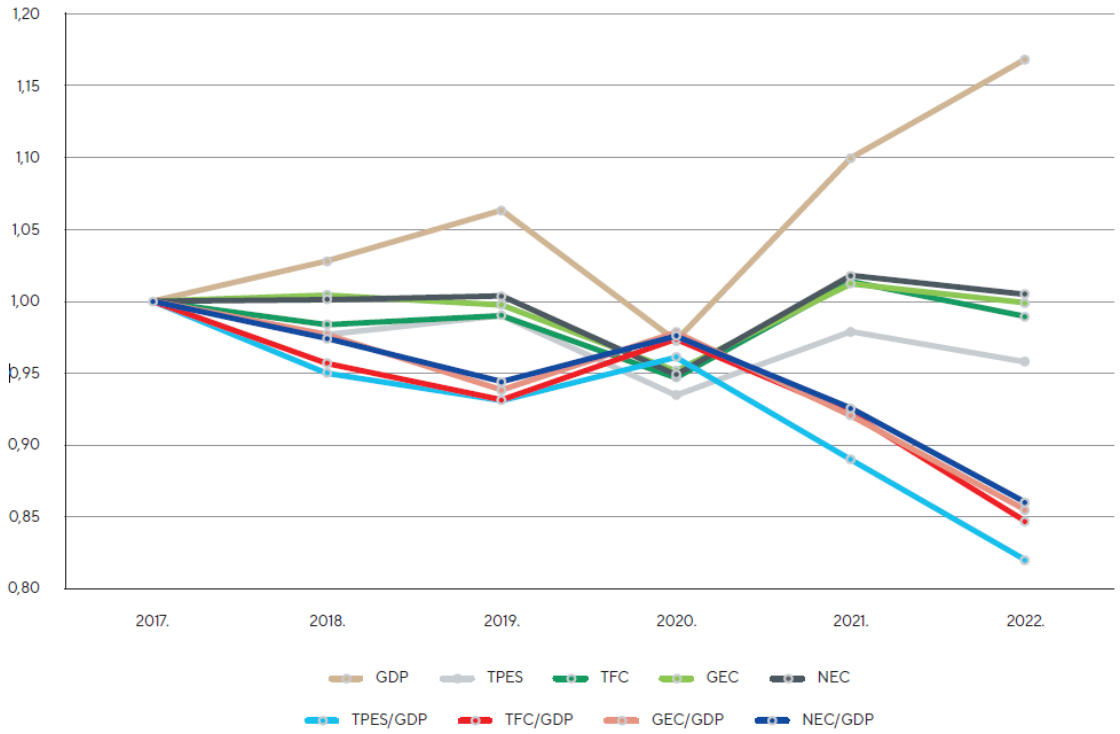


**Figure 1-1 Basic indicators of energy consumption development and economic indicators for the Republic of Croatia in the period 2017-2022**

From 2017 to 2022, there was a trend of increase in GDP at an average annual rate of 3.2 %. In the same period, total energy consumption increased at an average annual rate of 0.9 %, and final energy consumption at an average annual rate of 0.2 %. There was no change recorded in electricity consumption and net electricity consumption grew at an average

annual rate of 0.1 %. Losses of transmission and distribution of electricity also decreased at an average annual rate of 1.2 %.

The **primary energy production** trends are shown in Figure 1-2. During the six years from 2017 to 2022, primary energy production in Croatia decreased at an average annual rate of 2.6 %. An upward trend was achieved in producing energy from renewable sources, firewood and other solid biomass. In contrast, the production of other primary forms of energy (crude oil, natural gas and hydropower) achieved a downward trend.

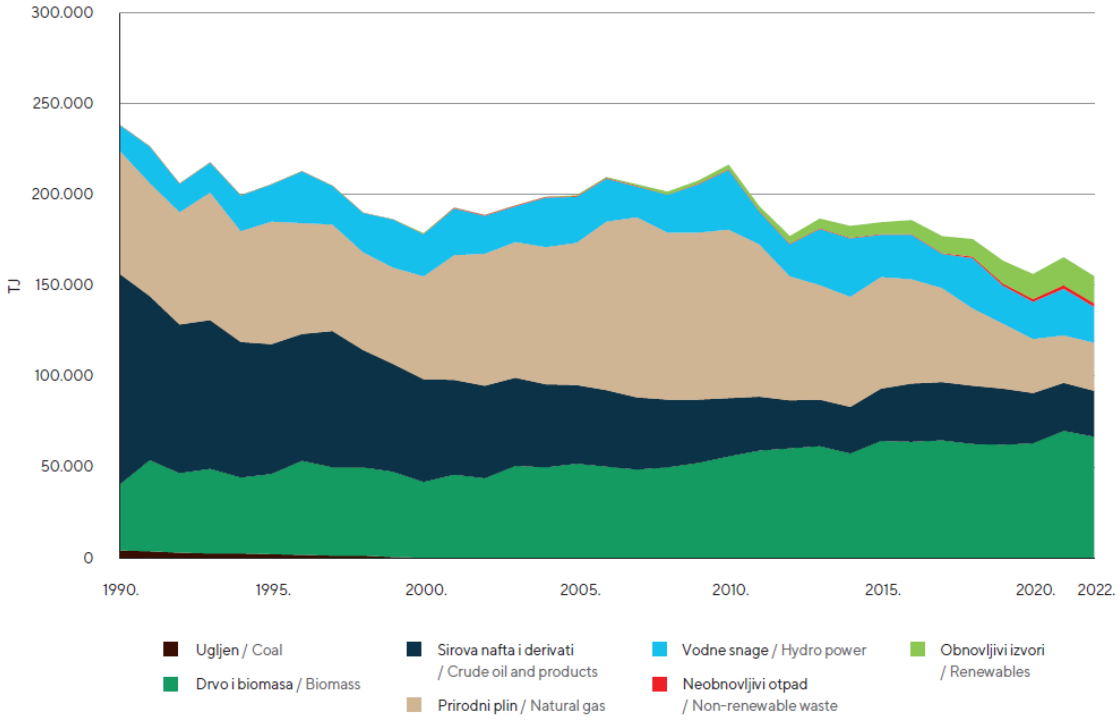


**Figure 1-2 Primary energy production**

Trends in **energy imports** until 2022 are shown in Figure 1-3.

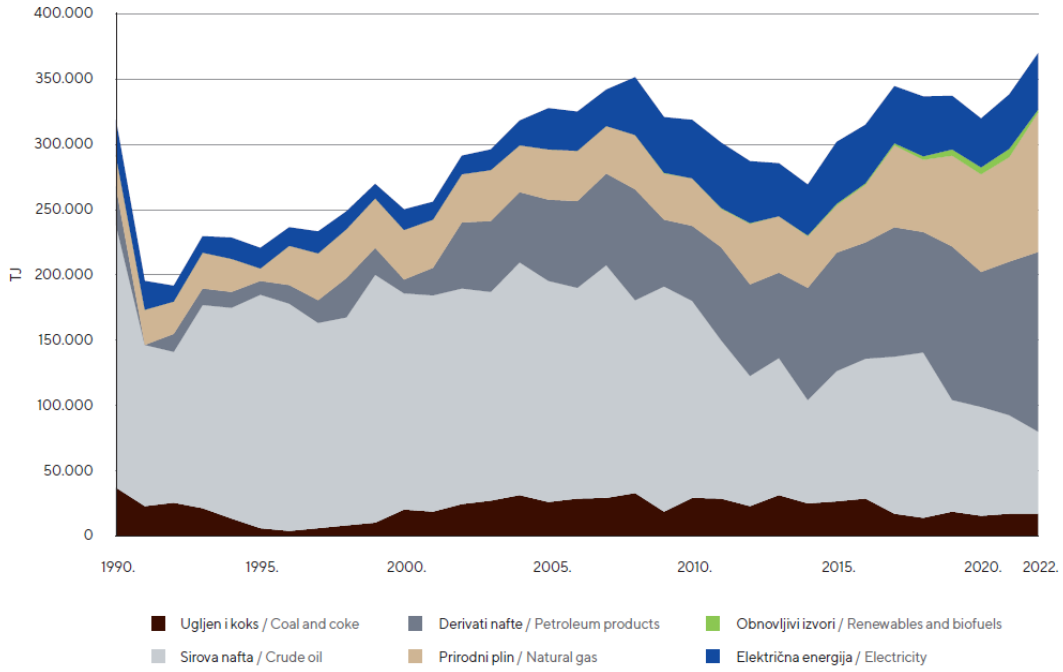


**Figure 1-3 Import of energy to Croatia**

From 2017 to 2022, energy imports increased to Croatia at an average annual rate of 1.4%. Specific changes in the structure of energy imports were achieved by increasing the share of petroleum products, natural gas and renewable sources. In contrast, the shares of electricity, coal, coke, and crude oil decreased.

In the said period, imports of renewable sources increased at an average annual rate of 8.5%, imports of natural gas 11.1% and imports of petroleum products 7.0%. Coal and coke imports decreased by 0.3%, crude oil imports by 12.2% and electricity imports by 0.4%.

From 2017 to 2022, total **primary energy consumption** decreased at an average annual rate of 1.0 %. During this period, reduced consumption of liquid fuels, natural gas, and electricity was achieved. Energy consumption from coal and coke, hydropower, wood and biomass, renewable sources, and non-renewable waste increased (Figure 1-4).

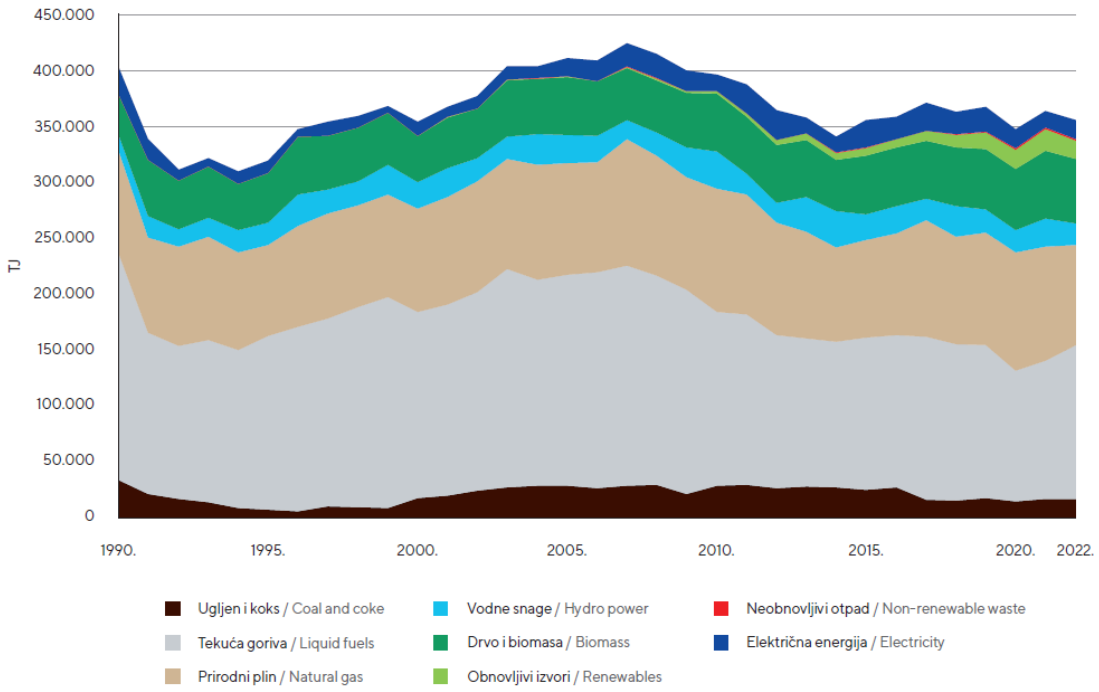


**Figure 1-4 Total energy consumption**

Energy legislation and climate legislation are aligned with the Acquis Communautaire.

The Republic of Croatia has adopted several energy-related documents that shape its strategic framework in this area.

In February 2020, the **Energy Development Strategy of the Republic of Croatia for 2030 with an outlook to 2050** was adopted, which is focused on the EU's goals of reducing greenhouse gas emissions, increasing the share of RES, energy efficiency, security, and quality of supply, as well as the development of the EU internal energy market, as well as available resources, energy infrastructure and the competitiveness of the economy and the energy sector.

In June 2021, the **Low-Carbon Development Strategy** was adopted to reduce greenhouse gas emissions in all sectors and create the foundation for developing a low-carbon society whose economy will be competitive within the European Union and globally.

As part of **the National Development Strategy of the Republic of Croatia until 2030**, Strategic Objective 8 was defined "Environmental and Energy Transition for Climate Neutrality".

To coordinate policies and measures for mitigating and adapting to climate change, the Government of the Republic of Croatia decided in 2018 to establish the **Committee for Intersectoral Coordination for Policy and Measures for Mitigation and Adaptation to Climate Change** („Official Gazette“, No. 9/18). The members of this Commission are representatives of competent state administration bodies at the level of assistant ministers/directors, and the President of the Commission appoints two technical working groups for low-carbon development and adaptation to climate change from experts from relevant ministries, professional institutions, representatives of the economy and non-governmental organisations.

In September 2019, the initial **Air Pollution Control Program for 2020 to 2029** was adopted („Official Gazette“, No. 90/19). The Program is the primary management instrument by which EU member states must ensure compliance with emission reduction obligations for 2020 - 2029 and 2030. It contains policies and measures by sector (energy, agriculture, waste, industry, transport) and an overview of forecasting further development in scenarios with the existing and additional measures.

The Program provides a general framework for integrated national energy and climate plans to ensure synergy and reduce implementation costs. Given that it relies heavily on measures and actions specified and adopted in national energy and climate strategies, the program is a key instrument for achieving these goals.

The program recognises and encourages strong synergy when planning policies and measures to reduce air pollutant emissions and improve air quality with policies and measures to reduce greenhouse gas emissions, increase the share of renewable energy sources and increase energy efficiency. Drafting of the First Amendments to the Air Pollution Control Program from 2020 to 2029 is underway.

Challenges in the energy sector will be approached with extreme care to ensure sustainable energy in terms of electricity and thermal energy production, distribution, and transmission to strengthen resistance to climate change. Increasingly frequent damage to the power system and its facilities due to extreme weather events represents a significant financial burden for all participants in the energy sector.

### ii. Current energy and climate policies and measures relating to the five dimensions of the Energy Union

#### Dimension "Decarbonization"

The decarbonisation dimension has two key elements

- reduction of greenhouse gas emissions and
- increasing the removal or increasing the sink.

The issue of climate change on a global scale is resolved by international agreements to which Croatia is also a party, the UNFCCC, and the Act on its ratification by the Croatian Parliament („Official Gazette“, International Contracts, No. 2/96). The Republic of Croatia is a party to the Kyoto Protocol based on the Act on Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change („Official Gazette“, - International Treaties, No. 5/07) and the Act on Ratification of Amendments to the Kyoto Protocol from Doha („Official Gazette“, - International Treaties, No. 6/15) and the Paris Agreement, based on the Act on Confirmation of the Paris Agreement („Official Gazette“, International Agreements, No. 3/17).

In 2018, several new EU regulations were adopted to regulate or restructure the field of climate change. Therefore, the adoption of a special Act on Climate Change and the Protection of the Ozone Layer („Official Gazette“, No. 127/19) has been initiated, which has been in force since January 1$^{st}$, 2020. The Act defines the competence and responsibility for climate change mitigation, climate change adaptation and protection of the ozone layer, climate change and

ozone layer protection documents, monitoring and reporting on greenhouse gas emissions, greenhouse gas emission trading system, sectors outside the greenhouse gas emission trading system, ozone-depleting substances and fluorinated greenhouse gases, financing climate change mitigation, climate change adaptation and ozone layer protection, climate change and ozone layer protection information system, as well as other issues related to climate change mitigation, climate change adaptation and ozone layer protection.

The Republic of Croatia, as a party to the UNFCCC, prepares and submits a national report on climate change every four years, which reports to the UNFCCC Secretariat on the implementation of obligations from the Convention. The latest reports are the Eighth National Report[6] and the Fifth Biennial Report of the Republic of Croatia[7], according to the UNFCCC.

In December 2019, the European Commission published the European Green Deal[8] that commits the European Union to achieving climate neutrality by 2050 and defines the decarbonisation of the energy system as key to achieving climate goals for 2030 and 2050. In June 2021, the European Climate Act[9] was adopted, making the achievement of climate neutrality by 2050 following the European Green Deal legally binding.

On July 14th, 2021, the European Commission published the "Fit for 55" legislative package, adopted during 2023 and 2024, which adapts existing climate and energy legislation to meet the EU's new reduction target greenhouse gas emissions of at least 55% by 2030. The goal of reducing greenhouse gas emissions by at least 55% by 2030 is also nationally determined contribution (NDC) of the EU and its member states under the Paris Agreement.

The obligation to reduce greenhouse gas emissions by at least 55% by 2030 compared to the level of emissions in 1990 is implemented jointly by the member states at the level of the European Union in two ways:

a.) through the EU greenhouse gas emission unit trading system (EU ETS), in which it is necessary to reduce emissions by -62% compared to 2005 levels. 43 plants from the Republic of Croatia and 3 airlines are included in the EU ETS.

b.) obligations to maintain emissions from sectors outside the ETS (so-called non-ETS) up to the level of the assigned annual quota. The goal of reducing emissions by 2030 at the EU level for the aforementioned sectors is 40% compared to 2005 levels.

For sectors outside the ETS (part of industrial processes, use of solvents and other products, agriculture, forestry, waste management, households and services, transport, etc.), for the member states and the Republic of Croatia, an annual national quota has been set that must

6 https://unfccc.int/documents/638337

7 https://www.haop.hr/sites/default/files/uploads/dokumenti/012_klima/dostava_podataka/Izvjesca/HRV_RoP_2019.pdf

8 Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions - European Green Deal (COM(2019) 640 final, December 11, 2019

9 Regulation (EU) 2021/1119 on establishing a framework for achieving climate neutrality and amending Regulation (EC) no. 401/09 and (EU) 2018/1999 (OJ L 243, July 9,.2021)

not be exceeded, otherwise, after using certain flexibilities, emission units must be purchased from other member states, which cover the excess.

The quota for sectors outside the trading system was established on the basis of solidarity between the member states of the European Union, according to which the Republic of Croatia must reduce emissions from these sectors by 16.7% by 2030 compared to the level of these emissions in the base year, 2005.

As part of the implementation of the Paris Agreement, the COP26 climate change conference (Glasgow, November 2021) was held, where the so-called Glasgow Climate Pact was adopted, which contains a series of decisions on intensified efforts to build resilience to climate change, reduce greenhouse gas emissions and ensure the necessary funding, and calls for the phasing out of fossil fuel subsidies and the consideration of further measures to reduce non-$CO_2$ emissions. These goals were reinforced at COP 28 in 2023, with the decision on the outcomes of the Global Stocktaking, which called on the parties to triple renewable energy sources, double energy efficiency by 2030, accelerate global efforts towards zero-emission energy systems, the use of zero and low carbon fuels, the transition from fossil fuels in energy systems, accelerating the reduction of emissions from road transport, including through the development of infrastructure and the rapid implementation of zero and low emission, etc.

As a party to the UNFCCC, Kyoto Protocol and Paris Agreement the Republic of Croatia has established a national system for monitoring greenhouse gas emissions in the country, and on an annual basis, prepares a report on the inventory of greenhouse gas emissions and submits it to the UNFCCC Secretariat (by 15$^{th}$ April of the current year) and the European Commission (by 15$^{th}$ January of the current year preliminary NIR, and then by March 15 the final NIR). The latest Report on the inventory of greenhouse gas emissions in the territory of the Republic of Croatia for the period 1990 - 2022 (NIR 2024) was submitted to the European Commission in March 2024 [11]. Since the UNFCCC Secretariat is currently working on new reporting tabular formats under the Paris Agreement, UNFCCC parties should submit their inventories of greenhouse gas emissions for the period from 1990 to 2022, exceptionally this year to the UNFCCC Secretariat - and until the end of 2024.

In addition to these conventions, the key laws relevant to the decarbonisation dimension are:

- Act on Climate Change and Protection of the Ozone Layer („Official Gazette“, No. 127/19)
- Environmental Protection Act („Official Gazette“, Nos. 80/13, 153/13, 78/15, 12/18, 118/18),
- Air Protection Act („Official Gazette“, Nos. 127/19, 57/22),
- Energy Act („Official Gazette“, Nos. 120/12, 14/14, 95/15, 102/15 and 68/18),
- Electricity Market Act („Official Gazette“, Nos. 111/21, 83/23),
- Thermal Energy Market Act („Official Gazette“, No. 80/13, 14/14, 102/14, 95/15, 76/18, 86/19)
- Act on Renewable Energy Sources and High Effective Cogeneration („Official Gazette“, Nos. 138/21, 83/23),
- Energy Efficiency Act („Official Gazette“, Nos. 127/14, 116/18, 25/20, 41/21)

- Act on Biofuels for Transport („Official Gazette", Nos. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18, 52/21),
- Act on the Deployment of Alternative Fuel Infrastructure („Official Gazette", Nos. 120/16, 63/22),
- Act on the Environmental Protection and Energy Efficiency Fund („Official Gazette", Nos. 107/03, 144/12),
- by-laws for implementing those laws.

The strategic planning documents related to low-carbon development and the fight against climate change are:

- National Development Strategy of the Republic of Croatia until 2030 („Official Gazette", No. 13/21),
- Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 („Official Gazette", No. 25/20),
- Climate Change Adaptation Strategy in the Republic of Croatia for the period until 2040 with an outlook to 2070 („Official Gazette", No. 46/20),
- Long-Term Strategy for the Renovation of the National Building Stock until 2050 („Official Gazette", No. 140/20),
- Low Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050 („Official Gazette", No. 63/21),
- Energy efficiency programme for the decarbonisation of the energy sector (ME, 2021)
- Croatian Hydrogen Strategy until 2050 („Official Gazette", No. 40/22).

In the **building sector,** the Republic of Croatia is strongly committed to achieving an energy-efficient and decarbonised building stock by 2050. To mobilise all stakeholders in the process of building and renovating buildings to achieve the long-term target of reducing $CO_2$ emissions by 80% in the building construction sector by the end of 2050, the Ministry of Physical Planning, Construction and State Assets has initiated a Charter of Cooperation for the Decarbonisation of Buildings by 2050. The contents of the Charter include the achievement of energy and climate targets at the national and EU levels through the decarbonisation of the building stock, renovation of buildings and construction of buildings with almost zero energy, which stresses the importance of further reduction in greenhouse gas emissions, increasing the share of renewable energy sources, improving energy security and introducing innovation and smart technologies that allow the building sector to support the overall decarbonisation of the economy. The signing of the Charter encourages continuous cooperation on the implementation of the Long-Term Strategy for the Renovation of the National Building Stock and the transition to the construction standard of buildings with almost zero energy consumption (nZEB).

The signatories to the Charter support and promote the decarbonisation of buildings in their future activities, wherever possible. By the end of March 2024, 84 stakeholders from the business and public sectors signed the charter[10].

In **the transport sector**, the Republic of Croatia faces the problem of high dependence on fossil fuels and the negative impact of road transport on the environment. The share of electric passenger cars in the total number of registered passenger cars in Croatia is less than 0.3%, which indicates that the market for electric vehicles is still not sufficiently developed. The hydrogen market in the transport sector also has not been developed, and there is no publicly available infrastructure for hydrogen supply.

*The Act on the Deployment of Alternative Fuel Infrastructure* („Official Gazette“, Nos. 120/16, 63/22) stipulates that the joint framework of measures for market development regarding alternative fuels in the transport sector and for the deployment of adequate infrastructure is defined in the *National Policy Framework for Deployment of Alternative Fuel Infrastructure of the Republic of Croatia (NPF)*, which was first adopted in 2017 („Official Gazette“, No. 34/17). It sets minimum targets for building alternative fuels infrastructure, including filling stations, joint technical specifications for filling and supply stations, user notification requirements, and measures needed to achieve national targets. The new NPF is expected to be adopted during 2025, which will set ambitious targets for deploying alternative fuel infrastructure in all transport modes. The initiative in question could lead to a significant increase in the share of vehicles powered by alternative energy sources and a faster development of the market for alternative fuels in Croatia.

Within the decarbonisation dimension, the **agricultural sector** plays an important role - both in the context of its own emissions and its contribution to renewable sources. The Agriculture Strategy until 2030 [12] („Official Gazette“, No. 26/22) defines development needs, strategic goals, areas of intervention, implementation mechanisms and sources of financing. One of the strategic goals in the Agriculture Strategy until 2030 is "strengthening the sustainability and resistance of agricultural production to climate change", within which one of the priorities is reducing vulnerability to climate change and encouraging production with low emissions. The current measures related to the decarbonisation dimension are shown in Table 1-5. The document in which the measure is planned is listed along with the name of each measure.

In the LULUCF sector, the largest sinks are realised in the category 'Forest land' (categorisation methodology according to the IPCC). Forest land accounts for 49.3% of the total area of Croatia (according to the national classification). The LULUCF sector sinks account for 23.7% of national emissions. Forest management and afforestation as tree breeding work are stipulated by forest management plans (FMP). There is relatively little suitable and available forest land for afforestation, which, like all other required forest works in the Forest Management Plans, must obtain the written consent of the ministry responsible for nature protection.

[10] Source:: https://mpgi.gov.hr/o-ministarstvu/djelokrug-50/energetska-ucinkovitost-u-zgradarstvu/povelja-o-dekarbonizaciji-zgrada/8915

**Table 1-5 Current measures within the dimension of "decarbonisation"**

| Measure name | Documents | Short description |
|---|---|---|
| Intersectoral policies and measures | | |
| Strengthening governance to achieve climate goals | Act on Climate Change and Protection of the Ozone Layer („Official Gazette“, No. 127/19), Decision on the establishment of the Commission for Intersectoral Coordination for Policy and Measures for Mitigation and Adaptation to Climate Change from 2018 | The commission is responsible for monitoring and evaluating the implementation and planning of policies and measures for mitigating and adapting to climate change in Croatia. Officials from competent state bodies were appointed to the Commission. The composition of the Commission, its tasks, and its working methods are determined by the Government of the Republic of Croatia based on the proposal of the Ministry responsible for environmental protection. |
| Promotion of the use of innovative information and communication technologies (ICT) to reduce greenhouse gas emissions | Act on Energy Efficiency („Official Gazette“, Nos. 127/14, 116/18, 25/20 and 41/21) | Innovative information and communication technologies are increasingly important in reducing greenhouse gas emissions and increasing energy efficiency. By intensifying their use in public administration, services and production processes, the productivity and efficiency of work will increase and, at the same time, reduce energy consumption and consequent greenhouse gas emissions. The measure is expected to increase the use of innovative ICT, monitor actual energy savings, and reduce greenhouse gas emissions. |
| European emissions trading system | Act on Climate Change and Protection of the Ozone Layer („Official Gazette“, No. 127/19), Regulation on the Method of Trading Greenhouse Gas Emission Units („Official Gazette“, No. 89/20) and Ordinance on the Method of Free Allocation of Emission Units to Plants and on Monitoring, Reporting and Verification of Reports on Greenhouse Gas Emissions from facilities and aircraft („Official Gazette”, No. 89/20) | Through the equal distribution of emission units, obligations to reduce emissions are distributed to system participants from all member states to contribute to the reduction of emissions at the EU level by at least 62% by 2030 compared to the 2005 level. |

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| $CO_2$ emission tax for the non-ETS stationary sources | Regulation on unit fees, correction coefficients and detailed criteria and benchmarks for determining compensation for carbon dioxide emissions into the environment („Official Gazette“, Nos. 73/07, 48/09, 2/18, 46/21) | The Regulation on unit fees, correction coefficients and detailed criteria and standards for determining the fee for the emission of carbon dioxide into the environment („Official Gazette“, Nos. 73/07, 48/09, 2/18, 46/21) prescribes the obligation to pay the fee for the $CO_2$ emission for all stationary sources which emit more than 450 tons of $CO_2$ per year. Fee payers who invest in energy efficiency, RES, and other measures to reduce $CO_2$ emissions and other greenhouse gas emissions are charged a lower fee. The Environmental Protection and Energy Efficiency Fund is authorized to calculate and collect costs. From 2013 onwards, the obligation to pay the $CO_2$ emission fee applies only to sources the ETS does not cover. |
| Covenant of Mayors for Climate and Energy in the Republic of Croatia | | The signatories of the Covenant support a joint vision for 2050: accelerating the decarbonisation of their territories, strengthening their capacity to adapt to the inevitable impact of climate change and allowing citizens to access safe, sustainable, and affordable energy. The Covenant encompasses 168 cities and municipalities, i.e., more than 2 million citizens of Croatia. |
| Charter of Decarbonisation of the National Building Stock by 2050 | | The signatories of the Charter are representatives of the state and local administration, the academic community and the professional public, the construction and energy sector and related industries who support and promote the decarbonization of buildings in their further activities, wherever possible. Through open partner dialogues, partners --Signatories of the Charter are encouraged to actively and continuously cooperate in creating and implementing the Long-Term Strategy for the Restoration of the National Building Fund and the transition to the nearly zero-energy building construction standard (nZEB). |
| RES | | |

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| Feed-in tariffs and a system of premiums to support the use of renewable energy sources in electricity generation and for highly efficient cogeneration | Act on renewable energy sources and high-efficiency cogeneration („Official Gazette“, Nos. 138/21 and 83/23)<br>Act on the Electricity Market („Official Gazette“, Nos. 111/21 and 83/23) | The primary mechanism responsible for the previous development of RES was incentive prices (feed-in tariffs). The Law on RES and high-efficiency cogeneration introduced a premium incentive system. |
| Increased use of renewable energy sources and energy efficiency in the industrial sector | Act on renewable energy sources and high-efficiency cogeneration („Official Gazette“, No. 138/21)<br>Act on Energy Efficiency („Official Gazette“, Nos. 127/14, 116/18, 25/20 and 41/21) | Use of available funds from the EU funds and from auctions of emission units in the EU ETS for the benefit of RES and energy efficiency in the industrial sector. |
| Promoting the use of renewable energy sources and energy efficiency through the Croatian Bank for Reconstruction and Development (CBRD) | Act on renewable energy sources and high-efficiency cogeneration (“„Official Gazette““, Nos. 138/21 and 83/23)<br><br>Act on Energy Efficiency („Official Gazette“, Nos. 127/14, 116/18, 25/20 and 41/21) | The goal of the lending program for environmental protection, energy efficiency and RES projects is to realise investment projects aimed at environmental protection, improving energy efficiency, and encouraging the use of RES. Loans are intended for investments in land, construction facilities, equipment, and devices. The end users of the loan can be local and regional self-government units, communal companies, trading companies, artisans, and other legal entities. |
| Encouraging the use of RES and energy efficiency with revenues from the sale of emission units from the EU ETS | Act on renewable energy sources and high-efficiency cogeneration („Official Gazette“, Nos. 138/21 and 83/23)<br>Act on Energy Efficiency („Official Gazette“, Nos. 127/14, 116/18, 25/20 and 41/21)<br>Act on the Fund for Environmental Protection and Energy Efficiency („Official Gazette”, Nos. 107/03, 144/12)<br>Act on the climate change and ozone layer protection („Official Gazette“, No. 127/19) | Funds for financing are provided from the Fund's reliable income from environmental polluter fees, which include fees for carbon dioxide emissions, fees for burdening the environment with waste, fees for environmental users and special environmental fees for motor vehicles. RES projects for which the Fund for Environmental Protection and Energy Efficiency allocates funds include solar, wind, biomass, and energy from small hydroelectric plants and geothermal energy. |
| Implementation at the local level | Integrated national energy and climate plan for the period from 2021 to 2030 | They are raising awareness about RES, which is expected to result in behavioural change. The target groups are local authorities, interest groups, and the public. |

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| Revitalization, construction and digitization of the energy sector and supporting infrastructure for the decarbonization of the energy sector | National Recovery and Resilience Plan (NPRR) 2021-2026<br><br>Act on the climate change and ozone layer protection („Official Gazette“, No. 127/19) | Accelerating investments in the development of the network in such a way that the existing electricity transmission and distribution system due to the increase in transmission capacity is revitalized, digitized, and upgraded with new capacities due to the increased needs in terms of RES by 2030. In addition to the NPRR funds, the Modernization Fund funds will also be used. |
| Decarbonization of the heating system in the public sector | National Energy Efficiency Action Plan for the period 2022-2024 [13] | Replacement of heating systems that use solid and liquid fossil fuels and co-financing for replacing natural gas with a new, more efficient system that uses RES. Also, encouragement and electrification of heating systems using heat pumps with mandatory production of electricity from photovoltaic systems on the building itself, connection of buildings to existing more efficient DHSs and development of new central heating systems to supply a more significant number of buildings. |
| Transport | | |
| Providing information to consumers on the cost-effectiveness of fuel consumption and $CO_2$ emissions of new passenger cars | Rulebook on the availability of data to consumers on official fuel consumption and official specific $CO_2$ emissions of new passenger vehicles („Official Gazette“, No. 113/21) | The purpose is to provide consumers with data on official fuel consumption and specific carbon dioxide emissions of new passenger vehicles intended for sale or leasing, enabling them to make an informed choice. |
| The obligation to use biofuels in transport | Act on Biofuels for Transport („Official Gazette“, Nos. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18, 52/21) | This Act regulates the production, trade and storage of biofuels, the use of renewable energy sources in transport, the adoption of programs and plans to encourage the production and use of renewable energy sources in transport, the powers and responsibilities for determining and implementing policies to promote the production and use of renewable energy sources in transport, measures to encourage the production and use of renewable energy sources in transport, as well as to promote research and development of new, advanced biofuels that do not compete with crops for food and feed, and establish criteria for sustainability and saving greenhouse gas emissions for |

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| | | biofuels, liquid biofuels and biomass fuels. |
| Special environmental fee for motor vehicles | Decree on Amendments to the Decree on Unit Charges, Corrective Coefficients and Detailed Criteria and Benchmarks for Determining Special Environmental Charges for Motor Vehicles („Official Gazette“, No. 2/21) | This Regulation prescribes unit charges and corrective coefficients based on which the special environmental charge for motor vehicles is calculated, as well as more detailed criteria and standards for determining the particular charge. A special fee is charged considering the type of engine and fuel, the working volume of the engine, the type of vehicle, $CO_2$ emissions and the age of the vehicle. |
| Special tax on motor vehicles | Act on Special Tax on Motor Vehicles („Official Gazette“, Nos. 15/13, 108/13, 115/16, 127/17, 121/19) | Based on the "polluter pays" principle, the calculation model is based on $CO_2$ emissions into the air from motor vehicles. The special tax is determined based on the selling 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 efficient vehicles and vehicles with lower greenhouse gas emissions. |
| Financial incentives for energy-efficient vehicles | National Policy Framework for the Deployment of Infrastructure and Development of Alternative Fuel Market in Transport („Official Gazette“, No. 34/17), | Subsidies for purchasing alternative fuel vehicles through the allocation of grants have been introduced to increase the share of energy-efficient vehicles. These funds are paid from the Protection and Energy Efficiency Fund's revenues realized from the income from the sale of emission units from the EU ETS and the Modernization Fund, among other things, by collecting a special fee for the environment on motor-driven vehicles. |

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| Development of alternative fuels infrastructure | National Policy Framework for the Deployment of Infrastructure and Development of Alternative Fuel Market in Transport („Official Gazette", No. 34/17), Act on Deployment of Alternative Fuels Infrastructure („Official Gazette", Nos. 120/16, 63/22)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette", No. 46/20) | The co-financing incentive that follows the Directive of the European Parliament and the Council of October 22nd, 2014, on the establishment of infrastructure for alternative fuels 2014/94/EU (OJ L 307, October 28th, 2014), Act on Deployment of Alternative Fuels Infrastructure and National Policy Framework for the Deployment of Infrastructure and Development of Alternative Fuel Market in Transport (NPF) and promotes the construction of filling stations by the said documents.<br><br>According to the Adaptation Strategy, it is necessary to implement measure E-06 fully, strengthening the resilience of the distribution network and including climate change in adopting sector strategies, development plans, and programs. |
| Promotion of electromobility and establishment of charging infrastructure in buildings | Act on Construction („Official Gazette", Nos. 153/13, 20/17, 39/19, 125/19)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette", No. 46/20) | The requirements for introducing electromobility by establishing charging infrastructure in buildings are applied to new and existing buildings.<br><br>According to the Adaptation Strategy, it is necessary to implement measure E-06 fully, strengthening the resilience of the distribution network and including climate change in adopting sector strategies, development plans, and programs. |
| Promotion of public procurement of clean vehicles in public road transport | Act on promoting clean vehicles in road transport („Official Gazette", No. 52/21).<br><br>Ordinance on the obligation to report to the European Commission and minimum goals in procedures for the public procurement of vehicles for road transport („Official Gazette", No. 86/21). | It obliges public contracting authorities to consider the effects of energy while procuring specific vehicles for road transport. It is to promote and encourage the market for clean and energy-efficient vehicles and increase the contribution of the transport sector to Union policies related to environmental protection, climate and energy and effects on the environment for the entire working life of the vehicle, including energy consumption and $CO_2$ emissions and emissions of certain pollutants. |

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| Promoting integrated freight transport | Act on Combined Transport of Goods („Official Gazette", No. 120/16)<br>Ordinance on incentives for the combined transport of goods („Official Gazette", No. 5/18) | The Ordinance provides incentives for the combined transport of goods by rail, inland waters or sea and the combined transport of goods on road sections. |
| Monitoring, reporting and verification of greenhouse gas emissions in the life cycle of liquid fuels | Rulebook on monitoring and reporting, the methodology for calculating greenhouse gas emissions during the lifetime of supplied fuels and energy and implementing projects to reduce emissions from oil and gas exploration and production („Official Gazette", No. 131/21). | Monitoring greenhouse gas emissions applies to fuels used to power road vehicles, non-road mobile machinery (including inland waterway vessels when not sailing at sea), tractors for agriculture and forestry, recreational vessels when not sailing at sea and electricity for use in road vehicles. |
| Industrial processes | | |
| Reducing emissions of volatile organic compounds in the solvent utilization sector | Regulation on limit values for contents of volatile organic compounds in certain paints and varnishes used in construction and vehicle finishing („Official Gazette", No. 86/21) | The regulation prescribes limit values for contents of volatile organic compounds which may be placed on the market. Developing and implementing a solvent management plan reduces volatile organic compounds and carbon dioxide emissions. |
| Handling of substances that deplete the ozone layer and fluorinated greenhouse gases | Air Protection Act („Official Gazette", Nos. 127/19, 57/22), Climate Change and Ozone Layer Protection Act („Official Gazette", No. 127/19) and Regulation on Substances that Deplete the Ozone Layer and Fluorinated Greenhouse Gases („Official Gazette", No. 83/21) | It is forbidden to release controlled substances and fluorinated greenhouse gases into the air while collecting, leakage testing, maintenance or servicing of appliances and equipment. |
| Permits issuance, technical and organizational measures for collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases | Act on Climate Change and Protection of the Ozone Layer („Official Gazette", No. 127/19) and Regulation on Substances that Deplete the Ozone Layer and Fluorinated Greenhouse Gases („Official Gazette", No. 83/21) | This set of measures defines how the used controlled substances and fluorinated greenhouse gases in products and equipment must be collected, reused, recovered, or destroyed. |
| Certification and capacity building and strengthening the knowledge of authorized repairers | Ordinance on the training of persons who carry out the activity of collecting, checking leaks, installing, and maintaining or servicing equipment and devices that contain substances that damage the ozone layer or fluorinated greenhouse gases or | Education of authorized repairers on collecting and handling controlled substances and fluorinated greenhouse gases during device and equipment servicing. Service technicians take an exam and are issued a certificate, which lasts indefinitely, but they are obliged to undergo training every five years. |

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| | depend on them („Official Gazette“, Nos. 3/13, 47/14, 61/17, 127 /19) and the Law on Climate Change and Protection of the Ozone Layer („Official Gazette“, No. 127/19) | |
| Leakage detection of controlled substances and fluorinated greenhouse gases | Climate Change and Ozone Layer Protection Act („Official Gazette“, No. 127/19) and Regulation on Substances that Deplete the Ozone Layer and Fluorinated Greenhouse Gases („Official Gazette“, No. 83/21) | Technical measures to prevent or eliminate leakage of controlled substances and fluorinated greenhouse gases |
| A fee to cover the costs of collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases | Act on Climate Change and Protection of the Ozone Layer („Official Gazette“, No. 127/19) and Regulation on Substances that Deplete the Ozone Layer and Fluorinated Greenhouse Gases („Official Gazette“, No. 83/21) | An entrepreneur who imports/introduces controlled substances and/or fluorinated greenhouse gases to place them on the market in the Republic of Croatia or for their own needs must pay a fee to the Environmental Protection and Energy Efficiency Fund. The cost is 0.20 EUR per kilogram of imported/introduced unused controlled substance and/or fluorinated greenhouse gas. |
| Waste management | | |
| Preventing generation and reducing the amount of solid municipal waste | Waste Management Act („Official Gazette“, Nos. 84/21, 142/23), Waste Management Plan of the Republic of Croatia for the period 2023 - 2028 („Official Gazette“, No. 84/23) | The prevention of waste generation is a priority in the order of priority in waste management. Waste prevention and reduction are achieved through reuse procedures, establishing reuse centres, applying by-product instruments, abolishing waste status, and limiting the placing of certain products on the market. The measure should be achieved through cleaner production, education, information and awareness-raising projects on sustainable waste management, economic instruments, implementation of regulations governing waste management and investments in modern technologies that prevent and/or reduce waste generation. |
| Increasing the amount of separately collected and recycled solid municipal waste | Waste Management Act („Official Gazette“, Nos. 84/21, 142/23), Waste Management Plan of the Republic of Croatia for the period 2023 - 2028 („Official Gazette”, No. 84/23) | Quantitative goals and deadlines for increasing the mass of separately collected and recycled waste defined by the Law on Waste Management and the Waste Management Plan of the Republic of Croatia for 2023 - 2028 are incorporated into the measure. |

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| | | Waste management goals encourage the transition to a more circular economy in which the value of products, materials, and resources is retained for as long as possible, and waste generation is reduced to the minimum possible extent. |
| Methane flaring | Act on waste management („Official Gazette“, No. 84/21, 142/23), Ordinance on waste landfills („„Official Gazette““, No. 4/23), Ordinance on waste management („Official Gazette“, No. 106/22) | The Ordinance on Waste Landfills determines the operating conditions of the waste landfill, which reduces the possible harmful effects of the landfill on the environment. Landfill gas is collected from all landfills that receive biodegradable waste. The collected landfill gas should be processed and used. If the collected gas cannot obtain energy, it should be burned to prevent methane emission into the atmosphere. |
| Reducing the amount of disposed biodegradable municipal waste | Waste Management Act („Official Gazette“, Nos. 84/21, 142/23), Waste Management Plan of the Republic of Croatia for the period 2023-2028 („Official Gazette“, No. 84/23) | The measure aims to reduce the mass of biodegradable fraction of waste disposed of in landfills, thereby reducing the methane emission produced by anaerobic waste decomposition processes.<br>According to the Waste Management Act, all permits for waste management in the Republic of Croatia may allow the disposal of a maximum of 264,661 tons of biodegradable municipal waste in one calendar year (35% of the mass of biodegradable municipal waste produced in 1997). |
| Use of biogas for electricity and heat generation. | Low-carbon development strategy of the Republic of Croatia until 2030 with a view to 2050 („Official Gazette“, No. 63/21) | The measure is associated with the "Feed-in tariffs and premium system for the support of the use of renewable energy sources in electricity generation and highly efficient cogeneration" in the chapter "Renewable energy sources". |
| Agriculture | | |
| Anaerobic manure decomposition and biogas production | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | By introducing a biogas plant, emission reduction is achieved by removing methane emissions from the disposal of used waste and producing electricity from renewable sources. The measure is related to the efforts to encourage the use of RES. Anaerobic digestion helps biogas plants reduce the source of readily degradable carbon in fertilizer |

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| | | applied to agricultural land, but it also potentially reduces $N_2O$ emissions from the nitrification process. |
| Improvement of livestock facilities and animal waste management systems | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Covering the place for manure storage – creating a natural layer (crust) with natural (straw) or (porous) artificial material. This measure reduces the direct emission of methane and ammonia. However, to a lesser extent, it improves the nitrification process (porous material) and causes a slight increase in nitrogen oxide emission. |
| Improvement of methods of application of mineral fertilizers | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | This measure applies new slow-acting fertilizers suitable for growing crops (fertilizers coated with polymers). The research indicates the possibility of reducing the need for fertilizer application per hectare (due to lower nitrogen losses) with unchanged or increased income. |
| Hydromelioration interventions and disaster protection systems | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | The construction of drainage, irrigation and protection systems against floods, droughts and other natural disasters can reduce nutrient loss due to leaching and leaching, which results in a reduced need for nitrogen application.<br><br>According to the Adaptation Strategy, it is necessary to implement measures for the P-07 Renovation and construction of buildings for melioration drainage to address adaptation to climate change. |
| Improvement and change of tillage system (reduced tillage) | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Tillage systems have a decisive influence on the parameters necessary for water storage in the soil, generally on water-air relations, water losses through evapotranspiration, the thermal state of the soil, and thus also on microbiological activity and soil respiration. The issue of reducing $CO_2$ emissions from agricultural soils in Croatia has not been sufficiently investigated in local conditions. |

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| | Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | According to the Adaptation Strategy, it is necessary to implement measure P-03 fully. The application of appropriate tillage (e.g., conservation tillage and other methods of reduced tillage among farmers) drainage is needed to address adaptation to climate change. |
| Expansion of crop rotation with greater participation of legumes | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Crop rotation is a system of crop production practised on arable land and represents a regular, spatial and temporal change of crops. The sowing of leguminous crops has multiple beneficial effects for agricultural soils; In this way, atmospheric nitrogen is bound, which is immediately used for protein synthesis, the risk of groundwater pollution with nitrates is prevented, the soil is enriched with organic matter, fertility is maintained, and certain crops (clover) can be effective in sequestering carbon in the soil. |
| Introduction of new cultivars, varieties and species | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | It encourages the development, education, and application of technologies at the national and regional level, facilitating the transition and adaptation of the entire production chain to produce new crops or enabling and encouraging the use of cultivars and varieties that are more resistant to drought and diseases and have a lower carbon footprint. Among other advantages, it aims to reduce the need to introduce nitrogen into the soil through fertilizers.<br>According to the Adaptation Strategy, measure P-04, the Cultivation of species and varieties of agricultural crops for the food and non-food chain and breeds of domestic animals that are more resistant to climate change should be fully implemented to address adaptation to climate change. |

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| Improvement of methods of application of organic fertilizers | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Research on increasing carbon sequestration in the soil by improving the methodology of applying organic fertilizers. Organic fertilizers stimulate the activity of soil microbes much more strongly than mineral fertilizers, and with them, much less salt and acids are introduced into the soil. |
| Agroforestry | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | It defines the potential and benefits of various agroforestry technologies to increase carbon sequestration in the soil. Agroforestry includes technologies applied in forestry and agriculture to create higher productivity, economic justification, ecological acceptability, and sustainable land use.<br><br>According to the Adaptation Strategy, it is necessary to fully implement measures ŠU-01, ŠU-02, ŠU-03, ŠU-04, ŠU-05, ŠU-06, ŠU-07, ŠU-08, ŠU-09, ŠU-10, ŠU -11, ŠU-12. to address climate change adaptation in the entire forestry sector. The negative impact of climate change on the forestry sector is significant. |
| Changing life habits | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | A significant reduction in emissions can be achieved by changing the lifestyles and styles of individuals. The goal is to encourage changes in consumer habits, food habits in the direction of including/using more food of plant origin, habits related to transport and travel, ways of using and owning various devices in households, etc., which can be expressed through the reduction of an individual's carbon footprint. |
| Collection and processing of pruning residues for use for energy purposes | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Optimization of the collection of pruned biomasses of permanent plantations, production of safely available biomass, activation of poorer quality soil in the Republic of Croatia, ensuring a low-carbon energy source during the process of heat and/or electricity production (increasing the share of RES, reducing $CO_2$ emissions). |
| LULUCF | | |

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| Creation of the Land Management Strategy of the Republic of Croatia | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Ongoing activities:<br>1. Establish a unique land information system in the Republic of Croatia<br>2. An analysis project of all LULUCF land categories depending on the cover, land use and management practices used on each land and related emissions/abysses is being implemented to consider the potential of each of the storage areas within each LULUCF land category to reduce emissions, and increase in the sink of greenhouse gases<br>3. A project to strengthen projections in the LULUCF sector is being implemented |
| Carbon accumulation on the surfaces of existing forests | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21)<br><br>Forest economic base of the area for the period 2016-2025 | Implement activities that contribute to increasing the content of carbon stock in forests, especially in biomass storage, and implement activities that ensure removals in a particular period greater than those defined by the reference level for forests (FRL).<br>Realization occurs under the Forestry Economic Basis of the Area for 2016-2025. |

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| Implementation of afforestation works | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21)<br>Forest economic base of the area for the period 2016-2025<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | Afforestation in non-forest areas (in terms of the IPCC methodology) is an activity that generates abysses. The Republic of Croatia cannot dispose of all grassland areas (according to the national regulation: non-vegetated productive forest land) for afforestation due to the assumed obligations related to preserving particular habitat types of interest to the European Union. Given that there are agricultural areas in the Republic of Croatia where production does not take place and which have been neglected for many years, the problem of these areas must be adequately addressed when creating the Land Management Strategy. It is necessary to evaluate the justification for converting these areas into forest areas by implementing afforestation. There is also a need to assess the effects of the afforestation of additional non-vegetated, productive forest land on fulfilling the obligations of the Republic of Croatia related to the use of renewable energy sources. It is necessary to create guidelines for further development based on the knowledge and experience gained through implementing afforestation activities.<br>According to the Adaptation Strategy, it is necessary to fully implement measures ŠU-07 Afforestation and forest restoration to strengthen resistance to climate change to address adaptation to climate change in the entire forestry sector. The negative impact of climate change on the forestry sector is significant. |

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| Production and use of wood and wood products | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21)<br><br>Forrest economic base of the area for the period 2016-2025 | By harmonizing available data and statistical reports, as well as new research, it should coordinate the information available for the needs of various accounts to international organisations with the aim of more accurate, transparent, and high-quality reporting, but also to create a harmonised basis for adopting medium- and long-term strategies in the forestry and wood processing sector. It includes the mapping of forestry and wood industrial production. Encourage using traditional and new wood products to increase outflow and reduce greenhouse gas emissions when storing wood products. It also requires the regulation of the export of untreated and semi-processed wood, which encourages the development of the domestic wood industry, and the regulation of the export of energy wood increases the share of energy production from renewable sources, which fulfils the assumed international obligations. It is necessary to promote activities that generate outflows and ensure that wood products and wood for energy purposes are used in ways that contribute to meeting both EU goals by 2030 (reducing emissions and increasing the share of renewable sources in total energy consumption) and are helpful for the climate environment. It is necessary to create guidelines for further development based on the knowledge and experience gained through implementing this measure. |
| Management of agricultural land | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | This measure implements activities in managing areas for agricultural production in a way that contributes to reducing emissions and increasing abysses. It is necessary to promote activities that benefit the climate and the environment and to create guidelines for further development based on the knowledge and experience gained through implementing this measure. |

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| Pasture management | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | This measure implements activities in the management of pastures in a way that contributes to reducing emissions and increasing abysses. It is necessary to promote activities that benefit the climate and the environment and to create guidelines for further development based on the knowledge and experience gained through implementing this measure. |
| Implementation of technical projects and scientific research in the LULUCF sector | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 (“„Official Gazette““, No. 63/21)<br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | Until 2030 and 2050, it is necessary to secure financial resources to implement technical and scientific projects in the LULUCF sector. Scientific projects should enable different models for moving to a higher level of the IPCC methodology (Tier 3) to determine the emissions/abysses of greenhouse gases as accurately as possible and consequently plan measures to reduce emissions and increase abysses.<br>According to the Adaptation Strategy, it is necessary to fully implement the measures ŠU-03 Strengthening the capacity for systematic monitoring and reporting of the state of forest ecosystems as a prerequisite for informed planning and implementation of adaptation to climate change, ŠU-06 Prediction (prognosis) of changes in the distribution of harmful organisms, ŠU-10 Risk assessment and the development of tools that ensure the constant adjustment of agricultural land and forest management to reduce damage from natural and elemental disasters, ŠU-12 Define communities and forest areas that are most susceptible to possible changes and define measures to reduce the threat of the most vulnerable forest areas and communities, P -01 Implementation of a pilot-research program of adaptation to climate change in agriculture to address adaptation to climate change in the entire forestry and agriculture sector. The negative impact of climate change on the forestry and agriculture sector is significant. |
| Fugitive emissions | | |

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| Modernization of refineries | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | This measure implements investments in the modernization and improvement of production to maintain the competitiveness of refineries and reduce fugitive emissions from refineries. |
| Measures to increase energy efficiency by improving processes and process units | Low-carbon development strategy of the Republic of Croatia for the period up to 2030, with a view to 2050 („Official Gazette“, No. 63/21) | Increase energy efficiency by implementing measures that reduce energy intensity through the more rational use of energy and raw materials and changes in production processes and equipment at pumping stations and in refineries, which contribute to reducing fugitive emissions. |

The existing legislative framework will be revised in order to take into account the new goals and new obligations defined by the Decarbonised Gases and Hydrogen Package and the Regulation on the Establishment of the Social Fund for Climate Policy:
DIRECTIVE (EU) 2024/1788 OF THE EUROPEAN PARLIAMENT AND COUNCIL of June 13th, 2024 on common rules for the internal market of gas from renewable sources, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/ EZ (amendment) (SL L, 2024/1788, July 15th, 2024),

REGULATION (EU) 2024/1789 OF THE EUROPEAN PARLIAMENT AND COUNCIL of June 13th, 2024 on the internal market of gas from renewable sources, natural gas and hydrogen, amending Regulations (EU) No. 1227/2011, (EU) 2017/1938, (EU) 2019/942 and (EU) 2022/869 and Decisions (EU) 2017/684 and repealing Regulation (EC) no. 715/2009 (amendment) (OJ L, 2024/1789, July 15th, 2024),

DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND COUNCIL of October 18th, 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC with regard to the promotion of energy from renewable sources and repealing Council Directive (EU) 2015/652 (OJ L, 2023/2413, October 31st, 2023),

REGULATION (EU) 2023/955 OF THE EUROPEAN PARLIAMENT AND COUNCIL of May 10th, 2023 on the establishment of the Social Fund for Climate Policy and on the amendment of Regulation (EU) 2021/1060 (OJ L 130, May 16th, 2023, pp. 1–51),

REGULATION (EU) 2024/1679 OF THE EUROPEAN PARLIAMENT AND COUNCIL of, June 13th, 2024 on Union guidelines for the development of the trans-European transport network, amending Regulation (EU) 2021/1153 and Regulation (EU) no. 913/2010 and repealing Regulation (EU) no. 1315/2013 (OJ L, 2024/1679, June 28th, 2024),

REGULATION (EU) 2023/1804 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of September 13th, 2023 on the introduction of infrastructure for alternative fuels and repealing Directive 2014/94/EU (OJ L 234, September 22nd, 2023, pp. 1–47),

REGULATION (EU) 2023/1805 OF THE EUROPEAN PARLIAMENT AND COUNCIL of September 13th, 2023 on the use of renewable and low-carbon fuels in maritime transport and amending Directive 2009/16/EC (OJ L 234, September 22nd, 2023, p. 48–100),

REGULATION (EU) 2023/2405 OF THE EUROPEAN PARLIAMENT AND COUNCIL of October 18th, 2023 on ensuring equal conditions of competition for sustainable air transport (ReFuelEU Aviation) (OJ L, 2023/2405, September 31st, 2023),

COUNCIL REGULATION (EU) 2022/2577 of December 22nd, 2022 on establishing a framework for accelerating the introduction of energy from renewable sources (OJ L 335, December 29th, pp. 36–44).

## Dimension 'Energy Efficiency'

Energy efficiency in the Republic of Croatia is regulated by:

- Energy Efficiency Act („Official Gazette“, Nos. 127/14, 116/18, 25/20, 32/21, 41/21),
- Building Act („Official Gazette“, Nos. 153/13, 20/17, 39/19, 125/19),
- Act on Protection against Light Pollution („Official Gazette“, No. 14/19),
- Act on the Fund for Environmental Protection and Energy Efficiency („Official Gazette“, No. 107/03, 144/12),
- Act on Public Procurement („Official Gazette“, No. 120/16, 114/22),
- Energy Act („Official Gazette“, No. 120/12, 14/14, 102/15, 68/18),
- by-laws following these Acts.

The national energy efficiency increase targets until 2020 and 2030 are defined in the Energy Efficiency Act. The 2030 targets are based on the first version of the NECP and are further set out in the National Energy Efficiency Action Plan (NEEAPEnU) for 2022-2024. The targets are expressed as the absolute amount of final energy consumption in 2030, which should amount to 286.9 PJ (6.85 Mtoe) or primary energy in 2030 344.4 PJ (8.23 Mtoe). The targets expressed as the absolute amount of primary and final energy consumption are shown in Figure 1-5.

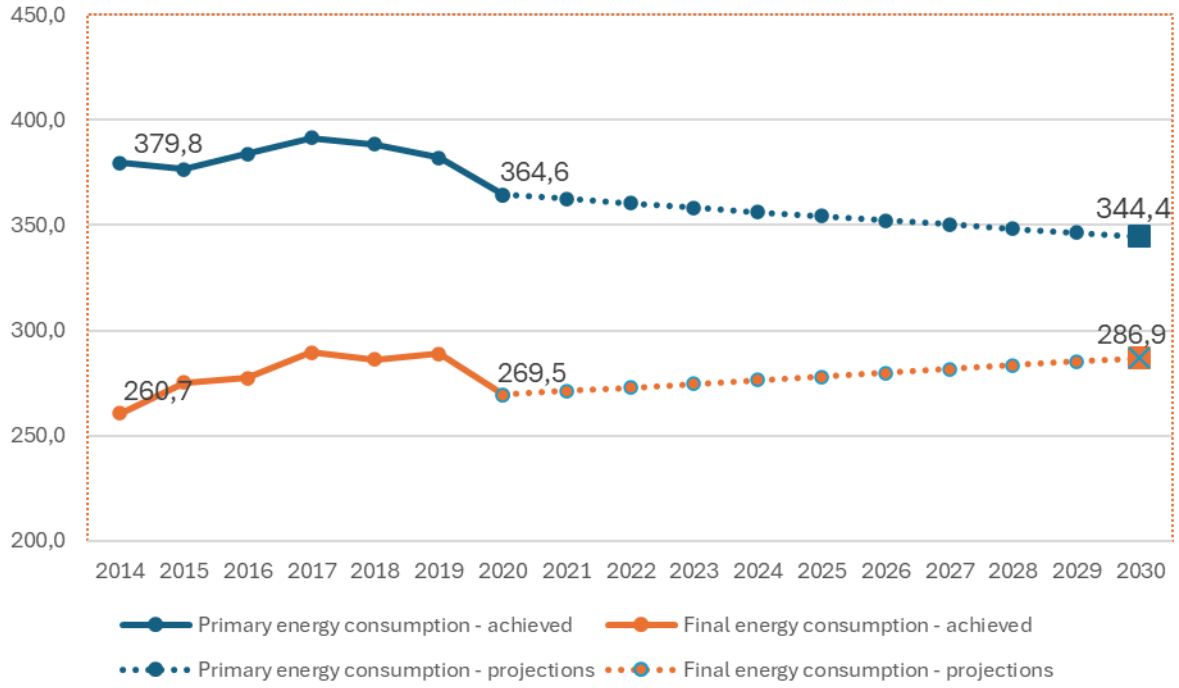


**Figure 1-5 Indicative trend of achieved energy consumption from 2014 to 2020 and consumption projections from 2021 to 2030 with existing measures**

Source: NEEAPEnU from 2022 to 2024

An overview of the regulatory measures defined in the laws mentioned above and relevant by-laws is shown in Table 1-6. The laws mentioned above and regulations in Croatia meet the requirements of the following EU directives:

- Directive 2012/27/EU of the European Parliament and of the Council of October 25th, 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (Text with EEA relevance (OJ L 315, Nov 14th, 2012) - (hereinafter: Directive 2012/27/EU on energy efficiency);
- Directive (EU) 2018/02 of the European Parliament and of the Council of December 11th, 2018 amending Directive 2012/27/EU on energy efficiency (Text with EEA relevance) (OJ L 328, Dec 21st, 2018) - (hereinafter: the Energy Efficiency Directive);
- Directive 2010/31/EU of the European Parliament and of the Council of May 19th, 2010 on the energy performance of buildings (recast) (OJ L 153, Jun 18th, 2010.);
- Directive (EU) 2018/844 of the European Parliament and of the Council of May 30th, May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance) (OJ L 156, Jun 19th, 2018) (hereinafter: the Directive on Energy Performance of Buildings);
- Directive 2010/30/EU on the presentation of energy consumption and other resources of energy-related products using labels and standardized product information (amendment) (Text relevant to the EEA) (OJ L 153, Jun 18th, 2010), i.e. Regulation 2017 /1369 on

establishing the framework for labeling energy efficiency and repealing Directive 2010/30/EU (Text relevant to the EEA. ) (OJ L 198, Jul 28th, 2017);

- Directive 2009/125/EC of the European Parliament and of the Council of 21st October 2009 establishing a framework for setting eco-design requirements for energy-related products (recast) (Text with EEA relevance) (OJ L 285, Oct 31st, 2009).

The existing legislative framework will be revised to take into account the new goals and new obligations defined in the following EU directives:

- Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast) (Text with EEA relevance) (OJ L 231, Sept 20th, 2023)
- Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (Text with EEA relevance) (OJ L, 2024/1275, May 8th, 2024).

**Table 1-6 Overview of existing regulatory measures for energy efficiency**

| **Energy Efficiency Act** |
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| The obligation of the Government of the Republic of Croatia to adopt the National Energy Efficiency Action Plan for three years with measures to be implemented on the entire territory of the Republic of Croatia under the Integrated National Energy and Climate Plan (NECP), which defines alternative policy measures including measures to ensure the annual renovation of 3% of the total floor area of heated and/or cooled buildings owned and used by the central government. |
| The obligation of counties and large cities (> 35,000 inhabitants) to adopt (three-year) Action Plans and annual energy efficiency plans. |
| Energy efficiency obligation scheme for energy suppliers – encourages the implementation of energy efficiency measures in households affected by energy poverty or in social housing spaces. |
| Suppliers must measure and account for consumption and inform customers about past consumption, including comparison with the average normal or reference final customer from the same category of final customers. |
| The obligations of energy distributors are to enter monthly data on metering and consumption of energy in the public sector in the national Energy Management Information System (ISGE) and to provide individual meters to final customers. |
| The obligations of the Energy Regulatory Authority are to promote energy efficiency through tariffs and provide incentives to improve efficiency in the planning and operation of natural gas and electricity infrastructure. |
| The obligations of transmission and distribution system operators are to provide network access and transmission and distribution of electricity produced from high-efficiency cogeneration. |
| The obligations of large enterprises to implement energy audits every four years include introducing an energy management system - The Ordinance on energy audits for large enterprises („Official Gazette“, Nos. 123/15, 5/20, 97/21). |
| The public sector must conduct energy audits of public lighting systems every five years and maintain and reconstruct public lighting in such a way as to reduce electricity consumption and meet other requirements prescribed by the Act on Protection against Light Pollution („Official Gazette“, No. 14/19) and the regulations arising from it. |

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| The public sector must systematically manage energy, which implies the appointment of a responsible person for energy management, regular monitoring of energy consumption and the entry of data on energy consumption into the National Information System for Energy Management (ISGE) - Ordinance on Systematic Energy management in the public sector („Official Gazette“, Nos. 18/15 and 06/16). |
| The obligation is to report all energy efficiency activities and realized savings in the national system for monitoring, measuring and verification of savings (SMiV) for the public sector, energy service providers and subsidy providers - Ordinance on the system for monitoring, measuring and verification of energy savings („Official Gazette“, Nos. 98/21, 30/22). |
| The competent ministries and the National Coordinating Body (NKT) must establish and run an energy efficiency platform - National Energy Efficiency Portal: https://www.enu.hr/. |
| Energy-related device labelling obligation - relevant EU regulations for individual groups of devices. |
| Regulation of energy services (energy performance contracts) in the public sector - Regulation on contracting and implementation of energy services in the public sector („Official Gazette“, No. 11/15) |
| It regulates the contracting of multi-apartment building energy services and energy renovation works. It determines the adoption of a decision on energy renovation based on a simple majority of votes of co-owners, which is calculated by co-ownership parts. |
| The obligation is to use energy efficiency criteria in public procurement procedures for energy-related products - Ordinance on energy efficiency requirements in public procurement procedures („Official Gazette“, No. 70/15). |
| The obligation is to meet the requirements for eco-design of energy-related products when placed on the market - Ordinance establishing conditions for eco-design of energy-related products („Official Gazette“, No. 50/15). |
| Ordinances on conditions and criteria for determining the quality-of-service systems and works for certification of installers of renewable energy sources - photovoltaic systems („Official Gazette“, No. 56/15); solar thermal systems („Official Gazette“, Nos. 33/15, 56/15 and 12/17); smaller biomass boilers and stoves („Official Gazette“, Nos. 39/15, 56/15 and 12/17); shallow geothermal systems and heat pumps („Official Gazette“, Nos. 56/15 and 12/17). |
| **Construction Act** |
| Energy management and heat conservation are essential requirements for buildings - Technical regulation on rational energy use and thermal protection in buildings („Official Gazette“, Nos. 128/15, 70/18, 73/18, 86/18 and 102/20). |
| Minimum energy performance of buildings, method of determining the energy performance of buildings, presentation of the technical, environmental, and economic feasibility of available high-efficiency alternative energy supply systems, equipping buildings with automation systems, and requirements for nearly zero-energy buildings. |
| The Government should adopt the Long-Term Strategy for the Renovation of the National Building Stock of the Republic of Croatia at the proposal of the Ministry responsible for the construction and update it every five years. |
| According to the proposal of the ministry responsible for construction affairs, the government should adopt energy renovation programs for buildings from 2021 to 2030. |
| The government should adopt the Green Infrastructure Development Program from 2021 to 2030, per the Ministry's proposal responsible for construction affairs. |
| According to the Ministry Responsible for Construction Affairs proposal, the government should adopt the Circular Management programme for spatial buildings from 2021 to 2030. |
| Promoting electromobility and establishing charging infrastructure in new buildings and buildings undergoing significant renovation for residential and non-residential buildings. |

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| The obligation is to regularly inspect heating and cooling or air conditioning systems in buildings and energy certification of buildings. |
| Ordinance on energy audit of buildings and energy certification („Official Gazette“, Nos. 88/17, 90/20, 1/21 and 45/21). |
| Ordinance on the control of the energy certificate of the building and the report on regular inspection of heating systems and cooling systems or air conditioning in the building („Official Gazette“, Nos. 73/15 and 54/20). |
| Ordinance on persons authorized for energy certification, an energy audit of buildings and regular inspection of heating systems and cooling or air conditioning systems in buildings („Official Gazette“, Nos. 73/15, 133/15, 60/20 and 78/21). |
| **Act on Protection against Light Pollution** |
| When planning, designing, constructing, maintaining, and reconstructing outdoor lighting, which is approved under the law governing construction, such technical solutions must be selected by the lighting project to ensure energy efficiency; local self-government units are obliged to adopt a lighting plan as well as an action plan for the construction/reconstruction of lighting; the Ordinance prescribes energy efficiency criteria for lighting. |
| Ordinance on the content, format, and manner of drafting a lighting plan and action plan for the construction and/or reconstruction of outdoor lighting („Official Gazette“, No. 22/23). |

In addition to regulatory measures, other energy efficiency measures are being implemented in Croatia, according to three-year national action plans. The last NAPEnU was prepared for the period from 2022 to 2024. The measures from this NAPEnU implemented in Croatia at the time of preparation of this updated NECP are presented in Table 1-7. These are mainly measures of financial incentives through grant mechanisms or financial instruments from national sources (the Environmental Protection and Energy Efficiency Fund) and EU sources (Recovery and Resilience Mechanism (MOO); funds are used under the National Recovery and Resilience Plan (NPRR); European Regional Development Fund (ERDF)).

**Table 1-7 Overview of existing non-regulatory energy efficiency measures by sectors of final consumption (excluding transport)**

| Name of the measure | Category of measure | Short description |
|---|---|---|
| Households | | |
| Energy renovation of multi-apartment buildings by 2030 | Financial: grants; financial instrument | Based on the Construction Act, the Government of Croatia adopted the program in December 2021. The program includes energy renovation of multi-apartment buildings damaged and multi-apartment damaged by the earthquake to reduce energy consumption and increase the safety and resilience of existing multi-apartment buildings to fire and earthquake. For the energy renovation of multi-apartment buildings undamaged in the C6 earthquake. NPRR initiatives: Renovation of buildings, i.e., investments C6.1. R1-I1 Energy renovation of buildings, allocation in the amount of EUR 39.8 million was ensured, and in 2022, a call is published and being implemented to allocate funds. The ERDF has provided EUR 89 million as a financial instrument for this programme. In addition, the EPEEF tool will be used based on the conclusion of the Government of the Republic of |

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| | | Croatia on measures to mitigate the energy crisis. With the addition of NPRR (RePowerEU), an additional EUR 120 million has been secured to implement this program, and a new call was published in 2024.<br><br>A total of EUR 54.5 million has been provided for the energy renovation of multi-apartment buildings damaged in earthquakes within the framework of the NPRR and the Supplement to the NPRR. |
| Program of energy renovation of family houses until 2030 | Financial: Grants | It is planned to use the funds from the sale of emission units from the EU ETS for the allocation of grants to the owners of family houses, which was confirmed by the conclusion of the Government of the Republic of Croatia on measures to mitigate the energy crisis. |
| An energy poverty curb programme involving the use of renewable energy sources in residential buildings in assisted areas and areas of special state concern for the period up to 2025 | Financial: Grants | The Government of the Republic of Croatia adopted the program in December 2021. The goal of the program is to renovate and install renewable energy sources in 387 residential buildings owned and managed by the Ministry of Physical Planning, Construction and State Assets. The NRRP provides funds for the program's implementation of around EUR 20 million, and the state budget provides other necessary funds. The Ministry of Physical Planning, Construction and State Assets has fully implemented the program. With the addition of NRRP (RePowerEU), an additional EUR 68,41 million was provided to implement this program. |
| Public sector | | |
| Energy renovation of public sector buildings by 2030 | Financial: ESCO model and grants | Based on the Construction Act, the Government of Croatia adopted the program in April 2022. NRRP secured grants of EUR 39.8 million (HRK 300 million), and EUR 33.2 million was provided for the implementation of the renovation through the ESCO model through the direct allocation of funds to the APN. Another EUR 185 million will be available from the ERDF as grants. With the addition of NRRP (RePowerEU), an additional EUR 33.18 million was secured for implementing this program through the ESCO model and EUR 60.18 million for the energy renovation of public buildings. |
| Energy renovation of buildings that have the status of cultural property by 2030 | Financial: Grants | The Government of the Republic of Croatia adopted the program in December 2021 based on the Construction Act. The funds are secured from the NRRP of EUR 39.8 million as grants. |
| Systematic energy management in the public sector | Informative | The programme is implemented by the APN and is based on the public sector's obligation to systematic energy management; savings in this program are the result of organizational and information measures.<br><br>In addition, APN started with implementing the Pilot Project to establish and implement systematic energy management and develop a new financing model, which extends the good practice of ISGE to residential buildings. Funds from the NRRP of EUR 1.6 million for this pilot project have been secured. |

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| Programme "Energy Efficient Public Lighting" | Financial: Affordable loans | The available funds from the ERDF to the OPCC 2014-2020 are EUR 20 million for energy renovation of public lighting systems; the program is implemented through lending provided by HBOR. |
| "Green" Public Procurement | Voluntary agreements and cooperative instruments | The Government of the Republic of Croatia adopted in 2021 the Decision on Green Public Procurement in central public procurement procedures („Official Gazette“, No. 49/21) set an obligation on the Central Office for Central Public Procurement to use green public procurement benchmarks to purchase green products and services. |
| Industry | | |
| Increasing energy efficiency and use of RES in manufacturing industries | Financial: Grants Affordable loans | The aim is to support the implementation of energy efficiency measures and/or measures for the use of renewable energy sources that will lead to a reduction in the consumption of delivered energy in production facilities by at least 20% compared to the reference energy delivered by continuing co-financing with grants that started in the period OPCC 2014-2020. To this end, EUR 60.9 million has been secured from the NRRP, and EUR 150 million will be additionally available as a financial instrument from the ERDF. Additional funds will also be provided from the Modernisation Fund. |

In addition to the above measures, the existing documents define several measures to provide information and education, as shown in the Table below.

**Table 1-8 Overview of existing intersectoral measures for energy efficiency**

| Name of the measure | Category of measure | Short description |
|---|---|---|
| Promoting nZEB standards of construction and renovation | Informative | This measure supports the legal obligation and includes educating and informing both the participants in the construction and the general public about the nZEB standard of construction and renovation. |
| Informative calculations | Regulatory Informative | Obligations of the supplier regarding measurement and calculation of consumption and informing customers about past consumption, which includes a comparison with the average normal or reference end customer from the same category of end customers of the supplier. |
| Awareness campaigns and promotion of energy services | Informative | Implement targeted promotional campaigns related mainly to co-financing programmes for energy renovation of buildings and promoting energy services through the national energy efficiency portal; inform consumers about the duties of suppliers under the scheme of obligations. |
| Energy efficiency education | Educational | Establish a certification system and provide lifelong learning to construction workers about energy efficiency. |

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| Integrated information system for monitoring energy efficiency | Informative - Monitoring the implementation and achieving energy savings | A comprehensive system for monitoring the performance of energy efficiency measures and verification of achieved savings. |

In addition to the above measures, all directed at the sectors of final energy consumption, the existing documents also define measures aimed at the energy infrastructure (generation, transmission and distribution of electricity and heat), as shown in Table 1-9. It should be noted that the Croatian Energy Regulatory Agency (CERA), based on the Energy Efficiency Act, is obliged to consider energy efficiency concerning its decisions on the operation of gas and electricity infrastructure when carrying out regulatory tasks under the laws regulating the electricity market and the gas market, namely:

- to ensure the implementation of an assessment of the potential for increasing energy efficiency of the gas and electricity infrastructure, in particular regarding transmission, i.e. transport, distribution, load management, interoperability and connection of energy generation facilities, including possibilities of access for energy microgenerators and
- to identify specific measures and investments to introduce cost-effective energy efficiency improvements into grid infrastructure, including deadlines for their introduction.

To carry out the stipulated tasks, the CERA has ensured the preparation of the study "*Assessment of Potential for Increasing Energy Efficiency of the Electricity Infrastructure*" [14]. The study has analysed measures that affect technical losses (decrease and increase), covered in the ten-year transmission and distribution system development plans.

These measures arise from the need to increase the safety of operations and to meet technical regulations, and related investments are too high to be justified exclusively by the savings that will be achieved by reducing losses. When prerequisites for introducing advanced technologies, such as load management, are created, the CERA will revise its assessment of the potential for increasing energy efficiency of the electricity infrastructure and determine deadlines for introducing advanced measures.

**Table 1-9 Overview of existing energy efficiency measures for energy infrastructure**

| Name of the measure | Category of the measure | Short description |
|---|---|---|
| Energy efficiency for decarbonisation of the energy sector | Heat production | The measure focuses on modernizing DHS production facilities by achieving diversification of thermal energy sources. Efforts to achieve this include replacing natural gas boilers with water/water heat pumps, high-efficiency natural gas cogeneration, industrial waste heat exploitation, energy utilisation of waste, solar energy utilisation, high-efficiency biomass cogeneration, biomass boiler rooms and geothermal energy utilization.<br>A comprehensive assessment of the potential for efficient heating and cooling in Croatia has shown that the measure that is the most significant in terms of savings and requires public support is geothermal energy. EUR 29 million is foreseen to be used to prepare geothermal energy projects in DHS through the Recovery and Resilience Mechanism. |
| Increasing the efficiency of the district heating system | Heat distribution | In the existing large district heating systems, a significant source of losses is the dilapidated distribution network, and this measure envisages the continuation of the replacement of hot water pipelines and steam pipelines with worn-out insulation of steel pipelines with new pre-insulated pipes and a technological shift towards the fourth generation of district heating. In smaller systems with boiler rooms, it is necessary to enable the reconstruction of boiler rooms, mainly by replacing them with high-efficiency cogeneration systems or systems that use heat pumps. The measure also envisages the development of new heating and cooling systems which use high-efficiency cogeneration or renewable energy sources. Given the provisions of Directive on energy efficiency, and with the introduction of the obligation of individual measurement at the level of the final consumer, district heating systems have become systems with variable demand for heat energy, which requires the introduction of advanced metering systems as an additional step in the integration of different energy systems and increasing overall energy efficiency.<br>Investments are insured by utility companies and against the use of EU funds, according to OPCC 2014-2020, of EUR 80 million. Additionally, through the Integrated Territorial Program 2021 - 2027, an additional EUR 12 million was secured for the project "Revitalization of the hot water network of the city of Zagreb" (25 km network) as phase II of the previous project in OPCC. |

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| Loss reduction and transmission network development | Power grids | The current cost of losses in the transmission network of the Republic of Croatia amounts to about 2% of the transferred electricity, which is the amount at the level of other ENTSO-E transmission system operators. An essential characteristic of the Croatian transmission network, both from operational safety and support of market activities, as well as from losses, is a powerful connection with neighbouring power systems (interconnections). On the one hand, this significantly increases the plant's safety; on the other hand, network losses increase due to transit. This measure implies the optimization of the topology of the transmission network, the reduction of losses, and the development of network capacity.<br>According to the adopted amendments to the Energy Efficiency Act in September 2021, the Ordinance on the system for monitoring, measuring and verifying savings („Official Gazette“, No. 41/21). Until 2030, CTSO will continue to implement measures related to the management of EES plants and actions associated with developing the transmission network for optimal (safe and efficient) plant operation. In addition to CTSO providing funds, this measure is proposed to program the use of EU funds. |
| Reducing losses in the distribution power grid and introducing advanced grids | Power grids | The measure implies the reduction of losses in the distribution network and the introduction of advanced benchmarks for end consumers by the HEP-Distribution System Operator (HEP ODS). Until 2030, HEP-DSO will continue to carry out activities to reduce technical and non-technical losses in the distribution power grid. Detailed analysis will determine the causes of increased losses in certain network parts and priorities for implementing activities to reduce technical and non-technical losses.<br>According to the adopted amendments to the Energy Efficiency Act in September 2021, the Ordinance on the system for monitoring, measuring and verification of savings („Official Gazette“, No. 41/21) was adopted, according to which the DSO is obliged to achieve measures to improve energy efficiency in the distribution network into the system for measuring, monitoring and verification of savings.<br>For the project "Modernization of the Croatian distribution electric power network", 156.3 million EUR of EU grants were allocated (a project with a total value of 285.6 million EUR) for advanced meters, network automation, better connection of the mainland with the islands and in the NATURA 2000 area through NPOO, as and additional EUR 70 million from REPower funds for advanced meters. |

## Dimension "Energy security"

Key legislation relevant to the dimension of energy security:

- Energy Act („Official Gazette“, Nos. 120/12, 14/14, 102/15, 68/18),
- Electricity Market Act („Official Gazette“, No. 111/21, 83/23),
- Gas Market Act („Official Gazette“, Nos. 18/18, 23/20),
- Oil and Petroleum Products Market Act („Official Gazette“, Nos. 19/14, 73/17, 96/19),
- Act on the Thermal Energy Market („Official Gazette“, No. 80/13, 14/14),
- Act on the Liquefied Natural Gas Terminal („Official Gazette“, No. 57/18, 83/23),
- Act on Regulation of Energy Activities („Official Gazette”, No. 120/12, 68/18),
- Act on Cyber security („Official Gazette”, No. 14/24),
- Act on Critical infrastructures („Official Gazette”, no. 56/13, 114/22),
- Act on the Regulation of Energy Activities („Official Gazette“, No. 120/12, 68/18),
- Act on Exploration and Exploitation of Hydrocarbons („Official Gazette“, Nos. 52/18, 52/19, 30/21).

The most critical measures currently being implemented to ensure energy security are shown in Table 1-10.

**Table 1-10 Existing measures to ensure energy security**

| Name of the measure | Documents | Short description |
|---|---|---|
| Preparing and publishing the report on the security of the electricity supply | Electricity Market Act („Official Gazette“, No. 111/21)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | The Transmission System Operator and the Distribution System Operator shall, no later than 31st March of the current year, submit to the Croatian Energy Regulatory Agency (CERA) for an opinion on an annual report on the security of supply in the transmission system or the distribution system for the preceding calendar year. Based on these reports, the Ministry prepares its annual report on the security of electricity supply and expected electricity needs in the Republic of Croatia for the next ten-year period. In cooperation with the Ministry, CERA may, based on those reports, require transmission system operators, distribution system operators |

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| | | and other electricity entities to implement specific measures in case there is a need to improve the security of the electricity supply. The above also applies to the entire segment of adaptation of the energy system to climate change following SPKP.<br>According to the Adaptation Strategy, measures E-01, E-02, E-03, E-04, E-05, E-06, and E-07 should be fully implemented to address adaptation to climate change in the entire energy sector and show vulnerability to climate change as well as suggested measures of adaptation to climate change. The negative impact of climate change on the energy sector is significant and constantly growing. The reports should contain the results of implementing these measures and activities. |
| Prescribing technical regulations, requirements and conditions for the safety and use of energy | Electricity Market Act („Official Gazette“, Nos. 111/21, 83/23)<br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | The Minister, with the prior approval of the Minister for Construction Affairs, prescribes technical regulations, requirements and conditions for the safety and use of energy for the protection of low-voltage networks and associated transformer stations, measures for the operation and maintenance of power plants, for the construction of overhead power lines with rated voltages from 1 kV to 400 kV, construction, use and maintenance of overhead power lines and power plants of rated AC voltage up to 1 kV and use and maintenance of low-voltage installations. According to the Adaptation Strategy, measures E-03, E-04, E-05, E-06, and E-07 need to be fully implemented to |

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| | | address adaptation to climate change in the entire energy sector and indicate vulnerability to climate change and proposed adaptation measures climate changes. The negative impact of climate change on the energy sector is significant and constantly growing. Technical regulations should contain the results of implementing these measures and activities. |
| Preparation and publication of reports of the transport system operator | Gas Market Act („Official Gazette“, Nos. 18/18, 23/20)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | The transmission system operator (PLINACRO d.o.o.) is obliged to prepare and submit a report for the previous year to CERA by 1st March of the current year, which must contain a report on the reliability, safety and efficiency of the transmission system, gas quality, quality of service, reliability of gas delivery, technical characteristics of the system, use of transmission system capacity, maintenance of system equipment and fulfilment of other duties and exercise of rights from this Act.<br><br>According to the Adaptation Strategy, measures E-01, E-02, E-03, E-04, E-05, E-06 and E-07 should be fully implemented in order to address adaptation to climate change in the entire energy sector and show vulnerability to climate change as well as suggested measures of adaptation to climate change. The negative impact of climate change on the energy sector is significant and constantly growing. The reports should contain the results of the implementation of these measures and activities. |

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| Plan of protection of the power system from significant disturbances | The network codes of the transmission system („Official Gazette“, No. 10/24)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | CTSO is responsible for the reliability and availability of the electricity supply system and the correct coordination of the generation, transmission, and distribution system, as well as for managing the electricity supply system and the system to achieve the safety of electricity delivery. CTSO prepares the Annual Report on the Security of Supply of the Croatian Power System, and the Croatian Energy Regulatory Agency approves it. All transmission system users implement the measures in the Defence Plan, which are mandatory for them. To ensure effective defence in cases of significant disruptions, but also to the system restoration plan, the transmission system operator shall adopt a System Defence Plan with technical and organisational measures taken to prevent the spread or exacerbation of disruptions in the transmission system to avoid disruption and system failure.<br><br>According to the Adaptation Strategy, measures E-01, E-02, E-03, E-04, E-05, E-06, and E-07 should be fully implemented to address adaptation to climate change in the entire energy sector and show vulnerability to climate change as well as suggested measures of adaptation to climate change. The negative impact of climate change on the energy sector is significant and constantly growing. The plan should contain the results of implementing these measures and activities. |
| Intervention plan of measures for the protection of gas supply security of the Republic of Croatia | Decision on the adoption of the Intervention Plan on measures to protect the security of the gas supply of | The intervention plan shall set out the procedures, roles, and responsibilities of the competent authorities and any gas market |

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| | the Republic of Croatia („Official Gazette“, No. 127/22) | participants involved in the event of soil supply disruption. Furthermore, the Intervention Plan regulates measures to eliminate or mitigate the impact of disruptions in the gas supply, which includes ensuring a reliable and efficient supply of natural gas, the criteria and method of determining enough natural gas to provide a reliable supply of natural gas to protected customers, and the order in which natural gas supply is reduced or suspended to individual categories of customers in the event of a crisis. |
| Building and holding compulsory stocks of oil and petroleum products | Oil and Petroleum Products Market Act („Official Gazette“, No. 19/14, 73/17, 96/19) | The Croatian Hydrocarbon Agency (CHA), as the Central Authority in the Republic of Croatia for mandatory stocks of oil and petroleum products, is obliged to form stocks at least in the amount of 90 days of average daily net imports, i.e., intake or 61 days of average daily domestic consumption of petroleum products in the previous calendar year, whichever is higher. Mandatory supplies of oil and petroleum products are formed to secure the supply of oil and petroleum products in case of threat to the state's energy security due to extraordinary disruptions to the supply of oil and petroleum products markets. |

The existing legislative framework will be harmonized with the new goals and obligations defined by the Decarbonised Gases and Hydrogen Package:

DIRECTIVE (EU) 2024/1788 OF THE EUROPEAN PARLIAMENT AND COUNCIL of June 13th, 2024 on common rules for the internal market of gas from renewable sources, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/ EC (amendment) (OJ L, 2024/1788, July 15th, 2024),

REGULATION (EU) 2024/1789 OF THE EUROPEAN PARLIAMENT AND COUNCIL of June 13th, 2024 on the internal market of gas from renewable sources, natural gas and hydrogen,

amending Regulations (EU) No. 1227/2011, (EU) 2017/1938, (EU) 2019/942 and (EU) 2022/869 and Decisions (EU) 2017/684 and repealing Regulation (EC) no. 715/2009 (amendment) (OJ L, 2024/1789, July 15th, 2024).

## Dimension "the Internal Energy Market"

Legislation relevant to the internal energy market includes laws regulating energy markets:

- Energy Act („Official Gazette“, Nos. 120/12, 14/14, 102/15, 68/18),
- Electricity Market Act („Official Gazette“, No. 111/21, 83/23),
- Energy Efficiency Act („Official Gazette“, Nos. 127/14, 116/18, 25/20, 41/21)
- Act on Renewable Energy Sources and High Effective Cogeneration („Official Gazette“, No. 138/21, 83/23)
- Thermal Energy Market Act („Official Gazette“, No. 80/13, 14/14, 102/14, 95/15, 76/18, 86/19)
- Gas Market Act („Official Gazette“, Nos. 18/18, 23/20),
- Oil and Petroleum Products Market Act („Official Gazette“, Nos. 19/14, 73/17, 96/19),
- Act on Biofuels for Transport („Official Gazette“, Nos. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18, 52/21)
- Act on the Regulation of Energy Activities („Official Gazette“, No. 120/12, 68/18),
- Act on Exploration and Exploitation of Hydrocarbons („Official Gazette“, Nos. 52/18, 52/19, 30/21).

Regarding electricity interconnection, first of all, it is necessary to consider the EU target according to which the desired level of electricity interconnection is at least 15% compared to the installed power of power plants in the observed state by 2030. The transmission system in the territory of the Republic of Croatia has already met and exceeded that target many times. The same applies if the existing electricity interconnection capacity is compared with the system's peak load or the RES's installed power in the territory of the Republic of Croatia.

The most important measures regarding the energy transmission infrastructure are shown in Table 1-11.

**Table 1-11 Existing measures for energy transmission infrastructure**

| Name of the measure | Documents | Short description |
|---|---|---|
| Preparation and implementation of electricity transmission grid development plans | Electricity Market Act („Official Gazette“, Nos. 111/21, 83/23)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | CTSO is an energy entity responsible for the transmission power grid's management, operation and management, maintenance, development, and construction.<br><br>As the owner of the transmission network of 110 kV to 400 kV, CTSO is obliged |

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| | | to develop and adopt, with the prior consent of the Ministry of Economy and the approval of CERA. The updated ten-year transmission network development plan includes detailed investments in the subsequent three-year and one-year periods. According to the Adaptation Strategy, measures E-01, E-02, E-03, E-04, E-05, E-06, and E-07 should be fully implemented to address adaptation to climate change in the entire energy sector and show vulnerability to climate change as well as suggested measures of adaptation to climate change. The negative impact of climate change on the energy sector is significant and constantly growing. The plans should contain the results of implementing these measures and activities. |
| Preparation and implementation of power distribution grid development plans | Electricity Market Act („Official Gazette“, Nos. 111/21, 83/23)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | HEP ODS, designated as the distribution system operator for the territory of the Republic of Croatia for 50 years, is responsible for the operation and management, maintenance, development, and construction of the distribution network and is obliged every year to develop and adopt, with the prior approval of CERA, an updated ten-year distribution network development plan, including detailed investments in the next three-year and one-year period.<br><br>According to the Adaptation Strategy, measures E-01, E-02, E-03, E-04, E-05, E-06, and E-07 should be fully implemented to address adaptation to climate change |

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| | | in the entire energy sector and show vulnerability to climate change as well as suggested measures of adaptation to climate change. The negative impact of climate change on the energy sector is significant and constantly growing. The plans should contain the results of implementing these measures and activities. |
| Preparation and implementation of gas transport system development plans | Gas Market Act („Official Gazette“, Nos. 18/18, 23/20)<br><br>Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette“, No. 46/20) | The transmission system operator must develop a ten-year transmission system development plan per the Energy Development Strategy and the Energy Development Strategy Implementation Programme and submit it to CERA for approval every two years. The transmission system operator shall operate, maintain, and develop a safe, reliable, and efficient transmission system.<br><br>According to the Adaptation Strategy, measures E-01, E-02, E-03, E-04, E-05, E-06, and E-07 should be fully implemented to address adaptation to climate change in the entire energy sector and show vulnerability to climate change as well as suggested measures of adaptation to climate change. The negative impact of climate change on the energy sector is significant and constantly growing. The plans should contain the results of implementing these measures and activities. |

The level of power reserves in the production part of the electricity system (ES) in Croatia and in the neighbouring systems with which the Croatian ES is interconnected enables safe and reliable system operation. The production and consumption of electricity by ES users within the synchronous area of continental Europe are continuously monitored in real-time to maintain a stable frequency of the ES. Any imbalance is corrected by balancing mechanisms.

Balancing mechanisms that activate energy from power reserves to maintain the frequency of the system after the occurrence of an imbalance in the system are:

- *Frequency Containment Reserve* (FCR)
- *Frequency Restoration Reserve with Automatic* Activation
- *Frequency Restoration Reserve with Manual Activation*
- *Replacement Reserve*

The adequacy of the ES in its current state is at a satisfactory level, taking into account the available domestic production capacities and the possibility of cross-border exchanges.

Flexibility can be defined as a change in the production pattern or power consumption due to a response to a stimulus (price signal or activation) to provide ancillary services to the ES, most commonly to the system operator. A market research pilot project is currently underway to ensure active power reserves of tertiary control through manageable consumption for the needs of CTSO. Within the framework of this project, by entering a contractual relationship with CTSO to provide ancillary services to ensure active power reserves of tertiary control, the end customer participates directly in the system balancing mechanism and receives compensation defined by the contract. Manageable consumption units may be any devices whose consumption can be reduced at the request of the transmission system operator, and which are part of the end customer's facility, such as electric ovens, cold stores, pumps, compressors, and the like.

Ancillary and flexibility services that distribution network users usually provide to the distribution system operator are not currently used in the Republic of Croatia. The Distribution System Grid Code, enacted in 2018 („Official Gazette“, No. 74/18), regulates new services that could be useful to the distribution system operator.

The establishment of the ECO balance group is regulated by the Act on Renewable Energy Sources and Highly Efficient Cogeneration („Official Gazette“, No. 138/21, 83/23). It consists of electricity producers and other entities performing electricity generation activities, entitled to incentive pricing following the agreements on purchasing electricity with the Croatian Energy Market Operator (CEMO).

Under the Act on Renewable Energy Sources and Highly Efficient Cogeneration, CEMO is designated as the head of the ECO balance group with the obligation to manage the ECO balance group, plan the production of electricity for the ECO balance group and sell the electricity produced by the members of the ECO balance group in the electricity market transparently and impartially.

One key indicator regarding consumer protection, competitiveness, and the development of the retail electricity market is the rate of supplier switching by end customers. The rate of supplier switching by end customers in entrepreneurship is higher than in the household category. The main reason is the regulatory framework for public procurement, whereby specific end customers from the entrepreneurship category are obliged to issue tenders to select the most favourable electricity supplier regularly.

Introducing an advanced measurement system is the fundamental prerequisite for enabling and developing energy management.

Measures in consumer protection are shown in Table 1-12.

**Table 1-12 Existing consumer protection measures**

| Name of the measure | Documents | Short description |
|---|---|---|
| Informative calculations | Energy Efficiency Act („Official Gazette“, Nos. 127/14, 116/18, 25/20, 32/21, 41/21) | Suppliers are obliged to measure and account for consumption and inform customers of prior consumption, including comparison with the average normal or reference final customer from the same category of final customer suppliers. |
| Obligations of the energy distributor to enter the data on energy measurement and consumption in the public sector into the National Information System for Energy Management (ISEM) monthly and provide individual meters to end customers | Energy Efficiency Act („Official Gazette“, Nos. 127/14, 116/18, 25/20, 32/21, 41/21) | Energy distributors shall ensure that, to the extent technically possible, financially justified and proportionate given potential energy savings, domestic energy and hot water final customers are provided with competitively priced individual meters that accurately reflect the actual energy consumption of final customers. |

Existing measures to combat energy poverty are shown in Table 1-13. The table shows the measures by which some progress or result has been achieved. Non-regulatory energy efficiency measures include a program of energy renovation and installation of renewable energy sources in 387 residential buildings owned and managed by the MMPPCSA (social housing). The Government of the Republic of Croatia adopted the Program in December 2021. The National Recovery and Resilience Plan (NRRP) provided funds for the Program implementation of about 20 million euros, and the addition to NRRP provided an additional EUR 68.41 million.

In addition, compensation was introduced for vulnerable energy buyers. The fee amounts to a maximum of EUR 26.54 and a maximum of EUR 70 per month until 31st March 2024. Vulnerable customers are determined according to the Regulation on the criteria for acquiring the status of a vulnerable customer of energy from networked systems („Official Gazette“, No. 95/15, 31/22, 28/24). In addition to the above, other measures exist, but these measures have not made progress and are therefore not included.

**Table 1-13 Existing measures to eliminate energy poverty**

| Name of the measure | Documents | Short description |
|---|---|---|
| Compensation of energy costs of vulnerable customers | Regulation on criteria for acquiring the status of vulnerable energy customers from networked systems („Official Gazette“, No. 95/15);<br>Regulation on Amendments to the Regulation on Criteria for Acquiring the Status of Vulnerable Buyers of Energy from Networked Systems („Official Gazette“, No. 31/22);<br>Regulation on Amendments to the Regulation on Criteria for Acquiring the Status of Vulnerable Buyers of Energy from Networked Systems („Official Gazette“, No. 28/24);<br><br>Regulation on the monthly amount of compensation for vulnerable energy buyers, the method of participating in the settlement of the costs of energy users of the compensation and the actions of competent centres for social welfare („Official Gazette“, No. 140/15), which was replaced by:<br>Regulation on the monthly amount of compensation for vulnerable energy buyers, the method of participating in the settlement of the costs of energy users of the compensation and the actions of the Croatian Institute for Social Work („Official Gazette”, Nos. 31/22, 104/22, 31/23) | Customers of electricity from the household category pay a supplement to the price of electricity. This supplement is charged by the supplier to the customers following the contract for the final customer supply and paid into the state budget. The funds thus collected are intended to finance vouchers for vulnerable customers. The changes in 2022 expanded the criteria for acquiring the status of an endangered customer, which increased the scope of this measure.<br><br>The voucher for vulnerable customers amounted to HRK 200.00 until 2022, when amendments to the Regulation on the monthly amount of compensation for vulnerable energy customers increased to HRK 400,00 and then to HRK 500,00. With the latest amendments to the Regulation in 2023, from April 1st, 2023 to March 31st, 2024, the voucher amount was determined and amounted to EUR 70. |
| An energy poverty curb programme involving the use of renewable energy sources in residential buildings in assisted areas and areas of particular state concern for the period to 2025 | A program to combat energy poverty that includes the use of renewable energy sources in residential buildings in subsidized areas and areas of special state care for the period until 2025<br><br>National Energy Efficiency Action Plan 2022-2024 | Through this Program, it is planned to renovate 387 multi-apartment buildings in assisted areas and areas of particular state concern. |

## Dimension "Research, Innovation and Competitiveness"

National documents relating to the dimension of “Research, Innovation and Competitiveness”, which were considered in the preparation of the NECP 2019, are:

- Education, Science and Technology Strategy („Official Gazette“, No. 124/13)
- Smart Specialization Strategy until 2029 (2023)
- Innovation Promotion Strategy of the Republic of Croatia 2014-2020 („Official Gazette“, No. 153/14) [9]
- Research Infrastructure Development Plan in the Republic of Croatia (2016) and
- Climate Change Adaptation Strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 („Official Gazette”, No. 46/20).

The development of policies relevant to this dimension is accompanied by the preparation and adoption of new documents, including, e.g.

- the National Plan for the Development of the Education System until 2027 („Official Gazette“, No. 33/23),
- Smart Specialization Strategy until 2029[11] was adopted during the creation of the NECP. The public consultation was held in December 2022, and the Government of the Republic of Croatia, at its session held on December 13th, 2023, adopted the Decision on the Adoption of the Smart Specialization Strategy until 2029.

The legal framework defining scientific research and private and public investments in research, development and innovation includes, among others, the following acts:

- Climate Change and Protection of the Ozone Layer Act („Official Gazette“, No. 127/19)
- Higher Education and Scientific Activity Act („Official Gazette“, No. 119/22)
- Croatian Science Foundation Act („Official Gazette“, No. 57/22)
- Quality Assurance in Higher Education and Science Act („Official Gazette“, No. 151/22)
- Investment Incentive Act („Official Gazette“, No. 63/22)
- State Aid for Research and Development Projects Act („Official Gazette“, No. 64/18)
- Public Procurement Act („Official Gazette“, Nos. 120/16, 114/22) and
- Small Business Development Promotion Act („Official Gazette“, Nos. 29/02, 63/07, 53/12, 56/13, 121/16).

The Act on Climate Change and Protection of the Ozone Layer determines and regulates the development of guidelines for scientific research in the field of climate change mitigation, as well as guidelines for scientific research in the field of impact assessment and adaptation to

[11] https://mingor.gov.hr/UserDocsImages/slike/Vijesti/2022/S3%20do%202029%20Tekst%20VRH%202023%2012%2013.pdf

climate change. It also prescribes the method of financing scientific research in climate change adaptation and mitigation change.

The Higher Education and Scientific Activity Act regulates the basic principles of performing higher education and scientific activities; establishment and operation of institutions; the process of hiring and promoting teachers, scientists and associates and their rights and obligations; basic issues of performing studies; the rights and obligations of students, conducting scientific and professional activities, support and financing of these activities and supervision and misdemeanour sanctions.

The Act on Quality Assurance in Higher Education and Science regulates internal quality assurance and improvement of higher education institutions and scientific institutes, external quality evaluation of higher education institutions and scientific institutes and the organization and powers of the Agency for Science and Higher Education.

The Investment Incentive Act regulates the system of investment aid and timely realization of investment activities, with the aim of successful and scheduled realization of sustainable and technologically advanced investment projects of high-added value in the territory of the Republic of Croatia. Aid relates to sustainable investment projects aimed at strengthening the competitive capacity in (i) manufacturing and processing activities, (ii) development and innovation activities, (iii) business support activities and (iv) high-added value service activities.

Aid governed by the Investment Incentive Act relates to projects pursuing one or more of the following objectives:

- contribution to the green and digital transition of the economy of the Republic of Croatia
- contribution to a sustainable industry concept and advanced technological solutions of Industry 4.0.
- introduction of new equipment and modern technologies
- higher employment and training of employees
- development of products and services of higher added value
- enhancing entrepreneurial competitiveness
- balanced regional development of the Republic of Croatia
- economic activation of inactive assets owned by the Republic of Croatia
- productivity growth of economic operators in the Republic of Croatia.

The Act on State Aid for Research and Development Projects regulates requirements for granting state aid for research and development projects in the horizontal aid category for research and development; the competencies of the bodies of the Republic of Croatia concerning granting state aid for research and development projects, the procedure for determining the fulfilment of conditions for exercising rights, record keeping and reporting as well as other issues related to the exercise of the right to aid for research and development projects. The purpose of the Act is to increase private sector investments in research and development, increase the number of entrepreneurs investing in research and development

and foster cooperation between entrepreneurs and organisations for research and dissemination of knowledge in research and development projects, whereby research and development includes creative and systematic work undertaken to increase knowledge - including knowledge of humanity, culture and society - and develop new applications of existing knowledge. Research and development activities must include five basic criteria: **new knowledge** (as the objective of the activity), **creative** (new concepts, ideas and methods that enhance existing knowledge), **uncertain in terms of outcome**, **systematic** (planned with secured funds and by recording outcomes) and **transferable** (outcomes are transferable as new knowledge) and/or **reproducible** (outcomes can be reproduced).

The Public Procurement Act defines one of the public procurement procedures as a "partnership for innovation". The public contracting authority may use a partnership for innovation if it needs innovative goods, services, or works that cannot be realized through the supply of goods, services or works already available on the market. Partnership for innovation seeks to develop innovative goods, services, or works and subsequently procure them if they are consistent with performance levels and maximum costs agreed upon between the public contracting authority and participants. This instrument stimulates innovations that affect demand for innovation, while grants to enterprises affect innovation supply.

The National Recovery and Resilience Plan enables the implementation of innovative public procurement in the Republic of Croatia (investment of NPRR C2.9. R3 ***Innovative public procurement***). This will support the implementation of the new Smart Specialization Strategy until 2029 in energy and climate, priority areas smart and clean energy, smart and green transport, sustainable and circular food, customized and integrated wood products[12] and related research and development.

The Small Business Development Promotion Act regulates the basis for implementing small business incentives, including grants for research, development and application of innovations and introduction of modern technologies.

In addition to the law, in December 2022, the Ministry of Science and Education and Youth adopted the National Guidelines for Technology and Knowledge Transfer (hereinafter: the Guidelines). The Guidelines offer recommendations and practical advice to offices for technology transfer (OTTs) and managers in research organizations to improve technology transfer and knowledge transfer activities and results. Their application should contribute to the effective use of the results of publicly funded research through proper management of intellectual property, increased commercialization, the development of entrepreneurial culture and related skills in public scientific organizations, and for a more successful interaction between the public and business sectors, which is also extremely important for research and development activities in areas related to energy, climate and the like.

Efficient infrastructure is needed to carry out research and development, in addition to human resources. The Scientific and Technological Forecasting project assessed the number of

[12] As part of S3 until 2029, the following thematic priority areas are defined: (i) personalized health care, (ii) smart and clean energy, (iii) smart and green transport (iv) security and dual purpose – awareness, prevention, response, rehabilitation (v) sustainable and circular food, (vi) customized and integrated wood products and (vii) digital products and platforms.

researchers in the Energy and Sustainable Environment of the Smart Specialization Strategy 2016-2020 to 800 researchers[13].

A Research Infrastructure Development Plan in Croatia until 2028 has been adopted[14]. The plan follows up on the 2016 document. It provides an overview of the national research infrastructure, including participation in international research organizations and infrastructures, parameters for its monitoring and basic criteria for selecting and financing future research, infrastructure projects and membership.

The institutional framework that supports the implementation of research, development and innovation and enables aid and incentives in this area includes the Ministry of Science, Education and Youth and the Ministry of the Economy, which propose specific legal measures and incentives and are responsible for creating policies and implementing programs, reforms and measures defined in national strategic documents such as the National Development Strategy 2030, the National Recovery and Resilience Plan 2021-2026, the Smart Specialization Strategy and the like. This includes financing from the state budget and European Union funds (e.g., European Structural and Investment Funds, Recovery and Resilience Mechanism). The government supports research and development in climate change mitigation and adaptation to climate change with financial resources from the income from the sale of emission units from the EU ETS and through the Fund for Environmental Protection and Energy Efficiency.

The Croatian Science Foundation supports scientific, study, and technological programs to develop science, higher education, and technological development in the Republic of Croatia and ensure social and economic development. The Act on the Croatian Science Foundation („Official Gazette“, No. 57/22), adopted in 2022, creates prerequisites for strengthening the capacity of the Foundation and more clearly defining its tasks in the field of implementation, coordination, creation, monitoring and evaluation of research and development project programs, thus creating a strong and independent system for selecting, financing and monitoring research and development projects.

The Agency for Mobility and EU Programmes (AMPEU) promotes and implements decentralised activities of the European Union programmes and other international programmes in the fields of education and training, youth, science, and sport; Erasmus+ and the European Solidarity Corps (ESC) and supports the implementation of the EU Framework Programme for Research and Innovation Horizon Europe.

The Croatian Agency for Small Business, Innovation, and Investment (HAMAG-BICRO) supports entrepreneurs during all developmental phases of business ventures - from idea research and development to commercialization and placement on the market. The Croatian Chamber of Economy, vocational chambers, the Chamber of Trades and Crafts, entrepreneurial support institutions, and digital innovation centres (E/DIH) support research, development, and innovation.

[13] Institute of Economics (2022). ANALYTICAL REPORT ON SCIENTIFIC AND TECHNICAL MAPPING. Ministry of Science, Education and Youth - Conducted scientific and technological mapping within the project Scientific and Technological Prediction (gov.hr)

[14] https://esavjetovanje.gov.hr/Documents/List/22083

### iii. Key issues of cross-border significance

Key issues of cross-border significance are the integration of energy markets, major infrastructure projects near the national border and cross-border infrastructure projects, international scientific and research cooperation related to the dimensions of the Energy Union, and other activities that may affect other EU Member States.

### iv. Administrative structures for the implementation of national energy and climate policies

The umbrella institution for the creation and monitoring of the implementation of national energy and climate policies as well as the coordination of national reporting according to the European Commission is the Ministry of Economy (ME) in cooperation with the Ministry of Environmental Protection and Green Transition (MEPGT).

The preparation and management of the GHG inventory in Croatia is the responsibility of the Ministry of Environmental Protection and Green Transition, the national contact point under the UNFCCC. The Institute for the Protection of the Environment and Nature within the Ministry of Environmental Protection and Green Transition is responsible for organizing the preparation of the greenhouse gas inventory, collecting activity data, developing a quality assurance and quality control plan (QA/QC plan), implementing inventory quality assurance procedures, archiving data, keeping records, selecting the authorized persons to prepare the inventory of greenhouse gases and ensuring access to data and documents for technical inspections of the inventory. In addition, the Institute for the Protection of the Environment and Nature plays an important role in administering user accounts of Croatian participants in the EU Emissions Trading System (EU ETS).

The National Coordination Body for Energy Efficiency also operates within the ME as a special organizational unit. It coordinates many stakeholders involved in defining and, more importantly, implementing the energy efficiency policy in Croatia. It systematically monitors the implementation through a system of monitoring, measurement, and verification of energy savings. It prepares reports and informs the public about plans, implemented measures, and their effects.

In addition to the ME, the Ministry of Environmental Protection and Green Transition also has an essential role in implementing national energy and climate is essential. It is responsible for spatial planning and creating policies and measures to achieve the set energy savings targets in buildings. The Ministry of Physical Planning, Construction and State Assets drafts laws, strategies and programs that direct the development of the overall spatial planning system and long-term integral renovation of buildings: family houses, multi-apartment buildings, commercial non-residential buildings and public sector buildings. The Ministry also performs activities as a Level 1 Intermediate Body to use EU funds within the OPCC.

The MEPGT plans to strengthen institutional capacities for integrating climate goals into projects and strategic and planning documents (Project Development of the National Network of Climate Officers from PCC 2021-2027). The idea is that certain officials in the counties (newly employed or existing) join the education system about climate policies and the application of climate certification and receive a certificate for this, which they will periodically renew. The purpose is to increase the capacity of regional self-government and improve

vertical coordination for implementing the Climate Change Adaptation Strategy, the Low Carbon Development Strategy, and the NECP.

It is also planned from the PCC 2021-2027 to establish a National Centre for the coordinated implementation of climate change adaptation policy through the improvement and strengthening of infrastructural, computer, digital, expert-scientific and human capacities necessary for the development of high-quality, reliable and timely support system for the adaptation of the Republic of Croatia to climate change. The planned Centre would deal with analyses and expert opinions on climate risks, indicators, and reporting, support the implementation of climate change adaptation policies, and be a central place for education and information.

The Ministry of the Sea, Transport and Infrastructure is responsible for national policy, action plans, and strategies for developing infrastructure to encourage using alternative fuels in transport and other measures to improve energy efficiency in transport.

At the implementation level, the Environmental Protection and Energy Efficiency Fund (EPEEF) plays an important role. The EPEEF is responsible for co-financing measures defined in the national energy and climate plans and acts as an intermediate body level 2 for operations implemented in phases for using EU funds under the Programme Competitiveness and Cohesion 2021 - 2027, in parts relevant to energy and climate. The EPEEF is the implementing body for the implementation of calls for projects and programs that are financed with funds obtained from the proceeds from the sale of emission units from the EU ETS on the EU market following the Plan for the use of financial resources obtained from the sale of emission units through auctions in the Republic of Croatia and is the implementing body for the Modernization Fund. The EPEEF also manages the funds paid by energy suppliers in the event of failure to fulfil their obligations under Article 13 of the Energy Efficiency Act and is obliged to invest them in alternative measures.

In the area of energy efficiency, the Agency for Transactions and Brokerage in Real Property has an essential role in implementing the energy renovation programme for the public sector, building on the energy service model and systematic energy management in the public sector, all following the powers defined by the Energy Efficiency Act („Official Gazette“ Nos. 127/14, 116/18, 25/20, 32/21, 41/21).

The Croatian Energy Regulatory Agency (CERA) regulates energy activities and is responsible for improving and implementing by-laws, issuing licenses, setting and changing tariffs, certifying eligible producer status, etc.

The Hydrocarbon Agency provides operational support to competent bodies in activities related to hydrocarbon exploration and exploitation, geothermal waters for energy purposes, underground storage of natural gas, permanent disposal of gases in geological structures, and ensuring compulsory stocks of oil and petroleum products.

The Croatian Energy Market Operator (CEMO) performs the public service of organizing the electricity and gas market and analysing and proposing measures for its improvement. It also performs tasks related to incentives for electricity production from renewable energy sources and cogeneration. It involves collecting compensation from suppliers and calculating and allocating funds based on concluded contracts with eligible producers entitled to an incentive price.

The transmission/distribution system operators (CTSO/HEP-DSO) transmit and distribute electricity within the grid. PLINACRO d.o.o. is the gas transmission network operator, whereas the oil storage system operator (JANAF) transports and stores oil and petroleum products.

It should also be noted that energy suppliers are the stakeholders who will play a key role in achieving the targets of energy efficiency policy. Since 2019, suppliers have been required to achieve energy savings by investing in and stimulating energy efficiency improvements by end customers or paying the EPEEF. The system of energy efficiency obligations for energy suppliers encourages suppliers to increase energy efficiency in households at risk of energy poverty so that the calculated savings resulting from energy efficiency improvement measures of such consumers increase by up to 30%. Such measures usually refer to consumer education through the distribution of leaflets, advertising campaigns, etc.

## 1.3 Consultation and participation of national and EU entities and the outcome of consultation

### i. Participation of the national parliament

In October 2019, a workshop organized by the Committee on European Affairs and the European Forum for Renewable Energy Sources (EUFORES) was held in the Croatian Parliament under the title: "The Clean Energy Package and the National Energy and Climate Plans - Outlook for Renewable Energies in Croatia" during which the Draft of the National Integrated Energy and Climate Plan was presented and discussed.

In October 2023, a thematic session of the Committee for Environmental and Nature Protection of the Croatian Parliament was held on the topic "Climate energy policy in the context of updating the Integrated National Energy and Climate Plan of the Republic of Croatia for the period from 2021 to 2030 (NECP)", at which presented and discussed the updated draft of the NECP submitted to the European Commission in June 2023.

### ii. Participation of local and regional bodies

Local and regional bodies participated in preparing the Draft of the National Integrated Energy and Climate Plan and all key strategic documents that served as the basis for the plan.

The local and regional bodies participated in consultative workshops organized within the framework of preparation of the Draft of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 and via e-consultations at events organized within the public presentation of the Green Paper and the White Paper, and via e-consultations in the process of preparation of the Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050.

Local and regional bodies also participated in a preliminary e-consultation to prepare the National Integrated Energy and Climate Plan Draft held in November and December 2018. The second round of workshops was organised upon completing all sections of the Draft in July 2019 as part of thematic cross-sectoral workshops open to all stakeholders. In October 2019, a meeting was organized with representatives of regional energy agencies, at which the Draft

was presented and finalized and then submitted for e-consultation. The e-consultation process is open to all stakeholders, including representatives of local and regional bodies.

In May 2023, a workshop was held for local and regional self-government units. The draft of the revised Plan was presented, and measures relevant to these units were discussed.

### iii. Consultations with stakeholders, including social partners, and inclusion of civil society and the general public

During 2018 and 2019, the stakeholders, including social partners, civil society and the general public, actively participated in a series of consultative workshops organized within the framework of preparation of the Draft of the National Integrated Energy and Climate Plan, preparation of the Draft of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050, at events organized within the public presentation of the Green Paper and the White Paper, which will serve as a basis for the preparation of the Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050, and via e-consultations in the procedure of preparation of the draft and final version of the National Integrated Energy and Climate Plan and the Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050.

In particular, the stakeholders were actively involved in the workshops on preparing the draft and completing the final version of the National Integrated Energy and Climate Plan. The first round of workshops related to the draft preparation was organized in November 2018. The second round of workshops for preparing the plan's final version was organized in July 2019 (within thematic cross-sectoral workshops).

The first draft of the National Integrated Energy and Climate Plan was submitted for e-consultation in December 2018, and 90 comments were received. The revised draft was submitted for e-consultation in October 2019.

As part of the LIFE-funded NECP Platform project, a multilevel climate and energy dialogue platform has been established. The platform brings together representatives of key stakeholders to develop the Integrated Plan. It includes relevant ministries, local and regional self-government, energy companies, research and academia sector, professional associations, and civil society organisations. The initial meeting of the platform, attended by 40 stakeholders, was held in March 2023, while the second meeting of the Platform, intended primarily for representatives of local and regional (self-)government, was held in May 2023. The third platform meeting was held in July 2023, where the draft of the updated NECP submitted to the European Commission was presented and discussed.

Also, from March to June 2023, thematic workshops were held on the update of the Integrated Plan (energy efficiency, renewable energy sources and transport, energy market and energy security, agriculture, LULUCF, waste, research, innovation, and competitiveness). More than 100 stakeholders from all relevant sectors participated in the workshops.

After submitting the draft of the updated NECP to the European Commission in June 2023, a series of meetings were held with representatives of the ministries relevant to individual segments of the NECP:

- With representatives of the Ministry of Finance and stakeholders from the financial sector on the topic of mobilizing private funds in decarbonization measures (October 2023);
- With representatives of a large number of ministries related to the assessment of the financial effects of the NECP (October 2023);
- With stakeholders relevant to research, innovation and competitiveness (October 2023);
- With the representatives of the ministry responsible for transport about links between the transport sector and NECP (October 2023);
- With representatives of the ministry responsible for agriculture about links between agriculture and NECP (October 2023 and February 2024).

### iv. Consultations with other member states

Consultation with other Member States took place at two levels:

- indirect presentation of the draft and final version of the plan;
- direct presentation of the draft and final version of the integrated energy and climate plan.

The text of the Draft of the National Integrated Energy and Climate Plan was translated into English, submitted to the European Commission, and published on the website of the ME at the same time as the Croatian version of the Draft was submitted and was thus made available to all Member States, allowing indirect consultation with Member States.

There were also activities related to the draft's direct presentation and the plan's final version. The process of preparing the Draft of the Integrated Energy and Climate Plan was presented to representatives of the Energy Union member states at the Technical Working Group on Energy and Climate meeting held on October 9$^{th}$, 2018. The Republic of Croatia is one of the EU Member States that has expressed interest in participating in the work of the Energy Union bodies and is available to transfer its experiences in developing the Plan to the Member States of the Energy Union.

Croatian representatives participated in a regional workshop held in Ljubljana in July 2019. This workshop was organized by the Ministry of Infrastructure of the Republic of Slovenia and was attended by representatives from Slovenia, Austria, Italy, Hungary, and Croatia. The workshop aimed to identify possible areas for cross-border and regional cooperation. Learn more about the results of regional cooperation in Chapter **"Regional cooperation on preparation of the plan 1.4"**.

In the organization of the Ministry of Environment, Climate and Energy of the Republic of Slovenia, a regional meeting of experts for national energy and climate plans of Austria, Italy, Croatia, Hungary and Slovenia was organized in February 2024 to exchange experiences in the creation and implementation of the NECP and identify opportunities cross-border and regional cooperation.

### v. Iterative procedure with the European Commission

Representatives of the ME participated in the work and meetings of the Technical Working Group on National Energy and Climate Plans of the European Commission.

The first draft of the National Integrated Energy and Climate Plan was submitted to the European Commission at the end of December 2018.

After the draft was submitted to the European Commission, the text was further edited and amended in parts related to evaluating the impact of measures and the dimensions of research, innovation, and competitiveness, which were underrepresented in the Draft.

During 2019, several bilateral meetings were held with the European Commission, which submitted its comments and recommendations on the National integrated energy and climate plan draft at the end of June 2019[15].

Recommendations and comments were largely adopted in the final text of the plan, and the Ministry of the Environment and Energy submitted to the European Commission replies to all the comments received.

The draft of the updated Plan was submitted to the European Commission within the deadline provided for in Regulation (EU) 2018/1999 on energy union management and climate action.

After submitting the draft of the revised Plan to the European Commission in July 2023, active work continued on the text, supplementing the parts related to the dimensions of research, innovation, and competitiveness and monitoring the effects of the measures.

After the European Commission's recommendations and comments were submitted in December 2024, the Ministry of Economy adopted all the recommendations in the final text of the Plan and discussed them with the road transport sector, which faces a significant challenge in achieving climate and energy goals.

The Ministry presented the answers to the European Commission's recommendations and comments in April 2024 at an event initiated by the European Commission called "Roadshow", where all relevant creators of national policies involved in climate and energy policy gathered.

## 1.4 Regional cooperation on the preparation of the plan

### i. Elements that are subject to joint or coordinated planning with other member states

Elements of cross-border significance are:

- integration of energy markets,
- major infrastructure projects near the national border and cross-border infrastructure projects,

[15] https://ec.europa.eu/energy/sites/ener/files/documents/hr_rec_en.pdf

- international scientific and research cooperation related to the dimensions of the Energy Union and
- other activities that may affect other EU Member States.

Key activities requiring coordinated planning with the neighbouring Member States were identified at a regional workshop in Ljubljana in July 2019, organized by the Ministry of Infrastructure of the Republic of Slovenia. At that workshop, the Member States identified the need and opportunity for further regional cooperation on topics covered by the Integrated Energy and Climate Plan and the Energy Union. Representatives of the competent ministries of Slovenia, Italy, Austria, Hungary, and Croatia participated in the workshop.

Some topics subject to joint or coordinated planning with other Member States are already being addressed at the EU level. It includes integrating the energy market and implementing major infrastructure projects of common interest (PCI) funded by the Connecting Europe Facility (CEF).

On the other hand, scientific and research cooperation is a much broader topic, and further cooperation is needed here, mainly at the user level. The Horizon 2020 Framework Programme is essential in this context and will continue as the Horizon Europe Framework Programme during the period covered by the plan.

Apart from the above, cooperation is vital in implementing projects and exchanging experiences, which needs special attention. Joint projects are of particular importance and, given the relatively low potential for individual Member States, will have a better implementation potential if the needs of several countries are combined (e.g., energy renovation of public or cultural property, etc.).

However, all these topics must strengthen joint activities in the future, which should be primarily promoted through regional workshops that present examples of good practice and serve as meeting points for professionals, institutions, and companies that could conclude and implement future joint projects on topics covered by the integrated energy and climate plan and areas of the Energy Union.

### ii. Explanation as to how regional cooperation is being considered within the plan

The first regional workshop organized by the Ministry of Infrastructure of the Republic of Slovenia was held in Ljubljana in July 2019 to establish regional cooperation in finalizing and implementing the plan. The workshop served as a basis for developing cooperation between Member States on the topics covered by the integrated energy and climate plan.

Regional cooperation is considered in the plan in two key segments:

- past cooperation;
- potential future cooperation.

The past cooperation was presented at the workshop in Ljubljana, where it was emphasized that the Republic of Croatia has excellent collaboration with the Republic of Slovenia and Hungary to establish the energy infrastructure, security of supply, and integration of energy markets.

Potential future cooperation was also discussed at the regional workshop. It is primarily aimed at continuing the integration of energy markets and further strengthening the cooperation between transmission system operators. It is imperative to emphasize the need to collaborate in new and still underexplored areas and to encourage joint scientific and research work. In this context, the Republic of Croatia singled out significant issues such as hydrogen, battery development, and $CO_2$ capture and storage, with the willingness to extend cooperation to other areas in the future. Establishing regional cooperation within the framework of the initiative "Clean Energy for the EU Islands", primarily with the Republic of Italy and other Mediterranean EU Member States, is also expected.

Also, upon completing the National Integrated Energy and Climate Plan, the Republic of Croatia will make the plan's text available to all EU Member States in Croatian and English. It will be available for consultations on its contents. It will further foster regional cooperation with identified Member States and other interested Member States.

In February 2024, a second regional workshop was held in the Ministry of Environment, Climate and Energy of the Republic of Slovenia organisation. This workshop further developed cooperation between neighbouring member states regarding the regional cooperation opportunities covered by the integrated energy and climate plan.

# 2 NATIONAL TARGETS

## 2.1 Dimension: decarbonisation

### 2.1.1 Emissions and elimination of greenhouse gases

#### i. Elements referred to in Article 4, item (a), subitem 1

The European Union ratified the Paris Agreement and committed to reducing greenhouse gas emissions. Croatia ratified the Paris Agreement in May 2017 („Official Gazette“, No.- IT 3/17) and shared the common EU goal. The common EU goal, as a nationally determined contribution (NDC), was updated and submitted to the UNFCCC Secretariat in 2023 to reduce the emissions of the EU and its member states by at least 55% by 2030. This goal is divided into two units, the first covering significant sources of greenhouse gas emissions subject to the European Emissions Trading System (ETS sector). The second covers sectors outside the ETS, which include other, relatively smaller sources of emissions, such as road and off-road transport (except for air transport, which is included in the ETS sector), small energy and industrial facilities not included in the ETS sector, households, services, agriculture, waste management, land use changes and forestry.

Land use, land conversion, and forestry (LULUCF) are among the most significant sectors contributing to reducing EU greenhouse gas emissions. The general goal at the EU level is 310 million tons of $CO_2$ equivalent net removal in the LULUCF sector in 2030. In 2026-2030, a binding national goal will apply to each member state, which for the Republic of Croatia amounts to - 5,527kt $CO_2$eq. The LULUCF Regulation (2023/839) offers Member States flexible options to help them achieve these goals. For example, financial resources above the established quota should be provided in the state budget when using the flexible option of transferring (purchasing) national annual emission quota (AEA) units from another member state to settle excess emissions.

The following goals for reducing greenhouse gas emissions until 2030 have been set for the Republic of Croatia.

| | **Goals for 2030 compared to 2005** |
|---|---|
| **Sectors in EU ETS** | -62 % (goal for the whole EU) |
| **Sectors outside EU ETS** | -40 % (goal for the whole EU)<br><br>-16.7 % (goal for the Republic of Croatia) |
| **Value of net removal in kt of $CO_2$ equivalent in 2030** | -310,000 kt $CO_2$eq (goal for the whole EU)<br><br>– 5,527kt $CO_2$eq (goal for the Republic of Croatia) |

ii. Where applicable, other national targets consistent with the Paris Agreement and existing long-term strategies; where applicable, to contribute to the Union's long-term commitment to reducing greenhouse gas emissions, other goals, including sectoral and adaptation targets, if available

**National targets for climate change adaptation**

Adaptation measures contributing to the decarbonisation dimension are elaborated in the Climate Change Adaptation Strategy in the Republic of Croatia until 2040 with an outlook to 2070 with an action plan („Official Gazette“, No. 46/20) [6].

Increasing the resilience of vulnerable systems and reducing damage from natural disasters will also contribute to the long-term sustainable development of the Republic of Croatia.

The adaptation strategy shows the impacts and challenges of adaptation to climate change in sectors sensitive to climate change, of which the following are essential for this plan:

- Energy: reduction of electricity production in hydroelectric power plants; increase in electricity consumption for cooling purposes; reduction of electricity and/or thermal energy production in thermal power plants; infrastructure damage due to extreme weather events;
- Spatial planning and arrangement: heat islands in settlements; floods due to rising sea levels; floods due to extremely high rainfall;
- Agriculture: change in the duration of the vegetation period and lower yields; greater need for irrigation water; more frequent floods and stagnation of surface water; decrease in growth and quality of animal products; reproductive disorders; emergence of new diseases;
- Forestry: higher frequency of heat islands; reduction of productivity of some forest ecosystems; migration of harmful organisms; shifting of the phenological phases of forest tree species; increase in sensitivity or death of tree species; damages due to natural disasters; reduction of certain generally useful functions of forests.

Chapters 2.3 and 3.3 outline climate change's impacts on energy supply security and adaptation measures. They address the national targets for the energy security dimension and the necessary measures to achieve them.

**The National Development Strategy of the Republic of Croatia until 2030 („Official Gazette“ No. 13/21)** recognises as a strategic goal the environmental and energy transition to climate neutrality (goal 8), which will be achieved through the reduction of emissions in the economy, transport, and building construction.

**The Low-Carbon Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 („Official Gazette“, No. 63/21)** focuses on reducing greenhouse gas emissions and preventing an increase in the concentration of greenhouse gases in the atmosphere and consequently limiting the global temperature increase. The objectives of the Strategy are: achieving sustainable development based on knowledge and a competitive low-carbon economy and efficient use of resources, increasing security of energy supply, sustainability of energy supply, increasing energy availability and reducing energy dependence, and solidarity by fulfilling the obligations of the Republic of Croatia under international treaties, within the

framework of EU policy, as part of our historical responsibility and contribution to global goals and reducing air pollution and impact on health and quality of life of citizens.

**Extraction and geological storage of $CO_2$**

In Croatia, $CO_2$ is injected into geological structures at the Ivanić and Žutica North oil fields, primarily as a tertiary method of increasing oil extraction from the reservoir. The pilot project of injecting $CO_2$ into wells at the Ivanić oil field began in 2003. It lasted three years, gaining the necessary experience and useful data on injecting carbon dioxide into geological structures. The $CO_2$ injection project on the Ivanić and Žutica North fields began in 2014 and was extended to the Žutica South oil field in 2020 with a total $CO_2$ injection capacity of 1.2 million $m^3$/day. $CO_2$ is extracted during gas production in the Molva gas field and transported to injection wells through an 80 km-long pipeline. $CO_2$ is injected into these fields through 26 injection wells, and production takes place through 76 production wells. The planned end of the $CO_2$ injection project on the Ivanić field is in 2038, while on the Žutica North and South fields, it is in 2050.

Until 2028, the "KOdeCO net zero" project is planned, including the design, construction, installation and integration of units to capture, liquefaction and purification $CO_2$ generated during cement production. $CO_2$ will be transported by ship and permanently stored in the Mediterranean. During ten years, permanent storage of 3.67 million tons of $CO_2$ is planned.

Croatia has significant $CO_2$ storage potential in depleted oil and gas reservoirs and within projects to increase oil and gas depletion in fields in an advanced exploitation stage. Regional aquifers have the most significant potential for underground $CO_2$ storage. Still, much less data is available for analysing $CO_2$ injection into the aquifer than for well-explored oil, gas-condensate and gas fields.

The total capacity of oil and gas fields in the Sava and Drava depressions, assessed as suitable for $CO_2$ storage, is estimated at around 144 million tons of $CO_2$.

The total capacity of deep saline aquifers for the geological storage of $CO_2$ is estimated at 2.6 billion tons of $CO_2$, with the largest capacity in northern and central Croatia. These assessments were made based on the works published so far, and a detailed evaluation of the potential is planned by implementing measure MS-5 by creating a National Feasibility Study with an action plan for preparatory activities for carbon collection and storage projects. This study will cover the phases of capture at emission sources, transport, injection and storage of $CO_2$ and the connection of the $CO_2$ transport system with other EU countries.

### 2.1.2 Renewable energy

#### i. Elements referred to in Article 4, item (a), subitem 2

The indicative national targets for RES by 2030 are shown in the table below.

**Table 2-1 Indicative national targets for RES shares until 2030**

| RES share, % | Achieved | | Targets 2030 |
|---|---|---|---|
| | 2021 | 2022 | |
| In the gross final consumption of energy | 31.7 | 29.4 | 42.5 |
| In the final consumption of electricity | 53.5 | 55.5 | 76.7 |
| In the final consumption of energy for heating and cooling | 38.0 | 37.2 | 47.1 |
| In the final consumption of energy in transport | 7.1 | 2.4 | 24.6 |

The figure below shows the trajectory of RES shares in the gross final energy consumption.

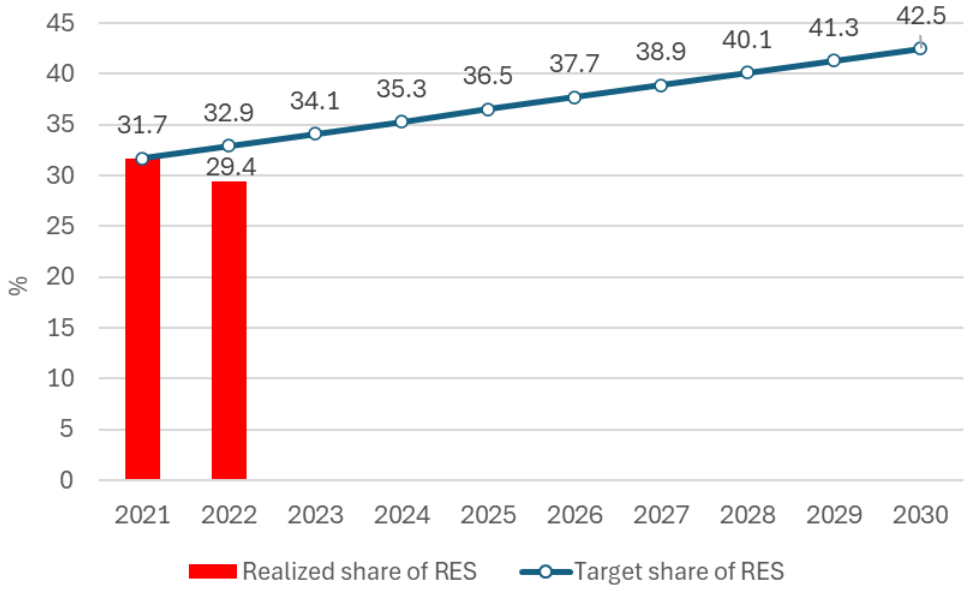



**Figure 2-1 Indicative trajectory of RES shares in the gross final energy consumption**

ii. Estimated trajectories for the sectoral share of renewable energy in final energy consumption from 2021 to 2030 in the power, heating and cooling and transport sectors

The figures below show indicative RES shares in electricity (Figure 2-2), heating and cooling (Figure 2-3) and transport (Figure 2-4).

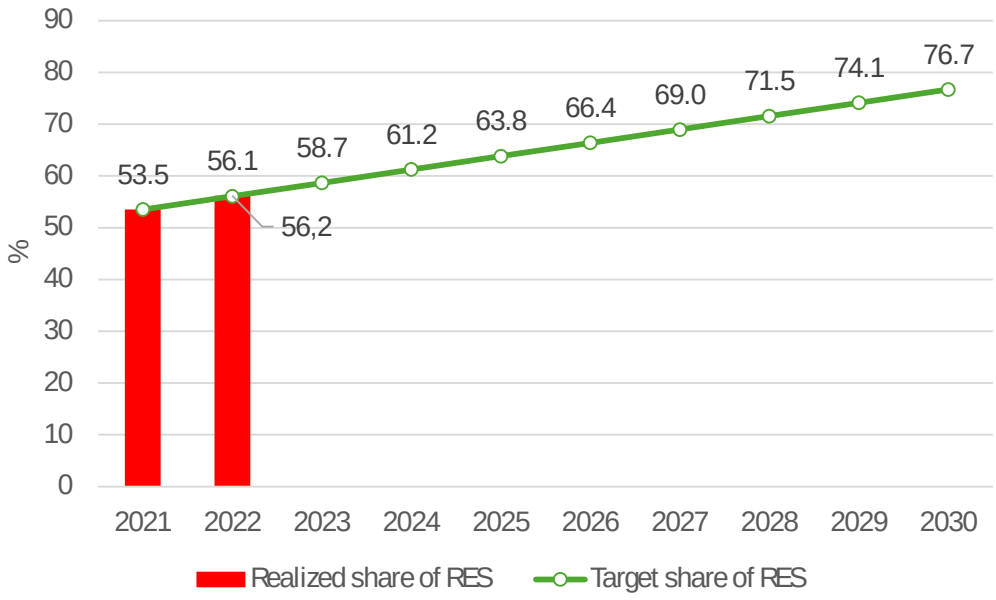



**Figure 2-2 Indicative trajectory of RES share in electricity**

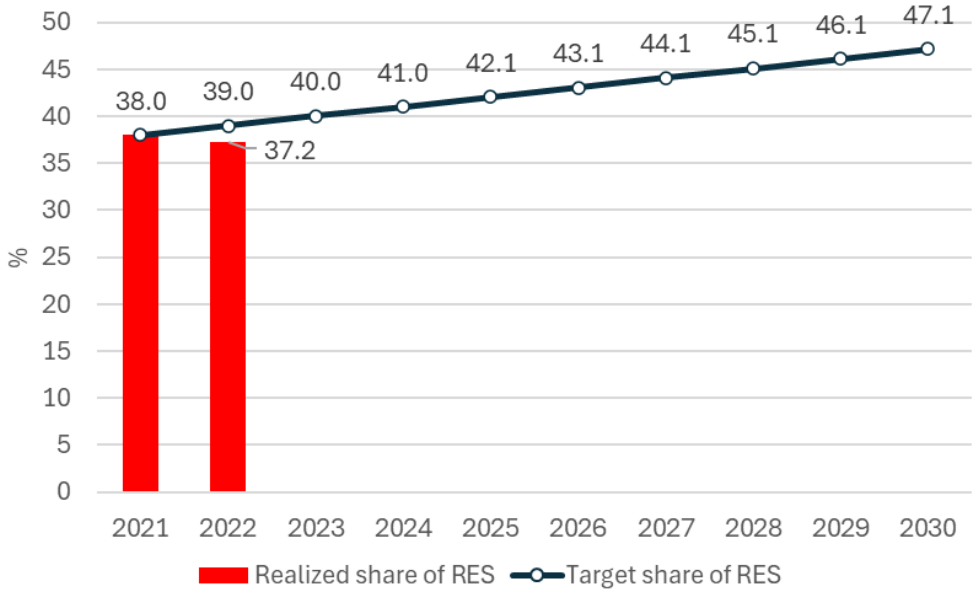



**Figure 2-3 Indicative trajectory of RES share in heating and cooling**

The efforts of the Republic of Croatia will be directed towards achieving the target regarding the RES share in heating and cooling, and the contributions of certain technologies can be expected to be higher or lower than estimated.

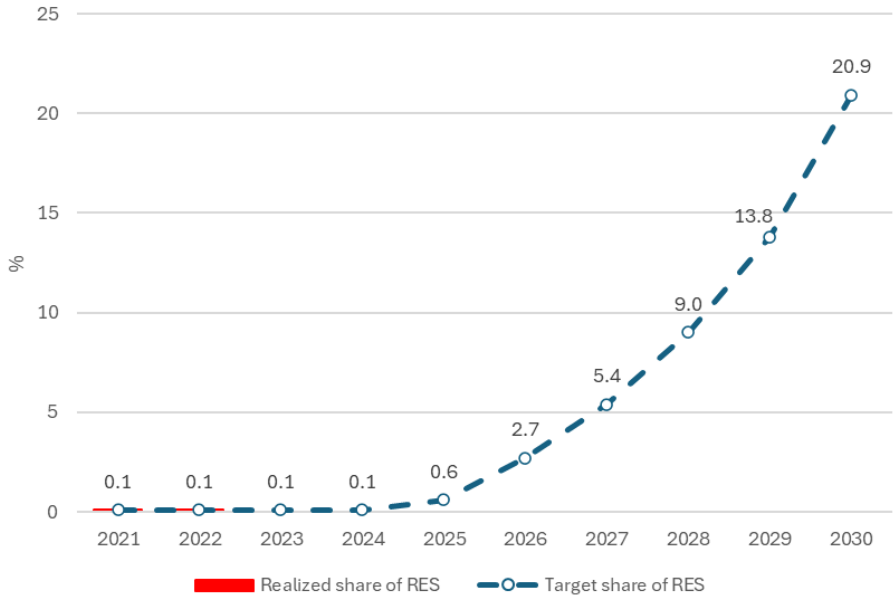



**Figure 2-4 Indicative trajectory of RES share in centralized heating and cooling systems**

Figure 2-4 shows the indicative trajectory of the share of RES in centralized heating and cooling systems. The increase in the mentioned share will contribute to the realization of the indicative trajectory of the share of RES in the entire heating and cooling sector. The stated goals will be achieved by applying geothermal energy, solar energy, heat pumps, biomethane, and in the period after 2030, hydrogen.

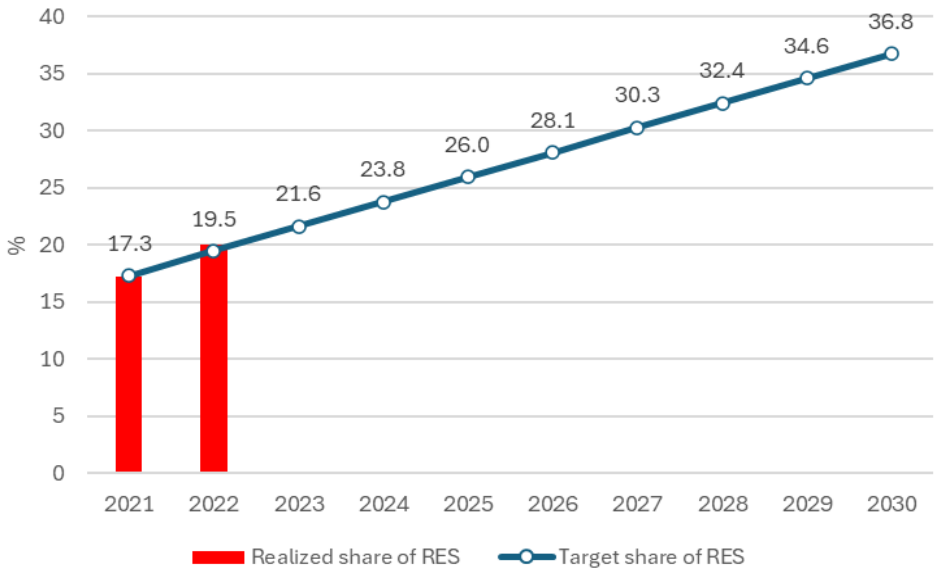



**Figure 2-5 Indicative trajectory of RES share in industry**

Figure 2-5 shows the indicative trajectory of the share of RES in the industry sector. The projected increase of about 2 percentage points per year will be achieved by the substitution of fossil energy with energy produced from renewable sources (solar energy, geothermal energy, biomethane, OIE electricity).

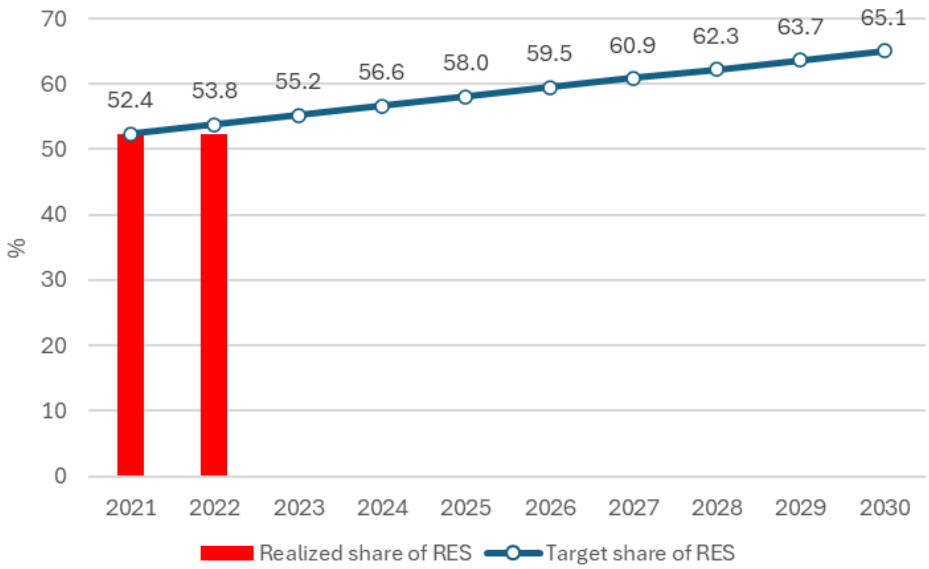



**Figure 2-6 Indicative trajectory of RES share in households and services (building sector)**

Figure 2-6 shows the indicative trajectory of the share of RES in the household and service sectors, where the largest share of energy consumption is related to consumption in buildings. This Plan envisages a reduction in final energy consumption in these sectors as a result of the application of energy efficiency measures. Given that in the existing structure of energy consumption, biomass occupies a large share, a significant decrease in biomass consumption is foreseen until 2030, that is, 2050. This will negatively affect the increase in the share of RES in these sectors, but through the increase in the use of heat pumps, solar energy for heating needs and the increase in the share of RES in centralized heating systems, an increase in the share of RES of about 1.2 percentage points per year is estimated.

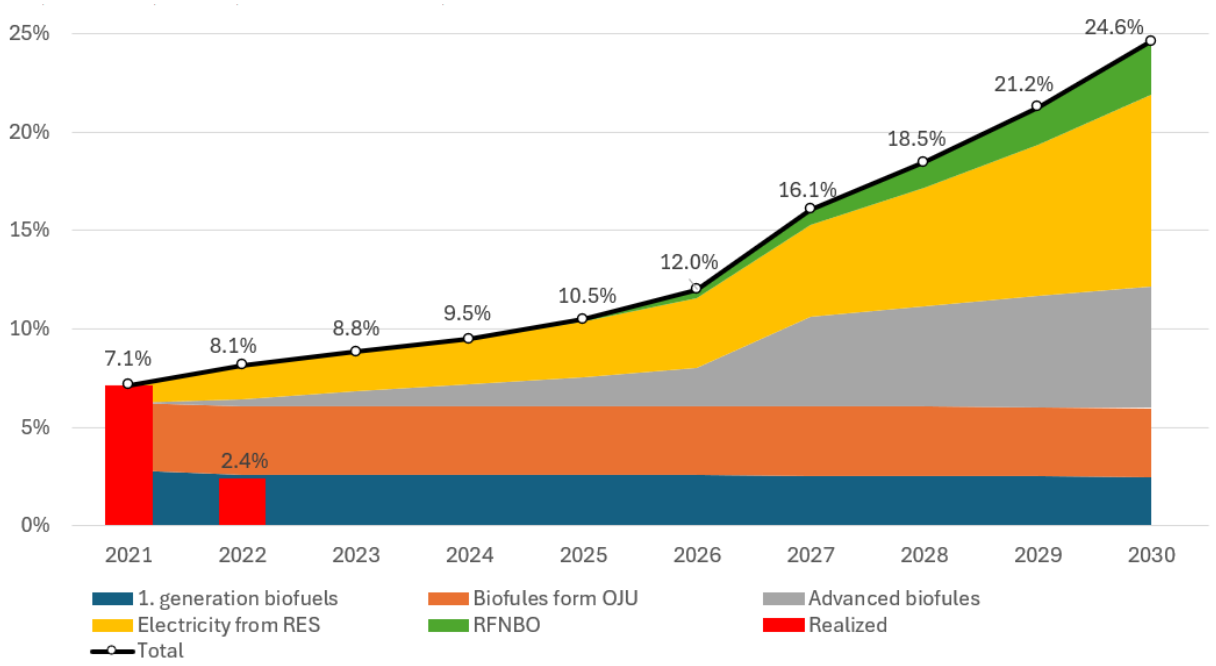


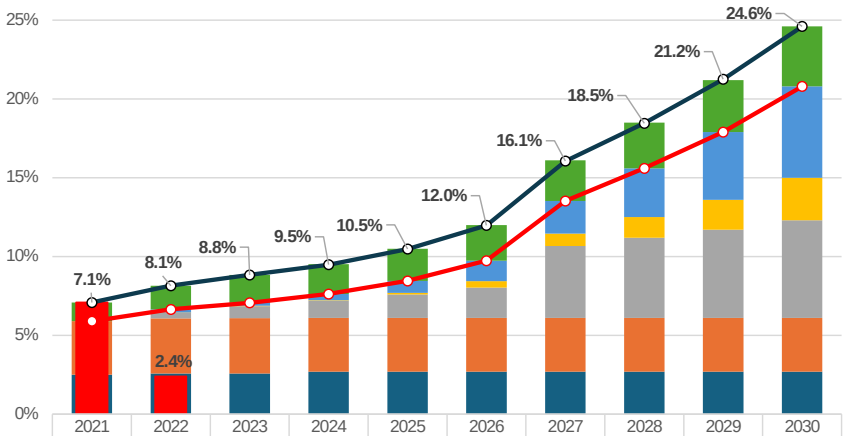

**Figure 2-7 Indicative trajectories of RES share in transport**

Regarding RES share in transport, the figure shows shares of electricity from RES, biofuels and advanced biofuels and biogas produced from the feedstocks listed in Annex IX, Part A of Directive (EU) 2018/2001 of the European Parliament and of the Council of December 11th, December 2018 on the promotion of the use of energy from renewable sources (recast) (Text with EEA relevance.) (OJ L 328, Dec 21st, 2018), (hereinafter: Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, RED II Directive). It should be noted that the estimated contributions result from a simulation model and that deviations from the calculated values may be expected in the implementation. The efforts of the Republic of Croatia will be directed towards achieving the goal regarding the share of RES in final consumption in transport, and the contributions of individual technologies can be expected to be higher or lower than presented here.

Indicatively, for the year 2030, a goal of 24.6% share of RES in direct consumption in transport is set, whereby the share of biofuels produced from crops for food and animal feed production will not exceed 2.6%. Consequently, considering the guidelines prescribed by Directive (EU) 2023/2413 of the European Parliament and of the Council of October 18th, 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC concerning the promotion of energy from renewable sources and repealing Council Directive (EU) 2015/652 (OJ L 2023/2413, Oct 31st, 2023) (hereinafter: Directive 2023/2413, RED III Directive)- in Article 26, the Republic of Croatia defines a lower minimum share of renewable sources than that specified in Article 25, paragraph 1, first subparagraph of point (a) the Directive mentioned above. The share of the obligation of the obliged entity to place renewable energy sources on the market in transport (share of obliged entities) is prescribed to meet the minimum National target for renewable energy in transport, i.e. the share that the distributors which place diesel fuel or motor gasoline for the propulsion of motor vehicles on the market are obliged to put on the market as part of the national target for renewable energy in transport, which, under a special law governing excise duties, is considered an excise duty obliged entity. The mandatory share of obliged entities in meeting the national target is expressed as a

percentage for each planning year of implementation of the Plan. The national target and the mandatory share of obliged entities meeting the target are shown below for each planning year from 2023 to 2030.

In addition to the obligation to place biofuels on the market, users of fuels in public transport and the public sector also contribute to the fulfilment of the national target by purchasing, renting, or leasing a certain number of vehicles using biofuels, biogas (biomethane), electric propulsion, or hydrogen from renewable energy sources. Also, users of electricity in railway and public road transport are obliged to procure only the electricity produced from plants using a renewable energy source listed in the origin guarantee system for transport purposes.




| | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| Public sector share | 1.2% | 1.5% | 1.8% | 1.9% | 2.0% | 2.3% | 2.6% | 2.9% | 3.3% | 3.8% |
| Share of the obligee - electricity from RES | 0.0% | 0.2% | 0.2% | 0.4% | 0.8% | 1.3% | 2.1% | 3.1% | 4.3% | 5.8% |
| Share of the obligee - RFNBO | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.4% | 0.8% | 1.3% | 1.9% | 2.7% |
| Share of the obligee - advanced biofules | 0.0% | 0.4% | 0.8% | 1.1% | 1.5% | 1.9% | 4.6% | 5.1% | 5.6% | 6.2% |
| Share of the obligee - biofuels from UCO | 3.4% | 3.5% | 3.5% | 3.4% | 3.4% | 3.4% | 3.4% | 3.4% | 3.4% | 3.4% |
| Share of the obligee - 1. generation of biofuels | 2.5% | 2.6% | 2.6% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% | 2.7% |
| Realized | 7.1% | 2.4% | | | | | | | | |
| National goal | 7.1% | 8.1% | 8.8% | 9.5% | 10.5% | 12.0% | 16.1% | 18.5% | 21.2% | 24.6% |
| Share of the obligee | 5.9% | 6.6% | 7.1% | 7.6% | 8.5% | 9.7% | 13.5% | 15.6% | 17.9% | 20.8% |

**Figure 2-8 National target for renewable energy in transport and share of obligees from 2023 to 2030**

Energy consumption in buildings is significantly reduced by 2030 due to the energy renovation of buildings, whereby the consumption of fossil fuels decreases, and the consumption of electricity (from renewable sources) and environmental energy increases. The most considerable reduction in consumption refers to firewood and natural gas, partly due to improving the insulation properties of buildings and partly due to replacing used technologies with heat pumps.

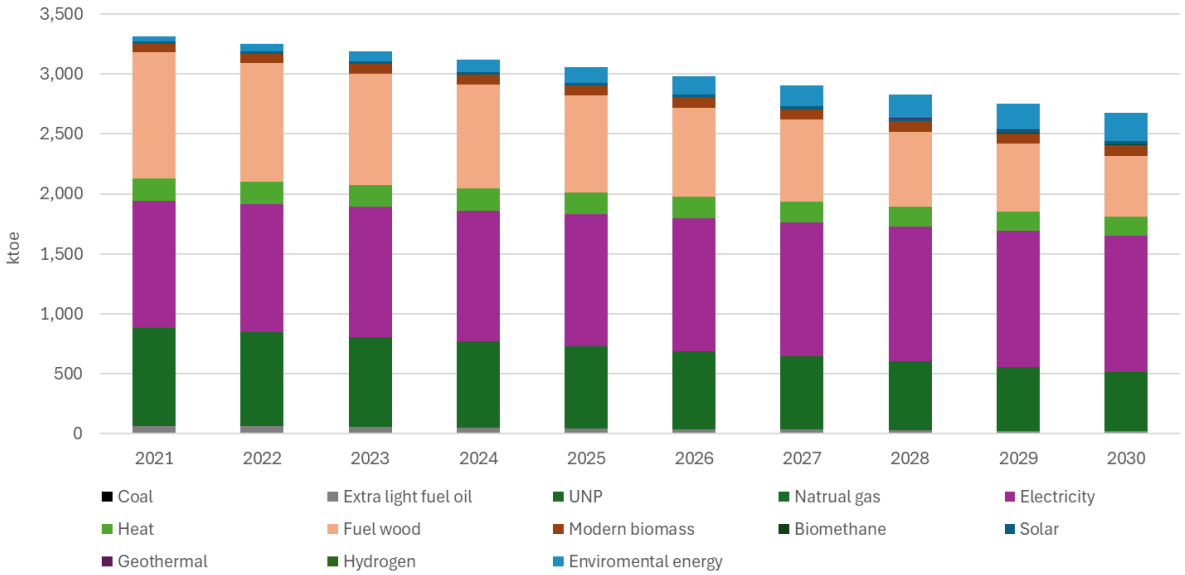



**Figure 2-9 Indicative path of use of RES in the building sector**

The predicted decrease in energy consumption in the industry sector by 2030 is about 10%. At the same time, coal and natural gas will achieve the most significant reduction in consumption, while electricity (with a higher proportion of RES) will increase consumption. Hydrogen is expected to be in use after 2025.

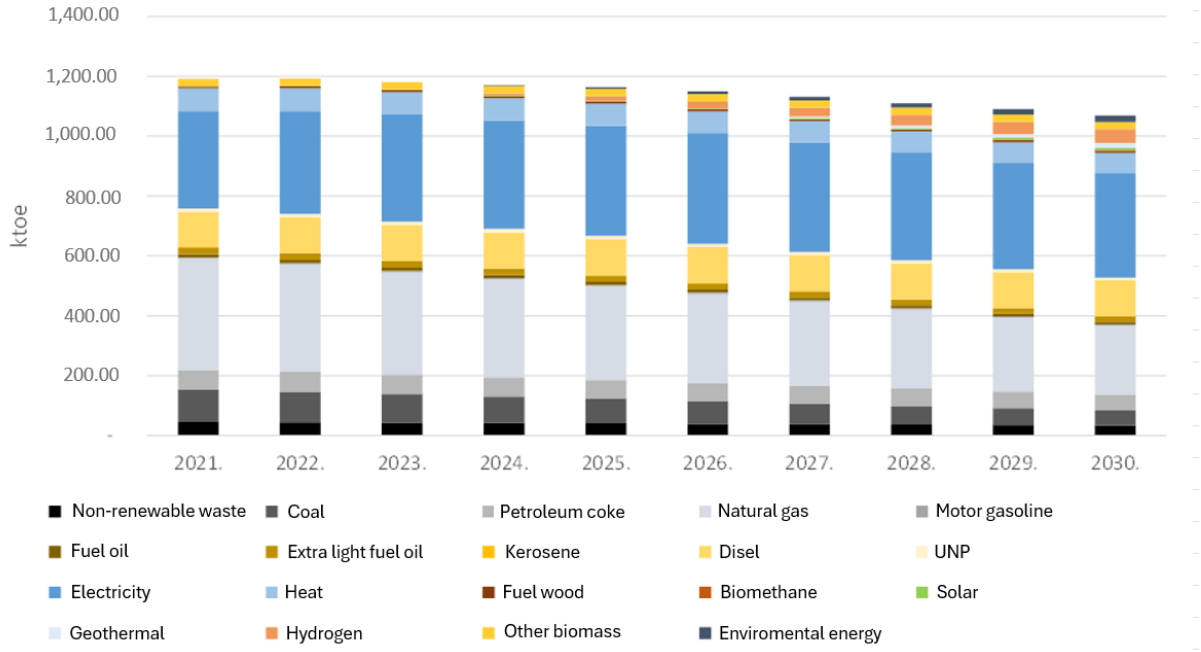



**Figure 2-10 Indicative path of use of RES in the industry sector**

### iii. Estimated trajectories of renewable energy technologies planned to be used by Member States to achieve total and sectoral trajectories of renewable energy from 2021 to 2030, including expected final gross energy consumption by technology and sector expressed in Mtoe and total planned installed capacity

The estimated contributions of renewable energy technologies are shown in Figure 2-11. and Tables 2-2 to 2-5.

**Table 2-2 Estimated contribution of RES technologies to gross final consumption**

| ktoe | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gross final RES consumption | 2,302 | 2,364 | 2,426 | 2,488 | 2,550 | 2,619 | 2,687 | 2,756 | 2,825 | 2,921 |
| Solar energy | 17 | 19 | 20 | 22 | 23 | 25 | 26 | 28 | 29 | 31 |
| Solid biomass | 1,154 | 1,096 | 1,038 | 980 | 921 | 863 | 805 | 746 | 688 | 630 |
| Gaseous biofuels | 0 | 2 | 3 | 5 | 6 | 8 | 9 | 10 | 12 | 13 |
| Liquid biofuels | 91 | 102 | 112 | 123 | 134 | 144 | 155 | 165 | 176 | 187 |
| Geothermal energy | 5 | 7 | 9 | 12 | 14 | 16 | 18 | 20 | 22 | 25 |
| Thermal energy from RES | 109 | 142 | 176 | 209 | 242 | 276 | 309 | 343 | 376 | 410 |
| Electricity from RES | 925 | 996 | 1,067 | 1,138 | 1,209 | 1,280 | 1,352 | 1,423 | 1,494 | 1,565 |
| Hydrogen | 0 | 0 | 0 | 0 | 0 | 7 | 14 | 20 | 27 | 61 |

"Thermal energy from RES" includes heat produced from renewable energy sources in public heating plants, boiler rooms, industrial heating plants and heat pumps.

**Table 2-3 Estimated contribution of RES technologies to electricity**

| ktoe | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gross final RES electricity | 925.1 | 968.4 | 1,033.7 | 1,112.8 | 1,191.9 | 1,271.0 | 1,350.1 | 1,429.2 | 1,508.3 | 1,564.7 |
| Hydro power plants | 606.5 | 605.8 | 605.2 | 604.5 | 603.9 | 603.2 | 602.6 | 601.9 | 601.3 | 600.6 |
| Wind power plants | 177.3 | 212.0 | 246.6 | 281.3 | 315.9 | 350.6 | 385.2 | 419.9 | 454.5 | 489.2 |
| Solar power plants PV | 12.8 | 13.1 | 35.5 | 71.6 | 107.8 | 143.9 | 180.0 | 216.2 | 252.3 | 265.7 |
| Geothermal power plants | 7.7 | 12.4 | 17.2 | 21.9 | 26.7 | 31.4 | 36.2 | 40.9 | 45.7 | 50.4 |
| Thermal – solid and gaseous biofuels | 120.8 | 125.0 | 129.2 | 133.4 | 137.7 | 141.9 | 146.1 | 150.3 | 154.5 | 158.7 |

**Table 2-4 Estimated contribution of RES technologies in heating and cooling**

| ktoe | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| Gross final RES for heating and cooling | 1,297.0 | 1,277.7 | 1,258.3 | 1,239.0 | 1,219.6 | 1,200.2 | 1,192.5 | 1,184.9 | 1,177.2 | 1,169.5 |
| Solar energy | 17.1 | 18.6 | 20.2 | 21.7 | 23.2 | 24.8 | 26.3 | 27.9 | 29.4 | 31.0 |
| Solid biomass | 1,154.4 | 1,096.1 | 1,037.8 | 979.5 | 921.2 | 863.0 | 804.7 | 746.4 | 688.1 | 629.8 |
| Gaseous and liquid biofuels | 0.0 | 3.1 | 6.2 | 9.2 | 12.3 | 15.4 | 18.5 | 21.6 | 24.7 | 27.7 |
| Geothermal energy | 5.0 | 7.2 | 9.3 | 11.5 | 13.7 | 15.9 | 18.1 | 20.3 | 22.5 | 24.7 |
| RES Heat | 120.6 | 152.7 | 184.8 | 216.9 | 249.1 | 281.2 | 313.3 | 345.4 | 377.5 | 409.6 |
| Hydrogen | 0 | 0 | 0 | 0 | 0 | 0 | 11.7 | 23.3 | 35.0 | 46.6 |

"Thermal energy from RES" includes heat produced from renewable energy sources in public heating plants, boiler rooms, industrial heating plants and heat pumps.

**Table 2-5 Estimated contribution of RES technologies in transport**

| ktoe | **2021** | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | **2030** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gross final RES in transport** | **103.4** | 117.5 | 123.2 | 128.9 | 136.3 | 147.7 | 210.9 | 226.6 | 243.9 | **263.9** |
| **Biofuels, 1st generation** | **55.7** | 53.9 | 54.0 | 53.7 | 53.5 | 53.5 | 52.8 | 51.8 | 51.1 | **49.9** |
| **Biofuels from UCO** | **35.5** | 36.6 | 36.8 | 36.8 | 36.8 | 36.5 | 36.3 | 36.1 | 35.3 | **34.9** |
| **Advanced biofuels (liquid and gaseous)** | **0.0** | 3.9 | 7.8 | 11.7 | 15.5 | 20.1 | 74.8 | 79.8 | 84.1 | **88.1** |
| **Hydrogen** | **0.0** | 0.0 | 0.0 | 0.2 | 1.2 | 4.3 | 8.1 | 13.1 | 19.1 | **26.8** |
| **Electricity from RES** | **12.2** | 23.1 | 24.5 | 26.5 | 29.3 | 33.3 | 39.0 | 45.8 | 54.3 | **64.3** |

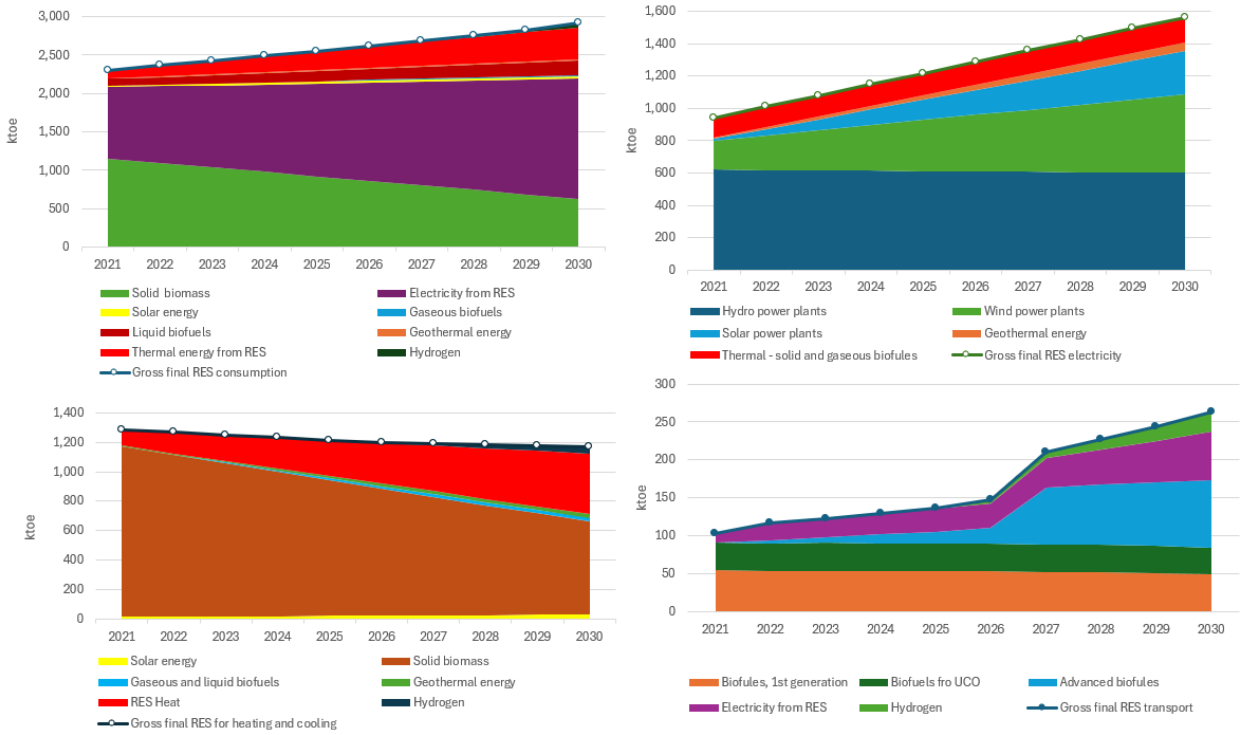



**Figure 2-11 Estimated contribution of RES technologies by sector**

The expected capacity structure for electricity production is shown in Table 2-6 and Figure 2-12 (capacities are indicative - deviations between individual RES technologies are expected). The development of individual technologies will depend on the state of the market at a particular moment, and it is possible that certain RES technologies will develop more intensively than projected during one period, and more slowly in another period. However, it is necessary that the capacities of all RES technologies be developed to a sufficient extent to achieve the target share of renewable energy in the gross direct consumption of electricity. Bearing this goal in mind, with regard to the locations and capacity of electricity production, it is crucial to take into account the capacities of the distribution and transmission power network, that is, the significantly increased amounts of investment in the construction of the necessary reinforcements of the network and the possibilities of their timely realization. Therefore, it is necessary to maximally encourage the use of already existing electricity infrastructure, and the production of electricity integrated within built-up areas, in capacities

appropriate to the energy needs near the location of production. In this way, in addition to reducing additional investments in the power grid, the energy efficiency of the power infrastructure is also increased. In contrast, the development of large electricity production capacities in locations far from consumption or overcapacity in relation to local electricity needs, as a rule, means lower energy efficiency, requires additional increased investments in new and existing electricity networks and the occupation of new areas with an unfavorable impact on the environment, increasing thus the cost of the energy transition and the risk of not achieving the goals of the share of renewable energy in the gross direct consumption of electricity.

**Table 2-6 Estimated powerplant capacities in the scenario with additional (WAM) measures (MW)**

| MW | Nuclear | Hydro | Gas | Fuel Oil | Coal | Biomass | Biogas | Geothermal | Wind | Solar | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 348 | 2,203 | 822 | 344 | 199 | 101 | 59 | 10 | 987 | 222 | **5,295** |
| 2030 | 348 | 2,631 | 879 | 0 | 199 | 135 | 59 | 68 | 2,268 | 2,382 | **8,969** |
| 2040 | 348 | 2,980 | 831 | 0 | 0 | 135 | 59 | 318 | 3,563 | 4,860 | **13,094** |
| 2050 | 348 | 3,200 | 461 | 0 | 0 | 135 | 59 | 405 | 4,353 | 5,770 | **14,732** |

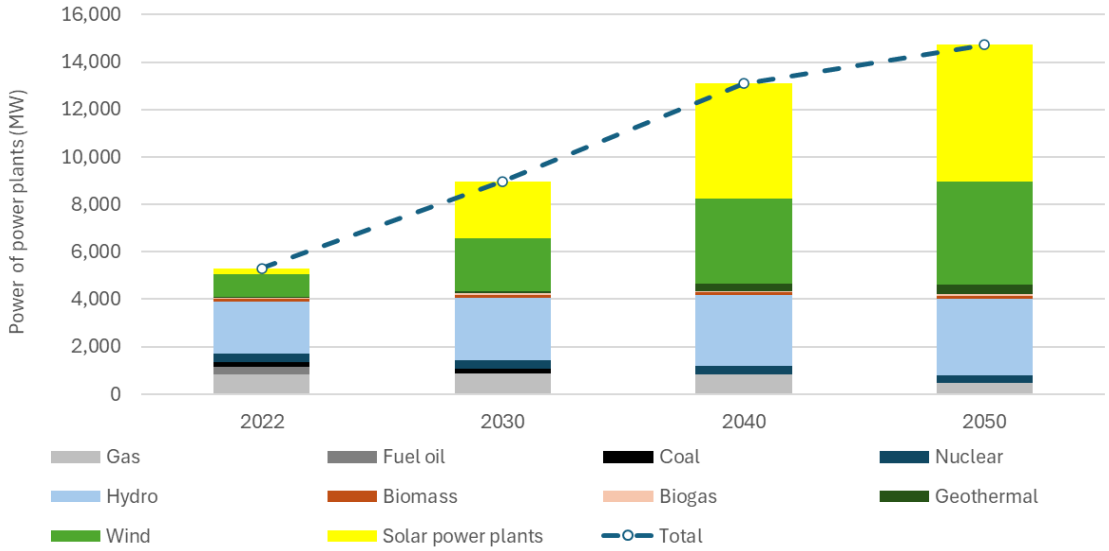



**Figure 2-12 Estimated power plant capacities in the scenario with the additional (WAM) measures**

About 2,2% of electricity consumption in Croatia in 2023 was covered by solar power plants, about 475 MW of installed power. According to the Regulation on quotas for encouraging the production of electricity from renewable energy sources and high-efficiency cogeneration („Official Gazette“, No. 57/20), quotas have been established for promoting the production of electricity from solar power plants depending on the installed power (from 50 kW to 500 kW inclusive, greater than 500 kW up to and including 10 MW and solar power plants with an installed capacity of more than 10 MW). The total quota for all three groups of solar power plants is 1,075 MW. According to the new Council Regulation (EU) 2022/2577 of December 22$^{nd}$, 2022, on establishing a framework for accelerating the introduction of energy from

renewable sources[16], OJ L 335, 29/12/2022, (hereinafter: Regulation on determining the framework for accelerating the introduction of energy from renewable sources), it is proposed to accelerate the introduction of renewable energy sources with an emphasis on the development, installation and speeding up of the licensing procedures for small integrated solar power projects up to 50 kW for households and businesses facing high prices energy, to become consumers of their own energy from renewable sources. It is necessary to highlight the advantage of integrated solar power plants in terms of minimal environmental impact and the possibility of multiple uses of already occupied space. Namely, using space for RES within built-up areas reduces the need to occupy new areas and enables using existing infrastructure. At the same time, the capacities of integrated solar power plants should reflect the needs of electricity consumption at or near the location of production, in order to optimize the necessary investments in the distribution power network.

The total capacity of hydropower plants in Croatia is approximately 2,200 MW. Of these, 9 are accumulation power plants with a total capacity of 1,487 MW, 7 are run-of-the-river hydropower plants with a total capacity of 407 MW, 36 are small hydropower plants with a total capacity of 34 MW and one is a pumped-storage hydropower plant with a capacity of 270 MW in turbine operation and 240 MW in pump operation. One unit out of two installed at HPP Dubrovnik (126 MW) is directly connected to the transmission network of the BiH power system.

By 2030, one large hydropower plant, several small hydropower plants (on watercourses and water supply systems), and one pumped-storage hydropower plant are expected to be constructed. Revitalising existing production plants is expected to extend their life cycle with a slight increase in their power. When planning, it is necessary to consider climate projections and the risks of climate change because, under their influence, the water regime changes significantly.

Considering the expected accelerated integration of RES and the energy transition to reduce greenhouse gas emissions, the only coal-fired power plant in Croatia - TPP Plomin 2 - is scheduled to be decommissioned by the end of 2032. However, a necessary prerequisite is to ensure a high level of power supply security in the area of Istria. The maximum load of the electric power system in Istria is about 350 MW, with an annual consumption of 450 GWh, while the installed power of TPP Plomin 2 is 210 MW, with a total annual production of up to 1.5 TWh/year.

Due to its geographical uniqueness, economic development and the expected increase in electricity consumption, as well as the increase in the required quality of supply, it is necessary to ensure adequate replacement production, i.e. network infrastructure, before decommissioning TPP Plomin 2 as the only significant and primary production facility in Istria. It is especially important considering the current level of electricity network connectivity of Istria with the rest of the Croatian system and the system of Slovenia, which is insufficient in the long term for the desired level of power supply security for existing and expected future

[16] Council Regulation (EU) 2022/2577 of 22 December 2022 establishing a framework for accelerating the introduction of energy from renewable sources, https://eur-lex.europa.eu/legal-content/HR/TXT/?uri=CELEX:32022R2577

customers of electricity in Istria. Namely, in the existing operating practice in a situation without TPP Plomin in operation when the consumption of Istria (load) is above 220 MW (which is approx. 40% of the time per year), there is a possible threat to the security of the supply of electricity to Istria, which is a phenomenon that occurs up to a couple of times a year. Moreover, high loads appear mainly after sunset. Hence, the solution to the problem is integrating SPP and ensuring adequate base local production, energy storage, or better connection with the rest of the system. It is essential to add that the water supply system of Istria also depends on the electricity supply, so from this aspect of the security of the supply of Istria, it is necessary to pay maximum attention, considering the risks of climate change.

The agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the regulation of status and other legal relations related to the investment, exploitation and decommissioning of the Krško Nuclear Power Plant and the Social Contract, which entered into force in 2003, regulate mutual relations, rights and obligations based on equal ownership shares of company members: GEN energy, and Hrvatska elektroprivreda. According to the contracts mentioned earlier, the Krško Nuclear Power Plant, located on the Republic of Slovenia territory, supplies 50% of the produced electricity to Hrvatska elektroprivreda. The operating life of the power plant has been extended until 2043, and negotiations are underway to extend the life of the Krško Nuclear Power Plant beyond 2043. Furthermore, following technological developments and the needs of the energy transition, other alternative solutions in the field of nuclear energy use will be considered, including small modular reactors (SMRs) and, at a later stage, fusion. It is important to bear in mind that nuclear technologies, in addition to electricity production, enable self-sufficiency in terms of future hydrogen production without CO2 emissions, because otherwise the same goal can only be achieved through imports. By introducing SMR technology when it is mature, certain locations where existing fossil fuel power plants were located can also be used, which significantly reduces the cost of investments in transmission systems. In this regard, a Working Group for Nuclear Energy was established at the Ministry of the Economy.

It should be noted that the estimated installed power capacities result from a simulation model and that deviations from the calculated values may be expected in the implementation. The efforts of the Republic of Croatia will be directed towards achieving the target regarding the share of RES in gross final consumption, and the installed capacity in some technologies can be expected to be higher or lower than estimated. The dynamics of the development of individual projects will affect this, especially in the development of geothermal projects, where the minimum contribution to the goal is considered; more new capacities are expected from the stable production of renewable electricity and thermal energy, for which new legal prerequisites have been made, and more projects are in the mature phase of potential testing.

iv. Estimated trajectories of biomass demand for energy, broken down into heat and electricity and transport, and trajectories of biomass supply by feedstock and origin (differentiation between domestic production and import). For forest biomass, evaluation of its source and impact on the sink in the LULUCF sector

The estimated trajectory of demand for biomass energy broken down into crude biomass, heat and electricity produced from biomass and biofuels in transport is shown in Figure 2-13.

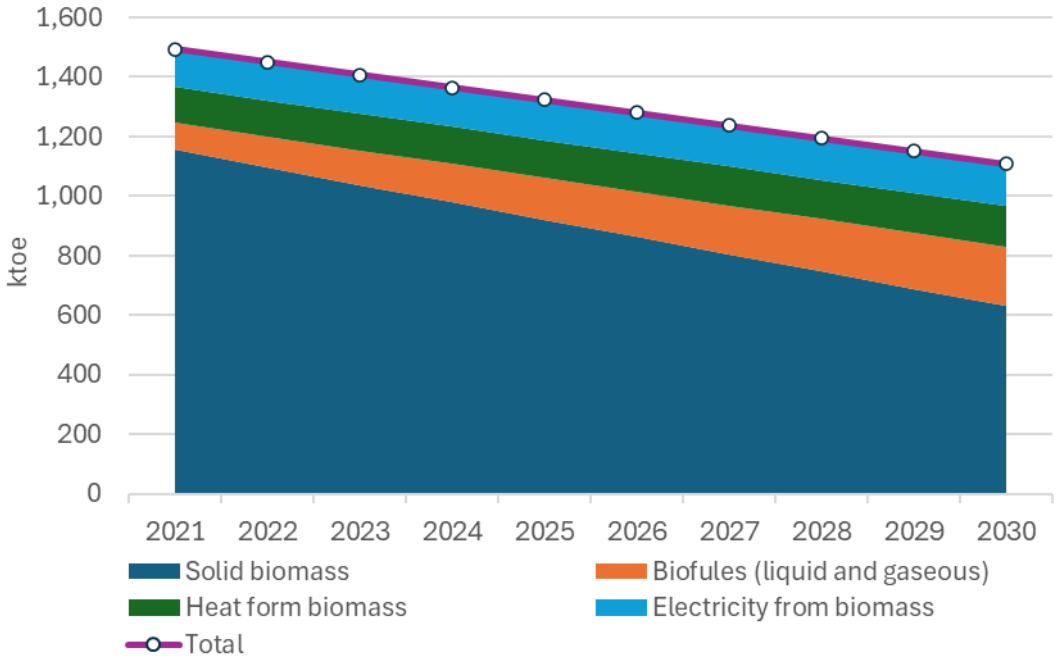



**Figure 2-13 Estimated trajectory of demand for biomass energy**

Solid biomass accounts for more than 30% of the final energy consumption in the household and service sectors. In comparison, less than 10% of the solid biomass used is the so-called modern biomass (pellets, briquettes, etc.). The import of solid biomass is relatively small and amounts to about 2% of the total needs.

The need for solid biomass will decrease as the housing stock is renovated. By 2030, firewood consumption will decrease by about 50%, while the consumption of modern biomass will increase slightly (by about 1%).

The Ministry of Agriculture, Forestry, and Fisheries established an Expert Working Group to develop a Bioeconomy Strategy until 2035, for which needs analyses related to energy from biomass were also carried out.

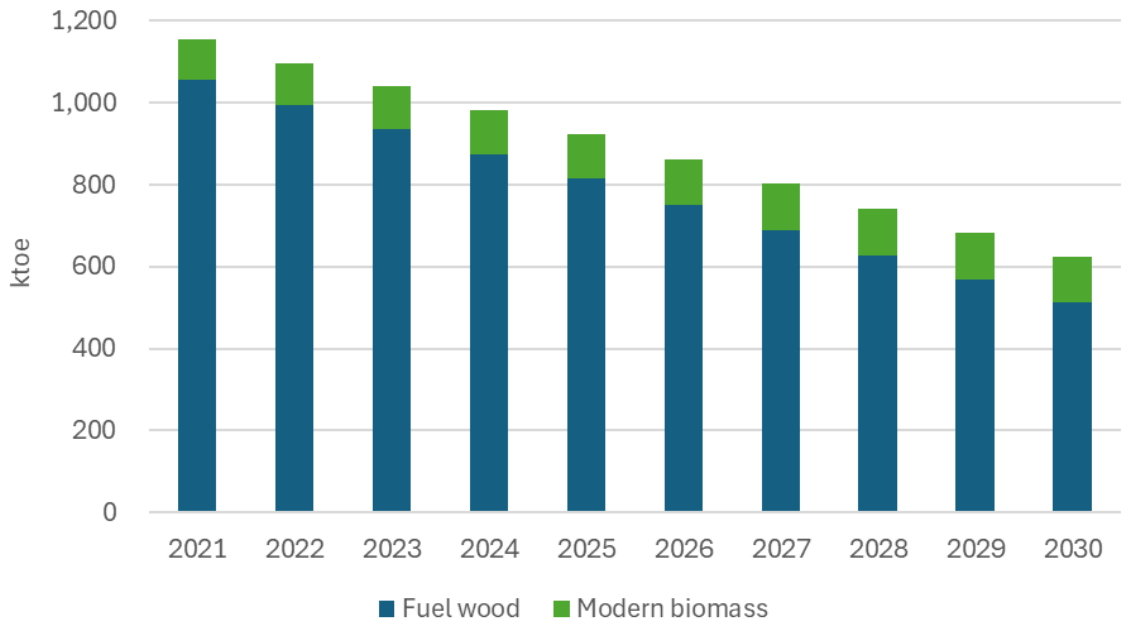



**Figure 2-14 Estimated trajectory of solid biomass energy demand**

v. If applicable, other national trajectories and targets, including long-term and sectoral ones (e.g. share of renewable energy in district heating, use of renewable energy in buildings, renewable energy produced by cities, renewable energy communities and consumers of own renewable energy, energy produced from sewage sludge from wastewater treatment)

Under the Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, all Member States committed to increase the share of RES for heating and cooling by 1.3 percentage points per year, or 1.1 percentage points per year if waste heat is not used, as the annual average for the period 2021-2025 and the period 2026-2030, compared to this share in 2020, expressed as a share of final consumption and according to the methodology laid down in the said document. However, this requirement shall also be deemed fulfilled if the share of renewable energy and waste heat and cold in centralised heating and cooling is more than 60%. However, following the Comprehensive assessment of the potential for efficiency in heating and cooling in Croatia according to Annex VIII of Directive 2012/27/EU on energy efficiency, the heat produced from cogeneration plants cannot be considered waste in the sense that it meets the conditions laid down in Article 24 (4) of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources. Based on the current situation and estimated increases in the share of RES in gross final consumption for heating and cooling, the Republic of Croatia fails to meet the condition referred to in Article 24 of the Directive on promoting energy use from renewable sources.

The Directive (EU) 2023/1791 on energy efficiency of September 13$^{th}$, 2023 defines the criteria for an efficient centralised heating and cooling system based on the share of renewable energy sources, cogeneration (and high-efficiency cogeneration) and waste heat. An efficient centralised heating and cooling system must meet the following criteria

- until December 31st, 2027, a system that uses at least 50% of energy from renewable sources, 50% of waste heat, 75% of heat obtained from cogeneration or 50% of a combination of such energy and heat;
- from January 1st, 2028, a system that uses at least 50% energy from renewable sources, 50% waste heat, 50% energy from renewable sources and waste heat, 80% heat obtained from high-efficiency cogeneration or at least a combination of such thermal energy entering the network in which the share of energy from renewable sources is at least 5%, and the total share of energy from renewable sources, waste heat or heat obtained by high-efficiency cogeneration is at least 50%.

The criteria are further tightened after 2035, whereby after 2050, only the system that does not use fossil fuels is considered efficient. According to the analysis of the production of most centralised heating and cooling systems for 2021, the share of cogeneration is 64.3%, and the share of renewable energy sources is 3.5%.

On July 14th, 2021, the European Commission published the legislative package "Fit for 55", which was adopted in 2023 and 2024, which adapts existing climate and energy legislation to meet the EU's new greenhouse gas emission reduction target of at least 55% by 2030. A key element in the 'Fit for 55' package is the revision of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, where the same Directive revised and strengthened the provisions and set a new EU target of at least 40% of the share of RES in final energy consumption by 2030, accompanied by new sectoral targets.

The current Russian-Ukrainian crisis has caused a significant increase in the prices of energy and energy-generating products and has led to increased energy security concerns. Based on all short-term developments at the European level and globally, the REPowerEU plan adopted a proposal for a new set of measures for energy savings, diversification of deliveries, abandonment of dependence on Russian fossil fuels, increasing investments in renewable, clean energy, and combining investments and reforms.

According to the RED III directive (EU Directive 2023/2413 regarding the promotion of energy from renewable sources), member states aim to increase the share of energy from renewable energy sources, including heat obtained from electricity from renewable sources and waste heat in centralised heating and cooling, by 2.2 percentage points as an annual average calculated for the period from 2021 to 2030 compared to the share from 2020.

Also, the increase in energy efficiency in district heating and cooling systems is already being implemented until 2020 as part of the State Aid Programme for increasing the efficiency of district heating systems. Under the Operational Programme "Competitiveness and Cohesion 2014-2020", Priority Axis 4 "Promoting energy efficiency and renewable energy sources", specific objective 4c3 "Increasing the efficiency of the heating system" through the mechanism of Integrated Territorial Investment. The expected effects are a reduction in losses in distribution systems by a relative 4% percentage point on the national level by the end of 2023 and a primary energy savings of 1 PJ over the same period. As planned beyond 2020, these savings will be relevant given the requirements of the Directive on the promotion of the use of energy from renewable sources, and it is expected that the reduction in losses in district heating and cooling systems, with the assistance of EU funds, will continue in the period until 2030. Regarding electricity generation for own needs, the most considerable contribution is

expected from photovoltaic systems integrated into buildings with connected energy storage systems at the same location. The EU Solar Strategy[17] sets out a comprehensive vision for rapidly reaping the benefits of solar energy and presents four initiatives to address the remaining challenges in the short term: i) promoting fast and massive use of photovoltaic technology within the framework of the European Solar Rooftops Initiative; ii) simplifying and shortening permit granting procedures iii) ensuring the availability of a large number of skilled labour to meet the challenges of solar power generation and deployment across the EU; and iv) establishing an EU Alliance for the Solar Photovoltaic Industry to facilitate the spread of a resilient industrial value chain in the field of solar energy in the EU, in particular in the sector of photovoltaic systems production.

The Regulation laying down a framework to accelerate the deployment of renewable energy, is binding. It should apply to all EU Member States for the next 18 months. It was adopted as a response to the deteriorating market situation due to the Russian-Ukrainian crisis, the sharp rise and instability of natural gas and electricity prices and the threat to the Union economy itself, i.e., security of supply. To mitigate any adverse effects, this Regulation proposes accelerating the deployment of renewable energy sources, focusing on developing, installing, and accelerating permit granting procedures for small-scale integrated solar energy installation projects to become self-consumers of own renewable energy. The focus is on the local community, households, renewal of the capacity of existing plants, installation of solar energy equipment and related energy storage capacities at the same location, as well as the means necessary for their connection to the grid, including permits for connection to the grid and environmental impact assessments if required. The Regulation establishes a framework for reducing the time limits for the permit granting procedure for those licenses that have a start date within the period of its application, relating to installing solar energy equipment up to 50 kW and renewing the capacities of renewable energy generating plants.

In the context of the low carbon transition, it will be essential to consider a fair energy transition and the need for regional added value within that transition, especially in specific areas such as islands. On islands, generating electricity from RES at the place of consumption means less investment in infrastructure and greater security of the system while helping to achieve national targets for the share of renewable energy in total production. In mid-2020, Croatia signed a Memorandum of Understanding for the implementation of the Clean Energy for EU Islands Declaration (Memorandum of Split) as a follow-up to the Valletta Declaration, which aims to improve the energy transition on islands while respecting the specificities of each island and to expand and strengthen cooperation between Member States. The Memorandum ensures detailed support to islands in preparing their strategies for the clean energy transition process and the collaboration of energy communities on islands. It recognises the importance of implementing projects to increase the use of renewable energy sources using innovative technologies, developing clean and sustainable transport and integrating the electricity system with other sectors. The Memorandum considers the objectives of the Paris Agreement and the European Green Deal, achieving a climate-neutral

[17] Communication from the Commission to the European parliament, the Council, the European Economic and Social Committee and the Committee of the regions EU Solar Energy Strategy COM/22/221 final, 18th May 2022; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022DC022

EU by 2050, the Clean Energy for All Europeans legislative package and national energy and climate plans.

As a signatory to this document, Croatia focused on decarbonisation on islands. The main objective will be precisely defining the needs related to the energy transition and the transition to clean energy, considering that self-supply is promoted on the islands (both for individuals and more extensive projects) as well as solutions which will not further burden the transmission system, and which will ensure the supply of electricity in any situation. In addition, clean transport should be promoted on islands, including shipping lines, enabling better connectivity between islands and land while reducing $CO_2$ emissions related to ship transport.

Therefore, it is vital that the measures proposed in the plan specifically address the islands and the needs of the islands in terms of electricity generation, energy efficiency, and decarbonisation. It is vital because it encourages self-supply and creating renewable energy and energy communities in areas geographically separated from the rest of the country. It also solves the problem of increased electricity consumption during the summer months. However, the most important thing is that the promotion of measures on the islands reduces the pressure on the energy transmission system and, at the same time, creates pilot projects that can then be applied to other parts of the Republic of Croatia. In addition to these measures, which will place particular emphasis on the islands, additional sources of financing need to be found for the generation of clean energy on the islands and their decarbonisation, which will facilitate the transition of the islands to clean energy and accelerate their decarbonisation, considering the people living there.

In addition to the above, the Smart Islands Declaration emphasises the need to encourage island communities to switch to clean energy, and it is imperative to strengthen the synergy between energy, transport and information and communication technology, along with including topics related to water and waste. This approach is based on ensuring optimal use and management of island resources and the contribution of sustainable and equitable development that will maximise island potential. One of the main determinants of smart islands is reducing the use of fossil fuels, increasing the use of significant renewable energy resources, and increasing energy efficiency. Decarbonisation aims to exploit the considerable potential of renewable energy sources, sun, wind, sea currents and waves, which will also increase the energy efficiency of buildings (lighting, heating and cooling in buildings) and infrastructure (e.g., street lighting, pumping stations). It emphasises the potential of islands as pilot locations for the development of integrated solutions such as the production of energy from waste, the use of energy produced from RES in transport and electric vehicles, or for desalination purposes by exploiting the synergy between sustainable energy, waste, water, and mobility.

## 2.2 Dimension: energy efficiency

### i. Elements referred to in Article 4, item (b)

Indicative national target of increase in energy efficiency **by 2030**

The national targets for increasing energy efficiency by 2030 are shown in Table 2-7.

**Table 2-7 Indicative national goals for energy efficiency in 2030**

| 2030 targets | PJ | Mtoe |
|---|---|---|
| Primary energy consumption[18] | 336.9 | 8.05 |
| Final energy consumption | 246.2 | 5.88 |

Figure 2-15 shows energy consumption trends by year from 2021 to 2030.

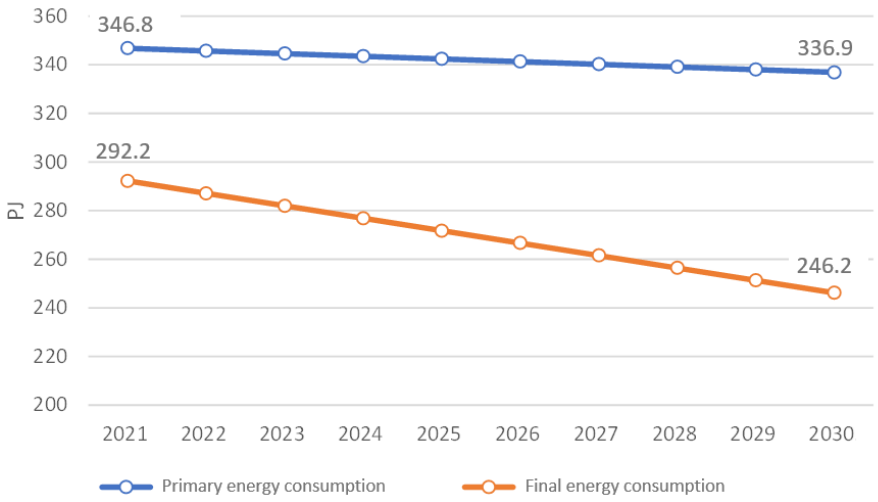



**Figure 2-15 Trends in primary and final energy consumption from 2021 to 2030**

The projection of the direct consumption of all forms of energy was made using a "bottom-up" approach, which allows for an overview of structural changes in energy use in different sectors (e.g., industry, households, service sector, transport) necessary to achieve the goals of mitigating climate change.

LEAP software tool (The Low Emission Analysis Platform[19]) was used to analyse direct energy consumption. The "end-use" modelling technique was applied in such a way that for each sector and sub-sector to model the WEM and WAM scenarios, and the current and future need for useful energy was determined according to the purposes, and then, with the application of the appropriate efficiency of technologies and the predicted representation of energy sources, the final energy consumption. In addition, the so-called "energy efficiency

[18] Total energy consumption without non-energy consumption

[19] Heaps, C.G., 2021. LEAP: The Low Emissions Analysis Platform. [Software version: 2020.1.54] Stockholm Environment Institute. Somerville, MA, USA. https://leap.sei.org

first" principle is used when modelling energy needs in each individual consumption sector. The possibilities of applying energy efficiency measures were first considered using the example of buildings and then introducing new technologies for heating and cooling, replacing energy sources, etc. The same principle was applied in other sectors.

The main determinants of changes in the energy sector applied in creating projections of final consumption of all forms of energy are as follows:

- Increasing energy efficiency in all parts of the energy chain (production, transport/transmission, distribution and consumption of all forms of energy) and applying the principle of energy efficiency first;
- Transition of as many activities as possible to the use of electricity (where it is technologically possible and cost-sustainable in the long term);
- The increasing profitability of investments in technologies for the use of RES is due to the expected drop in the prices of these technologies and the increase in the prices of emission units.

Additionally, on the side of energy production, energy transformation efficiency is also expected to increase through the construction of new cogeneration plants and gas thermal power plants (TE) with a higher degree of beneficial effect and an increase in the share of RES. On the side of transmission and distribution of electrical and thermal energy, a further reduction of losses to the level of developed energy systems is expected by 2030.

Energy consumption and driving parameters (e.g., the population's number and structure, the GDP's structure, etc.) are processed at the state level.

The possibility of meeting needs with all forms of energy (e.g. heat, electricity, natural gas, biomass, etc.) was analysed, starting from the availability of local resources and sources of primary forms of energy. For networked systems (e.g. electricity, natural gas), an analysis and optimisation of the operation and development of the system of production, transmission/transport and distribution of energy to end users was carried out according to the principle of minimum system cost, taking into account the limitations of environmental impact (including greenhouse gas emissions gases), strategic determinants in the area of security of energy supply and the influence of participation in the operation of the regional market (possible cooperation in the use of regional energy potential and sharing of infrastructure). The availability and condition of the existing energy infrastructure, the necessary replacement of elements and the construction of new system elements (e.g. power plants, transmission lines, pipelines, etc.) were considered.

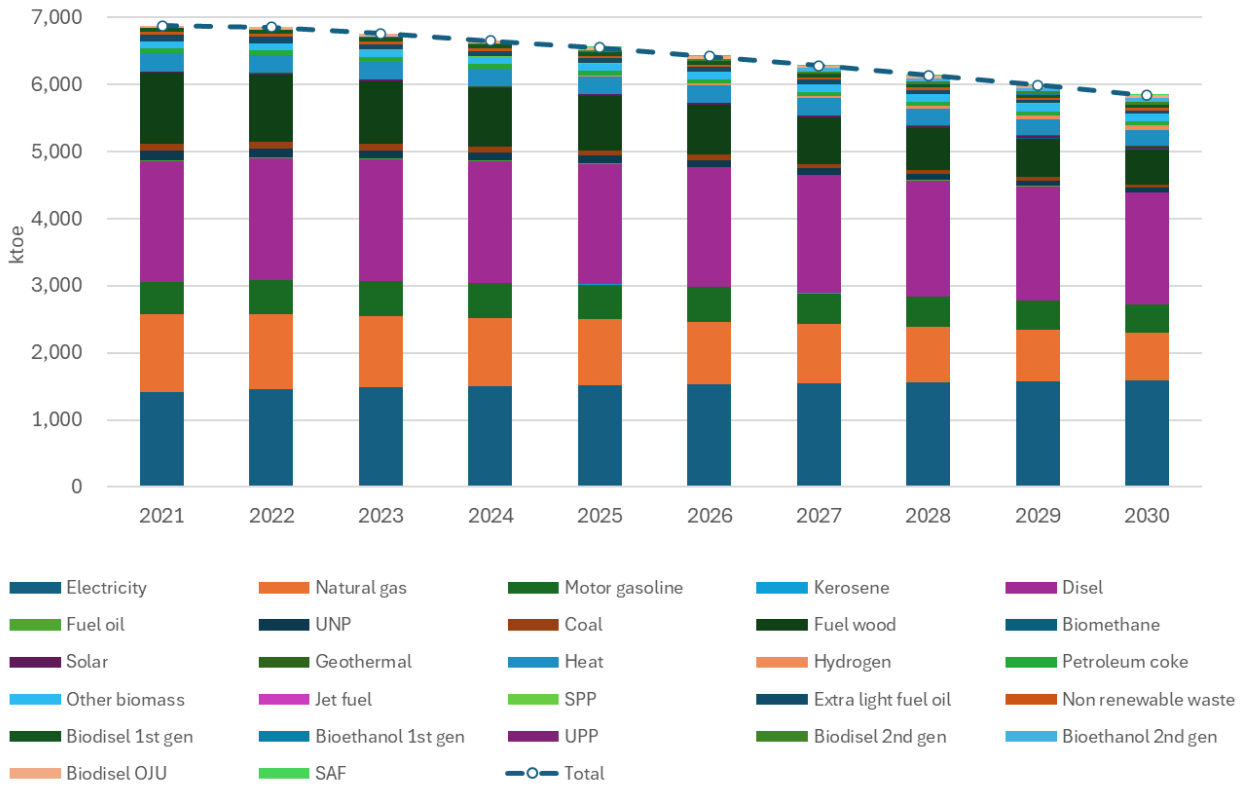



**Figure 2-16 Projection of final energy consumption according to energy sources**

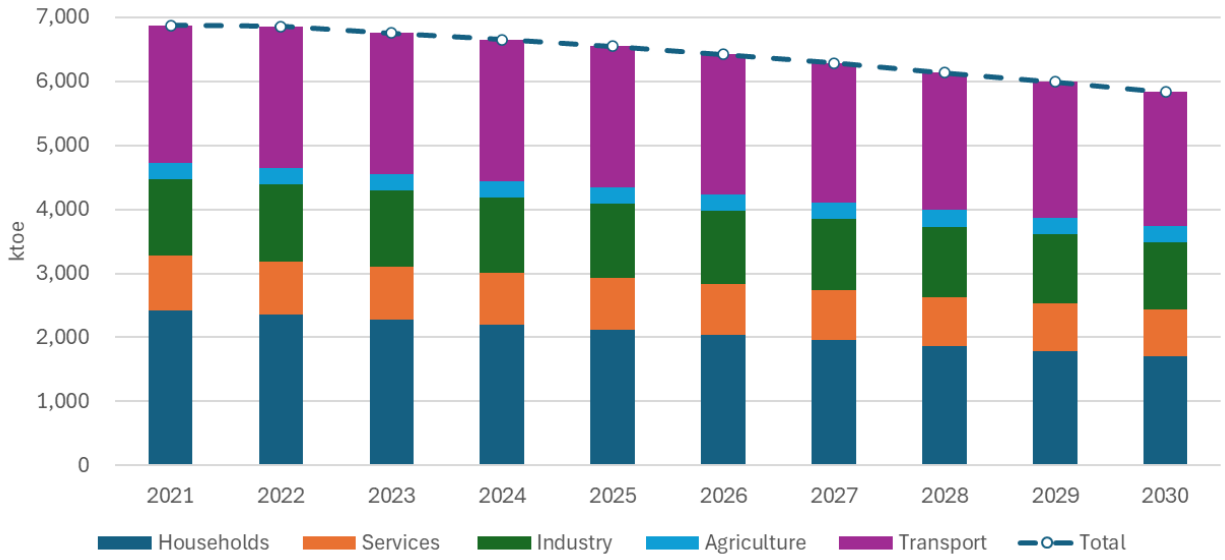



**Figure 2-17 Projection of final energy consumption according to energy sectors**

*Cumulative energy savings in the period 2021-2030 following Article 7 (1) (b) on the energy efficiency obligation scheme of Directive 2018/2002 amending Directive 2012/27/EU on energy efficiency*

The specified target of cumulative savings in the amount of **2,993.7 ktoe (125.3 PJ)** is calculated by Article 7 (1), item (b) of Directive 2018/2002 on energy efficiency, as shown in Table 2-8**.** A detailed calculation is given in Annex II.

A new increased target was calculated for the adopted Directive 2023/1791 from September 2023, shown in the table below.

**Table 2-8 The cumulative energy savings goal from 2021 to 2030 in line with Article 7 of the Energy Efficiency Directive**

| 2030 targets | Annual savings | | Cumulative savings | |
|---|---|---|---|---|
| | PJ | ktoe | PJ | ktoe |
| According to Article 7(1)(b) | 2.3 | 54.4 | 125.3 | 2,993.7 |
| According to Article 8, Directive 2023/1/1791 | 3.9 | 93.1 | 180.6 | 4,313.6 |

*Indicative targets of the long-term strategy of renovation of the national residential and non-residential building stock*

Following the Technical Regulation on Rational Use of Energy and Thermal Insulation in Buildings, if the application for the issuance of a location or construction permit (for which a location permit is not issued) was submitted on December 31st, 2019, the main project of the building must comply with the requirements of that regulation for buildings with almost zero energy. The obligation for buildings owned by public authorities began on December 31st, 2017. The total residential stock is expected to grow at an average rate of approximately 6,600 residential units from 2021 to 2030, 6,300 from 2031 to 2040 and 6,050 units from 2041 to 2050. The useful area of permanently occupied residential buildings in 2020, reduced by the area of newly built and renovated buildings since 2011, is 110,143,965 m², and the total useful area of non-residential buildings in 2020 is 58,722,937 m². Out of 110,143,965 m² of residential buildings, 38.5% (42,395,923 m²) are multi-apartment buildings, and 61.5% (67,748,042 m²) are single-family homes. The total useful area in non-residential buildings is 58,722,937 m², of which 42,623,410 m² is for commercial buildings and 16,099,527 m² for public buildings. The average building renovation rate from 2021 to 2030 is 2.0% (growth from 1.0% in 2021 to 3% in 2030, from 2031 to 2040 is 3.5% and from 2041 to 2050 is 4%).

The average final energy consumption in the residential sector will be 30 kWh/m² for newly built and renovated buildings. There are expected to be no significant variations for the non-residential sector.

Under Article 2a of Directive 2018/844 on the energy performance of buildings, the Republic of Croatia has adopted a long-term strategy for the renewal of the national building stock until 2050, with a plan of measures and indicators for 2030, 2040 and 2050. The goals defined in this Strategy are still relevant. Still, the goals for individual segments of the building stock are further elaborated through individual building energy renovation programs, which have already been adopted and are being implemented. The adoption of such programs follows the amendments to the EPBD, which requires the adoption of plans for specific segments of the building stock. It should be noted that the Long-Term Strategy was conceived in such a way as to achieve the goal of a decarbonised building stock by 2050, and thus, it is already highly ambitious.

*The total area of public administration buildings being renovated or equivalent savings in the period 2021-2030 under Article 5 of Directive 2012/27/EU on energy efficiency on the leading role of the public sector.*

According to the National Information System for Energy Management, a total of 13.8 million $m^2$ of useful heated area of public sector buildings was recorded in the Republic of Croatia in 2010. To meet the obligation to renovate 3% of the total floor area of heated and/or cooled buildings owned and managed by the central government in the period until 2020, the Republic of Croatia has chosen an alternative approach, i.e., it has set the target of 0.00489 PJ per year in equivalent savings.

Article 6 of Directive (EU) 2023/1791 of the European Parliament and the Council of September 13th, 2023, on energy efficiency and amending Regulation (EU) 2023/955 (amendment) extends this obligation to all public sector buildings larger than 250 $m^2$ that are not nZEB on January 1st, 2024. The obligation is to restore 3% of these buildings to nZEB or ZEB standards. Given that the transposition process of Directive 2023/1791 is ongoing, a detailed analysis of this obligation will be made. The size of this obligation will be determined - this will be expressed through the amendment of the Program for the Energy Renovation of Public Sector Buildings, an implementation measure also defined in this NECP (ENU-5).

### ii. Indicative milestones for 2030, 2040 and 2050, measurable indicators of progress defined at the domestic level, estimated expected savings and benefits based on evidence, and their contribution to the Union's energy efficiency targets as incorporated in the plans established in the strategies for the long-term renovation of the national residential and non-residential building stock (public and private), by Article 2a of Directive 2010/31/EU

Under Article 2a of Directive 2018/844 on the energy performance of buildings, the Republic of Croatia has adopted a new Long-term strategy for the renovation of the national building stock until 2050 (29th session of the Government of the Republic of Croatia, December 14th, 2020), with a plan of measures and indicators for 2030, 2040 and 2050. According to the text of the Long-Term Strategy, the building renovation rate from 2021 to 2030 is growing from the current 1 % to 3% per year in 2030, rising to 3.5% by 2040 and 4% by 2050. The increased renovation rate expressed in the Long-Term Strategy is the result of a significantly lower building demolition rate that describes the number of buildings that are abandoned or removed (in terms of energy consumption, buildings that are not used do not represent a burden on the energy system, but the obligation to decarbonise the total building stock by 2050 produces the need for renovation of buildings that are not used as well, i.e. the need to increase the intensity of renovation concerning the intensity of new construction).

**Table 2-9 Indicative goals of the energy renovation of buildings according to the Long-term strategy of renovation of the national building fund until 2050**

| | 2030 | 2040 | 2050 |
|---|---|---|---|
| Total renovated buildings | 30,838.830 | 41,063.535 | 32,099.102 |
| Renovated residential buildings | 20,171.751 | 26,966.267 | 21,117.537 |
| Target annual energy renewal rate | 2 % | 3.5 % | 4 % |
| Renovated non-residential buildings | 10,667.079 | 14,097.268 | 10,981.565 |

| | | | |
|---|---|---|---|
| Target annual energy renewal rate | 2 % | 3.5 % | 4 % |

The fundamental goal of the Long-Term Strategy remains unchanged—decarbonising the building stock by 2050. This NECP has changed the renovation dynamics described in the long-term strategy to achieve more ambitious goals as early as 2030. The renovation rate in 2022-2030 increases from the initial 1.0% per year to 3.5% annually in 2030.

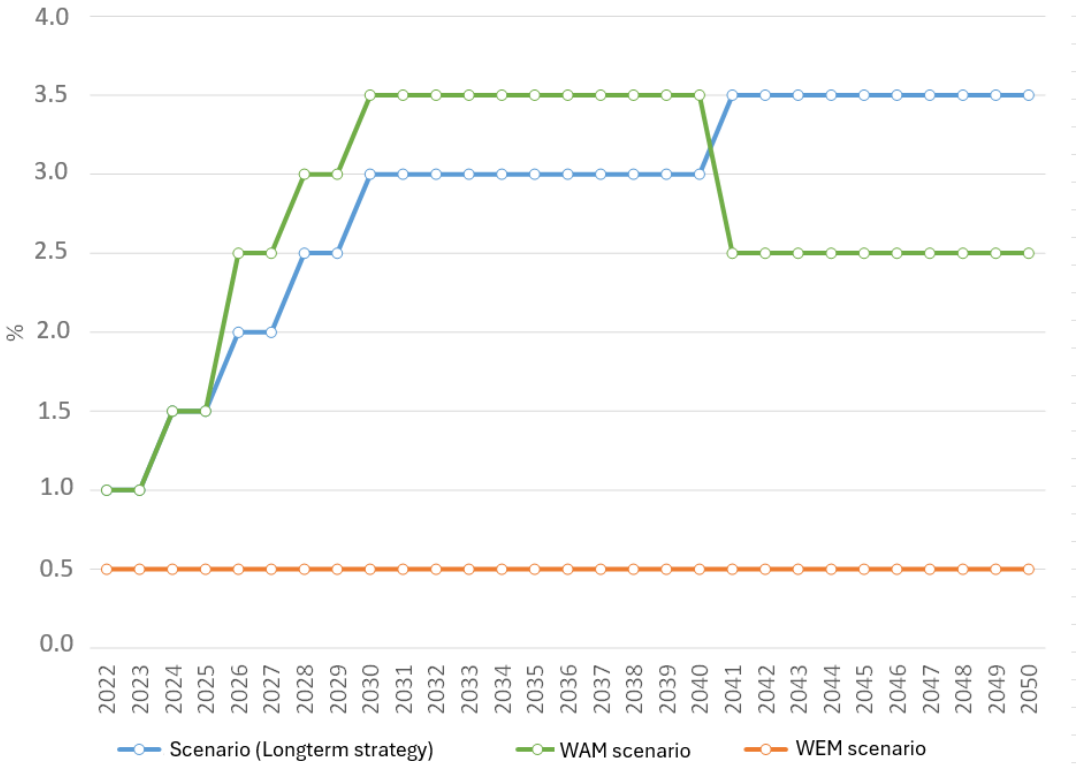



**Figure 2-18 Projection of building renovation rates according to scenarios**

Following the amendments to the EPBD from 2024, the existing energy renovation programs of specific segments of the building stock will be amended and harmonised with the NECP.

iii. If applicable, other national targets, including long-term targets or strategies and sectoral targets, and national targets in areas such as energy efficiency in the transport sector and energy efficiency concerning heating and cooling

Not applicable.

## 2.3 Dimension: energy security

i. National targets for strengthening the diversification of energy sources and supply from third countries to increase the resilience of regional and national energy systems;

the following goals have been established to increase the resilience of regional energy systems, as well as the Croatian energy system:

- Increasing the security of natural gas supply and
- Strengthening the role of hydrogen

The security of the natural gas supply in the Republic of Croatia will be increased by increasing the capacity of the liquefied natural gas terminal. In contrast, constructing new gas pipelines in EU countries and Western Balkan countries will improve the regional security of gas supply.

At the national level, domestic natural gas production is expected to increase from 745 million m3 in 2022 to around 920 million $m^3$ by 2030. At the regional level, by expanding the terminal's capacity for liquefied natural gas, the transit volumes of natural gas to Hungary and Slovenia are expected to increase by about 3 billion $m^3$ by 2030.

The institutional framework for the use of hydrogen will be regulated, providing the institutional prerequisites for strengthening the role of hydrogen in energy systems. At the same time, all the infrastructure built to increase the security of the natural gas supply will be ready for the transport and use of hydrogen, thereby contributing to this strategic goal.

ii. If applicable, national targets for reducing dependence on energy imported from third countries to increase the resilience of national and regional energy systems

The following goal was established to increase the resilience of the Croatian energy system:

- Increasing the share of own production in final consumption of oil and natural gas from 23% in 2022 to 30% in 2030.

This increase will be achieved by researching and exploiting potential hydrocarbon deposits. At the same time, the total consumption of hydrocarbons will be reduced, primarily by increasing the share of renewable energy sources in the final energy consumption, but also by targeted reduction of fossil fuels in individual heating systems.

iii. National targets for increasing the flexibility of the national energy system, particularly the use of domestic energy sources, demand management and energy storage

In this context, the following goal is defined

- Increasing the flexibility and safety of the energy system operation.

This goal will be achieved by implementing targeted measures to improve the management of electric power, gas and heat systems and by building and using energy storage. Special attention will be paid to improving the cyber security of the energy system.

## 2.4 Dimension: the internal energy market

### 2.4.1 Electricity interconnection

#### i. Level of electricity interconnection

Regarding the EU targets related to the desired level of electricity interconnection of at least 15% compared to installed power plants in the observed member state by 2030, the transmission system in the territory of the Republic of Croatia already meets and exceeds that target many times over. The same applies if the existing electricity interconnection capacity is compared with the system's peak load or the RES's installed power in the territory of the Republic of Croatia.

Namely, the sum of installed transmission capacities of interconnectors/interstate powerlines in the existing state is about 13,303.5 MVA, which is almost two and a half times more than the total installed power of power plants of 5,444 MW, or over four times the peak load of the system of about 3,361 MW. However, cross-border transmission lines alone do not mean much in coordinated mechanisms. Single transmission line, i.e. congestion on it, distant countries can limit the entire import/export of the Republic of Croatia or reduce it to some minimal values. Therefore, it is necessary to carry out detailed analyzes from the aspect of the ability to import/export.

The total cross-border exchange amounted to 11,504 GWh at the entry to the Republic of Croatia and 7,159 GWh at the exit from the Republic of Croatia. The price difference in the wholesale market exceeded the indicative threshold of EUR 2/MWh between Member States, regions, or trading zones. However, the average hourly price differences for the day-ahead markets in 2021 were significantly lower at the border between Croatia and Slovenia - EUR 0.35/MWh, which was contributed by integrating the Slovenian and Croatian electricity markets in 2018. The same progress is expected at the border between Croatia and Hungary since, as part of the CORE project (Core Flow-Based Market Coupling project) in June 2022, there was a connection between CROPEX and HUPX day-ahead markets where daily cross-border capacities at the Croatian-Hungarian border are no longer allocated directly through the JAO platform, but indirectly through the mechanism of connecting electricity exchanges.

No specific requirements are set regarding the further increase of cross-border capacity by 2030. Neighbouring transmission system operators (BiH, Serbia) are interested in the construction of new 400 kV interconnectors to BiH (Lika - Banja Luka) and Serbia (Ernestinovo - Sombor), which are being analysed through the development of a 10-year transmission grid development plan (TYNDP) within the ENTSO-E.

Developing new interconnection projects will be based on technological and economic considerations and cost-benefit analysis following the ENTSO-E methodology. Further enhancing possibilities of existing cross-border capacity exchanges is continuously strengthening the use of cross-border lines, primarily by eliminating congestion/limitations in the internal grid. It is expected that the following will have the most significant impact on the transmission network development plan: the start of the application of regional day-ahead capacity calculation based on power flows, the conclusion of CORE region agreements with third countries to consider the flows of third countries in the processes of regional capacity

calculation, the adoption of regional rules for activation of coordinated re-dispatching and trading in the opposite direction.

### 2.4.2 Infrastructure for energy transmission

#### i. Critical projects for power system and, where appropriate, modernisation projects needed to achieve the targets within the framework of the five dimensions of the Energy Union Strategy

Key targets for the power transmission infrastructure:

- Maintaining high reliability of the transmission system and the security of electricity supply of stipulated quality to customers,
- Accelerated integration of variable RES into the electricity system and increased availability of regulatory reserves to balance their production,
- Reducing internal congestion by developing a transmission network between production and consumption areas
- Timely realisation of investment plans, in particular capital investments that enable the integration of RES into the ES,
- Strengthening the electricity market by increasing the availability of transmission capacities for market participants within the trading zone and the region for coordinated capacity calculation by removing the constraints of the transmission network when bidding,
- Revitalisation and replacement of old/deteriorated grid units,
- Increasing the transmission capacity of individual lines planned for revitalisation by using high-temperature low-sag conductors (HTLS) and reducing losses in the transmission of electricity,
- Application of new technologies in transmission if they are technically and economically justified.

The biggest changes are expected in the distribution system, which should support the active participation of many network users in the energy transition, including the acceptance of a large number of distributed sources of electricity of lower power, a role in the connection and supply of charging stations for electric vehicles and the creation of preconditions for green transition in buildings.

The high level of RES integration in Croatia implies a significant extension and reconfiguration of the power grid, which was initially planned and built for entirely different operating conditions and needs, especially regarding the distribution system. In the meantime, a substantial proportion of the elements of the power grid have reached the end of their life, so in the coming period, it is necessary to realise a parallel process of revitalisation of the outdated existing power grid and upgrading of the new power grid required to accept a higher level of RES. For example, almost 50% of the length of the existing transmission lines in the

transmission network has already expired. For the same reason, it is necessary to revitalise an average of 7 transformer stations in the transmission network annually.

On the other hand, about 4,000 MW of installed RES power is currently connected in Croatia, 66% of the total installed production capacity.

The necessary investments in the transmission network up to 2026 will be realised mainly through the National Recovery and Resilience Plan, primarily by increasing the transmission capacity of the existing 110 kV and 220 kV lines. To a certain extent, this will fulfil the prerequisites for achieving the stated goals of the NECP.

However, the interest of investors in RES significantly exceeds the goals of the NECP, i.e. the needs of Croatia. Integrating RES above the NECP goals will require a) significant additional investments in the transmission 400 kV network and distribution network at all voltage levels and b) significantly greater flexibility of the power system, the main characteristic of which is a very gradual increase in the required investments. According to the current situation, by the end of 2033, about 4,800 MW of new production facilities will request connection to the transmission grid. For such a high integration of RES, it is necessary to ensure an additional EUR 872 million of investments in the 400 kV transmission network by 2030, on top of the expected EUR 1,4 billion investments in the distribution network. In other words, it will be necessary to start investments in the network for about 2.3 billion EUR in the next ten years, that is, on average, about 230 million EUR/year. The estimated value of investments in 400 kV transmission lines is about EUR 625 million, and in the corresponding 400/x kV transformer stations, EUR 177 million. In contrast, additional investments in the 110 and 220 kV transmission networks are expected at about EUR 60 million.

The network investments mentioned above are necessary for connection of new production facilities, requirements for increased flexibility, electrification, challenges related to climate change, network age, etc. According to existing regulations, allocating these costs should reflect natural causes and imply that the cost of building the network is divided between new network users (one-time connection fees) and end customers (network fees). Financing the entire specified amount only from the network fee would imply a significant increase (at least 30%, on top of the initial increase in the operator's operating costs). In order to optimize investments in the capacities of the transmission and distribution network necessary for the connection of new production facilities, it is necessary to maximally encourage the production of electricity integrated within built-up areas with the already existing electricity infrastructure. This is especially true for the distribution network, where the development of large electricity production capacities in locations far from consumption requires multiple increased investments in new and existing infrastructure and thereby increases the risk of not achieving the goals of the share of renewable energy in the gross final consumption of electricity.

In the planning and implementation of energy transmission infrastructure, measure E-06 Strengthening the resilience of the distribution network and measure E-07 Strengthening the resilience of the transmission network from the Climate Change Adaptation Strategy, must be implemented by creating and applying all vulnerability analyses and development plans implementing climate change adaptation measures.

### ii. Key goals for the gas transmission infrastructure

By upgrading and reconstructing the existing gas storage facility, the preconditions for increasing its output capacity by up to 20% have been met, the safety and reliability of the storage facility operation have been increased, and the costs of fuel and maintenance costs have been reduced. The gas storage system development plan includes further development and modernisation of existing storage facilities, as well as the construction of new storage capacities, which primarily provides for the construction of an underground gas storage facility at the location of the Grubišno Polje hydrocarbon exploitation field but also the potential construction of a new seasonal gas storage facility following possibilities and needs. The underground gas storage facility Grubišno Polje is planned as a storage facility with a relatively small working volume (about 60 million $m^3$) but relatively large injection capacities (about 70,000 $m^3$) and withdrawals (about 100,000 $m^3$). The primary purpose of this storage facility will be to cover the peak gas needs in the Croatian gas system, which will enable optimal utilisation of the existing gas storage facility and increase the flexibility of the entire gas system, as well as the security of gas supply in the Republic of Croatia.

Energy storage facilities and facilities for receipt, storage and gasification or decompression of liquefied natural gas (LNG) and compressed natural gas (CNG) have an increasingly key role in the European energy infrastructure. Expansion of such infrastructure facilities is an integral part of the functional network infrastructure.

The energy infrastructure for gas that needs to be built to implement priorities in the energy infrastructure of common interest is defined in the ten-year plan to develop the gas transport system. Under Regulation (EU) 2022/869 of the European Parliament and of the Council of May 30th, 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No. 347/2013 (OJ L 152, June 3rd, 2022), a list of projects of common interest of the EU is defined every two years.

### iii. If applicable, major infrastructure projects envisaged, other than projects of common interest

Major infrastructure projects are:

- gas pipelines for the transport of natural gas and biomethane, which are part of the network mainly consisting of high-pressure gas pipelines, excluding high-pressure gas pipelines used for the production or local distribution of natural gas;
- underground gas storage facilities;
- facilities for receipt, storage and gasification or decompression of LNG and CNG;
- all equipment essential for the protected, secure and efficient operation of the system or enabling a two-way interconnection, including compressor stations,

provided that the construction is technically and economically justifiable or enables the fulfilment of supply security obligations and according to the infrastructure standard (N-1 criterion) under Regulation (EU) 2017/1938 of the European Parliament and of the Council of October 25th, 2017, on security protection measures gas supply and invalidation of Regulation

(EU) no. 994/2010 (Text relevant to the EEA) (OJ L 280, September 28th, 2017) (hereinafter: Regulation on measures to protect the security of gas supply, SOS Regulation).

When planning all infrastructure projects, it is necessary to analyse climate risks and apply appropriate adaptation measures to climate change.

### 2.4.3 Market integration

i. National goals related to other aspects of the internal energy market, such as increasing system flexibility, in particular concerning promoting market prices of electricity under the relevant sectoral law, market integration and connection to increase the marketable capacity of existing interconnectors, smart grids, aggregation, demand management, storage, distributed energy production, mechanisms for dispatch, re-dispatch and limitation of service and price signals in real-time, including the timeframe for achieving the goals.

Connecting the day-ahead markets at the border between the Republic of Croatia, the Republic of Slovenia and Hungary significantly increased the liquidity of the Croatian Power Exchange (CROPEX), increasing the possibilities of energy placement at market prices. The existing market integration activities should continue towards South-Eastern Europe to achieve full integration into the EU internal market.

By connecting the CROPEX and HUPX day-ahead markets, the daily cross-border capacity at the Croatian-Hungarian border will not be allocated directly through the JAO platform but indirectly through connecting electricity exchanges. During the implementation of the CORE project, the methodology for calculating the available capacities at the Croatian-Slovenian and Croatian-Hungarian border also changed, switching to calculating capacities using the power flow method.

The markets of South-Eastern Europe are very significant for Croatia, given its good cross-border connectivity and energy availability. Still, market integration is limited by the level of development of national electricity markets in these countries. Bosnia and Herzegovina do not yet have a power exchange in place, and connecting the day-ahead market with Serbia can be achieved relatively quickly. The day-ahead market connection project in the area of the WB6 countries implements activities for the complete integration of the market in the region in the period of the next few years.

Although Croatia's wholesale electricity market is fully open, it is characterised by a dominant electricity producer. To increase competitiveness on the supply side, the number of participants in the wholesale market, especially in electricity generation, must increase.

It is necessary to increase the participation of end customers with their own generation in the electricity market to ensure flexibility and sufficiency and consider the possibility of forming capacity markets.

Enabling the aggregation of end customers and the participation of consumption responses in the electricity market is necessary.

Objectives:

- Further integration of the electricity market with neighbouring markets and the EU market
- Strengthening the competitiveness and liquidity of the wholesale market by increasing the number of market participants and the share of stock trading

The Intraday Auctions IDA project was implemented on June 13th, 2024. for June 14th, 2024 after the successful operational start of ID CCb, replacing the NTC intraday capacity budget with the intraday capacity budget based on power flows. The IDA enhances the Single Intraday Connected Market (SIDC) by introducing a pricing mechanism for intraday capacity, complementing the existing method of continuous trading. With the introduction of IDA, the new technical setup and communication processes of the market connection will be used alongside the SIDC XBID platform used for continuous trading. In this sense, IDA and continuous market mechanisms will support each other and enable the collection of bids and efficient allocation of transmission capacity. The IDA will be implemented across Europe to enable the pricing of cross-zonal capacity on an intraday time frame and to harmonize the calculation and allocation of cross-zonal capacity in the intraday market and to increase the overall efficiency of intraday trading as well as to adapt the new market link that allows renewable energy producers to offer their energy based on reliable production forecasts, thereby reducing the imbalance caused by variable RES.

In accordance with the EU clean energy package, it is prescribed to move the market one day in advance from a resolution of 60 minutes to 15 minutes, which implies a product offer of 15 minutes. The 15-minute products will enable better market integration of renewable energy sources, which was realized in Croatia at the beginning of 2024. The introduction of cross-border products of lower resolution for continuous trading in Croatia enabled participants to access the existing 15-minute products and better adjust their position on the market. Thus, it is possible to conclude a transaction of a 15-minute product in Croatia with another 15-minute product within the connected intraday market, which have already implemented products of the same name in their markets, such as Austria, Germany, Netherlands, Belgium, Bulgaria, Hungary, Romania, Slovakia and Slovenia.

In general, the goals of further integrating the electricity market with neighbouring and EU markets and strengthening the competitiveness and liquidity of the wholesale market are expected in 2025 and 2026 at the latest after successfully implementing test phases and successfully adapting system operators and exchanges to new trading conditions.

ii. If applicable, national goals related to the non-discriminatory participation of renewable energy sources, management of consumption and storage, among other things through aggregation, in all energy markets, including the timeframe for achieving the goals

Establishing market mechanisms that will enable more market participants and end consumers to provide ancillary services and system balancing is necessary.

Objectives:

- Development of the national balancing and ancillary services market

- Development of the national electricity market

All transmission and distribution network users, aggregators and all other electricity market participants who can do so can participate in the balancing market.

### iii. If applicable, national goals concerning ensuring that consumers participate in the energy system and benefit from their own production and new technologies, including smart meters

Analytical backgrounds developed to adopt the Energy Development Strategy ([2], [4]) define introducing advanced metering systems by 2025 as a priority for investment in the distribution system. Pilot projects for advanced grids are also envisaged, based on which additional insights will be gained into grid users' characteristics and possibilities of their active participation in the ES will be explored. The share of advanced meters increased from about 7% in 2019 to about 13% in 2021.

### iv. National goals concerning ensuring the adequacy of the electricity system as well as the flexibility of the electricity system concerning the production of renewable energy, including the time frame for achieving the goals

Regarding the future adequacy of the ES, it is necessary to consider the expected changes. According to the estimates of the share of RES in Chapter 2.1.2, it is required to secure appropriate investments in the transmission network and the management system and sufficient (available) possibilities of system balancing to ensure the satisfactory adequacy of the ES and to support the expected flexibility of its operation. Active participation of users in providing services to system operators will also contribute to the flexibility of the ES.

It is necessary to prepare the analysis of the impact of climate change on the adequacy of the ES, which may be reduced due to the failure of crucial production and transmission facilities caused by extreme weather as a result of a decrease in electricity production from hydroelectric power plants due to a reduction in the amount of water available and as a result of the limited operation of thermal power plants due to a decreased availability of the cooling medium of a reduced flow and high prices of $CO_2$ emissions.

In the conditions of growing intermittent electricity production from RES, cross-border electricity exchange is expected to increase. Further strengthening of cross-border and regional cooperation between power transmission system operators will be necessary to ensure the quality and security of the system's operation.

Strengthening cross-border cooperation to ensure satisfactory adequacy of EES in conditions of growing intermittent production from RES is expected during 2023 and in the following years, when the construction of new transmission lines, increase of transmission capacity of existing transmission lines 220 kV and 110 kV, and construction of transformer stations for connecting the 400 kV and 110 kV networks are expected.

v. If applicable, national goals for the protection of energy consumers and improvement of competitiveness in the retail market of the power sector

The rate of supplier switch by end customers is one of the critical indicators of the development of the retail electricity market. The rate of supplier switch by end customers from the entrepreneurship category is significantly affected by the legislative framework regulating public procurement, whereby particular end customers must issue tenders to select the most favourable electricity supplier regularly.

The Croatian goal of improving competitiveness in the retail electricity market is to expand the choice of suppliers (reduction of the HHI index for metering points from the household and entrepreneurship categories) and the number of products, which should be implemented under the current legal and expected by-laws. Further improvement of competitiveness in the electricity retail market is expected even after 2023, and all will be done by the amendments and additions to legal and by-laws.

### 2.4.4 Energy poverty and mobility poverty

i. If applicable, national energy poverty goals, including the time frame for achieving the goals

The first problem when setting goals and measures to combat energy poverty is defining which households should be considered energy-poor. In most countries, including the Republic of Croatia, energy poverty is determined exclusively by the income census: households below a certain income level are considered energy poor.

Although socially vulnerable households are inevitably also energy-poor, it is essential to point out that low income is not the only cause of energy poverty. The practice of other countries shows that energy poverty, in addition to low income, is also caused by households' low energy efficiency, which results in a greater need for energy.

Accordingly, socially vulnerable households represent only a subset of energy-vulnerable households and most often represent households with the most acute problem of energy poverty. By focusing on socially disadvantaged households as the only category of energy-poor customers, other households suffering from energy poverty are ignored.

Due to the negative effect of climate change on the most vulnerable categories of citizens, as well as the reduced ability to adapt to it, one of the goals in this area is to ensure the realization of the principle of equal treatment, i.e. protection against discrimination through the application of the principle of prohibition of discrimination when applying the NECP and considering the effects of its provisions.

Since the comprehensive, i.e. multidimensional, definition of energy poverty has not yet been established for the Republic of Croatia[20] to determine the percentage of energy-poor citizens in the Republic of Croatia, the analysis was carried out using the Population Income Survey

[20] It is necessary to draw up a Program for combating energy poverty, where, among other things, the definition of energy poverty would be established.

(EU-SILC, English Statistics on Income and Living Conditions) and in such a way that the following variables are averaged by year, under Directive (EU) 2023/1791 of the European Parliament and the Council of September 13th, 2023 on energy efficiency and amending Regulation (EU) 2023/955 (amendment):

1. inability to keep the home adequately warm and/or adequately cold[21],
2. the presence of visible mould and constant drafts,
3. outstanding obligations related to bills for utility services,
4. poverty risk rate.

Thus, the rate of energy poverty in the Republic of Croatia in 2022 amounted to 12.2% of the total number of households, while in 2021, it was slightly higher, at 12.4%.

It is necessary to create a Program for combating energy poverty, adopt a multidimensional definition of energy poverty and determine measures and indicators for monitoring. As part of the Program, the following will be achieved:

- Establish the definition of energy poverty and analyse climate change impact,
- Evaluate the scope and socio-economic characteristics of energy-poor households,
- Establish the objectives of measures to combat energy poverty,
- Establish indicators for monitoring the success of the implementation of the energy poverty elimination program,
- Provide energy consulting for all energy-poor citizens of the Republic of Croatia,
- Establish a system of measuring and monitoring energy poverty indicators at the national level and
- Establish a system of increasing energy efficiency at the level of energy-poor households and households at risk of energy poverty.

The list of priorities for implementing technical measures, the degree of co-financing and sources of funding will be elaborated in the Program for Elimination of Energy Poverty, which will be adopted by the end of 2025. The plan for using financial resources obtained from the sale of emission units through auctions in the Republic of Croatia for the period up to 2020 („Official Gazette“, No. 19/18 and 84/19) plans to co-finance measures to combat energy poverty. Another way to support the energy poor in the Republic of Croatia is through the Social Fund for Climate Policy.

Furthermore, to ensure a fair and inclusive climate transition, the EU established the **Social Fund for Climate Policy**, part of the "Fit for 55" legislative package. The Social Fund for Climate Policy aims to help vulnerable households, small businesses, and users of transport services in less favourable financial positions.

[21] Data are not available for 2021 and 2022, and the value from 2020 was used for the calculation. By conducting an additional analysis, it was determined that the indicator has a downward trend.

The new legislation aims to establish standard definitions of **energy poverty**, help fight energy poverty and **mobility poverty** across the EU and improve access to zero and low-emission mobility and transport in the EU. As part of the "Fit for 55" package, a new **emissions trading system (EU ETS2)** is being introduced in the construction sector and for road transport, where part of the revenue from the sale of emission units will be paid into the Social Fund for Climate Policy. The member states will use funds from the Social Fund for Climate Policy to help **vulnerable users (households, microenterprises, and transport users**):

- measures and investments to increase the energy efficiency of buildings, renovation of buildings, decarbonisation of heating and cooling in buildings and transportation with zero and low emissions,
- measures providing temporary and limited direct income support.

By **June 30th, 2025, Croatia** plans to draw up its **own Social Plan for climate policy**, in which cost-effective measures and an investment plan with established key stages and goals are adopted, and the budget from 2026 to 2032 is allocated.

A necessary prerequisite for the adoption and implementation of the Plan is to define the concepts of energy poverty and poverty in terms of mobility, with a particular focus on the challenges faced by islands, mountainous areas, and less accessible or less developed areas and regions, including less developed suburban areas and the most remote regions in the Republic of Croatia.

Therefore, in addition to the program mentioned above for combating energy poverty, it is necessary to create a **Program to tackle poverty in terms of mobility**. As part of the Program, the following will be achieved:

- Determine the definition of poverty in terms of mobility,
- Assess the scope and socio-economic characteristics of poverty in terms of mobility,
- Determine the objectives of measures to combat poverty in terms of mobility,
- Determine the indicators for monitoring the success of the implementation of the program to combat poverty in terms of mobility,
- Provide energy counselling for all poor groups (households, micro-enterprises, transport users) regarding mobility in the Republic of Croatia,
- Establish a system of measuring and monitoring indicators that describe poverty in terms of mobility at the national level,
- Encourage the transition from private to public transport, car sharing and cycling, and
- Support the development of the used electric vehicle market and further develop the network of electric charging stations.

The Program for Combating Poverty in terms of Mobility will elaborate on the priorities for implementing technical measures, the level of co-financing, and sources of funds. It is planned to be adopted by the end of the third quarter 2025. One way to support the most vulnerable groups in the Republic of Croatia will be through the Social Fund for Climate Policy and the remaining revenues from the EU ETS2 system.

## 2.5 Dimension: research, innovation, and competitiveness

### i. National goals and objectives for financing public and private research and innovation related to the Energy Union

The Republic of Croatia has set a goal to reach investments in research, development, and innovation in the amount of 1.4% of GDP, and in 2021, it was 1.24% of GDP[22]. Croatia aims to reach 2.5% by 2025 and 3% by 2030[23]. The share of research and innovation related to the Energy Union has not been determined. In 2021, total budget investments for research and development amounted to 0.71% of GDP (102 EUR per capita, 0.7 EUR per capita for energy and 1.1 EUR per capita for the environment).[24] Regarding private financing, according to the Smart Specialization Strategy until 2029, operating expenditures for research and development (BERD) are envisaged to increase from 0.6% of GDP to 1% of GDP. Amendments to the Act on State Aid for Research and Development Projects and defining the conditions of tax relief for conducting primary research, industrial research, or experimental development are envisaged.

The Smart Specialization Strategy until 2029 aims to achieve progress on the *European Innovation Scoreboard* from 25$^{th}$ to at least 18$^{th}$ place until 2030.

### ii. If applicable, national targets by the year 2050 relating to the promotion of clean energy technologies and, if needed, national targets that include long-term goals (2050) for the use of low-carbon technologies, including targets for the decarbonisation of energy-intensive industrial sectors and industrial sectors with a high carbon share and, if applicable, targets for carbon storage and transport infrastructure

The Republic of Croatia is increasing investment in research, development and innovation, investment in the transfer of knowledge and technology and the development of technologies based on knowledge and innovation through various support programs - from allocating grants and vouchers through loans to implementing strategic or pilot projects. In the Smart Specialization Strategy until 2029 (from now on S3), 4 of the 7 identified thematic priority areas (TPAs) are linked to low-carbon targets, energy efficiency and adaptation to climate change:

- Smart and clean energy,
- Smart and green transport,
- Sustainable and circular food,
- Customized and integrated wood products.

[22] Eurostat, 2023

[23] The target by 2025 is defined by the Government Programme of the Republic of Croatia 2020-2024, and by 2030 by the National Development Strategy of the Republic of Croatia until 2030

[24] Eurostat, GBARD by socioeconomic objectives, 2023

Also, within S3, indicative lists of interventions have been made according to individual TPAs, which include projects in the fields of Smart and Clean Energy and Smart and Green Transport, such as microgrid pilot projects and the development of a technological centre for smart and green mobility.

In TPA ***Smart and Clean Energy,*** during consultations with stakeholders from the business sector and the research community, proposals were received for conducting applied research in areas such as smart grid technology, waste-to-energy conversion, energy storage, carbon capture (IRI solutions for capturing and storing $CO_2$), green thermal energy, hydrogen (e.g. research on hydrogen-based decarbonisation solutions). Furthermore, in addition to the microgrid pilot project already mentioned, the public procurement of innovative solutions and the assessment of the existing framework for data regulation with the aim of possible liberalisation of access to specific energy-related data and revision of microgrid regulations are also being considered. The construction of a biorefinery to produce advanced biofuels is also planned (NPRR investment (C1.2.R1-I4).

The ***Smart and Green Transport*** TPA includes plans to turn towards environmentally friendly and digitalised transport solutions and technologies by encouraging research and innovation activities related to sustainability, technological optimisation and relevant application of ICT solutions related to transport and mobility. Such activities could be supported by decarbonisation and the development of integrated systems using the Internet of Things (IoT) and data-driven innovation. The following research areas are identified, e.g.:

- development of software for engine testing,
- advanced production methods (e.g. 3D printing, precision, and/or robotic production),
- artificial intelligence and machine learning in the transport system (e.g. logistics optimisation, vessel autonomy, railway safety, infrastructure monitoring),
- fuel storage and low greenhouse gas emissions operation for marine vessels, road vehicles, mobile machinery and locomotives,
- new and advanced materials and
- electronic devices, sensors and components.

It is also proposed to invest in public procurement of innovative solutions, projects within the European Innovation for Batteries (EuBatIn), infrastructure for vehicles and vessels using alternative fuels, regulatory review and reform activities to encourage the green transition, vocational skills, the establishment of a centre for intelligent transport systems, etc.

For specific technologies, the Hydrogen Strategy until 2050 („Official Gazette“, No. 40/22) sets the following goals for encouraging the development of science, research, and hydrogen technologies.

| **Strategic goal** | **Performance indicator** | **Initial value 2021/22** | **Target 2030** | **Target 2050** |
|---|---|---|---|---|
| Encouraging the development of science, research, and development of hydrogen technologies | Number of patents related to the hydrogen-based economy<br>Unit of measure: number<br>Code: II.02.6.51 | 0 | 5 | 50 |

Proceeds from the sale of emission units from the EU ETS are used to finance and will continue applied research into climate change mitigation and adaptation.

### iii. If applicable, national goals regarding competitiveness

Competitiveness is a broad issue that goes beyond the scope of the National Energy and Climate Plan. According to data for 2019, Croatia was ranked 63rd in the global competitiveness index, and the National Development Strategy for 2030 sets the goal of Croatia being among the forty-five most competitive economies in the world. In the S3 draft, a goal related to the regional scale of success in innovation has been set by 2030; Croatia ranks at least 38th according to the European Regional Competitiveness Index.

The Republic of Croatia currently has no defined national competitive goals related to the Energy Union. The Committee for Intersectoral Coordination for Policies and Measures for Climate Change Mitigation and Adaptation (envisaged by measure MS-1) will determine the national goals, indicators needed to monitor their achievement, and data sources. The ME will establish a system for monitoring their achievement.

# 3 POLICIES AND MEASURES

## 3.1 Dimension: Decarbonisation

### 3.1.1 Emissions and elimination of greenhouse gases

i. Policies and measures to achieve the target defined in Regulation (EU) 2023/857 of the European Parliament and the Council of April 19th, 2023 amending Regulation (EU) 2018/842 on the binding annual reduction of greenhouse gas emissions in member states from 2021 until 2030, which contributes to measures in the field of climate to fulfil obligations under the Paris Agreement and on the amendment of Regulation (EU) 2018/1999 as stated in point 2.1.1. and policies and measures to comply with Regulation (EU) 2023/839 of the European Parliament and of the Council of April 19th, 2023 amending Regulation (EU) 2018/841 concerning the scope, simplification of reporting and compliance rules and setting Member States' targets for 2030 and Regulation (EU) 2018/1999 with improving monitoring, reporting, monitoring progress and reviews by Regulation (EU) 2023/839, covering all key sectors that produce large emissions and sectors to strengthen removals, with prospects for a long-term vision and a long-term goal to become a low-emission economy and to achieve a balance between emissions and removals in line with the Paris Agreement

Measures are specified for the sectors significant for greenhouse gas emissions: cross-sectoral measures, industrial processes, waste management, agriculture and LULUCF.

**Cross-sectoral measures** are specified below.

#### MS-1 Strengthening governance to achieve climate goals

Regulatory measure; implementation 2021-2030

**Objective and description of the measure:** Under the Air Protection Act („Official Gazette“, No. 127/19) the Committee for Intersectoral Coordination for policy and measures for mitigation of and adaptation to climate change was established by the Decision of the Government of the Republic of Croatia in 2018 („Official Gazette“, No. 9/18). The Committee recommends the Government of the Republic of Croatia on the overall policy and measures for climate change mitigation and adaptation. It ensures political support for implementing the policy and climate change mitigation and adaptation measures. The composition, tasks, and manner of work of the Committee shall be determined by the Government of the Republic of Croatia at the suggestion of the ministry responsible for the environment. A decision is underway to establish a new Commission for Cross-Sectoral Coordination for Policies and Measures for Climate Change Mitigation and Adaptation with two technical working groups on 1) climate change mitigation and 2) climate change adaptation.

A system will be established to monitor the implementation of the Integrated Energy and Climate Plan concerning the reduction of national and sectoral greenhouse gas emissions and other goals by dimensions to achieve the green transition and EU climate goals more

effectively. An adequate management system is necessary to determine promptly that measures from the NECP are not being implemented, to identify and remove barriers, and to achieve the required speed of the low-carbon transition, to achieve Croatia's goals within the framework of EU legislation and climate neutrality until 2050.

An analysis of the potential for reducing greenhouse gas emissions by individual measures will be made, and a proposal will be made for sectoral targets to reduce emissions in sectors outside the ETS. It is planned to distribute the burden of reducing greenhouse gas emissions in such a way as to legally introduce the responsibility of each sector, which will be achieved through the Amendments to the Act on Climate Change and Protection of the Ozone Layer.

Preparing the NECP and the NECP Progress Report is an obligation based on the Regulation on Energy Union Management and Climate Action.

While preparing the first report on the implementation of the NECP in 2023, it became evident that not all the requested data could be provided because they were not collected or were fragmented. An adequate system for monitoring the implementation of measures from the NECP should be established.

To increase regional self-government capacity and improve vertical coordination for implementing the Climate Change Adaptation Strategy, the Low Carbon Development Strategy, and NECP, a system of educating officials on climate policies and applying climate verification at the county level will be established.

To implement the Climate Change Adaptation Strategy, and through the improvement and strengthening of infrastructural, computer, digital, expert-scientific and human capacities necessary for the development of a high-quality, reliable and timely support system for the adaptation of the Republic of Croatia to climate change, the National Centre for Adaptation to Climate Change will be established.

**Activities:**

- Establishment and management of the Commission for intersectoral coordination for policies and measures for mitigating and adapting to climate change;
- Management reform for the implementation of climate policies;
- Determining sectoral emission reduction targets in sectors outside the trading system, until 2030;
- Establishment of a system of educating officials on climate policies and application of climate verification (certification) at the county level;
- Establishment of the National Centre for Adaptation to Climate Change;
- Creation and implementation of an action plan to end the use of coal for the production of electricity by the end of 2032;
- Establishment of a system for monitoring the implementation of the NECP: Establish a system for calculating the potential for reducing greenhouse gas emissions by measures, monitoring the achievement of reductions, and issuing warnings in case of deviations from the planned goals. The system should also record the planned emission reduction and the responsible person and warn him if the measures are not

on the planned path, which may lead to the need to purchase emission units. The system should also show the reduction of emissions and the investment for each measure and provide insight into the cost of reducing emissions per implemented measure;
- Collecting data, creating a plan for ensuring and controlling the quality of the greenhouse gas inventory, approving the report on the greenhouse gas inventory and exchanging data on greenhouse gas emissions with international organizations and the EU;
- Control of compliance with the obligation to limit emissions up to the amount of the national annual emission quota;
- Creation of a corrective measures plan with other state administration bodies responsible for individual sector policies if the Republic of Croatia does not meet climate goals sufficiently.

**Funds needed for implementation**: EUR 28 million over eight years

**Sources of financing:** State budget, revenues from the sale of emission units from the EU ETS, LIFE program of the EC

**Executive Body:** Ministry of Environmental Protection and Green Transition, Ministry of Economy

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition, Ministry of Economy

**Impact:** Indirect contribution to reduction in greenhouse gas emissions.

**Monitoring method:** Number of Commission sessions, established centre for adapting to climate change, an established system for monitoring the implementation of the Integrated Energy and Climate Plan, and number of educated officials at the county level.

**Connection to other dimensions:** The measure is related to all five dimensions.

**Research and development:** Has an impact in monitoring the implementation and achieving goals.

### MS-2 Establishment of regional energy and climate agencies and capacity building

Organisational and financial measure; implementation 2021-2030

**Objective and description of the measure**: Regional energy agencies do not currently operate on the entire territory of the Republic of Croatia, and capacity building of existing regional energy agencies in the field of climate change mitigation and resilience and adaptation to climate change and their transformation into energy and climate agencies is needed. This measure aims to encourage establishing regional energy and climate agencies for the areas of the Republic of Croatia where they do not operate, as well as capacity building aimed at transforming existing energy agencies into energy and climate agencies.

**Sources of financing**: EU funds, funds of regional/local self-government units

**Executive Body:** Local and regional self-government units

**Monitoring bodies:** Ministry of Economy

**Impact**: Establish a regional energy and climate agency and transform existing regional energy agencies into regional energy and climate agencies.

**Monitoring method**: The number of newly established energy and climate agencies and the number of agencies transformed.

**Connection to other dimensions:** The measure is related to all five dimensions.

### MS-3 The EU emissions trading system

Regulatory measure; implementation 2021-2030

**Objective and description of the measure:** The EU Emissions Trading System (EU ETS) includes all activities listed in Annex I of Directive 2003/87/EC of the European Parliament and of the Council of October 13th, 2003 on the establishment of a system of trading in greenhouse gas emission units within the Community and on the amendment of Council Directive 96/61 /EC (Text with EEA relevance) (OJ L 275, Oct 25th, 2003), amended by Directive (EU) 2023/959 of the European Parliament and of the Council of May 10th, 2023 amending Directive 2003/87/EC on the establishment of an emissions trading system of greenhouse gases within the Union and Decision (EU) 2015/1814 on the establishment and functioning of the market stability reserve for the Union greenhouse gas emissions trading system (Text relevant to the EEA) (OJ L 130, May 16th, 2023). Through an even allocation of emission allowances, participants in the system from all Member States took on an obligation of lowering emissions to contribute to a reduction in emissions by at least 63% by 2030 compared to 2005 levels. This leads to the conclusion that the decrease in emissions from activities within the EU ETS is regulated at the EU level (2030 Climate and Energy Policy Framework). Since January 1st, 2013, the Republic of Croatia is integrated into the EU ETS. Following the EU ETS rules, operators of facilities and aeroplane operators obtained greenhouse gas emissions permits. They established a regime for monitoring emissions and delivering verified reports to the competent authority. Greenhouse gases covered by the EU ETS are carbon dioxide ($CO_2$), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). All operators, except electricity producers, have submitted their requests for emission units, which are allocated free of charge. Free emission allowances are allocated to facilities based on benchmarks defined under the reference value for 10% of the most efficient facilities in the same sector. Operators who will not have enough free allowances to cover their greenhouse gas emissions have the option of purchasing emission allowances through auctions or on the secondary ETS market (Ordinance on the method of free allocation of emission allowances to facilities and the monitoring, reporting and verification of reports on greenhouse gas emissions from facilities and aircrafts („Official Gazette“, No. 89/20).

The Act on Climate Change and the Protection of the Ozone Layer („Official Gazette“, No. 127/19), which transposes into the Croatian legal system the relevant EU regulations for the establishment and functioning of the EU ETS, regulates the monitoring of and reporting on greenhouse gas emissions, the greenhouse gas emissions trading system, aviation activities and sectors outside the greenhouse gas emissions trading system. Based on this Act, by-laws were also adopted (Regulation on the method of greenhouse gas emission allowance trading and Ordinance on the method of free allocation of emission allowances to facilities and the monitoring, reporting and verification of reports on greenhouse gas emissions from facilities and aircrafts, „Official Gazette“, No. 89/20). The existing ETS system is being reformed,

shipping is introduced into the system, and a separate ETS system for road transport and construction is being established, the so-called EU ETS 2.

**Activities:** The following will be implemented within the framework of the measure:

- continuation of activities of EU ETS obligees (facility operators and aircraft operators): updating of greenhouse gas emission monitoring plans, preparation of greenhouse gas emission reports, preparation of the verification report, preparation of the improvement report (if necessary), emissions trading at the primary and secondary market, submission of emission allowances, etc.;
- activities of other EU ETS participants (Ministry of Environmental Protection and Green Transition, verifiers, brokers…)
- activities of new EU ETS participants (ship operators): updating of greenhouse gas emission monitoring plans, preparation of greenhouse gas emission reports, preparation of the verification report, preparation of the improvement report (if necessary), emissions trading at the primary and secondary market, submission of emission allowances, etc.
- activities of participants of regulated entities of the new trading system, EU ETS-2: preparation of greenhouse gas emission monitoring plans, preparation of greenhouse gas emission reports, preparation of the verification report, preparation of the improvement report (if necessary), emissions trading at the primary and secondary market, submission of emission allowances, etc.

**Funds needed for implementation:** EUR 300 million per year

**Sources of funding:** Funds of EU ETS obliged entities

**Executive Body:** Ministry of Environmental Protection and Green Transition

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Impact:** The targeted reduction in greenhouse gas emissions is at least 2.2% per year (the new targeted reduction by 4.3 % by 2024 and 4.4% by 2028) by increasing energy efficiency, using renewable energy sources, and taking other measures to reduce emissions (undesirable: reducing production in facilities or reducing the number and length of airline flights).

**Monitoring method:** Preparation and verification of GHG emission reports.

**Connection to other dimensions:** To reduce the GHG emissions of EU ETS-obliged entities, using renewable energy sources (decarbonisation) and increasing energy efficiency are encouraged.

**Research and development:** The Innovation and Modernization Funds, within the framework of the EU ETS, co-finance research and development of technologies that do not emit or emit low amounts of greenhouse gases and the application of decarbonisation measures.

### MS-4 Strategic planning at the regional and local level

Organisational measure (planning); implementation 2024-2030

**Objective and description of the measure:** Regional and local self-government units play a vital role in achieving climate goals. Through strategic planning, they define measures for climate change mitigation and adaptation for their territory.

Counties, the City of Zagreb, and large cities are obliged to adopt programs for climate change mitigation, adaptation to climate change and protection of the ozone layer, which is an integral part of the umbrella program of environmental protection (Act on Climate Change and the Protection of the Ozone Layer, „Official Gazette“, No. 127/19). The representative body of a county adopts environmental protection programmes, the City of Zagreb and a large city for four years, after which reports on the implementation of the Programme are prepared (Environmental Protection Act „Official Gazette“, Nos. 80/13, 153/13, 78/15, 12/18 and 118/18). Eight of the thirty-seven obliged entities have adopted Environmental Protection Programmes with climate change mitigation programs, adaptation, and ozone layer protection (http://dokumenti.azo.hr/).

In 2008, the European Commission launched the European Covenant of Mayors for Climate and Energy initiative to encourage and assist local authorities in implementing climate and energy objectives. Cities and municipalities are voluntarily involved, individually or jointly, and by signing the Covenant, commit to act and develop a Sustainable Energy Development and Climate Adaptation Action Plan (SECAP) and report on its implementation every two years.

This initiative was endorsed by more than 160 cities and municipalities in the Republic of Croatia. Hence, the Covenant of Mayors covers over two million inhabitants, but only some have adopted documents and prepared reports.

Therefore, this measure aims to improve strategic planning at the regional and local levels.

**Activities:** The following will be implemented within the framework of the measure:

- Integrating low-carbon and climate change adaptation measures into the financial plan of regional and local self-government;
- Development of a system for monitoring and evaluating progress in achieving climate and energy goals set in planning documents of regional and local self-government;
- Develop guidelines for monitoring and reporting low-carbon and climate change adaptation measures from regional and local self-government planning documents.

**Sources of funding:** EPEEF - income from the sale of emission units from the EU ETS, JLP(R)S, and EU funds.

**Executive body:** Regional and local self-government units

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Impact:** Reducing energy consumption and greenhouse gas emissions.

**Monitoring method:** Reports on progress in implementing regional and local self-government planning documents for climate and energy.

**Connection with other dimensions:** Regional and local self-government planning documents for climate and energy encourage using renewable energy sources (decarbonisation) and increasing energy efficiency to reduce greenhouse gas emissions**.**

**Research and development:** The measure is indirectly connected to research and development and innovative measures to reduce greenhouse gas emissions.

### MS-5 Development and implementation of $CO_2$ collection, transport and storage projects (CCS)

Research and analytical measure; Financial measure; implementation 2021-2030

**Objective and description of the measure:**

Technologies for capturing, storing and using $CO_2$ are one of the possible solutions for reducing greenhouse gas emissions in industry. This technology can reduce emissions in certain industrial branches, which is challenging to implement with other measures, such as in the cement, steel, chemical, or petrochemical industries. Investment decisions and operator participation in CCS projects will depend on several factors, such as, among others, the costs of emission units, fuel and electricity prices, and the availability of alternatives to reduce $CO_2$ emissions. The challenge for developing CCS projects is the high cost of infrastructure construction and the need for coordination along the entire value chain. The final assessment of the potential for the development of CCS technology in Croatia also depends on a detailed evaluation of the $CO_2$ storage capacity.

The issue of geological storage of $CO_2$ is covered by the Act on Exploration and Exploitation of Hydrocarbons („Official Gazette“, No. 52/18, 52/19, 30/21), which enables the storage of $CO_2$ on the territory of the Republic of Croatia. This method needs to be further developed, and the potential and opportunities for this technology at the state level should be considered. By the end of 2026, a pilot project will be implemented to enable the development and commercialisation of capturing and storing $CO_2$, for which an investment of around EUR 14 million is foreseen through the NPRR. By 2028, the implementation of the KOdeCO net zero project worth 237 million EUR is planned. The project includes the design, construction, installation, and integration of units to capture, liquefaction and purify $CO_2$ that will be transported and permanently stored in the Mediterranean. From the mentioned amount, financing was approved from the Innovation Fund for the KOdeCO net zero project in the HOLCIM cement plant, for which 116.9 million EUR was allocated. The project mentioned above will build the necessary infrastructure for carbon capture in the cement factory in Koromačno, thanks to which greenhouse gas emissions from cement production, which amount to around 400,000 tons of $CO_2$eq per year, would be reduced entirely.

Companies will develop projects and apply for financing from the Innovation Fund.

**Activities:** The following will be implemented within the framework of the measure:

- Conducting research into the potential for geological storage of $CO_2$ in the Republic of Croatia;
- Implementation of $CO_2$ geological storage projects in the Republic of Croatia following expressed potentials;

- Preparation of a strategic study of the impact of the permanent carbon dioxide disposal on the environment;
- Informing the interested public about $CO_2$ capture and storage technology;
- Implementation of a pilot project for the capture and geological storage of $CO_2$.

**The funds needed for implementation:** EUR 14 million for the pilot project, EUR 237 million for the KOdeCO net zero project, and the amount determined upon analysing the potential for implementing other projects.

**Sources of funding:** EU funds (NPRR, Innovation fund), Modernisation fund, state budget

**Executive body:** CHA, companies

**Monitoring bodies:** Ministry of Economy

**Impact:** Reduction in greenhouse gas emissions.

**Monitoring method:** Geological $CO_2$ storage projects will be monitored by annual reports submitted by the executive body (CHA) to the monitoring body (ME).

**Measure implementation indicator (indicator):** Annual amount of $CO_2$ permanently stored in geological structures.

**Connection to other dimensions:** The measure's implementation directly impacts research, innovation, and competitiveness.

**Research and development:** The measure is directly connected to research and development and innovative measures to reduce greenhouse gas emissions.

### MS-6 Improving the sustainability of urban areas

Financial measure; implementation 2023 -2030

**Objective and description of the measure:** This measure aims to encourage cities and municipalities to build projects to revitalise and develop new urban environments on sustainability principles. The first step in achieving this goal was the development of the Programme for the Development of Green Infrastructure in Urban Areas for the period 2021-2030 and the Circular Spatial and Building Management Development Programme for the period 2021-2030, which were adopted by the Government of the Republic of Croatia in December 2021 and represent the national framework for the development of sustainability in urban areas. The programmes aim to improve the environmental, economic and social benefits of sustainable development by increasing the energy efficiency of buildings, developing green infrastructure in urban areas, reducing the temperature in the areas of heat islands, and encouraging circularity measures when planning new buildings, reusing abandoned and/or neglected existing spaces and buildings, reducing the amount of construction waste in urban areas. The next step is the implementation of the adopted Programmes, which envisages the development of studies, strategies and/or urban development plans in which, based on the analysis of the current situation and the development of studies and strategies, development projects will be defined to improve the development of cities and municipalities. The projects are co-financed by the EU's Recovery and Resilience Mechanism, as part of the Reconstruction of Buildings initiative, reform C6.1.R5

"Introduction of a new model of green urban renewal strategies and implementation of a pilot project for the development of green infrastructure and circular management of space and buildings" and from the EU Funds within the Competitiveness and Cohesion Programme 2021-2027, in line with the target for the period 2021-2027 PO2 "Greener, resilient Europe with low carbon emissions transitioning to zero net carbon emissions rate by promoting the transition to clean and equitable energy, green and blue investments, a circular economy, climate change mitigation and adaptation, risk management and prevention and sustainable urban mobility".

**Activities:** The following activities will be implemented within the measure:

- Implement measures and activities in the Programme for the Development of Green Infrastructure in Urban Areas for 2021-2030 („Official Gazette“, No. 147/21).
- Implement measures and activities set out in the Circular Spatial and Building Management Development Programme for 2021-2030 („Official Gazette“, No. 143/21).

**Funds needed for implementation:** The estimated cost for implementing programme activities in 2021-2030 is EUR 1,142,528,933.57.

**Sources of funding**: MPPCSA, EU funds

**Executive body:** MPPCSA, RLSUs and City of Zagreb

**Monitoring bodies:** MPPCSA

**Impact:** Reduction of heat demand and energy consumption in public and residential buildings, increase in RES usage, and consequently, reduction in $CO_2$ emissions.

**Monitoring method:** Number of LSGUs with developed strategies, number of implemented (pilot) projects, area of new and improved green infrastructure, area of circularly renovated buildings, reduction of projected energy consumption in circularly renovated buildings.

**Connection to other dimensions:** The measure is innovative and enables the development of urban environments that will contribute to decarbonization and energy efficiency and have numerous other social, economic, and environmental benefits.

**Research and development:** The measure is directly linked to research and development and innovative measures to improve urban areas' sustainability.

### MS-7 Greening of the public and private sector

Regulatory measure; implementation 2021-2030

**Objective and description of the measure**: The measure aims to improve the environmental properties of the public administration and the private sector, enabling systematic action to improve environmental properties and contribute to the greening of the public and private sectors. The introduction of a system for improving environmental properties will encourage continuous action towards reducing the negative impact on the environment, which results from everyday direct and indirect actions (reduce the environmental footprint, take responsibility for your impact on the environment and the economy, improve your environmental efficiency and inform the public and stakeholders about that performance).

The Republic of Croatia is in the process of becoming a full member of the OECD. The accession process implies adopting the OECD's legal instruments within the competence of individual working bodies of the OECD and evaluating the policies and practices of the candidate country. The guidelines for improving the environmental characteristics of the administration are drawn up to align with the OECD Recommendation for improving the environmental characteristics of public administration OECD/LEGAL/0283. The Republic of Croatia joined the Lead by-example initiatives: Net-Zero Government Initiative (NZGI) and Green Government Initiative (GGI), where the bond to achieve net zero emissions from the business processes of public state bodies administration by 2050 at the latest and establishing a plan to achieve the commitment to that goal.

The program for calculating and reducing the carbon footprint of entities outside the ETS system (business entities and the public sector) aims to reduce total greenhouse gas emissions for all activities for which the entity is responsible or on which it is dependent. It is necessary to calculate direct emissions and removal of greenhouse gases at the subject's location, either due to fuel combustion in the thermal power plant, from the production process, from the vehicle fleet, and fugitive emissions, then indirect emissions that occur outside the subject's location, and are related to the purchase and consumption of electricity, heat and cooling energy, but also other indirect emissions/removals related to flows of people and materials.

Calculating the carbon footprint will enable subjects to familiarize themselves with the structure of greenhouse gas emissions and determine the activities that contribute the most to reducing emissions. It is a sound basis for defining and implementing the Action Plan to reduce carbon footprint. Implementing the Action Plan would reduce greenhouse gas emissions and mitigate climate change, i.e., more effortless fulfilment of the obligations assumed by the Paris Agreement and, simultaneously, to the sustainability of their business.

**Activities:** The following activities will be implemented within the measure:

- Development of guidelines on improving the environmental properties of public administration,
- Support for the introduction of environmental management in organizations - Activities for the introduction of environmental management systems in the public and private sectors,
- Periodic creation and updating of the national database of greenhouse gas emission factors (partially implemented activity),
- Pilot projects for calculating the carbon footprint in selected public administration bodies,
- Preparation of carbon footprint calculations and preparation of action plans for business entities outside the ETS system,
- Monitoring and analysis of the achieved reduction of the carbon footprint of the business entities.

**Funds needed for implementation:** EUR 376,000

**Sources of funding:** Revenues from the sale of emission units from the EU ETS EPEEF; Competitiveness and Cohesion Program 2021-2027; state budget (MEPGT).

**Executive body:** Ministry of Environmental Protection and Green Transition, EPEEF

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition, Ministry of Finance, Ministry of Justice, Administration and Digital Transformation

**Impact:** Increasing energy efficiency, increasing RES usage, promoting sustainable use of resources and the circular economy, and mitigating climate change by reducing the greenhouse gas emissions of businesses.

**Monitoring method:** The number of public administration units with a system for improving environmental properties, analysis of non-financial reports in the Register of Annual Financial Reports maintained by the Financial Agency; calculation of the annual reduction of greenhouse gas emissions for all business entities, which participate in the voluntary/mandatory program of calculation and reduction of the carbon footprint.

**Connection to other dimensions:** Calculating and reducing economic operators' carbon footprints contributes to other dimensions, such as increasing energy efficiency and greater use of RES (decarbonisation). Implementing the measure also indirectly impacts energy security, research, innovation, and competitiveness.

**Research and development:** Innovative measures to reduce carbon footprints are encouraged because of research and development.

### MS-8 Improvement of the IT platform for waste management

Informative, educational, regulatory measure; implementation: 2024 - 2030

**Objective and description of the measure:** The new Circular Economy Action Plan, COM (2020) 98 final, presents a set of interconnected initiatives to establish a robust and coherent policy framework in which sustainable products, services and business models become the standard and consumption patterns are transformed so that waste is not produced. This product policy framework is gradually introduced, with value chains of essential products as a priority.

The circularity rate of the Croatian economy is very low, which means that most of the materials we consume do not return to the economy as raw materials. It is necessary to elaborate a systematic approach in all value chains relevant to the Croatian economy, which includes measures listed in the New Circular Economy Action Plan, based on which the EC integrates the principles of the circular economy into the production and consumption of plastic, water management, food systems, management of special waste flow, etc.

A successful transition of Croatia to a circular economy requires a political and economic response that requires close cooperation from all stakeholders: government, companies, civil society, academic community, media, and citizens. With this aim, the Committee for Circular Economy, an interdisciplinary advisory body of the Ministry of Environmental Protection and Green Transition, was established. Board members come from fourteen organizations and professional associations representing all critical public, private, scientific-research and civil sectors. The task of the Committee is to exchange knowledge and provide expert support to strengthen cooperation between all sectors and guide the way of thinking to improve the longevity of products and their recycling. One of the initiatives of the Committee is the establishment of a digital platform for the circular economy, an integral part of the IT platform

for waste management, which represents a space for exchanging knowledge, innovations, and best practices among all stakeholders to create and adapt circular technologies. According to the circular economy stakeholders, it is necessary to develop a National Action Plan to transition to a circular economy by adjusting the legislative framework. Including representatives of the Republic of Croatia in the European Circular Economy Stakeholder Platform enables direct access to innovations, best practices, and cooperation in them. The measure is linked to MS-9 and all Waste and circular economy sector measures.

**Activities:**

- Activities of the Circular Economy Committee - providing expert support for strengthening cooperation among all sectors;
- Improvement of the digital platform for the circular economy - exchange of knowledge, innovations and best practices among all stakeholders;
- Developing a National Action Plan for the transition to a circular economy;
- Inclusion of Republic of Croatia representatives in the European Platform of Circular Economy Stakeholders.

**Sources of funding:** State budget, Competitiveness and Cohesion Program 2021 - 2027, Modernization Fund, Environmental Protection and Energy Efficiency Fund, Innovation Fund, Horizon Europe Program.

**Executive Body:** Ministry of Environmental Protection and Green Transition (MEPGT)

**Monitoring bodies:** Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Physical Planning, Construction and State Property (MPPCSA), Ministry of Science, Education and Youth (MSE), Croatian Chamber of Economy (CCE), Ministry of Regional Development (MRD) and funds of the European Union

**Impact:**

- Encouraging sustainable use of resources and circular economy;
- Mitigating climate change through reducing greenhouse gas emissions;
- Direct access to innovation and best practices through the European Platform of Circular Economy Stakeholders;
- National action plan for transitioning to a circular economy by adapting the legislative framework.

**Monitoring method:**

- Report on the implementation of the Waste Management Plan of the Republic of Croatia for the period 2023 - 2028;
- Report on the implementation of policies and measures to reduce greenhouse gas emissions;
- Inclusion of Republic of Croatia representatives in the European Platform of Circular Economy Stakeholders.

**Measure implementation indicator:** Direct access to innovation and best practices through the European Platform of Circular Economy Stakeholders.

**Connection to other dimensions:** Research, innovation, and competitiveness.

**Research and development:** Direct access to innovation and best practices through the European Platform of Circular Economy Stakeholders.

### MS-9 Transformation of the bioeconomy sector

Economic, informational, educational, regulatory measure; implementation: 2024 -2030

**Objective and description of the measure:**

In the Bioeconomy Strategy 2018[25], the European Commission additionally emphasised the importance of the bioeconomy as a sector that, in addition to increasing the competitiveness of production and creating new jobs in the EU, will significantly contribute to mitigating climate change. The European Commission added reducing dependence on non-renewable sources, strengthening European competitiveness, and creating jobs to the goals of the 2012 Bioeconomy Strategy (achieving food security, sustainable management of natural resources and mitigating and adapting to climate change).

It is necessary to connect three key aspects: developing innovative technologies and processes, market development, the competitiveness of bio-based sectors, and political will for policy and stakeholder cooperation to encourage the development of the bioeconomy in Croatia. It will ensure the transformation of the existing "traditional" stakeholders of the bioeconomy from the agriculture, forestry, fishing and aquaculture sectors as well as the food, beverage, tobacco, wood and furniture products, textiles, clothing and leather, paper, chemicals and chemical products, pharmaceutical products and preparations, plastic, rubber, bio waste into new, modern stakeholders of the low-carbon bioeconomy. For the transition to a low-carbon bioeconomy, it is necessary to connect stakeholders (producers, industry, researchers, with policymakers) to exchange information and establish value chains following market requirements.

**Activities:** Within the framework of this measure, it is necessary to carry out various activities that will contribute to the strengthening of the Croatian bioeconomy, which includes:

- Establishment of the Coordination Body
- Development of digital platforms for networking and information exchange
- Planning and construction of distribution centres for biomass
- Regulating the use of waste sludge
- Encouraging the construction and modernisation of capacities in the bioeconomy sectors

[25] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Sustainable bioeconomy for Europe: Strengthening the link between economy, society and environment

- Encouraging the production of packaging from recycled material, bio-based and biodegradable plastic
- Implementation of green public procurement in the function of bioeconomy development
- Implementation of research and innovation related to the bioeconomy.

**Sources of funding:** State budget, Competitiveness and Cohesion Program 2021-2027, Integrated Territorial Program, Strategic Plan of the Common Agricultural Policy of the Republic of Croatia for the period 2023-2027, Modernization Fund, Environmental Protection and Energy Efficiency Fund (EPEEF), Innovation Fund, Horizon Europe Program.

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Environmental Protection and Green Transition (MEPGT), Ministry of the Economy (ME), Ministry of Science, Education and Youth (MSE), Ministry of Regional Development and EU Funds (MRDFEU)

**Monitoring bodies:** Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Environmental Protection and Green Transition (MEPGT), Ministry of the Economy (ME), Ministry of Science, Education and Youth (MSE), Ministry of Regional Development and EU Funds (MRDFEU)

**Impact:**

- Development of new technologies and processes;
- Market development and competitiveness of sectors based on the principles of the circular bioeconomy;
- Achieving the objectives of development based on low levels of carbon dioxide and other greenhouse gas emissions;
- Sustainable use of resources;
- Development of rural areas;
- Encouraging investment in technology and innovation.

**Monitoring method:**

- Annual report on the implementation of the Bioeconomy Strategy until 2035.

Note: The Bioeconomy Strategy until 2035 has not yet been adopted, and the Annual Report on the Implementation of the Bioeconomy Strategy until 2035 will be able to be used as a monitoring method only after its adoption.

**Measure implementation indicator:**

- Annual report on the progress of the bioeconomy (number);
- Established distribution centres for biomass (number);
- The added value of the Croatian bioeconomy (million EUR).

**Connection to other dimensions:** Research, innovation, and competitiveness

**Research and development:** Direct access to innovation and best practices through connecting manufacturers, industry and research.

### MS-10 Legal adjustments and technical bases for the introduction of hydrogen into the energy system

Regulatory and financial measure; implementation 2024-2030

The role of hydrogen in future energy and transport systems is expected to be more significant, especially as the goals for reducing greenhouse gas emissions are more ambitious. It is therefore necessary to promptly identify the opportunities associated with the use of hydrogen, consider its use in the coming decade, and explore the possibilities of financially stimulating hydrogen production and consumption. To this end, a hydrogen technology platform will be established, bringing together national stakeholders relevant to the research and application of hydrogen technology, monitoring the development of hydrogen technologies at the EU and international levels, and serving as a link between national, EU and international levels. The measure aims to present possible areas of development, financing, and support in implementing the strategy and specific projects for developing hydrogen technology to achieve the objectives defined in the Strategy. In addition, it is necessary to adopt a relevant legislative framework that will enable the implementation of hydrogen in the energy system.

**Activities:**

- Technical background for adopting the Action Plan to implement the Croatian Hydrogen Strategy from 2021 to 2050;
- Adjusting the legislative framework for introducing hydrogen into the energy system.

**Funds needed for implementation:** EUR 500,000 for the development of technical backgrounds

**Sources of funding:** State budget

**Executive body:** The Croatian Hydrocarbon Agency (CHA) is responsible for developing technical backgrounds, and the Ministry of Economy (ME) is responsible for the legislative framework's adjustment field.

**Monitoring bodies:** Ministry of Economy (ME)

**Impact:** The executive body shall provide the monitoring body with the developed Technical Background for adopting the action plan.

**Monitoring method:** Reports

**Measure implementation indicator:** National, regional, and international cooperation in hydrogen technologies is indispensable for developing a hydrogen-based economy. The measure will ensure and create conditions for the advancement and competitiveness of hydrogen technologies.

**Connection to other dimensions:** The measure is linked to decarbonisation, energy efficiency, research, innovation, and competitiveness.

**Research and development**: The measure concerns the research and development of RES technologies and the integration of hydrogen energy systems.

## MS-11 Reducing an individual's carbon footprint by changing lifestyle habits

Information measure; implementation 2024-2030

**Objective and description of the measure:**

By changing the lifestyles and styles of individuals and society, a significant reduction in resource consumption and greenhouse gas emissions can be achieved. Therefore, this measure aims to encourage changes in consumer habits, dietary habits in the direction of including/using more food of plant origin, habits related to transport and travel, ways of using and owning various appliances in households, etc., which can be expressed through the reduction of an individual's carbon footprint. However, to change our habits, we need to be aware of the impact of our own carbon footprint and know how to reduce it. The cultivation of grain for animal feed produces much more greenhouse gases than the production of grain for human consumption. Increasing the consumption of foods of plant origin contributes to better health, and significant reductions in emissions and water and energy savings can be achieved. Therefore, it is proposed that activities be carried out to educate and encourage citizens to change their lifestyle and eating habits and adopt energy-efficient practices.

**Activities:**

- Creation of Guidelines for proper nutrition (CIPH),
- Drafting of Guidelines for Physical Activity (CIPH,
- Creation and implementation of campaigns, public health actions, videos, posters and leaflets on the topic of changes in lifestyle and food habits to reduce the carbon footprint (CIPH, Ministry of Health, EPEEF),
- Report on the implementation of the European Health Survey (CIPH),
- Declaring food that enables consumers to make a "healthier choice" (Ministry of Health, CIPH).

**Funds needed for implementation:** EUR 500,000 EUR per year

**Sources of funding:** EU funds, other available sources, Ministry of Health, CIPH

**Executive Body:** EPEEF, Ministry of Health, CIPH

**Monitoring bodies:** Ministry of Health, CIPH

**Impact:** Change habits toward increasing (energy) efficiency, sustainable/circular use of resources, materials, and products; Positive effects on people's health. Awareness of the personal role in change and spillover into other aspects of professional life and decision-making, and ultimately mitigating climate change through reducing greenhouse gas emissions and the personal carbon footprint.

**Monitoring method:** Monitoring the implementation of the Information and Education Program (number of published tenders, funds spent on the implementation of the Program)

**Connection to other dimensions:** Energy efficiency, Energy security, Decarbonisation

**Research and development**: EHIS research to collect comparable data on health status and habits.

## MS-12 Collecting and processing of biomass from agriculture, forestry, fishing and aquaculture

Informational, financial measure; implementation 2024-2030

**Objective and description of the measure:**

According to the European Commission[26], Croatia's annual biomass production is 9.3 million tons, 70% of which comes from agriculture and 30% from forestry. This relatively large biomass could produce biobased products (food products, beverages and tobacco products, textiles, clothing and leather, wood products and furniture, paper, chemicals and chemical products, pharmaceutical products and preparations, plastics, rubber, etc.).

According to data from 2019, biomass production from agriculture amounted to 6.7 million tons, with an additional net import of 3.1 million tons. Of the total available agricultural biomass, 49% was intended for domestic food consumption, 10% was exported, and 41% was leftovers or by-products. The amount of food waste amounted to 298 thousand tons of dry matter. The consumption of agricultural biomass for bioenergy production was estimated at 1,000 tons of dry matter.

The production of forest biomass amounted to 2,785 thousand tons of dry matter according to data from 2019, and it is estimated that another 819 thousand tons of forest biomass were available that were not reported. Of the total available forest biomass, 478 thousand tons were exported as logs, 1,594 thousand tons ended up in processing, and the rest was used to obtain energy. 704 thousand tons of sawn timber, 325 thousand tons of pellets and 353 thousand tons of wood processing by-products were exported from Croatia. The specified quantities can be further increased by improving the waste treatment system. Regarding biomass from forestry, "primary residues from forestry" should primarily be used, which must not include e.g. dead wood, stumps, remnants from felling, etc. which should remain in the stand, as well as wood mass that was not grown for this purpose, but the wood raw material should be used circularly, i.e. the wood mass should be used efficiently in a way that is based on the multiple use of wood raw material in different cascading phases of the life of wood products.

An obstacle to using biomass in agriculture is the dispersion of production, which increases the collection costs. Croatia does not have adequate capacities for the collection and processing of biomass, and by organising centres for the collection and processing of biomass, opportunities will be created to increase the competitiveness of producers through the valorisation of biomass in innovative value chains in the bioeconomy. In addition, the return of biomass to the production cycle contributes to the reduction of the economy's $CO_2$ footprint and the efficient use of existing natural resources.

Centres for collecting and processing biomass represent places where biomass generated in agriculture, forestry, fishing, and aquaculture production is collected, sorted, and prepared

[26] https://knowledge4policy.ec.europa.eu/visualisation/biomass-flows_en

for the market. Since biomass is a renewable carbon source, its use in new value chains will significantly reduce $CO_2$.

**Activities:** The following will be implemented within the framework of the measure:

- Biomass collection and use,
- Organizing centres for the collection and preparation of biomass for the market,
- Starting the biomass market,
- Creation of new value chains.

**Funds needed for implementation:** the State Budget of the Republic of Croatia, the Competitiveness and Cohesion Program 2021-2027, the Integrated Territorial Program, the Strategic Plan of the Common Agricultural Policy of the Republic of Croatia for the Period 2023-2027, the Modernization Fund, the Fund for Environmental Protection and Energy Efficiency, and the Innovation Fund.

**Executive body:** Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Regional Development and Funds of the European Union (MRDFEU) and Ministry of Environmental Protection and Green Transition.

**Impact:**

- Reducing production costs
- Biomass market development
- Creation of new value chains through organised biomass collection
- Transition to a low-carbon bioeconomy
- Encouraging the development of a circular bioeconomy
- Investments in new technologies and innovative solutions

**Monitoring method:** Report on the implementation of the Bioeconomy Strategy until 2035.

Note: The Bioeconomy Strategy until 2035 has not yet been adopted, and the Annual Report on the Implementation of the Bioeconomy Strategy until 2035 will be able to be used as a monitoring method only after its adoption.

**Measure implementation indicator:**

- Established centres for biomass collection and processing
- Added value of the Croatian bioeconomy

**Connection to other dimensions:** Research, innovation, competitiveness, waste management.

**Research and development:** Direct access to best practices in biomass management through linking producers and research.

### MS-13 Elimination of fossil fuel subsidies

Financial measure; implementation 2024 - 2030

**Objective and description of the measure:** It is necessary to analyse the current system of subsidies establish accompanying social programs that will reduce the impact on the poorest citizens, and define a plan for their cancellation, all to determine the dynamics of the cancellation of all fossil fuel subsidies, primarily the exemptions from excise duties in transport and agriculture on fossil fuels.

**Activities:** Analyse the current system of subsidies, identify accompanying social programs that will reduce the impact on the poorest citizens, and define a plan for their cancellation. Develop a plan to abolish the fossil fuel subsidy system and propose alternative measures to permanently reduce the need to use fossil fuels. Analyse the economic impact of eliminating fossil fuel subsidies and determine the performance indicators for implementing the measure.

**Funds needed for implementation:** Regular work of ministries

**Sources of funding:** State budget

**Executive body:** Ministry of the Economy and Ministry of Finance

**Monitoring bodies:** Ministry of the Economy and Ministry of Finance

**Measure implementation indicator:** The current system of measures would have to be analysed by the end of the second quarter of 2026.

### MS-14 Carbon Removal Certification

Financial, environmental and regulatory measure; implementation: 2023-2030

**Objective and description of the measure**: Carbon removal certification should enable a significant increase in carbon removal to achieve the goal of a climate-neutral Union by 2050 and will help achieve the EU's ambitious climate goal. The carbon removal certification system is voluntary and encourages carbon removal activities. The importance of rewarding forest owners, farmers and land managers for their ecological ambitions at the farm level is especially recognized. The proposed regulation will also help companies report on corporate sustainability reporting and provide greater transparency to public and private organizations' climate neutrality claims to avoid manipulative green marketing.

The Republic of Croatia will develop this measure following the progress made in the framework prepared by the European Commission.

Carbon removal certification applies to the following:

- Permanent carbon removal (storage of atmospheric or biogenic carbon for several centuries);
- Temporarily stored carbon in durable products (such as wood-based construction) lasting at least 35 years, which can be monitored on-site throughout the monitoring period;

- Temporary carbon storage, e.g. forest and soil restoration, wetland management, and seagrass meadows for at least five years;
- Soil emission reductions that include carbon and nitrogen oxide reductions from soil management and, in general, by improving soil carbon balance, wetland management, no-till and cover cropping practices combined with reduced fertilizer use, etc., for at least five years.

**Activities:**

As part of the measure, the following activities will be implemented**:**

- Development of a public certification scheme (national certification scheme);
- Establishment of a national framework for certification and verification of carbon removal;
- Establishment of registries for a public certification scheme for carbon removal.

**Funds needed for implementation**: Funds will be required for research to determine nationally specific starting values and develop public certification schemes.

**Sources of funding**: Income from the sale of emission units from the EU ETS for research and development and after the introduction of the system.

**Executive Body:** Ministry of Environmental Protection and Green Transition

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition, Croatian Accreditation Agency

**Performance:** Certified units for carbon removal and emission reduction activities.

**Monitoring method**: Certified units recorded in public registers or the EU register when developed.

**Connection with other dimensions:** The measure is interdisciplinary**.**

**Impact:** Certified units for carbon removal and emission reduction activities**.**

**Research and development**: Research is needed on techniques for monitoring changes in carbon stock, particularly possible applications of modern technological solutions such as satellite imagery, drone application techniques, and more. Carbon mapping projects in soil, forest, and agricultural land must be supported. Research related to carbon capture, transport, storage, and utilization techniques should be supported. Research is also needed to improve emission inventories regarding geo-explicit representations and the application of national data.

### MS-15 Creation and implementation of the Social Plan for Climate Policy

Economic measure; implementation in 2026 - 2030

**Objective and description of the measure:** The Social Plan for Climate Policy is a document submitted to the European Commission by June 30$^{th}$, 2025 to be able to use the funds from the Social Fund for Climate Policy, and it must contain a mutually coordinated set of existing or new national measures and investments in response to mitigating the adverse effects of the EU ETS2 system on vulnerable households, vulnerable micro-enterprises and vulnerable

users of transport services, and to ensure affordable heating, cooling and mobility, while simultaneously monitoring and accelerating the measures necessary to achieve the Union's climate goals. The social plan for climate policy must contain a mutually coordinated set of existing or new national measures and investments in response to mitigate the adverse effects of the EU ETS2 system on vulnerable households, vulnerable micro-enterprises and vulnerable users of transport services and to ensure affordable heating, cooling and mobility, while simultaneously monitoring and accelerating the measures necessary to achieve the Union's climate goals. Measures from the Social Plan for Climate Policy will be intended for vulnerable households, vulnerable transport users and vulnerable micro-enterprises. The estimated costs of the plan will also include support given to public and private entities that implement measures and investments that benefit these vulnerable groups.

Measures that can be financed from the Social Fund for Climate Policy:

- Energy renovation of buildings with the worst energy properties;
- Facilitating access to affordable and energy-efficient housing;
- Replacement of heating and cooling systems in residential buildings of vulnerable households;
- Establishment of one-stop-shops at regional and local levels for the purpose of providing information on possible measures and investments intended for vulnerable groups;
- Supporting vulnerable households in the purchase of household appliances with the highest energy efficiency properties;
- Providing support to public and private entities in the development and provision of affordable energy efficiency solutions, including supporting the work of renewable energy communities and energy communities;
- Support to public and private entities in the development and provision of affordable energy efficiency solutions and appropriate financing instruments;
- Development and application of appropriate and complementary financing instruments;
- Providing access to zero and low emission vehicles and bicycles;
- Development of infrastructure for the use of vehicles and bicycles with zero and low emissions;
- Encouraging the use of affordable and accessible public transport;
- Temporary and limited direct income support (up to 35% of the SCP amount)
- Development of IT solutions, which includes encouraging the development of mobile applications, to improve access to transportation;
- Enabling the development of alternative transportation systems, such as car sharing and car-pooling schemes at regional and local levels
- Allocating direct income support to vulnerable groups to cover increased energy costs more easily.

**Activities:**

- Development of a social plan for climate policy,

- Preparation of analyses and studies to obtain the basis for the Social Plan for climate policy,
- Implementation of public consultation and inclusion of a wide range of stakeholders in the discussion on the creation of a social plan for climate policy,
- Cooperation with primary stakeholders (potential users of SCF) to ensure the sustainability of the implementation of measures,
- Creating a package of solutions, i.e. measures and investments that are adapted to the specific needs of some regions of the Republic of Croatia,
- Adaptation of national legislation to ensure further implementation of such measures, with the ultimate goal of freeing vulnerable groups from energy poverty,
- Operational work on the preparation and implementation of invitations and tenders from the SCF,
- Making and announcing calls

**Funds needed for implementation**: EUR 1.68 billion

**Sources of financing**: Social fund for Climate Policy, revenues from the sale of emission units from the EU ETS2 system

**Executive body**: EPEEF, Ministry of Environmental Protection and Green Transition in cooperation with the Ministry of Economy, Ministry of Finance, Ministry of Physical Planning, Construction and State Assets, Ministry of the Sea, Transport and Infrastructure and Ministry of Labour, Pension System, Family and Social Policy

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition in cooperation with the Ministry of Economy, Ministry of Finance, Ministry of Physical Planning, Construction and State Assets, Ministry of the Sea, Transport and Infrastructure and Ministry of Labour, Pension System, Family and Social Policy

**Impact**: Reduction of energy poverty and mobility poverty; reduction of the risk of energy poverty and mobility poverty; reduction of greenhouse gas emissions in the building and road transport sectors.

**Monitoring method**: Report on the implementation of the Social Plan for Climate Policy

**Measure implementation indicator (indicator):** Approved Social Plan for Climate Policy, number of households on which the measure was implemented, number of vulnerable households and persons affected by poverty in terms of mobility, number of buildings on which a thorough renovation was carried out, number of buildings on which other energy renovations were carried out, the number of fossil fuel heating plant units replaced, the number in MW or units of installed additional operating capacity for energy from renewable sources, the number of replaced large household appliances of the highest energy class, the number of vehicles with zero or low emissions purchased, the number of bicycles and other electromobility vehicles purchased, the number of built supply and charging points on alternative fuels, the number of users of discounted public transport tickets or free public transport tickets, the number of users of additional solutions for shared mobility or on-demand mobility, the number of km of built cycling infrastructure, the number of recipients of direct income support.

**Connection to other dimensions**: Decarbonisation - emissions; decarbonisation - RES; energy efficiency; RES in transport; alternative fuels and infrastructure for alternative fuels

**Research and development**: Energy efficiency in buildings; energy efficiency in heating and cooling; smart cities and communities; development of the used electric vehicle market; switching from private to public transport, car sharing and cycling.

### MS-16 – Green budget planning

Financial, environmental and regulatory measure, implementation 2023-2030.

**Objective and description of the measure:** The aim is to create an institutional framework for implementing the green state budget. A green budget helps to achieve environmental protection goals and consists of fiscal policy measures and rules to prevent environmental problems and improve existing damages. It implies using budget planning tools to achieve climate and environmental goals.

**Activities:** As part of the measure, the following activities will be implemented:

- Establishment of an institutional framework;
- Adoption of the methodology;
- Establishment of an intersectoral working group to work on the tagging of the functional classification of budget activities;
- Development of tools and methodologies for impact assessment.

**Funding sources:** State budget

**Executive body:** Ministry of Finance (MFIN)

**Monitoring bodies**: MFIN, other relevant TDUs

**Impact:** Implementation of the green budget and calculation of the impact of state budget funds on the environment and climate goals

**Connection with other dimensions:** Activity relates to all dimensions.

**Research and development:** Innovative measures related to the methodology of tagging budget activities are encouraged, as is monitoring of effects.

The measures related to **industrial processes and the use of products** are presented below.

### IP-1 Reduction of the share of clinker in cement production

Economic and environmental measure; implementation: 2025 – 2030 (2050)

**Objective and description of the measure:** Of the total direct emission of carbon dioxide ($CO_2$) from cement production, about 60 percent refers to the clinker production process, and the other 40 percent are emissions due to the combustion of fuel in the rotary kiln and for other needs in the cement production process. By reducing the share of clinker, i.e. increasing the share of mineral additives in the production of cement, the required amount of produced clinker is reduced, which contributes to the reduction of total $CO_2$ emissions in the production

of cement. The proportion of clinker in cement is defined by HRN EN 197-1. The increase in the proportion of mineral additives in cement depends on the composition of the raw material, the availability of additives of the appropriate composition on the market and the market requirements for certain types of cement with a higher proportion of additives and a smaller proportion of clinker.

**Activities:** The following will be implemented within the framework of the measure:

- Defining the availability of raw materials and necessary mineral additives;
- Defining the composition of basic minerals;
- Defining the quality of produced clinker;
- Defining the price of mineral additives;
- Defining market requirements;
- Determining the reduction of $CO_2$ emissions, the reduction of energy consumption and the reduction of financial expenses for raw materials.

**Funds needed for implementation:** EUR 1,000,000.00

**Sources of funding:** Funds from the sale of emission units, use of funds from the Fund for Environmental Protection and Energy Efficiency, the Modernization Fund and EU structural funds.

**Executive body:** Operators for the production of cement, Croatia Cement (Association of Croatian Cement Factories), Croatian Chamber of Commerce.

**Monitoring bodies:** ME

**Impact:** Reduction of $CO_2$ emissions, increase in energy efficiency (reduction of specific heat consumption) due to reduced production of clinker, reduced financial expenses for raw materials due to lower price of mineral additives.

**Monitoring method:** Monitoring of greenhouse gas emissions and monitoring of the fulfillment of the national annual quota is achieved through the following components:

- National system for calculation and reporting of anthropogenic emissions from sources and removals by means of greenhouse gas outflows,
- National system for monitoring policy and emission reduction measures and projections,
- Union Registry.

**Connection with other dimensions:** An increase in energy efficiency is encouraged, with the aim of reducing greenhouse gas emissions of plants included in the EU ETS.

**Research and development:** The Innovation and Modernization Funds, within the framework of the EU ETS, co-finance research and development of technologies without emissions or with low emissions of greenhouse gases.

### IP-2 Restrictions and ban on placing products and equipment containing fluorinated greenhouse gases on the market

Economic, and educational measure; implementation: 2024 - 2030

**Objective and description of the measure:** Regulation (EU) 2024/573 of the European Parliament and the Council of February 7th, 2024 on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) no. 517/2014 (Text with EEA relevance) (OJ L, 2024/573, Feb 20th, 2024), stipulates gradual reduction of emissions of fluorinated gases. The measure defines activities and procedures for reducing fluorinated greenhouse gas emissions, conducting equipment leakage checks, using equipment with leakage detection systems, keeping records of equipment on which leakage checks should be carried out, collection of fluorinated greenhouse gases to ensure their recovery, recovery or destruction, the development of a producer responsibility system for the collection of fluorinated greenhouse gases and their renewal, recovery or destruction, and the implementation of training and certification programmes.

**Activities:** The following will be implemented within the framework of the measure:

- Replacement of equipment and devices that use fluorinated greenhouse gases with equipment and devices that use natural working substances;
- Preventing or eliminating the release of fluorinated greenhouse gases into the atmosphere;
- Collection, recovery, and reuse of fluorinated greenhouse gases.

**Funds needed for implementation:** EUR 80,000,000.00

**Sources of funding:** Revenues from the sale of emission units from the EU ETS, the Modernization Fund.

**Executive Body**: Ministry of Environmental Protection and Green Transition, EPEEF

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Impact:** Reduction of greenhouse gas emissions, transition to natural working substances and increase in energy efficiency of cooling systems, correct collection and handling of fluorinated greenhouse gases during the servicing of devices and equipment, prevention or elimination of leakage into the atmosphere, development of a producer responsibility system for the collection of fluorinated greenhouse gases and their restoration, recovery or destruction and application of programs for training and certification of persons who perform the activity of collecting, checking leaks, installing and servicing equipment and devices containing fluorinated greenhouse gases.

**Monitoring method:** A national system for calculating and reporting anthropogenic emissions from sources and removals by greenhouse gas sinks and a national system for monitoring emission reduction policies, measures, and estimates.

**Research and development:** The measure is indirectly connected to research and development and innovative measures to reduce greenhouse gas emissions.

The following are measures related to **waste and the circular economy**.

Observing the joint effect of the measures is necessary since they complement each other. The measures include the objectives from the Waste Management Plan of the Republic of Croatia for the period 2023-2028 („Official Gazette“, No. 84/23) (hereinafter WMP), according to the obligations arising from the Waste Management Act („Official Gazette“, Nos. 84/21, 142/23) (hereinafter WMA) or EU legislation.

Following the New Action Plan for the Circular Economy - For a cleaner and more competitive Europe (COM(2020) 98 final)[27], the measures and activities of the WMP ensure the strengthening of circularity and the reduction of waste by applying the principles of sustainability throughout the value chain, from the design of sustainable products to strengthening the position of consumers and public contracting authorities (green public procurement, eco-labels, etc.), towards more efficient models of separate waste collection, its reuse and high-quality recycling. A group of measures and activities are focused on products that, in the context of value chains, are recognized as key to removing obstacles to expanding the market for circular products: electronic devices, batteries and vehicles, packaging, plastics, textile products, construction products and food.

The measures and activities defined by the Waste Prevention Program (hereinafter: WPP), as an integral part of the WMP, are relevant for achieving waste management goals. The implementation of waste prevention measures, to the greatest extent, will contribute to the sustainable management and strengthening of the circularity of the following waste streams: municipal waste and the main components of municipal waste (bio-waste, paper and cardboard, waste textiles and clothing, plastic waste), plastic waste, marine waste, waste from paper and cardboard, textiles and footwear, single-use plastic products, electrical and electronic waste, construction waste. Preventing the generation of municipal waste will contribute to the increase in the reuse of waste, reduce the amount of total municipal waste and biodegradable municipal waste deposited in landfills, and contribute to the achievement of the goals of Directive 1999/31/EC[28]. Implementing measures to prevent the creation of special categories of waste, especially in promoting reuse and application of eco-modulation in the extended producer responsibility system, and reducing the creation, will improve the management system of these special categories of waste. At the same time, it will contribute to achieving goals related to separate collection, reuse, recycling and recovery prescribed by EU directives on special categories of waste and goals related to reuse and recycling of municipal waste prescribed by Directive 2008/98/EC[29].

[27] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: New action plan for the circular economy - For a cleaner and more competitive Europe (COM(2020) 98 final) of 11.3.2020, https://eur-lex.europa.eu/legal-content/HR/TXT/?qid=1585811887070&uri=CELEX:52020DC0098

[28] Council Directive 1999/31/EC of 26 April 1999 on landfills (OJ L 182, 16.7.1999) as last amended by Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on landfills (OJ L 150, 14.6.2018), https://eur-lex.europa.eu/legal-content/HR/TXT/?uri=celex%3A31999L0031

[29] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives Text with EEA relevance (OJ L 312, 22.11.2008), https://eur-lex.europa.eu/ legal-content/HR/TXT/?uri=CELEX:32008L0098

Below are the measures to achieve the objectives of the PGO:

**Measures to achieve Goal 1. WMP - Municipal waste**

- WMP Measure 1. Improvement of the system for separate collection of municipal waste and infrastructure (capacity and technology) for recycling and other recovery procedures of municipal waste
- WMP Measure 2. Strengthening of awareness, information and education about waste management and products
- WMP Measure 3. Determination of the national composition of municipal waste
- WMP Measure 4. Introduction of the disposal fee
- WMP Measure 5. Construction of waste management centres

***Measures to achieve Goal 2. WMP - Waste packaging, Goal 3. WMP - Waste plastic products for single use, Goal 4. WMP - Construction waste, Goal 5. WMP - Waste vehicles, Goal 6. WMP - Waste batteries and accumulators, Goal 7. WMP - Waste electrical and electronic equipment, Target 8. WMP - Waste tires and Target 9. WMP - Other special categories of waste***

- WMP Measure 6. Analysis of the efficiency of the system for managing special categories of waste with suggestions for improvement
- WMP Measure 7. Improvement of the waste packaging management system and establishment of a system for the management of waste plastic products for single-use and fishing tools containing plastic
- WMP Measure 8. Improvement of the system for managing construction waste and waste containing asbestos
- WMP Measure 9. Improvement of the system for managing waste vehicles, waste batteries and accumulators, waste electrical and electronic equipment and waste tyres

**Measures to achieve Goal 10 of the WMP - Improve the hazardous waste management system**

- WMP Measure 10. Implementation of the project "Feasibility study of existing and necessary capacities for the treatment of hazardous waste and study for the identification of new locations contaminated with hazardous waste ("black spots")

**Measures to achieve Goal 11. WMP - Rehabilitate locations polluted by waste**

- WMP Measure 11. Rehabilitation and closure of non-hazardous waste disposal sites
- WMP Measure 12. Remediation of locations contaminated with hazardous waste ("black spots")
- WMP Measure 13. Remediation of locations polluted by waste dumped into the environment

**Measures to achieve Goal 12 of the WMP - Improve the information system and monitoring of waste management**

- WMP Measure 14. Creation and/or improvement of applications that are part of the waste management information system
- WMP Measure 16. Creation of a plan for monitoring the implementation of PGO

**Measures to achieve Goal 13. PGO - Improve supervision over waste management**

- WMP Measure 17. Education of participants involved in monitoring waste management

**Waste Prevention Program (WPP) measures**

- WPP Measure 1. Strengthening the policy framework for the transition to a circular economy in the construction sector
- WPP Measure 2. Strengthening the policy framework for the prevention of food waste
- WPP Measure 3. Improvement of the biowaste data monitoring system
- WPP Measure 4. Promotion of home composting
- WPP Measure 5. Encouraging the reduction of consumption of single-use plastic products
- WPP Measure 6. Encouraging the purchase of 'green' products and services
- WPP Measure 7. Awareness raising, education on waste prevention and exchange of good practices
- WPP Measure 8. Promotion of eco-design (systematic integration of aspects of environmental protection into product design to improve product behaviour concerning environmental protection throughout the product's lifetime)
- WPP Measure 9. Promotion of certified environmental management systems, including EMAS and ISO 14001 systems
- WPP Measure 10. Creation of a Waste Prevention Plan
- WPP Measure 11. Encouraging the exchange and reuse of used products

**Connection to other dimensions**: Research, innovation and competitiveness.

### GO-1 Prevention and reduction of waste generation

Regulatory, environmental, economic, and educational measure; implementation: 2024 - 2030

**Objective and description of the measure:** Waste prevention is a priority in waste management. The prevention and reduction of waste generation is achieved through reuse procedures, establishing centres for reuse, using by-product instruments, eliminating waste status, and restricting the placing of certain products on the market. The measure should be achieved through cleaner production, education, information and awareness-raising projects on sustainable waste management, economic instruments, the application of regulations

governing waste management and investments in modern technologies that prevent and/or reduce waste generation.

The specific objectives of the Waste Prevention Program are:

- Preventing the creation of communal waste;
- Preventing the creation of biowaste;
- Preventing the generation of electrical and electronic waste;
- Preventing the creation of waste paper and cardboard;
- Preventing the creation of plastic waste;
- Preventing the creation of construction waste;
- Preventing the creation of waste textiles and footwear;
- Preventing the creation of marine litter.

The GO-1 measure incorporates the objectives of the Waste Management Plan (WMP) according to the obligations arising from the WMP and EU legislation. Measure GO-1 combines the effects of the following measures from WMP and WPP:

- WMP - Measure 1, Measure 2, Measure 5, Measure 6, Measure 7, Measure 8, Measure 9, Measure 10, Measure 14, Measure 15, Measure 16, Measure 17
- WPP - Measure 1, Measure 2, Measure 3, Measure 4, Measure 5, Measure 6, Measure 7, Measure 8, Measure 9, Measure 10, Measure 11

**Connection to other dimensions**: Research, innovation and competitiveness.

### GO-2 Increasing the amount of separately collected and recycled waste

Regulatory, environmental, economic, and educational measure; implementation: 2024 - 2030

**Objective and description of the measure:** Municipal waste management, as one of the priority categories of waste in terms of quantity and composition, is conditioned by the legislative framework. Quantitative goals and deadlines for increasing the mass of separately collected and recycled waste are incorporated into the measure:

- Separate collection of problematic waste, paper and cardboard, glass, plastic, biowaste, metal, textiles and bulky waste;
- Meeting the goals of preparation for reuse, including repair and recycling, through the separate collection of paper and cardboard, metal, plastic, glass, biowaste and bulky waste in a minimum proportion of:
  - **WMP Scenario 1** - 55%, 60%, and 65% of the mass of municipal waste by 2025, 2030, 2035. Scenario 1 envisages the fulfilment of the goals specified in Article 11, paragraph 2 of Directive 2008/98/EC;
  - **WMP Scenario 2** - 50%, 55%, and 60% of the mass of municipal waste by 2025, 2030, 2035. Scenario 2 envisages a delay in the fulfilment of the goals specified in

Article 11, paragraph 2 for five years under Article 11, paragraphs 3 and 5 of Directive 2008/98/EC;

- Disposal limit for all waste that is suitable for recycling and other material and energy recovery procedures until 2030;
- Limitation on the amount of municipal waste that is disposed of:
  - **WMP Scenario 1 -** to a maximum of 10% of the total amount (by mass) of municipal waste generated by 2035. Scenario 1 envisages the fulfilment of the objectives specified in Article 5, Paragraph 5 of Directive 1999/31/EC;
  - **WMP Scenario 2** - to a maximum of 10% of the total amount (by mass) of municipal waste generated by 2040 and to a maximum of 25% of the total amount (by mass) of municipal waste generated by 2035. Scenario 2 envisages the fulfilment of the goals specified in Article 5, paragraphs 6 and 8 of Directive 1999/31/EC;
- mandatory processing of waste before disposal;
- reduction of the amount of biodegradable municipal waste disposed of in landfills.

The WMP goals are included in Scenario 1. In contrast, the extension of the deadline until 2030 included in Scenario 2 will be requested as a protective measure to avoid a situation of violation of Directive 2008/98/EC if, during the implementation of the WMP, it is shown that the achievement of the goal of at least 55% for recycling, sorting, reuse, and repair of waste by 2025 is not possible.

The GO-2 measure incorporates the objectives of the WMP according to the obligations arising from the WMP and EU legislation. Measure GO-2 combines the effects of the following measures from WMP and WPP:

- WMP - Measure 1, Measure 2, Measure 3, Measure 4, Measure 5, Measure 6, Measure 7, Measure 8, Measure 9, Measure 11, Measure 12, Measure 13, Measure 14
- WPP - Measure 1, Measure 2, Measure 3, Measure 4, Measure 5, Measure 8, Measure 9, Measure 11

**Connection to other dimensions:** Research, innovation and competitiveness.

### GO-3 Reducing the amount of disposed biodegradable waste

Regulatory, environmental, economic, and educational measure; implementation: 2024 - 2030

**Objective and description of the measure:** The measure aims to reduce the mass of the biodegradable fraction of waste disposed of in landfills, thereby reducing the emission of methane produced by anaerobic processes of waste decomposition. The GO-3 measure incorporates the objectives of the WMP according to the obligations arising from the PGO and EU legislation:

- All permits for waste management in the Republic of Croatia allow the disposal of a maximum of 264,661 tons of biodegradable municipal waste in one calendar year (35% of the mass of biodegradable municipal waste produced in 1997);

- Improve the system for collecting and recovering biowaste, separate collecting and recycling 36% of biowaste from municipal waste.

Applying binding goals related to the disposal and recycling of waste described in measure GO-2 reduces the mass of disposed biodegradable waste.

Measure GO-3 combines the effects of the following measures from WMP and WPP:

- WMP - Measure 1, Measure 2, Measure 3, Measure 4, Measure 5, Measure 7, Measure 8, Measure 9, Measure 11, Measure 14
- WPP - Measure 1, Measure 2, Measure 3, Measure 4, Measure 6, Measure 8, Measure 9

**Connection to other dimensions**: Research, innovation and competitiveness.

### GO-4 Ensuring a system for the treatment and use of landfill gas

Regulatory, environmental, economic, and educational measure; implementation: 2024 - 2030

**Objective and description of the measure:** The Ordinance on Landfills („Official Gazette“, No. 4/23) stipulates the operating conditions for landfills, which reduce the possible adverse environmental effects of landfills. Landfill gas is collected from all landfills receiving biodegradable waste. The collected landfill gas should be treated and used. If the collected gas cannot be used to generate energy, it should be incinerated, and methane emissions into the atmosphere should be prevented.

Applying binding targets for the disposal and recycling of waste, as described in the measure GO-2, positively affects the reduction of landfill gas generated.

Measure GO-4 combines the effects of the following measures from WMP and WPP:

- WMP - Measure 1, Measure 5, Measure 7, Measure 8, Measure 9, Measure 11, Measure 14
- WPP - Measure 1, Measure 2, Measure 3, Measure 4, Measure 8, Measure 9

*As pointed out in the introductory chapter, it is necessary to observe the joint effect of the measures since the measures complement each other. For this reason, the further elaboration of measures GO-1, GO-2, GO-3 and GO-4 is presented together.*

**Activities of measures GO-1, GO-2, GO-3, GO-4:**

- Application of the order of priority of waste management;
- Reducing the mass of waste for disposal;
- Increasing the amount of separately collected and recycled waste;
- Reducing the amount of disposed biodegradable waste;
- Incineration of landfill gas on a flare if the landfill does not have an electricity generation facility installed and if the landfill gas is not of the appropriate composition and quantity for electricity production.

**Funds needed for implementation:** An estimate of EUR 2,181,070,900 was used to implement WMP measures to assess financial resources for implementing measures in 2024 - 2030.

**Sources of financing:** Operational Program Competitiveness and Cohesion 2014 - 2020, National Recovery and Resilience Plan 2021 - 2026, Program Competitiveness and Cohesion 2021 - 2027 (the expected total amount of EU funding is EUR 602,026,274); national funds (state budget EUR 8,800,310, units of local and regional self-government EUR 282,009,462 EUR, Environmental Protection and Energy Efficiency Fund EUR 311,227,472), public-private partnership (EUR 150,507,665), civil sector (EUR 164,917) and private investments (EUR 826,334,800). Funds for the implementation of the WMP for the period 2026 - 2028, in the total amount of EUR 365,473,651, will be considered when planning the budget for the specified period within the given limits.

**Executive Body:** Ministry of Environmental Protection and Green Transition

**Monitoring bodies:** EU, Ministry of Economy, Ministry of Environmental Protection and Green Transition, Local and Regional Self-Government Units, Environmental Protection and Energy Efficiency Fund

**Impact:**

- Reduction of greenhouse gas emissions (kt $CO_2$-eq);
- Reducing the mass of disposed waste;
- Reducing the amount of disposed biodegradable waste;
- Establishment of an integrated waste management system according to the order of priority implemented under the objectives of national and EU legislation;
- Efficient waste recovery - waste management must be directed towards the effective application of the principles of the circular economy;

  - the backbone of the waste management system of the Republic of Croatia consists of waste management centres;

  - the establishment of recycling yards ensures the availability of separate municipal waste collection services;
- Transfer of knowledge and experience of EU countries in the application of best available techniques for waste treatment and recovery;
- Provision of support for investment projects.

**Monitoring method:**

- Report on the implementation of the Waste Management Plan of the Republic of Croatia for the period 2023 - 2028;
- Report on the implementation of policies and measures to reduce greenhouse gas emissions;

**Measure implementation indicator:** Establishment and improvement of the system for managing municipal waste and special categories of waste, potential for reducing greenhouse gas emissions (kt $CO_2$-eq).

**Connection to other dimensions:** Research, innovation, and competitiveness

**Research and development**: Application of the best available waste treatment and recovery techniques.

### GO-5 Reduction of food waste occurrence

Regulatory, environmental, economic, and educational measure; implementation: 2023 - 2030

**Objective and description of the measure:** Food waste prevention is carried out through the implementation of the Plan for the prevention and reduction of food waste for the period from 2023 to 2028, which continued planning activities to increase the amount of donated food, reduce food waste, and increase the food security of poorer population groups.

The plan includes the continuation of measures and activities that will contribute to further progress in the prevention and reduction of food waste in all stages of the food chain, from primary production through processing and production, trade, catering, and institutional kitchens to households, but also to the achievement of the sustainable development goal of the United of the people to reduce food waste per capita at the retail and consumer level by 50% and to reduce food loss in production and supply chains by 2030.

The measures include encouragement and further improvement of the food donation system in the Republic of Croatia; encouraging the reduction of food waste generation; promotion of social responsibility of the food sector; raising awareness and informing consumers about preventing and reducing food waste; monitoring the amount of food waste and investing in research work and innovative solutions that contribute to the prevention and reduction of food waste.

**Activities of the measure:**

- Implementation of the Plan for preventing and reducing food waste from 2023 to 2028.

**Funds needed for implementation:** EUR 5,734,953 will be needed to implement the Plan for preventing and reducing food waste from 2023 to 2028.

**Sources of financing:** State budget of the Republic of Croatia, National Recovery and Resilience Plan

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries

**Impact:** Reduction in food waste (tons and %), potential reduction of greenhouse gas emissions (kt CO2-eq).

**Monitoring method:** Measuring the amount of food waste

**Measure implementation indicator:** Reduction of food waste mass (t), greenhouse gas emission reduction potential (kt $CO_2$-eq).

**Connection to other dimensions:** Research, innovation, and competitiveness

**Research and development:** Exchange experiences and examples of best practices, as well as advice and recommendations for subjects in the food business, the scientific community, and consumers.

### GO-6 Circular economy measures to increase resource efficiency and business application models based on repair, recycling and recovery

Regulatory, environmental, economic, and educational measure; implementation: 2024 - 2030

**Objective and description of the measures:** The new action plan for the circular economy (COM(2020) 98 final) introduces measures to reduce waste production and the good functioning of the EU internal market for high-quality secondary raw materials. The action plan for the EU's circular economy is aimed at changing the way of production, empowering consumers to make sustainable decisions in business and everyday choices, and applying a production and consumption model that includes sharing, reusing, repairing and recycling existing products and materials as long as possible. Thus, the lifetime of products and raw materials is simultaneously extended, and the waste mass is reduced. Therefore, introducing circular economy principles minimises the pressure on the environment, increases the security of raw material procurement, competitiveness and innovation, creates new jobs, and consumers have longer-lasting, more resistant and more valuable products.

The goal of the circular economy concept is to separate economic growth from the use of natural resources, which can be achieved by removing waste and pollution already at the stage of conception/design of products and materials by keeping them in use as long as possible. True circularity requires products that can be reused, repaired, refurbished, reworked and repurposed, thus preventing product value from declining and can even gain quality the longer they circulate through the system.

Waste management, including the collection and processing of waste, is critical to increasing the circularity of the Croatian economy and reducing landfills' negative impacts on the environment, human health, and greenhouse gas emissions. Municipal waste accounts for the largest share of total waste in Croatia; the municipal waste recycling rate 2022 was only 34%, compared to the EU average of 49%.

In 2022, the World Bank, as part of the "Technical assistance for sustainable waste management - transition to a circular economy" project, prepared a Proposal of an Action Plan for implementing a circular economy in Croatia's construction waste management sector. The construction sector in Croatia has been identified as a sector with significant potential for applying circular economy principles because the construction sector includes many economic entities along the entire supply chain and value chain. In the end, the Proposal of the Action Plan for the implementation of the circular economy in the construction waste management sector in Croatia resulted in a list of goals, from which the measures and activities that are included in the Waste Management Plan of the Republic of Croatia for the period 2023 - 2028 derive („Official Gazette“ No. 84/23).

Closing the loop on materials management requires rethinking how we conceive/design products, manufacture them, consume them, and reuse materials at the end of a product's life. Opportunities are opening for the Croatian economy that requires a strategic approach focused on the measures listed in the New Action Plan for the Circular Economy, based on which the EC integrates the principles of the circular economy into the production and consumption of plastics, water management, food systems, management of unique waste

streams, etc. In Croatia, four priority sectors were defined: food, construction sector, plastics and textile production, considering their significant ecological and socioeconomic aspects.

Measure GO-6 combines the effects of the measures from the WMP and WPP that were previously mentioned. These measures impact the comprehensive application of circular economy measures, which can achieve a higher rate of circularity in the Croatian economy.

**Activities of the measure:**

- Implementation of the establishment of a sustainable and efficient waste management system - introduction of the principles of circular economy;
- Application of production and consumption models that include sharing, reuse, repair and recycling of existing products and materials;
- Extending the lifespan of products and raw materials;
- Elaboration of a systematic approach in all value chains related to the Croatian economy, which includes the measures listed in the New Action Plan for a circular economy - integrating the principles of the circular economy into the production and consumption of plastics, water management, food systems, management of special waste streams, etc.
- Implementation of the Action Plan proposal for the construction waste management sector;
- Encouraging other sectors in Croatia to effectively apply the principles of the circular economy, aimed at reducing the generation of waste and exploiting its economic value while avoiding negative impacts on the environment and climate change - a strategic approach focused on four priority sectors: food, the construction sector, plastics and textiles production, considering their significant ecological and socioeconomic aspects;
- Establishment of the Circular Economy Committee - sharing knowledge and providing expert support to strengthen cooperation among all sectors and guide ways of thinking to improve the longevity of products and their recycling;
- Create the National Action Plan to transition to a circular economy by adjusting the legislative framework.

**Funds needed for implementation**: Estimated financial resources for implementing WMP measures

**Sources of funding**: Funding for implementing WMP measures

**Executive Body**: Ministry of Environmental Protection and Green Transition

**Monitoring bodies:** EU, local and regional self-government units, Environmental Protection and Energy Efficiency Fund (EPEEF)

**Impact:**

- Separation of economic growth from the use of natural resources;
- Strengthening the policy framework to accelerate the transition to a circular economy by all economic sectors;

- Reducing pressure on the environment, increasing security of raw material procurement, competitiveness and innovation, creating new jobs;
- Reduction of greenhouse gas emissions (kt $CO_2$-eq)
- Development of awareness of the need for waste management - circular economy, encouraging intersectoral cooperation;
- Ensure grants for investment projects.

**Monitoring method:**

- Report on the implementation of the Waste Management Plan of the Republic of Croatia for the period 2023 - 2028;
- Report on the implementation of policies and measures to reduce greenhouse gas emissions;
- Including representatives of the Republic of Croatia in the European Circular Economy Stakeholder Platform enables direct access to innovations, best practices, and cooperation in them.

**Measure implementation indicator:** Reducing pressure on the environment, increasing the security of raw material procurement, and creating new jobs.

**Connection to other dimensions:** Research, innovation, and competitiveness

**Research and development:** Application of best available recycling and waste recovery techniques.

The measures related to the **agricultural sector** are presented below.

According to the IPCC methodology, in the agriculture sector, $CH_4$ and $N_2O$ emissions are observed due to livestock farming, the use of fertilisers and soil degradation processes, while in the LULUCF sector, carbon sinks/emissions are observed in six storage facilities and are closely related to the management methods of each soil category (e.g. soil cultivation). The future EU policy envisages linking emission reduction targets from the LULUCF and agriculture sectors into targets for one sector. In the Republic of Croatia, the Ministry of Agriculture, Forestry and Fisheries is responsible for animal husbandry and plant production, and the agricultural sector and LULUCF, according to the IPCC definition, are advantages for planning and implementing measures.

### POLJ-1 Improving storage capacity and practices when handling manure

Economic, environmental and educational measure; implementation 2023-2030

**Objective and description of the measure:** The measure aims to reduce methane, nitrogen, and ammonia emissions through manure collection and storage. The manure management category is the source of nitrogen compounds, ammonia, and particulate emissions. Emissions come from the excrement of animal manure deposited in and around the dwellings and collected as liquid manure, solid manure, or manure in a pit in the yard, with the latter two being viewed together as solid manure. Emissions come from animal housing, the yard, storage areas, and manure application on the soil and during grazing. In practice, several

measures are mainly applied at the same time, with different measures that can have a significant impact on emission reductions, such as:

- Changes in the fertilisation system (type of manure) and improvement of manure collection facilities,
- General improvement measures encourage the implementation of animal husbandry practices such as keeping animals on pasture. This dramatically affects emissions reduction because the depositing and manipulation of manure inside and outside the animal breeding facility is significantly reduced. Additionally, through the grazing of animals, it is possible to deposit manure on the pasture where it is directly absorbed by the plants and its absorption by the soil is carried out,
- Education of farmers on practices that contribute to the reduction of greenhouse gas emissions

This measure is related to the Common Agricultural Policy (CAP) and the Strategic Plan of the Common Agricultural Policy of the Republic of Croatia for the period 2023-2027. (hereinafter: Strategic Plan) as part of the following interventions:

- 73.10 - Support for investments in primary agricultural production
- 31.02. - Extensive pasture management
- 31.04. - Use of manure on arable land
- 70.06. - Payments for animal welfare (through the requirement to keep animals on pasture)
- 78.01. - Support for knowledge transfer.

**Activities:**

- Encourage farmers to invest in the construction of storage capacity (watertight tanks that are large enough to collect manure for six months) and manure manipulation, as well as purchasing equipment and machinery that contributes to reducing emissions;
- Encourage farmers to cover manure in storage areas, adding inorganic substances (adsorbents) to bind ammonia;
- Encourage farmers to shorten the time of manure manipulation from the farm to manure incorporation into the soil;
- Encourage farmers to change the animal husbandry system, which reduces manure deposition and the need for manure manipulation, such as extensive livestock keeping on pastures with low grazing pressure;
- Mandatory farmers' training on practices that contribute to reducing greenhouse gas emissions within the framework of interventions from the Strategic Plan.

**Funds needed for implementation:** Within the framework of the Strategic Plan, funds are provided for the implementation of interventions that contribute to the activities mentioned above:

• 73.10. - Support for investments in primary agricultural production - EUR 223,663,407.50 (the amount represents the total available funds for the implementation of the intervention,

which includes, among others, acceptable investments in storage capacities for manure and digestates, including equipment for handling and using manure and digestate exclusively for own needs)

• 31.02. - Extensive pasture management - EUR 48,420,000.00

• 31.04. - Use of manure on arable land - EUR 74,330,000.00

• 70.06. - Payments for animal welfare - EUR 155,476,470.00

**Sources of financing:** European Agricultural Fund for Rural Development (EAFRD), European Agricultural Guarantee Fund (EAFRD), State Budget of the Republic of Croatia

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries.

**Impact:** Emission reduction ($ktCO_2$), Improving competitiveness and efficiency of livestock production, increasing awareness and knowledge of farmers about the need to reduce emissions.

**Monitoring method:** Control of the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APARD), Inspection supervision of manure management facilities, Measurement of the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition.

**Connection with other dimensions:** Research, innovation and competitiveness

### POLJ-2 Anaerobic manure decomposition and biogas production

Economic measure; implementation in 2023-2030.

**Objective and description of the measure:** The measure aims to reduce agricultural holdings' dependence on fossil fuels and methane emissions from cattle and pig manure management systems by increasing the share of biogas plants.

Introducing biogas plants reduces greenhouse gas emissions due to the disposal of used litter and produces electricity from a renewable source. Additionally, apart from the fact that anaerobic digestion in biogas plants reduces the source of readily degradable carbon in manure applied to agricultural land, the nitrification process ($N_2O$ emission) is also potentially reduced.

The digester or fermenter is the central part of the biogas plant and bears the highest investment costs of the biogas plant. It also has the highest operating costs resulting from energy consumption for heating.

This measure is related to the Common Agricultural Policy (CAP) as part of the intervention:

73.03. – Use of renewable energy sources and

73.10. - Support for investments in primary agricultural production (among others, investments in biogas plants are also acceptable).

**Activities:** Construction of biogas plants

**Funds needed for implementation**: Common Agricultural Policy (CAP) foresees the allocation of EUR 30,000,000.00 through intervention 73.03. – Use renewable energy sources for investments in renewable energy sources (which also include biogas plants).

As part of the intervention 73.10, Support for investments in primary agricultural production is available at EUR 223,663,407.50 (the amount represents the total available funds for the implementation of the intervention, which includes, among other things, acceptable investments in biogas plants as part of investments in the construction of production facilities, i.e., increasing existing capacities by reconstructing buildings).

**Sources of financing**: European Agricultural Fund for Rural Development (EAFRD), State Budget of the Republic of Croatia, Modernization Fund

**Executive body:** Ministry of Agriculture, Forestry and Fisheries (MAFF)

**Impact**: Reduction of emissions (kt $CO_2$), production of electricity for own needs of agricultural holdings

**Monitoring method:** Control the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD) and measure the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition.

### POLJ-3 Improving and changing the soil tillage system (reduced tillage)

Economic, environmental and educational measure; implementation in 2023-2030

**Objective and description of the measure:** Increasing soil carbon sequestration through improvements and modifications to soil treatment systems.

Soil treatment systems are crucial for the parameters important for storing soil water, in general, water-air relationships, water losses by evapotranspiration, soil thermal state, and thus microbial activity and soil respiration.

Reduced tillage is the application of scientific research and practical checks that change the conventional tillage system by reducing the depth of basic and supplementary tillage, omitting one or more working operations, reducing the frequency of tillage, or entirely omitting tillage.

Thus, reduced tillage can be divided into basic concepts:

- Reducing classic tillage systems,
- Minimum tillage,
- No-till,
- Conservation tillage,
- Rational tillage.

In conditions of global climate change and more frequent and intensive droughts (according to the IPCC, in the regions of southern, south-eastern, and eastern Europe, and thus in the Republic of Croatia, a reduction in soil humidity of 15-25% can be expected in the warm half of the year), perhaps the most important the task of reduced tillage becomes the accumulation and storage of water in the soil. At the same time, in years of abundant rainfall, which has also been occurring lately, there is often excessive soil saturation with water, making the tillage problem even more challenging. Other reasons for applying these tillage systems are related to improvements in the soil's biological, chemical, and physical properties and the prevention and mitigation of erosion. Management systems that include conservation

tillage, organic fertilization, keeping part of the area under lawns, appropriate crop rotation, etc., positively impact the uplift of organic matter in the soil, which is crucial in maintaining all soil roles. The direct impact on greenhouse gas emissions from a reduced tillage system is primarily related to a significant effect on organic carbon content (increase in soil organic matter accumulation, especially in combinations of minimum tillage systems and intermediate crops in cereal cultivation) and from the point of view of reduced energy consumption (fossil fuels) due to fewer machine hours. Reduced tillage is also advantageous from the weed control standpoint, establishing optimal soil functioning and crop height per unit of production area - i.e., a total reduction in production costs.

Problems with soil fertility reduction are caused by the apparent decrease in the yield of cultivated crops, difficult soil cultivation, reduced utilization of applied fertilizers, and overall production efficiency.

This measure is linked to the Common Agricultural Policy (CAP) as part of the intervention

31.06. - Conservation agriculture and 78.01. - Support for knowledge transfer.

**Activities:**

- Encouraging agricultural producers to use conversational tillage, with the implementation of crop rotation, ensuring soil coverage of agricultural areas with plant residues or green cover;
- Mandatory farmers' training on practices that contribute to the reduction of greenhouse gas emissions within the framework of interventions from the Strategic Plan, preservation of organic matter in the soil, features of reduced tillage, integrated protection of arable crops from weeds, mechanical weed removal and soil coverage in conservation agriculture.

**Funds needed for implementation:** Within the framework of the Strategic Plan, funds are provided for the implementation of the intervention that contributes to the above activities:

• 31.06. - Conservation agriculture - EUR 37,500,000.00

**Sources of financing:** European Agricultural Guarantee Fund (EAGF)

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries

**Impact:** Emission reduction ($ktCO_2$), preservation of soil health and fertility, reduction of the risk of soil erosion, increase of farmers' awareness and knowledge of the need to reduce soil emissions and effective soil management.

**Monitoring method:** Control of the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD), Inspection supervision over the implementation of interventions, Measurement of the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition.

**Connection to other dimensions**: Research, innovation and competitiveness

## POLJ-4 Extension of crop rotation with a higher share of legumes

Economic, environmental and educational measure; implementation in 2023-2030

**Objective and description of the measure:** Retention of carbon in the soil by ensuring an optimal ratio of carbon and nitrogen, protection of soil and water from nitrate pollution by growing legumes to reduce or completely omit the use of nitrogen fertilizers. Cultivation of legumes promotes soil biogenicity and fertility, improves soil structure and prevents erosion.

Increasing soil carbon sequestration through crop rotation.

Fertilization is a system of plant production practised on arable land, representing the regular, spatial and temporal crop rotation (swapping crop). When determining crop rotation, care must be taken of soil type and fertility, pH value, climatic conditions, and the impact of culture on soil fertility, structure, and nutrient supply. Fertilization is planned individually for each economy according to production requirements, where adherence to the recommended sequence of cultures is essential. Crop rotation must include three primary groups of plants - arable crops, cereals, and legumes.

Today, crop rotation and soil treatment systems strongly influence soil's organic matter content changes. The crop rotation intended to have a long-term impact on maintaining the same humus level should include leguminous crops, clovers, and clover grass mixtures. It should, where possible, include the sowing of second crops for green harvests.

Sowing leguminous crops has many beneficial effects on agricultural soils. This binds atmospheric nitrogen, which is used immediately for protein synthesis and prevents the risk of groundwater contamination by nitrates that otherwise occur with the intensive application of mineral nitrogen fertilizers. The soil is enriched with organic matter, which has multiple positive effects on improving and maintaining the soil's favourable physical, chemical, and biological properties. Soil fertility is maintained, and cultures that follow in the crop rotation are allowed to use biologically bound atmospheric nitrogen. Individual crops (clover) can be effective in soil carbon sequestration. Furthermore, growing leguminous crops reduces the amount of nitrogen-rich organic fertilizers. As a rule, they do not need to be fertilized except in small amounts at the beginning of their vegetation for initial growth and development until they form root knots and until the nitrogen fixation process begins.

This measure is linked to the Common Agricultural Policy (CAP) as part of intervention

31.05. - Minimum leguminous content of 20% within agricultural areas.

78.01. - Support for knowledge transfer

**Activities:**

- Encouraging producers to increase the share of leguminous crops when creating crop rotation:
- Mandatory training of farmers on practices that contribute to increasing the share of legumes in crop rotation, integrated plant protection in growing legumes, organic fertilization and fertilizers, and soil improvers are used in organic production.

**Funds needed for implementation:** Within the framework of the Strategic Plan, funds are provided for the implementation of the intervention that contributes to the above activities:

31.05. - Minimum share of legumes of 20% within agricultural areas - EUR 67,411,750.00

**Sources of financing:** European Agricultural Guarantee Fund (EAGF)

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries

**Impact:** Emission reduction ($ktCO_2$), preservation of soil health and fertility, reduction of the risk of soil erosion, increase in farmers' awareness and knowledge of the need to reduce soil emissions and effective soil management

**Monitoring method:** Control of the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD), Inspection supervision over the implementation of interventions, Measurement of the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition.

**Connection to other dimensions:** Research, innovation, and competitiveness

### POLJ-5 Intensification of crop rotation by using intercrops

Economic, environmental and educational measure; implementation in 2023-2030

**Objective and description of the measure:** Changes in organic matter content/increase of carbon sequestration in soil and reduction of nitrate leaching by sowing intercrops.

The principles of good agricultural practice in soil and water protection against nitrates recommend the introduction of intercrops (second crops) between the harvest of the main crops. Sowing intermediate crops that can be used to feed livestock or plough for green fertilization will utilize residual nutrients, prevent further evaporation of soil water, reduce carbon loss from soil (eliminating the negative effect of "bare soil"), prevent nitrogen leaching into groundwater (especially in lighter soils) and increase organic mass on farms that have a narrow crop rotation on their arable land. Leguminous crops bind nitrogen from the air to enrich the soil, preserve and stimulate microbial activity, and prevent soil erosion. The increased cost of agricultural production per hectare is usually offset by savings in animal feed preparation or reduced need for mineral fertilizers. The problems in this process generally concern the time and farm work organisation. Still, they are solvable, which can only be conditionally said for the drought that can occur at the time after the harvest of the cereals, whereby the sowing of second crops is questionable.

This measure is linked to the Common Agricultural Policy (CAP) as part of intervention:

31.01. - Intensified diversity of agricultural areas

31.05. - Minimum leguminous content of 20% within agricultural areas

31.06. - Conservation agriculture

78.01. - Support for knowledge transfer.

**Activities:**

- Encouraging agricultural producers to diversify the types of use of farmland and the diversity of plant species (crops) on farmland and crop rotation that includes the sowing of intercrops
- Encouraging the cultivation of legumes as catch crops on agricultural land

- Mandatory training of farmers on the beneficial impact of the diversity of agricultural land on disease and pest control, better absorption of plant nutrients and soil fertility, prevention of erosion, and carbon sequestration.

**Funds needed for implementation**: Within the framework of the Strategic Plan, funds are provided for the implementation of interventions that contribute to the activities mentioned:

• 31.01. - Intensified diversity of agricultural areas - EUR 198,193,309.25

• 31.05. - Minimum share of legumes of 20% within agricultural areas - EUR 67,411,750.00

• 31.06. - Conservation agriculture - EUR 37,500,000.00

**Sources of financing:** European Agricultural Guarantee Fund (EAGF).

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries

**Impact:** Reduction of emissions (kt $CO_2$), preservation of soil health and fertility, reduction of the risk of soil erosion, increase of farmers' awareness and knowledge of the need to reduce soil emissions and effective soil management.

**Monitoring method:** Control of the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD), Inspection supervision over the implementation of interventions, Measurement of the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition**.**

**Connection to other dimensions:** Research, innovation, and competitiveness

### POLJ-6 Improvement of organic fertilizer application methods

Economic measure; implementation in 2023-2030

**Objective and description of the measure**: Increasing carbon sequestration in the soil by improving the methodology of applying organic fertilizers.

The application of organic fertilizers is important for the circulation of organic matter in the soil, about which there is a relatively large database at the global level.

Organic fertilizers stimulate the activity of soil microbes much more strongly than mineral fertilizers, and with them, much less salt and acids are introduced into the soil. The effectiveness depends on the microbiological activity in the soil, that is, at what speed they are broken down and transformed into nutrients suitable for adoption. Organic fertilizers have a much longer decomposition time, extending their effect over several years. Regular application of organic fertilizers increases the amount of humus in the soil. It improves soil properties, especially the structure, which results in a better water-air relationship, excellent water retention, greater availability of all nutrients and stronger resistance to erosion on sloping surfaces.

Underground application – direct injection into the ground using an injector prevents the loss of ammonia and reduces or eliminates the spread of unpleasant odours. This method is applicable for applying liquid beef and pig manure, where the $NH_3$ emission is lower by up to 30%.

When using the injector, although the loss due to volatilization is reduced, i.e. the amount of nitrogen available to plants increases, it is also possible to increase the loss of nitrous oxide from the soil. Therefore, the importance of proper dosage and application of fertilizers (organic and mineral) increases even more.

The limiting factor in increasing the use of specialized equipment for injecting organic fertilizer is the relatively high price of the equipment itself. Therefore, such an investment is indicated for more extensive (or consolidated) farms with the need for large fertilization capacities.

This measure is related to the Common Agricultural Policy (CAP) and the Strategic Plan as part of the 73.10 intervention. – Support for investments in primary agricultural production.

**Activities:**

- Encourage investment in machines for the application of organic fertilizer.

**Funds needed for implementation:** Within the framework of the Strategic Plan, funds are provided for the implementation of interventions that contribute to the activities mentioned above:

73.10. Support for investments in primary agricultural production—EUR 223,663,407.50 (the amount represents the total funds available for the implementation of the intervention, which includes, among other things, acceptable investments in agricultural holdings that include the cost of purchasing machines for the application of organic manure exclusively for own needs).

**Sources of financing:** European Agricultural Fund for Rural Development (EAFRD), State Budget of the Republic of Croatia

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries (MAFF).

**Impact:** Reduction of emissions (kt $CO_2$), improvement of competitiveness and efficiency of livestock production.

**Monitoring method:** Control the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD) and measure the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition.

**Connection to other dimensions:** Research, innovation, and competitiveness.

### POLJ-7 Agroforestry

Economic, environmental and educational measure; implementation in 2023-2030

**Objective and description of the measure:** Application of agroforestry technologies to increase carbon sequestration in the soil and define the potential for developing agroforestry systems in suitable areas.

Agroforestry encompasses technologies used in forestry and agriculture to create greater productivity, economic viability, environmental friendliness, and sustainable land use. Agroforestry is a common name for land management systems whereby permanent woody species are integrated with cultivating crops and/or animals in the same area unit. The integration can be spatial or in a time sequence. Ecological-economic interaction between forestry and agricultural components is standard. The goal is to create diverse, productive, profitable, healthy, and sustainable land management systems. The production capacity of

the land is used to a greater extent. Still, at the same time, a balance is reached between economic viability and habitat protection based on sustainability or sustainable development. Research shows that, with all the other benefits, some agroforestry systems (e.g., agro silviculture) are significant carbon sinks.

Agroforestry is applied to agricultural and forestland, including areas with degraded habitats (erodible areas, economically poorly valued devastated and degraded areas. Through experiments, agroforestry should show its applicability in our conditions concerning different forms, divisions, and other needs. It is essential to point out that some elements of agroforestry have been recorded throughout history in our country's coastal and littoral areas. First, cultivating land on terraces that were used to raise perennial plantations, olive groves, vineyards, and various fruit trees could only be used for animal husbandry in a limited manner.

This measure is related to the Common Agricultural Policy (CAP) and the Strategic Plan as part of the interventions:

70.08 – Preservation of extensive orchards and olive groves, within which extensive orchards and olive groves as permanent woody species are maintained with grass cover and the use of domestic animals, which contribute to the carbon sink.

78.01. – Support for knowledge transfer

**Activities:**

- Encouraging farmers to apply agroforestry practices;
- Mandatory training of farmers on the beneficial impact of applying agro-environmental practices, including agroforestry systems.

**Funds required for implementation:**

Within the framework of the Strategic Plan, funds are provided for the implementation of interventions that contribute to the activities mentioned above:

• 70.08 – Preservation of extensive orchards and olive groves - EUR 2,700,958.75

**Sources of funding:** European Agricultural Fund for Rural Development (EAFRD), State Budget of the Republic of Croatia

**Executive body:** Ministry of Agriculture, Forestry and Fisheries (MAFF).

**Impact:** Reduction of emissions (kt $CO_2$), higher productivity, ecological acceptability and sustainable land use.

**Monitoring method:** Control of the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD), Inspection supervision over the implementation of interventions, Measurement of the reduction of greenhouse gas emissions by the Ministry of Environmental Protection and Green Transition**.**

**Connection to other dimensions:** Research, innovation and competitiveness.

### POLJ-8 Hydro-amelioration interventions and systems of protection against natural disasters

Informational, educational, and economic measures; implementation 2021-2030

**Objective and description of the measure**: Increasing the share of agricultural areas under irrigation and reducing nitrate leaching from agricultural soils.

More than any other activity, agriculture pollutes the water with nitrogen (nitrates), phosphates and plant protection products (pesticides). The intensification of agriculture has led to the intensification of agrochemical pollution. Environmentally friendly agriculture means controlled application of mineral fertilizers, controlled drainage, re-use of drained water and use of water of appropriate quality.

Irrigation with larger rations than necessary can result in increased nutrient leaching from the arable horizon, especially nitrogen, into deeper horizons, resulting in the need for additional fertilization and, thus, increased emissions and increased costs. Drainage drains excess water from an agricultural surface, which most often occurs after heavy rain. Also, changes in soil air-water relationships affect the activity of beneficial microorganisms.

Proper irrigation and drainage of excess water enhance microorganism activity, reducing soil degradation and, thus, $CO_2$ losses. Earthworm activity is also increased, transferring carbon into deeper layers where it is longer-lasting.

In Croatia, surface drainage systems are built on an area of about 1,519,000 ha, and underground drainage systems are built on an area of about 166,542 ha. Most of the systems are over 25 years old.

Hydro-amelioration systems play a significant role in sustainable development. Significantly improve the properties of existing hydro-amelioration systems. Human interventions in water control include applying technologies and new management to ensure adequate quantities of water for plants, prevent excessive soil moisture and salinization, protect the soil from flooding, and maximize profits by using water. These interventions take place within economic, social, and environmental constraints.

Croatia is in a good position because it has a sufficient water supply. However, successful technological innovations in drainage and irrigation systems depend primarily on the sector's research programmes and personnel education. The main goals are, therefore, the growth of agricultural production and the system's sustainability.

**Activities:**

- Research programmes to improve the properties of existing hydro-amelioration systems;
- Construction of an irrigation system and personnel education.

**Funds needed for implementation**: EUR 15,000,000.00

**Sources of financing:** State Budget of the Republic of Croatia.

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries

**Impact:** Reduction of emissions ($ktCO_2$), reduction of losses and production optimisation, increased competitiveness, environmental friendliness while reducing agrochemical pollution, sustainable land use, and adaptation to climate change.

**Monitoring method:** Results of research programmes, educational programmes, and statistics on agricultural areas under irrigation.

**Connection to other dimensions:** Research, innovation, and competitiveness

### POLJ-9 Introduction of new cultivars, varieties and crops

Informational, educational measure; implementation 2024-2030

**Objective and description of the measure:** Determining the potential of new cultivars, varieties, and crops to increase soil carbon sequestration.

The introduction of new cultivars, varieties and crops is, in principle, subject to emergency adaptation measures (per the UNDP) - i.e., time-critical measures that also include the implementation of the system as a defence measure against climate change impacts on food production or achieving lower emissions.

In this context, it is vital to encourage the development, education, and implementation of technologies at the national and regional levels, including promoting the transition and adaptation of producers (as well as consumers, and therefore of the entire production chain) to the production of new crops, or by enabling and encouraging the use of cultivars and varieties which are more resistant to drought or disease, have a smaller carbon footprint or have other benefits.

An example of a possible strategy is the more rational production and use of new leguminous crops in response to the lack of protein in animal feed, the need to reduce the use of mineral fertilizers and the reduction of soil fertility.

Due to their considerable protein levels, naturally occurring legumes require a large amount of N. They can provide a large part (or complete need) of this nutrient from the atmosphere through biological fixation, provided they live in symbiosis with the effective strains of root nodule bacteria. It is for these reasons that little-known plant species that have a symbiotic relationship with root nodule bacteria have been recently investigated, such as Galega orientalis Lam., a new perennial forage legume living in effective symbiosis with Rhizobium galegae.

The main advantage of growing Galega orientalis Lam. is almost exclusively using symbiotically bound elemental nitrogen and not N from mineral fertilizers or small doses of "initial" mineral N up to 40 kg/ha. Galega as a new legume is interesting because of its longevity (7-15 years), resistance (soil type, drought, temperature); it is one of the earliest legumes, contains high-value proteins (1.5-2 t/ha); represents an excellent choice of animal feed (in green form, pelleted, as hay or in silos), with grain yield 3-6 times higher than in alfalfa; fertilizing and seed prices are low.

This measure is related to the Common Agricultural Policy (CAP) and the Strategic Plan as part of intervention 77.03. - Support for EIP operational groups. Cooperation projects are financed

within the intervention's framework, connecting research, other professional knowledge, and agricultural practices.

**Activities:**

- Research programs for the application of new cultures resistant to climate change.

**Funds needed for implementation:** Within the framework of the Strategic Plan, funds are provided for the implementation of the intervention that contributes to the activity mentioned above:

• 77.03. - Support for EIP operational groups - EUR 5,100,000.00

**Sources of financing:** European Agricultural Fund for Rural Development (EAFRD), State Budget of the Republic of Croatia.

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries

**Impact:** Defining species and varieties resistant to climate change, higher productivity, ecological acceptability and sustainable land use.

**Monitoring method:** Research results of research projects of operational groups and control of intervention implementation by the Agency for Payments in Agriculture, Fisheries and Rural Development.

**Connection to other dimensions:** Research, innovation, and competitiveness

**Research and development:** Systematic research is needed to assess potential emission reductions.

The land use, land-use change, and forestry sector (LULUCF) measures are presented below.

The LULUCF sector achieves removals by sinks, mainly in the wood mass of forests. Changes are monitored in six categories according to the methodology of the International Climate Change Authority (IPCC): forest land, crop/plantation land, grassland, wetland, populated areas and other land. Carbon storage facilities are observed: above-ground biomass, underground biomass, deciduous (O soil horizon), dead wood, soil, and wood products. Although soil carbon stocks are at the level of those in living biomass, it is impossible to monitor changes in soil carbon stocks in land categories without conversion (the largest area of a particular land category) because there is insufficient data. In the crop/plantation and grassland land categories (so-called agricultural land categories), the most significant contribution to removing carbon from the atmosphere can be made by implementing management practices that increase the carbon stock primarily in soil storage (carbon farming measures). Only through establishing a comprehensive monitoring and reporting system will it be possible to monitor the actual contributions of individual measures in soil storage on agricultural land categories at the national level.

The LULUCF sector is becoming crucial for transitioning towards a climate-neutral economy, as implementing defined measures cannot reduce greenhouse gas emissions from other IPCC sectors cannot be reduced to zero by implementing defined measures. The residue that can no longer be reduced will be covered by removals by sinks (carbon sequestration). Measures in the LULUCF sector should be carefully selected as numerous influential factors exist.

Sustainable forest management and agricultural land management in such a way that it contributes to the accumulation of carbon (carbon farming); sustainable pasture management has multiple benefits. It contributes to biodiversity, increases soil resilience and productivity, is resilient to climate change, prevents soil drainage and erosion, and ensures conditions for sustained productivity in food production and the use of biomass.

At the level of the European Union, a large number of documents related to climate change management, reduction of greenhouse gas emissions, forest and soil management, biodiversity, circular economy, nature restoration and others are relevant for achieving the goals of reducing emissions in the LULUCF sector and others, the most important of which is the Regulation LULUCF.

The LULUCF Regulation, which entered into force in 2018, aimed to increase removals by sinks and reduce greenhouse gas emissions in the LULUCF sector. When adopted, it did not set quantitative targets and put a 'net-emission' rule, meaning emissions and sinks in LULUCF land accounting categories should be balanced. The revision of the 2018 Regulation entered into force on May 5$^{th}$, 2023, setting a new target of -310 million t $CO_2$eq in 2030 at the EU level and setting removal targets for Member States from 2026 to 2030. For the Republic of Croatia, the target value of the net removal of greenhouse gases in 2030 was set at -5,527 kt $CO_2$eq. There is also a binding reduction trajectory from 2026 to 2030.

The next FEA for the period 2026 - 2035 will contain the goal of net removal of greenhouse gases in 2030 of -5,527 kt CO2eq.

Considering the share of a specific category of land in the total land area of the Republic of Croatia, the backbone for the implementation of measures in the LULUCF sector is for forest land, the Forest Management Plan of the Area (FEA), which is prepared for ten-year periods with views on the next ten years, and the implementation of measures from the Strategic Plan of the Common Agricultural Policy (SP CAP) of the Republic of Croatia for the period 2023-2027. The SP CAP is allocated support from the European Agricultural Funds for each measure, and it is aligned with the Agriculture Strategy until 2030, i.e., the National Development Strategy of the Republic of Croatia until 2030. The implementation of the SP CAP will ensure the contribution to the objectives of the European Green Plan, including the Biodiversity Strategy and the Forest Strategy and contribute to the objectives of the Low Carbon Strategy of the Republic of Croatia, the Integrated National Energy Climate Plan, and the new regulatory framework from the 'Fit to 55%' package.

The SP CAP contributes to the sustainable management of forests and forest land with a rich biodiversity of flora and fauna. Interventions for the reconstruction (conversion) of forests and interventions related to pastures, grasslands, and arable crops contribute to this. For numerous climate and environmental interventions, reimbursement is ensured for farmers and forest owners who change their usual production processes to preserve biodiversity and the environment by sustainable use of resources, which implies environmentally responsible, economically viable and socially responsible management.

In the SP CAP, related to LULUCF activities are mainly defined in Requirement 7, “Improve practices that contribute to adaptation and mitigation of climate change”, which includes the following interventions:

-31.02. - Extensive pasture management,

-31.04. - Use of manure on arable land,

-31.05. - Minimum leguminous content of 20% within agricultural areas,

-31.06. - Conservation agriculture,

-31.07 - Preservation of high nature value grassland (TVPV),

-31.08. - Application of organic fertilizers in permanent plantations,

-70.02. - Conservation of biodiversity and the environment on permanent grasslands,

-70.04. - Organic farming,

-70.08. - Preservation of extensive orchards and olive groves,

-73.05. - Reconstruction (conversion) of degraded forests,

-78.01. - Support to knowledge transfer.

In addition to prescribed management requirements, farmers who receive support under the CAP must comply with the conditions of multiple compliance per the Ordinance on conditionality („Official Gazette“, No. 26/23) and regarding good agricultural and environmental conditions (GAEC). Objectives of the GAEC standard: prevent soil erosion by defining minimum soil cover and minimum land management practices, maintain soil organic matter levels and soil structure, maintain permanent grasslands, protect biodiversity and preserve landscape features, protect and manage waters by establishing buffer zones along watercourses, by approving the use of water for irrigation and protecting groundwater from pollution.

Measures in the LULUCF and agriculture sectors strongly contribute to decarbonisation. The scope of some measures so far is not entirely measurable because the monitoring system is not in place and needs to be worked on (e.g., soil carbon, timber products, deadwood, deciduous wood), which is also an obligation under the UNFCCC Convention and the LULUCF Regulation.

The following describes the measures in the Scenario for Existing Measures (WEM). As explained below, the Republic of Croatia cannot achieve the objectives of the LULUCF Regulation with the WEM scenario for 2026- 2030. Research, analysis, and intensive public consultations are needed to define additional measures (Scenario with additional measures (WAM)). There are uncertainties due to natural disasters such as fires, pests, and diseases and climate change's and organic soil's effects on emissions.

Measures in the LULUCF sector are relatively cost-effective; mobilising funds for implementation will be key (CAP, LIFE, private funds). The LULUCF sector needs more robust policy support and a far stronger education of all segments of society, as this is a new and interdisciplinary area that has not been sufficiently perceived in decarbonisation so far. This includes the introduction of new mechanisms and business models and EU initiatives such as **carbon farming and the products of carbon storage facilities**. Establishing certification schemes for carbon removal and the regulation of the European Commission on Regulation 2023/839, which entered into force in May 2023, should help in this.

### LUF-1 Establishment, maintenance and upgrading of the National Information System for land in the Republic of Croatia

Regulatory, economic, information measure; implementation: 2021-2030

**Objective and description of the measure:** By 2025, it is necessary to create a Maintenance Plan for the National Information System for Land in the Republic of Croatia. For its development, it is essential to implement projects that:

1. Establish a unique land information system in the Republic of Croatia or determine the areas of each LULUCF land category by using spatially correctly determined data for each land category and each land conversion type from one land category to another.

**Activity:**

Ministry of Environmental Protection and Green Transition launched the LIFE CROLIS project (LIFE19 GIC/HR/001270) to establish a unique land information system for monitoring land cover (LC) and land use (LU) data in the Republic of Croatia. The task of the project is to create a new data model using spatial data collected at the national level and those available at the European level (e.g., within the COPERNICUS programme). For the selected years from the 1970-2020 series, LC and LU layers will be made, which, with the application of the EAGLE concept, will serve as the basis for creating layers for different purposes, for example, the LULUCF sector for which the total area of the Republic of Croatia should be shown in six categories of land. The LIFE Programme, Environmental Protection and Energy Efficiency Fund (EPEEF), and project partners fund the project. The project also upgrades the ARKOD system, which now covers the areas of agricultural land under incentive. It is upgraded with a module (ARCOD+) containing all other agricultural land areas.

2. Analyse all LULUCF land categories depending on the cover, land use, and management practices used on each land and the associated emissions/sinks to consider the potential of each of the storage areas within each LULUCF land category to reduce emissions and increase greenhouse gas sinks.

**Activity:** The project Defining activities to increase absorption in carbon storage was implemented by the provisions of the LULUCF Regulation regarding the trading of sinks that occur in the calculation categories of land. The project proposed some of the possible measures and determined the costs. Additional analyses and activities specified in measure LUF-8 are required to create a WAM scenario.

3. After conducting the above analysis, make detailed projections for developing future emissions/sinks in the LULUCF sector.

**Activity:** The Capacity Building Project for LULUCF projections was implemented. The project determined the WEM scenario in the NECP and the hypothetical WAM scenario. Implementing the CROWOODS project is in progress. The project is to establish a reporting system for wood products.

Calculation of emissions/sinks in the LULUCF sector and the mentioned projects should form the basis for planning the cover, use, and management of LULUCF land categories for each of the storage areas for the long-term development of the Land Management Strategy and adequately define the measures that will be implemented on each land category, which will reduce emissions and increase sinks of greenhouse gases in the Republic of Croatia.

Improvement and definition of forest fire protection measures should be an integral part of this strategy.

**Executive Body:** Ministry of Environmental Protection and Green Transition

**Monitoring body:** Agency for Payments in Agriculture and Rural Development (APARD)

**Impact:** Ensured conditions for long-term sustainable land management.

**Monitoring method:** Ministry of Environmental Protection and Green Transition

**Connection to other dimensions:** Renewable sources, energy security, energy market

### LUF-2 Carbon sequestration on areas of existing forests

Economic measure; implementation: 2021-2030

**Objective and description of the measure:** Implement activities that increase the carbon content of forests and biomass storage and implement activities that ensure removal in each period. According to the Regulation 2018/839 amendment, which entered into force in May 2023, targets have been set for 2030 for two periods: from 2021 to 2025 and from 2026 to 2030. For 2021-2025, the rules for the calculation of sinks are methodologically based on a comparison with the Reference Level for Forests and the reference levels for cropland, managed grassland, and managed wetland (average for years 2005 -2009).

**For 2021- 2025**, the Republic of Croatia sets a removal target higher than defined by the reference level for forests, fulfilling the condition of the so-called 'no debit rule' in the LULUCF sector, which the LULUCF Regulation sets.

Maintaining sinks higher than those defined by the FRL also ensures an increase in sink units that can be transferred to sectors outside the ETS and flexible mechanisms, i.e., sales to Member States.

In 2021-2025, activities will be outlined on the Forest Management Plan of the Republic of Croatia for 2016-2025. Forest Management Plan includes state-owned forests and private forests.

The management of forests in Croatia is influenced mainly by the consequences of the Homeland War. In Croatia, from 1991- 1995, no regular forest management activities were carried out in areas inaccessible due to the occupation of the territory. After the end of the war, parts of the area were gradually included in regular management activities, and part of the area cannot be managed today due to land mines. In the next few years, until the complete completion of the demining process, the Republic of Croatia will not be able to carry out regular activities of management of a part of its forests in the mine-contaminated areas. Under the explanation, Article 8, paragraph 4 of Regulation (EU) 841/2018 had the opportunity to participate in the FRL for 2021-2025, in addition to the criteria set out in Section A of Annex IV, may also consider the occupation of the territory, the circumstances of the war and post-war that had an impact on forest management during the reference period. The Republic of Croatia implemented this possibility by proposing the FRL for 2021-2025, which a Delegated Act adopted. Per Annex IV of the LULUCF Regulation, the EU FRL for Croatia was set at -3,906 $GgCO_2eq$ per year for 2021-2025. This calculation used a method that assumes instantaneous oxidation when estimating emissions/sinks in the storage of wood products

with the addition of fire emissions. The FRL is -4,368 $GgCO_2$-eq per year using a first-order decomposition formula to estimate carbon in a deadwood store.

In the negotiations on Regulation 2023/839, the Republic of Croatia officials repeatedly pointed out that it was not recognised in the new regulation and that the goal for 2026 - 2030 is in discontinuity with the goal from the previous period. The set goal of the Republic of Croatia for the LULUCF sector in Regulation 2023/839 for the period 2026 - 2030 is based on average data on sinks from the greenhouse gas inventory for 2016, 2017 and 2018 (data submitted in 2020) to which is added value (goal) of –593 kt $CO_2$eq, to achieve a net greenhouse gas removal value of –5,527 kt $CO_2$eq in 2030, which limits the increase in employment as foreseen by existing plans.

Regarding the increase in states, i.e. logging, it should be emphasised here that logging forest-cultivation interventions are a function of the care of a particular stand and its restoration. In diverse stands, these interventions co-occur on the same surface (stand), and in one-year stands, they are spatially and temporally separated. Trees from landscaped, well-groomed stands achieve their target dimensions optimally, ensuring a higher share of higher-quality raw materials and much higher economic value while ensuring high-quality young trees.

Regarding the existing method of forest management, it should be mentioned that the Republic of Croatia celebrated the 250$^{th}$ anniversary of organised forestry in 2015. The term sustainable development in the Republic of Croatia has its roots **in the forestry term permanent management**, which was first mentioned in 1713 and was introduced in Croatia in 1769.

The Republic of Croatia's LULUCF sector achieved 1.8% of the total removal of the EU LULUCF sector for 2016-2018. The proposed amendments to the Regulation envisage a share of the removal of the Republic of Croatia's LULUCF sector in the EU LULUCF sector of 1.35 t $CO_2$eq per capita, which is twice the EU average of 0.69t $CO_2$eq per capita.

In contrast to the projections made to calculate the reference level for forests (FRL), when parameters obtained based on economic practices during the reference period 2000-2009 were used, for the last available WEM (new WEM) projections, the regulations of the stats in the current forest management plans were used, as they were found in 2020 (based on FLFEBA). The new WEM scenarios developed for the needs of this NECP were taken from the Capacity Building for LULUCF Projections project, which is still ongoing and has not finalised the calculations. Projections show that the Republic of Croatia could have excess sinks in 2021-2026. This surplus may be used under the rules of Regulation 2018/842 concerning the emission limitation in the non-ETS sector, or it may be traded with it. The Republic of Croatia cannot transfer the surplus from the first to the second commitment period. Deviations from this projection can be most affected by natural disasters if they are significantly intensified in the future period.

In the period 2026-2030. under the new WEM scenario, carbon accumulation will continue. It is necessary to carry out activities to balance the forest's age structure to achieve long-term sustainable use and thereby ensure an optimal balance of the economic productivity of the forest with all existing and new biodiversity protection goals, which may include the adjustment of the statue. However, according to this scenario, for 2026-2030, the LULUCF goals of the sink targets set out by Regulation 2023/839 are not being achieved. It is necessary

to establish additional measures in forestry and all other LULUCF categories, including possible statute adjustments. At the same time, the challenge remains as to how and in what period the age structure of the forests will be balanced.

The shortage of sinks can be compensated by the flexibility mechanisms of Regulation 2023/839: by transferring allowances from non-ETS systems, purchasing allowances from other countries and/or compensating under Article 13b of Regulation 2023/839/EU (if conditions at EU level are met), but this should be the ultimate exception only in the event that all other available measures cannot ensure the sink targets established by Regulation 2023/839.

The Republic of Croatia should establish measures to achieve the targets by 2030. The analysis of the WAM scenario should consider the impact of climate change, for which reliable data are not currently available. Additional objectives stemming from the EU Biodiversity Strategy, nature restoration measures, and the European Forest Strategy, as well as circular economy measures and bioeconomy, should also be considered. It is necessary to determine the areas of coppice, macchia, and thicket that are justified to be transported to forests of a higher cultivation form to increase the outflow in the category of managed forest land and to intensify activities to protect forests from fire.

**Activities:** Implementation will follow the existing Forest Management Plan of the Republic of Croatia 2016-2025 and the new Forestry Economic Basis of the Republic of Croatia 2026-2035, which is in preparation.

**Funds needed for implementation:** The company Hrvatske šume d.o.o., which manages state-owned forests, operates based on turnover on the market with controlled price control. For state-owned forests that are not in the management system of the Croatian Forests, the institutions are the owners (e.g., nature protection institutions, the Ministry of Defence, the Faculty of Forestry, etc.). Significant long-term income is achieved through the compensation for the use of general useful functions of the forest (OKFŠ), through the compensation paid by all economic entities in the Republic of Croatia above a certain income threshold. Sources of financing are also private funds from forest owners, rural development programs, and the CAP. For illustration, funds needed to implement the existing policies at EUR 270 million per year for state forests (budget of Hrvatske šume d.o.o., average five years). Reducing the volume of logging reduces revenue and puts the sustainability of the long-term existing forest management system at risk; the impact of climate change will require increasing care and preventive action.

Listed are the CAP interventions directly contributing to the LUF2 measure for 2023-2027:

73.05. Reconstruction (conversion) of degraded forests - EUR 11,764,706.25 (1176 ha) and

72.01. Support for limitation in forest management (NATURA 2000, NKS) – EUR 8,823,530.00.

The total from CAP for the period 2023-2027 is EUR 20,588,236.25.

The measures and the envisaged resources are insufficient for the WAM scenario, which should ensure that the LULUCF target is met by 2030.

**Executive Body:** Ministry of Agriculture, Forestry and Fisheries (MAFF), Hrvatske šume d.o.o., Ministry of Environmental Protection and Green Transition, Public Institutions for Nature Protection

**Monitoring body:** Ministry of Environmental Protection and Green Transition, Ministry of Agriculture, Forestry and Fisheries

**Impact:** Provided conditions for long-term sustainable land management.

**Monitoring method:** Determining areas of forests that have been converted to a higher cultivation form (ŠGOP, NIR) and regions that are under management restriction measures related to Natura 2000 areas (control of the implementation of interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development).

**Connection to other dimensions:** Renewable sources, energy security, energy market

**Connection to adaptation to climate change:** Good land management is fundamental to increasing climate resilience; secured fire protection contributes to lower greenhouse gas emissions and has several positive effects on forest overall beneficial functions.

### LUF-3 Implementation of afforestation works

Economic measure; implementation: 2021-2030

**Objective and description of the measure:** Afforestation in non-forest areas (in terms of IPCC methodology) is an activity that generates sinks. The Republic of Croatia is not able to dispose of all grassland areas (according to the national regulation: non-vegetated productive forest land) for afforestation due to the obligations it has taken regarding the preservation of particular habitat types of interest to the European Union. Considering that there are agricultural areas in the Republic of Croatia where agricultural production does not take place and which have been neglected for many years, the problem of these areas must be adequately addressed when creating the Land Management Strategy. It is necessary to evaluate the justification for converting these areas into forest areas regarding vegetation or through implementing afforestation. Guidelines for further development must be drawn based on the knowledge and experience gained from implementing afforestation activities. Suppose an afforestation measure is introduced on land that will not be used for agricultural production. In that case, it will require strengthening seed production and nursery services in the forestry sector and providing forest reproduction material necessary for implementing these works.

The initiative of planting one million trees per year (forest areas, urban planting, agroforestry, inundation area, urban planting, agroforestry, waterways) will realise a particular sink potential, but this will have noticeable effects in twenty to thirty years.

In addition, converting shrubs and gargoyles formed on neglected agricultural soil into higher cultivation forms, which would then be introduced into FLFEBA, could yield significant quantities of new sinks. Areas where such interventions are possible should be determined. If the land is agricultural, the conversion should be into forest land and included in the FLFEBA.

The last two activities can help increase the number of sinks, but they do not even remotely solve the problem of achieving the goal by 2030.

**Activities:** Implementation will follow the existing Forest Management Plan of the Republic of Croatia 2016-2025 and the new Forestry Economic Basis of the Republic of Croatia 2026-2035, which is in preparation.

**Funds needed for implementation**: The CAP finances these interventions: 73.05. Reconstruction (conversion) of degraded forests—EUR 11,764,706.25 (1176 ha), far less than the possible potential of almost thirty times greater. According to the operational annual plan for the forests of private forest owners for 2023, afforestation works are planned for unvegetated forest land on an area of 8.30 ha with a total value of EUR 36,968.85.

**Impact:** The impact will be determined when areas and locations are determined. The effect cannot be significant until 2030, as these seedlings will grow significantly after twenty years.

**Monitoring method:** FLFEBA, NIR, Control of implementing interventions by the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD)

**Executive body:** Hrvatske šume d.o.o.**,** Ministry of Agriculture, Forestry and Fisheries (MAFF)

**Monitoring bodies**: Ministry of Agriculture, Forestry and Fisheries (MAFF)

**Connection to other dimensions:** Research, innovation and competitiveness. The connection to renewable energy sources, depending on the type of forest stands, at their mature age when the patrol begins, parts (remains) will be used for firewood.

**Research and development:** It is necessary to determine the areas where afforestation will be carried out and provide the required nursery capacities in time.

### LUF-4 Manufacture and use of wood and wood products

Regulatory, economic, educational, and information measure; implementation: 2021-2030

**Objective and description of the measure:** Harmonize the available data and statistical reports and use new research to harmonise the information available for different reporting to international organisations to provide accurate, transparent, and high-quality reporting, as well as to create harmonised bases for the adoption of medium and long-term strategies in the forestry and wood processing sector. It implies the mapping of forestry and timber industrial production. Encourage using wood products in traditional and new products to increase outflows and reduce greenhouse gas emissions in the wood storage facility. This also requires the regulation of exports of untreated and semi-treated timber, which encourages the development of the domestic timber industry, and the regulation of energy timber exports increases the share of energy production from renewable sources, thus fulfilling international commitments. Outflow-generating activities must be promoted to ensure that wood products and wood are used for energy purposes in ways that contribute to meeting both EU targets by 2030 (reducing emissions and increasing the share of renewables in total energy consumption) and are beneficial to climate and environment. Guidelines for further development must be drawn based on the knowledge and experience gained from implementing this measure.

Carbon bound in wood products will be emitted into the atmosphere gradually over several decades (depending on the product type), while biomass for firewood represents the current emission. The substitution of other materials that have a large carbon footprint, such as metal, plastic, and concrete products with wood, reduces emissions. The Republic of Croatia has a significant sink in the wood products sector at the removal level of -700 $ktCO_2$-eq/year in recent years, which makes 12% of the removal through sinks. Increasing the proportion of wood products and reducing the proportion of wood mass used as fuel is necessary. The main

factors identified for the Republic of Croatia are listed here: human resources/'know-how', demand for wood products, availability of raw materials, technological investments in the wood processing and wood production sector, raising the technological level, increasing productivity and profitability to increase the category of products of a higher degree of finalisation and products of higher added value.

This measure is related to the Common Agricultural Policy (CAP) and the Strategic Plan as part of the intervention:

73.07. Modernisation of technologies in pre-industrial wood processing (EUR 26,888,032.50)

73.09. Promotion of forest products and services (EUR 1,176,470.00).

The CAP establishes that the marketing of forest wood and non-wood products needs to be increased, which will also create the conditions for new jobs in rural areas.

**Activities:** Activities related to wood production according to the existing Forest Management Plan of the Republic of Croatia 2016-2025 and the new Forest Management Plan of the Republic of Croatia 2026-2035 are in preparation. The use of wood according to the National Plan for the Development of Wood Processing and Furniture Production of the Republic of Croatia for the period from 2023 to 2030 and the Action Plan for the Implementation of the National Development Plan for Wood Processing and Furniture Production of the Republic of Croatia for the period from 2023 to 2024 („Official Gazette“, No. 122/23).

**Sources of funding:** European Agricultural Fund for Rural Development (EPFRR), EU funds for regional development, and revenues from the sale of emission units from the EU ETS

**Executive body:** Hrvatske šume d.o.o.**,** Ministry of Agriculture, Forestry and Fisheries (MAFF)

**Monitoring body:** Ministry of Environmental Protection and Green Transition, Ministry of Agriculture, Forestry and Fisheries (MAFF)

**Impact:** The amount of wood products depends, among other things, on the intensity of logging; the goal is to increase the proportion of wood volume embedded in wood products to reduce the use of biomass for energy needs. Implementing energy efficiency measures will reduce the need for heating biomass in households. The sink realised by wood products has historically varied from 250 to 850 $ktCO_2$-eq in the last ten years.

**Monitoring method: "**Hrvatske Šume" data on logging and sorting volume, statistics on wood products monitoring

**Connection to other dimensions:** Connection to renewable energy sources and security of energy supply. If there is a supply disruption, an increase in biomass consumption for energy needs can be expected.

**Climate change adaptation:** The climate change adaptation strategy recognises the impacts and risks of climate change on the forest ecosystem, which can negatively affect biomass and the available amount of wood.

**Research and development:** Mass flows in the cascading approach to using wood from production to final products must be determined to improve monitoring statistics. The CROWOODS project is an initial project to enhance monitoring and define directions of action and possible measures.

### LUF-5 Land under managed crops

Economic measure; implementation: 2021-2030

**Objective and description of the measure:** To implement activities in managing agricultural production areas in a way that contributes to reducing emissions. Land management practices that can affect emissions and sinks, for example, in soil storage, are soil treatment methods, plantation/crop life (rotation period), crop/plantation type, fertiliser application, residue management, erosion control, application of irrigation systems etc.). Manner of area management in a climate and environmentally beneficial manner should be promoted, and guidelines for further development should be drawn up based on the knowledge and experience gained from implementing this measure.

The method of managing agricultural categories of land that applies emission reduction measures, conserving and increasing the soil's carbon content, is called 'carbon agriculture'. Carbon farming is the premise of agricultural development on the road to a climate-neutral economy. The obstacle is that no carbon maps have been made in agricultural soil. The EU is introducing the certification of outflows, which is intended to provide additional funding for carbon farming.

The following describes the measures that can potentially be considered carbon agriculture and which are financed through the Strategic Plan:

31.03. Intensified maintenance of ecologically significant areas: The intervention modifies the green practice of environmentally important areas, which is carried out on all types of agricultural land use and farms, regardless of the size of their agricultural area. The total allocation is EUR 5,2000,000.

31.06 Conservation agriculture: Conservation agriculture aims to achieve a high and sustainable production level while preserving natural resources and achieving acceptable profit. It is based on three interdependent principles: a minimum set of soil treatment interventions, permanent coverage of the production area with plants or plant residues and proper crop rotation. The target in 2023-2029 is the application to 150,000 ha. The total allocations amount to EUR 37,500,000.

31.08. Use of organic fertilizers in permanent plantations: The goal of using organic fertilizers is to maintain the content and amount of nutrients in the soil and in the plant at optimal values, which encourages better vegetative and generative development of plants and better quality of fruits. The use of ecological fertilizers in fertilizing permanent plantations reduces the adverse effects of agriculture on the environment, primarily on soil and water, and contributes to the production of quality and healthier products. It is planned to be implemented in 2023-2027, on 7,600.00 ha. The total allocation is EUR 7,600,000.00.

70.01. Reduction of land use in perennial plantations: The intervention aims to reduce the pressure of intensive agriculture on the environment by reducing soil, water, and air pollution through the reduced and timely application of protective agents. The targeted application is 120,745 ha in 2023-2027. The total allocation is EUR 41,834,630.

70.04. Organic farming: The Republic of Croatia plans to reach the goal of 14% of the agricultural area in organic farming by 2030. To encourage new farmers to participate in the organic production system and to keep those already in the system, the financing of support

for organic farming continues. In the same way, continuous education of farmers and raising awareness of the benefits of production according to the principles of organic farming, which further contributes to achieving this goal, continue. It will be implemented in 2023-2027 to 841,359 ha, with a total allocation of EUR 237,784,815.

According to GAEC 3 standards, which prohibit the burning of harvest residues except to prevent the spread or suppression of organisms harmful to plants, the maintenance of organic matter in the soil is ensured, which ensures adaptation to climate change.

**Activities:** According to CAP.

**Sources of funding:** Private investments, CAP, EU funds for regional development, and revenues from the sale of emission units from the EU ETS. Part of the financing could be realised through the voluntary sink certification system on the market.

**Executive body**: Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Environmental Protection and Green Transition (MEPGT)

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition, Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD), Croatian Agency for Agriculture and Food (CAAF).

**Impact:** This measure's influence could be decisive for implementing the objectives of the LULUCF Regulation. Given the possible limitation in the increase in logging, this measure can maximise outflows, increasing the soil's carbon content.

**Monitoring method:** It is necessary to urgently establish a soil carbon content monitoring system, according to the IPCC methodology, for the category 'land with crops that remain land with crops' Today, the Tier 1 approach is used for this category; it is necessary to move to Tier 2 by 2028 and then to Tier 3 reporting level after 2030. Partly at the project level, changes in soil carbon stocks will be registered through the sink verification system; integrating these data into the national system needs to be elaborated, especially as they are likely to be voluntary verification schemes. It will also be monitored through a biofuel sustainability certificate register, which should be established. The final aggregated data will be in NIR. The CROLIS system will monitor the areas of land under crops and conversions.

**Connection to other dimensions:** This relates to the RES dimension about using biomass from agriculture. The RED II Directive has established the obligation to determine from plants greater than 20 MW of input power and biogas plants for those greater than 2 MW of input power.

### LUF-6 Managed grassland

Economic measure; implementation: 2021-2030

**Objective and description of the measure:** By implementing activities in pasture management in a way that contributes to reducing emissions. Manner of area management in a climate and environmentally beneficial manner should be promoted, and guidelines for further development should be drawn up based on the knowledge and experience gained from implementing this measure.

Under the Strategic Plan, the following measures contribute to the LUF-6 measure:

31.02. Extensive pasture management: The maintenance of pasture grazing will contribute to the survival of characteristic landscapes, preserving pasture vegetation, characteristic plant and animal species, and valuable habitats. Grazing animals on pastures for an extended time contributes to their welfare. It is planned to apply to 122,500 ha in 2023-2027, with a total allocation of EUR 48,420,000.

31.07. Preservation of high nature value grassland: The intervention includes obligations that are so far within the Rural Development Programme of the Republic of Croatia for the period 2014-2020, implemented by users of type operation 10.1.3. Preservation of high natural value grassland differs in that for the eco scheme, Preservation of high natural value grassland users undertake a one-year commitment. In total, 2023-2027 plans for 22,500 ha, with a total allocation of EUR 29,807,500.

70.02. Conservation of biodiversity and the environment on permanent grasslands and arable land: Intervention is carried out on grasslands of great natural value and where grasslands and flower strips are established. These grasslands play a significant role in soil and biomass carbon storage. Implementation is planned for 2023-2027 on 3,548 ha, and the total allocation amounts to EUR 2,933,321.25.

**Activities**: According to CAP and the Forestry Economic Basis of the Republic of Croatia 2016-2025 and the current regulations for preserving biodiversity.

**Sources of funding:** CAP, EU funds for regional development, EPEEF through funds raised from auctions, private investments

**Executive body:** Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Environmental Protection and Green Transition (MEPGT)

**Monitoring body:** Ministry of Environmental Protection and Green Transition, Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD), Croatian Agency for Agriculture and Food (CAAF).

**Impact:** Grasslands have a higher carbon content in the soil than land under crops, while the carbon stock in the biomass storage is higher in the crop category than in the grassland category; therefore, the conversion of grassland to another soil category should be specifically analysed, since the result (when all storage sites are considered) may be either emissions or outflows.

**Monitoring method:** The impact of the measure will be monitored under the CAP and NIR.

**Connection to other dimensions:** Connection to RES, relatively lower intensity

**Connection to adaptation to climate change:** The measure contributes to increasing resistance to climate change.

**Research and development**: The key issue in managing this accounting category of land is protecting nature and biodiversity. Any repurposing should be carefully analysed and justified. Potential areas suitable for conversion under afforestation and forestation measures must be identified.

### LUF-7 Implementation of technical projects and scientific research in the LULUCF sector

Research measure; implementation: 2021-2030

**Objective and description of the measure:** Until 2030, it is necessary to provide financial resources for implementing technical and scientific projects in the LULUCF sector. Given the cost-effectiveness of measures in the LULUCF and agriculture sectors, the multiple positive indirect effects, and the state of available data and uncertainty, research in LULUCF projects should be prioritised. Scientific projects should enable the development of different models to move to a higher level of IPCC methodology (Tiers 2 and 3) to determine the GHG emissions/sinks as accurately as possible and, consequently, plan measures to reduce emissions and increase sinks. In doing so, climate change projections, risk assessments, vulnerability to climate change, and their negative or positive impact on greenhouse gas emissions/sinks in the LULUCF sector should be considered.

**Activities**:

1. Mapping of land suitable for conversion from lower cultivation forms to more;
2. Complete the LIFE CROLIS project and ensure its full implementation and upgrade;
3. Launch the CROWOODS project to build a reporting system for timber products;
4. Scientific projects to analyse the impact of climate change on carbon storage and the LULUCF sector;
5. Completion of the CRONFI II project – inventory of forests of the Republic of Croatia, which will determine the carbon content in litter, humus and soil, as well as large and small wood waste;
6. Map primary and old-growth forests of the Republic of Croatia about the new goals of 10% strict protection from the EU Biodiversity Strategy. Mapping of forests by age groups as defined by the Forest Strategy;
7. Creating a register to monitor the impact of the million trees annually initiative;
8. Create a carbon map for forest and agricultural soils in the Republic of Croatia soil. Use international databases;
9. Develop a system for monitoring the contribution of CAP measures to the reduction of greenhouse gas emissions;
10. Improve the system for monitoring the use of wood products and connect it with the benefits of substituting other materials;
11. Technical improvement projects will raise the level of reporting to methodological level 3 according to the IPCC, and other things will be determined during the implementation of the LUF-8 measure.

**Sources of funding**: Revenues from the sale of emission units from the EU ETS, state budget, science foundation, and EU funds (HORIZON, LIFE).

**Executive body:**

Ministry of Environmental Protection and Green Transition (activities ad 2, 3, 6, 8, 10 and 11)

Ministry of Agriculture, Forestry and Fisheries (activities ad 1, 5, 7, 9 and 10)

Ministry of Science, Education and Youth (ad 4)

**Monitoring bodies**: Ministry of Environmental Protection and Green Transition, Ministry of Agriculture, Forestry and Fisheries (MAFF) and Ministry of Science, Education and Youth

**Impact**: Contributing to increasing the sinkhole in the LULUCF sector and strengthening resilience to climate change.

**Monitoring method**: To be determined by the competent ministries.

**Connection with other dimensions**: Research, innovation and competitiveness

**Connection to adaptation to climate change**: The measure contributes to increasing resilience to climate change.

In constructing the planning, management, and reporting system, it is essential to establish an information system with georeferenced and harmonised data on land use and cover, naturally sensitive areas, soil vulnerable to desiccation, and soil rich in carbon as soon as possible. A plan for transitioning to higher reporting levels from the LULUCF sector under the LULUCF Regulation is needed.

### LUF-8 Activities to build the WAM scenario

Research measure; implementation: 2025-2030

**Objective and description of the measure**: The aim is to create a WAM scenario that increases the sink by 2030.

All activities related to forests and the forestry sector are carried out according to valid forest management plans, and the main direction is determined by the main forest management plan - the Forest Management Plan of the Republic of Croatia. It is a strategic document for which a strategic environmental impact assessment is prepared, and it is only possible to derive, evaluate and plan the recommended activity schedule for achieving the national goal of LULUCF and the measures planned for them, as well as quantify them, only from the valid Forest Management Plan of the Republic of Croatia. The WEM scenario presented in the NECP reflects the existing Forest Management Plan, which means existing economic practices, existing logging plans and restrictions in forest management concerning other regulations as found in 2020. It also considers the effects of natural disasters in the past ten years.

The following Forest Management Plan prepared for 2026 - 2035 is relevant to defining the WAM scenario and achieving the goal by 2030. It will also contain employment projections for the next 40 years, i.e., until 2065, which is extremely important for estimating future emissions and $CO_2$ sinks. All other forest management works, which are also crucial for mitigating climate change, are planned for ten years, i.e., until 2035. The following Forest Management Plan for 2026 - 2035 should consider the obligations to achieve the goal of net reduction of -5 527 kt $CO_2$ eq that the Republic of Croatia has by 2030 according to Regulation (EU) 2023/839.

There is an ongoing discussion at the EU level about the goal of reducing emissions by 2040, which is being implemented based on the Communication "Securing our future - The climate goal of the EU for 2040 and the path to climate neutrality by 2050 while building a sustainable, just and prosperous society " in which a new transitional climate goal of a net reduction of emissions by 90% by 2040 is proposed. At the same time, a new goal of carbon removal from the atmosphere through natural systems and industrial carbon removal of 400 Mt CO2eq is proposed, which should be reached at the EU level. This will also be taken into account during the preparation of the 2026-2035 PESCO.

Hrvatske šume d.o.o. is preparing the Forest Management Plan for all forests in the Republic of Croatia in cooperation with the Ministry of Agriculture, Forestry and Fisheries and private forest owners. Given that it is a strategic document from the forestry sector, the Ministry of Agriculture, Forestry and Fisheries, together with the entire forestry sector, will organise a discussion during 2025 of all stakeholders related to forests and forest products (private forest owners, wood processors, nature protection, climate etc.). The aim of the discussion should be to harmonise the future goals of forest management and forest management works with the set goals related to the LULUCF Regulation as well as with other goals associated with the preservation of biodiversity as well as the needs for wood forest products by the processing industry and wood for energy production.

In the last quarter of 2025, preliminary results of the second National Inventory of Forest Resources of the Republic of Croatia are expected with data that, with their credibility and quality, can contribute to the definition and design of forestry activities/works for $CO_2$ sinks under the obligation of sustainable forest management, NECP, LULUCF and other legislative obligations.

With the new Forest Management Plan and II, dedicated professional studies and projects will contribute to the national inventory of the Republic of Croatia's forest resources and update the NECP. The most recent study is "Practices of managing forest areas that increase sinkholes and/or reduce emissions."

The Republic of Croatia has a large area of forests. However, there is still a specific potential for afforestation, especially for converting degraded stands into tall forests. Practices carried out in addition to nature protection regulations create challenges/limits for implementing these activities. Further research is needed to map the areas for conversion, a large part of which territorially refers to the Mediterranean belt and the karst region, as well as ecologically, pedologically, and climatically sensitive areas. Part of the surface of these degraded forests in the Mediterranean (e.g., scrub and garrigue areas) could be used to implement afforestation works, which require significant financial resources and include additional resources to strengthen fire protection. In the continental part of Croatia, about 33,000 ha of potential land for conversion works have been recognised (abandoned agricultural land overgrown with forest vegetation and included in the Forest Management Plan), and estimates show that the implementation of these works also requires significant funds that exceed existing financial sources. Also, part of the scrubland in the Mediterranean part would potentially be suitable for conversion into forests with a high-growth form. The financial analysis of the necessary works for the potential measure of the WAM scenario, afforestation on ten kha of non-vegetated production land and conversion of 33 kha of thickets on the continent resulted in an amount of EUR 580 million in ten years.

The direction is to reduce the share of firewood by channelling it into wood products, thereby supporting the wood industry, which is important for regional development.

As part of the existing LUF-1 measure from the NECP, a unique land information system is being established by unifying and harmonising GIS data from different institutions. For this purpose, the project LIFE19 GIC/HR/001270 was launched, establishing the foundations of such a system that should also serve for planning and monitoring in the LULUCF sector.

Based on what has been elaborated, the year 2025 can be considered important due to the acquisition of recent and high-quality data on the qualitative and quantitative state of national forest resources, based on which all forest works and activities will be precisely prescribed until 2035, including for the NECP, i.e. the dynamics of the increase in the sinkhole $CO_2$ under the internationally assumed obligations and financial possibilities of all stakeholders/obligors of the implementation of the national NECP.

In doing so, climate change projections and risk assessments and their negative or positive impact on the WAM scenario should be considered.

**Activities:** The table lists the necessary activities for creating a WAM scenario:

| | **Activity** | **Completion** |
|---|---|---|
| 1 | Creation and adoption of a Forest Management Plan (FMP) | 2025 |
| 2 | The process of strategic environmental impact assessment of FMP | 2025. |
| 3 | 2. national inventory of forest resources of the Republic of Croatia | 2025 |
| 4 | Establishment of the CROLIS system - land information system of the Republic of Croatia (on the scale of LUF-1) | 2026 |
| 5 | Use and maintenance of CROLIS (in LUF-1 scale) | 2030 |
| 6 | Necessary activities are needed to complete the monitoring, reporting, and verification system (MRV, according to EU 2023/839). Research required for defining policies and measures and for projections (in the LUF-7 scale) | 2027 |
| 7 | Review of policies and measures of the LULUCF sector (final WAM scenario) | 2026 |

The costs for executing the abovementioned activities are around EUR 15 million (without the Forest Management Plan, FMP), of which EUR 9 million has been secured (EUR 2.6 million from the LIFE program). The rest of EUR 6 million should be secured from funds from sales of emission units from the EU ETS and the state budget.

Activity ad 6 includes the following:

- Determining areas for conversion of degraded stands and tall forests;
- Revision of FRL values;
- Connecting CROLIS with GIS databases of ecologically sensitive areas, nature protection areas, water sensitive areas, areas of nature restoration and areas with high climate risk;
- Analyses and monitoring sinkholes by selected land categories (CAP measures, wood products, emission outflows in settlements).

**Sources of funding**: The costs for executing the activities mentioned above are EUR 15.55 million (without the FMP), of which EUR 8.4 million is provided (EUR 2.6 million from the LIFE program), and the remaining EUR 7.15 million should be provided from the income from the sale of emission units from the EU ETS and the state budget.

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition, for activities 4) and 5), Ministry of Agriculture, Forestry and Fisheries (MAFF)

**Monitoring method**: Deliveries of reports according to the Gantt chart.

**Connection to other dimensions**: The WAM scenario affects renewable energy sources (use of biomass) and the security of supply.

**Research:** The impact of climate change on the forestry sector and the connection of climate change adaptation and mitigation measures in the LULUCF sector Activities ad 6) are within measure LUF-7, here in measure LUF-8, they are listed as necessary for creating a WAM scenario.

The following are measures related to **reducing fugitive emissions**.

### FUG-1 Modernization and transformation of refineries

Economic measure; implementation: 2026-2027

**Objective and description of the measure:** Implement investments in the modernisation and improvement of production to maintain the competitiveness of refineries and reduce fugitive emissions from refineries.

The measure includes the implementation of biofuel and sustainable fuel production projects of non-biological origin.

The measure reduces the use of fossil fuels and contributes to increasing the share of RES in the transport sector. It is expected to replace about 415,000 GJ per year of energy in transport, which traditionally comes from fossil sources.

**Activities:** Production of liquid and gaseous biofuels and renewable liquid and gaseous fuels of non-biological origin (RFNBO) intended for use in transport.

**Funds needed for implementation:** EUR 133,000,000.00

**Monitoring bodies:** Ministry of Economy

**Impact:** The demand for energy at the site has not reduced but increased due to the installation of new plants. Reduction of $CO_2$ emissions: 50,000 t/year.

**Monitoring method:** The effects of this measure are monitored based on INA d.d. data before and after the application of the measures.

**Executive body:** INA d.d.

**Connection to other dimensions:** Investing in modernising and improving production achieves decarbonisation goals.

### FUG-2 Measures to increase energy efficiency by improving processes and process units

Economic measure; implementation: 2024- 2026

**Objective and description of the measure:** Increasing energy efficiency is achieved by implementing measures that reduce energy intensity through more rational use of energy and raw materials and by modifying production processes and equipment at pumping stations and refineries, which reduces fugitive emissions.

**Activities:** Projects to increase energy efficiency in the Rijeka Oil Refinery include significantly replacing existing equipment to improve energy performance.

**Funds needed for implementation:** EUR 46,000,000.00

**Sources of financing:** INA d.d.

**Monitoring bodies:** Ministry of Economy

**Impact:** Total reduction in energy consumption: 550,000 MWh/year, reduction in natural gas consumption: 653,000 MWh/year, increase in electricity consumption: 103,000 MWh/year, reduction in $CO_2$ emissions: 115,000 t/year.

**Monitoring method:** The effects of this measure are monitored based on INA d.d. data before and after the measures' application.

**Executive body:** INA d.d.

**Connection to other dimensions:** Investing in increasing energy efficiency achieves decarbonisation goals.

### ii. If relevant, regional cooperation in this area

At a regional workshop held in Ljubljana in July 2019, the proposed topics for regional cooperation within the framework of the dimension of decarbonisation/emission and greenhouse gas removal were

- joint development of parts of national climate change adaptation strategies (e.g. for the Adriatic region),
- joint management of waterways,
- joint development of a soil map (relevant for the cultivation of biomass for non-food purposes and for monitoring the carbon content of the soil),
- scientific cooperation in the study of hydrogen, the removal and storage of greenhouse gases
- exchange of experiences related to greenhouse gas emissions, removals and adaptation to climate change.

In addition, the LIFE-CROLIS project on using geo-information systems and modern satellite imaging technologies in land data harmonisation for LULUCF envisages workshops with a call to neighbouring countries, which foresees the dissemination of information and networking.

A good opportunity is to participate in Interreg programmes with neighbouring countries, where the climate and environmental space are shared, and joint projects can provide synergies.

According to Article 9.1 of the Paris Agreement, developed country Parties to the Agreement should provide financial resources to assist developing country Parties in mitigation and adaptation in addition to their existing obligations under the Convention. Reporting on implementation shall be submitted every two years. In the Environmental Protection and Energy Efficiency Fund activities framework, support schemes should be developed, and

provisions should be made for the proceeds of the sale of emission units from the EU ETS system and the future trading system in the transport and building sector.

iii. Without prejudice to the applicability of the rules on state aid, financial measures in this area at the national level, including Union support and use of Union funds, if applicable

Part of the costs of implementing the measures envisaged within the dimension of decarbonisation—greenhouse gas emissions and removals—will be financed from the state budget, sale of emission units from the EU ETS system, the Modernization Fund, and extra-budgetary funds. The use of EU funds, namely cohesion policy funds through technical assistance to national bodies' administration and direct support from future operational programmes, is expected. The bulk of support for agriculture and the LULUCF sector is currently delivered through SP CAP measures.

Financing of the envisaged measures is also expected through the programmes of the European Investment Bank, the European Bank for Reconstruction and Development and other financial institutions and the Modernization Fund. The development of innovative projects for funding from the Innovation Fund will be encouraged. The use of financial resources from the sale of a part of the national quota in sectors outside the ETS was not considered, as there is no information on how transfers between Member States will be carried out. So far, there is limited experience in this area and no information on the cost of these emission units.

In line with the amendments to the LULUCF Regulation, the EU will consider the possibility of financing the emission reductions achieved in the LULUCF sector from the sale of emission units from the EU ETS system, in addition to the SP CAP, and consider the future carbon storage certification system. In the forestry sector, changes will be needed, given existing plans that could have economic and sociological consequences. The LULUCF sector is linked to rural development, and these incentives have strong horizontal action.

### 3.1.2 Renewable energy

i. Policies and measures for achieving a national contribution to the binding target at the EU level by 2030 for renewable energy and trajectories referred to in Article 4, item (a), subitem 2 and, if applicable and available, elements from item 2.1.2, including sector-specific measures and technology-specific measures

#### OIE-1 Information, education, and capacity building for using RES

Information measure; implementation 2021-2030

**Objective and description of the measure:** Informing all relevant stakeholders will be conducted by organising targeted informational campaigns related to investments in systems using renewable energy sources, especially in systems for their own needs. Information, education, and capacity building for the use of RES will be implemented at the national level. The target sectors are the energy sector (NACE code D), primary sector (NACE code A),

manufacturing (NACE code C), construction industry (NACE code F) and the population of the Republic of Croatia (general population).

**Activities:** The following activities will be implemented within the measure:

- information campaigns (raising awareness of the benefits of RES technologies through education and promotion of good practices with an emphasis on small projects up to 500 kW);
- implementation of educational programmes on the use of RES in kindergartens and schools;
- promotion of accredited study programmes in the field of renewable energy sources (in addition to general energy/RES studies, the emphasis is also on specific fields such as geo-energy, geoengineering, bioeconomy, etc.);
- training programs that promote the design, implementation and use of RES systems in buildings (photovoltaic systems, solar thermal systems, heat pumps, furnaces and biomass boilers, biogas/biomethane, biopropane, biobutane);
- education and promotion of the use of geothermal energy for thermal purposes;
- setting up and organising an advisory service with experienced practitioners involved, especially for small projects (up to 500 kW);
- development of online tools, publications and other modern communication tools to make available all relevant information on administrative procedures, accredited equipment and certified installers;
- capacity building and enhancement for all market players (active customers, energy communities, renewable energy communities, energy suppliers, aggregators, system operators, installers);
- promotion of new financial mechanisms that increase RES capacities
- promotion of corporate power purchase agreements for larger price-related projects;
- consulting with the financial sector, promoting good practice and education for larger projects.

**Funds needed for implementation:** around EUR 1 million per year

**Funding sources:** Income from the sale of emission units from the EU ETS system and EU funds.

**Executive body:** Ministry of Environmental Protection and Green Transition – implementation and sponsorship of education and promotion programs, organisation of an advisory service, design of new business models for the implementation of biogas plants and biomass cogeneration; EPEEF– provision of part of the funds, participation in promotion and education activities and promotion of new financial mechanisms that increase RES capacities, intended for groups of citizens at risk of energy poverty; MPPCSA – promotion of the use of RES systems in buildings; CHA: promotion of the use of geothermal energy; Croatian Chamber of Commerce – promotion of the use of RES systems to entrepreneurs; HEP DSO – promotion of small RES capacities built so far, with an emphasis on the positive impact on the network

(reduction of peak loads, etc.); Ministry of Agriculture in cooperation with LGUs - promotion and supply of biomass for the needs of the bioeconomy, decarbonisation of livestock, development of the bioeconomy; Suppliers - promotion of corporate contracts; LGUs - with programmes to promote RES in kindergartens and schools

**Monitoring bodies:** Ministry of Economy

**Impact:** Increase in energy production and the share of RES in total energy consumption and reduction of greenhouse gas emissions from the energy sector and the above target sectors. Increasing the number of citizens interested in using RES.

**Monitoring method:** Number of events, number of users

**Connection to other dimensions:** The measure is related to increasing energy security and developing the internal energy market. The measure can also be linked to the energy efficiency dimension by promoting the use of RES in buildings with energy efficiency measures.

**Research and development**: Information, education and capacity building for RES use is not directly related to research and development.

### OIE-2 Spatial planning requirements for using RES

Regulatory measure; implementation: 2021- 2026

**Objective and description of the measure:** Analysis of the existing state of spatial capacities, defining guidelines and criteria for specific spatial planning elements for RES planning at the state, county and local level, further to the carried out activities of the professional background "Analysis of spatial capacities and conditions for the use of the potential of renewable energy sources in the Republic of Croatia" created for the needs of the State Spatial Development Plan[30].

**Activities:** The following activities will be implemented within the measure:

- analysis of spatial plans with a review of planned locations, mapping of resource potential for individual renewable sources (wind, solar, hydropower, geothermal water for energy purposes, SMR) concerning existing and advanced energy conversion technologies and adaptations to climate change based on ecosystem characteristics within specific space for utilisation of RES (planned and potential space), possibilities of energy storage from RES and integration into the existing transmission and distribution system;

[30] https://mpgi.gov.hr/o-ministarstvu-15/djelokrug/zavod-za-prostorni-razvoj-4276/publikacije-i-strucne-podloge/4383

- supplementing the Spatial Planning Strategy and the Act on Spatial Planning by defining the framework for placing offshore wind farms in spatial plans, and supplementing the Spatial Plan of the exclusive economic zone of the Republic of Croatia in the Adriatic Sea and the spatial plans of coastal counties with provisions and locations for research and placement of offshore wind farms;
- identification and mapping of spatial, environmental (bio-ecological, landscape, geological) and social (use of space) and infrastructural constraints, and the sensitivity of space for plant construction and operation, given the characteristics of existing and advanced RES utilisation technologies and battery system placement;
- development of sensitivity maps for RES accommodation and systems for energy storage, with a focus on wind and solar power plants, for the entire Republic of Croatia, i.e. defining the so-called *Go-to* areas according to the Communication from the European Commission "REPowerEU*: Joint European Action for more affordable, secure and sustainable energy*";
- defining guidelines and criteria for the selection of spaces suitable for RES exploitation, spatial-planning conditions and protection measures in procedures under special laws;
- adopting guidelines and criteria for the regulation of specific spatial planning elements in the state-level RES utilisation space and their implementation into state-level spatial planning documents at the national, regional and local levels, with the application of protection measures in procedures under special laws;
- professional education and encouragement of cross-sectoral cooperation of experts in the field of spatial planning, nature and environment protection, energy and other experts relevant to the spatial planning and development of RES projects;
- upgrading existing information systems with the data necessary to identify the potential constraints and space sensitivity to the construction of RES facilities (generating plants using RES with associated infrastructure).

**Funds needed for implementation:** Initial funds EUR 300,000, funds earmarked for implementation of the strategy and action plan for the application of protection measures in procedures under special laws, state budget.

**Funding Sources:** EU funds, World Bank (for mapping and analysis); budget of the state, counties, cities and municipalities (for the application of protection measures in procedures under special laws and the new generation of spatial plans).

**Executive body:** Ministry of Physical Planning, Construction and State Assets (MPPCSA) in cooperation with the Ministry of Economy (ME), in collaboration with the Ministry of Environmental Protection and Green Transition, Ministry of Culture and Media; Ministry of Tourism and Sports and Ministry of counties, cities and municipalities.

**Monitoring bodies:** Ministry of Physical Planning, Construction and State Assets and Ministry of Economy

**Impact:** Increasing the number of sites and areas for RES in new generation spatial plans (PP), with sustainable use of space and natural resources (acceptable environmental and nature impacts) and reducing greenhouse gas emissions, accelerating the duration of RES project development.

**Monitoring method:** Number of counties that have defined the conditions for the location and construction of RES plants, based on prescribed guidelines, with due regard for the sensitivity of the area in their area, with the application of protection measures in procedures under special laws; duration of administrative procedures in the framework of development of RES projects; number of locations and areas for RES (production facilities using RES with associated infrastructure).

**Connection to other dimensions:** The measure is related to increasing energy security (conditions for increasing energy production) and developing the internal energy market. Some research needs to be carried out within this measure, so the measure is related to the research and development dimension.

**Research and development**: Link through exploration of resource potential and mapping spatial, environmental, and infrastructural constraints and space sensitivity for plant construction and operation.

### OIE-3 Developing a regulatory framework for using RES

Regulatory measure; implementation: 2023- 2026

**Objective and description of the measure**: The existing legal framework must be reworked (completed and refined) to improve procedures and practice. The goal is to establish a rounded and functional regulatory framework and established procedures for planning and implementing RES projects at the state and local levels.

The regulatory framework for using renewable energy sources comprises more laws and by-laws whose provisions complement each other and intertwine. These are essentially the Energy Act („Official Gazette“, Nos. 120/12, 14/14, 95/2015, 102/15 and 68/18), the Electricity Market Act („Official Gazette“, Nos. 121/21, 83/23), the Thermal Energy Market Act („Official Gazette“ Nos. 80/13, 14/14, 102/14, 95/15, 76/18, 86/19) and the Renewable Energy Sources and High-Efficiency Cogeneration Act („Official Gazette“, No. 138/21, 83/23) as a separate law for the field of renewable sources, with accompanying by-laws. Exploration and exploitation of geothermal energy are regulated by the Hydrocarbon Exploration and Exploitation Act („Official Gazette“, Nos. 52/18, 52/19 and 30/21). The Biofuels for Transport Act („Official Gazette“, Nos. 145/10, 26/11, 144/12, 14/14, 94/18 and 52/21) regulates using renewable energy sources in transport. In addition to energy laws, regulations and documents relevant to spatial planning and construction (Spatial Planning Act („Official Gazette“, Nos. 153/13, 65/17, 114/18, 39/19, 98/19 and 67/23), the Construction Act („Official Gazette“, Nos. 153/13, 20/17, 39/19 and 125/19) as well as spatial plans at the state and lower level) and regulations in the field of environmental protection (Environmental Protection Act („Official Gazette“, Nos. 80/13, 153/13, 78/15, 12/18 and 118/18) and the Nature Protection Act („Official

Gazette“, Nos. 80/13, 15/18, 14/19 and 127/19) with regulations on the needs and assessment of the impact of projects on the environment are of crucial influence on the administrative procedures necessary for obtaining the required permits).

The Energy Act, as the basic act governing the energy sector, defines the essential strategic documents of the energy sector and declares the use of renewable energy sources of interest to the Republic of Croatia. Under the Energy Act, the Ordinance on permits for performing energy activities and keeping a register of issued and revoked permits for performing energy activities („Official Gazette“, No. 44/22) was adopted, which recognises new activities in the energy sector (aggregation, energy storage and organisation of the energy community of citizens). Based on the Act, a system of guarantees of energy origin was established, elaborated in more detail by the new Regulation on the system of guarantees of energy origin („Official Gazette“, No. 28/23), which, among other things, extends the forms of energy for which CEMO issues guarantees of energy origin.

The Electricity Market Act has transposed into Croatian legislation Directive (EU) 2019/944 of the European Parliament and of the Council of June 5th, 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast) (Text with EEA relevance.) (OJ L 158, June 14th, 2019) and thus the newspapers and institutes which that Directive brings into the framework for the electricity market. Under the Act, methodologies have been adopted for determining the amount of tariff items for electricity transmission and distribution and guaranteed supply, Ordinance on general conditions for the use of the network and electricity supply („Official Gazette“, No. 100/22), Methodology for determining the fee for connection to the electricity network („Official Gazette“, No. 84/22), Ordinance on the change of suppliers and aggregators („Official Gazette“, No.84/22) and Ordinance on the quality of electricity supply („Official Gazette“, No. 84/22), Ordinance on connection to the distribution network (HEP-DSO, 7/2023), Ordinance on connection to the transmission network (CTSO, 7/2023). However, the decision on the amount of the unit fee for connection to the electric power network has not yet been adopted (CERA).

The Renewable Energy and High-Efficiency Cogeneration Act entered into force in December 2021 and takes over the provisions of the amended Directive (EU) 2018/01 on the promotion of the use of energy from renewable sources and ensures the implementation of Directive (EU) 2018/1999 on the and Regulation on the Governance of the Energy Union and /09Regulation 1099/08 of the European Parliament and of the Council of October 22nd, 2008 on energy statistics (Text with EEA relevance) (OJ L 304, Nov 14th, 2008). The law regulates the development of the NECP, measures to encourage renewable energy sources and high-efficiency cogeneration, the system of incentives, the takeover of electricity from end customers with their own production or users of self-supply plants, the inclusion of renewable energy for heating and cooling and centralised heating and cooling, and other issues important for the functioning of all segments of the RES sector. Under the Act, the Energy Efficiency Programme for the Decarbonisation of the Energy Sector was adopted [17] („Official Gazette“, No. 143/21), the Regulation on the Share in Net Supplied Electricity of Privileged Producers, which electricity suppliers are obliged to take over from the electricity market operator for 2023 („Official Gazette“, No. 156/22), the Regulation on the Use of Renewable Energy Sources and High-Efficiency Cogeneration („Official Gazette“, No. 28/23), the Decision on the Fee for

Renewable Energy Sources and High-Efficiency Cogeneration („Official Gazette“, No. 31/23) and the Regulation on the Criteria for Payment of Reduced Fee for Renewable Energy Sources and High-Efficiency Cogeneration („Official Gazette“, No. 31/23). It is precisely the Regulation on the use of renewable energy sources and high-efficiency cogeneration that establishes the methodology for determining the share of energy from RES in gross final energy consumption, sustainability and greenhouse gas emission saving criteria for biofuels, bioliquids and biomass fuels and their verification. Together with the Regulation on the system of guarantee of energy origin, it presents the acts necessary for the complete transposition of the Directive 2018/01 on promoting the use of energy from renewable sources into Croatian legislation. Regarding floating solar power plants and their installation on water surfaces that are public property by amending the law in the field of water management (Water Act („Official Gazette“, Nos. 66/19 and 84/21) and the Ordinance on the issuance of water rights acts („Official Gazette“, No. 9/20)), it is possible to obtain a water rights permit for the use of water surfaces for the installation of floating facilities.

Accordingly, the Ministry of Energy (energy, environmental, and nature protection), Ministry of Physical Planning, Construction and State Assets (MPPCSA) (spatial planning, construction), CHA (geothermal energy), CERA, CEMO, CTSO, and DSO, as well as other competent public bodies for individual administrative areas (agricultural land, forests, water management), are responsible for creating and improving the regulatory framework for the RES sector.

Further refinements of the RES framework, the next revision of the EU climate and energy legislation and the proposed reform of the EU electricity market model are also to be expected, which, among other things, aims to increase the use of RES.

**Activities:** The following activities will be implemented within the measure:

**All participants:** i) continuous removal of obstacles and relief of administrative procedures that limit the greater use of energy from RES, ii) elimination of cross-sectoral non-compliance of regulations that prevent the implementation of RES projects.

**Ministry of Economy and Ministry of Environmental Protection and Green Transition:** i) prepare for the Government of the Republic of Croatia a proposal for a regulation on the conditions of tenders for energy approval ii) ensure the adoption of the missing by-laws and proactively cooperate with the competent entities in the process of their preparation and harmonisation iii) strengthen the capacity to guide investors during the entire licensing procedure, iv) prepare an analysis of the drivers, obstacles and alternatives and the possibilities of support for the conclusion and implementation of corporate contracts for the purchase of renewable energy, to determine their potential in achieving national goals and create a favourable and stable regulatory environment, v) monitor the adoption of EU legislative acts and harmonise regulations within their competence under the adopted directives and regulations, vi) simplification of procedures for the development of RES projects, vii) define a complete regulatory framework for the construction and operation of energy storage.

**CERA:** Determine the unit amount of the fee for connection to the electricity network

**Ministry of Environmental Protection and Green Transition:** i) consider the need to raise the limit to carry out the environmental and nature impact assessment procedure, ii) legally define cases in which it is not necessary to carry out new procedures related to environmental impact assessment when applying newer technology.

**ME and MPPCSA I:** i) ensure compliance with energy regulations for spatial planning and construction, and ii) ensure uniform application by competent authorities through education, information, supervision, etc.

**MSTI:** Amend the Act on Concessions on Maritime Property to recognize the use of the marine area for the production of energy from renewable energy sources in order to enable the development of renewable sources at sea, primarily offshore wind farms and heat pumps.

**MPPCSA:** i) Regulation on simple buildings regulate the status of solar power plants used for self-supply to exempt them from the obligation to obtain an energy permit ii) regulate the status of agrosolar power plants and geothermal wells for agricultural purposes in the Spatial Planning Act iii) ensure the continuation of the functioning of the system of certified installers for small RES systems iv) ensure the implementation of the obligation to use the RES system on new buildings (regulations related to construction)

**CEMO, ME, MPPCSA, CERA, CTSO, DSO:** Develop and publish a manual - a guide that provides complete information on the procedures for obtaining permits for the construction of a renewable energy production plant, considering in particular small projects and projects of consumers of their own energy from renewable sources (obligation under the Renewable Energy Sources and High-Efficiency Cogeneration Act)

**MPPCSA:** Regulates and introduces obligations for the use of RES in new buildings (construction-related regulations)

**MPPCSA:** Ensure the continuation of the functioning of the system of certified installers for small RES systems

**Funding sources**: Budgetary funds

**Executive body**: ME and Ministry of Environmental Protection and Green Transition – general regulation of the legislative framework (adoption of missing regulations, refinement of existing regulations, monitoring of the revision of EU legislation and harmonisation); MPPCSA – the refinement of regulations for spatial planning and construction concerning RES projects, the continuation of the functioning of the system of certified installers; CERA – methodology and connection fee, energy activity permit; CEMO – rules for organising the energy market, drafting a comprehensive manual in cooperation with other stakeholders; CTSO and DSO - planning the development of the transmission and distribution system; MAFF – construction of PV systems on agricultural land; CHA - continuation of the implementation of geothermal projects.

**Monitoring bodies:** ME

**Impact:** Implementing the measure will result in a functional RES market, increased energy production, and a share of RES in total energy consumption.

**Monitoring method:** Energy balance, plan, and implementation of legislative acts

**Connection to other dimensions:** The measure is related to the dimension of increasing energy security and developing the internal energy market (legislative sector development).

### OIE-4 Use of RES for electricity production

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** Provide financial incentives for developing RES projects for electricity and heat production. The use of RES for electricity production will be encouraged at the national level.

**Activities:** The following activities will be implemented within the measure:

- CEMO continues to pay incentives for the production of electricity to power plants using RES for the duration of the purchase contract (incentive system, premium system);
- CEMO prepares three-year RES plans and announces tenders for assigning market premiums;
- The promotion of electricity production through the premium system under the system modifications made possible by changing the market status of individual RES technologies and by developing a day-ahead and intraday electricity market exclusively to mitigate the market risks of new RES projects; the premium system is implemented to a minimum extent, including the implementation of a hybrid model of stimulating premiums/market, as a transition measure to full market integration of RES;
- Through EPEEF, the use of renewable energy sources for the production of electricity and energy storage systems for self-supply and customers with their own production continues to be encouraged through the allocation of grants;
- Revision of quotas for all types of renewable energy sources;
- Developing a new model of incentives for biomass fuel plants while ensuring maximum fulfilment of sustainability objectives and greenhouse gas saving criteria;
- Development of a model of the use of existing connections for new RES within the scope of the built power plants;
- The activities of reviewing and analysing potential geothermal potentials and initiating the launch of bidding procedures to select the most suitable bidder for the exploration of geothermal waters for energy purposes will continue to increase the share of RES in electricity production;
- Continued application of the surplus energy-absorbing model from self-supply plants and self-producing end-customers with possible investment support and the supplier's obligation to absorb surplus energy;

- The EPEEF allocates part of the revenues from the sale of emission units through EU ETS for measures to stimulate RES on the investment side and to relieve end customers from increasing the RES incentive fee following the Act on Climate Change and Protection of the Ozone Layer;
- Certification of origin of renewable energy sources, green hydrogen, biomethane and other biofuel;
- The Ministry of Agriculture, Forestry and Fisheries, through the Agriculture Strategy, provides financing for investment aid for biomass and other RES projects;
- Development of models for encouraging the participation of citizen energy communities and renewable energy communities as applicants for tenders in which renewable energy technologies are co-financed.

**Funds needed for implementation:** around EUR 1 billion for the entire period under review

Levelled costs of electricity production from solar and wind power have reached market price levels, especially after a significant increase in electricity prices in the previous period and are market competitive. The reaction to the rise in electricity prices is also evident in the incentive system itself, where a part of the incentive system projects terminated long-term contracts and turned to the market. Considering all the above, it is not necessary to plan significant financial incentives for larger solar and wind power projects but to enable them to appear on the market (measure). However, it is expected to continue encouraging biomass, biogas, hydropower, and geothermal energy by stimulating electricity production and other sectoral measures. Furthermore, it is necessary to promote the exploitation of geothermal energy through the reduction of investigative risk, which can be realised with EU funds and through other financial mechanisms as well as through geological risk reduction programs by conducting preliminary exploratory activities by the CHA, to equalise the price of energy obtained from geothermal water with other RES.

**Funding Sources:** RES fee (CEMO); proceeds from the sale of renewable energy in the market; proceeds from trade in guarantees of origin; the revenues from the sale of emission allowances (the EPEEF) for RES investment grants and as additional revenue to the EPEEF for the operational promotion of RES managed by CEMO; EU funds; special funds (European Agricultural Fund for Rural Development, etc.) to support biomass projects.

**Executive body:** CEMO - payment of incentives, the establishment of a premium model with a protective price and a shortened duration of premium agreements, invitation to tender; ME - making plans; EPEEF - participation in RES investment grants and as support of operational incentive systems; MAFF - implements the Rural Development Programme and participates in RES investment grants; CHA (Hydrocarbon Agency) - defining exploratory actions, determining rules and conditions when exploring and exploiting geothermal waters for energy purposes, as well as providing expert support in conducting public tenders.

**Monitoring bodies:** ME

**Impact:** The measure will ensure an increase in energy production and a share of RES in total energy consumption and, consequently, a reduction in greenhouse gas emissions. It also

creates a precondition for establishing a monitoring system to meet the sustainability criteria and the expected reductions in biomass gas emissions from biomass plants.

**Monitoring method:** Energy balance, according to the amount of electricity produced from RES, according to reports by CEMO and system operators.

**Connection to other dimensions:** The measure is related to the dimension of increasing energy security since the expected result is an increase in energy production from locally available sources and the development of the internal energy market.

**Relationship to climate change adaptation:** The use of RES is planned with the integration of climate change adaptation measures and strengthening of resilience, i.e., reducing the vulnerability of RES technologies to climate change. When planning and implementing projects, assessments of risk and vulnerability to climate change must be considered, and appropriate measures to strengthen resilience to climate change must be incorporated.

**Research and development**: The measure concerns the research and development of RES technologies and their integration into energy systems.

### OIE-5 Use of RES for thermal purposes

Financial measure; implementation 2023 -- 2026

**Objective and description of the measure:** Providing financial incentives for developing RES projects for thermal needs.

**Activities:** The following activities will be implemented within the measure:

- EPEEF participates with financial incentives on the investment side for projects using RES for thermal needs;
- CHA will continue with the activities of review and analysis of geothermal potential in the Pannonian part of Croatia, initiate the initiation of tender procedures to select the most favourable bidder for the exploration of geothermal waters for energy purposes and ensure their inclusion in spatial plans (related to the RES measure – 2);
- CHA and EPEEF will support the development of geothermal energy use projects;
- ME will consider defining an administrative-incentive framework for the use of heat pumps, including reducing the duration of the procedure for obtaining the necessary permits, and in cooperation with HERA, consider establishing dynamic tariffs for electricity for heating purposes;
- Through the Agriculture Strategy, the Ministry of Agriculture, Forestry and Fisheries provides financing of investment aid for biomass and other RES projects.

**Funds needed for implementation:** EUR 1 billion for the entire observed period

We expect continued encouragement to use biomass, biogas, geothermal energy, and heat pumps. Exploiting geothermal energy will be encouraged through the co-financing of geothermal potential research.

**Sources of funding:** revenues from sales of emission units from EU ETS for RES investment grants; funds from EU funds, the EEA Financial Mechanism, and the Norwegian Financial Mechanism

**Executive body:** ME; EPEEF – participation in RES investment grants; MAFF – implements the Agriculture Strategy and participates in RES investment grants; CHA – defining investigative actions, determining the rules and conditions for the exploration and exploitation of geothermal waters for energy purposes, as well as providing expert support during public tenders; conducting exploratory activities to reduce the geological risk of exploration and exploitation of geothermal waters; MRDEF – implements financing programmes from European and other funds; CERA - enables dynamic tariffs for electricity.

**Monitoring body:** ME

**Impact:** The measure will ensure an increase in the share of RES in the production of thermal energy and, consequently, a reduction in greenhouse gas emissions. It also creates a precondition for establishing a monitoring system to meet the sustainability criteria and the expected reductions in biomass gas emissions from biomass plants.

**Monitoring method:** Number of co-financed RES projects for thermal needs; amount of heating and cooling energy resulting from these projects; number of geothermal water reservoirs investigated

**Connection to other dimensions:** The measure is related to the dimension of increasing energy security since the expected result of the measure is an increase in energy production from locally available sources and energy efficiency in the building sector.

**Research and development**: The measure concerns the research and development of RES technologies and their integration into energy systems.

### OIE-6 Use of RES in centralised and closed district heating systems

Financial measure, regulatory measure; implementation 2025-2030

**Objective and description of the measure**: Enable an increase in the share of RES in DHS by using available sources such as shallow and deep geothermal, solar energy, and water energy and allow the achievement of the status of efficient centralised heating and cooling for all heating systems in the Republic of Croatia. The key technologies are heat pumps in combination with heat tanks. In addition to promoting the use of low-temperature renewable energy sources, they enable the integration of the electricity and heating sectors and the balancing services of the electricity network.

**Activities:** The following activities will be implemented within the measure:

- Amendments to the Heat Market Act that would identify key technologies for the decarbonisation of thermal energy heating and storage systems and identify steps for their planning, construction, connection and use;
- Development of the legal basis for achieving the target share of renewable energy and waste heat in centralized heating systems;

- Amendment to the Decree on Environmental Impact Assessment - daily and seasonal thermal energy tanks are not directly recognised as a type of intervention according to the current Decree on Environmental Impact Assessment;
- The upgrading of the Construction Act and the Physical Planning Act – in the current Construction Act and the Physical Planning Act, the types of buildings are recognised. Still, integrated building systems such as constructing a geothermal well, a seasonal tank, and a heat pump are vaguely defined as one integrated system. Currently, the Physical Planning Act recognises the concept of stage construction and phase construction in a complex building, with one location permit for which one or more building permits are issued. It is necessary to define how to approach the stages of construction in such a case around the impact on the environment, obtaining spatial planning documentation and obtaining the necessary permits;
- Defining the conditions for the construction of seasonal heat tanks—For thermal energy storage, no geological or pedological conditions (e.g., depths for excavation, soil composition, etc.) have been defined that need to be met during the construction of seasonal heat tanks;
- Determine urban zones of potential heating – analysis of spatial plans, mapping of heat consumption and determining zones where users can potentially connect to the district heating network;
- Co-financing the development of plans for increasing RES in centralised or closed district heating systems;
- Co-financing investments in technologies for RES, identified in the plan to increase the RES share in centralised and closed DHS;
- Co-financing of investments in heat storage technologies (daily, weekly and seasonal heat tanks).

**Funds needed for implementation:** EUR 750 million for the entire observed period

**Sources of financing:** Environmental Protection and Energy Efficiency from the income from the sale of emission units from the EU ETS, the Modernization Fund and other available sources in accordance with the Act on Climate Change and Protection of the Ozone Layer, EU funds

**Executive body:** EPEEF, ME, MPPCSA

**Monitoring bodies:** ME

**Impact:** Increasing the share of renewable energy sources, reducing $CO_2$ emissions and increasing energy efficiency in heating systems.

**Monitoring method**: Energy from renewable energy sources is produced in heating systems, and energy is delivered to the district heating network. Electrical energy is measured to drive the heat pump compressor to gain insight into the energy taken from the environment.

**Connection to other dimensions:** The measure is related to all dimensions.

**Research and development**: The measure is related to the research and development of RES technologies and integrating RES into energy systems. The most significant emphasis should be on research into waste heat use in heating systems. It is necessary to map waste heat sources in cities with existing centralised heat systems and make preliminary technical

feasibility studies. Centralised heat systems can also be used for cooling via absorption heat pumps. For this purpose, a preliminary feasibility study in a city with an existing heating system is necessary.

### OIE-7 Sharing Energy and Energy Communities

Regulatory and financial measure; implementation 2025 -2030

**Objective of the measure:** To encourage energy sharing and the establishment of energy communities; increase the share of RES in direct consumption; improve data access and sharing.

**Description of the measure:** Supplementing the existing rules of access to the power grid, developing procedures and practices for exchanging information between system operators and users, and improving the possibilities of calculating energy exchange for energy communities (energy communities of citizens and renewable energy) are necessary. Support will be provided for the establishment of energy communities.

Several laws cover the current regulatory framework for the use of renewable energy sources, and the key laws in this regard are the Act on Renewable Energy Sources and High-Efficiency Cogeneration and the Act on the Electricity Market, with several by-laws. It is necessary to supplement and improve the laws mentioned above and corresponding by-laws to encourage the wider use of renewable energy sources in direct consumption to meet the set climate goals and harmonise the national regulatory framework with EU directives. It is needed to supplement by-laws and develop good practices to enable energy sharing, improve tariffs for more efficient distribution network use, and improve the rules and the possibility of accessing measurement or calculation data to improve the efficiency of performing energy activities, providing services and energy sharing.

The establishment and work of energy communities will be encouraged by building the capacity of stakeholders (instructions for the establishment and work of energy communities will be prepared - related to measure OIE-1), the preparation of technical documentation and investment costs for projects owned by energy communities will be co-financed (related to measures OIE-4 and OIE-5) and, under the framework for granting state aid, it will be possible to provide operational support for projects owned by energy communities.

**Activities:**

- Establish a regulatory framework that will encourage the establishment and operation of energy communities;
- Improve network access rules for all participants, enable access and simpler exchange of information on measurement and billing data;
- To ensure the general simplification, organisation, and running of administrative procedures, as well as the removal of barriers to implementing the necessary activities.

**Sources of funding:** Budgetary funds, EPEEF, CEMO, Cohesion Fund, Modernization Fund, Recovery and Resilience Plan, EEA Financial Mechanism, Norwegian Financial Mechanism, and other funding sources

**Executive body:**

- **ME** - general arrangement and improvement of the legislative framework;
- **CERA** – improvement of the regulatory framework; assessing existing obstacles and potential for the development of renewable energy communities;
- **HEP DSO** – improvement of by-laws and practices for the functioning of energy communities and energy sharing,
- **EPEEF** - preparation and implementation of supporting financial mechanisms for energy communities,
- **CEMO** - preparation and implementation of the allocation of operating grants for energy community projects.

**Monitoring bodies:** ME, CERA

**Impact:** The measure's application results in a functional sharing of electricity and increased energy production from RES.

**Monitoring method:** Energy balance, plan and implementation of legislative acts, assessment of existing obstacles and potential for developing renewable energy communities

**Measure implementation indicator:**

- Number of valid permits issued to energy communities;
- Number of active energy-sharing schemes;
- Number of OMMs included in electricity sharing schemes;
- Number of OMMs included in electricity sharing schemes where there is electricity production;
- Total connection power in the direction of taking electricity from the network on all OMMs included in sharing schemes;
- Total connection power in the direction of electricity delivery to the network on all OMMs included in the sharing schemes.

**Connection to other dimensions:** The measure is connected to increasing energy security and developing the internal energy market (legislative regulation of the sector).

### OIE-8 Use of hydrogen and new technologies

Organisational, technical and financial measure; implementation in 2025 -2030.

**Objective and description of the measure**: Croatia will improve its use of hydrogen and new technologies to reduce greenhouse gas emissions in the transport sector and industry.

**Activities:**

- Production of hydrogen from renewable sources by building an electrolyser capacity of at least 10 MW
- Introduction of infrastructure for renewable energy in the transport sector by building six hydrogen filling stations (related to measure TR-7)

**Funds required for implementation**: EUR 42.6 million

**Sources of funding:** NPRR

**Executive body:** ME

**Monitoring bodies:** ME, CHA

**Impact**: Use of renewable energy sources for hydrogen production; increased use of renewable energy sources

**Monitoring method:**

- Amount of hydrogen produced from renewable energy sources
- Number of hydrogen filling stations

**Connection to other dimensions**: Energy security

**Connection to adaptation to climate change**: When planning and implementing projects, assessments of risks and vulnerabilities to climate change must be considered, and appropriate measures to strengthen resilience to climate change must be incorporated.

**Research and development**: Yes. It is related to ES-11.

ii. If relevant, specific measures for regional cooperation and, optionally, an estimated renewable energy production surplus could be transferred to other Member States to achieve the national contribution and trajectories from item 2.1.2.

At a regional workshop held in Ljubljana in July 2019, the proposed topics for regional cooperation within the decarbonisation/renewable energy sources dimension were

- joint development of RES projects, analysis of statistical transfer opportunities,
- collaboration in the context of the "Clean Energy Initiative for EU Islands",
- exchange of experiences related to energy communities and energy production from RES for own needs,
- exchange of experiences related to energy-positive neighbourhoods and joint development of project proposals for the Joint Program Initiative Urban Europe,
- exchange of experiences related to the integration of RES into space and social acceptance of RES.

Countries participating in informal regional coordination are considering the proposals made and will agree on the next steps.

iii. Specific measures for financial support, if applicable, including EU support and use of EU funds, to promote the production and use of renewable energy in electricity generation, heating, cooling and transport

The required amount of RES support for electricity is estimated in the next section.

iv. If applicable, an assessment of the support for electricity from renewable sources to be implemented by Member States under Article 6 (4) of Directive (EU) 2018/2001

It is estimated that support of EUR 0.8 to 1.1 billion is needed over the period under review.

The amount of aid mentioned above was calculated based on the investment subsidy required to level the cost of electricity at 55 EUR/MWh. It calculates the subsidy needed for all the

technologies envisaged per MW of installed capacity. That amount was multiplied by the projected power installed in power plants and technology.

The final amount of support required will depend primarily on technology development.

### v. Specific measures to introduce one or more contact points, streamline administrative procedures, provide information and training and facilitate acceptance of energy purchase contracts

As referred to in Directive (EU) 2018/2001 of the European Parliament and of the Council of December 11th, 2018 on the promotion of the use of energy from renewable sources and relating to authorisation, certification and licensing procedures applicable to electricity-generating installations and associated transmission and distribution networks for the production of electricity, heating or cooling from renewable sources, to the process of converting biomass into biofuels, bioliquids, biomass fuels or other energy products, as well as to renewable liquid and gaseous transport fuels of non-biological origin, proportionate and necessary, and contributing to the implementation of the energy efficiency principle in the first place, it is required to take the measures needed to ensure that:

(a) simplified and accelerated administrative procedures at the appropriate administrative level and the establishment of predictable timeframes;

(b) the objectivity, transparency and proportionality of the rules governing authorisation, certification and licensing, and that they do not discriminate against applicants and take complete account of the specificities of individual renewable energy technologies;

(c) transparency and dependence on the costs of administrative fees paid by consumers, planners, architects, builders, installers and suppliers of equipment and systems; and

(d) establishing simplified and less burdensome authorisation procedures, including through a simple notification procedure, for decentralised installations and for producing and storing energy from renewable sources.

### vi. The assessment of the need for the construction of new infrastructure for centralised heating and cooling produced from renewable energy sources

In terms of greater integration of RES into district heating systems and the eventual development of district cooling systems, it is necessary to create the conditions for the connection and operation of production plants to produce heating and cooling energy from RES. Aspects of the procedure and cost of connection of such facilities need to be further considered in such a way as to maximise the technology of high-capacity electric boilers and heat pumps as production plants for district heating and cooling systems. It is also estimated that greater integration of RES into district heating systems and the construction of district cooling systems in the market will offer highly competitively priced thermal energy, consequently creating the need to build new and expand existing distribution infrastructure. Of particular interest are geothermal power plants, which are mainly of the baseload type, which means that they are in operation throughout the year with very short shutdown periods. In the projects of geothermal power plants, in addition to electricity production, there is also the possibility of cascading use of the remaining thermal energy of geothermal water

for various purposes (heating, space heating, dryers, aquaculture, etc.). Such systems increase the efficiency of geothermal plants and, thus, the cost-effectiveness of the entire geothermal project. Using geothermal energy reduces the consumption of conventional energy sources (e.g. fossil fuels), resulting in a positive environmental impact. Using RES in district heating systems will be supported by implementing the ENU-15 measure, increasing the heating system's efficiency.

vii. If applicable, specific measures to encourage the use of energy from biomass, in particular for the production of new biomass, considering the availability of biomass: domestic potential and imports from third countries and other uses of biomass in other sectors (agriculture and forestry sectors); as well as measures for the sustainability of biomass production and use

The most important measures to stimulate biomass energy use are POLJ-4 Anaerobic degradation of manure and biogas production and TR-7 Development of the low-carbon fuel market. Sustainability of biomass production and use will be encouraged under measure MS-9 Strengthening activities for the development of the bioeconomy.

### 3.1.3 Other elements

i. National policies and measures affecting the EU emission trading system (EU ETS) sector and assessment of its complementarity with and impact on the EU Emissions Trading System (EU ETS), if applicable

Under the Decree on the criteria for payment of the reduced fee for renewable energy sources and high-efficiency cogeneration („Official Gazette“, No. 31/23) and the Decision on the fee for renewable energy sources and high-efficiency cogeneration („Official Gazette“ No. 31/23), EU ETS entities pay a lower fee for renewable energy sources and high-efficiency cogeneration than the fee for other final electricity customers.

Croatia introduced $CO_2$ emission allowances in 2007 based on the Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for carbon dioxide emissions into the environment („Official Gazette“, Nos .73/07, 48/09, 2/18, 46/21). The payers are individual stationary sources that emit $CO_2$ in quantities of over 450 tonnes per year, and the unit charge is 1.49 EUR/$tCO_2$ (HRK 11.20/ $tCO_2$). ETS participants are exempted from the obligation to pay $CO_2$ emission allowances to avoid the double financial burden due to greenhouse gas emissions.

Reducing the fee for renewable energy sources and high-efficiency cogeneration and releasing the obligation to pay the $CO_2$ fee makes it easier for ETS participants from Croatia to do business. On the other hand, the relatively high price of emission allowances on the ETS market stimulates the implementation of measures to reduce greenhouse gas emissions.

ii. Policies and measures for achieving other national goals, if applicable

Not applicable.

### iii. Policies and measures for achieving low-emission mobility (including transport electrification)

The expected effects of a group of low-emission mobility incentives are:

- cumulative reduction of final energy consumption in transport sector in projections for the scenario with additional measures compared to the scenario with existing measures, which amounts to 5.2 PJ in 2030;
- share of RES in turnover of 24.6%.

#### TR-1 Regulatory instruments to promote a cleaner transport system

Regulatory measure, parafiscal measure; implementation 2021 - 2030

**Objective and description of the measure:** The measure aims to encourage changes in the transport system to reduce environmental pollution and achieve a more sustainable transport system. This measure includes the application of regulatory instruments such as regulations, standards and taxes that will encourage the use of low-emission vehicles and increase the use of public transport and pedestrian and bicycle paths.

**Activities:** The measure covers the following activities:

- Inform consumers about the fuel economy and $CO_2$ emissions of new passenger cars under the Ordinance on the availability of data to consumers on official fuel consumption and the official specific $CO_2$ emissions of new passenger cars („Official Gazette“, No. 113/21). The purpose of this Regulation is to provide consumers with information on official fuel consumption and official specific emissions of carbon dioxide of new passenger cars intended for sale or leasing to enable them to make informed choices.
- Collect a special environmental fee for motor-powered vehicles under the Regulation amending the Regulation on unit fees, correction coefficients and more detailed criteria and benchmarks for determining the special environmental fee for motor-powered vehicles („Official Gazette“, No. 2/21). This Regulation lays down the unit fees and correction coefficients based on calculating the specific environmental charge for power-driven vehicles and the detailed criteria for determining the specific charge. 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.
- Collect a special tax on motor vehicles intended for use on roads under the Act on special tax on motor vehicles („Official Gazette“, Nos. 15/13, 108/13, 115/16, 127/17 and 121/19). Objective and description of the measure: Based on the "polluter pays" principle, the calculation model is based on $CO_2$ emissions into the air from motor vehicles. The special tax is determined based on 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.

- Monitoring, reporting and verification of greenhouse gas emissions in the lifetime of fuels and energy, under the Ordinance on the manner of monitoring and reporting and the methodology of calculating greenhouse gas emissions in the lifetime of fuels and energy delivered and the manner of implementing projects for reducing emissions resulting from oil and gas exploration and production („Official Gazette“, No. 131/21). Greenhouse gas emission monitoring shall apply to fuels used for the propulsion of road vehicles, non-road mobile machinery (including inland waterway vessels when not at sea), agricultural and forestry tractors, recreational craft when not at sea and electricity for use in road vehicles.
- Encourage integrated freight transport following the conditions defined by the new program on incentives in combined freight transport . The new program will prescribe incentives for the combined transport of goods by rail, inland waterways or sea, as well as incentives for the combined transport of goods by road, all under the expected amendments to the Council Directive 92/106/EEC on establishing common rules for certain types of combined transport of goods between member states and Regulation (EU) 2020/1056 of the European Parliament and the Council regarding the calculation of external costs and the generation of consolidated data.
- Legislative adaptations for cleaner transport that will ensure the development of alternative fuels infrastructure, increase the share of renewable sources in final energy consumption in transport and promote clean and energy-efficient vehicles in road transport through amendments to laws and bylaws.

In this regard, Croatia will fully transpose the obligations under the Renewable Energy Directive adopted in December 2018, as well as the obligations that will arise from the adoption of the Proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources. It will be necessary to achieve an ambitious target in the context of renewable energy in the transport sector in 2030 and, in particular, to stimulate the use of alternative forms of energy in transport (electricity, hydrogen, biomethane). The Biofuels for Transport Act will be amended („Official Gazette“, Nos. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18, 52/21).

The activity also foresees the implementation of obligations defined by the Construction Act („Official Gazette“, Nos. 153/13, 20/17, 39/19, 125/19) concerning the promotion of electromobility and the establishment of charging infrastructure in buildings and the Act on the Establishment of Alternative Fuels Infrastructure („Official Gazette“, Nos. 120/16, 63/22), which establishes a common framework of measures for the establishment of alternative fuels infrastructure, to minimise oil dependence and mitigate the negative impact of transport on the environment, and which establishes minimum requirements for the construction of alternative fuels infrastructure, including charging points.

The activity also includes conducting an analysis of the existing tariff system and examining the possibility of introducing new tariff models exclusively for electric mobility. The key determinant of the new tariff model should be enabling the commercialization of infrastructure for charging electric vehicles in the early phase of e-mobility development when there is a relatively small number of electric vehicle users on the market.

- Promote public procurement of clean vehicles in road transport under the Act on the Promotion of Clean Vehicles in Road Transport („Official Gazette“, No. 52/21). This Act

lays down obligations for contracting authorities and contracting entities to take into account the energy and environmental effects of certain road transport vehicles in the context of public procurement to promote and stimulate the market for clean and energy-efficient vehicles and to increase the contribution of the transport sector to Union policies relating to environmental, climate and energy protection for the entire life of the vehicle, including energy consumption, $CO_2$ emissions and emissions of certain pollutants. Under the law, the Ordinance on the obligation to report to the European Commission and minimum objectives in public procurement procedures for road transport vehicles („Official Gazette“, No. 86/21) was adopted, which defines minimum procurement objectives for the share of clean light and heavy vehicles.

**Funds needed for implementation:** The competent ministries plan to finance the implementation of these activities within their annual budgets as an integral part of their regular activities.

**Funding Sources**: State Budget

**Executive bodies:** ME, MSTI, MI, MPPCSA, EPEEF, CERA

**Monitoring bodies:** ME, MSTI, Central State Administration Body in charge of public procurement policy, MPPCSA

**Impact:** Energy savings, reduction of $CO_2$ emissions, reduction of pollutant emissions, acceleration of the development of the market for alternative energy products, increase of the share of RES in final energy consumption in transport and increase of the share of vehicles powered by alternative energy sources in road transport.

**Monitoring method:** Vehicle register, reports on passenger and tonne-kilometres achieved final energy consumption balance, verified reports on greenhouse gas emissions over the life of the fuel, documentation on public procurement procedures carried out.

**Measure implementation indicator:** Share of registered vehicles powered by alternative energy sources, shares of passenger and tonne-kilometres achieved in a particular type of transport, shares of renewable energy sources in final energy consumption, reduction of greenhouse gas emissions, share of clean light and heavy vehicles and in the total number of vehicles covered by public procurement contracts.

**Connection to other dimensions:** Direct connection to the energy efficiency dimension (activities act on the market by directing it towards more energy-efficient vehicles)

**Research and development:** Sustainable mobility and alternative fuels in transport require the development of new technologies in vehicles, infrastructure and advanced management systems based on information and communication technologies.

### TR-2 Programme for co-financing the purchase of new alternative fuel vehicles and the development of alternative fuel infrastructure in road transport

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** In the context of co-financing of cleaner transport projects, special lines of co-financing for specific purposes will be defined for purchasing vehicles of all categories with alternative energy sources. Incentives for co-financing the purchase of vehicles will be conducted consistently, transparently and continuously. One of the activities will be the development of financial instruments such as interest subsidies based on subsidising financing costs under credit programs and ensuring more favourable financing conditions for targeted investment projects in new vehicles with zero $CO_2$ emissions.

The implementation of such a financial instrument of interest subsidy will be carried out through the Croatian Bank for Reconstruction and Development (CBRD) and is based on the implementation of CBRD's regular credit programs that are implemented directly or in cooperation with commercial banks, i.e. framework loans to banks and leasing companies for financing of their acceptable clients and projects, which achieves the "crowding in private sector" effect. The measure will be aimed at business entities and replacing their existing vehicle fleets.

These activities will be primarily geared towards alternative fuels, for which the assessment of the existing situation has shown a minor representation in the total number of vehicles. They will be time-limited until the minimum representation of vehicles is achieved. The minimum degree of market uptake will be defined by revising the National Policy Framework for the Establishment of Infrastructure and the Development of Alternative Fuel Markets in Transport by January 1st, 2025. The revision of the National Policy Framework for the Establishment of Infrastructure and the Development of Alternative Fuel Markets will establish mandatory national goals that lead to the introduction of sufficient infrastructure for alternative fuels in accordance with Regulation (EU) 2023/1804 of the European Parliament and the Council of September 13th, 2023 on the introduction of infrastructure for alternative fuels.

To achieve the appropriate modal integration of Croatian transport flows with the European Union transport network, the Republic of Croatia is obliged to carry out activities that will result in the construction of alternative fuels infrastructure on the trans-European transport network located geographically in the territory of the Republic of Croatia. In this regard, the Republic of Croatia is obliged to implement the transition initiative towards the use of alternative energy sources in the transport sector in a way that encourages the construction of publicly available infrastructure for alternative fuels. By adopting and implementing *the Programme to promote the construction of alternative fuels infrastructure in the Republic of Croatia*, the Republic of Croatia will endeavour to provide sufficient infrastructure to supply alternative fuels to light and heavy road transport vehicles.

**Activities:** The measure covers the following activities:

- Conduct activities to co-finance energy-efficient vehicles with low greenhouse gas emissions through public calls.
- Implement co-financing activities for alternative fuel infrastructure through public calls.
- Establish a central register of alternative fuels infrastructure that will facilitate the driver's user experience and provide insight into energy consumption for analytical purposes.

**Funds needed for implementation:**

- EUR 120.8 million for the construction of alternative fuel infrastructure
- EUR 319.5 million for energy-efficient vehicles with low greenhouse gas emissions

**Sources of financing:** National recovery and resilience plan (EUR 53.2 million), revenues from the sale of emission units from the EU ETS, funds collected from the special vehicle fee and the special environmental fee for non-marketing biofuels, Connecting Europe Facility, European Regional Development Fund, Cohesion Fund, InvestEU, Innovation Fund, Modernisation Fund.

**Executive bodies:** ME, MSTI, EPEEF

**Monitoring body:** ME

**Impact:**

- increasing the number of places for supplying light vehicles with electricity in residential areas,
- increasing the installed power for supplying light-duty vehicles with electricity along the core and comprehensive TEN-T network,
- increasing the installed power for the supply of heavy-duty vehicles with electricity along the basic and comprehensive TEN-T network,
- increasing the installed power for electricity supply in safe and secure parking lots,
- increase in installed power for the supply of heavy-duty vehicles with electricity in urban hubs,
- increase in the number of stations for the supply of hydrogen,
- increasing the share of vehicles powered by alternative energy sources in the total number of registered vehicles,
- Save energy, reduce $CO_2e$ emissions and reduce pollutant emissions,
- estimated savings in 2030: 0.74 PJ; estimated $CO_2$ emission reductions in 2030: 361,7 $ktCO_{2e}$; cumulative energy savings in 2021-2030 2.76 PJ; cumulative reduction of $CO_{2e}$ emissions in the period 2021- 2030 of 1532.9 $ktCO_{2e}$.

**Note:** The estimated savings are cumulative from implementing TR-2, TR-3, and TR-7 measures.

**Monitoring method:** This measure will be monitored using the Energy Saving Monitoring, Measurement and Verification System (SMIV) estimation method. The cumulative capacity of alternative fuels infrastructure will be monitored through the central register of alternative fuels infrastructure.

**Measure implementation indicator:** Number of registered vehicles powered by alternative energy sources, installed capacities and geographical distribution of alternative energy supply infrastructure

**Connection to other dimensions:** Direct connection to the energy efficiency dimension

**Research and development:** Sustainable mobility and alternative fuels in transport require the development of new technologies in vehicles, infrastructure, and advanced management systems based on information and communication technologies.

### TR-3 Improving the public transport system and promoting sustainable integrated transport

Financial measure, information and organisational measure; implementation 2021 - 2030

**Objective and description of the measure:** The measure aims to promote the sustainable development of urban transport systems through the optimisation of freight transport logistics and intelligent management of public parking areas, the introduction of platforms for integrated passenger transport, the introduction of car-sharing systems in cities, the introduction of low-emission zones in cities, the introduction of public urban bicycle systems and the construction of associated cycling infrastructure, intelligent transport management (upgrading, adaptation and replacement of obsolete signalling devices and equipment, the installation of advanced traffic equipment and smart traffic lights equipped with an autonomous system of power from renewable sources, the construction and equipping of central operational centres for supervision and management of intersections with set 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 consider integration, participation and evaluation principles to meet the citizens' mobility needs now and, in the future, and ensure a better quality of life in cities and their surroundings. Appropriate outreach campaigns will accompany the activities. This measure aims to cover all counties, large cities (with more than 35,000 inhabitants) and municipalities and cities that together form a geographical entity with more than 35,000 inhabitants.

In addition, the measure aims to modernise regular public urban and suburban bus traffic passengers by procuring new electric or hydrogen propulsion vehicles and building the necessary infrastructure to promote vehicles with reduced $CO_2$ emissions. The aim is also to modernise the tram fleet in Osijek and Zagreb to provide a better and faster public transport service and increase the number of passengers using public transport, ultimately reducing $CO_2$ emissions in transport.

The measure will also encourage projects to develop and implement urban mobility ecosystems (i.e., the so-called MaaS – mobility as a service), closely integrated with public urban transport, consisting of three key components necessary for fully autonomous vehicles to function and participate in traffic. These are: (i) fully autonomous electric vehicles of the fifth level of autonomy, (ii) development and construction of specialised infrastructure for autonomous and electric vehicles integrated with public urban transport, (iii) development of a software platform for managing the complete system.

**Activities:**

- Co-financing activities will be implemented through public calls from the EPEEF and activities undertaken independently by the LGUs under their plans for the sustainable development of transport systems;
- Procurement of alternatively powered buses and construction of associated infrastructure;
- Modernization of tram traffic by procuring modern low-floor/semi-floor trams;
- Implementation of a digitised system of self-driving vehicles;
- A minimum of 15 developed sustainable urban mobility plans. Establish and implement specialised co-financing programs for measures identified by sustainable mobility plans in cities. Specialised programs will cover at least the following:
    - optimisation of freight transport logistics,
    - intelligent management of public parking areas
    - introduction of platforms for integrated passenger transport,
    - introducing a car-sharing system,
    - introducing low-emission zones in cities,
    - introducing a system of public city bicycles and the construction of the associated bicycle infrastructure,
    - introducing a system for automated, intelligent traffic management,
    - upgrade, adaptation and replacement of outdated signalling devices and equipment,
    - installation of advanced traffic equipment and intelligent traffic lights equipped with an autonomous power supply system from renewable sources,
    - construction and equipping of central operational centres for monitoring and managing intersections with installed traffic lights.

**Funds needed for implementation:** EUR 470.2 million

**Sources of financing:** National Recovery and Resilience Plan (EUR 376.6 million), OP Competitiveness and Cohesion (EUR 29.8 million), Competitiveness and Cohesion Program (EUR 63.8 million), revenues from the sale of emission units from the EU ETS.

**Executive body:** MSTI, EPEEF

**Monitoring bodies:** MSTI, ME

**Impact:**

-a fully functional commercial service of the autonomous driving system,

-a minimum of 70 buses powered by alternative fuels,

-at least 30 modern trams,

-save energy, reduce $CO_2e$ emissions and reduce pollutant emissions,

-estimated savings in 2030: 0.74 PJ; estimated $CO_2$ emission reductions in 2030: 361,7 $ktCO_{2e}$; cumulative energy savings in 2021-2030 2.76 PJ; cumulative reduction of $CO_{2e}$ emissions in the period 2021- 2030 of 1532.9 $ktCO_{2e}$.

**Note:** The estimated savings are cumulative from implementing TR-2, TR-3, and TR-7 measures.

**Monitoring method:** The effects of this measure will be recorded separately by projects prescribed by the TD methodology, with the possible addition/development of a new BU methodology.

**Measure implementation indicator:** Number of fully implemented projects.

**Connection to other dimensions:** Direct connection to the energy efficiency dimension

**Research and development:** Sustainable mobility and alternative fuels in transport require the development of new technologies in vehicles, infrastructure, and advanced management systems based on information and communication technologies.

### TR-4 Development of energy-efficient maritime transport and inland navigation

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** The measure encourages the construction of an onshore electricity supply system for seagoing ships and inland waterway vessels. Supply of electricity from the mainland for ships and vessels *On-Shore Power Supply (OPS)* is a distributed energy system that reduces the need for ships and vessels to use built-in generators and helps reduce air pollution and noise in ports. In addition, the measure also envisages encouraging the construction of publicly available stations for the supply of hydrogen, ammonia and/or liquefied natural gas to seagoing ships and/or inland waterway vessels powered by hydrogen, ammonia or liquefied natural gas. Likewise, the measure involves co-financing the procurement of ships and alternative fuel vessels.

**Activities:**

- Encouraging the construction of infrastructure for the supply of maritime transport (system of electricity supply from land to container and passenger ships for navigation by sea, and infrastructure for the supply of hydrogen, liquefied natural gas and ammonia in seaports);
- Encouraging the procurement of ships/vessels powered by alternative fuels.

**Funds needed for implementation:** EUR 204.7 million

**Sources of financing:** National Recovery and Resilience Plan (EUR 45.2 million), OP Competitiveness and Cohesion (EUR 47.8 million), Program Competitiveness and Cohesion (EUR 111.8 million), revenues from the sale of emission units from the EU ETS.

**Executive body:** ME, MSTI, EPEEF

**Monitoring bodies:** ME, MSTI

**Impact:** The indicative target for the period to 2030 is 80 MVA of installed OPS power and the installed infrastructure in seven seaports and four inland waterway ports

**Monitoring method:** Central Register of Infrastructure for Alternative Fuels.

**Measure implementation indicator (indicator):** Installed capacity of OPS systems, number of ports in which alternative fuel supply infrastructure is installed, capacity of installed infrastructure, number of ships/vessels powered by alternative fuels.

**Connection with other dimensions:** Direct connection with the decarbonisation dimension

**Research and development:** Sustainable mobility and alternative fuels in water transport require the development of new technologies in the field of vessels/vehicles, infrastructure and advanced management systems based on information and communication technologies.

### TR-5 Development of energy-efficient rail transport

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** This measure establishes the aim of constructing an appropriate number of stations for the supply of electricity or hydrogen from electric trains with a battery storage system and from hydrogen-powered trains on sections of the basic and comprehensive TEN-T network whose electrification is not possible for technical or cost reasons. In addition, in the period up to 2030, additional investments will be made in the renovation, modernisation, construction and maintenance of the railway infrastructure to enable better quality rail transport services, increase the number of service users, and thus increase the share of rail transport in total transport. The National Plan for the Development of Railway Infrastructure until 2030 established the implementation framework and action plan, which determined the concrete measures to be implemented to achieve the special goals of the National Plan.

**Activities:** Introduction of new battery-powered trains for passenger transport by rail on non-electrified railways and construction of stable energy connections for battery charging under the *Program for encouraging the construction of infrastructure for alternative fuels in the Republic of Croatia*.

Implementation activities determined by the National Railway Infrastructure Development Plan:

- improvement of the railway infrastructure management system,
- improvement of the railway infrastructure maintenance system,
- preparation and implementation of the program of renovation and modernisation of railway infrastructure,
- energy renovation of locations managed and owned by public railway companies,
- installation of infrastructure for the use of renewable and alternative energy sources,
- construction of infrastructure for the integration of railways into public passenger transport at the main transport hubs,
- modernisation of existing and construction of new railway infrastructure for intermodal transport,

- improving the capacity of railway infrastructure in the port area (in sea and river transport),
- construction of railway infrastructure for access to air terminals,
- improvement of the traffic management and signalling-safety infrastructure subsystem,
- improvement and modernisation of the intersection with the railway line,
- improvement of the infrastructure for security and technical controls,
- adaptation of the railway infrastructure to the requirements of the Schengen area.

**Funds needed for implementation:** EUR 4,040.3 million

**Sources of funding:** National Recovery and Resilience Plan (EUR 256.7 million), OP Competitiveness and Cohesion (EUR 102.5 million), Program Competitiveness and Cohesion (EUR 619.9 million), CEF, national funds, loans and other funds of the infrastructure manager.

**Executive Body**: ME, MSTI

**Monitoring bodies:** ME, MSTI

**Impact:** The indicative goal for up to 2030 is six operational locations with a high-power connection for charging batteries. Improving the economic and financial sustainability of the public railway infrastructure. Reconstruction and modernisation of railway infrastructure. Reducing the negative impact of the railway system (traffic) on the environment. Improving the conditions for intermodal freight and integrated urban transport and enhancing the safety of the railway system**.**

**Monitoring method:** Central Register of Infrastructure for Alternative Fuels.

**Measure implementation indicator:** Number of locations with a high-power battery charging port, number of trains powered by electricity or hydrogen. Completed project activities defined by the National Railway Infrastructure Development Plan.

**Connection to other dimensions:** Direct connection to the energy efficiency dimension and decarbonisation

**Research and development:** Sustainable mobility and alternative fuels in transport require the development of new technologies in vehicles, infrastructure, and advanced management systems based on information and communication technologies.

Connection with other dimensions: Direct connection with the decarbonisation dimension

### TR-6 Development of energy-efficient air transport

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** The electricity supply should replace liquid fuel consumption in airports to reduce greenhouse gas and pollutant emissions. All aircraft in the commercial transport function should be able to use the external electricity supply while parked at exits or positions away from terminals at TEN-T airports. In this respect, it is

necessary to build infrastructure for the electricity supply of stationary aircraft and infrastructure for the supply of preconditioned air (fixed or mobile systems that enable the external supply of conditioned air for cooling, ventilation or heating of stationary aircraft cabins).

**Activities:**

Adopting the Programme to encourage the construction of alternative fuels infrastructure in the Republic of Croatia will define the objectives for constructing infrastructure intended for air transport supply. In principle, the airports of the TEN-T core and comprehensive network set the objective of ensuring electricity supply (aeronautical fixed or mobile power units*) at all terminals used for commercial air transport by January 1st, 2025. Ground Power Unit (GPU*) and Preconditioned Aircraft at Standstill (Fixed or Mobile Air Supply Units*) Pre-Conditioned Air Unit (PCA)*).

The objective in question shall also be set for all positions away from the terminal used for commercial air transport up to January 1st, 2030.

The objective shall be that the electricity supplied comes from the electricity grid or is produced on the site as energy from renewable sources by January 1st, 2030 at the latest.

The objectives do not apply to short-term parking spaces, aircraft defrosting spaces, parking spaces in military zones, or parking spaces for general air transport (maximum take-off masses of less than 5.7 t).

By adopting a new national policy framework for the development of the market for alternative fuels in the transport sector and for the introduction of appropriate infrastructure, a plan will be defined for the introduction of alternative fuels infrastructure at airports that are not intended for the supply of electricity to stationary aircraft, in particular for the supply of hydrogen to aircraft and the charging of aircraft with electricity.

**Funds needed for implementation:** EUR 52 million

**Sources of funding**: National Recovery and Resilience Plan

**Executive Body:** ME

**Monitoring bodies:** ME

**Impact:** Indicative target for 2030 - infrastructure available at seven airports (total of 40 GPU systems and a total of 50 PCA systems)

**Monitoring method:** Report on the installed infrastructure by airports.

**Measure implementation indicator (indicator):** Number of airports where infrastructure is available, number of GPUs and PCAs intended for air traffic supply.

**Connection to other dimensions**: Direct connection to the decarbonisation dimension.

## TR-7 Developing a low-carbon fuel market

Financial measure, regulatory measure; implementation 2021 - 2030

**Objective and description of the measure:** Increasing the share of RES in transport by 2030 through developing the market for low-carbon fuels and achieving the planned share of fuels produced from renewable energy sources in final energy consumption in transport. The measure's implementation is based on amendments to the relevant laws and by-laws based on the Renewable Energy Directive. The measure also implies the creation of a long-term sustainable supply chain of biomass and the constructing a bio-industrial complex designed to produce advanced biofuels with negative net greenhouse gas emissions. Likewise, the measure implies the creation of preconditions for investment to enable sustainable business models for investment in the construction of synthetic fuel plants.

In addition to reducing greenhouse gases and diversifying energy sources, the goal is to encourage the development of new business models for the production and use of biofuels, launch pilot projects for the production and use of biofuels, stimulate growth and innovation, and create new jobs. The measure will focus on sustainable and environmentally friendly biofuels, and the goal is to encourage the development and implementation of new technologies for the production and use of biofuels, financing of pilot projects, education and training.

In addition, this measure aims to gradually introduce sustainable aviation fuels ("SAFs") to the civil aviation market in Croatia, following the provisions of the Regulation on ensuring equal conditions of market competition for sustainable air transport (ReFuelEU Aviation). The aim is to encourage the reduction of greenhouse gas emissions from aviation and promote sustainable practices in the air transport sector.

**Activities:**

- Construction of an energy self-sustaining bio-industrial complex intended for the production of advanced biofuels
- Development, adoption and implementation of the Plan and Programme for the production and use of biofuels in transport
- Development, adoption and implementation of the Plan and Program for the Production and Use of Synthetic Fuels
- Creation, adoption and implementation of the Plan and Program for the production and use of sustainable aviation fuels,
- Support for pilot projects for testing and demonstration of new business models in the biofuels sector,
- Offering various financial instruments for companies dealing with sustainable biofuels, such as incentives or subsidies,
- Developing educational programs for training the workforce in the subject area and strengthening cooperation with the scientific community.

**Funds needed for implementation:** EUR 355 million

**Sources of funding:** National recovery and resilience plan – REPowerEU (C7.1. R1-I5 / C1.2 R1-I4) – EUR 99,542,106, INA – EUR 225 million, state budget and other available funds (EUR 5 million per year).

**Executive Body:** ME, INA

**Monitoring bodies:** ME

**Impact:** Meeting the preconditions for supplying the market with low-carbon fuels, meeting the set targets for the share of renewable energy sources in the transport sector, fulfilling the set goals regarding the share of sustainable aviation fuels (from 2025, each year a minimum share of SAFs of 2% and from 2030, each year the minimum share of SAFs is 6%).

**Monitoring method:** Reports on the quantity of RES placed on the market in the transport sector, reports from fuel suppliers, and reports from aircraft operators.

**Measure implementation indicator:** Share of RES in final energy consumption in the transport sector, share of SAFs in aviation fuel.

**Connection to other dimensions:** This includes the dimensions of energy efficiency, security, research, innovation, and competitiveness.

**Research and development:** To achieve the goal, improving existing and developing new technologies for low-carbon fuel production, as well as new business models to increase the use of advanced biofuels and synthetic fuels, are necessary.

### iv. Where applicable, national policies, deadlines and measures planned with a view to phasing out energy subsidies, in particular for fossil fuels

Climate change mitigation and adaptation are considered pillars of climate policy implementation. In terms of climate change adaptation, a Climate Change Adaptation Strategy has been developed *in the Republic of Croatia until 2040 with a view to 2070.* („Official Gazette“, No.46/20). The development of a Climate Change Adaptation Strategy is a fundamental prerequisite and appropriate instrument for the successful implementation of the vulnerability assessment process, the implementation of adaptation measures, and, in this regard, for increasing the resilience of specific sectors and the entire economy and society to climate change.

According to the Draft Adaptation Strategy, the Republic of Croatia is highly vulnerable to the effects of climate change, especially in the sectors of agriculture, forestry, fisheries, energy, and tourism. The success of all these sectors depends mainly on climatic factors.

Five national priorities have been identified under which climate change adaptation measures must be implemented. These are:

1. ensuring sustainable regional and urban development
2. ensuring preconditions for the economic development of rural areas, coastal areas and islands
3. ensuring sustainable energy development
4. strengthening management capacity through a networked monitoring and early warning system

5. ensuring continuity of research activities.

Based on the general principles for defining measures, analysing the current situation by sector and assessing the degree of vulnerability and possible responses to the challenges of climate change adaptation, the Adaptation Strategy identifies a set of measures for each sector and cross-sectoral measures. The measures are regulatory, administrative, implementing, public education and awareness, and research and development measures. In addition to character, measures are also prioritised (measures of very high importance, high importance and medium importance).

The adaptation strategy will be implemented through action plans, including elaborating concrete measures and activities for a specific five-year period.

## 3.2 Dimension: Energy efficiency

The expected impact of a group of measures to promote energy efficiency and transport is equivalent to a reduction in final energy consumption in projections for the scenario with additional measures compared to the scenario with the existing measures, which amounts to 17.61 PJ in 2030.

Planned policies, measures and programmes for the achievement of the national target of increasing energy efficiency by 2030, as well as the other targets set out in Section 2.2, including planned measures and instruments (as well as that of a financial nature) for the promotion of energy performance of buildings, are listed below, according to specific areas.

### ~~i.~~ Energy efficiency obligation schemes and alternative policy measures referred to in Articles 7a and 7b and Article 20 (6) of Directive 2012/27/EU

**ENU-1 Energy Efficiency Obligation System for Suppliers**

Regulatory measure; implementation: 2019 – 2030

**Objective and description of the measure:** The Energy Efficiency Obligation System was established by the Energy Efficiency Act („Official Gazette“, Nos. 127/14, 116/18, 25/20), and the Ordinance further defines its functioning on the Energy Efficiency Obligation System („Official Gazette“, No. 41/19). With the entry into force of the Energy Efficiency Act („Official Gazette“, No. 41/21), the Ordinance on the system of energy efficiency obligations („Official Gazette“, No. 41/19) ceases to be valid. The elements of the system of energy savings obligations and the manner of its implementation are transferred to the Ordinance on the system for monitoring, measuring and verifying energy savings („Official Gazette“, Nos. 98/21 and 30/22). The obligees of the energy efficiency obligation system are energy suppliers. The obligees of the energy efficiency obligation system are energy suppliers. The system has been functional since 2019 when suppliers who delivered more than 300 GWh of energy to the market in 2017 entered it. In 2020, the suppliers who delivered more than 100 GWh of energy to the market in 2018 entered the system of obligations, and from 2021 onwards, all those suppliers who supplied more than 50 GWh of energy to the market during the previous year. From 2021 to 2030, the goal is to achieve cumulative energy savings in final consumption by

achieving new annual savings every year. According to Directive 2018/02, amending Directive 2012/27/EU on energy efficiency, the system is set up so that it is necessary to achieve savings of 0.8% of annual final consumption every year. According to the agreed amendments to the 2023 Energy Efficiency Directive, these targets change and are as follows: in the period from 2021 to 2023, the goal is to achieve savings of 0.8%, from 2024 to 2025 1.3%, and from 2026 to 2027 1.5% and from 2027 to 2030 1.9% of annual final energy consumption. It raises the national target of the Republic of Croatia from the previous 125.3 PJ (2,993.7 kten) to 180.6 PJ (4,313.6 kten).

According to the Energy Efficiency Act, the goal is to achieve 70% of the savings from Article 8(7) of the Energy Efficiency Directive through the system of energy efficiency obligations. Analyses were carried out concerning the new goal, and a new distribution of the goal between alternative policy measures and the obligation system was determined at 50:50%. The same needs to be prescribed through amendments to the Act.

**Activities:** The following activities will be implemented within the measure:

- On the Amendments to the Energy Efficiency Act to transpose the amended Energy Efficiency Directive;
- It is necessary to amend and regularly improve the Ordinance on the system for monitoring, measuring and verifying energy savings to fully comply with the requirements of the amended Energy Efficiency Directive;
- In light of experience and the provisions of Directive 2018/02 on energy efficiency, legislative changes should also be considered to improve the functioning of the system, especially in the area of savings trading;
- Revenues from fees collected based on the obligation system shall be used purposefully by the Fund. That is why it is necessary to create a Schedule for the use of funds collected from the obligation system fees, the application of which must start in 2021. Creating such a schedule is necessary to ensure the optimal allocation of funds from all available sources and that the fund has clear guidelines for investing these resources. Given the alternative measures provided in this Plan, it is necessary to direct these funds to the building sector, in particular to public buildings of the central government and the family home, with a focus on citizens at risk of energy poverty.

**Funding Sources:** Energy Efficiency Obligation Scheme payer funds

**Executive body:** Obligated entities of the Energy Efficiency Obligation System (suppliers)

**Monitoring bodies:** ME-NKT

**Impact:** Reduction of final energy consumption and consequent reduction of $CO_2$ emissions: estimated savings in 2030 19.5 PJ (466.1 ktoe); estimated reduction in $CO_2$ emissions in 2030 1,094.9 $ktCO_{2e}$; cumulative energy savings in the period 2021-2030 90.3 PJ (2,156.8 ktoe); cumulative reduction in $CO_2$ emissions in 2021-2030 5,067.9 $ktCO_{2e}$.

**Monitoring method:** The realised savings are monitored and proven by using bottom-up methods according to the Ordinance on the system for monitoring, measurement and verification of energy savings

**Connection to other dimensions:** Given that the obligation is placed on the market energy activity of energy supply, there is a direct link to the dimension of the internal energy market

The Republic of Croatia also envisages implementing alternative measures, including measures described as follows: ENU-3, ENU-4, ENU-5, ENU-7, ENU-8, EUNU-17, and ENU-18. In addition, alternative measures include transport measures TR-2 and TR-3 and measures to combat energy poverty UET-9.

### ii. Long-term strategies for the renovation of the national stock of residential and non-residential buildings, public and private, including policies, measures and actions to encourage cost-effective major renovations, policies and actions targeting the worst-performing segments of the national stock of buildings under Article 2a of Directive 2010/31/EU

Key to this area is the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of Croatia by 2050. Three essential energy renovation programmes between 2021 and 2030 are expected to be conducted for apartment buildings, family houses, and public buildings to reduce energy consumption in building construction. A new programme for commercial buildings based on co-financing will not be adopted. Still, it is expected that this segment of the building stock will be covered by the activities of the supplier within the energy efficiency obligation system as well as the energy services market. In addition to these programmes based on financial incentives, it is planned to implement a comprehensive information measure, the ultimate goal of which is to encourage the decarbonisation of buildings and a generally green and digital transition in the building sector based primarily on the principle of "*energy efficiency first*".

It should be pointed out that building energy renovation programs are critical measures in this dimension. Still, they also contribute to the decarbonisation goals, i.e., increasing the use of renewable energy sources. At the same time, all programs are based on the principle of 'energy efficiency first' because the essential condition for obtaining grants for energy renovation is reducing the energy required for heating and cooling in buildings. Buildings with poor energy characteristics are obliged to improve these characteristics with measures on the outer envelope, and it is impossible to apply some other measures without such intervention, such as replacing the heating system in the building. Buildings with good energy properties, i.e., low required energy for heating and cooling, are allowed to receive co-financing only for improving energy efficiency and decarbonising technical systems in the building. With this, through co-financing programs for the energy renovation of buildings, the principle of 'energy efficiency first' has already been vigorously applied in Croatia.

In accordance with the provisions of the EU Directive 2024/1275 on the energy performance of buildings, Article 17, paragraph 15, from January 1$^{st}$, 2025, no financial incentives can be given for the installation of independent fossil fuel boilers, with the exception of those selected for investment before 2025. , in accordance with Regulation (EU) 2021/241, Article 7, Paragraph 1, Point (h) sub-item i. the third indent of Regulation (EU) 2021/1058 and Article 73 of Regulation (EU) 2021/2115 of the European Parliament and the Council.

### ENU-2 Promoting the decarbonisation and application of the "*energy efficiency first*" principle in buildings

Information measure; implementation 2019 -2030

**Objective and description of the measure:** The Charter of Cooperation for the Decarbonisation of Buildings by 2050, initiated by the Ministry of Physical Planning, Construction and State Property, which supports the EU's vision of decarbonisation of buildings by 2050, was undertaken to improve cross-sectoral communication and cooperation between state administration bodies and the private sector. Through workshops and the Open Partner Dialogue, the aim is to create a broad network of connected professionals ready to engage in dialogue and contribute to decarbonising the building stock by 2050. Open Partner Dialogues bring together representatives of state and local government, the academic community and the professional public, the construction and energy sectors, and related industries at thematic workshops organised by the Ministry. The contents of the Charter include the achievement of energy and climate targets at the national and EU levels through the decarbonisation of the building stock, renovation of buildings and construction of nearly zero energy buildings, awareness of the importance of further reduction in greenhouse gas emissions, increasing the share of renewable energy sources, improving energy security and introducing innovation and smart technologies that allow buildings to support the overall decarbonisation of the economy. The signing of the Charter encourages continuous cooperation on the development of the Long-Term Strategy for the Renovation of the National Building Stock and the transition to a nearly zero energy building standard (nZEB). The signatories to the Charter support and promote the decarbonisation of buildings in their future activities, wherever possible. Current activities should be expanded per EU guidelines, and the principle of "*energy efficiency first*" should be encouraged.

In addition to networking with experts through the partners' dialogue, the general public and target groups will be informed by organising targeted "Energy *efficiency first*" information campaigns related mainly to energy renovation and decarbonisation of buildings. Applying the principles of green building (building on the principles of sustainability) as an essential segment of sustainable development and circular economy will be promoted. It is necessary to strengthen and support the hitherto adopted policies of the Republic of Croatia in the field of sustainable development, energy efficiency and national guidelines for building quality and culture (ApolitikA) to apply the best global standards of green building (e.g. international green building certificates), to develop the national green building system, and to raise awareness of the untapped opportunities and risks (if not implemented) and of the various opportunities (if implemented) that arise from applying the principles of green building to the individual and the community as a whole, to the private and social sectors of the economy and investment.

**Activities:** The following activities will be implemented within the measure:

- Information and promotion are envisaged through open partner dialogues, workshops, and educational activities focused on energy efficiency, systematic energy management, smart technologies, green building, and nZEB standards.

- Timely information and assessment of buildings' readiness for smart technologies under the *"Smart Readiness Indicator"* protocol and a broad dialogue related to the application of SRI in the Republic of Croatia are envisaged.
- Preparation of the Guide and guidelines on green and sustainable construction and nZEB standards for investors and designers
- Media campaigns for energy certification and promotion of nZEB standards will inform the general public to raise awareness of the significance of energy certificates and their relevance for energy renovation and demonstration of nZEB standards. Information is available in the Information System of Energy Certificates (IEC), and a targeted campaign will also be carried out to inform and raise awareness.
- Organisation open partner dialogues on energy poverty, raising awareness of energy poverty and establishing criteria for energy-poor and low-income households to prevent and alleviate energy poverty by implementing energy efficiency and RES measures.
- Organising open dialogues related to energy renovation of multi-residential buildings (cooperation with managers), promoting energy communities, etc.

**Funds needed for implementation:** The MPGI plans to finance the implementation of these activities within its annual budgets as an integral part of its regular activities.

**Funding Sources:** State Budget (MPPCSA)

**Executive Body:** MPPCSA

**Monitoring bodies:** MPPCSA, ME-NKT

**Impact:** Increasing the level of awareness of the benefits of energy efficiency with the consequent change in behaviour and reduction in energy consumption by applying concrete measures Support for a regulatory measure for the construction and renovation of buildings as well as a promotional measure that will result in a measurable reduction of energy consumption, greater use of RES and avoided $CO_2$ emissions. Increase of professional capacities for the implementation of energy efficiency measures.

**Monitoring method:** Using top-down methods at a sectoral level. Reports on information and education activities carried out.

**Connection to other dimensions:** Direct connection to decarbonisation (nZEB standard implies a tendency towards zero emissions of embodied and operational carbon (green building, reduced energy consumption and increased use of RES), internal market (energy poverty).

**Research and development**: Educational activities in the field of green building stimulate research and development in this segment (technologies and methods for 'greening' buildings). The NZEB standard creates the need to develop new building materials, improve building technical systems, and develop control and automation systems based on information and communication technologies. Digitalisation of the system encourages innovation in the information segment (use of information and communication technologies).

## ENU-3 Energy renovation programme for apartment buildings

Financial measure; period up to 2030

**Objective and description of the measure:** By decision of the Government of the Republic of Croatia, the Program for energy renovation of multi-apartment buildings for the period up to 2030 was adopted („Official Gazette“, No. 143/21). Several categories of renovation are foreseen (integral energy renovation, in-depth renovation, comprehensive renovation) and three implementation models (renovation of apartment buildings not damaged in the earthquake, renovation of apartment buildings damaged in the earthquake, financial support for citizens at risk of energy poverty). It is necessary to encourage the restoration to the nZEB standard more strongly. In addition, it is necessary to consider establishing a special fund from which the costs will be reimbursed to energy-poor households or households at risk of energy poverty to remove the obstacle to securing a sufficient number of co-owners consent for energy renovation. The implementation of the Programme must be accompanied by strong promotional activities and technical assistance to applicants, and it is necessary to ensure the monitoring of energy consumption before and after energy renovation, for which it is necessary to create preconditions within the ISGE. A total of 6.27 million $m^2$ of multi-apartment buildings should be renovated up to 2030, in line with the Long-Term Strategy for the Renovation of the National Building Stock. It plans to renovate an average of about 700,000 $m^2$ of multi-apartment buildings annually. Savings were calculated assuming the energy renovation of buildings meets the requirements of the Technical regulation on rational use of energy and thermal protection in buildings, according to the periods of construction of buildings.

Note: The objectives, conditions, activities, and stated numerical values are indicative and are set out in detail in the Energy Renovation Programme for Multi-residential Buildings for the period up to 2030, which is updated every three years.

**Activities:** The following activities will be implemented within the measure:

- The implementation is carried out in the manner set out in the Energy Renovation Programme for Multi-residential Buildings for the period up to 2030 (adopted on December 23rd,2021).

**Funds needed for implementation:** The estimated investment cost in 2021-2030 is EUR 3.81 billion.

**Sources of financing:** Grants of EUR 2.28 billion should be provided, with maximum co-financing of energy audits, energy certificates, project documentation and technical assistance in the preparation and implementation of the project. Consideration should be given to using national funds and other sources of funding. The funds available from the National Economic Development Fund and its Supplement are EUR 160 million for the undamaged buildings and EUR 54.4 million for the earthquake-damaged buildings. The EPEEF provided another EUR 80 million, based on the Conclusion of the Government of the Republic of Croatia regarding the energy renovation of family houses and multi-apartment buildings in the territory of the Republic of Croatia, from October 19th, 2023. These funds are predicted to be spent by the end of 2026. Funds available from PCC 2021-2027 are EUR 89 million.

Therefore, it is necessary to consider the possibility of using national funds and other sources of financing in addition to designing innovative financial instruments.

**Executive body:** MPPCSA; other bodies in the system of use of the European Funds;

**Monitoring bodies:** ME-NKT

**Impact:** Reduction of thermal needs and energy consumption in multi-apartment buildings and increase in the use of RES and consequent reduction of $CO_2$ emissions; estimated savings in final consumption in 2030 amount to 1.87 PJ (44.55 ktoe; 518.16 GWh); estimated reduction in $CO_2$ emissions in 2030 124.88kt $CO_2$); cumulative energy savings in the period 2021-2030 8.45 PJ (201.90 ktoe; 2,348.0 GWh); cumulative reduction in $CO_2$ emissions in 2021- 2030. 565.87 kt$CO_2$.

**Monitoring method:** Energy Saving Monitoring, Measurement and Verification System using the bottom-up method for integral building renovation.

**Connection to other dimensions:** There is a direct connection with the dimension of decarbonisation because energy renovation encourages the use of RES in buildings.

**Climate change adaptation:** Energy renovation makes buildings more resilient to climate change's effects, such as extreme temperature conditions.

**Research and development**: Energy renovation, mainly its focus on the nZEB standard, is an incentive for research and development in the field of new building materials, advanced technical systems in buildings, and information and communication-based management and automation systems.

### ENU-4 Energy renovation programme for family houses

Financial measure; period up to 2030

**Objective and description of the measure:** The programme needs to be conceptualised as a continuation of the implementation of the Energy Efficiency Programme for single-family homes from 2014 to 2020, with co-financing from the Environmental Protection and Energy Efficiency Fund. It is necessary to ensure the continued implementation of the renovation of family homes by renewing public calls for grants every year for 2021-2030. The primary sources of co-financing should be revenues from the sale of emission units from the EU ETS and revenues from fees paid by suppliers in the energy efficiency obligation system in case of non-fulfilment of their obligations. Several categories of renovation are envisaged (implementation of individual energy renovation measures, integrated energy renovation, deep renovation, comprehensive renovation) and three implementation models (renovation of family houses undamaged by the earthquake, renovation of family houses damaged by the earthquake and renovation of family houses of citizens at risk of energy poverty). The Programme will allow for implementing individual measures, but considering the order of measures (e.g., replacing the heating system with a more efficient system that uses RES should only be possible for those houses with good thermal characteristics and do not require any interventions on the building envelope). Renovations up to the nZEB standard should be encouraged. Substantial promotional activities must accompany the implementation of the Programme. In total, over 11.5 million $m^2$ should be renovated by 2030. It would mean the

annual renovation of an average of 13,500 houses or 1.35 million $m^2$ annually. Savings were calculated assuming the energy renovation of buildings meets the requirements of the Technical regulation on rational use of energy and thermal protection in buildings, according to the periods of construction of buildings. Annual savings amount to 0.447 PJ.

**Note:** The objectives, conditions, activities, and stated numerical values are indicative and will be specified in detail in the Energy Renovation programme for family homes for the period up to 2030.

**Activities:** The following activities will be implemented within the measure:

- In accordance with the requirements of Directive (EU) 2024/1275 on the energy performance of buildings, MPPCSA will create a plan for the energy renovation of family houses, which the Government will adopt;
- The EPEEF is responsible for fully implementing this measure by announcing annual public calls, the criteria of which it develops in cooperation with the MPPCSA.

**Funds needed for implementation:** The estimated investment cost in 2021-2030 is EUR 3.44 billion. EPEEF provided EUR 120 million based on the Conclusion of the Government of the Republic of Croatia regarding the energy renovation of family houses and multi-apartment buildings in the territory of the Republic of Croatia, from December 19$^{th}$, 2023, which is expected to be spent by the end of 2025. Additionally, EUR 25 million has been secured for renovating citizens' family homes at risk of energy poverty.

**Funding sources:** Grants from the EPEEF should be continuously provided up to the eligible costs of equipment and energy renovation works. Funds are from proceeds from the sale of emission units from EU ETS, revenues from the energy efficiency obligation system MPPCSA, and other sources of income from the EPEEF.

**Executive body:** MPPCSA - development of the Programme, defining criteria, operational monitoring of the implementation of the Programme; EPEEF - overall implementation of the Programme through annual public calls

**Monitoring bodies:** ME-NKT

**Impact:** Reduction of thermal needs and energy consumption in family houses and increase of RES use and consequent reduction of $CO_2$ emissions; estimated savings in final consumption in 2030 amount to 4.47 PJ (106.78 ktoe; 1.241,80 GWh); estimated reduction in $CO_2$ emissions in 2030 299.27 kt$CO_2$; cumulative energy savings in the period 2021-2030 20.26 PJ (483.85 ktoe; 5,627.2 GWh); cumulative reduction in $CO_2$ emissions in 2021-2030 1,356.16 kt$CO_2$.

**Monitoring method:** Energy Saving Monitoring, Measurement and Verification (SMiV) system using the bottom-up method for integral building renovation or other appropriate methods if individual measures are implemented.

**Connection to other dimensions:** Direct connection to the decarbonisation dimension, as energy renovation use, encourages the use of RES in buildings.

**Climate change adaptation:** Energy renovation makes buildings more resilient to some of the effects of climate change, such as extreme temperature conditions.

**Research and development**: Energy renovation, mainly its focus on the nZEB standard, is an incentive for research and development in the field of new building materials, advanced technical systems in buildings, and information and communication-based management and automation systems.

### ENU-5 Energy renovation programme for public sector buildings

Financial measure; period up to 2030

**Objective and description of the measure:** The measure represents the continuation of implementing the Program for Energy Renovation of Public Sector Buildings from 2016 to 2020. The Government of the Republic of Croatia adopted the Energy Renovation Program for the Public Sector up to 2030 („Official Gazette“, No. 41/22). The NPRR and the PCC have provided funds for the period up to the end of 2026 for 2021-2027 (with implementation until 2030) to ensure the activation of private capital and the ESCO market, especially for buildings that are suitable for such financing models (buildings with continuous operation, such as hospitals, prisons, homes for the elderly, etc.) and which belong to the category of central government buildings, for which there is a binding renovation goal defined in Energy Efficiency Directive 2012/27/EU. Market models need to be combined with grants to meet the nZEB standard. In addition to EU funds. Grants should be provided under the same conditions for buildings unsuitable for market models. The renovation of the public sector building must be directed to the nZEB and ZEB standards wherever technically feasible. Approximately 350,000m$^2$ of public buildings are planned to be renovated annually. Savings were calculated assuming the energy renovation of buildings meets the requirements of the Technical regulation on rational use of energy and thermal protection in buildings, according to the periods of construction of buildings. Annual savings amount to 0.169 PJ.

**Note:** The objectives, conditions, activities, and stated numerical values are indicative and will be detailed in the Energy Renovation programme for public sector buildings until 2030.

**Activities:** The following activities will be implemented within the measure:

- Implementation in the manner established by the Programme,
- For energy renovation of central government buildings and other public sector buildings, the Energy Service Model (ESCO), implemented by ATMIP, will be applied where feasible, with co-financing provided by NPRR, PCC and EPEEF - this segment of the Programme is necessary to mobilise private capital, develop the energy services market and achieve the objectives without additional public sector borrowing.

**Funds needed for implementation:** The estimated investment cost in 2021-2030 is EUR 1.2 billion.

**Funding sources:** Grants are provided from NPRR and EU funds with maximum co-financing of energy audits, energy certificates, project documentation and technical assistance in the preparation and implementation of the project. Income from the sale of emission units from the EU ETS and income from the energy efficiency obligation system. One hundred million EUR

for grants and 66 million EUR for the ESCO model have been secured from the NPRR. EUR 185 million in grants were secured from the PCC.

**Executive body:** MPPCSA; other bodies in the system of use of the European Funds;

**Monitoring bodies:** ME-NKT

**Impact:** Reducing heat demand and energy consumption in public sector buildings and increasing RES usage and consequently reducing $CO_2$ emissions; estimated savings in 2030 1.69 PJ (40.40 ktoe); estimated $CO_2$ emission reductions in 2030 46.52 $ktCO_2e$; cumulative energy savings in 2021-2030 9.30 PJ (222.20 ktoe); cumulative $CO_2$ emission reductions in the period 2021-2030 264.93 $ktCO_2e$.

**Monitoring method:** Energy Saving Monitoring, Measurement and Verification System using the bottom-up method for integral building renovation.

**Connection to other dimensions:** Direct connection to the decarbonisation dimension, as energy renovation use, encourages the use of RES in buildings.

**Climate change adaptation:** Energy renovation makes buildings more resilient to some of the effects of climate change, such as extreme temperature conditions.

**Research and development**: Energy renovation, mainly its focus on the nZEB standard, is an incentive for research and development in the field of new building materials, advanced technical systems in buildings, and information and communication-based management and automation systems.

### ENU-6 Energy renovation programme for buildings that have the status of a cultural property

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** By decision of the Government of the Republic of Croatia, the Program for energy renovation of buildings with cultural property status until 2030 was adopted („Official Gazette“, No. 143/21). Protected buildings within the meaning of this Programme can be classified into two categories: Individually protected cultural property (individual buildings and building complexes) and Buildings within a protected cultural and historical unit. The programme does not cover buildings protected as preventively protected cultural or registered cultural property. The programme has this programme: a holistic (integral) approach and an approach with the application of individual developed two basic approaches to the energy renovation of buildings, which are the subject of energy renovation measures.

**Note:** The objectives, conditions, activities, and stated numerical values are indicative and are set out in detail in the Programme for Energy Renovation of Buildings with Cultural Property Status by 2030.

**Activities:** The following activities will be implemented within the measure:

- Implementation in the manner established by the Programme.

**Funds needed for implementation:** Energy renovation programmes for buildings with cultural property status and to achieve national goals amount to EUR 2.5 billion from 2021 to 2030. It includes required investments of EUR 1.8 billion and maintenance costs of EUR 0.7 billion.

**Funding sources:** Given the very high investment return periods, it will be necessary to make the most of the programme's co-financing with grants to reduce simple investment return periods and to encourage the energy renovation of such buildings. EU Funds and funds raised through monument annuities are recognised as grant funding sources. The funds provided in the NPRR are also used. Considering the total investment needs, the total required investments amount to approximately EUR 182 million annually from 2021 to 2030, of which the required co-financing would amount to EUR 135 million. Given that around EUR 13 million is collected annually from the monumental annuity, the remaining amount of about EUR 122 million annually must be secured from EU Funds. It is necessary to co-finance the same with grants, with a considerable share of the total investment to encourage the energy renovation of buildings with cultural property status. EUR 40 million has been secured from NPRR.

**Executive body:** MPPCSA; other bodies in the system of use of the European Funds.

**Monitoring bodies:** ME-NKT.

**Impact:** Reduction of thermal needs and energy consumption in buildings with the status of cultural property and increase in the use of RES and consequently reduction of $CO_2$ emissions; estimated cumulative savings from up to 2030. 6.32 PJ (150.95 ktoe); estimated reduction in $CO_2$ emissions in 2030 245.48 ktCO2e.

**Monitoring method:** An Energy-Saving Monitoring, Measurement, and Verification System (SMiV) using the bottom-up method for integral building renovation.

**Connection to other dimensions:** Direct connection to the decarbonisation dimension, as energy renovation use encourages using RES in buildings.

**Climate change adaptation:** Energy renovation makes buildings more resilient to some of the effects of climate change, such as extreme temperature conditions.

**Research and development**: Energy renovation, mainly its focus on the nZEB standard, is an incentive for research and development in the field of new building materials, advanced technical systems in buildings, and information and communication-based management and automation systems.

### iii. Description of policies and measures to encourage energy services in the public sector and measures to remove regulatory and non-regulatory barriers that prevent the acceptance of energy efficiency contracts and other models of energy efficiency services

Article 25 of the *Energy Efficiency Act* („Official Gazette“ No. 127/14) defines the energy service as a framework for the implementation of energy efficiency projects and other related activities based on an energy performance contract with a guarantee that under benchmark conditions, it leads to a verifiable and measurable or assessable improvement of energy efficiency and/or energy and/or water savings. According to the *Act on Amendments to the*

*Energy Efficiency Act* („Official Gazette“ No. 116/18), the definition is being extended to include cases where an energy service provider provides energy management expertise without direct investment and the possibility of reducing energy-related costs without reducing energy consumption is included.

According to the Act on Amendments to the Energy Efficiency Act, the content of the energy performance contract is defined only for public buildings. However, access to this issue is being liberalised in the private sector, so a positive impact on the market can be expected.

Legislation and the implementation policy provide incentives for implementing energy efficiency measures through financial instruments, especially energy services. It is also necessary to secure the inclusion of financial resources from European structural and investment funds through a combination of energy services or public-private partnerships. It is also required to align secondary legislation (ordinances) further and prepare publicly available documentation that will explain in more detail the complex issue of energy performance contracts, such as the energy service contracting model, details of contracting and securing supply of energy products and energy performance, budget and legal issues, workflows of projects, identification of projects and various technical specifications related to the intensity of consumption of specific public buildings, examples from practice and a sample contract with all elements.

iv. Other planned policies, measures and programmes for achieving the indicative national target of increase in energy efficiency for 2030, as well as other objectives under 2.2 (for example, measures aimed at promoting public buildings and energy-efficient public procurement as desirable models, measures to promote energy audits and energy management systems, providing information to consumers and training measures, and other measures to promote energy efficiency)

*Measures in the public sector*

The public sector is expected to continue implementing the existing measures and expanding their scope. The measures listed below and the Program for energy renovation of public sector buildings (measure ENU-5) will reduce energy consumption in the public sector under Article 5 of the revised Directive (EU) 2023/1791 on energy efficiency. The ENU-5 and ENU-6 measures contribute to achieving the goals from Article 6 of the revised Directive (EU) 2023/1791 on energy efficiency related to the renovation of public sector buildings. Data from the ISGE system (measure ENU-7) will be used to establish the basic energy consumption in the public sector. These detailed analyses of consumption by sector will be carried out as part of the process of transposition of the Directive into national legislation (amendments to the Energy Efficiency Act and the Ordinance on systematic energy management in the public sector) and through the revision of the Program for energy renovation of public sector buildings (to determine the area of buildings that need to be renovated). Energy consumption in public transport will undoubtedly be excluded, while the problem of unavailability of data has been identified for the consumption of the armed forces, i.e. it is currently not possible to determine the exact energy consumption of the armed forces, so indeed, it will not be possible to exclude it, i.e. it will be calculated with the entire stationary energy consumption in the public sector. However, the final decision on this will be made based on a detailed analysis and the process of establishing the base consumption.

## ENU-7 Systematic energy management in the public sector

Informational measure; implementation 2014 -2030

**Objective and description of the measure:** The public sector in Croatia is obliged to systematically manage energy, as stipulated explicitly by the Energy Efficiency Act and the Ordinance on Systematic Energy Management („Official Gazette“, Nos. 18/15, 06/16). The measure is based on the energy management (ISEM) information system. The goal is to cover and regularly monitor all public sector buildings and public lighting systems by the end of 2030 using the ISEM. Savings based on systematic energy management activities and the introduction of telemetry in the previous period have been set at around 335 TJ per year (according to the 4$^{th}$ NEEAP). Since this measure has been systematically worked upon since 2014, the assumed potential for savings has been reduced to 100 TJ per year due to conservative estimates.

**Activities:** The following activities will be implemented within the measure:

- Automation of energy-generating product and water consumption data collection (remote reading), integration of ISEM with energy-generating products and water supplier systems, education of energy experts and advisers responsible for energy management in their buildings, and further development and improvement of ISEM will be implemented by 2021. Emphasis will be placed on developing modules for monitoring and verifying the energy savings achieved due to the renovation and fulfilling the default use regime of the building to achieve and maintain the level of comfort. The goals are to remotely read all locations in the public sector whose energy and water consumption exceeds EUR 53,090.00/year by 2020, connect supplier databases with the ISEM database for automatic data collection, and connect ISEM with all relevant energy databases. In addition, by 2021, plans are being implemented for measures that include potential analysis and optimisation of peak electricity contracting, reduction of excess reactive energy, and potential analysis and optimisation of thermal power contracting.
- In the period from 2021 to 2030, it is planned to introduce the energy management system and apply ISEM in all public sector buildings and to improve and expand the whole system through the following activities:
    1. Bring together all installed remote reading systems in the ISEM.
    2. Integrate ISEM with other bases: DGU (Geoportal of the State Geodetic Administration), Cadastre, Register of Protected Facilities, IEC, SMIV, etc.;
    3. Prescribe ISEM as a system for verifying actual savings after building renovation (define what data the sensors on the premises send to the system; ISEM is already ready to receive data) and develop a methodology for calculating and verifying actual savings after building renovation, considering the default building usage regime.
    4. Extend the use of ISEM to all sectors (private, industrial...) voluntarily and/or as an obligation related to receiving financial assistance for renovation or implementation of energy efficiency measures.

- The pilot project for establishing and implementing systematic energy management and developing a new financing model for multi-apartment buildings will be implemented using the funds exclusively from the Resilience and Recovery Mechanism (NPRR).

5. Upgrade the ISEM to carry out a financial analysis of the cost-effectiveness of renovation based on actual data.
6. ISEM's development is in the direction of so-called artificial intelligence, whereby the system proposes measures to increase energy efficiency according to input parameters.
7. Introduce measuring devices/sensors to measure indoor temperature and air quality in public buildings and connect to ISEM.

- Apart from upgrading the ISEM, this measure envisages continuing and broadening the scope of education for public and other sector institutions, creating a base of users familiar with energy efficiency and competent to act within their institutions, and elaborating the proposal that the position of energy manager be introduced in public institutions.

**Funds needed for implementation:** The funds required for the implementation of all planned activities are planned by APN as part of its regular activities and budget, while for the pilot project, funds from NPRR are provided exclusively (EUR 1.6 million).

**Sources of funding:** State Budget (APN) + NPRR for the Pilot Project.

**Executive body:** APN.

**Monitoring bodies:** ME-NKT.

**Impact:** Reducing energy consumption in public buildings; changes in the habits and behaviour of users of public sector buildings, estimated savings in 2030 0.20 PJ (4.78 ktoe); estimated $CO_2$ emission reductions in 2030 5.50 $ktCO_{2e}$; cumulative energy savings in 2021-2030 1.90 PJ (45.41 ktoe); cumulative $CO_2$ emission reductions in the period 2021-2030 54.13 $ktCO_2e$.

**Tracking method:** Up to now, monitoring energy savings has been made possible through the ISEM system through basic and advanced database analyses. The savings achieved are based on measured data on the consumption of all forms of energy. By connecting to metering systems, database synchronisation provides verified and real-time data that enables strategic planning and implementation of measures. Based on direct hourly monitoring of energy and water consumption through the ISEM system, quality indicators of energy needs are obtained, and they can be better planned and managed.

**Connection to other dimensions:** The public sector can become an informed player in the energy market through systematic monitoring and understanding of energy consumption.

**Research and development**: The obligation of systematic energy management in the public sector is stimulating research and development in monitoring and managing energy consumption in buildings based on information and communication technologies.

### ENU-8 Energy renovation programme of public lighting

Financial measure, energy services; implementation 2021 -2030

**Objective and description of the measure:** Energy renovation of public lighting in the Republic of Croatia is currently being implemented with EU funds from the European Regional Development Fund, using the financial instrument of loan at favourable interest rates offered by the CBRD to local and regional government units. To this end, EUR 20,17 million are available, and the loan covers up to 100% of eligible project costs. The estimated savings in this first phase of the Programme are around 15 GWh in 2023. By the end of 2030, the current potential is estimated at 225-280 GWh. At the same time, renovation of public lighting would meet the technical standards for road lighting, which would mean improving traffic safety and reducing light pollution. The financing models to be used in the next period should also enable the mobilisation of private capital through energy services or public-private partnerships to achieve the best multiplier effect. Models to be considered include subsidies for interest rates on commercial loans/required returns to the service and guarantee provider. For projects requiring investment in new public lighting infrastructure (columns, additional lamps and the like), securing grants to meet the standardised technical requirements is necessary. It has been assumed that by the end of 2030, all the estimated potential for improving the energy efficiency of the public lighting system will be achieved, and an annual electricity saving of 25 GWh (0.90 PJ; 2.15 ktoe) has been estimated. (Note**:** The objectives, conditions and activities set out in this document are indicative and will be detailed in the Energy Renovation Programme of Public Sector Buildings for the period up to 2030).

**Activities:** The following activities will be implemented within the measure:

- Ministry of Economy will develop an Energy Renovation Programme for the Public Lighting System for the period up to 2030, which the Government will adopt based on market models of project implementation;

**Funds needed for implementation:** The estimated investment cost until 2030 is around EUR 400 million.

**Sources of financing:** Private equity (ESCO companies), local self-government units.

**Executive body:** ME – establishes the implementation model by developing the Program, promotes and informs local self-government units; L(R)GUs – initiation of projects, contracting energy service/PPP

**Monitoring (supervisory) bodies:** ME - National Coordination Body for Energy Efficiency

**Impact:** Reduction of electricity consumption in public lighting systems, reduction of light pollution; estimated savings in 2030 0.90 PJ (21.50 ktoe); estimated $CO_2$ emission reduction in 2030 - 19.60 $ktCO_{2e}$; cumulative energy savings in 2021-2030 4.95 PJ (118.25 ktoe); cumulative $CO_2$ emission reduction in 2021-2030 - 157.95 $ktCO_{2e}$

**Monitoring method:** Energy-saving monitoring, measurement, and verification system using the bottom-up method to replace public and outdoor lighting

**Connection to other dimensions:** The potential integration of photovoltaic power generation systems for public lighting is directly linked with the decarbonisation dimension.

**Research and development**: Energy renovation of public lighting is an incentive for the further development of lighting technology and lighting management systems based on information and communication technologies and for integrating other services into the public lighting system (e.g., broadband Internet, etc.).

### ENU-9 Green Public Procurement

Information measure; implementation 2014 -2030

**Objective and description of the measure:** Public authorities are big consumers, so the share of public procurement in GDP varies from 14-17%. Therefore, by including environmental criteria in public procurement, i.e. by increasing the demand for green products and services, the development of the green market can be strongly influenced. Green products and services have a smaller environmental and carbon footprint. Therefore, green public procurement is a priority for the circular economy, energy efficiency and other energy-climate-environmental policies.

The implementation of green public procurement in Croatia was introduced with the 1st National Action Plan in 2015, following which numerous education and communication measures were initiated. The Law on Public Procurement („Official Gazette“, Nos. 120/16, 114/22) obligates using the most economically advantageous offer (ENP) criteria in public procurement procedures. The public contracting authority may not specify only the price or only the cost as the only criterion for selecting the offer. In that case, the relative weight of the price or cost may not exceed 90%. It enables the inclusion of green public procurement criteria in public procurement procedures, which achieves multiple positive environmental, social and financial effects.

The decision of the Government of the Republic of Croatia on green public procurement in central public procurement procedures („Official Gazette“, No. 49/21) obliges the Central State Office for Central Public Procurement, which is one of the significant contracting authorities in Croatia, to apply green public procurement criteria in its procedures to the extent that it is under technical suitability, financial possibilities, broader sustainability and a sufficient level of market competition. The Ministry responsible for environmental protection publishes the annual savings of carbon dioxide emissions resulting from implementing this Decision.

The Ministry of Economy conducts information and educational activities on green public procurement. It maintains a national website that serves as a communication channel for standards, examples of good practices, education, and other information related to green public procurement (www.zelenanabava.hr).

According to the latest Statistical Report on Public Procurement in the Republic of Croatia, concerning the value of the concluded contracts, about 10% of them used green public procurement criteria.

To further encourage green public procurement, binding goals and deadlines, improved monitoring and reporting, and hard work on education and information are necessary.

**Activities:** The following activities will be implemented within the measure:

- Informational and educational activities on green public procurement;
- Adopting binding minimum goals and deadlines for green public procurement for individual groups of products will be mandatory for all public procurement obligees, as well as determining monitoring and reporting methods.

**Funds needed for implementation:** The Ministry of Economy plans the funds required to carry out all the envisaged activities as part of its regular activities and budget**.**

**Sources of funding:** State budget (Ministry of Environmental Protection and Green Transition)

**Executive body:** Ministry of Economy in cooperation with the members of the Green Public Procurement Committee; Central State Office for Central Public Procurement; State administration bodies, L(R)GUs and other public procurement clients.

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Impact:** Reducing energy consumption and greenhouse gas emissions.

**Monitoring method:** Monitoring the achieved energy savings in the future will be carried out by applying BU methods for each group of devices that have been procured, respecting the energy efficiency criteria. The most significant number of purchases is expected to be related to computer and office equipment and motor vehicles. The Central State Office for Central Public Procurement Office monitors the data on the quantities and types of equipment purchased and submits data to the NCB, which enters them into the System for Measuring, Monitoring and Verification of Energy Savings. The quantities of all procurement procedures applying the 'green' criteria should be monitored.

**Connection to other dimensions:** Direct connection to the decarbonisation dimension (green electricity supply, electric vehicle procurement, etc.)

**Research and development**: Public procurement can drive development activities by continuously increasing 'green' requirements for devices, equipment and buildings.

### ENU-18 Increasing the energy efficiency of public water supply, drainage and wastewater treatment systems

Financial measure; implementation in 2024-2030.

**Objective and description of the measure**: Water services are activities of general interest and are performed as a public service; the infrastructure is owned by the public sector, i.e. local self-government units and/or regional self-government units, and legal entities for the management of water services and water-communal projects are local and/or district (regional) utility companies. The most energy-intensive process in this sector is the supply of drinking water, which accounts for about 43.5% of the total electricity consumption of water services and 1.13% of the total electricity consumption in the EU. The water services sector is a significant electricity consumer and has excellent potential for reducing energy consumption through more efficient management of resources, applying energy efficiency measures and

renewable energy sources. Increasing energy efficiency and the share of renewable energy sources in the water services sector would reduce operational costs and financial losses. The water services sector could be an excellent example of using the energy services of ESCO companies. It could also be considered the possible participation of the bond parties of the energy efficiency obligation system in achieving savings in the water services sector in proportion to the share of co-financing/encouragement in implementing measures. Most estimates of potential energy efficiency savings for water utilities in the EU indicate that savings of 10-30% are possible through operational improvements and investment. In comparison, up to 50% of energy savings can be identified in wastewater treatment plants.

**Activities**: As part of the measure, the following activities will be implemented:

- Inform stakeholders about the program and conduct educational workshops about its obligations, goals, and implementation;
- Evaluation of the current state of systematic energy management in the water services sector at the national level (APN);
- Drafting instructions for systematic energy management, data collection, and reporting (ISGE) to determine the energy consumption of the water services sector at the national level and the potential for increasing energy efficiency and the use of RES in the public water supply, drainage, and wastewater treatment system in the Republic of Croatia (Ministry of Protection Environment and Green Transition);
- Collection and analysis of data on energy consumption in public water supply, drainage and wastewater treatment systems; determination of priority locations for the implementation of measures to increase energy efficiency and RES; analysis and preparation of instructions for planning and programming financial resources for financing investment studies and project documentation (Ministry of Environmental protection and green transition);
- EPEEF implements this measure by announcing annual public calls. The criteria for these calls are developed in cooperation with the Ministry of Environmental Protection and Green Transition based on the analyses carried out.

**Funds needed for implementation**: Investment assessments will be made during and after the analyses. For the program's first phase, EUR 70 million has been secured from the Modernization Fund for the call issued by the Ministry of Environmental Protection and Green Transition.

**Sources of funding:** Modernisation fund, EPEEF, JL(R)S, Hrvatske vode, energy services of ESCO companies, obligees of the energy efficiency obligation system, state budget, EU

**Executive body**: Ministry of Environmental Protection and Green Transition, APN, JL(R)S, public local and/or regional (regional) utility companies for managing water services and water utility projects.

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Impact**: Estimated savings in direct consumption in 2030 amount to 0.15 PJ (3.58 ktoe; 41.67 GWh); estimated reduction of $CO_2$ emissions in 2030: 6.63 kt$CO_2$; cumulative energy savings

in 2026-2030: 0.45 PJ (10.75 ktoe; 125.00 GWh); cumulative reduction in $CO_2$ emissions in 2026-2030: 18.68 kt$CO_2$.

**Monitoring method**: According to the Rulebook on the System for Monitoring, Measuring and Verifying Energy Savings, achieved savings are monitored and proven using bottom-up methods.

**Connection to other dimensions:** Direct connection with the dimension of decarbonisation because the program encourages the use of renewable energy sources and the reduction of emissions through the use of more efficient equipment, systematic monitoring of energy consumption, modernisation of water infrastructure operations and the use of smart technologies, the sector has the potential to become an active participant in the energy market in the future (consumption response, dynamic electricity prices, electricity storage, etc.).

**Research and development**: Use of new technologies that contribute to decarbonisation goals; involvement of the local professional community in the project's development.

*Measures to promote energy audits and the energy management system*

The implementation of energy audits and the promotion of systematic energy management from 2021 to 2030, except through the leading role of the public sector, will be ensured by the continued application of legally binding provisions. Namely, based on the Act on Energy Efficiency, the Ordinance on Energy Inspections for Large Enterprises („Official Gazette“, Nos. 123/15, 05/20, 97/21), the Construction Act, and the Ordinance on Energy Inspection of Buildings and Energy Certification („Official Gazette“, Nos. 88/17, 90/20, 1/21 and 45/21), the following obligated parties in Croatia have the legal obligation to perform energy audits:

- Large enterprises (assets > EUR 17.23 mil, revenue > EUR 34.47 mil, > 250 employees) every four years (except where energy and environment management system (ISO 50001) has been set up with an energy audit obligation);
- Public lighting;
- Public buildings whose usable (net) area exceeds 250 m² every ten years;
- Existing buildings or parts of buildings constituting autonomous units and subject to the obligation of energy certification of buildings when they are sold, rented or leased;
- Regular inspection of the available parts of the heating system or the combined heating and ventilation system of the space with an effective nominal power of more than 70 kW, such as heat generators, control systems and circulation pumps or pumps used for building heating, at least once every ten years, as far as possible perform together with the energy audit of the building;
- Regular inspection of available parts of the cooling or air conditioning system or combined air conditioning and ventilation systems with an effective nominal power of more than 70 kW at least once every ten years, which can be done together with the energy inspection of the building;
- If the effective nominal power of the heating system or combined space heating and ventilation system, cooling or air conditioning system, or combined air conditioning and ventilation system is greater than 290 kW, it must be ensured that the building is

equipped with automation and building management systems if it is technically and economically feasible;

- Heating systems in buildings with boilers using liquid (> 100 kW every two years) or gaseous fuel with a total nominal power of 20 kW (every ten years) and larger (every four years);
- Cooling and air conditioning systems in buildings with one or more thermal/cooling energy generating units with a total nominal power of 12 kW and larger (every ten years).

These statutory obligations shall be adjusted continuously, particularly in light of the amended Energy Performance of Buildings Directive and the Energy Efficiency Directive, which imposes an obligation to introduce an energy management system in companies that are large consumers. The new requirements for energy audits and energy management systems will be transposed into the legislative framework by amendments to the Energy Efficiency Act and the relevant regulations that follow from it.

In addition, a new fiscal measure for promoting systematic energy management in the business sector is expected.

### ENU-10 Systematic energy management in the business (service & production) sector

Fiscal measure; implementation 2023-2030

**Objective and description of the measure:** Although large companies are obliged to carry out energy audits regularly, this obligation does not ensure continuous consideration of energy consumption in the company, nor does it include small and medium-sized enterprises. A comprehensive analysis will be performed regarding the possibilities of using the tax system (including taxes and parafiscal charges) to stimulate companies to introduce such a system and thus ensure continuous consideration of energy consumption to encourage companies to introduce certified energy management systems (ISO 50001).

**Activities:** The following activities will be implemented within the measure:

- In cooperation with the Ministry of Finance, the Ministry of Economy shall, in 2025, prepare a comprehensive analysis of the possibilities of using the tax system to encourage systematic energy management in the business sector - for each proposed solution, the effects must be evaluated, and the method for monitoring them should be defined;

**Funds needed for implementation:** The funds required to develop a comprehensive analysis of the use of the tax system to stimulate systematic energy management in the business sector are planned by the Ministry of Economy as part of its regular activities and budget; the implementation of the tax policy itself does not require additional funds

**Sources of funding:** State budget (ME)

**Executive body:** ME – preparation of analysis and solution proposal; MFIN - integration of proposed solutions into the tax system.

**Monitoring bodies:** ME - National Coordination Body for Energy Efficiency

**Impact:** Reducing businesses' energy consumption in the service and industrial sectors.

**Monitoring method:** The monitoring method for the selected tax solution will be determined.

**Connection to other dimensions:** Through systematic monitoring and understanding of energy consumption, the business sector can become an informed participant in the energy market and choose solutions that will contribute to decarbonisation.

**Research and development**: Encouraging systematic energy management opens the need for research and development of energy monitoring and management systems based on information and communication technologies.

*Providing information to consumers and training measures*

Providing information to consumers will continue by improving the implementation of existing regulatory and informational measures.

### ENU-11 Information on energy efficiency

Informational measure; implementation 2014 -2030

**Objective and description of the measure:** Providing information to the general public and target groups shall be conducted by organising targeted information campaigns related to specific programmes encouraging energy efficiency, particularly energy renovation of buildings.

The National Coordination Body for Energy Efficiency (NCB) will maintain the national energy efficiency portal and provide up-to-date information to ensure the continued promotion of energy efficiency and energy services. Particular attention should be given in the following period to informing consumers of the supplier's obligations within the obligation system.

**Activities:** The following activities will be implemented within the measure:

- Ensuring continuous information through the National Energy Efficiency Portal – portal www.enu.hr is the central point for current information on energy savings in the Republic of Croatia. The portal's content is grouped around three fundamental drivers of change: citizens, the public sector, and the commercial sector along the EE heading in Croatia, which contains all essential documents, strategic orientations and information on institutions operating within the field of energy efficiency. The portal publishes all information on activities, advice, events, projects, tenders, news and obligations related to energy efficiency in the Republic of Croatia. ME - NCBEE is committed to maintaining and ensuring the full functionality of the portal;
- Targeted information campaigns need to be implemented as part of other measures, in particular energy renovation measures for buildings, and the bodies responsible for implementing these measures are also in charge of implementing information activities.
- Targeted information campaigns should also be directed to the professional public, which, in cooperation with other stakeholders (professional associations, academic community, non-governmental organizations, etc.), should be regularly informed

about the current issues and trends in the field of energy efficiency, including green building, circular economy and sustainable mobility.

**Funds needed for implementation:** The funds required to carry out all the activities envisaged are planned by the ME as part of its regular activities and budget.

**Sources of funding:** State budget (ME)

**Executive body:** ME - NCBEE; Bodies responsible for implementing other measures (MCPPCSA, EPEEF, L(R)GUs, etc.)

**Monitoring bodies:** ME - National Coordination Body for Energy Efficiency

**Impact:** Increasing awareness of the benefits of energy efficiency with the consequent change in behaviour and reduction in energy consumption by applying concrete measures.

**Monitoring method:** Monitoring the impact of this measure is possible by applying top-down methods on the sectoral level. Market research should be done before conducting each info campaign, and the effects should be proven by repeating the same survey after the campaign.

**Research and development**: The measure encourages innovation in the information segment (use of information and communication technologies).

### ENU-12 Development of a framework to ensure adequate skills in the context of green jobs required for building renovation

Educational measure; implementation 2017-2030

**Objective and description of the measure:** Training will be achieved by implementing the existing measure and adapting the activities to the needs and the actual situation. It is essential to systematically work on attracting young people to construction and other technical occupations, which will contribute to the availability of professional staff to implement energy renovation of buildings in the long run, which is the basis for achieving the set energy and climate targets. 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 (building on the principles of sustainability) as an essential segment of sustainable development and the circular economy. The aim is to develop a framework for ensuring adequate skills for a long-term, complex and systematic reconstruction process after the earthquakes by improving educational and training programs.

**Activities:** The following activities will be implemented within the measure:

- It is envisaged to further implement the system of continuous training and certification of construction workers - through authorized CROSKILLS training centres, according to the Ordinance on the system of training and certification of construction workers who install parts of the building that affect energy efficiency in building construction. It should lead to increased use of energy efficiency and renewable energy sources in everyday construction practice and increased demand for an educated workforce by increasing the practical knowledge of on-site workers specialising in all phases of construction and maintenance procedures.

- Further implementation of the system of continuous training and certification of construction workers through the Holder of the training program, certification program or equivalent qualification program for installers of renewable energy systems: photovoltaic systems, solar thermal systems, shallow geothermal systems and heat pumps and smaller boilers and biomass furnaces is foreseen, and all according to the regulations on conditions and criteria for determining the quality system of services and works for the certification of installers of renewable energy sources[31].
- A National Skills Development Plan will be developed for green jobs related to energy renovation and post-earthquake reconstruction.
- National guidelines for continuously training construction workers in energy efficiency will be improved and implemented.
- Develop educational programs to encourage greater use of BIM (Building Information Modelling) in the construction and spatial planning system to develop relevant skills with integrated knowledge of energy renovation and post-earthquake reconstruction.
- Promote the use of BIM technology in the construction and spatial planning sector.
- Implement a campaign for retraining and training workers for post-earthquake reconstruction and promote educational programs that are the subject of this reform, intending to attract interested participants to the program.

**Funds needed for implementation:** The funds required to carry out all the activities envisaged should be determined based on the results and recommendations of CROSKILLS training centres.

**Sources of financing:** NRRP – secured EUR 4.05 million; EU funds for strengthening human resources to integrate the principles of green and sustainable construction and circular economy into the existing systems of vocational education, adult education and lifelong learning.

**Executive body:** AVETAE – co-financing training centres for the implementation of worker training; CES – co-financing of training/retraining of the unemployed; Faculty of Civil Engineering in Zagreb, within the CROSKILLS project; MCPPCSA - setting up and applying the principles of green building in cooperation with the Croatian Green Building Council and the Faculty of Architecture (AF).

**Monitoring bodies:** MPPCSA and Ministry of the Environmental Protection and Green Transition.

[31] Rulebook on conditions and criteria for determining the quality system of services and works for the certification of installers of renewable energy sources - photovoltaic systems („Official Gazette“, No. 56/15); Rulebook on conditions and criteria for determining the quality system of services and works for the certification of installers of renewable energy sources - solar thermal systems („Official Gazette“, Nos. 33/15, 56/15 and 12/17); Rulebook on conditions and standards for determining the quality system of services and works for the certification of installers of renewable energy sources - smaller boilers and biomass stoves („Official Gazette“, Nos. 39/15, 56/15 and 12/17); Rulebook on conditions and standards for determining the quality system of services and works for the certification of installers of renewable energy sources - shallow geothermal systems and heat pumps („Official Gazette“, Nos. 56/15 and 12/17))

**Impact:** Available expert capacities to implement energy efficiency measures.

**Monitoring method:** The number of educated experts within established educational programmes/training centres is monitored.

**Connection to other dimensions:** Through education on green building, which includes significant use of RES, the connection with the dimension of decarbonisation is achieved.

**Research and development**: Educational activities in the field of green building stimulate research and development in this segment (technologies and methods for 'greening' of buildings).

*Measures in the process industry sector*

From 2021 to 2030, ETS (MS-3: European Emission Trading System) remains the main policy instrument for reducing industrial sector emissions. For non-ETS facilities, the obligation to pay $CO_2$ emission fees shall remain, according to the Regulation on unit charges, corrective coefficients and detailed criteria and standards to determine the special environmental fee for motor vehicles („Official Gazette“, Nos. 73/07, 48/09, 2/18, 46/21), and the decisions on the amount of the unit fee for greenhouse gas emissions for operators of non-ETS facilities.

In addition, the system of suppliers' obligations is expected to improve energy efficiency in this sector by exploiting cost-effective energy efficiency potentials and using market models, such as energy efficiency contracting. From 2027, fossil fuel suppliers will enter the EU ETS2.

From 2021 to 2030, financially encouraging energy efficiency measures and using RES in manufacturing industries from public sources are also foreseen.

**ENU-17 Increasing energy efficiency and use of RES in manufacturing industries**

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** EUR 60 million was secured from the EU Funds in the past period, based on the OPCC. The absorption of funds was excellent, which proves that industrial plants in the Republic of Croatia have significant potential for improving energy efficiency, reducing energy consumption and reducing the share of conventional (fossil) fuels in total energy consumption by introducing renewable energy sources. This measure aims to ensure the continuation of co-financing of implementing such measures in manufacturing industries through grants and financial instruments.

**Activities:** The following activities will be implemented within the measure:

- All available funding sources that can be used to ensure co-financing of energy efficiency measures and RES in the industry will be identified, considering national and EU financing sources (EU Funds, Modernisation Fund, Recovery Fund, etc.)
- For each identified funding source, eligible projects will be identified, and the financing mechanism and method of its implementation will be elaborated in detail.
- These programmes shall be provided as set out in the relevant documents.

- State aid award program for investment in energy efficiency measures and high-efficiency cogeneration in the production sector.
- Program for awarding state grants for investments in promoting energy from renewable energy sources.

**Funds needed for implementation:** It is impossible to determine until detailed analyses have been carried out.

**Funding sources:** NRRP (which provides EUR 61 million) PCC (EUR 150 million roll out financial instruments) and Modernisation fund (EUR 160 million).

**Executive body:** Ministry of Environmental Protection and Green Transition, in cooperation with the Ministry of Economy and other bodies, using EU funds, NPRR, and EPEEF.

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Impact:** Reducing the energy consumption of businesses in the industrial sector. Estimated cumulative savings until 2030: 29.81 PJ (711.95 ktoe); estimated reduction of $CO_2$ emissions in 2030: 1,157.87 kt$CO_2$e.

**Monitoring method:** Depending on the type of projects implemented, the methods defined in the Ordinance on the Energy Saving, Monitoring, Measurement and Verification System will be used.

**Connection to other dimensions:** No risk.

**Research and development**: Given the diversity and continuous development of industrial production, this measure opens up the need for further research and development of more energy-efficient industrial technologies and renewable energy sources.

v. If applicable, a description of policies and measures to promote the role of local RES energy communities in contributing to implementing the policies and measures referred to in subitems i., ii., iii. and iv.

Energy communities will be promoted under the RES-7 measure.

vi. A description of the measures to identify measures aimed at exploiting the potential for increasing the energy efficiency of gas and electricity infrastructure

Measures to increase the energy efficiency of the electricity infrastructure (transmission and distribution networks) are based on the Ten-Year Development Plans of the Transmission Network for the period from 2023 to 2032 and the Ten-Year Development Plan of the Distribution Network for the Period 2024 to 2033 and the CERA Decision on Implementation of Energy Efficiency Measures. The measure to increase the energy efficiency of the gas transmission system is based on the Ten-Year Development Plan for the Gas Transmission System from 2021 to 2030. For Croatia, improving the infrastructure for producing, transmitting, and distributing energy for heating and cooling is essential.

## ENU-13 Energy efficiency of the power transmission system

Financial and organizational measures; implementation 2021-2030

**Objective and description of the measure:** Current losses in the transmission grid of the Republic of Croatia amount to about 2% of the transmitted electricity, which is the amount at the level of other operators in the ENTSO-E transmission system. An essential feature of the Croatian transmission grid regarding plant safety and support of market activities and losses is the powerful connection with neighbouring electricity systems (interconnections). On the one hand, this significantly increases the plant's safety, but on the other hand, the transmission increases the grid losses. CTSO (Croatian Transmission System Operator) will continue to implement measures related to the operation of the electricity system operation development and measures associated with the development of the transmission grid by 2030 to reduce technical losses in the grid further. For this measure, along with the provision of funds by CTSO, it is proposed to program the use of EU funds in the next programming period, 2021 - 2027.

**Activities:** The following activities will be implemented within the measure:

- Measures related to the operation of the electricity system: topological changes in the grid depending on the current operating state; change of switching state of transformers 400/220 kV, 400/110 kV, 220/110 kV and 110 /x kV owned by/within the competence of CTSO and optimization of operation of transformers with oblique control (TS Žerjavinec, TS-HPP Senj); voltage management and optimization of power flows in the grid; voltage regulation and reactive power compensation optimization of generator operation (operating points with power factor in the range 0.95 -1).
- Measures related to the short-term and long-term development of the transmission network include the replacement of old power transformers with new transformers with more minor losses, revitalization of old powerlines with the replacement of conductors, using HTLS conductors with a larger cross-section of aluminium sheath or more minor losses; replacement of submarine 110 kV cables; transmission network reinforcements (construction of new lines); installation of devices for reactive energy compensation (VSR, SVC); replacement of overhead 110 kV lines with cable lines.

Replacing older equipment with new ones, which has a reduced loss, reduces overall system-level losses. Further reduction of losses in the future can be achieved by developing new and more energy-efficient technologies and further revitalising and constructing the grid using the latest generation conductors with more negligible electrical resistance, i.e., more minor losses.

**Funds needed for implementation:** The funds required for the implementation of all planned activities of the ten-year transmission network development plan 2023-2032 total EUR 1.246 billion, of which EUR 563 million are CTSO's own funds and EUR 345 million for facility connections (from connection fees and/or EU funds). In addition, EUR 335 million has been allocated for the transmission system alone for the modernization, digitalization and revitalization of the electricity system through the NPOO.

**Funding Sources:** CTSO, EU funds, NRRP

**Executive body:** CTSO

**Monitoring bodies:** ME - National Coordination Body for Energy Efficiency, CERA

**Impact:** The following table shows the reduction of losses in the transmission system

| Measure | Estimation of potential savings in losses (GWh/year) | | |
|---|---|---|---|
| | 2022 – 2024 | 2025- 2026 | 2027 – 2031 |
| **Replacement of conductors in the overhead lines (HTLS conductors)** | 0.4 | 0.5 | 0.6 |
| **Replacement of 110 kV submarine cables** | 0.9 | 1.5 | 1.5 |
| **Planned grid reinforcement** | 7.8 | 14.9 | 18.8 |
| **Installation of compensation devices (2xVSR + 1xSVC)** | -3.2 | -3.5 | -3.5 |
| **The planned replacement of power transformers** | 0.2 | 0.2 | 0.3 |
| **Planned cabling of 110 kV overhead lines** | 0.1 | 0.4 | 0.5 |
| **Optimising power flows** | 0.7 | 0.7 | 0.7 |
| **Optimising the operation of power transformers** | 5.6 | 6.8 | 7.3 |
| **Sum of application of all measures (GWh/year)** | 15.9 | 25 | 38 |

According to these estimates, in the period 2022-2024, it is possible to expect savings in electricity losses of about 15.1 GWh on average per year, in the period 2025-2026 about 25 GWh on average per year, and in the period 2027-2031 about 38 GWh on average per year.

The estimate of the savings is entirely based on the assumptions given in the Ten-Year Grid Development Plan 2022-2031 made by CTSO.

**Monitoring method:** The monitoring of the effects of this measure is achieved based on data on realized electricity losses before and after the implementation of the measure with normalization according to the amount and duration of the load – CTSO has developed a methodology for calculating savings from energy efficiency measures in the transmission network and the savings will be determined according to this methodology.

**Connection to other dimensions:** Investments in the transmission grid directly affect the dimensions of energy safety and the internal energy market while reducing losses and achieving decarbonisation goals.

**Research and development**: The measure entails research and development by developing new and more energy-efficient technologies related to the transmission system (electricity equipment) and its management (information and communication technologies).

## ENU-14 Reduction of losses in the distribution power grid and introduction of smart grids

Financial and organizational measures; implementation 2021-2030

**Objective and description of the measure:** In the period of up to 2030, HEP-DSO will continue to conduct activities to reduce technical and non-technical losses in the distribution power grid. A detailed analysis will identify the causes of increased losses in some parts of the grid and the priorities for implementing activities to reduce technical and non-technical losses. Based on the experience gained from the implementation of a pilot project for the deployment of advanced grids in pilot areas using EU funds, it is necessary to programme the continuation of the use of EU funds in the next programming period from 2021 to 2027 for the further development of advanced grids.

**Activities:** The following activities will be implemented within the measure:

- Technical loss reduction activities, including:
  - Increasing the cross-section of the conductors in the initial parts of MV and LV bushings in which the highest amount of losses is generated
  - separation of MV and LV bushings into two or more, depending on the topology of the bushing and the acceptance options in TS HV/MV and MV /MV or TS MV /LV
  - moving part of the LV bushing to an adjacent closer and/or less loaded LV bushing or TS MV/LV
  - replacement of HV/MV and MV /MV power transformers due to overload
  - replacement of old MV/ LV energy transformers, with reduction of transformer over-dimensioning
  - interpolation of new TS HV/MV, MV/MV and MV/LV (primarily when overloading existing TSs, i.e. when connecting new customers and manufacturers with larger connecting power)
  - transition to 20 kV and gradual introduction of 110/10 (20) kV direct transformation
- Non-technical loss reduction activities, which include:
  - further installation and introduction of as many advanced meters into the remote monitoring and readout system as possible
  - further comprehensive implementation of the connection and measuring points control (KPiMM), with an emphasis on detecting unauthorized electricity consumption
  - and continued reconstruction of existing connections and measuring points located in the customers' premises.

**Funds needed for implementation:** HEP-DSO funds: The total investment cost of installing advanced metering devices in all 2.4 million measuring points from 2021 to 2030 is

approximately EUR 313 million [32]. Of the above amount, 223.8 million euros were allocated and granted for use to HEP-DSO through the NRRP.

As EU directives require the transition from conventional metering to advanced metering devices, From the NPOO, the largest part of the aforementioned 223.8 million euros for the above activities, i.e. 150 million euros, was allocated specifically for the area of adapting the existing metrology system to a system for working with advanced measuring devices. First, it is an investment in installation of smart meters, adapting the existing authorized services for the preparation of calibration meters (gauges), which are adapted to the verification of electro-mechanical meters, to the technology that enables the preparation and certification of advanced electronic meters. With the adjustments, it is also required to make available the support to work with new technologies, above all solving communication problems (G3 PLC) and computing process problems (upgrades of FW meters and hubs, data acquisition, transmission and processing).

The operator of the distribution system is in the focus of the energy transition regarding the scope and costs of the necessary transformation from a simple distribution of electricity to an operator of an active distribution system and support for the active participation of a large number of network users in the energy transition. The ten-year investment plan of HEP-DSO can be used to assess the necessary investments, according to which in the ten-year period 2024-2033. planned investments in the total amount of EUR 1.42 billion, of which:

- Investments in 110kV energy facilities: EUR 241 mil.
- Investments in 35 kV energy facilities: EUR 148 mil.
- Investments in 10kV and 20 kV energy facilities: EUR 273 mil.
- Investments in low-voltage facilities: EUR 103 mil.
- Investments in secondary systems, measuring devices and development: EUR 297 mil.
- Investments in business infrastructure: EUR 129 mil.
- co-financed investments (over 98% from NPRR) EUR 233 mil.

From 2024 to 2030, investments in the total amount of EUR 1.08 billion are planned.

In addition, an investment of EUR 100 mil. per year is forcasted from the connection fee for the purposes of creating electricity conditions and connecting network users. At the same time, it is important to note that investments in the connection of RES to the distribution network depend on the way the measures are implemented and will be significantly higher in the event that, instead of the maximum use of already existing electricity infrastructure and electricity production, they are integrated within built-up areas, in capacities suitable for energy needs near the location of production, they are developing large capacities of

[32]The stated amounts of investments and the number of advanced meters and other systems included in the advanced measurement infrastructure are based on the results of analyses for the comprehensive introduction of advanced measurement carried out in 2017. According to Art. 31 of the Electricity Market Act, an economic assessment of all long-term costs and benefits of such a system for the market and individual end customers is underway and the assessment of the necessary funds and effects on the reduction of electricity losses will be revised.

electricity production in locations far from consumption and the existing electricity infrastructure.

**Funding Sources:** HEP-DSO, EU funds

**Executive body:** HEP-DSO

**Monitoring bodies:** ME, CERA

**Impact:** Reduction of losses in the electricity distribution grid – HEP DSO prepares a balance sheet for the previous year, which separately shows electricity losses.

Total electricity losses consist of technical and non-technical losses. Technical losses are due to the distribution grid's operating state and the grid elements' technical characteristics. They can be divided into:

- Voltage-dependent, i.e. permanent losses resulting from the maintenance of the ES in standby mode for the supply of customers with electricity;
- Electricity-dependent losses, i.e. variable losses resulting from the flow of electricity through the components of the ES.

Based on the assumed changes in load, consumption, investment features and start-up of individual facilities, a possible total reduction in technical losses with the implementation of the 10-Year Grid Development Plan 2019-2028 is estimated at 284 to 455 GWh (these values represent cumulative savings in a given period), of which in the first three years (period 2019-2021) from 8.5 to 13.4 GWh on average per year. Measured according to the average annual consumption in 2015-2017 of 16,310 GWh, the average yearly decrease in technical losses in 2019-2021 ranges from 0.05% to 0.08%. The effect of measures, i.e. the reduction of technical losses, grows over the years as the scope of measures increases with time. For example, the number of transformers with reduced losses will be significantly higher at the end of the ten years; therefore, the annual savings at the end of the ten years will also be higher.

Non-technical losses, i.e. commercial losses, are the consequence of the taken over, i.e. consumed electricity that has, for some reason, not been accounted for. According to the estimate of the share of technical and non-technical losses in the total losses of the distribution grid, technical and non-technical losses account for about 50% of the total losses. Accordingly, for assessing the effect in the period 2021-2030, a constant proportion of technical (50%) and non-technical losses (50%) in the total electricity losses was assumed.

| **Projection of electricity losses in TWh** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
| **Technical losses** | 0.658 | 0.662 | 0.665 | 0.668 | 0.672 | 0.675 | 0.678 | 0.682 | 0.685 | 0.689 |
| **Non-technical losses** | 0.658 | 0.662 | 0.665 | 0.668 | 0.672 | 0.675 | 0.678 | 0.682 | 0.685 | 0.689 |
| **Total losses** | 1.316 | 1.324 | 1.330 | 1.336 | 1.344 | 1.350 | 1.356 | 1.364 | 1.370 | 1.378 |

Implementing advanced metering devices and systems for their networking reduces non-technical electricity losses with end customers. Advanced meters are equipped with indicators for power outages and parameter changes, which detect unauthorized power consumption by signalling unauthorized access to the device and its unauthorized use and, ultimately, remote shutdown of power to the customer, at which point such behaviour was detected.

Summation meters installed in transformer stations based on measurements of total consumption and energy production at low-voltage outputs from the transformer station allow accurate calculation of energy losses in the medium voltage and low voltage distribution grids, comparing the amount of energy consumed in TS MV/ LV and the amount of energy consumed by end customers. By installing summation meters, more efficient and faster detection and reduction of unauthorized consumption is expected.

Several cost-benefit analyses for installing advanced measuring devices in EU Member States have identified an expected reduction in unauthorized consumption of 50% of non-technical losses (Lithuania, Slovenia), which aligns with the experience of other international pilot projects. Based on the above, the forecast for reducing unauthorised consumption in Croatia is set at 50% of non-technical losses.

The non-technical losses incurred during the reference period by the implementation of advanced measuring devices and their networking systems are shown in the table below and calculated based on an estimate of the amount of non-technical losses, an estimated maximum reduction of unauthorized consumption of 50% of the total non-technical losses after completion of the implementation of advanced metering devices and systems for their networking.

| **Projection of electricity losses with the implementation of advanced measuring devices and systems for their networking in TWh** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
| **Technical losses** | 0.658 | 0.662 | 0.665 | 0.668 | 0.672 | 0.675 | 0.678 | 0.682 | 0.685 | 0.689 |
| **Non-technical losses** | 0.496 | 0.467 | 0.438 | 0.409 | 0.379 | 0.350 | 0.321 | 0.321 | 0.321 | 0.321 |
| **Total losses** | 1.154 | 1.129 | 1.103 | 1.077 | 1.051 | 1.025 | 0.999 | 1.003 | 1.006 | 1.010 |

Cumulative energy savings in the period 2021-2030 24.4 ktoe (284 GWh; 1.0 PJ); cumulative $CO_2$ emission reductions in the period 2021-2030 32.6 kt$CO_2$e.

The savings estimate is entirely based on the assumptions in the 10-Year Distribution Grid Development Plan 2019-2028 of HEP-DSO.

**Monitoring method:** HEP-DSO prepares a balance sheet for the previous year, explicitly showing electricity losses.

**Monitoring method:** HEP-DSO prepares a balance sheet for the previous year, explicitly showing electricity losses.

**Connection to other dimensions:** Investments in the distribution grid directly affect the dimensions of energy safety and the internal energy market while reducing losses and

achieving decarbonisation goals. Advanced measurements strengthen the customer's role in the energy market.

**Research and development**: The measure entails research and development by developing new and more energy-efficient technologies related to the distribution system (electricity equipment) and its management (information and communication technologies for advanced grids and advanced metering).

### ENU-15 Increasing the efficiency of the district heating system

Financial and organizational measures; implementation 2021-2030

**Objective and description of the measure:** In the existing large centralised heating systems, a significant source of losses is the deteriorated distribution 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 towards the fourth generation of district heating. In smaller systems with their own boiler room, it is necessary to allow for 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. Given the provisions of Directive 2018/02 on energy efficiency, and in particular with the introduction of the obligation of individual measurement at the level of the end-user, district heating systems have become systems with variable heat demand, which requires the introduction of advanced metering systems as an additional step towards the integration of different energy systems and increasing overall energy efficiency.

**Activities:** The following activities will be implemented within the measure:

- Preparation of documentation for replacement of the deteriorated distribution systems;
- Replacement of distribution systems with deteriorated insulation of steel hot water pipes and steam lines with new pre-insulated pipes;
- Introduce advanced metering.

**Funds needed for implementation:** An estimate of the funds has yet to be made according to the plans of the DHS operator

**Funding Sources:** DHS Operators, EU Funds

**Executive body:** Manufacturers, distributors and suppliers of heat from DHS

**Monitoring bodies:** ME - National Coordination Body for Energy Efficiency

**Impact:** Reducing losses in DHS

**Monitoring method:** The monitoring of the effects of this measure is achieved based on data from district heat distributors on losses before and after the application of the measures.

**Connection to other dimensions:** Decarbonisation, energy safety, internal energy markets

**Research and development**: Transition to the fourth and fifth generation of district heating and cooling; energy storage; flexibility of energy systems

### ENU-16 Increasing the efficiency of the gas system

Financial and organizational measures; implementation 2021-2030

**Objective and description of the measure:** The potential for increasing the energy efficiency of the gas transmission system is the largest in the consumption of natural gas, which is mostly (70%) consumed for preheating of natural gas before delivery to customers, and only a more minor part (30%) for heating of business premises and various technological burdens, i.e. blowing out the system. In the coming period, Plinacro will carry out energy efficiency improvement activities following the Ten-Year Plan for the Development of the Croatian Gas Transmission System 2021-2030.

**Activities:** The following activities will be implemented within the measure:

- Pressure reduction, from the pressure of the transmission system to the delivery pressure to the customers, causes significant subcooling of natural gas, which is unacceptable for technical and safety reasons and, consequently, for commercial reasons. This preheating is carried out at reducing metering stations and reducing metering nodes through gas boilers and associated heat exchangers and heating cables. Considering that newer and more efficient designs have replaced preheating systems on most of the measuring-reduction stations in the previous period, their energy efficiency aims to be maintained by regular maintenance and, if necessary, replacing them with new systems of maximum energy efficiency. In the next period, Plinacro will continue systematically replacing boiler equipment (boilers, burners, boiler management system).
- One of the measures, which has already been implemented in several facilities, is to reduce the preheating temperature of the exhaust gas from the previous 15°C to 12°C, thus achieving additional savings. From 2016 to 2019, natural gas consumption for preheating decreased by 16%. However, the stated temperature reduction will only be possible for those facilities where a reduced outlet gas temperature will not affect the gas supply's safety and customers' safety.
- There is room for increased energy efficiency in optimising the gas transmission system concerning system pressures. Lower transmission system pressure means less gas reduction for the user and less preheating, thus less energy and gas consumption. Of course, these possibilities are currently limited due to the current technical characteristics of the gas transportation system, the conditions for taking over domestic gas and gas from imports and its delivery to customers. However, with the further development of the gas transmission system, above all compressor stations, which are necessary but will be significant customers of propulsion energy, optimal operation and management of the system will have to be given great attention. Every effort should be made to minimize technological gas emissions when maintaining the system.

- Electricity in the gas transmission system is used to drive electrical appliances, provide cathodic protection, and provide lighting. Although its share in the energy consumption of the gas transmission system is significantly less than that of natural gas, its regular maintenance and (where necessary) replacement of inefficient energy-using devices will effectively reduce its consumption.

**Funding Sources:** Plinacro

**Executive body:** Plinacro

**Monitoring bodies:** ME - National Coordination Body for Energy Efficiency, CERA

**Impact:** Reducing losses in the gas transportation system

**Monitoring method:** The effects of this measure are monitored based on Plinacro data

**Connection to other dimensions:** Reducing losses in the gas system contributes to the goals of supply safety, decarbonisation, and the internal energy market.

### vii. Regional cooperation in this area, if applicable.

At a regional workshop held in Ljubljana in July 2019, the proposed topics for regional cooperation within the energy efficiency dimension were

- exchange of experience and good practice in the field of energy efficiency,
- regional freight management (encouraging the use of rail transport energy-efficient logistics),
- regional planning for the development of alternative fuel infrastructure,
- regional cooperation on developing efficient public transport (rail, bus, green tourism).

### viii. Financial measures in this area at the national level, including EU support and use of EU funds.

For the period up to 2020, the following financial resources are available to stimulate energy efficiency in Croatia:

- Funds from the sale of greenhouse gas emission allowances from EU ETS, distributed following the Plan for the use of financial resources obtained from the sale of the emission allowances in auctions in Croatia by 2020 („Official Gazette“, No. 19/18) and
- ESI Funds, particularly the European Regional Development Fund (EFRR) following the Operational Programme Competitiveness and Cohesion 2014-2020.

ERDF measures and related activities were implemented until the end of 2023. The impact of activities implemented after the beginning of 2021 is monitored and counted from 2021 to 2030.

In the period 2021-2030, for the financial measures envisaged by this Plan, national funds from the sale of emission allowances will be used, along with other revenues from the Environmental Protection and Energy Efficiency Fund, as well as EU funds for the new programming period 2021 - 2027, with implementation until 2030. **It is necessary to include in all programme and planning documents that determine the operation of the Environmental Protection and Energy Efficiency Fund and the use of EU funds the measures proposed herein and plan for sufficient funds for their implementation**.

For the implementation of the measures defined in this NECP, funds were provided based on the National Recovery and Resilience Plan (NRRP), for the use of the Recovery and Resilience Mechanism, and the Competitiveness and Cohesion Programme (PCC), for the use of EU Funds, primarily the ERDF. In addition, the funds collected from the sale of emission allowances through EU ETS, which the EPEEF collects, and the funds of the Modernization Fund are also planned to be used. An overview of the available funds is given in the table below.

**Table 3-1 Overview of available sources of financing for energy efficiency measures**

| Funds source | Investment priorities / Reform | Available allocation from NRRP [mil. EUR] | Available allocation from Suppl. NRRP [mil. EUR] | Existing financial measure | Financing mechanism |
|---|---|---|---|---|---|
| **NRRP and Supplement to NRRP** | C6.1. R1-I1 Energy renovation of buildings<br>C7.2.11 Energy renovation of buildings | 39.82 | 120 for undamaged MAB<br>54.5 for MAB damaged in earthquakes | Energy renovation programme for multi-apartment buildings (ENU-3) | Grants |
| | C7.2.12 Renovation of buildings damaged in the earthquake with energy renovation | 73.00 | 93.36 | Programme of energy renovation of public sector buildings (ENU-5) | Grants |
| | | 19.91 | 68.41 | Energy Poverty Reduction Programme (UET-6) | Grants |
| **NRRP** | C6.1. R1-I3 Energy renovation of buildings with the status of cultural property | 39.82 | | Energy renovation of buildings with the status of protected cultural heritage (ENU-6) | Grants |
| **NRRP** | C6.1. R6 Pilot project of establishment and implementation of systematic energy management and development of a | 1.59 | | Systematic Energy Management in the Public Sector (ENU-7) | Grants |

| | | | | | |
|---|---|---|---|---|---|
| | new financing model | | | | |
| | C6.1. R2 Development of a framework to ensure adequate skills in the context of green jobs needed for post-earthquake reconstruction | 4.05 | | Development of a framework for ensuring adequate skills in the context of green jobs required for the renovation of buildings (ENU-13) | Grants |
| **NRRP** | C1.2. R1-I2 Fostering energy efficiency, heating and renewable energy sources to decarbonise the energy sector | 61.05 | | Increasing energy efficiency and use of RES in manufacturing industries (ENU-19) | Grants |
| **CCP-EFRD** | RSO2.1. Promoting energy efficiency and reducing greenhouse gas emissions | 150.00 | | Increasing energy efficiency and use of RES in manufacturing industries (ENU-19) | Financial instrument: loan |
| | | 89.00 | | Energy renovation programme for multi-apartment buildings (ENU-3) | Financial instrument: loan |
| | | 185.00 | | Programme of energy renovation of public sector buildings (ENU-5)<br>Energy Poverty Reduction Programme (UET-6) | Grants |
| **EPEEF** | Funds raised through the sale of emission units from EU ETS | 145.00 (for the period up to the end of 2025) | | Family Energy Renovation Programme (ENU-4) | Grants |
| **Modernisation Fund** | Supporting investment in energy efficiency measures and high-efficiency cogeneration in the manufacturing industry | 80.00 | | Increasing energy efficiency and use of RES in manufacturing industries (ENU-17) | Grants |

## 3.3 Dimension: Energy security

### i. Policies and measures relating to the elements referred to in 2.3.

Policies and measures relating to the elements referred to in 2.3. are classified by sectors, such as electricity, district heating systems, gas and oil, and petroleum products, and are presented below.

#### ES-1 Construction and use of energy storage facilities

Financial measure; implementation 2025 - 2030

**Objective and description of the measure:** It is planned to build additional energy storage tanks based on battery systems (at the producer, at the level of the transmission and distribution network, at the consumer), hydrogen technology, and reversible hydroelectric power plants to increase the possibility of energy storage in the system and increase the regulatory possibilities of the electricity system then develop heat storage tanks with producer/end customers, introduce charging stations for electric vehicles that enable energy storage, develop underground energy storage in the form of compressed gas and use other innovative energy storage technologies (financed from EU funds). By 2030, the need for the construction of battery tanks with a total power of 250 MW is foreseen.

**Activities:**

- Construction of storage tanks at users of the electric power network
- Construction of heat storage tanks at the manufacturer's location, at the level of the distribution network of heat systems

**Funds needed for implementation:**

- The total necessary funds for the construction of battery tanks are estimated at EUR 250 million.

**Sources of financing:** Modernization Fund, NRRP

- Funding from the Modernization Fund in the priority investment category for which a total of 70% of funds are allocated for the production and use of renewable electricity, improving energy efficiency, **energy storage**, modernization of the energy grid and the transition of coal-dependent regions

**Executive body:** Participants in the electricity market

**Monitoring bodies:** ME

**Impact**: Approval and monitoring of the implementation of the Ten-Year Development Plan of the CTSO Transmission Grid and the Ten-Year Development Plan of the HEP-DSO Distribution Grid

**Monitoring method:** Ten-year Transmission and Distribution Grid Development Plan

**Research and development:** Investing in research and development of new technologies to modernize and increase the need for the adoption of RES in the electricity and heat grid

## ES-2 Improvement of the electricity system management

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** The current electricity system will not be able to accept many renewable energy sources planned by 2026 and 2030, which is necessary because producing energy from renewable sources is one of the most critical measures of decarbonization of the energy sector. So further development of techniques and procedures for managing the electricity system is expected through this measure, with the application of several modern tools that should enable a high level of automation of the management system, as well as the development of coordination with other transmission system operators in the region and beyond, together with the European coordination centres and communication with other participants of the electricity market. With the increasing share of renewable sources in the structure of electricity production, the need for sufficient regulatory capacity to run the electricity system has also increased. Maintaining a high level of security in the overall management system will be of particular relevance to prevent cyberattacks that could endanger the electricity system and power supply. The planning will also consider the risks of extreme weather, which climate change increases.

**Activities:**

- The measure plans to modernise and digitize, as well as expand the electricity system, which will accept an increasing amount of electricity from renewable sources most efficiently and stably;
- Mapping the potential of expansion and revitalization of the powerline grid and accompanying infrastructure to speed up the process of grid development, but also take into account the areas located within Natura 2000 and islands poorly connected to the mainland;
- Investment in electricity storage infrastructure in cases where such investments relate to projects for the implementation of which they are responsible and are implemented by transmission and distribution system operators – if the storage equipment represents a fully integrated network component;
- Adequate north-south connection with which to ensure a smooth flow of energy to continental Croatia and further to other EU members (electricity production from RES is concentrated mainly in the southern part of Croatia);
- Reduce the "bottlenecks" of the current electricity system.

**Funds needed for implementation:**

- About EUR 335 million for the capacity increase of the high-voltage grid (220 kV and 110 kV) to strengthen capacities in the south of Croatia, the adequate connection of the south and north of Croatia and six large islands with the mainland;
- In addition to these financial expenditures, CTSO plans to invest an additional EUR 0.667 billion by 2026;
- Around EUR 223.8 million for the modernisation of the distribution system (around EUR 150 million for the modernisation and development of the advanced grid, including smart meters and the development of a "smart grid", almost EUR 47 million

for the modernisation of the grid in Natura 2000 areas, and around EUR 27 million for submarine cables at the distribution level);

- in addition to the stated financial expenditures, HEP-DSO plans to invest about EUR 1.27 billion in the next ten-year period.

**Funding Sources:** Modernisation Fund, OPCC, potential funds from all of the above sources in terms of investment amounts, income from network users and regular income from tariff items.

**Executive body:** CTSO, HEP-DSO

**Monitoring bodies:** CERA

**Impact:**

- By mid-2026, it is planned to revitalize about 550 km of medium and low voltage powerlines,
- Increase the number of smart meters to 100,000 by mid-2026,
- Renewal of submarine cables for six islands to further stabilize and modernize the system.

**Monitoring method:** Approval and monitoring of the implementation of the Ten-Year Development Plan of the CTSO Transmission Grid and the Ten-Year Development Plan of the HEP-DSO Distribution Grid.

**Connection to other dimensions:** During the revitalization, construction and digitisation of the system and the accompanying infrastructure for decarbonization of the energy sector, special attention will be paid to enhanced nature protection because, during the development of the electricity infrastructure, the reduction of environmental impact will be considered.

**Research and development:** Investing in research and development of new technologies to modernize and digitize due to the increasing need to adopt RES in the electricity grid.

### ES-3 Development and maintenance of the district heating systems

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** District heating systems have been defined as one of the priorities of the energy policy of the Republic of Croatia. The most significant potential for developing and improving existing district heating systems is primarily in increasing the energy efficiency of production units, infrastructure and equipment at end-users, measuring heat with charge according to actual consumption and increasing the reliability and security of energy supply. Today's inefficient second-generation central heating systems, designed for high temperatures in distribution networks, need to be improved by third-generation systems using pre-insulated pipes, compact heat substations or fourth-generation systems based on smart energy systems and a two-way central heating system. It is imperative to improve the DHS, primarily by reducing heat losses in the existing distribution network, as well as further development of production plants of existing central heating systems, which implies the integration of renewable energy sources and reducing the consumption of fossil fuels (fuel oil and natural gas). Therefore, this measure envisages the maintenance and upgrading of existing DHS systems, stopping the trend of disconnecting customers from the DHS systems,

introducing heat storage tanks for thermal energy, and using RES for DHS and replacing existing DHS production with renewable sources (e.g. biofuels) as well as the use of heat pumps.

**Activities:**

- Reduction of thermal losses of the existing distribution grid of central heating systems
- Replacement of fuel oil boilers with biomass boilers, replacement of fuel oil boilers with heat pumps water/water
- Replacement of natural gas boilers with compression heat pumps water/water
- Replacement of natural gas boilers – utilisation of industrial waste heat
- Replacement of natural gas boilers – waste heat utilisation
- Replacement of natural gas boilers with high-efficiency biomass cogeneration
- Replacement of natural gas boilers - utilisation of geothermal energy

**Funds needed for implementation:** EUR 400.5 million

- 55% of the total investment amount relates to reducing thermal losses of the distribution network of central heating systems.
- 39.62% of the total investment relates to replacing existing natural gas cogeneration with high-efficiency natural gas cogeneration.

Two activities, i.e. investments (revitalization of the existing distribution grid and introduction of high-efficiency cogeneration), are already underway in the existing DHS.

**Sources of funding**: The NRRP has secured EUR 29 million to support the development of geothermal projects. The EEA Financial Mechanism provides just over EUR 8 million for preparing and implementing geothermal projects, including those related to the DHS. It is necessary to provide funds from structural and investment funds. Funding needs to be updated in line with the audit of this NECP and the Comprehensive Analysis of the Potential for Efficient Heating and Cooling. It is also necessary to consider the possibility of using the Modernisation Fund.

**Executive body:** Thermal energy producers and distributors

**Monitoring bodies:** ME

**Impact:** The proposed measures to increase the energy efficiency of the DHS until 2030 would ensure a reduction of primary energy in the amount of 833.18 GWh or a decrease in $CO_2$ emissions in the amount of 193,967.87 tons of $CO_2$ and determine a fairer price of district heat for the end customer in the future.

**Monitoring method:** District heat suppliers are obligated parties to the energy savings obligation system under the Energy Efficiency Act and are obliged to achieve energy savings annually and cumulatively from 2021 to 2030. These savings can also be achieved through measures on the DHS side (production and distribution), and a recommendation will be issued to the obligated parties to implement cost-effective measures themselves. Through the implementation of these measures, energy operators in the heating system will improve their systems, achieve financial benefits and achieve the obligation, i.e. avoid the penalization of

non-compliance with this obligation, while at the same time contributing to the achievement of national energy efficiency and RES goals in heating and cooling.

**Connection to other dimensions:** Decarbonisation-RES**,** energy efficiency

**Research and development:** The measure is related to the research and development of RES technologies and integrating RES into energy systems. The most significant emphasis should be on research into waste heat use in heating systems. It is necessary to map waste heat sources in cities with existing centralized heat systems and make preliminary studies of technical feasibility. DHS systems can also be used for cooling via absorption heat pumps. For this purpose, a preliminary feasibility study in a city with an existing heating system is necessary.

### ES-4 LNG terminal capacity increase

Financial and technical measure; implementation 2023 - 2027

**Objective and description of the measure:** The liquefied natural gas terminal on the island of Krk has been in operation since 1st January 2021. The initial gasification capacity of 2.6 billion $m^3$/year was increased in April 2022 to 2.9 billion $m^3$ of natural gas per year, the maximum capacity of the existing gas pipeline. In August 2022, the Government of the Republic of Croatia adopted the *Decision on Increasing the Security of Gas Supply by building the Zlobin-Bosiljevo gas pipeline and increasing the capacity of the LNG terminal to 6.1 billion* $m^3$ *of gas per year*. The investment is estimated at EUR 180 million, of which EUR 25 million is planned to increase the terminal's capacity and EUR 155 million to build the Zlobin-Bosiljevo transport pipeline. The pipeline will be able to transport hydrogen when production sources and market conditions for hydrogen consumption are developed. The construction of this section of the gas pipeline will contribute to the security of the gas supply in the Republic of Croatia. Still, it will not increase the capacity for gas transport to neighbouring countries. For a more significant regional impact, it is necessary to build transport pipelines to Hungary and Slovenia.

**Activities:** Increasing the LNG terminal's capacity and constructing the Zlobin-Bosiljevo transport gas pipeline.

**Funds needed for implementation:** EUR 180 million

**Sources of funding:** Croatian and European funds

**Executive body:** Plinacro

**Monitoring bodies:** Ministry of Economy

**Impact:** Security of natural gas supply, diversification of gas supply sources.

**Monitoring method:** Reports to CERA

## ES-5 Security of natural gas supply for EU countries

Financial and technical measure; implementation 2023 - 2027

**Objective and description of the measure:** The evaluation of the European Network of Transmission System Operators for Gas (ENTSOG) has shown that, in the medium term, the expansion of the capacity of the LNG terminal on the island of Krk will further help to alleviate the dependence on gas supply from Russia it would be necessary to improve the Croatian transport network towards Slovenia and Hungary to reap these benefits.

It includes the construction of gas infrastructure:

1. Towards Slovenia (Lučko-Zabok-Jezerišće-Sotla gas pipeline): 70 km, EUR 145 million.

2. Towards Hungary – first phase (Bosiljevo-Sisak-Kozarac gas pipeline): 122 km, EUR 306 million.

3. Towards Hungary – second phase (Kozarac-Slobodnica gas pipeline): 128 km, EUR 272 million.

The pipeline construction is necessary to create the preconditions for transporting 6.1 billion $m^3$ of gas from the LNG terminal to EU countries. The planned investment amounts to EUR 723 million.

Procurement for all projects can start immediately, and projects can be built within 2.5 to 3 years, or at the latest in 2026, except for the second phase of interconnection to Hungary, the completion of which can be projected for 2027. All pipelines can transport hydrogen when production sources and market conditions for hydrogen consumption are developed.

**Activities:** Construction of transport pipelines Lučko-Zabok-Jezerišće-Sotla to Slovenia and gas pipelines Bosiljevo-Sisak-Kozarac and Kozarac-Slobodnica to Hungary.

**Funds needed for implementation**: EUR 723 million

**Funding sources:** Company funds and European funds.

**Executive body:** Plinacro.

**Monitoring bodies:** ME.

**Impact:** The security of natural gas supply, mitigation of dependence on gas supply from Russia, and diversification of supply sources are projects with a cross-border and multi-country dimension.

**Monitoring method:** Reports to CERA.

## ES-6 Security of natural gas supply for the Western Balkans

Financial and technical measure; implementation 2025 - 2030

**Objective and description of the measure:** The evaluation of the European Network of Transmission System Operators for Gas (ENTSOG) showed that projects of common interest and additional projects identified in the REPowerEU plan, if implemented, would provide additional benefits to the Energy Community Contracting Parties, whose needs would be fully met. By completing the projects recognized by *Flagship 5 of the Economic Investment Plan* for

the Western Balkans (EIP projects), the Energy Community Contracting Parties will have access to various alternative sources and directions. Below is a quote from the Annex of the Economic Investment Plan for the Western Balkans, Flagship 5 – COAL TRANSITION:

• Gas interconnection between Bosnia and Herzegovina and Croatia – brings diversification of gas supply sources and increases the potential and diversification of the existing gas distribution system in the country.

• The construction of the Fier-Vlora pipeline in Albania will be completed, and priority will be given to the Ionian-Adriatic pipeline along the coast.

This measure includes the construction of:

1. Southern gas interconnections with Bosnia and Herzegovina: Gas pipeline Split-Zagvozd (DN800/75bar, 52 km) and Gas pipeline Zagvozd-border with Bosnia and Herzegovina (DN500/75bar, 22 km), with an estimated investment of EUR 169 million.

2. The rest of the Ionian-Adriatic gas pipeline (IAP) Zagvozd-Ploče-Dubrovnik-Prevlaka-Dobreč (DN800/75bar, 200 km) and compressor station (KS), with an investment estimate of EUR 580 million.

All pipelines can transport hydrogen when production sources and market conditions for hydrogen consumption are developed.

**Activities:** Construction of the Southern Gas Interconnection between the Republic of Croatia and Bosnia and Herzegovina (gas pipeline Split-Zagvozd and Zagvozd-border with Bosnia and Herzegovina), construction of the Ionian-Adriatic gas pipeline (Zagvozd-Ploče-Dubrovnik-Prevlaka-Dobreč and compressor station (KS).

**Funds needed for implementation**: EUR 749 million

**Funding sources:** Company funds and European funds.

**Executive body:** Plinacro

**Monitoring bodies:** Ministry of Economy

**Impact:** Security of natural gas supply, mitigation of dependence on gas supply from Russia, diversification of supply sources, projects have a cross-border and multi-country dimension

**Monitoring method:** Reports to CERA

### ES-7 Construction and improvement of gas transmission system management

Financial and technical measure; implementation 2023 - 2030

**Objective and description of the measure:** This measure envisages the construction of new gas infrastructure and the renewal and upgrade of the monitoring and management system following the Ten-Year Plan for the Development of the Gas Transmission System to increase the security of the natural gas supply and improve the supervision and management of the gas transmission system.

**Activities:** By the Ten-Year Development Plan of the Transmission System, the most significant investments in the system of monitoring and management of the transmission system are

allocated to the system of remote monitoring and management of the transmission system (SCADA), associated telecommunication subsystems (optical and radio communication system), the system for managing the capacity of the transmission system (SUKAP) and investments in cybersecurity of the process communication system.

**Funds needed for implementation:** EUR 26.5 million (ten-year period)

**Funding sources:** Company funds and European funds

**Executive body:** Plinacro

**Monitoring bodies:** Ministry of Economy

**Impact:** Safe and reliable operation of the gas transmission system.

**Monitoring method:** Reports to CERA

**Measure implementation indicator:** Security and functionality of gas transmission system management, capacity leasing functionality, and uninterrupted gas flow through the transmission system.

**Connection to other dimensions:** Decarbonisation - RES, energy efficiency, energy security

**Research and development:** Not in society itself (possible innovative solutions from service providers).

### ES-8 Exploration of potential hydrocarbon deposits

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** The aim is to mitigate the decline in oil and gas production and thus reduce dependence on imported energy.

**Activities**: Prepare tender documents for the exploration and exploitation of hydrocarbons on land and monitor the implementation of ongoing projects. In addition to the already open tenders, the plan is to issue licenses for the exploration and exploitation of hydrocarbons in the areas of previous tenders. This activity enables continuous exploration of hydrocarbon potential, consequently increasing hydrocarbon exploitation in the country.

**Funds needed for implementation:** EUR 322.5 million

**Funding sources:** Investors' private capital

**Executive body:** CHA

**Monitoring body:** CHA

**Impact:** Increasing the security of hydrocarbon supply.

**Monitoring method:** CHA reports (number of launched tenders, number of issued permits

### ES-9 Reduction in fossil fuel usage for heating needs in individual heating systems

Regulatory measure; implementation: 2023 -2030

**Objective and description of the measure**: Phasing out the use of fossil fuels for individual heating needs.

**Note:** When replacing individual thermo-technical systems in buildings, it is necessary to apply technologies that use renewable energy sources, either in individual systems or through new or existing high-efficiency centralized heat systems, which meet the criteria given in Directive (EU) 2023/1791 on energy efficiency. At the same time, finding an optimal solution for each building is necessary, respecting the principle of "energy efficiency in the first place".

**Activities**: By-laws should prohibit the sale and installation of individual heating and cooling systems that use fossil fuels for all buildings that wish to maintain or achieve the status of almost zero energy buildings.

The measure contains several steps:

- Develop an action plan with a timetable for the prohibition of individual heating and cooling systems using fossil fuels (first boilers using coal, then medium heavy fuel oil, then extra light fuel oil, etc.) and a catalogue of solutions by which RES technologies can substitute technologies based on fossil fuels
- Design financial programmes that will co-finance the substitution of old heating and cooling systems according to the action plan
- Organise information campaigns throughout the Republic of Croatia for all relevant stakeholders (citizens, equipment manufacturers, distributors, designers, installers, etc.)
- Organise and provide technical support at all levels (building owners, entrepreneurs, etc.).
- Consider introducing penalties for those who do not comply with the ban on the use of fossil fuels for individual heating and cooling.
- Develop a system for monitoring the implementation and enforcement of this prohibition.

**Funding sources**: EPEEF and EU funds

**Executive body**: ME and MPPCSA

**Monitoring bodies:** MPPCSA

**Impact:** The measure will ensure a reduction in the total energy consumption of fossil fuels and, consequently, a reduction in greenhouse gas emissions. The measure will significantly improve air quality in all urban areas where fossil fuels are used for heating and cooling.

**Monitoring method**: According to statistical reports, the amount of energy produced for heating and cooling.

**Connection to other dimensions**: The measure is related to decarbonisation, increasing energy security and developing the internal energy market (legislative sector development).

## ES-10 Cybersecurity

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** Achieving resilience, reducing cybercrime, developing cyber defence policy and cyber defence capability, developing industrial and technological resources and establishing a coherent international cyberspace policy with three areas highlighted: (1) resilience, technological sovereignty and leadership, (2) building operational capacity for prevention, deterrence and retaliation, (3) developing global and open cyberspace.

**Activities:**

1. Monitoring the security of the national cyberspace to detect threats that may result in a cyber crisis.
2. Produce and submit data on trends and threats in cybersecurity monthly.
3. Preparation of reports on security incidents and threats in cyberspace.
4. Preparation of an annual activity report of the Operational and Technical Coordination for Cybersecurity.
5. Assessment of cybersecurity in the Republic of Croatia based on the data obtained from implementing the document Methodology of assessing the state of cybersecurity in the Republic of Croatia.
6. Preparation of a report on the state of cybersecurity in the Republic of Croatia.

**Funds needed for implementation:** EUR 1,600,000 under the NRRP, followed by new significant investments in 2023 and beyond

**Funding sources:** NRRP, EU funds

**Executive body:** A large number of state bodies (each of these bodies should develop its own abilities to detect and deal with threats and risks that come from cyberspace daily, to act proactively):

- The operational and technical coordination relies in particular on the information of CARNet NCERT and ZSIS CERT, and the recommendations and instructions for the public in the event of a threat are published on the official website of the Ministry of the Interior and CARNET – NCERT
- MOI
- National CERT
- The SOA Cybersecurity Centre
- Information Systems Security Bureau (ZSIS)
- HAKOM (Croatian regulatory agency for network activities)

**Monitoring bodies:** National Cybersecurity Council and Operational and Technical Coordination for Cybersecurity

**Impact:** Increasing cyber resilience and capacity building for research and prosecution of cybercrime and responses to cyber threats

**Monitoring methods:**

- Produce and submit data on trends and threats in cybersecurity monthly.
- The Operational and Technical Coordination members present data on events, trends and threats in the cyberspace of the Republic of Croatia at regular sessions for the sectors within their competence, and the same data are entered in the minutes of the Coordination session.
- Minutes of the Operational and Technical Coordination sessions and monthly reports on trends and threats based on the data presented during the sessions shall be regularly submitted to the National Cybersecurity Council.
- Preparation of reports on security incidents and threats in the cyberspace of the Republic of Croatia on an annual basis
- Assessment of the state of cybersecurity based on the data obtained from the implementation of the document Methodology of assessing the state of cybersecurity
- Preparation of a report on the state of cybersecurity

**Connection to other dimensions:** Energy efficiency, development of the internal energy market.

**Research and development:** Strengthening research capacities to strengthen cybersecurity and investing in innovation achieves a higher level of cybersecurity in the energy sector (training and education, procurement of investigative, analytical computer kits to analyse digital evidence, etc.).

### ES-11 Establishment of a hydrogen-based economy

Organisational, regulatory and financial measures; implementation in 2024 -2030.

**Objective and description of the measure**: The measure aims to develop a hydrogen-based economy encompassing the entire value chain, including the production, storage, transportation, and use of renewable hydrogen while strengthening research and development. The measure will also encourage the use of hydrogen in transport (linked to measure TR-7).

**Activities:**

- Formation of a national coordination body for hydrogen, which will program, implement and report on the implementation of strategic planning acts, map stakeholders, coordinate projects of national interest, identify and activate financing means, and communicate with other member states regarding the positioning of projects and negotiate in the context of complementarity projects.
- Creation of the Hydrogen Development Plan and Program.
- Establishment of the North Adriatic Valley of Hydrogen institution (upon completion of the North Adriatic Valley of Hydrogen project financed by the Horizon Europe program).
- Initiate projects within the Northern Adriatic Hydrogen Valley.

- Encourage the use of hydrogen in transport (refit of 5 diesel locomotives) and establish a chain of filling stations in railway and public city transport (related to measure TR-7).

**Funds required for implementation**: EUR 58.5 million

**Sources of funding**: NPRR

**Executive body:** Ministry of Economy.

**Impact**: Established hydrogen value chain, functional Northern Adriatic Hydrogen Valley.

**Monitoring methods:**

- Qualitative indicators: establishing a national coordination body for hydrogen; creating and publishing the Hydrogen Development Plan and Program.
- Quantitative indicators: a call has been announced as part of which EUR 13.5 million will be spent, and projects will be implemented; at least five locomotives switched to hydrogen, and at least five hydrogen filling stations built for the transport sector.

**Connection to other dimensions**: Decarbonisation

**Research and development**: Yes. The investment aims to develop a hydrogen-based economy that will encompass the entire value chain and include the production, storage, transportation and use of renewable hydrogen while strengthening research and development. The Northern Adriatic Hydrogen Valley project, funded by the Horizon Europe program, is a public-private partnership encouraging research and development of hydrogen-related technologies.

### ii. Regional cooperation in this area

Regional cooperation in energy security has existed for many years, during which neighbouring countries jointly planned cross-border connections for powerlines, gas pipelines, and oil pipelines. The cooperation of transmission system operators has its formal basis in EU regulations and grid rules: the Croatian transmission system operator and operators from all neighbouring countries are part of the same regional security centre, and the cooperation consists of joint implementation of security analyses, capacity calculations, short-term adequacy forecasts and joint supply disruption planning.

Following the Regulation (EU) 2019/941 of the European Parliament and of the Council of June 5th, 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC (Text with EEA relevance.) (OJ L 158, Jun 14th, 2019) regional risk preparedness plans will be jointly developed. Bilateral measures will be proposed and implemented as necessary.

Under Article 23 of the Regulation 2019/943 Regulation (EU) 2019/943 of the European Parliament and of the Council of 5th June 2019 on the internal market for electricity (recast) (Text with EEA relevance) (OJ L 158, Jun 14th, 2019), ACER adopted at the end of 2020 a methodology for assessing the adequacy of generation facilities at European level, i.e. on the scope of the activities of the ENTSO. This methodology is based on the so-called probabilistic approach, where different conditions in the power system are analysed depending on climatological conditions (35 historical climatological years are taken into account) and the availability of thermal power plants. The final result of the assessment is the statistical indicators of LOLE (Loss of Load Expectation) and EENS (Expected Energy not Served), for which each country defines limit values. These analyses are carried out at the national,

regional and continental levels, aiming to increase the security of electricity supply and more efficient integration of new generation plants into the electricity system.

iii. Financial measures in this area at the national level, including EU support and use of EU funds, if applicable.

The use of EU cohesion policy funds, the Connecting Europe Facility (CEF), the Modernisation Fund and the Innovation Fund is expected.

## 3.4 Dimension: The internal energy market

### 3.4.1 Electricity Infrastructure

i. Policies and measures to achieve the targeted level of interconnection referred to in Article 4 (d)

As stated in 3.3, no specific requirements are set concerning further increase of cross-border capacity by 2030. The possible construction of new interconnections will depend on market opportunities and positive cost-benefit analyses.

The planned removal of restrictions on the internal network will further increase the possibility of cross-zonal exchange at individual borders. The economic operator is CTSO, and CERA has approved investments in internal or cross-border grid enhancements.

ii. Regional cooperation in this area

It is described in the context of regional cooperation in the energy security dimension.

iii. Financial measures in this area at the national level, including EU support and use of EU funds, if applicable.

The project related to revitalising and reconstructing the existing energy infrastructure is strategically important for the Republic of Croatia. Co-financing from EU funds is envisaged through the National Recovery and Resilience Plan (NPRR) for their realization.

### 3.4.2 Energy transmission infrastructure

i. Policies and measures relating to the elements of 2.4.2, including, where applicable, specific measures to facilitate the implementation of Projects of Common Interest (PCIs) and other key infrastructure projects.

**UET-1 Development of the electricity transmission grid**

Financial measure; implementation 2021 - 2030

**Objective and description of the measure**: CTSO is responsible for the management, operation, maintenance, development and construction of the electricity transmission

network in the Republic of Croatia and is obliged to develop and adopt ten-year, three-year and one-year investment plans for developing the transmission network every year. At the time of adoption of this document, the Ten-Year Transmission Grid Development Plan 2022-2031 has been in force. During the entire implementation of this document, annual amendments to the Ten-year Development plan will be made.

**Activities:** According to the Ten-Year Transmission Grid Development Plan

**Funds needed for implementation:** EUR 872 million

**Sources of funding:** Fee for using the transmission network; participation of new users in creating technical conditions in the grid for connection of their plants; EU funds (Structural, Innovation and Modernization Fund), NPRR.

**Executive body:** CTSO

**Monitoring body:** Ministry of the Economy

**Impact:** Safe and reliable operation of the transmission grid

**Monitoring method:** Reports to CERA

**Connection to other dimensions:** Decarbonisation - RES, energy efficiency, energy security, research, innovation and competitiveness

**Notes**: Besides the financial resources needed to cover the costs of building the transmission network, it is necessary, through the electricity transmission fee, to provide financial resources for system services with an emphasis on balancing the system. The provision of services is achieved, among other things, through the procurement of ancillary services (most of which relate to balancing services for frequency and power regulation).

Also, through the electricity transmission fee, it is necessary to eliminate the expected congestion in the transmission network and provide financial resources for the redispatching of production facilities to eliminate periodic restrictions in the transmission network. The funds will depend on the level of RES integration in Croatia and the region and the development of the transmission network, and it is expected to reach significant values in the future.

### UET-2 Development of the gas transmission system

Financial measure; implementation 2021 - 2030

**Objective and description of the measure**: Planning the development of the gas transmission system is carried out through the development of the 10-year plan for the development of the gas transmission system. Under the Gas Market Act („Official Gazette“, Nos. 18/18 and 23/20), the transmission system operator is obliged to prepare a ten-year plan for developing the transmission system and submit it to CERA for approval every two years. At the time of preparation of this document, the Ten-Year Gas Transmission System Development Plan of the Republic of Croatia 2021-2030 has been in force. The plan will be continuously updated throughout the implementation period of this document.

**Activities:** According to the Ten-Year Transmission Grid Development Plan.

**Funds needed for implementation:** EUR 903 million + EUR 749 million for constructing the Ionian-Adriatic gas pipeline and the southern gas interconnection with Bosnia and Herzegovina.

**Funding sources:** Company funds and European funds, REPOWER

**Executive body:** Plinacro

**Monitoring body:** Ministry of Economy

**Impact:** Safe and reliable operation of the gas transmission system

**Monitoring method:** Reports to CERA.

**Connection to other dimensions:** Decarbonisation - RES, energy efficiency, energy security, research, innovation and competitiveness

### UET-3 Equipping the gas transmission system for the future possibility of transmission of up to 100% hydrogen

Financial, environmental and technical measure; implementation 2025 - 2030

**Objective and description of the measure**: This measure includes the project of planning and reconstruction of gas nodes and safety and measuring equipment for the reception and addition of decarbonized gases to the gas transmission system. It includes the development of a 'smart gas network' including advanced digital systems and components, control systems, sensor technologies, gas flow and quality management devices (compressors, gas flow control kits, reconstruction and chromatography equipment, etc.), to enable interactive and intelligent monitoring, measurement, quality control and management of the reception and transmission of decarbonised gases. The implementation of the project will allow the reception and mixing of decarbonised gases (biomethane and hydrogen) into the gas transmission system, which will reduce greenhouse gas emissions and facilitate the transition to a transmission system that will transport 100% of decarbonised gases in the future. The project will contribute to achieving the objectives set by the European Green Deal. The implementation of this measure is expected in the next 10-15 years, and according to the first indicative estimates, the required investments amount to EUR 54 million.

Following Annex II 3. (a) of Regulation (EU) 2022/869 of the European Parliament and of the Council of May 30$^{th}$, 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/09, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No 347/13 (OJ L 152, Jun 3$^{rd}$, 2022), the project belongs to the category of trans-European energy infrastructure for hydrogen: '*Pipelines for the transport of hydrogen, mainly under high pressure, including converted natural gas infrastructure, which provides access on a transparent and non-discriminatory basis to a larger number of network users*'.

This Project is part of the Croatian hydrogen network, and through other planned projects ($H_2$ interconnection HR-HU (HYD-N-1255), $H_2$ interconnection HR-SLO (Lučko-Zabok-Rogatec) HYD-N-619, H2 supply system Croatia-North HYD-N-1274 and $H_2$ supply system Croatia-South

HYD-N-1307 ), together with other projects under the provisions of the Croatian Hydrogen Strategy from 2021 to 2050 will enable the cross-border transport of renewable hydrogen between Croatia, Hungary and Slovenia. It will also be part of an indispensable link in the regional hydrogen transmission network from a potential terminal for liquid hydrogen on the island of Krk, from Eastern Europe, the Balkans and the countries of the southern and eastern Mediterranean to the end users of hydrogen in Croatia and the growing regional and European hydrogen market. The project contributes to Corridor E (Eastern and Southeastern Europe), the hydrogen network's European backbone.

The implementation of the project will enable the adaptation of the existing Croatian gas transmission system for hydrogen transport. It allows the increase of hydrogen transmission capacity on the existing interconnections with the neighbouring EU Member States (Croatia/Slovenia and Croatia/Hungary) and potential future interconnections. In addition, it will allow the transport of gases from all production sites and allow the transmission of hydrogen across the borders of EU Member States, as well as an increase in the transmission capacity of hydrogen by more than 10% for all repurposed or newly built $H_2$ interconnections, compared to the situation before the implementation of the project.

The project will enable the transmission of hydrogen produced by electrolysis, which will help integrate renewable energy sources and help balance electricity transmission and distribution systems. A new optical communication cable will be laid in the same pipeline channel, expanding the existing optical telecommunications network.

The project will be part of Croatia's smart gas network and will be able to transport 100% of hydrogen. Its implementation and management systems will use state-of-the-art information solutions, innovative technologies and cybersecurity. By the stage of a complete transition to 100% hydrogen transport, the project will allow transport, i.e. mixing other renewable gases, such as biomethane, at different percentages.

It will enable market integration, supply security, the development of the hydrogen market, and the reduction of natural gas consumption and $CO_2$ emissions.

**Activities:** Equipping existing gas pipelines and other assets related to the gas network for the possibility of mixing (bio)methane and hydrogen

**Funds needed for implementation:** EUR 54 million

**Funding sources:** Company funds and European funds

**Executive body:** Plinacro

**Monitoring bodies:** Ministry of Economy

**Impact:** Market integration, among other things, through connecting existing or new hydrogen networks of EU Member States and ensuring interoperability of connected systems; security of supply and flexibility of the gas system; sustainability, including reducing greenhouse gas emissions by increasing the use of renewable hydrogen or low-carbon hydrogen, with a focus on hydrogen from renewable sources; integration of renewable and

low-carbon gases into the gas network; possibility of flexibility and seasonal storage of energy from renewable sources.

**Monitoring method:** Reports to CERA.

**Measure implementation indicator:** security and functionality of gas transmission system management, the flexibility of the gas system, interoperability of connected systems

**Connection to other dimensions:** Decarbonisation - RES, energy efficiency, energy security

**Research and development:** Not in the company itself (possible innovative solutions from service providers).

#### ii. Regional cooperation in this area

Since the energy transmission infrastructure of the Republic of Croatia is connected to the systems of neighbouring countries, full technical and operational compliance with the operators of those systems is required, which is regulated by the relevant documents.

It is planned to integrate the Croatian gas transmission system with the gas transmission systems of all neighbouring countries comprehensively. So, already in the preparatory phase of interconnection projects, the gas transmission system operator is intensively cooperating with the transmission system operators in those countries.

Other opportunities for regional cooperation in the context of energy transmission infrastructure are described in the framework of regional cooperation in the energy security dimension.

#### iii. Financial measures in this area at the national level, including EU support and use of EU funds, if applicable.

In the next period, several interventions are planned for constructing new facilities in the CTSO transmission network, for which co-financing from the National Recovery and Resilience Plan (NPRR) is envisaged through EU funds. In addition to EU funds, several projects will be co-financed by new network users following the applicable legal regulations.

### 3.4.3 Market integration

#### i. Policies and measures relating to the elements referred to in 2.4.3.

Connecting the day-ahead markets at the border between Croatia and Slovenia and Croatia and Hungary significantly increased the liquidity of the Croatian Power Exchange (CROPEX), increasing the possibilities of energy placement and price harmonization. The legislative and institutional framework for achieving the defined objectives of cross-border market integration is adequate, and no specific measures need to be implemented. The course and speed of implementing regional market integration in Southeast Europe will depend on institutions' readiness in neighbouring countries, especially non-EU countries (Serbia and BiH). In addition, Intraday Auctions (IDA) will be carried out across Europe to enable the pricing of cross-border capacity within the intraday timeframe, as well as to adapt the new market integration that allows variable renewable energy producers to offer their energy based on

more reliable production forecasts, thus reducing the imbalance caused by intermittence of variable RES.

Implementing 15-minute products in the intraday and day-ahead market is also foreseen. Currently, 15-minute products in the intraday market are already used at certain borders (BE-NL, BE-DE, NL-DE, AT-DE, AT-HU, AT-SI, AT-SK, HU-SK, HU-RO and BG-RO). The idea is for Croatia to join by Q1 2025. In line with the EU Clean Energy Package (CEP), the Single Day-Ahead Coupling (SDAC) is preparing to move the day-ahead market auction from a resolution of 60 min to 15 min, which implies a product offer of 15 min. Big Bang approach - one go-live for all trading zones (30 min for Ireland, 15 min for all other zones).

Market integration will also significantly increase the wholesale market's competitiveness and liquidity. The non-discriminatory legal framework and the independence of the transmission system operator, with adequate oversight by regulators, are crucial for increasing the number of market participants and competitiveness in the supply area.

Additional measures and activities must be taken to enable the active participation of end consumers (customers) and other grid users in the electricity market, particularly in providing flexible services.

### ii. Measures to increase the flexibility of the energy system concerning the production of energy from renewable sources such as smart grids, aggregation, demand management, storage, distributed energy generation, mechanisms to dispatch, re-dispatch and restrict services and real-time price signals, including the introduction of intraday market connecting and cross-border balancing markets

**UET-4 Analysis of the impact of demand response pilot projects on the distribution network**

Other measures; implementation 2025 - 2030

**Objective and description of the measure:** Implementation of pilot projects and analysis of their impact on the distribution network.

**Activities for the implementation of the measure:**

- HEP DSO will define the points in the network where it will analyse the impact of spending managment;
- A public call for the implementation of demand response projects will be published;
- The effect of pilot projects on the distribution network will be analysed;
- In cooperation with CTSO, pilot projects impact on the transmission network will be analysed, and a proposal for coordination between DSO and CTSO will be made;
- The results of the pilot projects' implementation will be publicly presented to interested stakeholders and will be used when defining a public call for co-financing the implementation of demand response projects (which is determined by measure UET-5).

**Sources of funding:** Budget HEP DSO, EU Funds.

**Executive body:** HEP-DSO

**Monitoring bodies:** CERA

**Monitoring method:** It is impossible to monitor this measure's direct effects.

**Connection to other dimensions:** Energy efficiency

**Research and development:** Some research needs to be carried out within this measure, so the measure is related to the research and development dimension.

### UET-5 Co-financing the implementation of demand response projects

Financial measure; implementation 2025 - 2030

**Objective and description of the measure**: EPEEF will co-finance their implementation based on public calls to encourage the broader implementation of demand response projects. Demand response projects will be implemented with large customers (industry, services) and households. The response to the demand will be achieved through equipment installed at the customer's premises and connected to the control and measurement system. The public call will use the results of analyses to measure UET-4 (Analysis of the impact of demand response pilot projects on the distribution network). In addition to using funds from the income from the sale of emission units from the EU ETS, the Ministry of Environmental Protection and Green Transition and the Ministry of Economy will determine other sources of financing for the co-financing of these projects.

**Activities**: EPEEF elaborates on the tender documentation with the consent of the Ministry of Environmental Protection and Green Transition, the Ministry of Economy, and MRDFEU. EPEEF conducts a public call.

**Sources of financing**: Funds from the income from the sale of emission units from the EU ETS.

**Executive body**: EPEEF

**Monitoring bodies:** Ministry of Environmental Protection and Green Transition

**Monitoring method**: Reports of the Ministry of Environmental Protection and Green Transition.

**Connection with other dimensions**: Decarbonisation - RES, energy efficiency, energy security

**Research and development**: Possible innovative solutions from service providers.

## iii. Measures to ensure non-discriminatory participation of renewable energy sources, demand response and storage, including through aggregation, in all energy markets

### UET-6 Development of the National Balancing Market

Regulatory measure; implementation 2023 - 2030

**Objective and description of the measure:** The aim is to increase competition in the national balancing market and enable all transmission and/or distribution network users to participate in the national and EU balancing market.

**Activities:** In June 2018, the Croatian Transmission System Operator d.d. launched a pilot project entitled "Ensuring the power reserve of tertiary regulation through manageable consumption" to open the balancing market. From December 14th, 2020, by the provisions of the Rules on the balancing of the electricity system, CTSO is conducting the procurement procedure of the mFRR reserves of power and/or balancing energy for the security of the system is carried out by public tendering as an improvement to the pilot project. From July 2024, CTSO conducts the procurement of aFRR reserve power and/or balancing energy through public tenders. Connection to the EU platform for the exchange of balancing energy (implementation of the appropriate IT program solution - EES Balancing Platform).

**Sources of financing**: CTSO

**Executive body:** System operators, network users (aggregators, energy storage facilities, energy communities, active customers...)

**Monitoring body:** CERA

**Monitoring method:** Number of participants active in the balancing market.

**Connection to other dimensions:** Energy efficiency

**Progress towards the goal:** Participation in the balancing market is enabled for end-users (or groups of users) of the transmission and/or distribution network, who have met the conditions defined by the pre-qualification procedures and have concluded contracts for the provision of balancing services with CTSO. Additional liberalization and upgrading of the market and integration into the EU market is expected after 2025. CTSO is responsible for the local implementation and harmonization of business processes and program systems that enable safe and optimal operational connection and participation on the MARI and PICASSO platforms, as well as interaction with service providers at the national level.

iv. Policies and measures to protect consumers, especially vulnerable and, where applicable, energy-poor consumers, and to improve the competitiveness and contestability of the retail energy market

Measures for protecting vulnerable consumers (UET-8 and UET-9) are elaborated in Chapter 3.4.4. Measures of UET-5, UET-6, and UET-7 are foreseen to strengthen competitiveness.

v. Description of measures to enable and develop demand response, including those addressing tariffs to support dynamic pricing

**UET-7 Elaboration of a regulatory framework for active participation of grid users in the electricity market**

Informational and regulatory measure; implementation: 2023 - 2025

**Objective and description of the measure:** It is necessary to amend and supplement the existing regulatory framework, including the implementing rules to enable the active role of grid users in the electricity market. The introduction of the aggregator as a market participant and enabling the launch of pilot projects for the provision of ancillary services will analyse in detail the services that users can provide to the distribution or transmission system operator.

It will also analyse the potential for the provision of ancillary services and flexibility services through demand response, the needs of the system operator for ancillary services and their possible types, scope, mode and period of provision. Obstacles to using ancillary services will be identified, and suggestions will be made for removing them. Implementing this measure will also consider new technologies (battery tanks, electric vehicle charging stations, etc.), whose more comprehensive application also requires the amendment of the regulatory framework.

**Activities:** Developing a regulatory framework for new energy markets; developing a regulatory framework for an independent aggregator; developing a regulatory framework for providing ancillary services.

**Funds needed for implementation**: Regular work of state bodies

**Sources of funding:** CERA, HEP-DSO, CTSO

**Executive body:** Ministry of Economy and bodies responsible for adopting implementing regulations

**Monitoring body:** Ministry of the Economy

**Impact:** The emergence of aggregators in energy markets; the emergence of other electricity markets

**Monitoring method:** Reports from CERA

**Connection to other dimensions:** Decarbonisation - RES, energy security

**Research and development**: User involvement; advanced technologies for users; development of RES; energy storage; system flexibility

### UET-8 Introduction of advanced consumption measurement systems and measurement data management

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** To enable the further development of the electricity market and the active role of electricity buyers in the markets, advanced metering devices, measurement data management systems, and systems at the consumption level are planned to be introduced.

**Activities:** According to the Ten-Year Transmission Grid Development Plan.

**Funds needed for implementation:** EUR 274 million

**Funding sources:** Electricity distribution fee; participation of network users; EU funds (Structural, Innovation and Modernisation Fund), NPRR

**Executive body:** HEP-DSO

**Monitoring bodies:** CERA

**Impact:** Enabling the active role of customers in the electricity market, digitalization and improvement of DSO operations, support to the electricity market, establishment of a single

system for managing metering data, reduction of electricity losses (energy efficiency and reduction of unauthorized electricity consumption).

**Monitoring method:** Reports to CERA, approval and monitoring of the implementation of the Ten-Year Distribution Network Development Plan.

**Measure implementation indicator (indicator):** Implementation (by years) of the comprehensive installation plan for the advanced measurement infrastructure system.

**Connection to other dimensions:** Decarbonisation - RES, energy efficiency, energy security

**Research and development:** User involvement; advanced user technologies; development of RES; system flexibility.

### 3.4.4 Energy poverty and mobility poverty

#### i. If applicable, policies and measures for the achievement of objectives set out in 2.4.4.

The following measures will be implemented to achieve the objectives set out in 2.4.4 in the period from 2021 to 2030:

**UET-9 Implementation of the Programme for the reduction of energy poverty and Programme for combating poverty in terms of mobility**

Information and financial measure; Implementation 2021 - 2030

**Objective and description of the measure:** Development of programmes to combat energy poverty, alleviate energy poverty and the degree of vulnerability to it; establishment of an energy poverty monitoring system; creation of a program to fight poverty in terms of mobility, alleviating poverty in terms of mobility and the degree of vulnerability to it; establishment of a poverty monitoring system in terms of mobility.

**Activities:** Within the framework of both mentioned programs, capacity building will continue through local centres, and energy-poor citizens as well as citizens at risk of energy poverty, as well as mobility-poor citizens will be provided with adequate information and advice on energy efficiency measures that contribute to combating energy poverty, as well as the possibilities of co-financing activities in this field and information on the provision of other forms of direct income support to address the rising prices of road transport and fuel for heating or information and possible incentives adopted for the transition from private to public transport. Also, when it comes to poor citizens in terms of mobility, special focus will be placed on the challenges faced by vulnerable households on islands, mountainous areas and less accessible or less developed areas and regions, including less developed suburban areas and the most remote regions in the Republic of Croatia. Furthermore, indicators necessary for monitoring both forms of poverty will be identified, and a monitoring system will be established through the already existing system of collecting data on consumption and habits of households (State Statistical Office, EUROSTAT, Energy Poverty Hub). Based on the data, a possible expansion of the criteria for acquiring the status of vulnerable energy customers will be analysed. The implementation of energy efficiency measures in energy-poor households will be co-financed, for example, the replacement of household appliances according to the "old for new" system, improvement or replacement of the heating system

(improvement of the efficiency of the heating system and replacement of energy sources (especially electricity and fuel oil)) environmentally, economically and energetically more favourable, especially for systems that use renewable energy sources and the implementation of other technical energy efficiency measures. A model for meeting energy costs regarding mobility will be developed and implemented. In the Long-term Strategy for Energy Renovation of Buildings until 2050, measures will be given to combat energy poverty through energy renovation of buildings and criteria for determining vulnerable groups of citizens threatened by energy poverty. The above-mentioned measures will be further developed in the Program for Energy Renovation of Multi-apartment Buildings for the 2021-2030 period and the Program for Energy Renovation of Family Houses for the 2021-2030 period. They will also be prescribed by the Social Plan for climate policy with defined achievement indicators, key stages and goals.

**Funds needed for implementation:** Not estimated. A preliminary assessment will be possible after the programs mentioned above have been prepared.

**Funding Sources:** Energy Efficiency Obligation Scheme payer funds, EU funds, revenues from the sale of emission units from the ETS1 and ETS2 systems, Social Fund for Climate Policy

**Executive body:** Ministry of Economy, Ministry of the Sea, Transport and Infrastructure

**Monitoring bodies:** Ministry of Economy, Ministry of Environmental Protection and Green Transition, Ministry of Labour, Pension System, Family and Social Policy, Ministry of Physical Planning, Construction and State Assets, Ministry of the Sea, Transport and Infrastructure

**Impact:** Establishment of a system for monitoring energy poverty and poverty in terms of mobility and vulnerability to the same; capacity building to alleviate energy poverty and mobility poverty; establishment of a model for the settlement of energy costs; reduction of final energy consumption and consequent reduction of $CO_2$ emissions in energy-poor households and households threatened by it and poor in terms of mobility.

**Monitoring method:** CBS surveys; Realized savings are monitored and proven using bottom-up methods according to the Ordinance on the system for monitoring, measuring and verifying energy savings.

**Connection to other dimensions:** Decarbonisation - emissions; decarbonisation - RES; energy efficiency; RES in transport; alternative fuels and infrastructure for alternative fuels

**Research and development**: Energy efficiency in buildings; energy efficiency in heating and cooling; smart cities and communities; development of the used electric vehicle market; switching from private to public transport, car sharing and cycling.

### UET-10 Implementation of the Programme for Combating Energy Poverty, which includes the use of renewable energy sources in residential buildings in assisted areas and areas of special state care for the period up to 2025

Informational and financial measure; Implementation 2022 – 2025

**Objective and description of the measure:** Alleviation of energy poverty and the degree of threat in buildings owned and operated by the Ministry of Physical Planning, Construction and

State Assets, in which residents are not able to participate in the financing of necessary repairs.

**Activities:** By decision of the Government of the Republic of Croatia, the Program for Suppression of Energy Poverty was adopted, which includes the use of renewable energy sources in residential buildings in subsidized areas and areas of special state concern for the period until 2025 („Official Gazette“, No. 143/21). For the purpose of the Program, 413 residential buildings were identified, 407 buildings from the working list and 12 additional buildings were covered, but 22 were covered in other units, which gives a total number of 397 buildings. Renovation priorities were determined according to the perceived deficiencies of the buildings, and possible energy savings for heating and primary energy, which the renovation of the buildings will realize, were estimated. In total, 387 buildings are included, with a total area of 297,575 m², for the refurbishment of which EUR 47 million must be invested. All buildings' total possible primary energy saving amounts to 27 GWh per year. The program also envisages the use of renewable energy sources, mainly photovoltaic systems, the total potential of which can ensure the production of electricity at the location for self-consumption in the amount of about 4,360 MWh per year, which will reduce $CO_2$ emissions by about 691 tons per year.

**Sources of financing:** Recovery and resilience mechanism, state budget (remaining available funds collected based on a solidarity fee for an endangered energy buyer), funds of the obligors of the energy efficiency obligation system, EPEEF, and EU funds.

**Executive body:** MPPCSA, EPEEF

**Monitoring bodies:** ME-NKT

**Impact:** Comprehensive renovation of buildings in assisted areas and areas of special state concern; building capacity to alleviate energy poverty; establishing a model to meet energy costs; reducing final energy consumption and $CO_2$ emissions in energy-poor and vulnerable households.

Estimated savings in direct consumption in 2030 amount to 0.56 PJ (13.27 ktoe; 154.38 GWh); estimated reduction of $CO_2$ emissions in 2030: 25.25 kt$CO_2$; cumulative energy savings in the period until 2030: 3.61 PJ (86.28 ktoe; 1,003.47 GWh); cumulative reduction of $CO_2$ emissions in the period until 2030: 228.42 kt$CO_2$.

**Monitoring method:** CBS publications; The realized savings are monitored and proven using bottom-up methods according to the Ordinance on the system for monitoring, measuring and verifying energy savings up to ISGE upgrade.

## 3.5 Dimension: Research, innovation and competitiveness

### i. Policies and measures relating to the elements referred to in 2.5.

The state will increase investment in research, innovation and competitiveness, as well as investment in knowledge transfer and the development of knowledge and innovation-based technologies through policies and measures related to science and research and those associated with developing competitiveness. Support programmes in research, development,

and innovation, as well as in the development of knowledge and innovation-based technologies, shall include the award of grants and vouchers until the implementation of strategic or pilot projects. Specific programmes and financial instruments, including loans and state aid schemes, are also being developed for entrepreneurs.

### IIK-1 Establishment of a system for identifying and monitoring the achievement of research, innovation and competitiveness objectives

Organizational measure; Implementation 2025 - 2027

**Objective and description of the measure**: Development and establishment of a system for monitoring progress in the field of research and development, innovation and competitiveness related to the Energy Union; establishment of identifiers to establish the monitoring of scientific research/research and innovation activities, regardless of the source of funding, with a standard set of basic data: project duration, eligible costs, project participants, budget, sources of financing, area of action, project description, planned and achieved performance indicators, thematic priority area S3 and thematic priority of the Energy Union (if applicable).

**Activities**: Define methodology, identifiers, link to existing databases, data entry, testing, and information.

**Impact**: Established system for identifying and monitoring innovation, research and competitiveness

### IIK-2 Establishment of systematic financing of research and development projects

Organizational measure; Implementation 2024 - 2030

**Objective and description of the measure:** The measure creates preconditions for the continuous and systematic implementation of research and innovation and the strengthening of research capacities and plans to implement and co-finance research and innovation projects, including larger (strategic) scientific research projects, with large amounts of funding. It elaborates on objectives and indicators and establishes a system for monitoring the achievement of goals and indicators in the field of research and development, innovation and competitiveness; it develops criteria for grouping research teams (e.g. through the cooperation of several research institutions) and private partners and connecting scientific and research teams in the field of natural, technical, biomedical and biotechnical sciences with research teams in the field of social sciences and humanities to strengthen the transdisciplinary approach to solving critical societal challenges related to the Energy Union.

**Activities:**

- Defining the objectives of financing public and private research and innovation related to all dimensions of the Energy Union, the amount of financing and the dynamics of publication of thematic tenders (one-year and multi-year)
- Regular launch of thematic tenders for research and development projects related to the Energy Union
- Co-financing of projects accepted in EU tenders

**Impact**: Established system of continuous financing of scientific research projects and cooperation between science and economy; Implemented scientific research projects priority for the Republic of Croatia

### IIK-3 Strengthening competitiveness in the area of low-carbon economy

Financial measure; implementation 2021 - 2030

**Objective and description of the measure**: The measure encourages increased competitiveness in the field of low-carbon products and services by co-financing entrepreneurial activities related to the Energy Union.

**Activities**: It will continue to support entrepreneurs throughout the development stages of their business - from the idea's research and development to commercialisation, marketing, and intellectual property protection 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 to support the transfer of research results from the public to the private sector to create new products and services.

**Funds needed for implementation:** To be determined subsequently

**Executive body**: HAMAG-BICRO, MSE, ME

**Monitoring body:** MSE

**Impact**: Low-carbon products and services marketed

**Connection with other dimensions**: The measure is linked to all dimensions of the Energy Union as it encourages entrepreneurship in all areas relevant to the Energy Union.

### IIK-4 Transfer of knowledge and technologies from science to the economy system with an emphasis on low-carbon technologies

Financial measure; implementation 2021 - 2030

**Objective and description of the measure:** The measure encourages the development of technology transfer offices or related organizational units in public scientific organizations to transfer knowledge and develop technologies to create a low-carbon economy.

**Activities**: Provide annual support to public scientific organizations for the establishment of development companies or subsidiaries resulting from the results of scientific research; provide 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; mentor the development of business plans and pitching to investors, finance experts on protection of intellectual property rights; finance grants for projects in the concept validation phase, etc. with a focus on sustainable technologies that contribute to low carbon development.

### IIK-5 Strengthening the work of scientific centres of excellence established in the field of natural, technical, biotechnical and biomedical sciences

Financial measure; implementation 2021 -2030

**Objective and description of the measure:** The measure encourages the continued work of established Centres of Excellence and those whose work has been positively evaluated in the periodic evaluation process to further development of a low carbon economy**.**

**Activities**: Provide grants for industrial and experimental research of scientific centres of excellence, with the aim of further building on the results of research financed in the financial period 2014-2020.

**Executive body:** MSE

**Impact**: Results of industrial and experimental research in low-carbon development.

**Monitoring method**: Reports on the work of the CRE are submitted annually to the MSE.

### IIK-6 Strengthening research and innovation and increase competitiveness in the field of low-carbon economy

Capacity building; implementation: 2020 – 2030

**Objective and description of the measure**: Capacities of institutions involved in stimulating and monitoring research, innovation and competitiveness in the low-carbon economy will be built.

**Activities:** The activities relate to three different levels of action: - the first part relates to the activities of bodies responsible for planning and implementing public policies related to research and development activities. The second part relates to strengthening the capacity to encourage and monitor research at the level of individual scientific research institutions. The third part concerns selecting relevant research topics under the relevant TPP S3.

Representatives of all bodies involved in the implementation of measures IIK 1-5 will be supported to participate in lectures, workshops, working group meetings, and 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 Europa, Eureka, etc.), European Partnerships under the EU Framework Programme for the research and innovation in relevant Pan-European networks and consortia. The transfer of know-how with other EU Member States and other stakeholders within the Republic of Croatia will be organized if necessary.

**Funding sources**: Technical assistance, revenues from the sale of emission units from the EU ETS, EU funds

**Executive body**: HAMAG-BICRO, MSE, ME

**Monitoring body**: ME

**Impact**: Capacities in bodies responsible for stimulating research, innovation and competitiveness in low-carbon technologies.

### IIK-7 Analytical substrates for the green transition

Regulatory and educational measure, implementation: 2020 - 2030.

**Objective and description of the measure**: Analytical bases are needed that will enable decision-makers and policymakers to determine the position of the Republic of Croatia in the negotiations for the goals for 2040 and the achievement of climate neutrality in 2050 as well as all viewpoints related to climate goals.

Research is needed to move to higher levels of application of the Intergovernmental Panel on Climate Change (IPCC) methodology and improve the data collection system, including the energy balance on which the Inventory of Greenhouse Gas Emissions is based.

**Activities:**

- Analysis of the effects of reducing greenhouse gas emissions by measures until 2030, 2040, 2050 and 2060, including the potential of reducing emissions by measures related to the determination of sectoral targets for reducing emissions in sectors outside the trading system until 2030 and 2040 and including and socioeconomic analysis;
- Creating precise analyses and researching to identify persons, households and entrepreneurs in the territory of the Republic of Croatia in energy poverty and poverty in terms of transport and those at risk of these two types of poverty;
- Establishing accompanying social programs that will reduce the impact of climate transition on the poorest citizens;
- Research aimed at moving to higher levels of application of the methodology of the Intergovernmental Panel on Climate Change (IPCC) and improving the data collection system, including the energy balance, on which the Inventory of Greenhouse Gas Emissions is based, following the recommendations of the UNFCCC review team;
- Analysis of appropriate financial instruments for the mobilization of private funds and the implementation of measures from the NECP;
- Analysis of appropriate fiscal benefits to encourage the implementation of low-carbon transition measures;
- Establishing accompanying social programs that will reduce the impact of the climate transition on the poorest citizens
- Development of a plan to abolish the fossil fuel subsidy system with a proposal for alternative measures to permanently reduce the need to use fossil fuels.

**Sources of financing**: Income from the sale of emission units from the EU ETS.

**Executive body:** Ministry of Environmental Protection and Green Transition.

**Monitoring body:** Ministry of Environmental Protection and Green Transition.

**Impact**: More effective implementation of climate policy and achievement of climate goals.

**Monitoring method:** Number of performed analyses.

ii. Collaboration with other Member States in this area, including information on how the objectives and policies of the Strategic Energy Technology Plan (SET) are transposed into the national context

The Republic of Croatia has been included in the steering group of the European Strategic Energy Technology Plan (SET-Plan) since 2015 and covers all ten key activities. The link between SET Plan activities at European and national levels will be ensured through capacity building foreseen under measure IIK-6.

At a regional workshop held in Ljubljana in July 2019, the topic of regional cooperation within the dimension of research, innovation and competitiveness scientific and research cooperation with the possibility of expanding was proposed regarding the following issues:

- energy storage,
- digitization of energy systems and grids,
- energy communities,
- advanced grids,
- RES rich systems,
- integration of energy systems (electrical, gas, thermal, transport)
- removal, storage and use of $CO_2$,
- hydrogen,
- energy poverty
- consumer behaviour.

iii. Financial measures in this area at the national level, including EU support and use of EU funds, if applicable.

Scientific and research projects stimulating entrepreneurship will be funded from national, European Structural and Cohesion Funds for 2021 - 2027, the Innovation Fund and directly from the European Union budget, with priority given to low carbon projects.

In addition, financial support is needed for research projects applying to relevant international tenders, which increase the knowledge needed to create a green and competitive low-carbon economy in which resources are used more efficiently and whose objectives are aligned with priority topics. The themes of the projects will be identified in line with national priorities. Financial support will be provided as a percentage based on own co-financing of projects for the costs of organizations registered in the Republic of Croatia.

# SECTION B: ANALYTICAL BASIS

# 4 CURRENT SITUATION AND PROJECTIONS WITH EXISTING POLICIES AND MEASURES

## 4.1 Projected evolution of main exogenous factors influencing energy system and GHG emission developments

### i. Macroeconomic forecasts (GDP and population)

The most critical factors influencing energy systems and GHG emission developments are demographic and economic movements.

The population's number, dynamics and spatial distribution according to different demographic and economic characteristics are the basic determinants of steering overall development. The official census published on the website of the Croatian Bureau of Statistics was used as a source in 2021, while the value in 2050 was taken from Eurostat, and the values between them were obtained by linear interpolation.

Also, projections of economic trends in the period up to 2050 have been made. For the development of the projection of gross domestic product (GDP) *Gross Domestic Product* (GDP) of the Republic of Croatia, official data was published on the Croatian National Bank website for 2021, while the remaining years were obtained using the projected real growth rates.

**Table 4-1 Trajectories of economic parameters based on medium demographic projections**

| Components | 2021 | 2025 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|
| GDP, real in prices from 2021, billion EUR | 57.232 | 65.898 | 71.852 | 83.148 | 96.918 |
| GDP, index, 2021 = 100 | 100 | 115.1 | 125.5 | 145.3 | 169.3 |
| GDP per capita, real in prices from 2021, thousand EUR | 14.8 | 17.3 | 19.5 | 23.8 | 29.4 |
| GDP per capita, index 202. = 100 | 100 | 117.3 | 132.0 | 161.1 | 198.6 |
| Population, in millions | 3.87 | 3.80 | 3.68 | 3.49 | 3.30 |

*Source: Croatian National Bank / Eurostat*

The projection of GDP and economic structure movements is based on the observed trend of GDP movements, employment and labour productivity, demographic projections, and the existing economic structure.

### ii. Sectoral changes expected to affect the energy system and greenhouse gas emissions

The projection of final consumption of all forms of energy was made using a *bottom-up* approach that provides an insight into structural changes in the area of energy use in various sectors (e.g. industry, households, services, transport), which are necessary to achieve the climate change mitigation goals.

LEAP (The Low Emissions Analysis Platform[33]) software tool was used to analyse final energy consumption. LEAP is a complex and versatile software system for integrated energy planning and climate change mitigation assessment developed by the Stockholm Environment Institute (SEI). LEAP supports a wide range of different modelling methodologies. For example, it is possible to apply bottom-up modelling techniques, end-use consumption techniques or macroeconomic top-down modelling on the energy consumption side. In this study, the end-use modelling method was applied so that for each sector and subsector, the current and future need for useful energy was determined according to the purposes. Then, the final energy consumption was calculated by applying appropriate efficiency technologies and the predicted representation of energy sources.

The LEAP tool enables scenario analyses that allow policymakers to determine and evaluate alternative scenarios by comparing energy needs, societal costs and benefits, and environmental impacts. In the LEAP tool, individual policy measures can be described, which can then be combined in different combinations and permutations into alternative integrated scenarios. This approach allows policymakers to assess the impact of individual policies and the interactions that occur when multiple policies and measures are combined. For example, the effects of a measure to improve the thermal insulation of a facility in combination with a measure to replace the primary energy source (space heating technology) may be less than the sum of the effects of the two measures if considered separately.

In the energy model developed for this document, two scenarios are defined. The first, the **Scenario with Existing Measures (WEM)**, represents the future trends of energy flows in line with the expected improvements in technology and structural changes in energy consumption and production driven mainly by market principles and without the active role of the Republic of Croatia in the design and implementation of energy-climate measures. The second, **the Supplementary Measures Scenario (WAM)**, assumes the implementation of an active policy in support of the energy transition. This implies the implementation of the measures elaborated on in this document.

The main determinants of changes in the energy sector applied in making projections of the final consumption of all forms of energy are the following:

- Increasing energy efficiency in all parts of the energy chain (production, transport/transmission, distribution and consumption of all forms of energy) and applying the principle of energy efficiency as a first recourse;

[33]Heaps, C.G., 2021. *LEAP: The Low Emissions Analysis Platform.* [Software version: 2020.1.54] Stockholm Environment Institute. Somerville, MA, USA. https://leap.sei.org

- Switching as many activities as possible to the use of electricity (where technologically feasible and long-term cost-effective);
- The increasing profitability of investing in RES technologies is due to the expected fall in the prices of these technologies and the rise in the prices of emission units.

In addition to sector-specific measures, the analysed scenario for the energy sector development also considers the effects of regulatory measures, which will have a cross-sectoral impact. It primarily concerns establishing a functional system of energy efficiency obligations for energy suppliers per Article 7 of Directive 2012/27/EU on energy efficiency.

In addition, energy efficiency is also expected to be increased on the energy production side by constructing new cogeneration plants and gas-fired power plants (TPPs) with higher efficiency and an increase in the share of RES. In the transmission and distribution of electricity and heat, further losses are expected to be reduced to the level of developed energy systems by 2030.

The assessment of future energy consumption considers the impact of expected climate change on the ways and dynamics of consumption of different types of energy. For example, expected changes in temperature and weather conditions can affect energy use for space heating and cooling and seasonal energy consumption.

Energy consumption and driving parameters (e.g. population size and structure, GDP structure, etc.) were processed at the state level.

The possibilities of meeting the needs of all forms of energy (e.g. thermal, electric, natural gas, biomass, etc.) were analysed, starting from the availability of local resources and sources of primary forms of energy. For grid systems (e.g. electricity, natural gas), the analysis and optimization of the operation and development of the system of production, transmission/transport and distribution of energy to end-users on a minimum cost basis were carried out, taking into account the environmental impact limitations (including greenhouse gas emissions), strategic determinants in the area of security of energy supply and the impact of participation in the operation of the regional market (possible cooperation in the exploitation of regional energy potential and sharing of infrastructure). The availability and condition of the existing energy infrastructure, the required replacement of elements and the construction of new elements in the system (e.g. power plants, powerlines, pipelines, etc.) were taken into account.

The PLEXOS model was used for the long-term optimal construction plan, to optimize electricity and district heating systems (in the part of thermal energy production), and to analyse/confirm the feasibility of operating the ES hourly in selected characteristic years.

### iii. Global energy trends, international fossil fuel prices, carbon pricing within the EU ETS

In analysing electricity supply options, fuel prices recommended by the European Commission were used[34]. This document recommends using harmonised estimates of individual input parameters in the Member States and the presentation of monetary values converted into EUR2020 (previously used EUR2016).

The ESTAT HICP (Harmonized Indices of Consumer Prices) index values were used for this conversion. If a Member State uses other values, it is necessary to indicate the reasons and differences and conduct a sensitivity analysis per the recommended harmonised values of the selected parameters.

#### International fuel prices

Table 4-2 and Figure 4-1 show estimated fuel prices by 2050.

**Table 4-2 Estimated fuel prices by 2050**

| $EUR_{2020}$ | Crude oil EUR/GJ | Crude oil EUR/toe | Crude oil EUR/barrel | Natural gas (NCV) EUR/GJ | Natural gas (NCV) EUR/toe | Coal EUR/GJ | Coal EUR/toe |
|---|---|---|---|---|---|---|---|
| **2025** | 15.4 | 643 | 88 | 13.2 | 554 | 3.1 | 128 |
| **2030** | 15.4 | 643 | 88 | 11.3 | 473 | 3.1 | 130 |
| **2035** | 15.4 | 643 | 88 | 11.3 | 473 | 3.1 | 131 |
| **2040** | 16.3 | 680 | 93 | 11.3 | 473 | 3.3 | 139 |
| **2045** | 17.6 | 738 | 101 | 11.3 | 473 | 3.5 | 146 |
| **2050** | 19.7 | 824 | 112 | 11.8 | 494 | 3.7 | 153 |

*Source: EU Recommended parameters for reporting on GHG projections in 2023*

Figure 4-1. shows the expected trend of fuel prices by 2050, compared to 2021 (the last year before significant disturbances and price changes in the energy market).

[34]Recommended parameters for reporting on GHG projections in 2023, Version after consultation of WG2 under the Climate Change Committee on 10th March 2022, sharing of draft recommendations on 30th March 2022 and consultation of National Experts designated by members of WG2 on 26th April 2022, EUROPEAN COMMISSION DIRECTORATE-GENERAL FOR CLIMATE ACTION

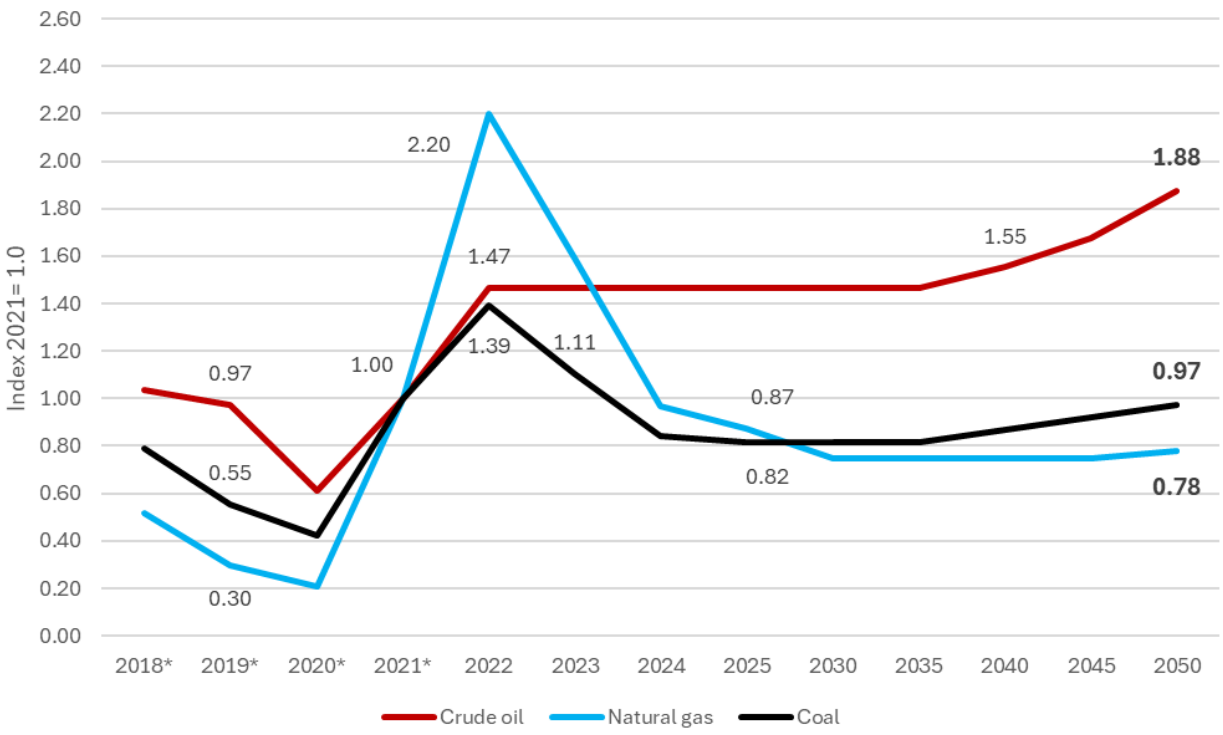



**Figure 4-1 Fuel price change index until 2050**

*Source: EU Recommended parameters for reporting on GHG projections in 2023*

For natural gas, it is recommended to conduct a sensitivity analysis within the limits of the expected lowest and highest price, as shown in the table and figure below.

**Table 4-3 Natural gas price projection**

| EUR2020 | Natural gas (NCV) – low price | | Natural gas (NCV) – high price | |
|---|---|---|---|---|
| | **EUR/GJ** | **EUR/t** | **EUR/GJ** | **EUR/t** |
| 2025 | 5.0 | 209 | 14.6 | 611 |
| 2030 | 6.7 | 281 | 13.8 | 579 |
| 2035 | 7.4 | 308 | 13.1 | 547 |
| 2040 | 8.6 | 361 | 13 | 544 |
| 2045 | 9.3 | 391 | 13.2 | 553 |
| 2050 | 9.5 | 397 | 13.8 | 577 |

*Source: EU Recommended parameters for reporting on GHG projections in 2023*

According to the low-cost scenario, a significant drop in the price of natural gas is expected from 2025 (market stabilisation and infrastructure realisation). By 2050, no substantial change in the price of natural gas is expected.

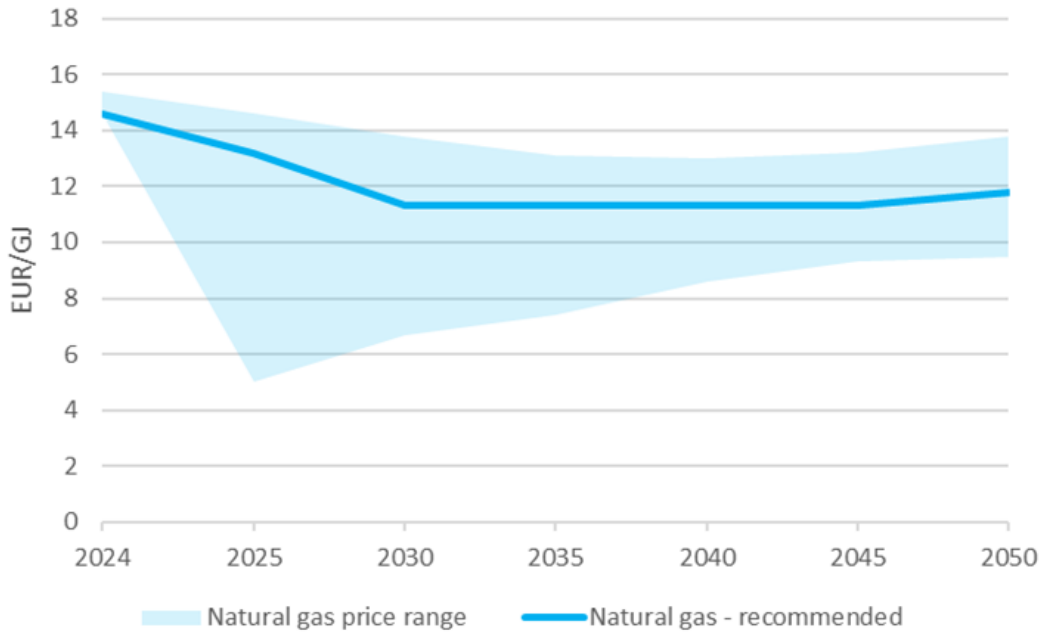



**Figure 4-2 Recommended natural gas price range for sensitivity analyses**

Table 4-4 shows fuel prices according to the estimates of the International Energy Agency[35].

**Table 4-4 Fuel price estimates according to IEA**

| $EUR_{2020}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Product** | **Scenario** | **Unit** | **2021** | **2030** | **2035** | **2040** | **2045** | **2050** |
| Crude oil | Stated Policies | EUR/barrel | 56.6 | 67.6 | 69.3 | 72.6 | 74.6 | 78.3 |
| | Announced Pledges | | | 52.4 | 51.5 | 51.5 | 50.7 | 49.8 |
| Natural gas (EU*) | Stated Policies | EUR/MBTu | 7.8 | 7.0 | 7.0 | 7.1 | 7.3 | 7.6 |
| | Announced Pledges | | | 6.5 | 6.0 | 5.5 | 5.2 | 5.2 |
| Coal (EU*) | Stated Policies | EUR/t | 98.9 | 49.7 | 54.4 | 53.9 | 52.8 | 53.0 |
| | Announced Pledges | | | 51.5 | 47.2 | 45.8 | 44.8 | 44.0 |
| * - prices relevant for the EU | | | | | | | | |

*Source: IEA World Energy Outlook 2023 ("World Energy Outlook for 2022 of the International Energy Agency") [16]*

The above estimates show that the EU's fuel price recommendations are well above the prices estimated in IEA WEO 2023.

A constant price of EUR 0.50/GJ is estimated for nuclear fuel and EUR 4.6/GJ for biomass.

[35] IEA World Energy Outlook 2023

### Emission unit prices in the EU emission unit trading system

All power plants that use fossil fuels above 20 MW of input nominal thermal power are assumed to participate in the European emission trading system. The European Commission has prepared recommended price levels for emission units until 2050 to create national energy and climate plans, shown in the table below. As in the case of fuel prices, all amounts are expressed in 2020 EUR.

**Table 4-5 Recommended emission allowance prices by 2050**

| Emission unit prices | 2021 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| NECP - EC Recommendation EUR2020/t $CO_2$, Scenario with existing measures (WEM) | 54 | 80 | 80 | 82 | 85 | 130 | 160 |
| NECP - EC Recommendation EUR2020/t $CO_2$, Scenario with additional measures (WAM) | 54 | 80 | 80 | 120 | 250 | 360 | 410 |

*Source: EU Recommended parameters for reporting on GHG projections in 2023*

Two trajectories for developing emission unit prices were recommended: one for the *WEM (With Existing Measures*) scenario and the other for the *WAM (With Additional Measures*) scenario.

### iv. Changes in technology cost

Expected trends of specific investments in electricity generation technologies for 2020-2050 have been taken from IEA WEO 2022 for the EU territory. The option of coal-fired thermal power plants was not considered. In contrast, the possible construction of a carbon capture and sequestration system (CCS) was envisaged for natural gas-fired thermal power plants. Expected specific investments are shown in the following table.

**Table 4-6 Expected specific investments in power plants**

| Technology | 2021 | 2030 | 2050 |
|---|---|---|---|
| | Specific investment (EUR2020/kW) | | |
| **CCGT** | 824 | 824 | 824 |
| **CCGT + CCS** | 2,556 | 2,473 | 1,814 |
| **OCGT** | 412 | 412 | 412 |
| **Nuclear** | 5,441 | 4,205 | 3,710 |
| **Solar PV (large)** | 668 | 437 | 338 |
| **Solar PV (buildings)** | 923 | 627 | 495 |
| **Wind power plants (land)** | 1,311 | 1,245 | 1,195 |
| **Wind power plants (sea)** | 2,506 | 1,649 | 1,237 |
| **Biomass and biogas** | 3,092 | 3,009 | 2,927 |
| **Geothermal plants** | 2,350 | 2,267 | 2,102 |

*Source: IEA WEO 2022*

Natural gas-fired thermal power plants are not expected to progress technologically except in the context of carbon collection and storage development. For nuclear power plants, the

possibility of making greater use of this technology to reach global emissions reduction targets was assumed (the estimate presented relates to projects to be implemented in Europe). Concerning the Small Modular Reactors (SMR) option, the commercialization of this option is projected after 2035, by which time all elements of the utilization program will be known.

Further specific cost reductions are expected for RES sources, especially for solar power plants. No significant technological/cost progress is expected for large and small HPPs and biomass power plants.

### Batteries

The possibility of building lithium-ion batteries is also foreseen for storing surplus electricity and providing flexibility services in the electricity system. The power-to-pack ratio is assumed to be 1:4 (i.e. a battery that can be charged or discharged in 4 hours). Specific investments are shown in Table 4-7.

**Table 4-7 Specific investments in battery systems (4 hours of storage)**

| Component | EUR2020 | 2021 | 2030 | 2050 |
|---|---|---|---|---|
| The cost of the battery-tank | EUR/kWh | 171 | 124 | 61 |
| The cost of the management system | EUR/kW | 619 | 493 | 297 |
| Fixed cost | EUR/kW | 7.9 | 5.7 | 2.8 |
| Variable cost | EUR/MWh | 2.2 | 1.4 | 0.5 |
| Total specific cost (4 hours) | EUR/kW | 1,311 | 995 | 544 |

Individual storage systems (i.e. end-user level) are assumed to be at least 20 % more expensive than high storage capacity batteries (system level). It is possible to build batteries at all voltage levels.

### Hydrogen production technologies

For hydrogen production, it is assumed that the electrolysis process will produce all quantities. The expected costs of such a facility are shown in the following table. It is also necessary to predict the costs of the hydrogen tank, and the amounts shown are increased by 20%.

**Table 4-8 Specific investments in hydrogen production facilities (electrolysis)**

| Item | Unit | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| CAPEX (at the level of technology input) | EUR2020/$kW_e$ | 836 | 650 | 418 |
| Efficiency (NCV) | % | 64 | 69 | 74 |
| OPEX (5 in relation to CAPEX) | % | 1.5 | 1.5 | 1.5 |
| "Stack" lifetime | h | 95,000 | 95,000 | 100,000 |

*Source: IEA G20 Hydrogen report: Assumptions, Revised version, December 2020*

## 4.2 Dimension: decarbonization

### 4.2.1 Emissions and elimination of greenhouse gases

#### i. Trend of current GHG emissions and removals within the framework of the EU Emissions Trading System, outside the EU trading system, LULUCF and other energy sectors

The latest available data from the Report on the Inventory of Greenhouse Gas Emissions for 2022 (NIR2024) and the EU Climate Action Progress Report show that the Republic of Croatia is not on the way to meeting the defined goal in the sectors covered by the distribution of efforts (ESR sectors). In this sense, the biggest problem is the increase in emissions from the transport sub-sector, in which a 9% increase in emissions was recorded in the period from 2022 to 2023 (data from NIR 2024 and energy balance for 2023). Therefore, the intensification of measures to reduce transport emissions is necessary.

In addition to the transport sub-sector, measures to reduce emissions of fluorinated greenhouse gases should be intensified. Greenhouse gas removals using sinks are exclusively related to the LULUCF sector and amounted to 4,867 kt $CO_2$ eq in 2022, which is 15.6% less than in 2021. The goal of the LULUCF Sector is to have removals by sinks of 5,527 kt $CO_2$eq in 2030.

According to the latest data, this goal is also in jeopardy, and the biggest reason is increased felling, fires on forest land and grasslands, and a decrease in the category of wood products.

The trend of GHG emissions in the Republic of Croatia is presented in Figure 4-3.

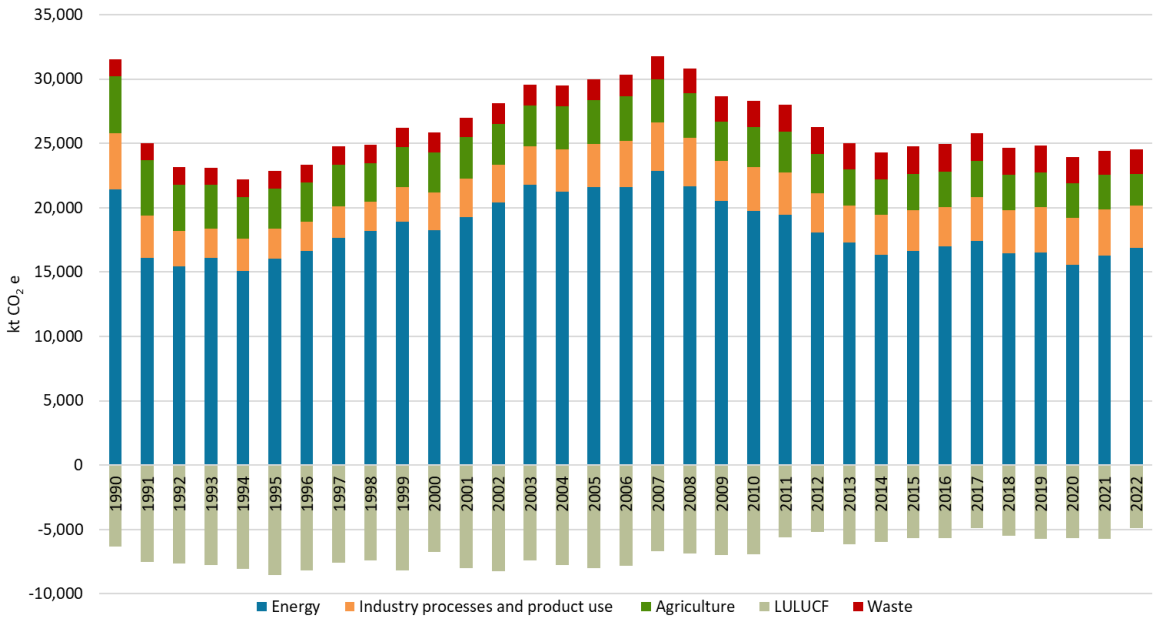



**Figure 4-3 Trend of GHG emissions in the Republic of Croatia**

Since January 1st, 2013, plants in the Republic of Croatia participate in the EU Emissions Trading System for GHG. The ETS and non-ETS sectors' emissions are shown from 2013 to 2022 (Figure 4-4).

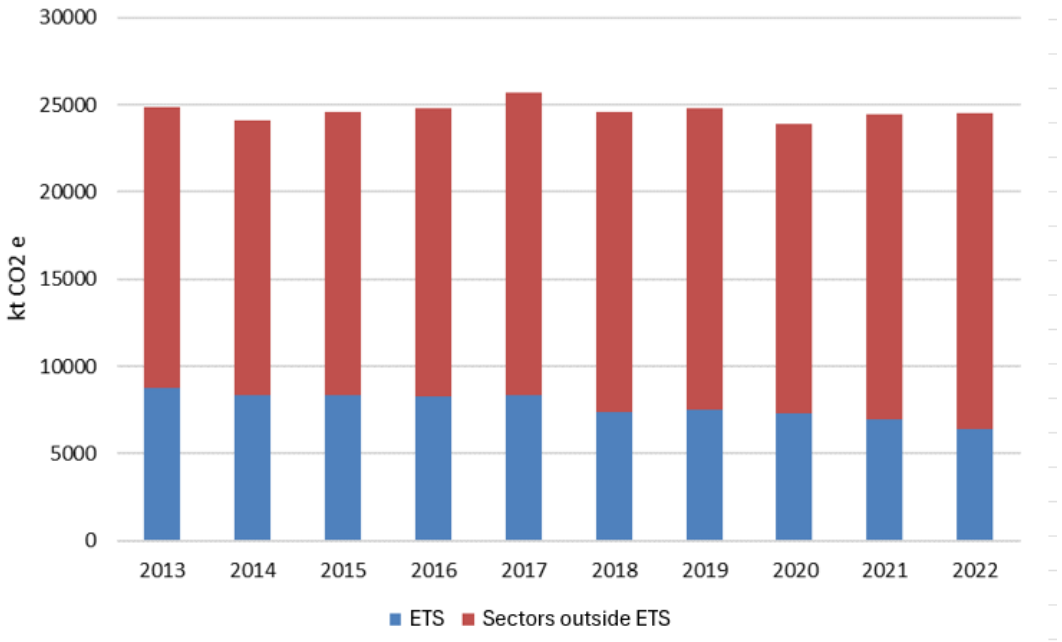



**Figure 4-4 Trend of GHG emissions from ETS and non-ETS sectors in the Republic of Croatia**

ii. Estimates of sectoral trends in addition to existing national and EU policies and measures at least until 2040 (including the estimates for 2030).

Estimates of GHG emissions by sectors with existing national policies and measures and EU policies and measures by 2040 are presented in Figure 4-5.

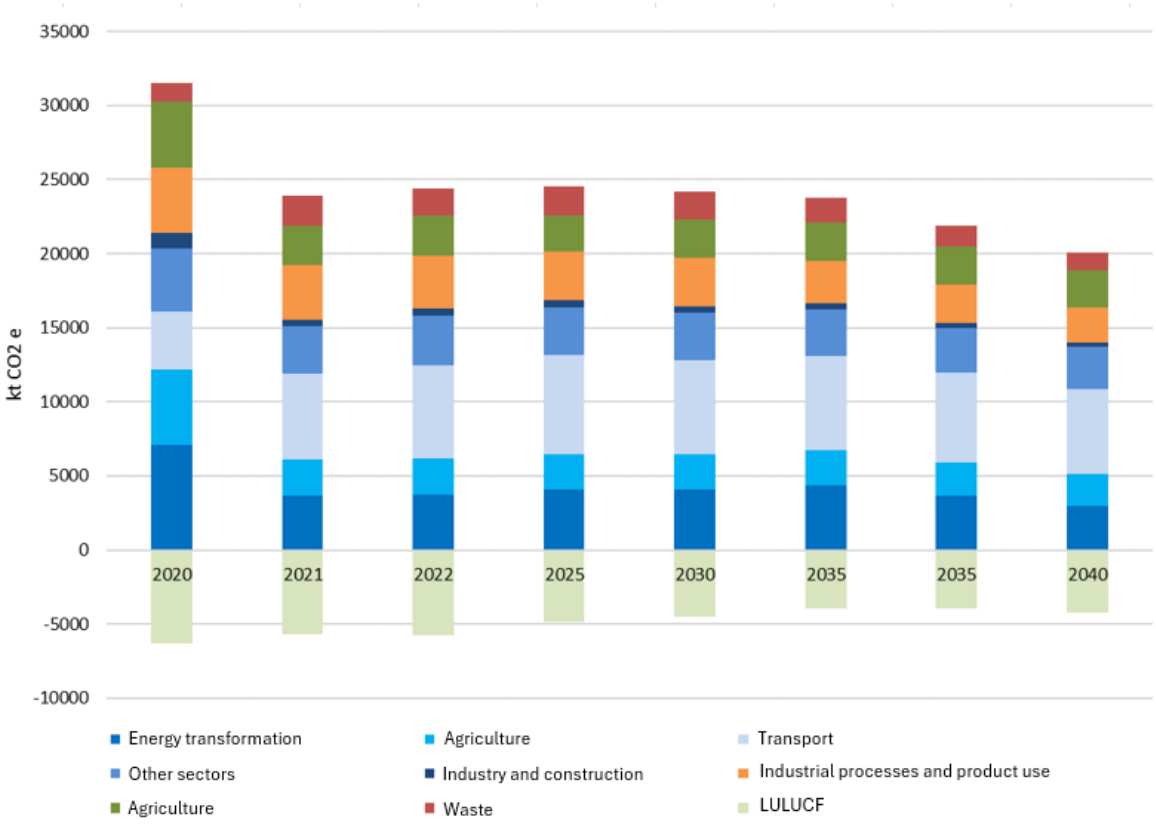



**Figure 4-5 Projection of GHG emissions and sinks, with the existing measures – WEM scenario**

Trends in emissions by greenhouse gases ($CO_2$, $CH_4$, $N_2O$, HFC, $SF_6$) for the scenario with existing measures (WEM) from 2020 to 2040 are shown in Table 4-9.

**Table 4-9 Projections of greenhouse gas emissions $CO_2$, $CH_4$, $N_2O$, HFC, $SF_6$, for the scenario with existing measures, kt $CO_2e$**

| | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|
| $CO_2$ | 11,002.74 | 12,634.16 | 13,674,11 | 12,390.67 | 10,784.59 |
| $CH_4$ | 4,034.76 | 3,620.10 | 3,217,26 | 3,029.06 | 2,847.73 |
| $N_2O$ | 1,636.79 | 1,544.58 | 1,528.62 | 1,487.58 | 1,447.04 |
| HFC | 1,572.23 | 1,512.69 | 1,013.76 | 790.46 | 567.15 |
| $SF_6$ | 9.35 | 8.10 | 4.95 | 3.70 | 2.45 |
| **Total** | **18,255.88** | **19,319.64** | **19,438.70** | **17,701.46** | **15,648.96** |

### 4.2.2 Renewable energy

i. Current share of energy from renewable sources in final gross energy consumption and in different sectors (heating and cooling, electricity and transport) as well as by technology in each of these sectors

In the case of the scenario with existing measures (WEM), RES shares and forecasts with existing measures are presented below.

**Table 4-10 Indicative trajectories of RES shares by 2030 in the scenario with existing measures (WEM)**

| Share RES, % | Achieved | | Projection to 2030 (WEM scenario) |
|---|---|---|---|
| | 2021 | 2022 | |
| In the gross final consumption of energy | 31.7 | 29.4 | 35.0 |
| In the final consumption of electricity | 53.5 | 55.5 | 63.6 |
| In the final consumption of energy for heating and cooling | 38.0 | 37.2 | 40.0 |
| In the final consumption of energy in transport | 7.1 | 2.4 | 10.7 |

### ii. Indicative estimates of trends with existing policies by 2030 (with an outlook to 2040)

The following figure shows the expected trajectories (shares) for the observed categories: total RES in the gross final energy consumption (Figure 4-6), RES in electricity (Figure 4-7), RES in heating and cooling (Figure 4-8) and RES in transport (Figure 4-9) for a scenario with existing measures (WEM).

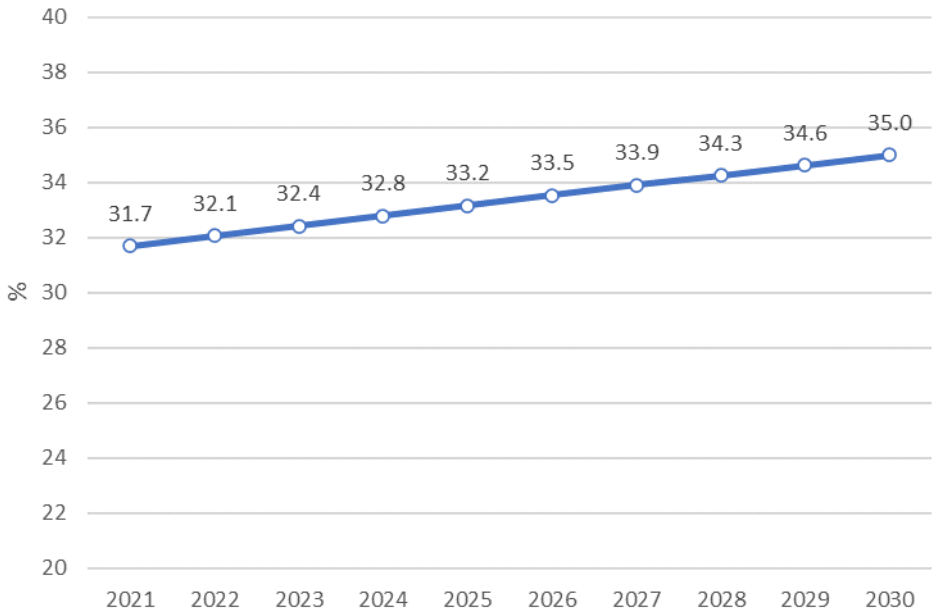



**Figure 4-6 Indicative trajectory of RES shares in the gross final consumption of energy (WEM)**

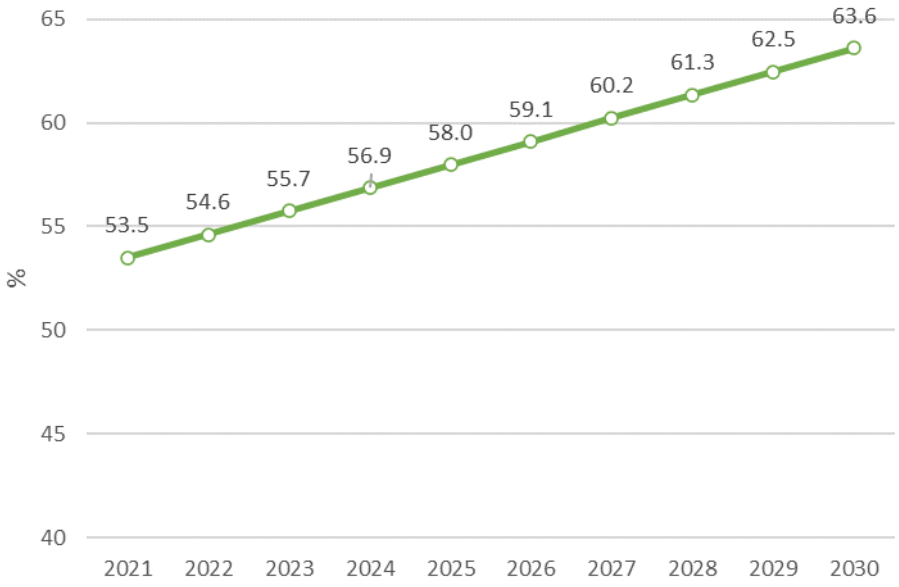



**Figure 4-7 Indicative trajectory of RES shares in electricity (WEM)**

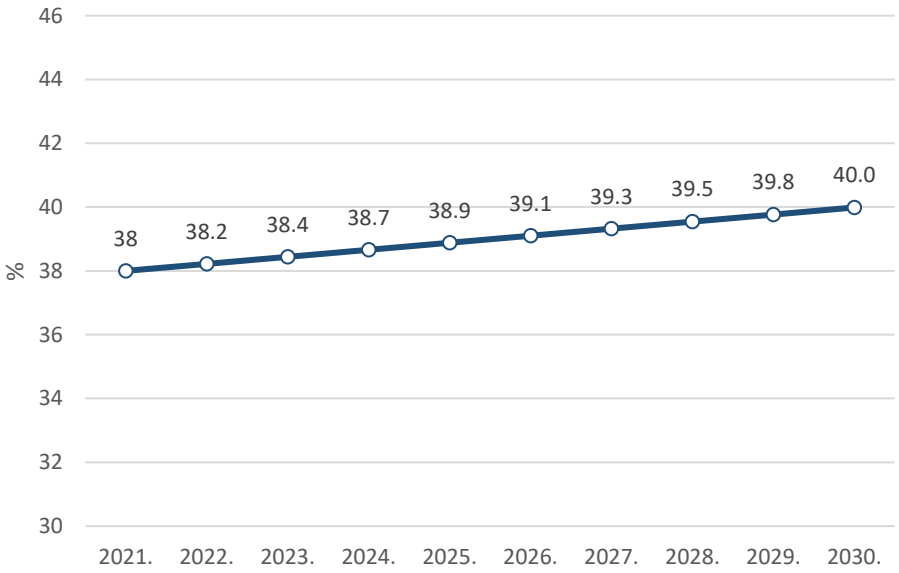



**Figure 4-8 Indicative trajectory of RES share in heating and cooling (WEM)**

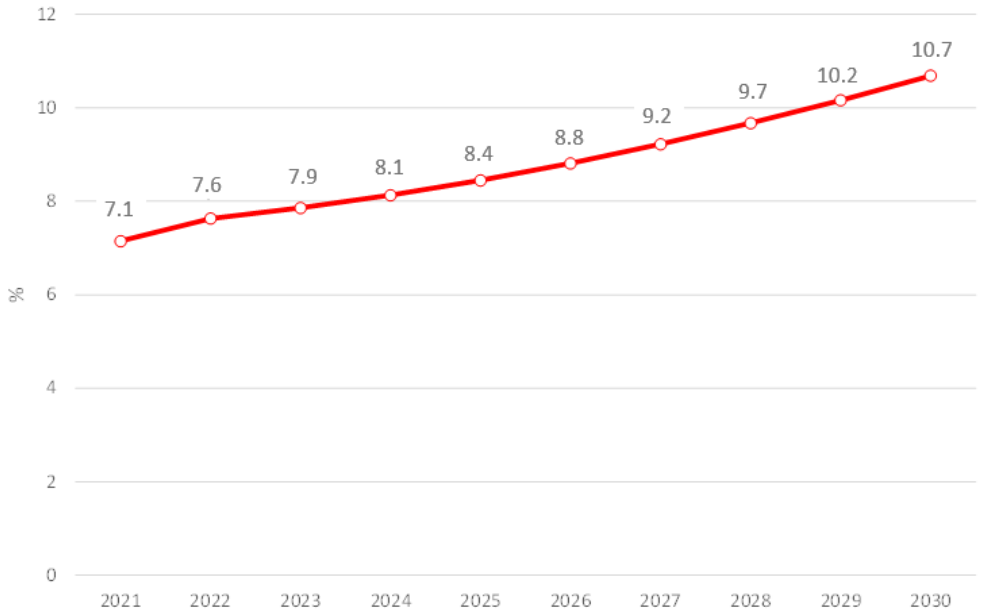



**Figure 4-9 Indicative trajectory of RES share in transport (WEM)**

Evaluated contributions of technologies for energy production from RES for the scenario with existing measures are shown in Figure 4-10 and Tables 4-11 to 4-14.

**Table 4-11 Estimated contribution of RES technologies to gross final energy consumption (WEM)**

| ktoe | **2021** | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | **2030** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gross final RES consumption** | **2,304.5** | 2,341.3 | 2,378.2 | 2415.0 | 2,451.9 | 2,488.7 | 2,525.6 | 2,562.4 | 2,599.2 | **2,636,1** |
| **Solar energy** | **17.1** | 17.8 | 18.5 | 19.2 | 19.9 | 20.6 | 21.4 | 22.1 | 22.8 | **23.5** |
| **Solid biomass** | **1154.4** | 1,144.8 | 1135.3 | 1,125.7 | 1116.2 | 1,106.6 | 1,097.1 | 1,087.5 | 1,078.0 | **1,068.4** |
| **Gaseous biofuels** | **0.5** | 0.4 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | **0.0** |
| **Liquid biofuels** | **91.2** | 91.0 | 90.7 | 90.5 | 90.2 | 90.0 | 89.8 | 89.5 | 89.3 | **89.0** |
| **Geothermal energy** | **5.0** | 5.0 | 5.0 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | **4.9** |
| **Thermal energy from RES** | **108.7** | 122.8 | 136.9 | 151.0 | 165.1 | 179.2 | 193.3 | 207.4 | 221.5 | **235.6** |
| **Electricity from RES** | **927.8** | 959.6 | 991.5 | 1,023.4 | 1,055.3 | 1,087.1 | 1,119.0 | 1,150.9 | 1,182.8 | **1,214.7** |

"RES heat" includes heat produced from renewable energy sources in public heating plants, boiler rooms, industrial heating plants and heat pumps.

**Table 4-12 Estimated contribution of technologies for RES in electricity (WEM)**

| ktoe | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gross final RES consumption** | **927.7** | 959.6 | 991.5 | 1,023.4 | 1.055.2 | 1,087.1 | 1.119.0 | 1,150.9 | 1,182.8 | **1,214.7** |
| **Hydro power plants** | **571.4** | 569.6 | 567.7 | 565.9 | 564.0 | 562.2 | 560.3 | 558.5 | 556.6 | **554.8** |
| **Wind power plants** | **177.3** | 202.3 | 227.3 | 252.3 | 277.2 | 302.2 | 327.2 | 352.2 | 377.2 | **402.2** |
| **Solar power plants PV** | **12.8** | 19.7 | 26.5 | 33.4 | 40.2 | 47.1 | 53.9 | 60.8 | 67.7 | **74.5** |
| **Geothermal power plants** | **45.0** | 45.2 | 45.4 | 45.6 | 45.8 | 46.0 | 46.3 | 46.5 | 46.7 | **46.9** |
| **Thermal production - solid and gaseous biomass** | **121.2** | 122.9 | 124.6 | 126.3 | 127.9 | 129.6 | 131.3 | 133.0 | 134.7 | **136.4** |

**Table 4-13 Estimated contribution of technologies for RES in heating and cooling (WEM)**

| ktoe | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Final RES-H&C** | **1,285.1** | 1,272.4 | 1,259.8 | 1,247.1 | 1,234.5 | 1,221.8 | 1,209.2 | 1,196.5 | 1,183.8 | **1,171.2** |
| **Solar energy** | **17.1** | 19.4 | 21.8 | 24.1 | 26.5 | 28.8 | 31.2 | 33.6 | 35.9 | **38.3** |
| **Solid biomass** | **1,154.4** | 1,122.7 | 1,091.0 | 1,059.3 | 1,027.5 | 995.8 | 964.1 | 932.4 | 900.7 | **869.0** |
| **Gaseous and liquid biogas** | **0.0** | 2.6 | 5.3 | 7.9 | 10.5 | 13.2 | 15.8 | 18.5 | 21.1 | **23.7** |
| **Geothermal energy** | **5.0** | 4.9 | 4.9 | 4.9 | 4.8 | 4.8 | 4.8 | 4.7 | 4.7 | **4.7** |
| **RES heat** | **108.7** | 122.8 | 136.9 | 151.0 | 165.1 | 179.2 | 193.3 | 207.4 | 221.5 | **235.6** |

"RES heat" includes heat produced from renewable energy sources in public heating plants, boiler rooms, industrial heating plants and heat pumps.

**Table 4-14 Estimated contribution of technologies for RES in transport (WEM)**

| ktoe | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gross final RES in transport** | **103.4** | **111.1** | **112.7** | **114.6** | **116.6** | **118.9** | **121.2** | **123.8** | **126.5** | **129.3** |
| **Biofuels** | **91.2** | 88.0 | 88.4 | 88.7 | 88.9 | 89.0 | 89.1 | 89.0 | 89.0 | **88.8** |
| **Electricity from RES** | **12.2** | 23.0 | 24.4 | 25.9 | 27.7 | 29.8 | 32.2 | 34.7 | 37.5 | **40.4** |

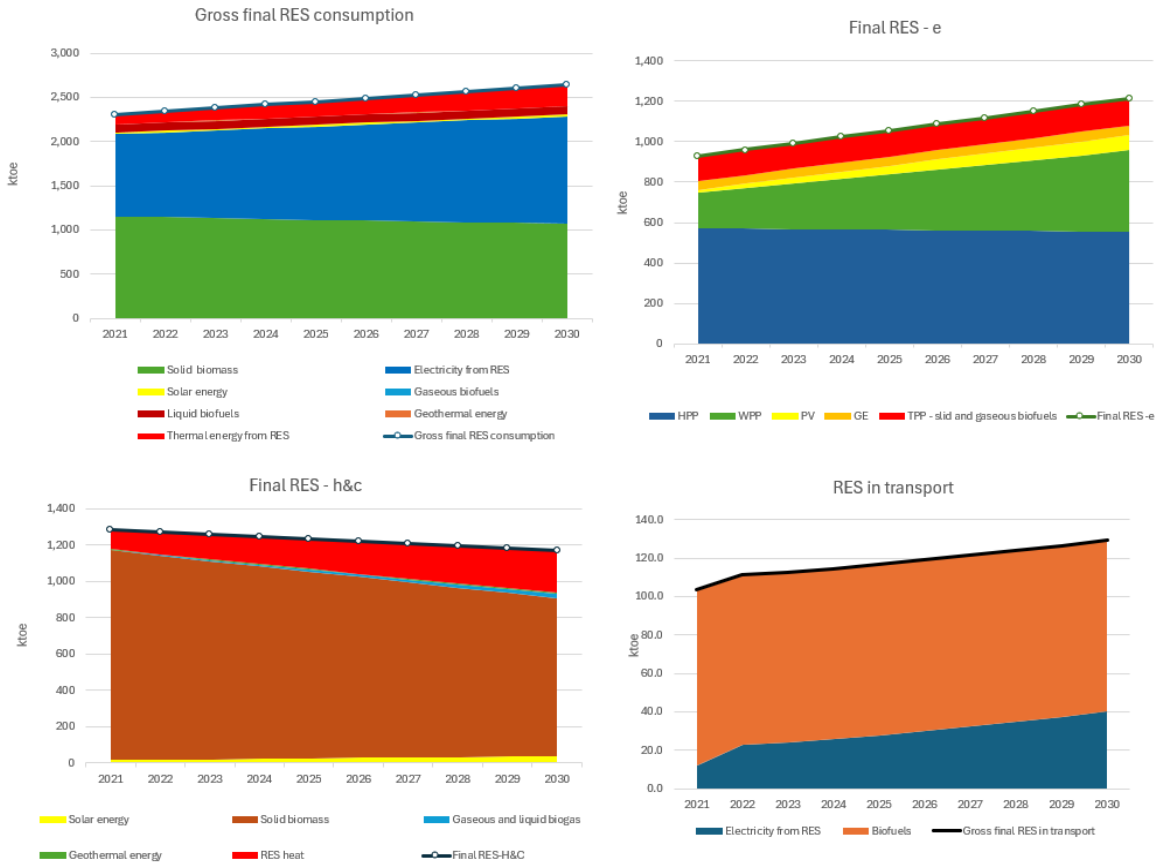



**Figure 4-10 Estimated contribution of RES technologies by sectors (WEM)**

The expected structure of electricity generation capacity in the Scenario with existing measures (WEM) is presented in Table 4-15 and Figure 4-11.

**Table 4-15 Estimated power plant capacities in the scenario with existing measures (WEM)**

| MW | Nuclear | Hydro | Gas | Fuel Oil | Coal | Biomass | Biogas | Geothermal | Wind | Solar | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 348 | 2,203 | 822 | 344 | 199 | 101 | 59 | 10 | 987 | 223 | **5,296** |
| 2030 | 348 | 2,393 | 1,079 | 0 | 199 | 135 | 59 | 10 | 1,886 | 1.266 | **7,375** |
| 2040 | 348 | 2,780 | 1,819 | 0 | 0 | 135 | 59 | 38 | 2,496 | 2,345 | **10,020** |
| 2050 | 0 | 2,980 | 1,784 | 0 | 0 | 135 | 59 | 68 | 3,260 | 3,430 | **11,716** |

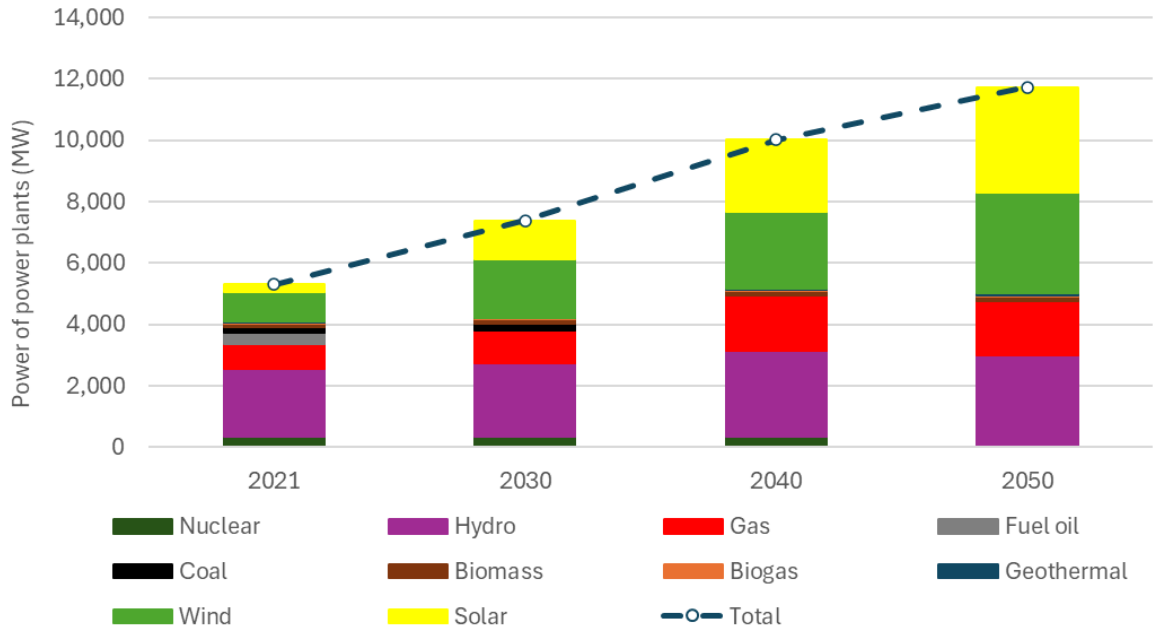



**Figure 4-11 Estimated powerplant capacity in the scenario with the existing measures (WEM)**

## 4.3 Dimension: energy efficiency

### i. Current primary and final energy consumption in the economy and by sector (including industry, residential, service and transport)

The most recent data on energy consumption in the Republic of Croatia available at the moment of drafting this plan for 2022 are presented in Table 4-16 and Table 4-17.

**Table 4-16 Structure of energy consumption by sectors in 2022**

| 2022 | PJ |
|---|---|
| **TOTAL ENERGY CONSUMPTION** | 356.2 |
| Transformation losses | 32.0 |
| Operational consumption | 18.0 |
| Transport and distribution losses | 9.3 |
| Non-energy consumption | 8.1 |
| **FINAL ENERGY CONSUMPTION** | 280.9 |
| Industry | 47.3 |
| Transport | 93.1 |
| Residential | 95.7 |
| Service | 33.9 |
| Agriculture and forestry | 10.0 |
| Fishery | 0.9 |

**Table 4-17 Structure of energy consumption by energy-generating products in 2022**

| 2022 | PJ |
|---|---|
| **TOTAL ENERGY CONSUMPTION** | 356.2 |
| Coal and coke | 17.0 |
| Liquid fuels | 137.9 |
| Natural gas | 89.3 |
| Renewable energy sources | 93.2 |
| Waste non-renewable | 1.9 |
| Electricity | 16.9 |
| FINAL ENERGY CONSUMPTION | 280.9 |
| Coal and coke | 3.4 |
| Liquid fuels | 117.1 |
| Natural gas | 43.9 |
| Renewable energy sources | 45.7 |
| Waste non-renewable | 1.9 |
| Electricity | 58.5 |
| Thermal energy | 10.4 |

*Source: Annual Energy Review – Energy in Croatia 2022, Ministry of the Economy, December 2023, [10]*

### ii. Current potential for the application of high-efficiency cogeneration and efficient district heating and cooling

The potential indicators for the application of high-efficiency cogeneration and efficient district heating and cooling are taken from the document “Comprehensive assessment of the potential for efficient heating and cooling in Croatia according to Annex VIII of Directive 2012/27/EU on energy efficiency", from July 2021, which was developed for the needs of the Ministry of the Economy under Article 14 (1) of Directive 2012/27/EU on energy efficiency.

The established overall (theoretical) potential for high-efficiency cogeneration plants in the Republic of Croatia is observed through two scenarios of shares of future consumers of DHS coupled with high-efficiency cogeneration: reference and SIM scenario. The reference or BAU scenario (BAU – business as usual) implies development with the application of existing measures, while the SIM scenario (SIM - scenario with integrated measures) considers additional measures.

**Table 4-18 Total annual delivered energy at the entrance to the distribution network of district heating systems in 2019, 2030 and 2050 – SIM scenario**

| Energy source/technology | 2019 | SIM-2030 | SIM-2050 |
|---|---|---|---|
| DHS- natural gas (boilers, CHP, high-efficiency CHP) | 1,677.0 | 911.9 | 437.4 |
| DHS-fuel oil boilers | 34.7 | 0.0 | 0.0 |
| DHS-biomass boilers | 3.8 | 7.0 | 13.3 |
| DHS-high efficiency cogeneration on biomass | 105.5 | 150.0 | 256.3 |
| DHS-Solar energy | 2.1 | 24.8 | 33.5 |
| DHS-geothermal energy | | 422.3 | 477.1 |
| DHS-heat pumps - electricity | | 14.2 | 24.2 |
| DHS-heat pumps - RES from the environment | | 48.3 | 82.1 |
| DHS-waste heat from the industry | | 15.0 | 22.7 |
| DHS-heat from thermal treatment of waste | | 130.0 | 195.8 |
| **TOTAL** | **1,823.0** | **1,723.5** | **1,542.3** |

The scenario with integrated measures in 2030 and 2050, respectively, envisages the following measures:

- complete shutdown of fuel oil boilers (by 2030),
- significant reduction of natural gas boilers,
- increasing high-efficiency cogeneration using biomass,
- significant increase in the use of geothermal energy,
- use of heat from thermal treatment of waste (significant potential in densely populated urban areas),
- use of compression heat pumps water/water (the figure shows the operating electricity and heat taken from the environment),
- use of waste heat from industry (a small part),

- use of solar energy (a small part).

### iii. Projections considering existing policies, measures and energy efficiency programmes, as described in 1.2. (ii), for primary and final energy consumption by sector by 2040 at least (including projections for 2030)

Projections of primary and final energy consumption from 2021 to 2040, considering only existing policies, measures and energy efficiency programmes, are presented in Figure 4-12.

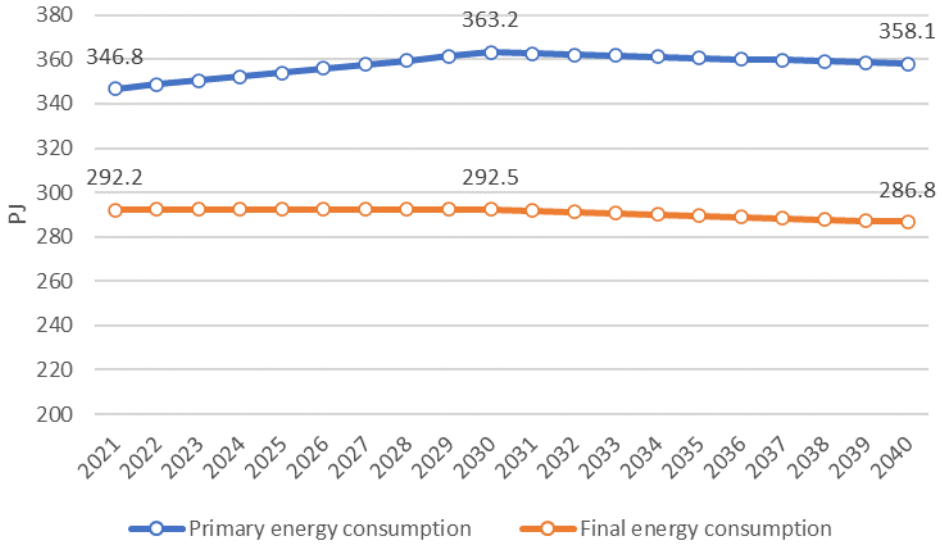



**Figure 4-12 Trajectory of energy consumption until 2040 with existing policies, measures, and energy efficiency programs (WEM)**

### iv. Cost-effective levels of minimum requirements in terms of energy efficiency resulting from national calculations, according to Article 5 of Directive 2010/31/EU

Minimum energy performance requirements of buildings are determined by the cost-optimal method by Article 5 of Directive 2010/31/EU on the energy performance of buildings in 2013 and 2014 for residential buildings (single-family and multi-dwelling) and non-residential buildings (offices, buildings where educational institutions are located, wholesale and retail trade buildings, hospitals, hotels, restaurants and halls)[36]. The energy performance is determined through maximum permissible primary energy for buildings, using several additional parameters that define more precisely the behaviour of a building (required energy, thermal transmittance of the external envelope, share of RES, performance level of the technical building systems and others). During 2018, a new cycle of cost optimization of minimum requirements for the energy performance of buildings was initiated by using dynamic calculation methods of the energy performance of buildings and by comparing values with the national algorithm for calculating the energy performance of buildings to align

[36]All reports under Article 5 (2) of Directive 2010/31 / EU and Article 6 of Regulation (EU) 244/12 of 16th January 2012 on the levels of minimum energy performance requirements for buildings and building elements listed are available on the MCPP website: http://mgipu.hr/default.aspx?id=12841 (date of access: 27/11/18)

requirements with market changes and new available technologies and to elaborate the calculation method and determine the energy performance of buildings.

## 4.4 Dimension: energy security

### i. The current mix of energy sources, domestic energy sources, dependency on imported energy, including relevant risks

**Electrical Grid**

The actual responsibility for supplying the ES of the Republic of Croatia, that is, securing sufficient quantities of electricity, lies with several entities, namely:

- Suppliers who are obliged to settle their contractual obligations to customers, in particular, HEP-Supply (Opskrba) as the most significant commercial supplier and HEP Elektra as the universal and guaranteed supplier,
- HEP-DSO for the procurement of electricity needed to cover losses in the distribution grid,
- CTSO is needed to procure electricity to cover losses in the transmission grid and the technical works related to electricity procurement to balance the system.
- HEP Production as a mandatory service provider for energy balancing and non-frequency services.

The most significant responsibility of CTSO regarding the security of supply and self-sufficiency of the system is to maintain a high level of transmission network reliability, i.e. mainly the interconnection lines, and to maintain/increase the cross-border transmission capacity at all borders to technically enable the import of lacking quantities of electricity in the power system of the Republic of Croatia and the exchange with neighbouring countries. It should be noted that the possibility of importing energy into the Croatian power system depends not solely on CTSO but also on other system operators. All market participants can use the available cross-border transmission capacity, not just those who import energy into the Croatian electricity system.

As there are enough production facilities in the broader region according to ENTSO-E data, and given the existing satisfactory liquidity of the electricity stock exchanges in the area, the preliminary conclusion is that the lacking amounts of electricity will need to be procured over the next period through market transactions, whereby the existing cross-border transmission capacity is estimated as high enough to support the expected level of imports, and secure operation of the Croatian ES.

An exception to the preceding conclusion may occur only in case of a severe crisis in the broader European area when, due to the simultaneous threat to the sufficiency of the electricity system in several countries, the ability to procure electricity from imports would be limited. Such a scenario has not yet occurred, but a specific, albeit low, likelihood of such an event or a series of simultaneous disadvantageous events should not be ignored. According to the current situation in the electricity exchanges, it is possible to expect intermittent periods of extremely high electricity prices (> 200 EUR/MWh) either due to increased

consumption (for example, in the case of very cold weather) or temporary unavailability of production facilities (failures, accidents), i.e. their reduced production capacity (calm weather without sun and wind, possible restrictions in gas supply, etc.). Under the requirements of the ENTSO-E and the network rules of the Croatian transmission system, the Croatian Transmission System Operator has adopted a Plan to protect the electricity system from significant disturbances. It is a document with specific technical and organizational measures which need to be taken to restore the system from faulty operation or system failure to regular operation, and in total, it includes:

- a way of announcement of a significant disturbance,
- a way to activate a large disturbance protection plan,
- measures and procedures for the protection of the electricity system from significant disturbances,
- plan for under-frequency load shedding of the electricity system,
- plan for limitation of electricity consumption and emergency load shedding of the electricity system,
- plan for the re-establishment of the electricity system,
- issuing instructions to the authorized person of the transmission system user and the authorized person of the distribution system operator,
- informing the operators of neighbouring transmission systems,
- mutual reporting and communication with the neighbouring transmission system operators, the authorized users of the transmission grid and the authorized operator of the distribution grid,
- guidelines for the re-establishment of the power supply,
- reference to working procedures,
- reporting major disturbances and
- analysis of significant disturbances.

### ii. Projections of trends with existing policies and measures at least by 2040 (including projections for 2030)

The structure and expected production of primary energy for the Scenario with existing measures (WEM) are presented in Table 4-19. and Figure 4-13.

**Table 4-19 Expected primary energy production - WEM scenario**

| PJ | Liquid fuels | Natural gas | Renewable energy resources | Non-renewable waste | Total |
|---|---|---|---|---|---|
| **2021** | 26.28 | 26.11 | 111.43 | 1.89 | **165.71** |
| **2030** | 30.25 | 32.18 | 122.46 | 1.63 | **186.52** |
| **2040** | 32.29 | 27.89 | 145.61 | 1.32 | **207.10** |

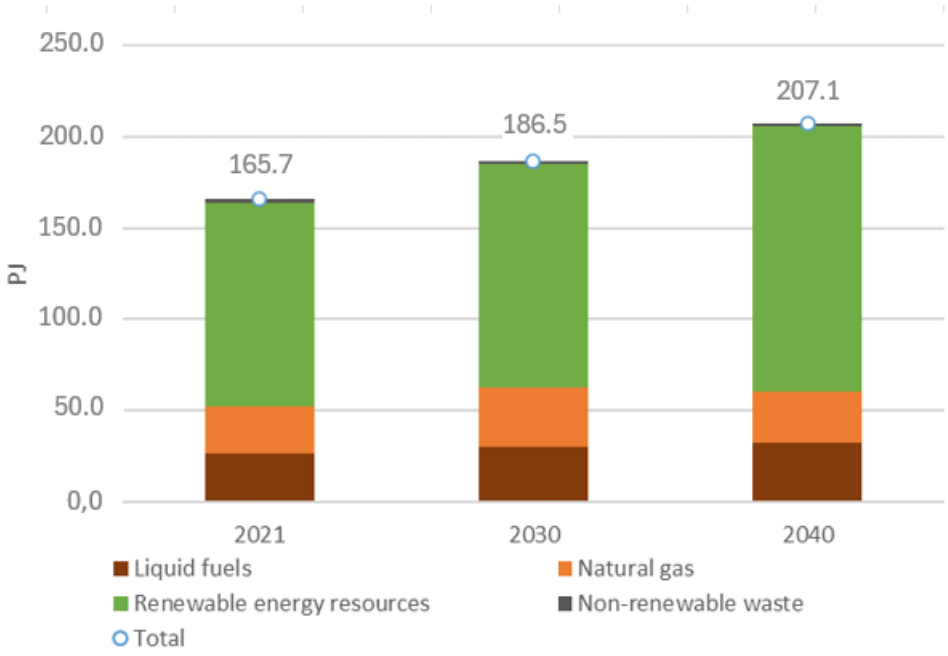



**Figure 4-13 Expected primary energy production (WEM)**

The following table and figure show the structure and expected total energy consumption (production + import-export) for the Scenario with existing measures (WEM).

**Table 4-20 The expected total energy consumption (WEM)**

| PJ | Coal | Liquid fuels | Natural gas | Renewable sources | Non-renewable waste | Electricity | Total |
|---|---|---|---|---|---|---|---|
| **2021** | 17.4 | 119.2 | 101.7 | 105.5 | 1.9 | 14.3 | 360.0 |
| **2030** | 13.8 | 128.5 | 107.3 | 122.5 | 1.6 | 9.1 | 382.8 |
| **2040** | 4.1 | 114.1 | 97.3 | 148.8 | 1.3 | 11.7 | 377.3 |

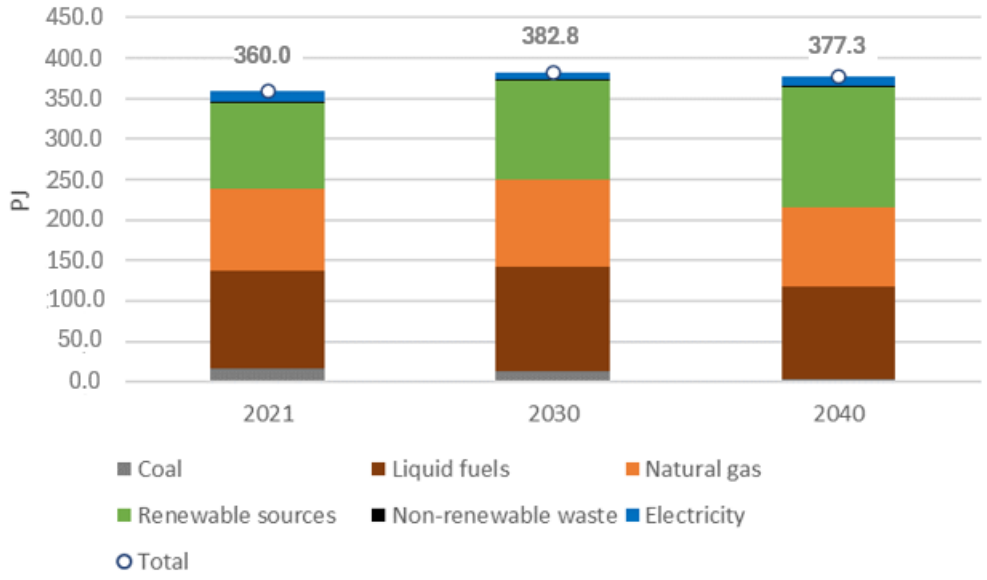



**Figure 4-14 The expected total energy consumption (WEM)**

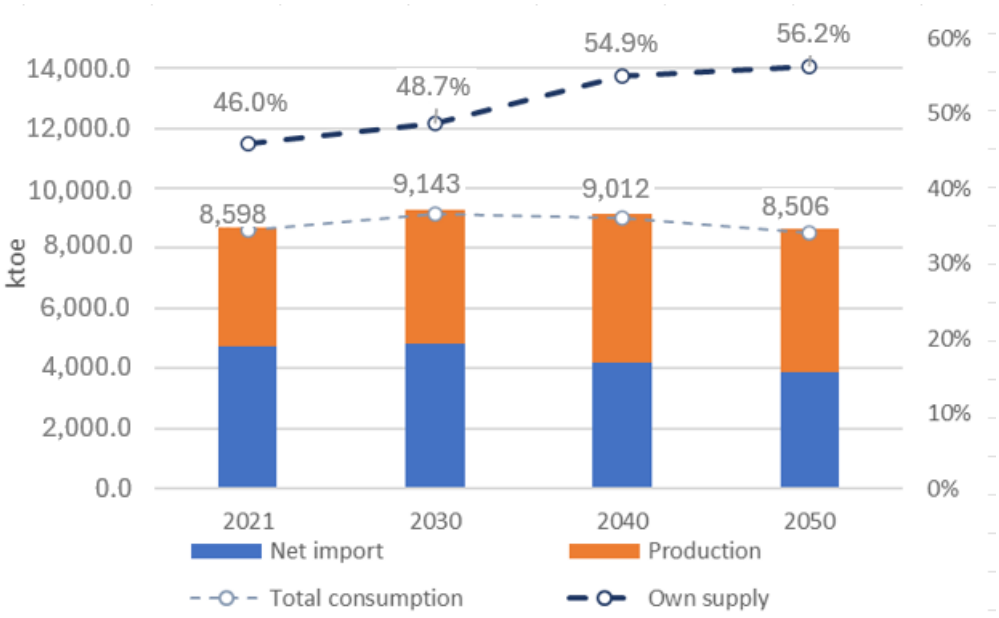



**Figure 4-15 Total energy consumption and own supply (WEM)**

## 4.5 Dimension: the internal energy market

### 4.5.1 Electricity interconnection

#### i. Current interconnection level and main interconnectors

The Croatian electricity system is connected to the systems of neighbouring countries with 400 kV, 220 kV, and 110 kV voltage levels. With 400 kV transmission lines (a total of seven transmission lines, of which three are double and four are single), the Croatian electricity system is connected to the following systems:

- Bosnia and Herzegovina (400 kV transmission line Ernestinovo - Ugljevik and 400 kV transmission line Konjsko - Mostar),
- Serbia (400 kV transmission line Ernestinovo - Sremska Mitrovica 2),
- Hungary (2x400 kV transmission line Žerjavinec - Heviz, 2x400 kV transmission line Ernestinovo - Pecs) and
- Slovenia (2x400 kV transmission line Tumbri - Krško, 400 kV transmission line Melina - Divača).

The interconnectivity between the Croatian system and neighbouring ENTSO-E members is also achieved with eight 220 kV transmission lines. In addition, the Croatian system is also connected to the environment at 110 kV level (a total of 18 transmission lines in permanent or periodic operation).

Given that the level of electricity exchange with neighbouring systems is affected by the pronounced dependence of the production portfolio in Croatia on hydrology, the increasing share of wind farms with also very variable production and variable prices in the wholesale electricity markets in the environment, the power of exchange towards neighbours is also highly variable. However, the total exchange with neighbouring systems is still significantly lower than the total exchange capacity. Hence, the utilization factor of individual interconnectors (the ratio of transmitted energy and the multiplication of time and installed power) varies between 0 and 50%, with an average estimate of 35%.

In 2022, about 11.9 TWh entered the Croatian electricity system, and about 7.2 TWh came out. The largest exchange is performed with the electricity system of Slovenia and Bosnia and Herzegovina, which is expected given the very high level of installed interconnected capacities. With BiH alone, Croatia has as many as 21 interconnectors, and with Slovenia, eight interconnectors. Quantities of electricity exchanged with neighbouring countries (Slovenia, Hungary, Serbia and Bosnia and Herzegovina) in 2019, 2020 and 2021 are shown in Figure 4-16.

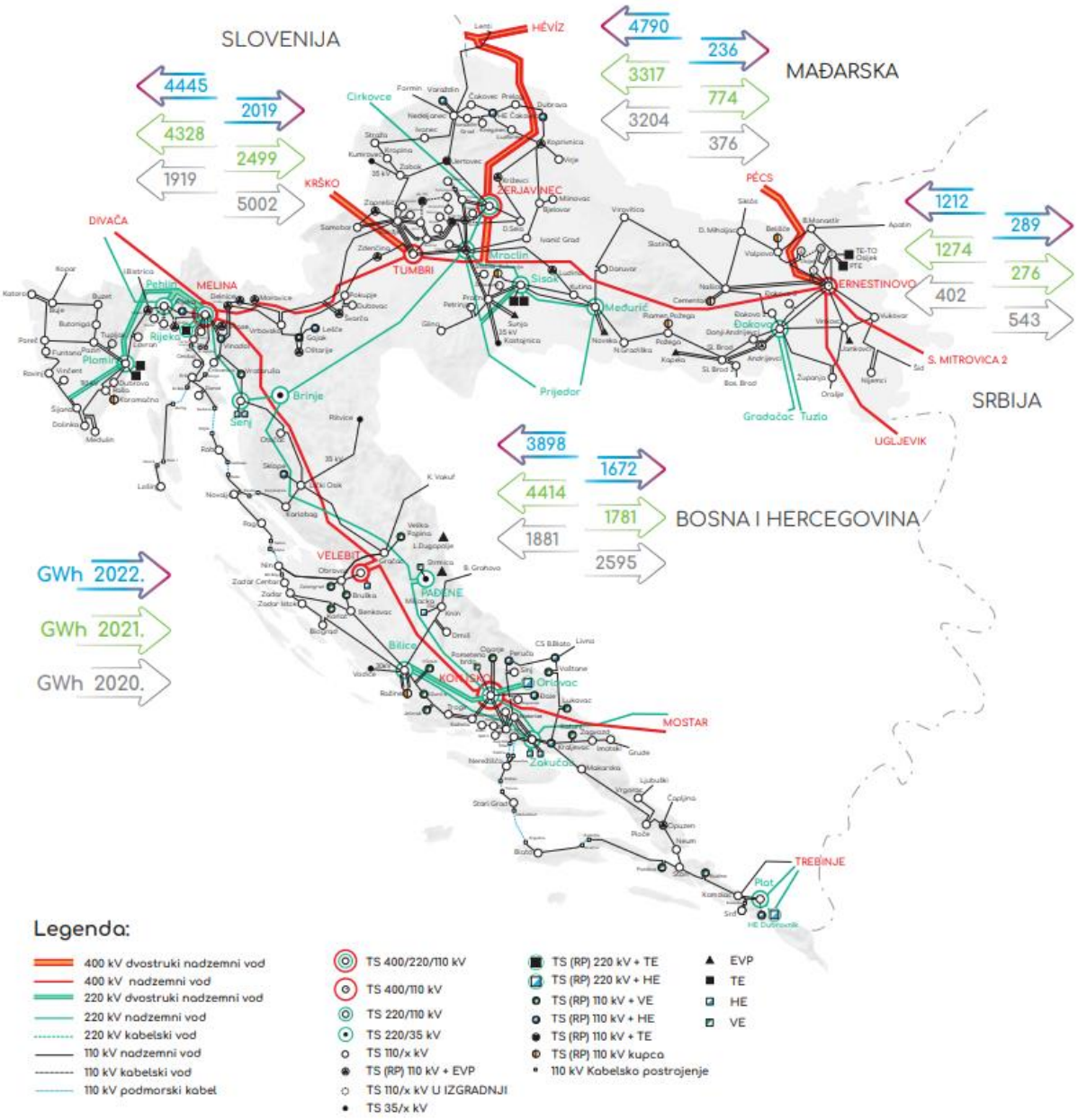



**Figure 4-16 Exchange of electricity with neighbouring countries in 2020, 2021 and 2022**

*Source: CTSO*

Good interconnection with neighbouring systems enables significant export, import and transit of electricity through the transmission grid. It places the Republic of Croatia as an essential link between the electricity systems of Central and Southeastern Europe.

### ii. Projections for requests to increase the number of connecting lines (including projections for 2030)

Regarding additional new interconnectors at the level of ENTSO-E, the possibility and justification of the construction of the following lines are currently analysed:

- 400 kV transmission line Đakovo (Republic of Croatia) – Tuzla (Bosnia and Herzegovina);
- 400 kV transmission line Đakovo (Republic of Croatia) – Gradačac (Bosnia and Herzegovina);
- 400 kV transmission line Ernestinovo (Republic of Croatia) – Sombor (Republic of Serbia).

However, their possible realisation is unrealistic in the short or medium term. It depends on many factors, including the development of the future electricity market and the integration of RES into the ES of the entire region.

After 2030, it is possible to build a new 400 kV transmission line Lika - Banja Luka, which would further connect the ES Croatia and ES BiH. Technical-economic analyses of the justifiability of its construction are made.

### 4.5.2 Infrastructure for energy transmission

#### i. Key characteristics of the existing transmission infrastructure for electricity and gas

**The electricity transmission grid on the territory of the Republic of Croatia** consists of overhead lines and cables, substations and other high-voltage equipment/plants that operate under the voltage levels of 400 kV, 220 kV and 110 kV. The transmission grid connects power plants and larger consumer centres, or distribution grid, through several possible directions to achieve a satisfactory level of security of supply to customers with electricity of the prescribed quality.

The total length of high voltage overhead lines and cables of the abovementioned voltage levels is currently around 7,800 km, and the grid contains around 200 substations of 400/220/110 kV, 400/110 kV, 220/110 kV and 110/x kV. The backbone of the transmission grid is a 400 kV grid that connects the wider Osijek, Zagreb, Rijeka and Split areas; a significant number of extensive production facilities is connected to 220 kV grid that connects certain regions within the country, while 110 kV grid connects local areas and serves to supply the distribution grid or large customers directly connected to this voltage level, where part of power plants/generators is also connected to 110 kV grid.

CTSO d.o.o. is also responsible for developing the transmission grid and guiding and managing the electricity system. All this is conducted by the National Dispatch Centre (NDC) and four regional management centres. The balancing of the system is also under the management of CTSO, as well as the supply of ancillary services for the system that enables the achievement of equivalent production and electricity consumption within a specific period or maintenance of the frequency and voltage at the prescribed level, as well as cross-border power/energy exchange according to the operational rules of the European transmission system operators (ENTSO-E), maintenance of prescribed voltage conditions in all parts of the grid, or compensation of reactive energy within the system, re-establishment of power supply after major disruptions or system failures, or island power plant operation on electrically isolated areas after significant disruptions.

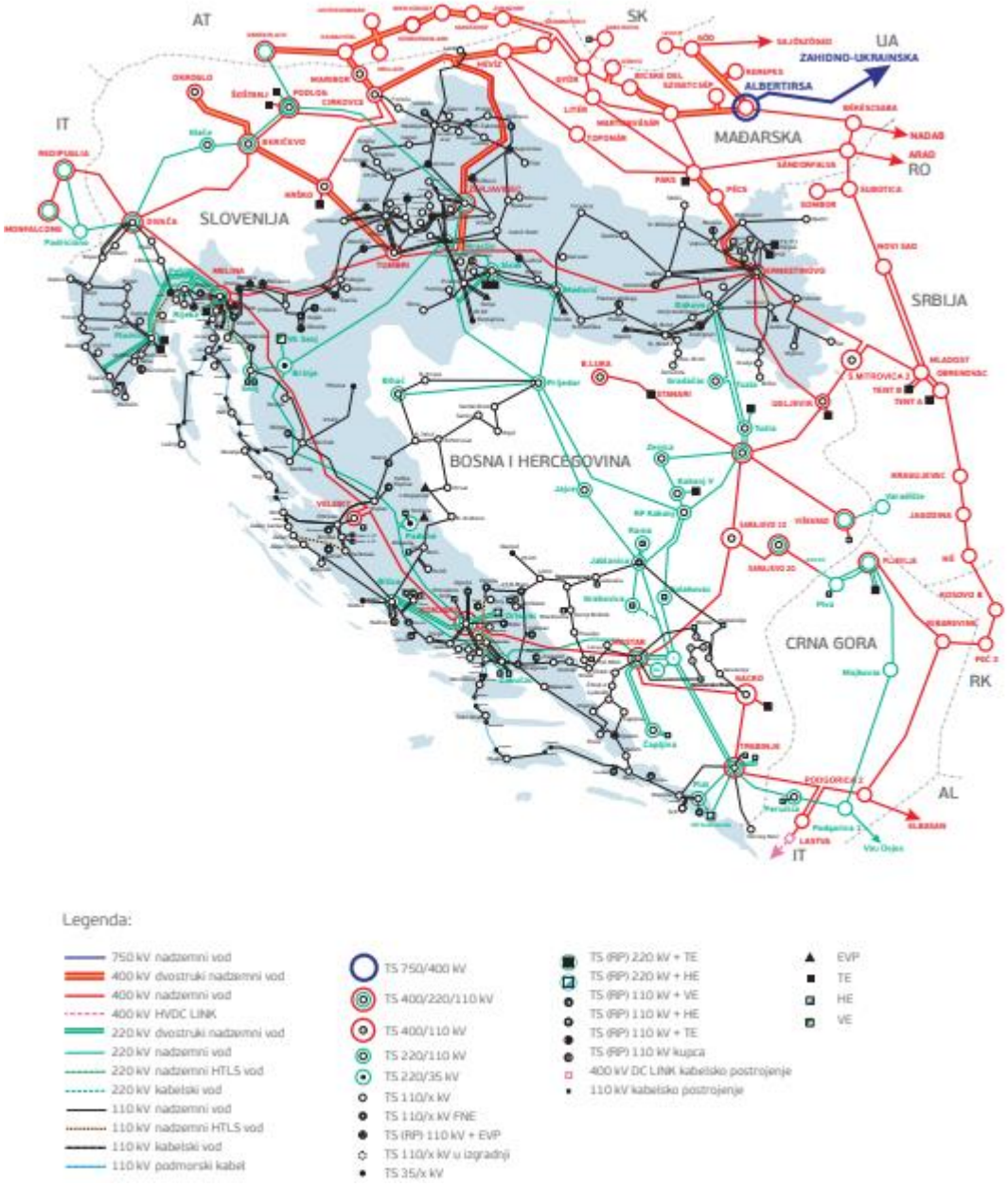



**Figure 4-17 Croatian electricity system transmission grid with surroundings**

*Source: CTSO*

The transmission grid topology (form) is currently determined per the actual spatial distribution of electricity consumption, locations of existing power plants, market conditions in Croatia and its surroundings, and the system's prescribed grid planning and operational management. The transmission grid is designed so that in the event of a single disruption of a line, transformer or generator, the transmission of electricity of the prescribed quality will not be prevented in any part of the country. With the existing amounts of basic input parameters that are important for the planning and operation of the transmission grid in the amount of around 3,300 MW of peak load, 17 TWh of electricity consumption per year, annual energy imports of around 7 TWh, transmission for third parties in the amount of up to 7 TWh and connection to the transmission grid of power plants of a total power of around 4,600 MW, the

construction of the transmission network was sufficient for the needs of meeting security of supply and installed production capacity (in the past, only local disruptions of certain parts of the system occurred rarely) and low annual amounts of electricity that was not supplied from the transmission grid (order of magnitude up to 1 GWh). The frequency is stable, and its usual and extraordinary deviations are within the prescribed limits.

The installed transmission capacity of interconnectors exceeds the peak load of the electricity system many times over. Figure 4-18 shows the ratios of installed power of interconnectors and the peak load, that is, installed production capacity in European countries. Based on both criteria, Croatia is among the best-connected countries in Europe, along with other small systems with relatively low levels of load and installed power of power plants.

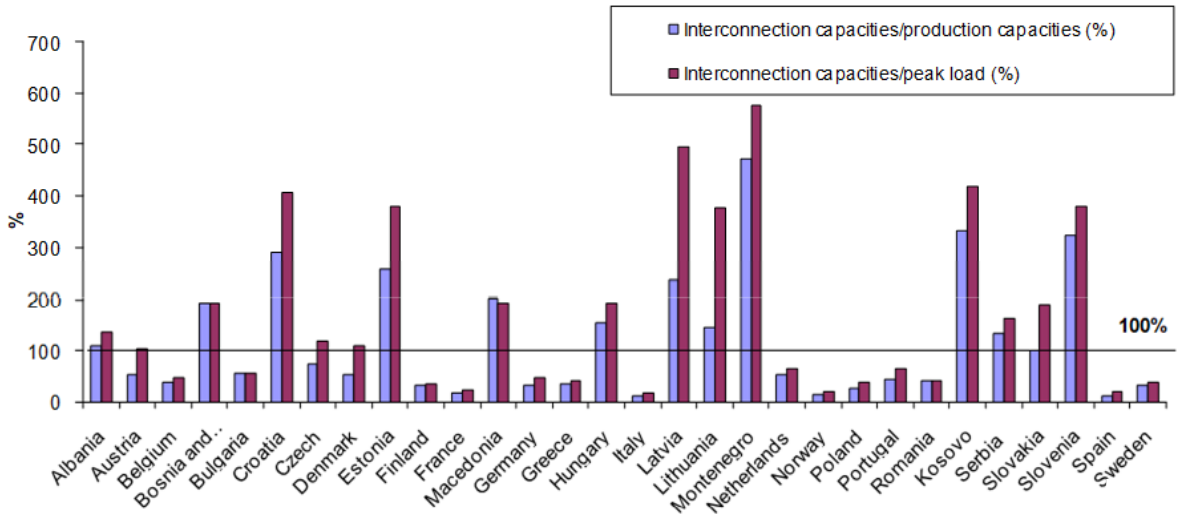



**Figure 4-18 Installed power of interconnectors and installed power of production concerning peak load in European countries**

An unfavourable characteristic of the transmission grid is the relatively high proportion of old plants and grid units, especially the 110 kV and 220 kV voltage levels, which CTSO plans to renew and revitalize systematically in the coming period. Nonetheless, the existing reliability indicators are at a very high level with a relatively low annual electricity loss (below 500 GWh), given the high transits to which the grid is exposed.

In recent years, variability in the availability and activity of production plants in the territory of the Republic of Croatia has been observed, caused primarily by market reasons (first, the non-competitiveness of domestic power plants such as TPP Rijeka, TPP Sisak A and B, TPP Plomin 1, and then after the extreme increase in prices, their re-competitiveness and reactivation, such as TPP Rijeka, which was reactivated after almost eight years). Therefore, the sufficiency/security of supply for customers largely depends on the import of electricity, whose capabilities are conditioned by the availability of cross-border transmission capacities and the amounts of those capacities that are made available to market participants and whose values cannot be independently influenced by CTSO. The recent introduction of a new (so-called flow-based instead of the former NTC on EU borders, until NTC is still used on non-EU borders) cross-border transmission capacity allocation mechanism in the EU is expected to increase network throughput and available cross-border transmission capacities significantly.

**The gas transmission system in the Republic of Croatia** comprises 2,544 km of gas pipelines available to the transmission system operator (PLINACRO). Gas in the gas transmission system is withdrawn through eight connectors at input measuring stations, of which four connectors receive gas from the production fields located on the territory of the Republic of Croatia, two connectors receive gas from import supply routes, one connector receives gas from the LNG terminal, and one connector withdraws gas from the underground gas storage facility.

Gas transmission from the transmission system is carried out through 201 connectors at 156 output-measuring reduction stations. The gas transmission system of the Republic of Croatia reached a significant level of development regarding capacities and distribution on almost 95% of the territory of the Republic of Croatia, as well as regarding the connection with gas systems of neighbouring countries, technological reliability and operational safety. The gas transmission system enables gas to be delivered to 19 counties. The gas transmission system of the Republic of Croatia is shown in the figure below.

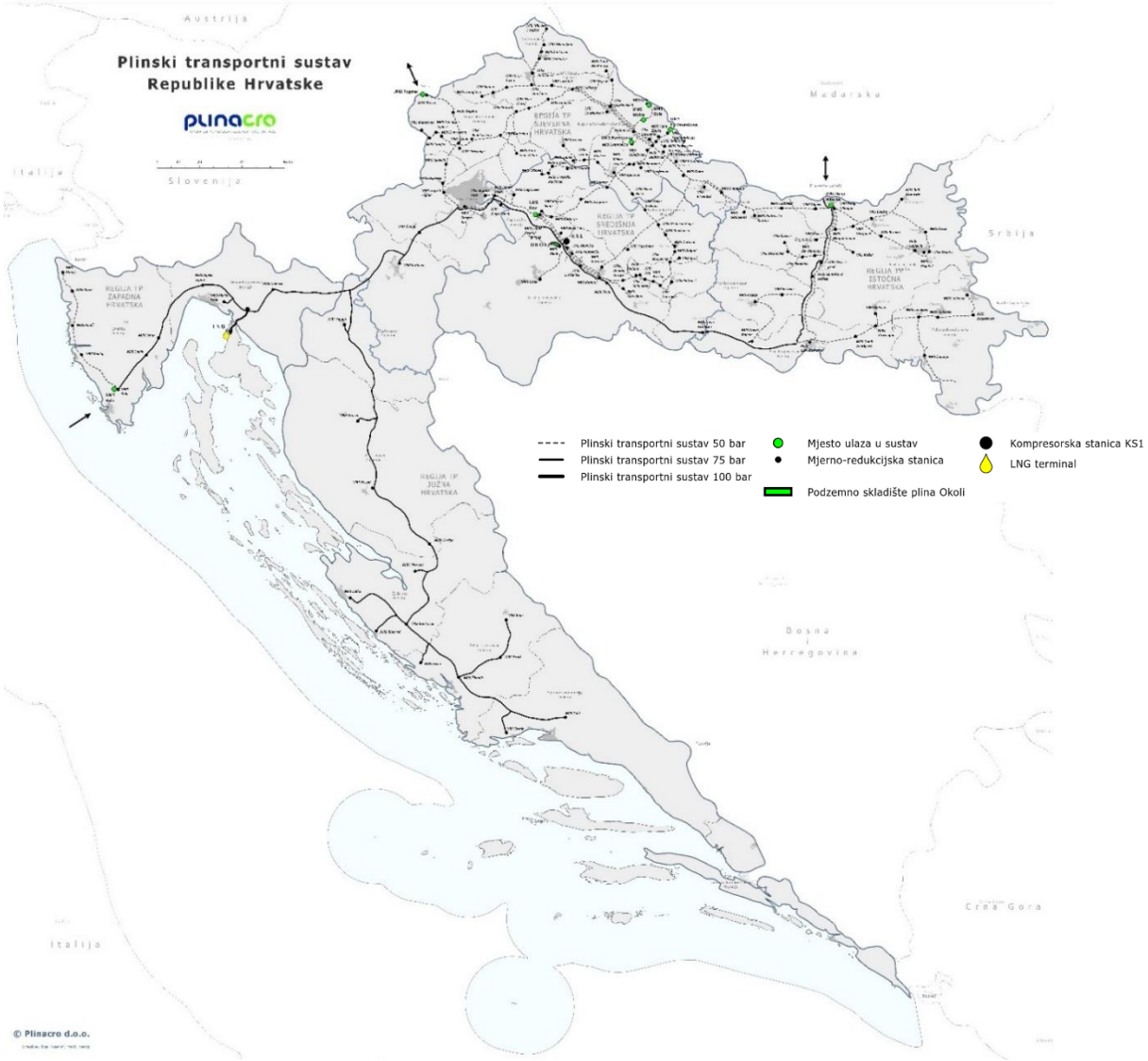



**Figure 4-19 The gas transmission system in the Republic of Croatia**

*Source: PLINACRO*

In 2022, the system transported 41.04 TWh of natural gas, of which 14.7% was taken from production facilities on the territory of the Republic of Croatia, 13% from import supply routes, 64.5% from liquefied natural gas terminals and 7.8 % from underground gas storage. Gas quantities taken into the transport system were delivered to distribution systems, end customers on the transport system, transport systems of neighbouring countries (international transport) and underground gas storage. In 2022, the most significant amount of gas transported daily was 142 GWh.

### ii. Projections regarding the requirements for expansion of the grid at least by 2040 (including projections for 2030)

Having in mind the expected accelerated integration of RES and projected energy transition with the aim of reducing greenhouse gas emissions, the **electricity transmission grid development** should be determined considering the following:

- Peak load at the level of transmission grid level is planned to amount to around 2,900 MW in 2020 and around 3,200 MW in 2030,
- For possible development scenarios, the construction of new hydropower plants and associated connections to the transmission network in the amount of 250 MW by 2030 and an additional 1,650 MW by 2040 is planned,
- For possible development scenarios, the construction of new gas blocks/block with a total capacity of 160 MW by 2030 is envisaged,
- Construction of over an additional 1,345 MW in wind farms (planned with this NECP), which is an increase compared to the existing construction of wind power plants of 948 MW,
- Construction of over an additional 460 MW in solar power plants connected to the transmission network,
- Remain in the TPP Plomin 2 until the observed period and continue to take over half of the production of NPP Krško.

According to the preliminary assessment, the total investment in the transmission grid (including connectors for new conventional power plants, wind farms and solar power plants, as well as other various costs identified in the ten-year development plan of the transmission grid for the period 2022-2031), having in mind the above-described input assumptions, would amount to around EUR 1.13 billion in the ten years (in period between 2021-2030). Considering the significant increase in unit prices and network development costs, the total planned investments in the transmission network must be updated in detail every year.

**Figure 4-20 Foreseen topology of 400 kV and 220 kV grid on the territory of the Republic of Croatia in 2031**

*Source: CTSO*

Investment-demanding network reinforcements, including those contained in the official ten-year transmission network development plan for the period 2023-2032, are the following:

- Increase of transmission power of 220 kV transmission line Konjsko - Krš Pađene - Brinje in the medium-term by replacing ACSR conductors with HTLS conductors to receive the production of WF and SPP in the Dalmatia area,
- Increase in the transformation capacity in SS Konjsko by installing a third 400/220 kV transformer, as well as by equipping the associated 400 kV and 220 kV transformer fields,
- Increase in the transformation capacity in SS Velebit by installing an additional 400/110 kV transformer, as well as equipping the associated 400 kV and 110 kV transformer fields,

- Construction of a new 400 kV transmission line Konjsko - Lika in the long-term to continue with the construction of WF and SPP, and extension of 400 kV switchyard Lika foreseen as part of the connector to the HPP grid Senj 2,
- Construction of (2x)400 kV transmission line Lika - Melina to remove possible restrictions in the transmission of production of HPP, WF and SPP in the area of Dalmatia and Lika towards the wider Rijeka area,
- Formation of at least two to three "zone connectors" or 400/110 kV substations, appropriately connected to 400 kV and 110 kV grid, through which the energy produced by WF and SPP would be transmitted through 400 kV grid in remote areas, in the case where 110 kV grid can no longer take over the entire production of these power plants (locations foreseen for "zone connectors" are the wider Drniš/Knin and Sinj areas, but final locations will depend on the locations and powers of new WF and SPP foreseen for the connection to the transmission grid),
- Construction of SS 220/110 kV Vodnjan 2x150 MVA, and increasing the 2x110(220) kV transmission line Plomin – Vodnjan to 220 kV,
- Revitalization of 220 kV interstate/interconnection lines Đakovo – Gradačac, Đakovo – Tuzla and Zakučac – Mostar,
- After 2030, it is possible to build a new 400 kV transmission line Lika - Banja Luka, which would further connect the ES Croatia and ES BiH.

The implementation of the Plan achieves an increase in the reliability, safety, availability, sufficiency (adequacy) of RES integration in order to reduce CO2, an increase in the market volume in order to reduce the price of electricity. en. for the end customer.

Since CTSO is responsible for the reliability and availability of the electricity transmission system, the correct coordination of production, transmission and distribution systems and the operation of the electricity system in a way to ensure the security of electricity supply, in the future, it will have to follow the functioning of the electricity system with an increased level of integration of variable sources of electricity, inform competent institutions promptly in the event of any endangerment of the security of electricity supply and propose possible application of permitted mechanisms to develop production capacities.

It is necessary to point out that the current Ten-year plan for developing the transmission network should envisage any investment in the transmission network.

**Planning the development of the gas transmission system** is carried out through the 10-year plan for the development of the gas transmission system. The transmission system operator must prepare a ten-year development plan and submit it to CERA for approval every two years. At the time of preparation of this document, the Ten-Year Gas Transmission System Development Plan of the Republic of Croatia 2021-2030. The plan will be continuously updated throughout the implementation period of this document.

Considering the expected trends in the future consumption of natural gas, the expected changes in the seasonal characteristics of consumption and peak loads, the need for new quantities of gas from imports, obligations under EU regulations and the anticipated development of the gas transmission system in the broader and narrower region, strategic

determinants of the future development of the gas transmission system of the Republic of Croatia are:

- supply security obligations and according to the infrastructure standard (N-1 criterion) by Regulation concerning measures to safeguard the security of gas supply (SOS Regulation),
- necessary diversification of supply and increase of efficiency of the transport system,
- increasing the internal security of the transmission system and
- allowing gas transmission to neighbouring countries.

**Obligations on security of supply and infrastructure standard:**

Strategic projects that meet the obligation under the infrastructure standard increase capacity at the entrance to the gas transmission system. The construction and commissioning of the liquefied natural gas terminal on the island of Krk ensured a new natural gas supply route and diversified routes and sources of natural gas supply, which significantly increased the security of natural gas supply in the Republic of Croatia and also a prerequisite for gas transport to neighbouring countries, which indirectly leads to an increase in the efficiency of the gas transmission system.

**Gas transmission system for the diversification of supply and the increase of efficiency of the transmission system**

Further development of the gas transmission system to strengthen the diversification of gas supply includes the expansion of the capacity of the liquefied natural gas terminal, the construction of evacuation gas pipelines and the construction of the Ionian-Adriatic gas pipeline for the supply of gas from the Caspian region or the eastern Mediterranean. The Ionian Adriatic Pipeline (*IAP*) would allow gas supply from the Trans-Adriatic Pipeline (*TAP*) to Croatia and countries in the region and possible transport to Hungary, Slovenia, Bosnia, and Herzegovina.

The capacity of the existing transmission system limits the current gas supply capacity from the LNG terminal. Therefore, first of all, it is necessary to build the Zlobin-Bosiljevo gas pipeline (58 km), and then the Bosiljevo-Sisak-Kozarac gas pipeline (122 km) and Kozarac-Slobodnica gas pipeline (128 km) for gas transport to Hungary, as well as the Lučko-Zabok-Jezerišće-Sotla gas pipeline (70 km) for gas transport to Slovenia. The construction of these pipelines will enable the full utilization of the capacity of the expanded liquefied natural gas terminal and increase the transport of gas through the Croatian gas transmission system, consequently increasing the efficiency of the Croatian gas transmission system.

**Gas transmission system for internal operational security of supply**

The transmission system that serves as an internal security of supply will provide a more stable and secure supply of those gas-powered areas from gas pipeline branches that have only one power source and will allow for the creation of internal loops that increase the security of supply.

**Gas transmission system for export**

The transmission system in the export function is referred to as the gas pipeline systems of relatively minor regional influence connecting the gas systems of Croatia, Bosnia and Herzegovina and Slovenia.

Gas pipeline systems Lička Jesenica-Bihać, Zagvozd-Imotski-Posušje (the so-called southern gas interconnection) and Slobodnica-Bosanski Brod would enable gas supply to neighbouring Bosnia and Herzegovina. In contrast, the Umag-Koper gas pipeline would connect Istria and south Slovenia. The construction of these pipelines depends primarily on neighbouring countries' interests and the economic justification for their construction. The Southern Gas Interconnection with Bosnia and Herzegovina procurement can start immediately, and construction can be completed within three years.

The 10-Year Gas Transmission Grid Development Plan of the Republic of Croatia 2021-2030 lists all the above projects. The final investment decision is necessary for their realization. All these pipelines will be able to transport hydrogen when hydrogen production sources and market conditions for hydrogen consumption are developed.

### 4.5.3 Electricity and gas markets, energy prices

#### i. Current situation of electricity and gas markets, including energy prices

**Electricity**

In Croatia, there is the CROPEX power exchange, which has the possibility of day-ahead and intraday trading. In December 2015, CROPEX became NEMO (Nominated *Electricity Market Operator*), i.e. an exchange with the right and responsibility to implement day-ahead and intraday market coupling processes at the EU level. Connecting Croatia with the EU market at the day-ahead level should be realized through the IBWT (Italian *Borders Working Table*) project and at the intraday level through the EU XBID (Cross *Border Intra Day*) project. In addition to connecting with the EU market, cooperation between CROPEX and the transmission system operator from Bosnia and Herzegovina (NOS BiH) has been initiated on the implementation of the cross-border interconnection of the day-ahead markets of Croatia and Bosnia and Herzegovina. Furthermore, specific initiatives for developing a regional power exchange in Southeastern Europe based on the Nord Pool exchange model exist.

Since June 19$^{th}$, 2018, the Croatian day-ahead market has been connected to the MRC (Multi-Regional Coupling) day-ahead market, i.e. to the uniform European day-ahead market via the Croatian-Slovenian border. On June 8$^{th}$, 2022, (for the trading day of June 9$^{th}$, 2022) as part of the CORE project (Core Flow Based Day Ahead Market Coupling Project), the day-ahead market based on the power flow budget - Core FB DA MC was connected on the Croatian and Hungarian border.

16 transmission system operators (including CTSO) as well as 10 nominated electricity market operators (NEMOs) participated in the development of this project. Orders from the CROPEX DA market are matched with other orders in the Core region and, together with cross-zonal capacities, represent input data for the day-ahead market connection algorithm (SDAC). Additional value to the entire project is given by the fact that the topology of the Core FB CC and MC project includes the Croatian-Hungarian border (for which until then explicit capacity auctions were conducted), so that the Croatian trading zone is connected via Slovenia and

Hungary to other trading zones in SDAC the region. With the implementation of the CORE project, the daily capacity for market connection on the Croatian-Slovenian and Croatian-Hungarian border is calculated using the Flow-Based method instead of the previously used NTC method. The SIDC (Single Intraday Coupling) intraday coupling project started on June 12, 2018. Croatia joined the SIDC in the second wave, in November 2019, together with Hungary and Slovenia. SIDC is based on shared IT system with a shared order book (SOB), capacity management module (CMM) and shipping module (SM). It allows requests entered by market participants of any trading zone to be matched with requests entered in a similar manner by market participants of any other trading zone within the project, as long as cross-border capacity is available. The intraday solution supports explicit allocation at the Croatian-Slovenian and French-German borders (as required by national regulatory authorities) and implicit continuous trading. It is in line with the EU target model of the integrated intraday market.

The intraday connection of markets throughout Europe is a key component for completing the European internal energy market. With the increasing share of non-permanent energy sources in the overall European energy mix, linking intraday markets through cross-border trading is becoming an increasingly important tool for market participants to keep their market positions balanced. The purpose of the SIDC initiative is to increase the overall efficiency of intraday trading.

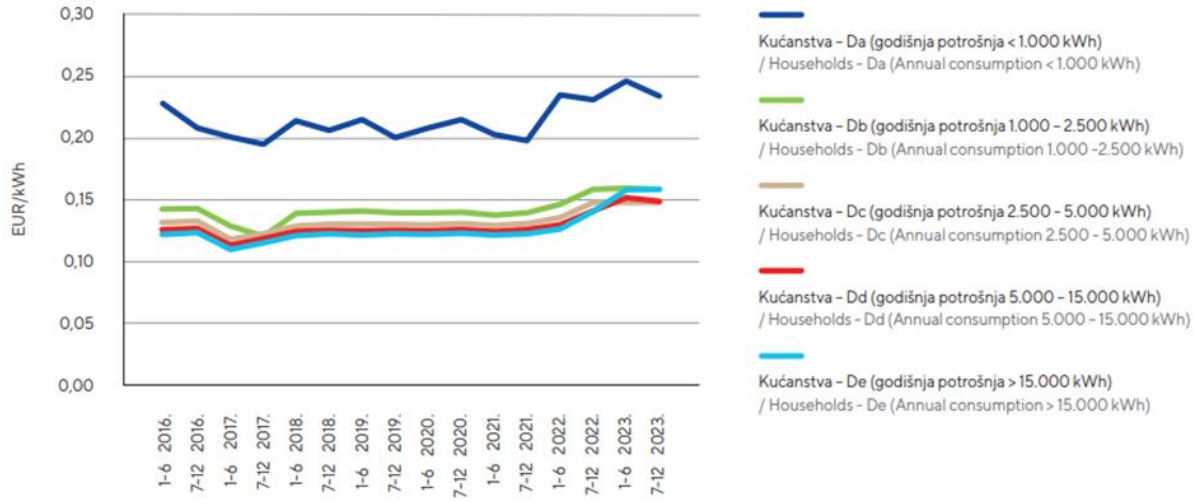



**Figure 4-21 Electricity prices for household end customers in Croatia**

*Source: Energy in Croatia 2023*

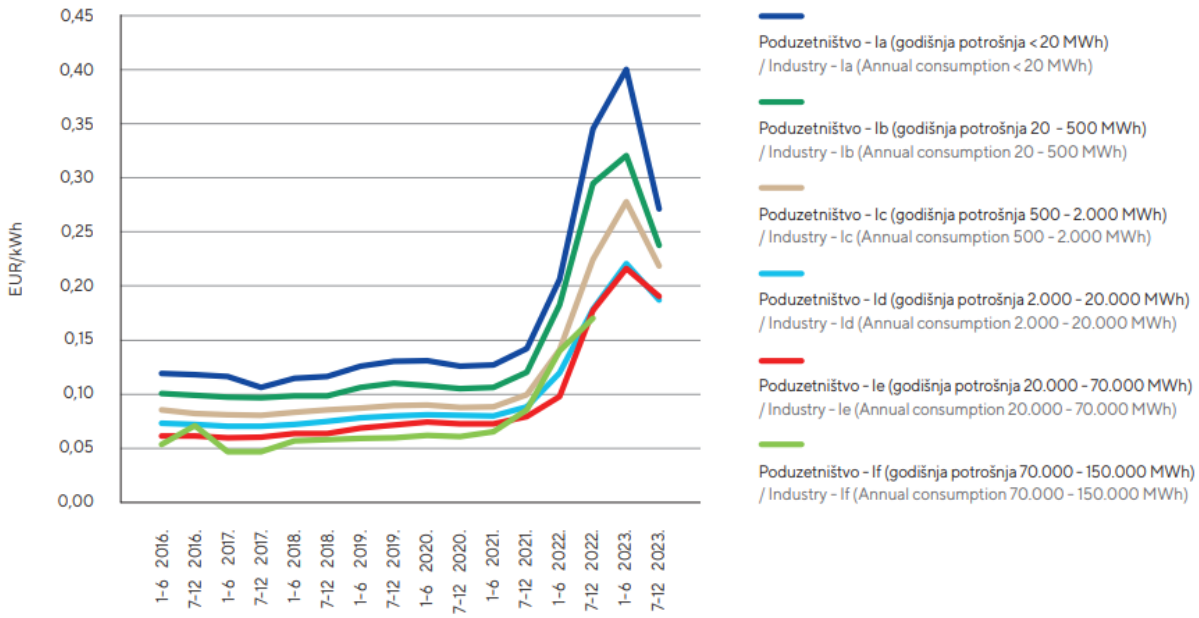



**Figure 4-22 Electricity prices for business end customers in Croatia**

*Source: Energy in Croatia 2023*

The ECO balance group is regulated by the Act on Renewable Energy Sources and Highly Efficient Cogeneration („Official Gazette“, Nos. 138/21 and 83/23). It consists of electricity producers and other entities performing the activity of electricity generation, which are entitled to incentive pricing following the agreements on the purchase of electricity with the Market Operator and the right to a guaranteed purchase price based on an agreement on the purchase of electricity at a guaranteed purchase price. In addition to the electricity producers mentioned above, all other privileged electricity producers may be members of the ECO balance group and thus assume all rights and duties in the ECO balance group except for the acquisition of electricity at the regulated purchase price.

The Act on Renewable Energy Sources and High-Efficiency Cogeneration defines the market operator as the leader of the ECO balance group with the obligation to run the ECO balance group in such a way that it is separate from other activities within their competence while respecting the principles of transparency, impartiality and independence. The market operator is obliged to plan the electricity production for the ECO balance group and to report the ECO balance group's contractual schedules under the ECO balance group under the production plan of the ECO balance group.

The obligations of the members of the ECO balance group are regulated by the Rules for the Management of the ECO balance group adopted by the Market Operator with the prior consent of the ministry responsible for energy and the opinion of the Croatian Transmission System Operator d.d. and HEP – Distribution System Operator d.o.o. The members of the ECO balance group are obliged to submit the data and documentation necessary for the planning of electricity production for the ECO balance group per the Rules for the Management of the ECO balance group.

The market operator is obliged to bear the costs incurred by calculating the balancing energy according to the transmission system operator due to the deviations in hourly electricity

production plans from the realized hourly electricity deliveries of the ECO balance group. The Market Operator shall bear the costs of the balancing energy of the ECO balance group from the funds for the payment of incentives and monthly collected funds from the members of the ECO balance group whose connected power of the production plant exceeds 50 kW.

The level of balancing energy costs of the ECO balance group depends on the divergence of the hourly EE production plans from the realized hourly deliveries of the EE ECO balance group and is calculated following the Methodology for determining the prices for the calculation of balancing electricity to entities responsible for the divergence, which the Croatian Energy Regulatory Agency issues.

### Natural gas

According to Eurostat data, historical natural gas prices for household and business final customers are presented below. Natural gas prices for household customers include value-added tax (VAT), while natural gas prices for industrial customers are expressed without VAT.

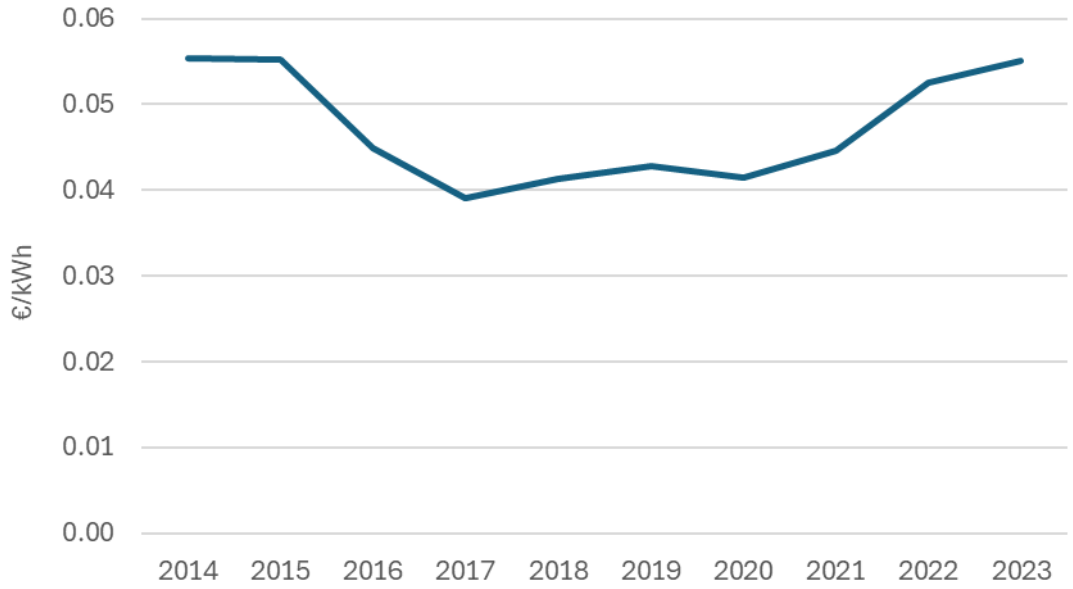



**Figure 4-23 Natural gas prices for household customers in Croatia**

*Source: Energy in Croatia 2023*

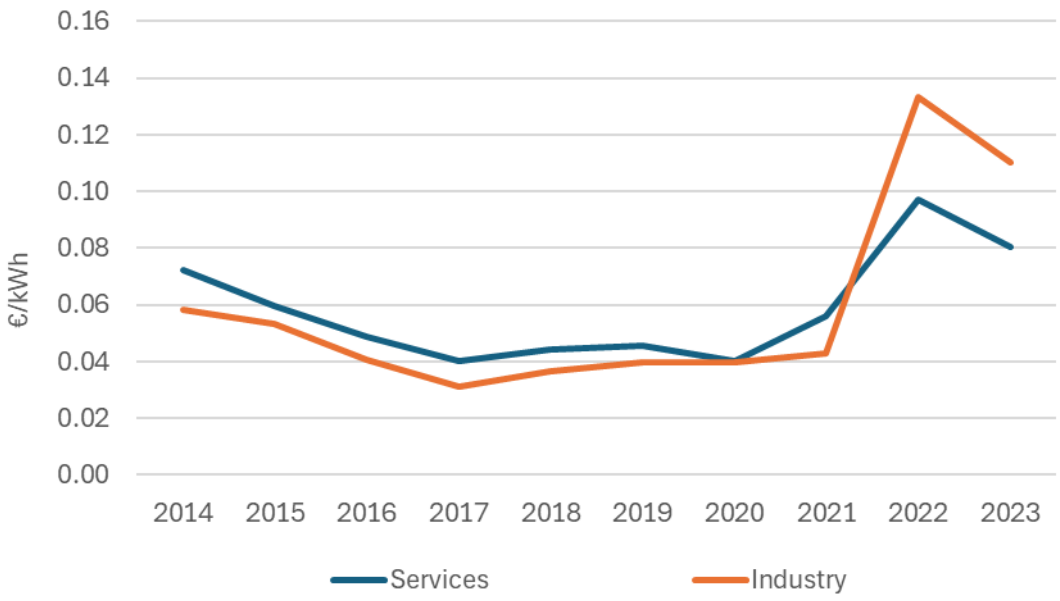



**Figure 4-24 Natural gas prices for business customers in Croatia**

*Source: Energy in Croatia 2023*

## 4.6 Dimension: research, innovation and competitiveness

### i. The current situation of low-carbon technologies and, to the extent possible, their position on the global market

Smart specialization strategies enable the identification of priorities for investing in knowledge-based investments in sectors where the country or region has comparative advantages. The development of low-carbon technologies in Croatia in 2016-2020 was supported by the Smart Specialization Strategy of the Republic of Croatia from 2016 to 2020. [21], these technologies were mainly within the thematic priority area of energy and sustainable environment, and in the Smart Specialization Strategy until 2029, the thematic priority area was smart and clean energy.

The Smart Specialization Strategy of the Republic of Croatia until 2029 lists the following key goals and subgoals:

- Improving scientific excellence
    - Improvement of financing conditions for scientific excellence
    - Developing the capacity of young researchers
    - Strengthening research infrastructure
- Bridging the gap between the research and business sectors
    - Increasing cooperation between research organizations and companies
    - Improving the market readiness of research and development results

- Increasing innovation efficiency
    - Improvement of the start-up ecosystem
    - Support for digitization and green transition of companies
    - Improving skills for innovation
    - Increasing the market reach of innovative products

The Low-carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050[37] states that research is needed within the following topics:

- development of models, methods of integral carbon control, improved calculations of emissions/sinks, emission/sink estimates, application of calculations using the overall lifecycle method,
- research of technologies, technical and non-technical measures to reduce emissions and increase sinks in all sectors (energy, transport, agriculture, forestry, waste management, and industrial processes)
- research on links between mitigation of climate change and adaptation to climate change and interaction with other environmental constituents
- development of integral models of impact assessment of policies and measures to mitigate climate change on the economy, environment and society
- research on sociological aspects of climate change, development of models and methods of raising visibility and public awareness of climate change
- research into the potential of biomass, biomass production, biomass utilization and related socio-economic aspects
- exploring the potential of all renewable energy sources, the costs and benefits of their use, and their impact on the environment, nature and Natura2000
- study of integrated solutions, energy efficiency, renewable energy sources across sectors, optimization models for smart cities, green cities and urban infrastructure
- research of advanced grids and smart systems
- developing concepts and planning for smart cities
- research related to the construction of a circular economy, the introduction of a system for the management and utilization of resources, energy and carbon footprint management system
- research into sustainable urban mobility, cooperative, intelligent and automated transport solutions
- research into the possibilities of increasing carbon sequestration on forestry and agricultural land and possible innovative measures in animal husbandry.

[37] Republic of Croatia, Ministry of Economy, Low-carbon development strategy of the Republic of Croatia until 2030 with a view to 2050, https://ec.europa.eu/clima/sites/lts/lts_hr_hr.pdf, p. 65

Significant technological advances are expected in applying ICT technologies in all sectors, with a particularly outstanding impact in the energy and transport sectors. The development of energy storage systems, electric vehicle and battery infrastructure, autonomous systems in various sectors and robotics will play a decisive role.

The Croatian Bureau of Statistics collects data on the foreign trade of the Republic of Croatia. It publishes the aggregated data according to the national classification of activities and by sectors. Currently, there is monitoring of exports of all products under the nomenclature under Commission Implementing Regulation (EU) 2017/1925 of October 12th, 2017, amending Annex I to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff (OJ L 282, Oct 31st, 2017), but specific low-carbon products need to be defined and reported on separately.

### ii. Current level of public and private research and innovation spending on low-carbon technologies, current number of patents and current number of researchers

According to the 2017 estimate, gross domestic expenditure on research and development (GDERD) was 0.86% of GDP. By 2020, a target of 1.4% of GDP share has been set, and 1.25% has been achieved. At the EU level, the goal was to reach 3% of gross domestic R&D expenditure by 2020, and reaching this goal in Croatia, according to the Smart Specialization Strategy until 2029, is projected by 2030.

The State Bureau of Statistics monitors gross domestic expenditures for research and development by sectors ((i) business sector, (ii) state and private non-profit sector and (iii) higher education) and fields of science. According to the latest data (for 2021), out of a total of HRK 5.5 billion (EUR 725 million) invested in research and development, 46.5% of investments were from the business sector, 32.3% were investments in higher education, and 21.1 % refers to state and non-profit sector investments.

In addition, the CBS publishes annual progress towards the Sustainable Development Goals, including Goal 9 Industry, Innovation and Infrastructure. According to the latest indicators in 2021, 0.93% of the active population is employed in research and development (in 2016, this share was 0.64%), the gross added value in the sector of environmental goods and services is 1.47% (2016: 1.52%) and the number of applications submitted to the European Patent Office increased (27, compared to 16 in 2016).[38]

Within the framework of the data on which the Central Bureau of Statistics publishes these aggregated data, it will be necessary to determine the areas of research and development relevant to low-carbon development and to report on them separately.

In 2022, 130 patent applications were filed. Of these, 122 applications were submitted by domestic and eight by foreign applicants. Of the total number of domestic applications, 45.1% of patents were applied for by natural persons and 54.9% by legal persons. Among foreign applicants, both natural and legal persons had a share of 50.0% of applications.

[38] https://podaci.dzs.hr/media/atbjbcfy/sdg-2023_hr.pdf; https://www.epo.org/about-us/annual-reports-statistics/statistics/21/statistics/patent-applications.html

According to the technical field, in 2022, the largest share of applications was in the field of chemistry (35.0%), followed by the field of general mechanical engineering (33.1%), while the smallest number of applications was from other fields (6.8%). According to the International Classification of Patents, which enables the identification of the technological base of patents and the sector in which their application is most likely in 2022, the largest share of patent applications was in area B Production procedures, transport (27.8%).

In 2022, 51 patents were recognized in the national procedure. Of these, 44 patents are from domestic applicants, and seven are from foreign applicants. Of the total number of recognized domestic patents, 61.4% are patents of natural persons, and 38.6% are patents of legal entities. Among foreign applicants, 71.4% were recognized patents of legal entities and 28.6% were patents of natural persons.[39]

Identifying relevant areas and reporting on them will be necessary to monitor innovations pertinent to the low-carbon transition. Out of the total number of patent applications by domestic applicants in 2018, the largest share of applications came from Continental Croatia 64.5%, and Adriatic Croatia 35.5%. In 2022, three-fifths of patent applications and more than four-fifths of recognized patents refer to domestic applicants from the City of Zagreb and Adriatic Croatia: of the total number of patent applications by domestic applicants in 2022, applicants from the City of Zagreb filed 36.8%, and 23.8% applicants from Adriatic Croatia. Among the recognized patents, in 2022, 43.2% were granted to applicants from the City of Zagreb and 40.9% to applicants from Adriatic Croatia.[40]

Patent statistics provide information on the success of research, development and innovation activities in selected technology areas. The number of patents is one measure of the ability to discover new opportunities and activities within the country and translate knowledge into potential economic benefits.

[39] https://podaci.dzs.hr/23/hr/58335

[40] https://podaci.dzs.hr/23/hr/58335

### iii. Breakdown of current price elements that make up the three price components (energy, grid, and taxes and fees)

**Electricity**

The structure of the price of electricity consists of the market part and the regulated part (Figure 4-25). The regulated part is prescribed by law and is the same for all suppliers. It applies to charges for using the transmission and distribution grid, the fee for renewable energy sources and high-efficiency cogeneration, the compensation for vulnerable customers (paid only by customers in the household category) and other excise duties. The market share of the price of electricity varies from supplier to supplier and is defined by the electricity supply contract.

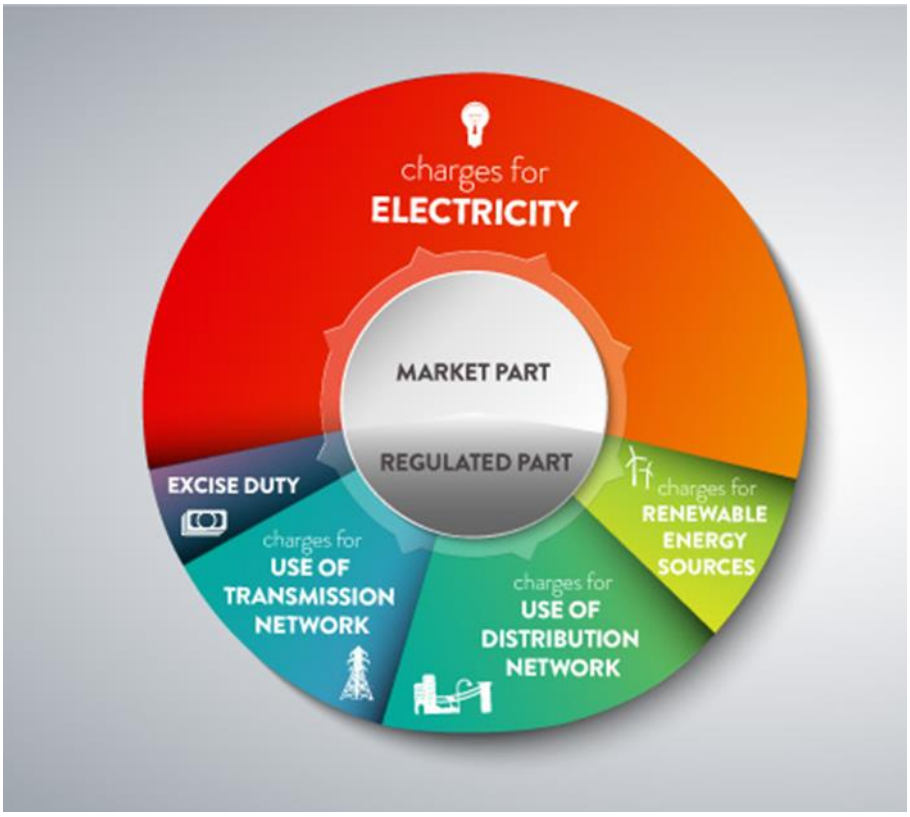



**Figure 4-25 Retail electricity price structure**

*Source: HEP Opskrba*

All end customers of electricity in Croatia have the right to choose their supplier and negotiate the price of electricity with them. The price of electricity in the Republic of Croatia varies depending on the supplier the end customer chooses. The electricity supplied is calculated according to three tariffs:

- higher daily tariff (VT), which is calculated every day from 7 a.m. to 9 p.m. in the wintertime period and from 8 a.m. to 10 p.m. in the summertime period;
- lower daily rate (NT), which is calculated in the remaining time;
- a single daily tariff item (JT) lasts every day between 0 am and 24 am.

Figure 4-26. shows the structure of the total price of electricity for end customers in the Republic of Croatia according to EUROSTAT's consumption classes in 2021, where:

- **IF** – a very large industry with a consumption of 100,000 MWh/year, a peak load of 15 MW and a consumption ratio day/night of 52/48 (tariff system VN entrepreneurship – White)
- **IE** – a large industry with a consumption of 24,000 MWh/year, a peak load of 4 MW and a day/night consumption ratio of 63/37 (tariff system MV (35 kV) business – White)
- **ID** – medium industry with consumption of 2,000 MWh/year, a peak load of 0.50 MW and consumption ratio day/night 63/37 (tariff system SN (10 kV) business – White)
- **IB** - medium-sized enterprise with consumption of 150 MWh/year, a peak load of 0.05 MW and a consumption ratio day/night 68/32 (tariff system NN enterprise - Red)
- **DC** – Medium households with a consumption of 3.5 MWh/year and with a day/night consumption ratio of 66/34 (NV household tariff system – White).

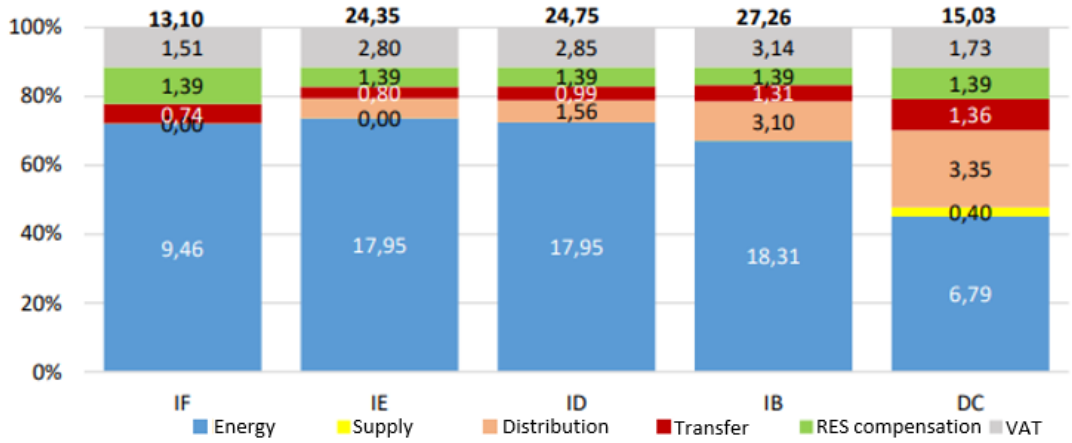



**Figure 4-26 Structure of the total electricity price for end customers in the Republic of Croatia according to EUROSTAT consumption classes in 2023**

*Source: CERA – Yearly report 2023*

According to the Act on Amendments to the Value Added Tax Act („Official Gazette" No. 115/16), from January 1st, 2017, the new, reduced value-added tax (VAT) rate for the electricity supply, including fees associated with that delivery, is applied. The current 25% VAT rate, valid until December 31st, 2016, changed to the 13% rate, valid from January 1st, 2017.

## Natural gas

The basic elements of gas price are the supply price and the price of gas transmission, gas storage, gas supply and gas distribution. Transport, distribution and the public service of gas supply and guaranteed supply, as well as gas storage, are regulated by the respective Methodology of determining the amount of tariff items and the Decision on the amount of tariff items issued by CERA.

The Methodology of determining the price of non-standard services for gas transmission, gas distribution, gas storage, acceptance and shipment of LNG and public service of gas supply regulates the price structure of non-standard services of regulated activities.

Following the Methodology of determining the price of balancing energy of the gas system, the gas market operator determines the daily price of positive and negative balancing energy for the gas system.

### Wholesale procurement price for public service and guaranteed gas supply

The price of gas procurement is defined by the Methodology for determining the amount of tariff items for the public gas supply service and guaranteed supply.

### The price of acceptance and shipment of liquefied natural gas

Tariffs for acceptance and dispatch of LNG are determined by the Methodology of determining the amount of tariff items for acceptance and dispatch of LNG, adopted by CERA. For the calculation of tariff items for the reception and dispatch of LNG, a regulatory account model for a regulatory period of 5 years will be used.

### Cost of gas transmission

The price of gas transmission is determined by the Methodology used to determine the amount of tariff items for gas transmission and the Decision on the amount of tariff items for gas transmission. The price of gas transmission is expressed through a fee for the usage of the transmission system. The amount of the fee is determined and paid according to the total contracted capacity of the transmission system of each individual user for each month, including transactions on the secondary market and overruns calculated for each connection for each gas day for each individual user based on the measured quantities of gas transported. The capacity can be contracted at year, quarter, month, day and, only on interconnections, an hour.

### Gas storage price

The working volume of one Standard Bundled Unit (SBU) is set at 50 GWh, and users lease the service of the standard bundled unit on an annual/multi-year basis.

Gas storage fees are defined by the Decision on the amount tariff items for gas storage („Official Gazette“, No. 122/16) issued by CERA based onf the Methodology of determining the amount tariff items for gas storage.

### Cost of gas supply for public service of gas supply and guaranteed supply

Tariff items for gas supply are determined by the Methodology of determining the amount of tariff items for the public service of gas supply and guaranteed supply.

The final gas supply price consists of the tariff item for the amount of gas delivered (Ts1) and a fixed monthly fee (Ts2). The amounts of tariff items for the public service of gas supply for suppliers in the public service obligation are determined by the Decision on the amount of tariff items for the public service of gas supply.

### Gas distribution price

Tariff items for gas distribution for the regulatory period 1$^{st}$ October 2022 to 31$^{st}$ December 2026 are defined by the Decision on the amount of tariff items for gas distribution, which states the amounts of tariff items for gas distribution for energy operators. The final gas distribution price consists of the tariff item for the amount of distributed gas (Ts1) and a fixed monthly fee (Ts2). Tariff items Ts1 are defined for each individual distributor in 12 tariff

models (TM) depending on annual consumption, while tariff items Ts2 are prescribed in the same amount for all distributors.

### Gas selling prices

The average gas selling price on the wholesale market in the Republic of Croatia, excluding VAT, in 2022 was 0.1007 EUR/kWh, which is 199.4% more than in 2021 when it was 0.0336 EUR/kWh (reduced to the gross calorific value).

A substantial gas price increase in the wholesale market occurred in the third quarter of 2022, whereby the gas price increased by 82.3% compared to the second quarter of 2022. At the same time, the wholesale price of gas in the third quarter of 2022 was 0.1546 EUR/kWh (without VAT), which is 331.6% more compared to the same period a year earlier.

The average retail price of gas in the Republic of Croatia for end customers in the business category in 2022 was 0.0860 EUR/kWh (without VAT), which, compared to 2021, represents an increase of 144.7%, while the average sales price of the price of gas for end customers in the household category was 0.0428 EUR/kWh (without VAT), which represents an increase of 36.6% compared to 2021.

## iv. Description of energy subsidies, including those for fossil fuels

In the Republic of Croatia, a system to encourage using renewable energy sources for electricity production was introduced in 2007. RES electricity producers received FITs for the kilowatt-hour of electricity produced, depending on the renewable energy source used and technology, following the Tariff System for the production of electricity from renewable energy sources and cogeneration („Official Gazette“ Nos. 33/07, 63/12, 121/12, 144/12, 133/13, 151/13, 20/14, 107/14, 100/15), where the subsidy is equal to the difference between the FIT and the market price of electricity. Plants for which a FIT contract has been concluded will continue to receive the contract price for the duration of the contract (12 years for contracts concluded until 2013, i.e. 14 years for contracts concluded after 2013).

Since 2016, the Act on Renewable Energy Sources and High-Efficiency Cogeneration has come into force, and it envisages the so-called premium system as part of an incentive framework.

Another type of energy subsidy in the Republic of Croatia is excise duty exemptions, as the Excise Duty Act prescribes. Excise duty exemptions are provided for unleaded motor gasoline and blue-dyed diesel for agricultural, fishing, aquaculture and navigation purposes. Beneficiaries of this right exercise this right under special regulations based on a permit and a fuel card issued by the authority competent for agriculture and fisheries, the authority competent for agriculture and fisheries, or the authority competent for maritime affairs. Each beneficiary is assigned a corresponding approved annual quantity of blue-dyed diesel for dedicated consumption - a quota.

In addition, the same law provides for the use of energy products and electricity for non-excise purposes, such as:

- energy-generating products used as motor fuel in air transport (excluding private flights),

- energy-generating products used as motor fuel for navigation, including fishing and electricity produced on board (excluding the use of crafts and vessels for private purposes),
- energy-generating products used by the energy-generating products and electricity producer in their production facilities for the further processing or production of other energy-generating products and electricity (unless used as motor fuel for vehicles),
- energy-generating products used for the joint production of heat and electricity in a single process (cogeneration),
- energy-generating products used in mineralogical processes,
- in cases of dual use of energy-generating products - if used as a heating fuel and simultaneously for purposes other than propulsion or heating (use of energy-generating products for chemical reduction, in electrolytic and metallurgical processes),
- energy-generating products used for purposes other than motor or heating fuel and
- natural gas used in households and natural gas used as motor fuel for vehicles and in other specific cases described in the law.

The same Act allows for reimbursement of excise duty on diesel used in the commercial transport of goods and passengers purchased in forms of non-cash payment in the Republic of Croatia for persons registered for the commercial transport of goods and passengers established in the European Union. The excise duty refund is determined in the amount of the difference between the excise duty valid on the day of purchase of diesel fuel in the Republic of Croatia and the minimum prescribed excise duty on diesel fuel, amounting to EUR 330, which is then converted into the national currency. Beneficiaries of the right to refund are obliged to enter the register of beneficiaries of the right to refund excise duty on diesel fuel in the commercial transport of goods and passengers. This type of refund aims to reduce the cost of domestic carriers and increase their competitiveness in the European market.

It can be concluded that most energy subsidies are aimed at increasing energy efficiency and using renewable energy sources, which will continue in the future while respecting state aid restrictions. A smaller part of energy subsidies is related to exemptions from excise duties in transport and agriculture. It is necessary to analyse the current system of subsidies, establish accompanying social programmes that will reduce the impact on the poorest citizens, and define a plan for their abolition to determine the dynamics of the abolition of subsidies primarily on fossil fuels. The current system of measures would have to be analysed by the end of the second quarter of 2026. In addition to the above, the analysis will cover the economic impact of phasing out fossil fuel subsidies, performance indicators, and a detailed plan for phasing out subsidies. The competent authorities responsible for implementing this measure are the Ministry of Economy and Finance. It is also important to emphasize that fossil fuel subsidies are a socio-political issue when deciding to abolish them. The same should be based on a social program to reduce and avoid a negative impact on the most vulnerable users, such as households, micro and small businesses and transport users.

# 5 ASSESSMENT OF IMPACTS OF PLANNED POLICIES AND MEASURES

## 5.1 Impacts of planned policies and measures described in point 3 on the energy system and greenhouse gas emissions and greenhouse gas removal, including comparison with projections based on existing policies and measures (as described in point 4).

i. Projections of energy system trends and greenhouse gas emissions and removals as well as, where relevant, emissions of air pollutants in accordance with Directive (EU) 2016/2284 under planned policies and measures, including relevant Union policies and measures, at least until ten years after the period covered by the plan (including projections for the last year of the period covered by the plan)

Projections of the most important energy and climate indicators, considering the expected sectoral changes by 2030, are presented below:

- The expected overall reduction in greenhouse gas emissions is from 25.8% (WEM) to 40.3% (WAM) by 2030, compared to 1990 levels.
- Final energy consumption of 292.5 PJ (WEM) or 246.2 PJ (WAM) in 2030 is expected.
- The rate of building renovation increases from the current 0.7% per year from 2014 to 2019 to 1.1% to 3.5% from 2021 to 2030 and reaches a ten-year average of 1.6%. The abandonment rate of the existing building stock is significantly increased, as evidenced by the increase in temporarily unoccupied units between two consecutive censuses.
- The penetration of electric and plug-in hybrid vehicles, whose share in vehicle sales reaches 30% in 2030, is expected.
- Increase in the share of renewable energy sources in gross final energy consumption to 42.5% by 2030
- Decarbonisation of electricity production by increasing the share of renewable energy sources to 76.7% by 2030

Increasing energy efficiency is strongly present in all consumption sectors, with the most substantial effects expected in the building sector and transport.

In the building sector, a continuation of good practices and strengthening of energy efficiency of all buildings (residential and non-residential) is expected, targeting renovation according to the nZEB standard, which also implies a greater utilization of RES (photovoltaic systems, solar thermal collectors, biomass boilers, heat pumps).

Projections of greenhouse gas emissions from mobile and stationary energy sources in the Republic of Croatia are presented in Figure 5-1. The scenario with existing measures (WEM) and the scenario with additional measures (WAM) are shown.

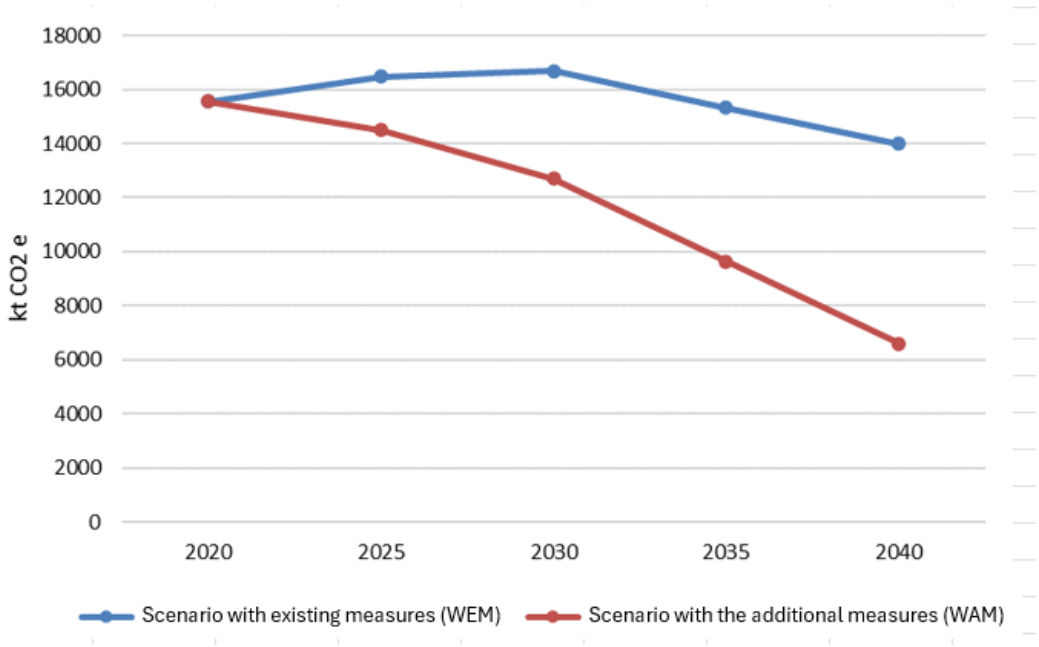



**Figure 5-1 Greenhouse emissions projections for the scenario with existing measures (WEM) and scenario with additional measures (WAM) - energy sources**

The potential of additional measures to reduce emissions by the energy sector is illustrated in Table 5-1, and it represents the difference between emissions from scenarios with the existing and the additional measures.

**Table 5-1 Greenhouse gas emission reduction potential of additional measures (mobile and stationary energy sources)**

| *$CO_2$e emission reductions (kt)* | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|
| Production and transformation of energy | 500.52 | 1,334.59 | 1485,33 | 1,637.13 |
| Industry and construction | 147.68 | 609.41 | 747,4 | 1,435.12 |
| Transport | 293.53 | 784.30 | 1,688.8 | 2,591.22 |
| General consumption | 369.76 | 986.08 | 1,359.6 | 1,733.20 |
| Fugitive emissions | 0 | 0 | 0 | 0 |
| Emission reduction potential - energy sources | 1,311.49 | 3,714.37 | 5,281.31 | 7,396.67 |

Projections of greenhouse gas emissions from mobile and stationary energy sources in the Republic of Croatia are presented in Figure 5-2.

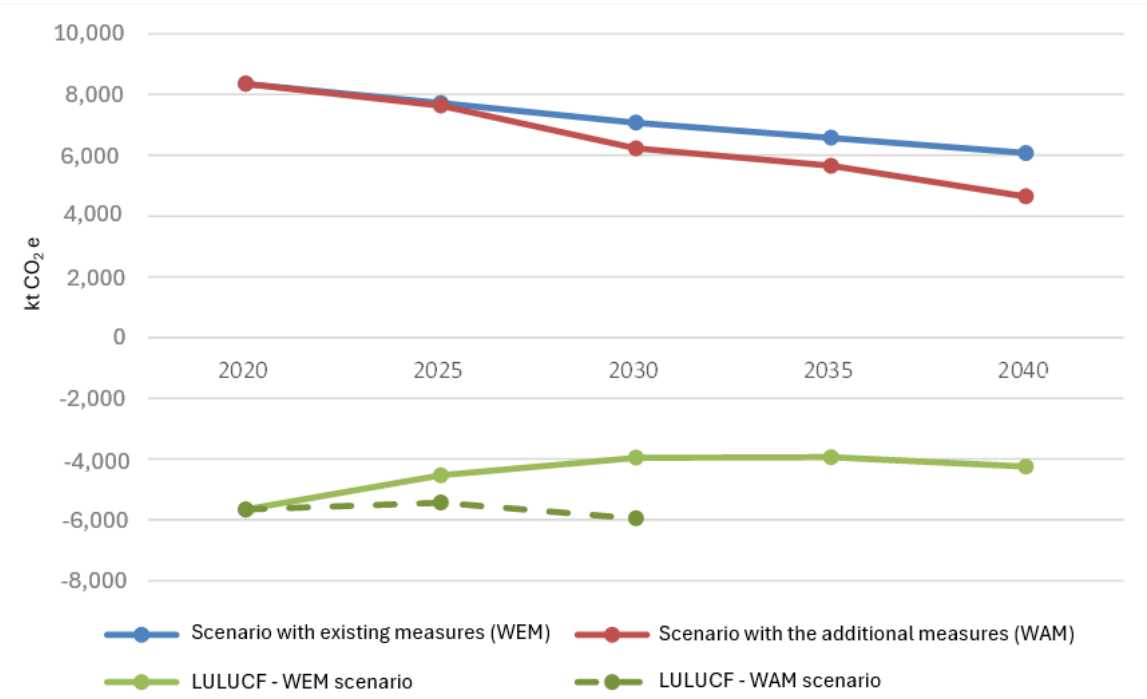



**Figure 5-2 GHG projections for the scenario with existing measures (WEM) and scenario with additional measures (WAM)- non-energy sources**

The potential of additional emission reduction measures for non-energy sectors is shown in Table 5-2. It represents the difference between the greenhouse gas emissions of the existing measures scenario (WEM) and the additional measures scenario (WAM).

**Table 5-2 Greenhouse gas reduction potential for additional measures (non-energy sources)**

| **$CO_{2e}$ emission reductions (kt)** | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|
| Industrial processes and product use | 9.53 | 737.86 | 778.35 | 1,256.67 |
| Agriculture | 78.68 | 112.88 | 145.85 | 180.64 |
| LULUCF* | 903.45 | 1,993.36 | - | - |
| Waste | 0 | 0 | 0 | 0 |
| Emission reduction potential - non-energy sources | 88.21 | 850.73 | 924.20 | 1,437.31 |

Total greenhouse gas emissions in the Republic of Croatia are shown in Figure 5-3. The trend of historical emissions and expected emission reductions for the Existing Measures Scenario (WEM) and the Additional Measures Scenario (WAM) is presented. The emission of greenhouse gases in 2030 would be 25.8 - 40.3% lower than the emission level from 1990.

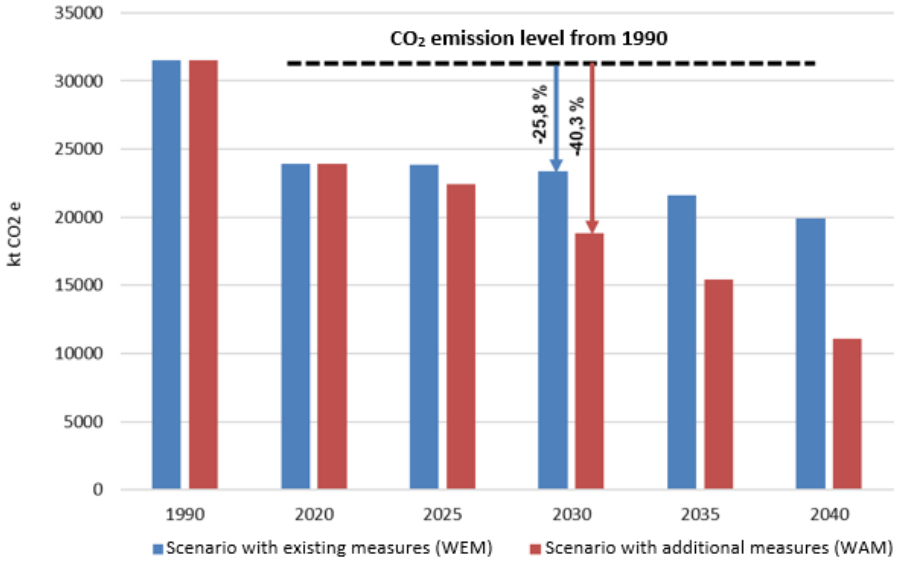



**Figure 5-3 Projection of total greenhouse gas emissions for the scenario with existing measures (WEM) and the scenario with additional measures (WAM)**

Trends in emissions by greenhouse gases ($CO_2$, $CH_4$, $N_2O$, HFC, $SF_6$) for the scenario with existing measures (WEM) and the scenario with additional measures (WAM) in the period from 2020 to 2040 are shown in Table 5- 3.

**Table 5-3 Projections of greenhouse gas emissions $CO_2$, $CH_4$, $N_2O$, HFC, $SF_6$, kt $CO_2e$**

| **WEM*** | **2020** | **2022** | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|---|---|
| $CO_2$ | 11,002.74 | 12,534.15 | 12,634.16 | 13,674,11 | 12,390.67 | 10,784.59 |
| $CH_4$ | 4,034.76 | 3,834.08 | 3,620.10 | 3,217,26 | 3,029.06 | 2,847.73 |
| $N_2O$ | 1,636.79 | 1,494.54 | 1,544.58 | 1,528.62 | 1,487.58 | 1,447.04 |
| HFC | 1,572.23 | 1,812.05 | 1,512.69 | 1,013.76 | 790.46 | 567.15 |
| $SF_6$ | 9.35 | 10.00 | 8.10 | 4.95 | 3.70 | 2.45 |
| Total | **18,255.88** | **19,684.82** | **19,319.64** | **19,438.70** | **17,701.46** | **15,648.96** |
| **WAM*** | **2020** | **2022** | **2025** | **2030** | **2035** | **2040** |
| $CO_2$ | 11,002.74 | 12,534.15 | 11396.98 | 9448.63 | 6626.41 | 2493.06 |
| $CH_4$ | 4,034.76 | 3,834.08 | 3478.90 | 2934.84 | 2657.96 | 2385.15 |
| $N_2O$ | 1,636.79 | 1,494.54 | 1,532.79 | 1,496.85 | 1,444.16 | 1,395.25 |
| HFC | 1,572.23 | 1,812.05 | 1,503.21 | 988.46 | 763.83 | 539.20 |
| $SF_6$ | 9.35 | 10.00 | 8.06 | 4.83 | 3.58 | 2.33 |
| **Total** | **18,255.88** | **19,684.82** | **17,919.93** | **14,873.60** | **11,495.94** | **6,814.98** |

** - does not include emissions from international maritime and air transport*

**Table 5-4 Projections of greenhouse gas emissions by sectors, kt $CO_2e$**

| WEM* | 2022 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|
| Energy | 10,140.8 | 10,088.20 | 10,375.42 | 9,354.44 | 8,333.46 |
| Transport | 6,7310.0 | 6,291.49 | 6,394.66 | 6,066.22 | 5,738.58 |
| Industrial processes and product use | 3,277.1 | 3,226.03 | 2,830.46 | 2,613.51 | 2,397.39 |
| Waste | 1,935.3 | 1,681.75 | 1,252.70 | 1,081.64 | 914.22 |
| Agriculture | 2,467.9 | 2,566.04 | 2,543.34 | 2,526.62 | 2,512.50 |
| LULUCF | -4,867.2 | -4,533.9 | -3,957.9 | -3,941.0 | -4,247.2 |
| **TOTAL (excluding LULUCF)** | **24,552.0** | **23,853.5** | **23,396.6** | **21,642.4** | **19,896.1** |
| **TOTAL (including LULUCF)** | **19,684.8** | **19,319.64** | **19,438.70** | **17,701.46** | **15,648.96** |
| **WAM*** | **2022** | **2025** | **2030** | **2035** | **2040** |
| Energy | 10,140.8 | 9,070.25 | 7,445.35 | 5,762.02 | 3,528.00 |
| Transport | 6,7310.0 | 5,997.95 | 5,610.36 | 4,377.33 | 3,147.36 |
| Industrial processes and product use | 3,277.1 | 3,216.50 | 2,092.60 | 1,835.16 | 1,140.72 |
| Waste | 1,935.3 | 1,681.75 | 1,252.70 | 1,081.64 | 914.22 |
| Agriculture | 2,467.9 | 2,487.36 | 2,430.46 | 2,380.77 | 2,331.86 |
| LULUCF | -4,867.2 | -4,533.9 | -3,957.9 | -3,941.0 | -4,247.2 |
| **TOTAL (excluding LULUCF)** | **24,552.0** | **22,453.8** | **18,831.5** | **15,436.9** | **11,062.2** |
| **TOTAL (including LULUCF)** | **19,684.8** | **17,919.93** | **14,873.60** | **11,495.94** | **6,814.98** |

** - does not include emissions from international maritime and air transport*

The net removal target for the Republic of Croatia in 2030 amounted to -5,527 kt$CO_2$eq.

In the previous table, the emissions from the LULUCF sector are shown for the WAM scenario as equal to the WEM scenario, and the implementation of the LUF-8 measure will create a WAM scenario that achieves the national LULUCF target of -5,527 kt$CO_2$eq by 2030.

The Republic of Croatia does not fulfil the obligation to reduce greenhouse gas emissions from the non-ETS sector in the existing measures scenario in 2030 (-16.7 % compared to 2005), while the scenario with additional measures fulfils this obligation. The emission reduction from the sector outside the ETS would amount to 8.2 to 21.3% by 2030, compared to the emission from 2005 (Figure 5-4).

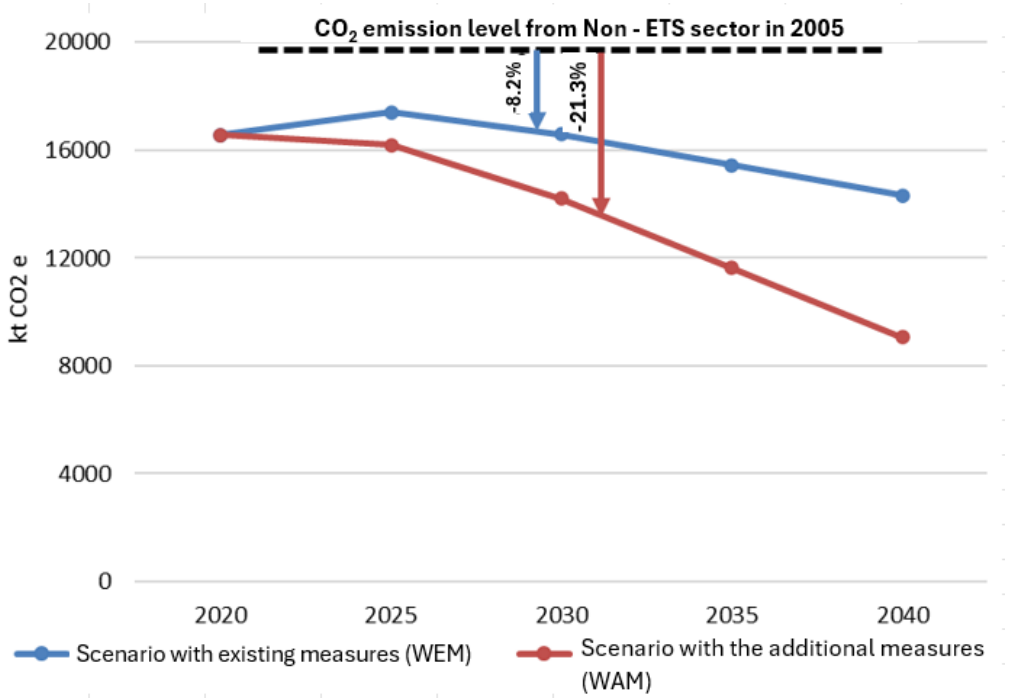



**Figure 5-4 Projection of greenhouse gas emissions from sectors outside of ETS for the scenario with existing measures (WEM) and the scenario with additional measures (WAM)**

The reduction of emissions in the ETS sector in 2030 would be 40.7-60.0% compared to the emission levels in 2005. The projection of greenhouse gas emissions for the ETS sector is shown in Figure 5-5. The part of emissions at the plant itself that will not be reduced will be compensated by purchasing emission units on the market.

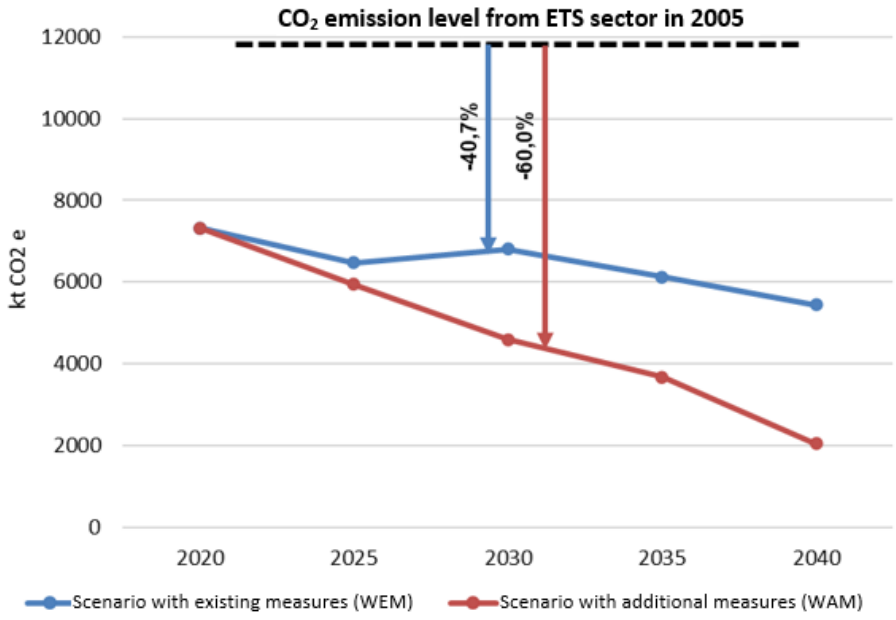



**Figure 5-5 Projection of greenhouse gas emissions from the ETS sector for the scenario with existing measures (WEM) and the scenario with additional measures (WAM)**

For the scenario with existing measures (WEM) and scenario with additional measures (WAM), greenhouse gas emissions for international air transport have also been calculated based on the energy balance data for the projection period 2025-2040. The GHG projections are equal for both scenarios analysed (Table 5-5).

**Table 5-5 Greenhouse gas emissions from international air transport**

| $CO_{2e}$ (kt) emission | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|
| International Air Transport (WEM = WAM) | 350.00 | 401.66 | 385.62 | 421.24 |

ii. Assessment of policy interactions (interaction between existing and planned policies and measures in one dimension and interaction between existing and planned policies and measures of different dimensions) at least until the last year of the period covered by the plan, in particular to fully understand the impact of energy efficiency/energy savings policies to determine the size of the energy system and reduce the risk of lost investment in the area of energy supply

The description of each measure indicates the dimensions to which the measure in question has an effect.

iii. Assessment of the interactions between existing policies and measures and planned policies and measures, as well as between those policies and measures and the Union's climate and energy policy

The description of each measure indicates the dimensions to which the measure in question has an effect.

## 5.2 Macroeconomic and, to the extent possible, health and environmental impacts, employment and education impacts, social and skills impacts (in terms of costs and benefits, as well as cost-effectiveness) of the planned policies and measures described in item 3 at least up to the last year of the period covered by the plan, including a comparison with projections made on the basis of existing policies and measures

The macroeconomic effects were analyzed based on the assessment of total investments from 2024 to 2050. Total investments are estimated at EUR 112.2 billion (including investments in nZEB new construction), EUR 45.5 billion from 2024 to 2030 and EUR 66.7 billion from 2031 to 2050. The analysis assumes that the investments are linearly distributed over the years; an average of EUR 6.5 billion is invested annually in the first period and EUR 3.3 billion in the second period.

Macroeconomic effects are calculated by input-output analysis based on the input-output table for the Republic of Croatia. The analysis considers the direct and indirect multiplicative effects of investments that are disaggregated by different estimates into individual activities (out of a total of 65 activities), which are in the symmetric input-output table, given the specificity of each investment. Direct effects include additional employment, i.e. income, in the sectors producing goods and services to meet the additional final demand. Indirect effects include indirect employment, i.e. income, of other sectors that increase production levels to deliver the intermediate inputs required for production in the sector that directly supplies output for final demand. The input-output model covers the existing technological links between 65 different activities, i.e. sectors of the Croatian economy.

The analysis results are divided into 2024 to 2030 and 2031 to 2050.

In the first analysed period from 2024 to 2030, with an estimated annual investment of EUR 6.5 billion, employment would increase by about 132,000 employees, added value by 3.8 billion EUR/year, and GDP by 4.5 billion EUR/year.

Between 2031 and 2050, with an estimated annual investment of EUR 3.3 billion, employment would increase by about 141,000, added value by 2.0 billion EUR/year, and GDP by 2.4 billion EUR/year.

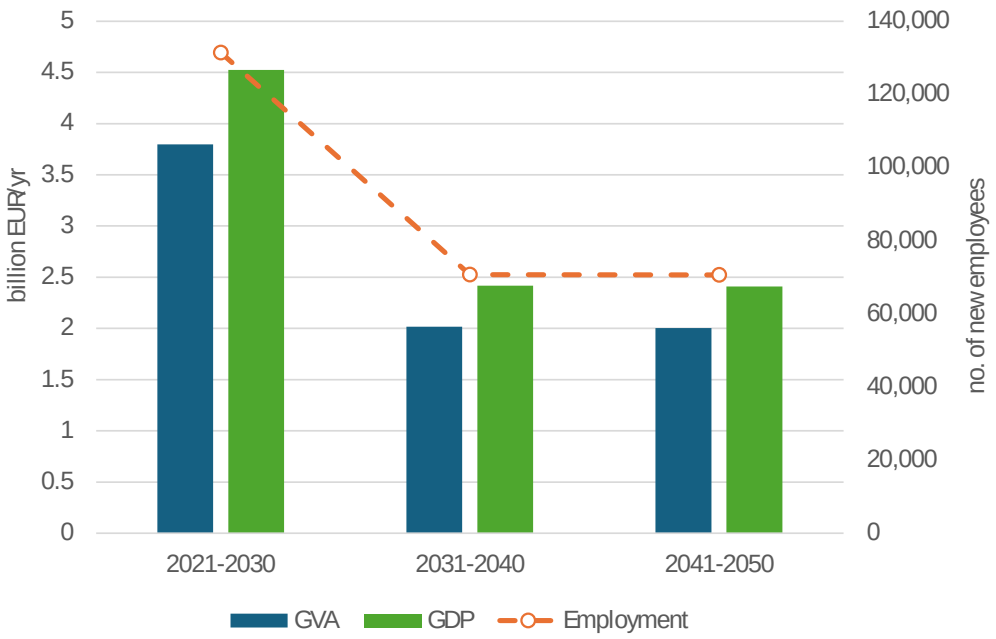



**Figure 5-6 Absolute annual effects of investments by periods**

The analyses and results indicate the significant macroeconomic impact of the integrated national energy and climate plan on the Croatian economy, as shown by its effects on GDP and employment, both overall and by sectors.

To a certain extent, the analysis is limited by the availability and quality of the required input data, which primarily refers to the disaggregation of total investments by sectors of the Croatian economy and the ratios of imported and domestic components by sectors. Input-output analysis is a static analysis that does not consider future changes in technological links between different industries.

Considering the current Croatian macroeconomic situation, the state of the labour market, and demographic trends, the potential adverse social effects of the green transition are insignificant. They could mostly be limited to the local impacts. On the contrary, the investments required for a successful green transition will create demand for new jobs. Considering that a significant part of the investments will be realized in the construction sector, which mainly employs workers with low and medium qualifications, the demand for such workers will increase. It means that the green transition will not threaten such workers. On the contrary, investors' demand for such work could increase their wages and reduce income inequality. To further improve the green skills of the Croatian workforce, the Croatian Employment Service launched a program of vouchers for education in 2022, which includes the so-called "green programs". Green programs are available for employed and unemployed people, and funds are provided by the National Recovery and Resilience Plan 2021-2026. and the European Social Fund.
However, localized adverse effects could still occur, for example, in cities with a robust economic reliance on polluting industries.
Report for Croatia 2020, Annex D identifies Istria County and Sisak-Moslavina County as priority regions in the transition process concerning electricity production from coal and industry dependent on fossil fuels and given that these are the areas on which the reduction

of GHG emissions could have the most significant impact. The challenges of the transition to Istria County are related to cement production and the abolition of electricity production from coal. Sisak-Moslavina County is almost the poorest county in the Republic of Croatia (Regional Development Index in 2024 ranks 18th out of 21), further impoverished by the earthquakes in 2020, leaving significant social and economic consequences. GHG emissions in Sisak-Moslavina County arise from the chemical industry and oil processing. These energy-intensive industries employ a considerable number of people, so decarbonization requires long-term investments in climate-neutral technologies while harnessing the potential of the local workforce.

The manufacturing sector in Istria County contributes the largest share of GHG emissions, with around 25% of regional GDP and 20% of employment. The gradual abolition of the use of fossil fuels in production processes can lead to the loss of jobs in the industry and requires the diversification of the economy. The significant reliance of the Labinština area on energy-intensive economic entities could potentially have significant negative effects in the event of shutdown of economic entities, their operations or workforce reduction. Any change in the structure of employment within economic entities will be strongly felt in the labour market. The economic impact of economic entities is exceptionally significant, and any changes in their operations or future business plans will significantly affect local communities. The number of endangered jobs is estimated at 2,800, and an additional 1,000, more than 90%, reside in covered areas.

From the perspective of the climate transition in Sisak-Moslavina County, the most significant is the production sector, which contributes the largest share of GHG emissions and employs 24% of the regional workforce. Economic entities, i.e. industrial plants, employ about 2,325 people in Sisak-Moslavina County. Observing the direct and indirect employment provided by the entities, it is inevitable that these facilities greatly influence the offer of jobs in the local community and the county. Closing the entity or restructuring the workforce or supplier network will significantly negatively impact Sisak-Moslavina County. The transition process towards a low-carbon economy of Sisak-Moslavina County will enable significant changes in the structure of the county's economy, as well as in the occupations in demand, and it will be necessary to retrain the affected workers into sustainable occupations for which there is demand on the market.

The Integrated Territorial Program 2021 - 2027 (ITP) includes the European Regional Development Fund and the Just Transition Fund (FPT). The FPT is designed as a critical financial mechanism to support the socio-economically most vulnerable areas in their transition towards climate neutrality and to prevent the growth of regional differences that could occur on that occasion. Funds from FPT of EUR 185.9 million for 2021-2027 will be used in Sisak-Moslavina and Istria County within the ITP, Specific objective JSO8.1. It is enabling regions and people to mitigate the social and economic effects as well as the impact on employment and the environment that are a consequence of the transition towards the achievement of the climate and energy targets of the Union by 2030 and the climate-neutral economy of the Union by 2050, based on the Paris Agreement. The final territorial and thematic scope of FPT support is defined by the Territorial Plan for Just Transition (TPPT), which is an attachment to the ITP.

Within the framework of the mentioned Specific goal, i.e. Priority 4. Just transition of the ITP, the following related types of activities are foreseen:

- Investments in business infrastructure are primarily directed towards the green and digital economy as the backbone of the area's future development, especially in decarbonization and abandonment, i.e., replacement of obsolete technologies based on fossil fuels with high greenhouse gas emissions. The mentioned activity includes investments by entrepreneurial support institutions (coworking spaces, technological innovation incubators, centres (HUB) of knowledge, creativity and innovation) in entrepreneurial zones. This intervention does not include investments in ETS installations since the investment in carbon capture and storage technology in Holcim d.o.o. is the only ETS investment financed through FPT. (FROM)
- Developing agricultural and food business infrastructure in Istria County by establishing an agribusiness centre. (FROM)
- Encouraging research and innovation activities through investment in the highly developed sector of research, development and innovation (IRI), reconstruction and equipping of public research institutions, performing applied research; activities related to the transfer of knowledge and technology; staff recruitment; creation of research studies; experimental development, activities encouraging SMEs to use innovations in green and digital technologies in their own business. (FROM)
- Investing in improving the circular economy through building and equipping recycling yards, creating technical preconditions for efficient reuse of waste, and conducting targeted informational and educational activities. (FROM)
- Implementing programs aimed at future competencies through retraining and career counselling of adult education (such as employed persons, socially vulnerable persons, and persons in a disadvantageous position) with an emphasis on technological directions and occupations that follow the development guidelines of the local economy. (FROM)
- Implementing programs aimed at future competencies through constructing and equipping educational institutions to improve educational programs aimed at student competencies. (FROM)
- Mobilize the ETS sector to reduce the share of regional greenhouse gas emissions in the total national account through direct investments that contribute to the reduction of overall $CO_2$ emissions, following the climate goals of the European Green Plan on carbon neutrality (Holcim d.o.o., carbon capture and storage technology). (FROM)
- Contribution to the reduction of the share of regional greenhouse gas emissions in the total national account through investment programs in production innovation of SMEs, which aim to improve the efficiency of production and business processes innovatively, all in the context of the transition to an emission-neutral economy. (FROM)
- Implementing programs aimed at developing skills and employment opportunities in the region through investment in the construction and equipping of the Master's School. (Sisak-Moslavina County)
- The development of the ICT industry as a driver of employment with high added value. And the increase in employment opportunities for the workforce that lost their jobs due to the transition through investing in the launch of a gaming industry campus in the city of Novska while providing support to SMEs and start-ups in the gaming industry, but also to other sectors (timber industry, metallurgical industry, tourism,

agriculture, education, etc.) including the provision of innovative digital services. The technologies that will be used for the digital transformation of SMEs are game development (gamification) with Virtual reality and Augmented reality, Blockchain technologies and the Internet of Things (IoT). (Sisak-Moslavina County)

- Encouraging the competitiveness and recognition of artisans and entrepreneurs from the county through establishing infrastructure (including equipment) to develop new business incubators in Sisak-Moslavina County. (Sisak-Moslavina County)

  The main target groups are local and regional self-government units; entrepreneurs and craftsmen; working population, workers, unemployed, schoolchildren, students and other local populations; research and educational institutions; and civil society organizations.

  It is estimated that the planned investments in these two counties will create direct and indirect jobs and influence the training and retraining of people.

  By amending the Regional Support Map for the Republic of Croatia for the period 2022 - 2027, it was possible to increase the maximum intensity of support by ten percentage points in the area of Sisak-Moslavina County as an area determined for support from the Just Transition Fund.

## 5.3 Overview of required investments

### i. Existing investment flows and forecasts of future investments concerning planned policies and measures

Tables 5-6 and 5-7 show an estimate of total investments for the period 2024-2030 as well as for the period 2031-2050. The total estimated investments until 2030, including the necessary investments in constructing new buildings (nZEB new construction), amount to about EUR 45 billion.

**Table 5-6 Assessment of necessary investments in the energy sector until 2050**

| Million EUR | 2024–2030 | 2031–2050 |
|---|---|---|
| Production of electricity | 5,028 | 8,096 |
| Electricity transmission | 1,045 | 2,500 |
| Distribution of electricity | 1,780 | 4,400 |
| Heating industry | 1,371 | 510 |
| - infrastructure (network) | 401 | - |
| - geothermal energy | 770 | 290 |
| - solar systems | 90 | 20 |
| - heat pumps | 110 | 200 |
| Solar thermal systems (except those used in heating) | 140 | 200 |
| Transport and distribution of natural gas (hydrogen) | 1,733 | 54 |
| Increasing the capacity of the UPP terminal | 180 | - |
| Hydrocarbon research | 323 | 323 |
| Construction - energy renovation of buildings | 10,950 | 16,788 |
| Construction - nZEB new construction | 15,624 | 26,544 |
| Transport | 5,208 | 5,022 |
| - road transport | 440 | 1,540 |
| - railway transport | 4,040 | 2,000 |
| - maritime transport and inland navigation transport | 205 | 180 |
| - air transport | 52 | 182 |
| - public transport and integrated transport | 470 | 1,120 |
| Production of low-carbon fuels | 319 | 599 |

| | | |
|---|---|---|
| Energy storages | 250 | 420 |
| Extraction and geological storage of $CO_2$ | 251.3 | 460 |
| Reduction of fugitive emissions | 179 | - |
| Cybernetic security | 2 | - |
| Improving the sustainability of urban environments | 1,143 | - |
| **Total** | **45,523** | **66,725** |

**Table 5-7 Estimate of the required investments in the non-energy sector by 2050**

| **Million EUR** | **2024–2030** | **2031–2050** |
|---|---|---|
| Industrial processes and product use* | 2 | 4 |
| Agriculture | 865.4 | 571.4 |
| Waste | 2187 | - |
| LULUCF | 471.5 | - |
| **Total** | **3,525.9** | **575.4** |

** Estimation of total investments related only to non-energy sources and product use projects. Investments in projects of industry energy sources and the construction of CCS systems are shown as part of the energy sector (Industry and construction).*

*** For the assessment of financial resources for the implementation of measures in the period 2024 - 2030, the assessment of financial resources for the implementation of the measures of the Waste Management Plan of the Republic of Croatia for the period 2023 - 2028 was used EUR 2,181,070,900 + financial resources for implementation of the Plan for the prevention and reduction of food waste in the Republic of Croatia for the period from 2023 to 2028 and the estimated cost of implementing measure C1.5. R4 Improvement of the food donation system from the National Recovery and Resilience Plan 2021 - 2026 of EUR 6,000,000.*

The most significant investments are expected in the construction of nearly zero energy buildings and houses and electricity generation plants (the majority of which will be investments in plants using renewable energy sources). Regarding the necessary incentives, the greatest need will bein decarbonising transport sector and the energy renovation of the existing building stock.

The figure below shows the total necessary investments until 2030, according to groups of measures. The listed investments do not include investments in the construction of new residential and commercial buildings (n-ZEB new construction). The necessary investments for implementing the measures are estimated at EUR 33.8 billion, of which it is possible to finance about 32% (EUR 10.8 billion) from various programs (NPRR, OPCC, Repower, Modernisation Fund, EU-ETS-2, Social Fund, etc.)

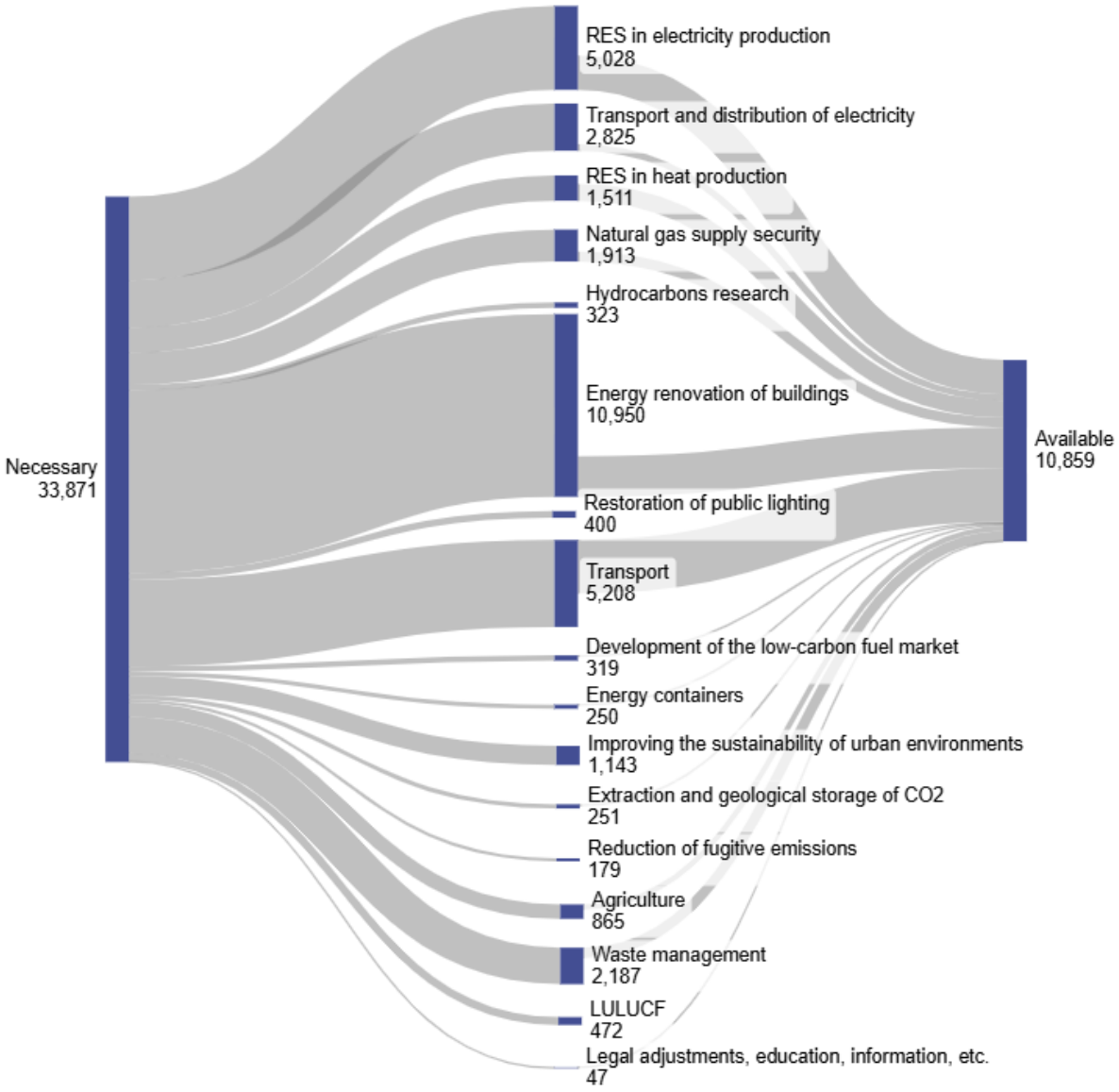



**Figure 5-7 Investments necessary for the implementation of the measures defined by the NECP**

ii. Sector or market risk factors or barriers in the national or regional context;

The most significant risks are delays in implementing regulatory measures and insufficient funds to implement financial measures.

These risks will be minimized by continuously monitoring the implementation of measures and, if necessary, corrective action.

iii. Analysis of additional support from public finances or sources to fill the gaps identified under subitem ii.

The implementation of the measures will be realized through the financing or co-financing of projects from 1) public budgetary and extra-budgetary funds, 2) private funds, and 3) national

and international sources of financing for energy efficiency and renewable energy projects, which include credit and grants.

Given that the volume of necessary investments often exceeds the capacity of the public sector, it is encouraged to direct private financial flows to finance project activities and investments in infrastructure development, which aligns with the objectives of sustainable financing of the European Union. Private interest in sustainable investment has increased significantly in recent years, as has the use of available EU funds to finance various energy and climate transition projects.

National funding sources include funds and banks based in Croatia, which specialize in financing projects in the energy and transport sectors. In addition to classic lending forms, grants are available to investors. It is essential to mention that commercial banks have also recognized the investment potential in this sector, as evidenced by the launch of credit lines for energy efficiency and renewable energy projects. One of the largest sources of financing at the national level is the *Environmental Protection and Energy Efficiency Fund*, which was established as an extra-budgetary fund to finance national energy programs. *The Croatian Bank for Reconstruction and Development (HBOR)* is a development and export bank with the primary goal of stimulating the development of the Croatian economy. In the domestic financial system, HBOR plays the role of a development bank, export bank and export credit agency of the Republic of Croatia, which enables financial support and the encouragement of investments in environmental protection projects, energy efficiency and the use of renewable energy sources.

In addition to credit and guarantee activities, HBOR is also an active participant and holder of the development of alternative sources of financing (private equity and venture capital funds).

The benefits of using EU funds to finance project activities are contained in the possibilities of financing a wide range of project activities, from the lowest levels of technological readiness (TRL), which include basic research and the formulation of a technological concept, to demonstration activities and successfully proven technologies (competitive production). Depending on the desired and targeted results, a diverse profile of applicants is acceptable for project financing, from public sector bodies and organisations for research and dissemination of knowledge to private applicants from the economy, especially small and medium-sized enterprises for which calls for financing of individual project activities are often dedicated and targeted and available.

EU funding for project finance and private and public funding should be combined and used synergistically to create new business and investor opportunities. EU funding sources should act as a catalyst for effectively mobilising and distributing private and public funds for sustainable investment. In line with the objectives of the European Green Deal, the financing of programmes and projects in the energy and transport sectors in general is ensured under **the Multiannual Financial Framework (MFF) for the period** 2021-2027 and the **NextGenerationEU instrument (NGEU)**. From both sources of funds, individual financial mechanisms and instruments are available that enable financing for the energy sector and sustainable project activities.

The “Next Generation EU - NGEU” introduced the **Recovery and Resilience Mechanism** (*Recovery and Resilience Facility - RRF*), which will allow Member States, through their own national recovery and resilience plans, to use grants and loans to finance reforms and related investments that accelerate recovery and increase the resilience of the economy and society.

The Recovery and Resilience Mechanism aims to mitigate the economic and social consequences of the coronavirus pandemic and make European economies and societies more sustainable, resilient and prepared for the challenges and opportunities of the green and digital transition. The mechanism is based on six pillars: green transition; digital transformation; economic cohesion, productivity and competitiveness; social and territorial cohesion; resilience of health, economic and social sectors and institutions; and policies for the next generation. Croatia's **National Recovery and Resilience Plan (NPRR)** is aligned with national strategic development documents and European priorities focused on the digital and green transition, which are based on the modernisation of the economy and society based on more significant investment in innovation and new technologies.

**The Connecting Europe Facility (CEF)** is a financial instrument established to further invest in the construction of new and upgrade existing transport, energy and telecommunications infrastructure, from which Member States can finance projects on the nine corridors of the Trans-European Transport Network (TEN-T) Core Network. The total CEF transport allocation for 2021-2027 is EUR 25.81 billion. In the transport field, CEF 2.0 will promote interconnected and multimodal networks for the development and modernisation of rail, road and maritime infrastructure, as well as inland waterway infrastructure, and contribute to safe mobility. All EU Member States, international organisations, research centres, and local and regional authorities can apply for CEF funding.

**Horizon Europe** is the European Union's Framework Programme for Research and Innovation for 2021-2027. It is one of the Union's key instruments to strengthen the European Research Area, strengthen European competitiveness, steer and accelerate the digital and green transition, and improve European recovery, preparedness, and resilience. It makes the most ambitious and prominent transnational research and innovation framework programme globally.

The specific objectives and pillars of the Global Challenges and European Industrial Competitiveness programme structure support the creation and transfer of new knowledge, technologies and sustainable solutions to foster the competitiveness of Member States' industries and strengthen the impact of research and innovation in implementing Union policies. Particular emphasis has been placed on encouraging the development of innovative solutions in small- and medium-sized start-ups and society, aiming to address global challenges. In addition, activities under the third pillar of Innovative Europe shall encourage the development, transfer and deployment of all forms of innovation, particularly in SMEs, while contributing to the other specific objectives of the Programme.

The first strategic plan of Horizon Europe 2021-2024 set out strategic guidelines to guide investment in the first four years of its implementation, based on:

- promoting open strategic autonomy by leading the development of critical digital, development and new technologies, sectors and value chains
- restoration of European ecosystems and biodiversity and sustainable management of natural resources
- a digital road to Europe as the first circular, climate-neutral and sustainable economy
- building a more resilient, inclusive and democratic European society.

Within those above, the possibility of using funds for research, development and innovation activities to use alternative fuels is evident.

Funds allocated to the Republic of Croatia for the financial period 2021-2027 in current prices, amount to more than EUR 14 billion from the MFF and slightly more than EUR 11 billion from the NGEU. A significant part of the mentioned funds refers precisely to the funds that will be implemented following Regulation (EU) 2021/1060 of the European Parliament and the Council of 24th June 2021 on establishing common provisions on the European Fund for Regional Development, the European Social Fund Plus, the Cohesion Fund, The Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and the financial rules for them and the Asylum, Migration and Integration Fund, the Internal Security Fund and Instrument for financial support in the area of border management and visa policy (OJ L 231, 30th June 2021) (hereinafter Common Provisions Regulation CPR)[41].

Funding from **the European Regional Development Fund (ERDF)** is possible for infrastructure investments, research and innovation, productive investments in SMEs and investments aimed at preserving existing and job creation, equipment, software and intangible assets, and networking, cooperation and exchange of experience. The **Cohesion Fund (CF)** supports investment in transport and the environment, mainly focusing on renewable energy and investments in TEN-T. In the Republic of Croatia, investments to support the construction of infrastructure for the use of alternative fuels are planned within the ***Programme for Competitiveness and Cohesion 2021-2027*** **(PCC),** financed from the European Fund for Regional Development and the Cohesion Fund within the EU Cohesion Policy.

Building on the European Fund for Strategic Investments, the **InvestEU** programme aims to attract investment from the private sector, including investments in sustainable energy and transport, to provide economies in these regions with new sources of growth. This programme establishes an EU guarantee of around EUR 26.2 billion, allowing investment partners to take on more significant risks and support projects they would otherwise have given up. The EU guarantee is targeted at four areas: sustainable infrastructure (EUR 9.9 billion), research, innovation and digitalisation: EUR 6.6 billion, SMEs (EUR 6.9 billion), social investment and skills (EUR 2.8 billion). All four areas will include projects to support a just transition towards climate neutrality in the EU.

In addition to the financial instruments and mechanisms defined in the Common Provisions Regulation related to support for alternative fuels infrastructure, the following sources of funding are also available:

**The Innovation Fund** is one of the largest funds for innovative low-carbon technologies, supporting the vision of a climate-neutral Europe by 2050[42]. The Innovation Fund aims to boost low-carbon investment in all Member States, accelerating Europe's transition to a first climate-neutral continent. The Innovation Fund shall support projects demonstrating highly innovative technologies, processes or products with significant greenhouse gas emission reduction potential. It is intended for projects with high readiness and can quickly bring new solutions to the market. Support is provided to projects under four thematic areas: Innovative

[41]Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Financial Support Instrument in the field of border management and visa policy

[42]Legislative framework of the Innovation Fund

production and use of renewable energy sources, including component production, carbon capture and utilisation, and carbon capture and storage (CCU and CCS); energy-intensive industries, including carbon-intensive products and energy storage, including component production plants.

The **Modernisation Fund** supports investments in line with the climate and energy objectives of the European Union by 2030, i.e., investments in line with the Paris Agreement[43]. It was established for the period from 2021 to 2030 to support investments in modernising the energy system and improving energy efficiency in less developed member states with Directive 2003/87/EC of the European Parliament and of the Council of October 13th, 2003 on the establishment of a system for trading greenhouse gas emission units. within the Community and amending Council Directive 96/61/EC (Text with EEA relevance) (OJ L 275, 25th October 2003) (hereinafter: EU ETS Directive). Based on the analysis of investment needs, investment maturity, policy priorities, and the impact and potential for using other sources of financing, the Modernisation Fund in Croatia will finance investments in:

- production and use of electricity from renewable sources, including hydrogen from renewable sources;

- heating and cooling from renewable energy sources;

- reduction of total energy consumption due to energy efficiency, among others, in the fields of industry, transport and waste;

- energy storage and modernization of energy networks, including consumption management, pipelines for centralized heating, electricity transmission networks, increasing the interconnection of Member States and infrastructure for zero-emission mobility.

The fund is financed by auctioning 2% of the total amount of emission units in the EU emissions trading system (hereinafter: EU ETS), and it is estimated that the Republic of Croatia has EUR 1.3 billion available from 2021 to 2030.

**The JustTransition Mechanism** is the most critical tool for transitioning to a climate-neutral economy. While all regions will need financial assistance, as foreseen in the Investment Plan for the European Green Deal, the 2021-2027 mechanism will mobilise at least EUR 100 billion in targeted support to mitigate the socio-economic consequences of the transition in the hardest-hit regions. The mechanism will stimulate the necessary investments to help workers and communities dependent on the fossil fuel industry. In addition, the EU budget allocates significant resources through instruments directly relevant to the transition[44].

The Just Transition Mechanism will cover three primary sources of funding:

1. **The Just Transition Fund** has funds of EUR 8.4 billion in current prices from the multi-year financial framework for 2021-2027. To be able to withdraw their share of the Fund, Member States should, in dialogue with the Commission, draw up territorial plans for a

[43]Commission Implementing Regulation (EU) 2020/1001 of July 9, 2020 on establishing detailed rules for the application of Directive 2003/87/EC of the European Parliament and of the Council regarding the operation of the Modernization Fund, which supports investments in the modernization of energy systems and the improvement of energy efficiency in certain countries member (OJ L 221, 10.7. 2020) and Commission Implementing Regulation (EU) 2023/2606 of 22 November 2023 amending Commission Implementing Regulation (EU) 2020/1001 on establishing detailed rules for the application of Directive 2003/87/EC of the European of the Parliament and the Council regarding the operation of the Modernization Fund, which supports investments in the modernization of energy systems and the improvement of energy efficiency of certain member states (OJ L 2023/2606 23.11.2023)

[44]Memo: More on the Investment Plan for the European Green Deal and the Just Transition Mechanism

just transition and identify the territories in need of assistance. More funds are available from the European Regional Development Fund and the European Social Fund Plus, and they will also provide additional funds at the national level. The total value of these funds will be EUR 30-50 billion, which will mobilise even more investment. Grants from the Just Transition Fund are primarily earmarked for regions. In particular, it will support workers in developing skills and competencies for the future labour market and help SMEs, start-ups, and incubators create new economic opportunities in these regions. Investments in the clean energy transition, such as investments in energy efficiency, will also be supported[45].

2. A specific programme for a just transition under the InvestEU programme will mobilise investments worth up to EUR 45 billion.
3. The public sector lending facility, supported by the EU budget, with the involvement of the European Investment Bank, will enable the mobilisation of investments of EUR 25-30 billion. This instrument will provide loans for the public sector, for example, for investments in district heating networks and building renovation.

The Just Transition Mechanism offers funding through the Just Transition Platform. Still, the Commission will provide technical support to Member States and investors and involve relevant communities, local authorities, social partners, and NGOs. The Just Transition Mechanism will include a strong governance framework based on territorial plans for a just transition.

With the new Regulation, the LIFE Programme fully supports the objectives of the European Green Plan in transforming the EU into an equal and prosperous society with a modern, resource-efficient and competitive economy with no greenhouse gas emissions in 2050 and where economic growth is decoupled from resource use[46]**.** In the new 2021-2027 programming period, LIFE is divided into two areas, each with two sub-programmes:

1. **Environment workstream:**
   - 'Nature and Biodiversity' sub-programme
   - 'Circular economy and quality of life' sub-programme
2. **Area Action in the field of climate:**
   - "Climate Change Mitigation and Adaptation" Sub-programme
   - 'Clean Energy Transition' sub-programme.

The financial envelope for the implementation of the LIFE programme for the period from 2021-2027 amounts to **EUR 5 432 000 000,** and, following the Regulation, LIFE can provide different types of grants for various kinds of projects (standard action projects, strategic nature projects, strategic integrated projects, technical assistance projects and coordination and support actions). The co-financing rate through the LIFE Programme is up to 60% of the

[45]Regulation (EU) 2021/1056 of the European Parliament and of the Council of 24th June 2021 on the establishment of the Just Transition Fund (OJ L 231, 30.6.2021). It was amended by Regulation (EU) 2024/795 of the European Parliament and of the Council of 29th February 2024 on the establishment of the Platform for Strategic Technologies for Europe (STEP) and on the amendment of Directive 2003/87/EC and Regulation (EU) 2021/1058, (EU) 2021/1056, (EU) 2021/1057, (EU) no. 1303/13, (EU) no. 223/14, (EU) 2021/1060, (EU) 2021/523, (EU) 2021/695, (EU) 2021/697 and (EU) 2021/241 (OJ L, 2024/795, 29.2.2024.

[46]Regulation (EU) 2021/783 of the European Parliament and of the Council of 29 April 2021 establishing a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EU) No. 1293/13 (Text with EEA relevance) (Oj L 172, 17th May 2021)

total eligible costs, i.e. up to 75% for priority species from the Nature and Biodiversity sub-programme. In contrast, the eligible applicant is each legal entity registered in the territory of the European Union: public bodies, private commercial organizations and non-profit organizations.

**Other international sources of funding**

Other international sources of financing include specialised funds and foreign-owned banks, which have unique lines dedicated to energy efficiency and renewable energy projects. The two most active European financial institutions, the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), have been present in Croatia for a long time as financial partners on significant infrastructure projects.

**The European Investment Bank** is a non-profit European Union financial institution specialising in the long-term financing of projects supporting EU development policy. EIB-funded projects are not closely specialised in one sector, so it is possible to obtain funding for various infrastructure projects, including energy efficiency and renewable energy projects.

**European Local Energy Assistance (ELENA)** is a technical assistance service launched in cooperation with the European Commission and the European Investment Bank at the end of 2009. Technical assistance will be provided to cities and regions in developing projects from the energy sector that contribute to the *20-20-20* initiative and the *Covenant of Mayors*.

**The European Bank for Reconstruction and Development (EBRD)** is an international financial institution dedicated to assisting transition countries in their transition to a market economy and democratic order. The beneficiaries primarily come from the private sector, but the EBRD also works closely with regional banks to finance projects in the public sector. The EBRD funds projects in agriculture, energy efficiency and supply, industrial production, local community infrastructure, tourism, telecommunications and transport.

**The European Investment Bank (EIB) and the German Development Bank (KfW)** launched, with the support of the European Commission, the **Green for Growth Fund – Southeast Europe** at the end of 2009. The Fund's primary objective, which operates in Southeast Europe, is to encourage the development of a financial market to lend energy efficiency and renewable energy projects.

In addition to public sources, the private sector will also play an essential role in financing. The Government of the Republic of Croatia established the Forum for Support of Sustainable Financing (hereinafter referred to as the Forum) by Decision of 21st December 2023. The forum aims to create a platform to connect the participants in the financial sector (banking and non-banking) with relevant ministries and supervisory bodies. The forum will encourage cooperation to prevent or remove obstacles to sustainable financing, raising awareness of the financial consequences that may arise from the non-management or poor management of ESG risks. The forum will ensure that the financial sector serves the interests of sustainable financing in the Republic of Croatia and will enable an open dialogue through strategic discussions and exchange of information among stakeholders to influence the direction of private sector capital flows into renewable energy sources, emphasizing the need to invest in green infrastructure.

The Forum will support the timely adaptation of the EU financial sector to regulatory requirements (Taxonomy, CSRD, ESRS, EGS ratings, etc.) by organising education and workshops.

## 5.4 Effects of planned policies and measures described in point 3 on other Member States and on regional cooperation at least until the last year of the period covered by the plan, including comparison with projections based on existing policies and measures

### i. To the extent possible, effects on the energy system of neighbouring countries and other Member States in the region

Cross-border and regional integration of energy markets is expected to lower energy and energy-generating product prices. At the same time, greater integration of variable renewable energy sources into national electricity systems will cause increased variability in cross-border electricity flows, which will require the construction of more robust transmission grids and possibly the construction of new interconnectors, which may reduce the quality of electricity delivered to customers and potentially compromise the stability of the system's operation for an expected lower inertia and higher speeds of frequency change. Quality problems and reduced system inertia are expected to be addressed on a European level.

### ii. Effects on energy prices, utilities and energy market integration

The expected changes in the energy sector are economically viable and will not entail higher costs. In doing so, the nature of costs will change - investment costs will increase and operating and energy costs will be reduced.

Ultimately, energy markets will be fully integrated, both geographically - at the level of the European Union and neighbouring countries- and sectorally - and there will be an interconnection between the electricity, heat, gas, and transport sectors.

### iii. If relevant, effects on regional cooperation

It will be necessary to strengthen cross-border and regional cooperation further in all dimensions of the Energy Union.

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ACLMT - Agency for Coastal Lines and Maritime Transport

AMPEU - Agency for Mobility and EU Programmes

APN - Agency for legal transactions and real estate brokerage

ASHE - Agency for Science and Higher Education

ATMIP - Agency for Transactions and Mediation in Immovable Properties

CBRD - Croatian Bank for Reconstruction and Development

CBS - Croatian Bureau of Statistics

CCE - Croatian Chamber of Economy

CEF - Connecting Europe Facility

CEMO - Croatian Energy Market Operator

CERA - Croatian Energy Regulatory Agency

CHA - Croatian Hydrocarbon Agency

CHPP - Combined Heat and Power Plant

CIPH - Croatian Institute of Public Health

CNG - Compressed natural gas

CSF - Croatian Science Foundation

CTSO - Croatian Transmission System Operator d.d.

DHS - District Heating System

DSO - Distribution System Operator

EnU - Energy efficiency

EPEEF - Environmental Protection and Energy Efficiency Fund

ERDF - European Regional Development Fund

ES - electricity system

ESCO - Energy Service Company

ESIF - European Structural and Investment Funds

ETS - Emissions Trading System

EU - European Union

FI - Financial instruments

FMP - Forest Management Plan

FRL - Forest Reference Level

GDP - Gross Domestic Product

GPP - Green Public Procurement

HAMAG BICRO - Croatian Agency for SMEs, Innovation and Investments

HEC - High efficiency cogeneration

HEP - Hrvatska elektroprivreda - Croatian Electrical Utility Company

HEP DSO - HEP Distribution System Operator d.o.o.

HHI - Herfindahl

HPP - Hydroelectric Power Plant

HTLS - High Temperature Low Sag

IAP - Ionian Adriatic Pipeline

ICT - Information and Communication Technologies

IEA - International Energy Agency

IPCC - Intergovernmental Panel on Climate Change

ISEM - Energy Management Information System

JLP(R)S - Units of Regional Self-government

LNG - Liquefied Natural Gas

LULUCF - Land Use, Land Use Change and Forestry

MAFF - Ministry of Agriculture, Forestry and Fisheries

ME - Ministry of Economy

MEPGT - Ministry of Environmental Protection and Green Transition

MI - Ministry of the Interior

MPPCSA - Ministry of Physical Planning, Construction and State Assets

MRDFEU - Ministry of Regional Development and Funds of the European Union

MOO - Recovery and Resilience Mechanism

MSE - Ministry of Science, Education and Youth

MSP - Ministry of State Property

MSTI - Ministry of the Sea, Transport and Infrastructure

NCB - National Coordination Body

NEEAP - National Energy Efficiency Action Plans

NFAP - National Forestry Accounting Plan

NPF - National Policy Framework for the Establishment for the Deployment of Alternative Fuels Infrastructure of the Republic of Croatia

NRRP - National Recovery and Resilience Plan

NTC - Net Transfer Capacity

nZEB - Nearly Zero Energy Building

OPCC - Operational Programme Competitiveness and Cohesion 2014-2020

PCI - Projects of Common Interest

RES - Renewable Energy Sources

SECAP - Sustainable Energy and Climate Action Plan

SIPO - State Intellectual Property Office

SMiV - System for Measuring and Verifying

SPP - Solar power plant

TPP - Thermal power plant

TYNDP - Ten-Year Grid Development Plan

UN - United Nations

UNFCCC - United Nations Framework Convention on Climate Change

WF - Wind farm

WF Wind farm AMPEU – Agency for Mobility and EU Programmes