



REPUBLIC OF CROATIA

MINISTRY OF ENVIRONMENT AND ENERGY

Integrated National Energy and Climate Plan for the Republic of Croatia

for the period 2021-2030

December 2019

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INTRODUCTION

In a communication from the European Commission on *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy* 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 will be achieved through five key dimensions of the Energy Union: 1. *energy security*, 2. *an internal energy market*, 3. *energy efficiency*, 4. *decarbonisation* 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 will be an essential tool for the efficient and effective construction of the Energy Union and the achievement of 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 on coordination between actors responsible for climate and energy policy, at EU, regional and national level.

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 has been adopted (hereinafter referred to as the Regulation 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 (hereinafter referred to as the Integrated Energy and Climate Plan) should cover the period from 2021 to 2030.

The achievement of the objectives of the Energy Union is to be ensured through a combination of Union initiatives and consistent national policies set out in integrated national energy and climate plans.

The Integrated National Energy and Climate Plan for the period 2021-2030 builds on existing national strategies and plans. It provides an overview of the current energy system and the 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, which include the **reduction in greenhouse gas emissions**, **energy from renewable sources**, **energy efficiency** and **electricity interconnection**. It should be ensured that the Integrated Energy and Climate Plan is consistent with and contributes to the Sustainable Development Goals.

The Integrated National Energy and Climate Plan for the period 2021-2030, pursuant to Article 12 of the Act on the Strategic Planning and Development Management System of the Republic of Croatia (Official Gazette No. 123/17), shall be adopted by the Government of the Republic of Croatia at the proposal of the Ministry of the Environment and Energy.

The table below includes the most important targets that the Plan sets for 2030.

Indicator	Target
Reduction in greenhouse gas emissions for the ETS sector, compared to 2005	at least 43% ¹
Reduction in greenhouse gas emissions for non-ETS sectors, compared to 2005	at least 7%
Share of RES in gross final energy consumption	36.4%
Share of RES in final energy consumption in transport	13.2%
Primary energy consumption (total energy consumption without non-energy consumption)	344.38 PJ (8.23 ktoe)
Final energy consumption	286.91 PJ (6.85 ktoe)

¹ The target for Croatia is indicative while the target at the EU level is binding

SECTION A: NATIONAL PLAN

1. OVERVIEW AND PROCESS FOR ESTABLISHING THE PLAN

1.1 Summary

i. Political, economic, environmental and social context of the plan

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

The 7th National Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change was published in 2018. In addition to information on greenhouse gas emissions, it 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. Emissions of greenhouse gases are decreasing. According to the number and quantity of pollutants being released into water and/or sea, the largest load is borne by the water catchment area of the Sava River. There are still minefields ("mine-suspected areas") on the territory of Croatia.

With regard to the social context of the plan, the development of the regions of Croatia and population of the areas are uneven, with growing pressure on larger cities [1]. The trend of departure from rural areas continues. Due to the emigration of a share of the working age population and the recovery of the economy, the dynamics of decrease in the unemployment rate is 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, at the detriment of decrease in highly-active age groups [1].

Croatia currently has considerably lower rates of economic activity of the population than most EU countries [2]. In the overall energy balance of Croatia, there is a significant dependence on oil, gas and electricity import. Considerable electricity imports are a consequence of market uncompetitiveness and the low level of operation of thermal power plants using old technology, as well as the binding environmental requirements for individual production facilities. Industrial production is continuously decreasing, and the highest revenue is realized by the processing industry.

ii. Strategy relating to 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.

There are four key strategies that address the **dimension of decarbonisation**. The **Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050** (hereinafter referred to as the Energy Development Strategy) [3] is an obligation under the Energy Act (OG Nos. 120/12, 14/14, 95/15, 102/15, 68/18). For the purposes of developing the Energy Development Strategy, analytical backgrounds have been prepared (the so-called Green Paper [2] and White Paper [4]) presented to the professional and interested public at the end of 2018 and beginning of 2019. The analytical backgrounds contain elaborated targets for the use of renewable energy sources (RES), energy efficiency, the internal energy market and energy security. The Energy Development Strategy defines the optimal energy mix and development projects with the aim of ensuring the energy independence of the Republic of Croatia, with particular emphasis on strengthening the production of energy from renewable sources. Also, special attention is paid to the security of supply, sustainability and competitiveness of the energy system. All of the above is in line with the objectives of the EU Directives in terms of reducing consumption, reducing greenhouse gas emissions, sustainability of energy development, competitiveness of the energy system and a positive investment environment. The **Long-Term Strategy to Encourage Investment in the Renovation of the National Building Stock of the Republic of Croatia by 2050** is crucial for the use of renewable energy sources in building construction, which, through the nZEB request for new buildings and the renovation of existing buildings, includes the obligation to cover a substantial portion of primary energy for the building by using renewable energy sources at the location of the building or in its immediate vicinity.

The third strategic document for the dimension of decarbonisation is the **Draft of 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). The preparation of the Low-Carbon Development Strategy and the Action Plan for the Implementation of the Low-Carbon Development Strategy for a period of five years is an obligation under the Air Protection Act (OG Nos. 130/11, 47/14, 61/17 and 118/18). The Draft of the Low-Carbon Development Strategy was prepared during 2017, when it was submitted for public debate, and refers to the sectors of energy, industry, transport, general consumption, agriculture, waste and land use. The final adoption of the Draft of the Low-Carbon Development Strategy has been postponed in order to align it with the Energy Development Strategy.

One of the objectives within the decarbonisation dimension is also adaptation to climate change, which is elaborated in the **Draft of 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]. The Draft of the Strategy has been subject to consultation with competent bodies and institutions and with the interested public, and the adoption of the document is expected upon the adoption of the Low-Carbon Development Strategy.

It should be noted that at the time of adoption of this document, the Low Carbon Development Strategy and the Adaptation Strategy have not been formally adopted. If the final text of these documents will differ from the drafts considered when preparing this document, this will be taken into account within the framework of reporting on the implementation of the Integrated Plan, as well as in the framework of the update to the plan expected in 2024.

The key document for **the energy efficiency dimension** is the **Long-Term Strategy to Encourage Investment in the Renovation of the National Building Stock of the Republic of Croatia by 2050**, which promotes the need to invest in the building stock. The revised strategy aligns the renovation objectives with the NECP in light of demographic trends and activities in the construction sector, with trends of accelerated abandonment of the existing building stock of poorer properties and gradual growth in new construction. The current energy renovation rate of 0.7% per year will gradually rise to 3% over the 2021-2030 period, with a 10-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 stock into nearly zero-energy buildings, i.e. climate neutral.

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

The national strategies relevant to the dimension of **research, innovation and competitiveness** are the **Strategy of Education, Science and Technology** [7], the **Smart Specialization Strategy of the Republic of Croatia 2016 - 2020** [8] and the **Innovation Promotion Strategy of the Republic of Croatia 2014- - 2020** [9]. With regard to these strategies, this document also outlines systematized measures expected to contribute to research, innovation and competitiveness of the Croatian economy in sectors relevant to the energy transition.

iii. Overview tables with key objectives, policies and measures of the plan

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

The objective of reduction in greenhouse gas emissions for the Republic of Croatia for 2030 is set by Directive (EU) 2018/410 of the European Parliament and of the Council of 14th March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 and Regulation (EU) 2018/842 of the European Parliament and of the Council of 30th May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No. 525/2013,

separately for participants in the emissions trading system (ETS sector) and for non-trading sectors (non-ETS sectors). These are shown in Table 1-1

Table 1-1.: Achieved emission reductions in 2017 and targets by 2030

Scope	GHG emissions in 2005 (kt CO ₂ e)	Achieved emission reduction in 2017 compared to 2005	Target for the period 2013-2020 compared to 2005	Target for the period 2021-2030 compared to 2005
ETS sector	10,649	-21.4 %	-21 % (EU-wide target)	-43 % (EU-wide target)
Non-ETS sectors	17,404	-4.2 %	-10 % (EU-wide target) +11 % (target for Croatia)	-30 % (EU-wide target) -7 % (target for Croatia)

Targets in 2030 are shown in Table 1-2.

Table 1-2: Estimated values of key indicators, Green Paper

	Target for 2030
Share of RES in the gross final consumption of energy	36.4%
Energy efficiency	
Primary energy consumption ²	344.38 PJ
Final energy consumption	286.91 PJ

Measures relevant to individual dimensions of the Energy Union are shown in Table 1-3. 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 (EU) 2018/1999 on the Governance of the Energy Union and to the United Nations Framework Convention on Climate Change (UNFCCC) within the framework of preparing national reports and biennial reports of the Republic of Croatia to the UNFCCC, so 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.

² Primary energy consumption, according to EUROSTAT guidelines, is defined as total energy consumption minus non-energy consumption.

Table 1-3 Overview of measures

Abbreviation 1 ³	Abbreviation 2 ⁴	Name	Impact on other dimensions
Decarbonisation			
MS-1	MCC-1	Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change	2,3,4,5
MS-2	MCC-2	Supporting the establishment and capacity building of regional energy and climate agencies	2,3,4,5
MS-3	MCC-3	Promoting the use of innovative information and communication technologies (ICTs) to reduce GHG emissions	2,3,4,5
MS-4	MCC-4	The EU Emissions Trading System	2,4
MS-5	MCC-5	CO2 emission tax for the non-ETS stationary sources	2,4,5
MS-6	MCC-6	Covenant of Mayors for Climate and Energy in the Republic of Croatia	2,3,4,5
MS-7	MCC-7	Charter of Cooperation for the Decarbonisation of Buildings by 2050	2,3
MS-8	MCC-8	Establishing of Platform for Carbon Capture, Use and Storage	5
MS-9	MCC-9	Improving sustainability of urban areas	2,3,5
MS-10	MCC-10	Establishing of Programme for Carbon Footprint Calculation and Reduction in Businesses	2,3,4,5
MS-11	MCC-11	Establishing of Platform for Circular Economy	2,3,4,5
MS-12	MCC-12	Establishing of Platform for Bioeconomy	2,3,5
MS-13	MCC-13	Establishing of Platform for Hydrogen Technologies	3,5
IP-1	MIP-1	Reduction of clinker content in cement production	
IP-2	MIP-2	Limiting fluorinated greenhouse gas emissions	
IP-3	MIP-3	Gradual decrease in the amount of fluorocarbons that can be placed on the market	
IP-4	MIP-4	Restricting and prohibiting market placing of certain products and equipment	
IP-5	MIP-5	Reduction of fluorinated greenhouse gas emissions from mobile air-conditioning systems	

³ According to the dimensions of the energy union

⁴ According to the IPCC methodology

GO-1	MWM-1	Preventing generation and reducing the amount of solid waste	
GO-2	MWM-2	Increasing the amount of separately collected and recycled solid waste	
GO-3	MWM-3	Assuring a system for the treatment and use of landfill gas	
GO-4	MWM-4	Reducing the amount of disposed biodegradable waste	
GO-5	MWM-5	Use of biogas for biomethane production and electricity and heat generation	
POLJ-1	MAG-1	Change in diet of cattle and pigs and animal feed quality	
POLJ-2	MAG-2	Improvement of livestock facilities and manure management systems	
POLJ-3	MAG-3	Modification of livestock farming system	
POLJ-4	MAG-4	Anaerobic decomposition of manure and biogas production	
POLJ-5	MAG-5	Improvement of breeding program, animal health and welfare	
POLJ-6	MAG-6	Improvement and change of soil tillage system (reduced tillage)	
POLJ-7	MAG-7	Extension of crop rotation with higher involvement of legumes	
POLJ-8	MAG-8	Intensification of crop rotation using intermediate crops	
POLJ-9	MAG-9	Improvement of mineral fertilizer application methods	
POLJ-10	MAG-10	Improvement of organic fertilizer application methods	
POLJ-11	MAG-11	Agroforestry	
POLJ-12	MAG-12	Hydromelioration interventions and systems for protection against natural disasters	
POLJ-13	MAG-13	Introducing new cultivars, varieties and species	
POLJ-14	MAG-14	Changes in human nutrition	
POLJ-15	MAG-15	Collection and treatment of agricultural plantations and residues for energy use	
LUF-1	MLF-1	Development of the Land Management Strategy of the Republic of Croatia	
LUF-2	MLF-2	Carbon accumulation on forests areas	
LUF-3	MLF-3	Reforestation works	
LUF-4	MLF-4	Manufacture and use of wood and wood products	
LUF-5	MLF-5	Agricultural land management	
LUF-6	MLF-6	Pasture management	

LUF-7	MLF-7	Implementation of technical projects and scientific research in the LULUCF sector	5
FUG-1	MEN-24	Refinery modernization	2,3
FUG-2	MEN-25	Measures to increase energy efficiency by improving processes and process units	2,3
FUG-3	MEN-26	Methane flaring	
OIE-1	MEN-16	Information, education and capacity building for RES use	2,3,4
OIE-2	MEN-17	Spatial planning requirements for using RES	3,4,5
OIE-3	MEN-18	Promoting the RES use for production of electricity and thermal energy	3,4,5
OIE-4	MEN-19	Development of the regulatory framework for RES use	4
TR-1	MTR-1	Providing information to consumers on fuel cost-effectiveness and CO2 emission of new passenger cars	2
TR-2	MTR-2	Special environmental fee for motor vehicles	2
TR-3	MTR-3	Special tax on motor vehicles	
TR-4	MTR-4	Monitoring, reporting and verification of greenhouse gas emissions in the life cycle of fuels and energy	2
TR-5	MTR-5	Regulatory framework development for cleaner transport	2,3
TR-6	MTR-6	Financial incentives for energy-efficient vehicles	2
TR-7	MTR-7	Development of alternative fuel infrastructure	2
TR-8	MTR-8	Promotion of integrated freight transport	
TR-9	MTR-9	Promotion of sustainable intermodal transport at national level	2,3
TR-10	MTR-10	Promotion of intermodal and intelligent transport and development of alternative fuels infrastructure at local and regional level	2
TR-11	MTR-11	Training for drivers of road vehicles for eco-driving	2
TR-12	MTR-12	Promotion of boat transport using alternative fuels	2
TR-13	MTR-13	Advanced biofuels market development plan	2,3,4,5
Energy efficiency			
ENU-1	MCC-14	Energy efficiency obligation scheme for suppliers	1
ENU-2	MEN-1	Promoting nearly-zero energy standard in buildings construction and refurbishment	1,3,5
ENU-3	MEN-2	Energy renovation programme for multi-apartment buildings	1
ENU-4	MEN-3	Energy renovation programme for single family houses	1

ENU-5	MEN-4	Energy renovation programme for public sector buildings	1
ENU-6	MEN-5	Energy renovation program for heritage buildings	1
ENU-7	MEN-7	Energy management system in the public sector	1
ENU-8	MEN-6	Energy renovation programme for public lighting	1
ENU-9	MCC-15	Green public procurement	1,5
ENU-10	MEN-8	Energy management system in business (service & production) sector	1
ENU-11	MEN-9	Informative bills	1
ENU-12	MEN-10	Providing information on energy efficiency	1
ENU-13	MEN-11	Energy efficiency education	1
ENU-14	MCC-15	Integrated information system for monitoring energy efficiency	1
ENU-15	MEN-12	Energy efficiency of the electricity transmission network	1,3
ENU-16	MEN-13	Reduction of losses in the distribution network and introduction of smart grids	1,3,4
ENU-17	MEN-14	Increasing efficiency of district heating systems	1,3,4
ENU-18	MEN-16	Increasing efficiency of the gas transport network	1,3,4
Energy security			
ES-1	MEN-21	Integrated planning of security of energy and energy products supply	1,2,4
ES-2	MEN-22	Construction and use of energy storage facilities	1,2,4,5
ES-3		Improvement of the power system management	2,4,5
ES-4	MEN-23	Development and maintenance of centralised thermal systems	2,4
ES-5	MEN-24	LNG terminal construction	4
ES-6		Gas transport system construction and management improvement	4
ES-7		Development of the Adriatic oil and derivatives market with oil and derivatives storage capacities optimization	4
ES-8		Exploration of potential hydrocarbon deposits in Slavonia, Dinarides and Adriatics	4
Internal energy market			
UET-1	MEN-28	Development of the electricity transmission network	1,2,3,5
UET-2	MEN-29	Development of the gas transport network	1,2,3,5
UET-3	MEN-30	Elaboration of the regulatory framework for active participation of customers in the electricity market	1,3
UET-4	MEN-31	Introduction of advanced metering and data management systems	1,3

UET-5	MEN-32	Adoption and implementation of the Programme for energy poverty alleviation	1,2,3,5
Research, innovation and competitiveness			
IIK-1	MCC-17	Research, innovation and competitiveness status quo analysis and determining targets, indicators and monitoring system	1,2,3,4
IIK-2	MCC-18	Co-financing industrial research and experimental development projects aligned with the National Development Strategy	1,2,3,4
IIK-3	MCC-19	Supporting low carbon entrepreneurship development	1,2,3,4
IIK-4	MCC-20	Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies	1,2,3,4
IIK-5	MCC-21	Supporting further work of excellence centres active in the field of natural, technical, biotechnical and biomedical sciences	1,2,3,4
IIK-6	MCC-22	Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy	1,2,3,4

1.2 Overview of current policy situation

i National and Union energy system and policy context of the national plan

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 2013 to 2017 are shown in Figure 1-1 [10].

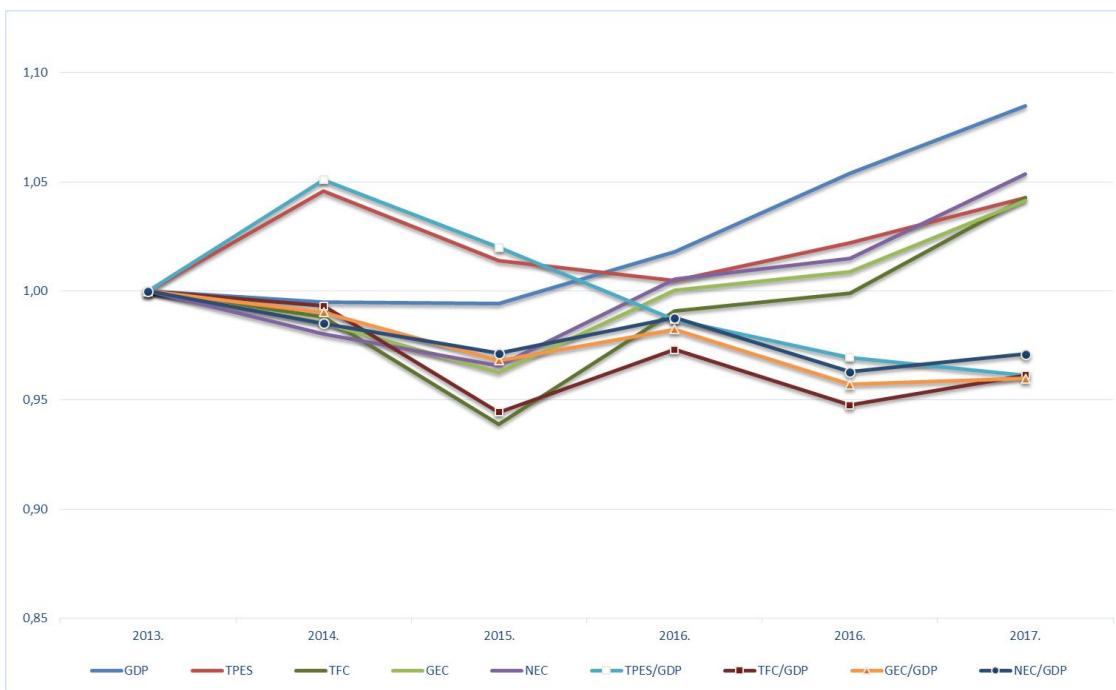


Figure 1-1. Basic indicators of energy consumption development and economic indicators for the Republic of Croatia in the period 2013-2017

Between 2012 and 2017, the GDP grew at an average annual rate of 1.6 percent. There was also an increase in electricity consumption, so total electricity consumption grew at an average annual rate of 0.8 percent and net electricity consumption at an average annual rate of 1 percent. Losses of transmission and distribution of electricity also decreased at an average annual rate of 1.3 percent.

The trends in the production of primary energy are shown in Figure 1-2. Primary energy production [10]. During the six-year period from 2012 to 2017, primary energy production in Croatia increased at an average annual rate of 0.9 percent. A downward trend was observed in the production of natural gas, while an upward trend was achieved in the production of other primary forms of energy. Natural gas production declined at an average annual rates of 5.6 percent. The fastest growth was achieved in renewable energy production with an annual growth rate of 23.3 percent, while the production of crude oil increased at an average annual rate of 4.4 percent. The energy of utilized water resources increased at an average annual rate of 2.6 percent. In the production of heat produced by heat pumps and in the production of firewood and other solid biomass, production increased at an average annual rate of 1.7 percent and 1.4 percent respectively.

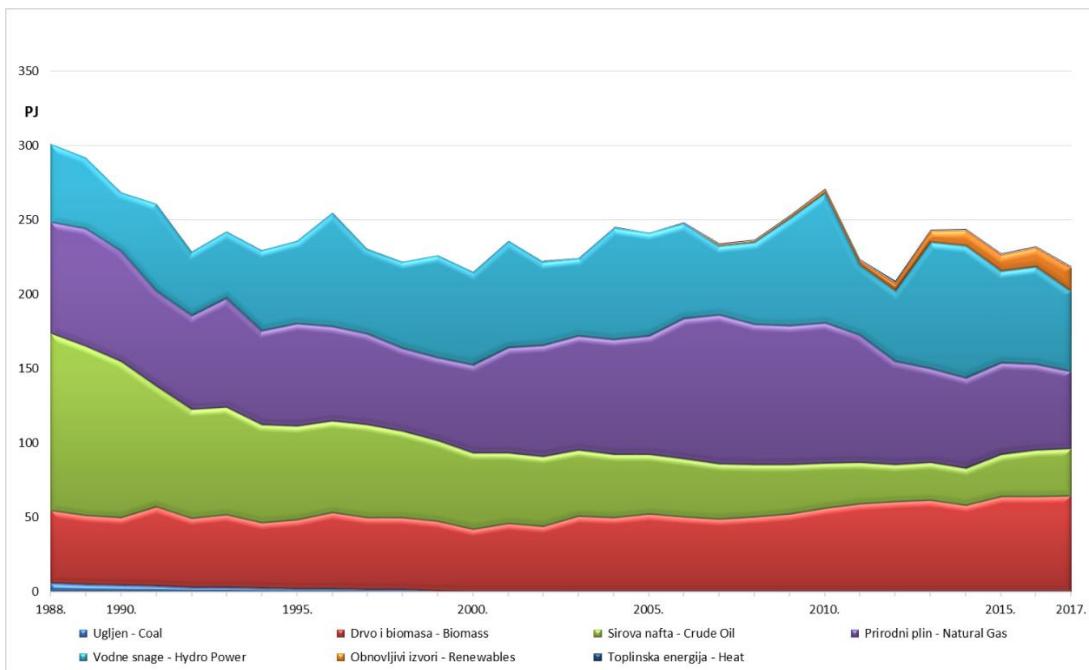


Figure 1-2. Primary energy production

Trends in energy imports until 2017 are shown in Figure 1-3. Import of energy to Croatia [10].

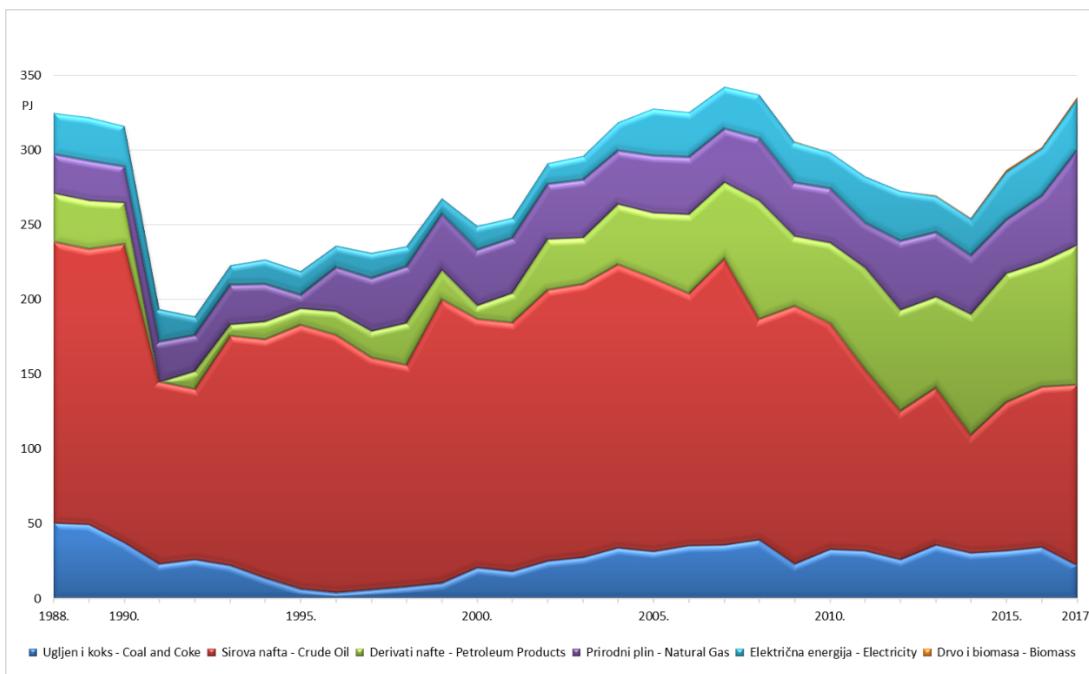


Figure 1-3. Import of energy to Croatia

During the period from 2012 to 2017, there was a trend of increase in import of energy to Croatia at an average annual rate of 4.2 percent. Only coal and coke imports saw a downward trend at an average annual rate of 3 percent, while imports of all other forms of energy increased. Imports of wood and biomass increased at an average annual rate of 43.7 percent,

import of natural gas 6.4 percent, import of petroleum products 6.7 percent and import of crude oil 3.9 percent. The average annual rate of increase in electricity imports was 0.6 percent.

Energy legislation and climate legislation are aligned with the *acquis communautaire*. At the implementation level, energy and climate fall within the competence of two ministries - the Ministry of the Environment and Energy and the Ministry of Construction and Physical Planning.

The development of the new Energy Development Strategy has begun in 2018. In view of the increasingly stringent restrictions on greenhouse gas emissions and the need for long-term energy planning, the Energy Development Strategy covers the period up to 2030, with an outlook to 2050. At the time of adoption of this document, the draft Energy Development Strategy was submitted to the Croatian Parliament. At the same time, the parameters of the Energy Development Strategy are included in the Draft of the Low Carbon Development Strategy, which will integrate energy and climate policies at the strategic level.

As part of the preparation of the National Development Strategy by 2030, the Ministry of the Environment and Energy together with the Ministry of Construction and Physical Planning set up the Thematic Working Group on Energy and Sustainable Environment and creates key areas of intervention and strategic projects to contribute to national and EU targets of reduction in CO₂ emissions by 40% and increase in energy efficiency by 32.5% until 2030.

In order to coordinate policies and measures for mitigation of and adaptation to climate change, in 2018 the Government of the Republic of Croatia adopted a decision on the establishment of the Committee for intersectoral coordination for policy and measures of mitigation of and adaptation to climate change. The Committee acts through the work of the Coordination Group and the Technical Working Group.

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

Dimension "Decarbonization"

The decarbonization dimension has two key elements

- emissions and elimination of emissions;
- renewable energy sources (RES).

The issue of climate change on a global scale is addressed by the *United Nations Framework Convention on Climate Change (UNFCCC)*. The Republic of Croatia became a party to the UN Framework Convention on Climate Change (UNFCCC) in 1996, by passing the Act on its ratification in the Croatian Parliament (International Treaties, OG No. 2/96). The Republic of Croatia is a party to the Kyoto Protocol pursuant to the Act on the Ratification of the Kyoto Protocol along with the United Nations Framework Convention on Climate Change

(International Treaties, OG No. 5/07) and the Act on the Ratification of the Doha Amendment to the Kyoto Protocol (International Treaties, OG No. 6/15) and the Paris Agreement, pursuant to the Act on the Ratification of the Paris Agreement (International Treaties OG No. 3/17). The most important regulation of the Republic of Croatia governing climate change is the Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18).

During 2018, a number of new EU regulations were adopted, which regulate or restructure the field of climate change. This is the reason why a special Act on Climate Change and Ozone Layer Protection will be enacted, which passed its first reading in the Croatian Parliament's enactment procedure.

The Republic of Croatia as a Party to the UN Framework Convention on Climate Change (UNFCCC) prepares and submits every four years a national report on climate change reporting on the implementation of the Convention's obligations. The most recent report is the Seventh National Report and the third biennial report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC) [1].

As a party to the Kyoto Protocol, the Republic of Croatia has set up a national system for monitoring greenhouse gas emissions in the country, and on an annual basis prepares the Greenhouse Gas Emissions Report and submits it to the UNFCCC Secretariat (by 15th April of the current year) and to the European Commission (by 15th January of the current year). The most recent Greenhouse Gas Inventory Report on the territory of the Republic of Croatia for the period 1990-2017 was published in 2019 [11].

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

- Environmental Protection Act (OG Nos. 80/13, 153/13, 78/15, 12/18, 118/18),
- Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18),
- Act on the Deployment of Alternative Fuel Infrastructure (OG No. 120/16),
- Energy Act (OG Nos. 120/12, 14/14, 95/15, 102/15, 68/18),
- Electricity Market Act (OG Nos. 22/13, 102/15, 68/18),
- Act on the Environmental Protection and Energy Efficiency Fund (OG Nos. 107/03, 144/12),
- Act on Renewable Energy Sources and Highly Efficient Cogeneration (OG Nos. 100/15, 111/18),
- Act on Biofuels for Transport (OG Nos. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18),
- by-laws for implementation of those laws.

In the **sector of building construction**, the Republic of Croatia is strongly committed to achieving an energy-efficient and decarbonised building stock by 2050. For the purposes of mobilizing all stakeholders in the process of building and renovating buildings to achieve the long-term target of reducing CO₂ emissions by 80% in the building construction sector by the end of 2050, the Ministry of Construction and Physical Planning 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 level through the

decarbonisation of the building stock, renovation of buildings and construction of nearly zero energy buildings, 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 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. By the end of October 2019, the Charter was signed by around 50 stakeholders from the business and public sectors⁵.

In the **transport sector**, the share of alternative fuel vehicles is still relatively small (less than 3 percent). In December 2016, *the Republic of Croatia passed the Act on the Deployment of Alternative Fuels Infrastructure* (OG No. 120/2016) transposing into national law the provisions of Directive 2014/94/EU of the European Parliament and of the Council of 22nd October 2014 on the deployment of alternative fuels infrastructure in the part referring to a Member State. Pursuant to the Act, a joint framework of measures for market development regarding alternative fuels in the transport sector and for deployment of adequate infrastructure is defined in *the National Policy Framework for Deployment of Alternative Fuel Infrastructure of the Republic of Croatia*, which was adopted in Croatia in 2017 (OG 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, as well as measures needed to achieve national targets. All other issues relating to the deployment of alternative fuels infrastructure not regulated by this Act or the NPF shall be governed by the regulations governing the areas of transport infrastructure, physical planning, spatial data infrastructure, construction, energy, energy efficiency, environmental protection, and laws establishing and defining the scope of activity of the Environmental Protection and Energy Efficiency Fund.

Within the decarbonisation dimension, the **agricultural sector** plays an important role - both in the context of its own emissions and in the context of its contribution to the use of renewable sources. *The Rural Development Programme of the Republic of Croatia 2014-2020* [12] defines priorities and areas of intervention, selection of relevant measures and allocation of funds based on expected outcomes. One of the objectives of the Programme is the efficient use of resources and strengthening resilience to climate change in agriculture, food-processing industry and forestry, emphasizing that the generation of renewable energy in these sectors is a priority for the development of bioeconomy and reduction in greenhouse gases by 2020. Furthermore, the importance of using wood biomass, biomass from agriculture and solar energy in agriculture and the food processing industry is emphasized. Current measures

⁵ Source: <https://mgipu.gov.hr/o-ministarstvu-15/djelokrug/energetska-ucinkovitost-u-zgradarstvu/povelja-o-dekarbonizaciji-zgrada/8915> (accessed on: 8th November 2019)

relating to the dimension of Decarbonization are shown in Table 1-4. Along with the name of each measure, a document adopting the measure is specified.

Table 1-4: Current measures within the dimension of "decarbonisation"

Name of the measure	Documents	Short description
Intersectoral policies and measures		
Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change	Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18), Decision of the Government of the Republic of Croatia (OG No. 9/18)	The Committee is responsible for monitoring and evaluating the implementation and planning of policy and measures for mitigation of and adaptation to climate change in the Republic of Croatia. Officials from competent state administration bodies were appointed to the Committee. The composition of the Committee, tasks and the manner of the work of the Committee is determined by the Government of the Republic of Croatia at the suggestion of the ministry responsible for environment.
Promoting the use of innovative information and communication technologies (ICTs) to reduce greenhouse gas emissions	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Innovative information and communication technologies play an increasingly important role in reducing greenhouse gas emissions and improving energy efficiency. By intensifying their use in public administration, services and manufacturing processes, work productivity and efficiency will increase, while simultaneously reducing energy consumption and the resulting greenhouse gas emissions. It is expected that the measure will increase the use of innovative ICTs and monitoring of real energy savings as well as reduction in greenhouse gas emissions.
European Union Emissions Trading System	Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18), Regulation on the manner of greenhouse gas emissions trading (OG No. 69/12, 154/14)	Through an even allocation of emission allowances, participants in the system from all Member States took on an obligation of reducing emissions for the purposes of contributing to a reduction in emissions at the EU level by at least 43% by 2030 compared to 2005.
CO ₂ emission tax for the non-ETS stationary sources	Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon	The Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon

	dioxide into the environment (OG Nos. 73/07, 48/09, 2/18)	dioxide into the environment (OG Nos. 73/07, 48/09, 2/18) stipulates the obligation to pay the CO ₂ emission tax for all stationary sources emitting more than 450 tons of CO ₂ per year. The obligated parties investing in energy efficiency, renewable energy sources and other measures to reduce CO ₂ emissions and other greenhouse gas emissions pay a lower tax. The Environmental Protection and Energy Efficiency Fund is authorized to calculate and charge the costs. From 2013 onwards, the obligation to pay the CO ₂ emission tax applies only to non-ETS sources.
Covenant of Mayors for Climate and Energy in the Republic of Croatia		The signatories of the Covenant support a joint vision for 2050: accelerating decarbonisation of their territories, strengthening capacity to adapt to the inevitable impact of climate change and allowing citizens to access safe, sustainable and affordable energy. The Covenant encompasses 82 cities and municipalities, i.e. more than 2 million citizens of the Republic of Croatia.
Charter of Decarbonisation of the National Building Stock by 2050		The signatories to the Charter are representatives of state and local government, academic community and the professional public, the construction and energy sectors, and supporting industries that support and promote the decarbonisation of buildings in their activities, wherever possible. Partners-signatories to the Charter are encouraged, through open partner dialogues, to actively and continuously cooperate 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).
RES		
Feed-in tariffs and a system of premiums to support the use of renewable energy sources in electricity generation and	Act on RES and COE (OG Nos. 100/15, 123/16, 131/17, 111/18), National RES Action Plan until 2020 [13]	The main mechanism for the development of renewable energy sources has so far been stimulating pricing (feed-in

for highly efficient cogeneration		tariffs). It is expected that this system of stimulation will continue in the forthcoming period for 500 kW plants. The Act on Renewable Energy Sources and Highly Efficient Cogeneration introduced an incentive scheme through premiums.
Increased use of renewable energy sources and energy efficiency in the industrial sector	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Use of available funds from ESIF and funds available at auctions of emission allowances in the EU ETS for the use of renewable energy sources 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)	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	The objective of the loan programme for environmental protection, energy efficiency and renewable energy projects is the realization of investment projects aimed at environmental protection, improving energy efficiency and promoting the use of renewable energy sources. Loans are intended for investment in land, buildings, equipment and devices. The final loan beneficiaries may be units of local and regional self-government, utility companies, companies, small businesses and other legal entities.
Promoting the use of renewable energy sources and energy efficiency through the funds of the Environmental Protection and Energy Efficiency Fund	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Funds for financing are secured from the dedicated revenues of the Fund paid by environmental polluters, which include fees for carbon dioxide emissions, fees for burdening the environment with waste, environmental user fees and special environmental fees for motor vehicles. Renewable energy projects for which the Environmental Protection and Energy Efficiency Fund grants funds include solar energy, wind energy, biomass, energy from small hydropower plants and geothermal energy.
Implementation at the local level	National RES Action Plan [13]	Raising awareness of renewable energy sources with expected results of behaviour changes The target groups are local authorities, interest groups, the public.

Transport

Providing information to consumers on cost-effectiveness of fuel consumption and CO ₂ emissions of new passenger cars	Environmental Protection Act (OG Nos. 80/13, 153/13, 78/15, 12/18, 118/18), Ordinance on availability of information on fuel consumption cost-effectiveness and CO ₂ emissions from new passenger cars (OG No. 7/15)	Each supplier of new passenger cars intended for sale is obliged to provide consumers with available information on fuel consumption levels and specific CO ₂ emissions of passenger cars. The Ministry of the Interior once a year and no later than 31st March of the current year prepares the Guidelines on cost-effectiveness of fuel consumption and CO ₂ emissions of new passenger cars available for purchase on the market in the Republic of Croatia. The Guidelines contain required information for each model of new passenger cars available on the domestic market.
Training drivers of road vehicles for eco-driving	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13), 4th National Energy Efficiency Action Plan for the period until the end of 2019 [15]	Pilot projects were conducted and systematic training for drivers of road vehicles for eco-driving was implemented. This saves energy and increases the level of awareness of all citizens and drivers in the Republic of Croatia on advantages of this modern, intelligent and environmentally friendly driving style. Special elements are dedicated to education on eco driving for drivers of passenger cars, buses and trucks. Education on the eco-driving elements is carried out among the drivers who received their driver's license prior to the entry into force of the Ordinance on Training of Driver's License Candidates from 2009, which introduced an obligation for all driving schools and instructors to carry out training on the elements of eco-driving during the standard training of candidates.
Obligation of use of biofuels in transport	Act on Biofuels for Transport (OG Nos. 65/09, 145/10, 26/11, 144/12, 14/14, 94/18); Excise Duties Act (OG No. 106/18); Ordinance on Excise Duties (OG No. 1/19); National Action Plan for Promotion of Production and Use of Biofuels in Transport for the period 2011-2020 (Ministry of Economy, Labour and Entrepreneurship, 2010)	In 2010, the National Action Plan that promotes the production and use of biofuels in transport for the period 2011 - 2020 was prepared. The National Renewable Energy Sources Action Plan (Ministry of the Economy, Entrepreneurship and Crafts, 2013) identified the goals and policies related to increasing the share of RES in final energy consumption by 2020 and the

		specifically estimated contribution of biofuels in transport. The use of clean biofuels in transport is exempt from payment of excise duty on motor fuels.
Special environmental fee for motor vehicles	Act on the Environmental Protection and Energy Efficiency Fund (OG Nos. 107/03, 144/12), Regulation on unit charges, corrective coefficients and detailed criteria and standards to determine the special environmental fee for motor vehicles (OG Nos. 114/14, 147/14)	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.
Special tax on motor vehicles	Act on Special Tax on Motor Vehicles (OG 15/13, 108/13, 115/16, 127/17)	The tax applies to vehicles intended for use on the roads in the Republic of Croatia at the moment of their first registration in the Republic of Croatia. The tax depends on the price of the vehicle, fuel type and CO ₂ emission. Electric vehicles are not subject to this tax.
Financial incentives for energy efficient vehicles	National Policy Framework for the Deployment of Infrastructure and Development of Alternative Fuel Market in Transport (OG No. 34/17), 4th National Energy Efficiency Action Plan for the period until the end of 2019 [15]	In order to increase the share of energy efficient vehicles, subsidies for the purchase of alternative fuel vehicles through allocation of grants have been introduced. These funds are paid from the revenues of the Environmental Protection and Energy Efficiency Fund realized through the sale of emission allowances in auctions and, inter alia, by collecting a special environmental fee for motor vehicles.
Development of alternative fuels infrastructure	National Policy Framework for the Deployment of Infrastructure and Development of Alternative Fuel Market in Transport (OG No. 34/17), Act on Deployment of Alternative Fuels Infrastructure (OG No. 120/16), 4th National Energy Efficiency Action Plan for the period until the end of 2019 [15]	The co-financing incentive that follows the Directive on the deployment of the alternative fuels infrastructure, 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 in accordance with the said documents.
Promotion of integrated and intelligent transport systems and alternatives fuels in urban areas	4th National Energy Efficiency Action Plan for the period until the end of 2019 [15]	This measure include promotion of optimization of transport of goods, integrated transport of citizens, intelligent transport management, promotion of car-sharing schemes, promotion of

		public bicycles and measures to support the development of infrastructure for alternative fuels in urban areas.
Promotion of clean and energy efficient vehicles in public road transport	Act on Promotion of Clean and Energy Efficient Vehicles in Road Transport (OG No. 127/13), Ordinance on the methodology for calculation of operational costs during the period of utilization of vehicles for road transport (OG No. 136/13)	This Act stipulates that all contracting authorities and carriers performing public liner transport on the basis of a public service contract, when purchasing vehicles for road transport, must take into account their energy and environmental effects during the period of vehicle utilization.
Promoting integrated freight transport	Act on Combined Transport of Goods (OG No. 120/16) Ordinance on incentives for combined transport of goods (OG 5/18)	The Ordinance provides for incentives for combined transport of goods by rail, inland waters or sea, and incentives for combined transport of goods on road sections.
Monitoring, reporting and verification of greenhouse gas emissions in the life cycle of liquid fuels	The Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18), Regulation on the quality of liquid petroleum fuels and the method of monitoring and reporting and methodology for calculation of greenhouse gas emissions in the life cycle of delivered fuels and energy (OG No. 57/17)	The supplier placing fuel on the domestic market will monitor the greenhouse gas emissions per unit of energy during the fuel life cycle. Suppliers should compile a certified report to be submitted to the Ministry of the Environment and Energy.
Industrial processes		
Reducing emissions of volatile organic compounds in solvent utilization sector	Regulation on limit values for contents of volatile organic compounds in certain paints and varnishes used in construction and vehicle finishing products (OG 69/13)	This Regulation prescribes limit values for contents of volatile organic compounds which may be placed on the market. Development and implementation of solvent management plan reduces emissions of volatile organic compounds and thereby carbon dioxide emissions.
Handling of substances that deplete the ozone layer and fluorinated greenhouse gases	Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18), Regulation on substances that deplete the ozone layer and fluorinated greenhouse gases (OG No. 90/14), Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	It is forbidden to release controlled substances and fluorinated greenhouse gases into air while performing activities of collecting, leakage testing, maintenance or servicing of appliances and equipment.
Technical and organizational measures for collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases	Regulation on substances that deplete the ozone layer and fluorinated greenhouse gases (OG No. 90/14), Plan for Air Protection, Ozone Layer Protection and Climate Change	This set of measures defines how the used controlled substances and fluorinated greenhouse gases contained in products and equipment must be

	Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	collected, reused, recovered or destroyed.
Capacity building and strengthening the knowledge of authorized repairers	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13), Ordinance on the training of persons who perform the activities of collecting, leakage testing, installation and maintenance and servicing of equipment and appliances containing substances that deplete the ozone layer or fluorinated greenhouse gases or depend on them (OG No. 03/13)	Education of authorized repairers on collection and handling of controlled substances and fluorinated greenhouse gases during device and equipment servicing.
Leakage detection of controlled substances and fluorinated greenhouse gases	Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18), Regulation on substances that deplete the ozone layer and fluorinated greenhouse gases (OG No. 90/14), Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	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	Regulation on substances that deplete the ozone layer and fluorinated greenhouse gases (OG 90/14)	An entrepreneur who imports/introduces controlled substances and/or fluorinated greenhouse gases for placing on the market in the Republic of Croatia or for their own needs, is required to pay a fee to the Environmental Protection and Energy Efficiency Fund. The fee amounts to HRK 3.00 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	Sustainable Waste Management Act (OG Nos. 94/13, 73/17, 14/19, 98/19), Waste Management Plan of the Republic of Croatia for the period 2017- 2022 (OG No. 3/17)	This measure should be achieved by cleaner production, education, economic instruments and enforcement of regulations on integrated environmental protection requirements, as well as investing in modern technologies. In accordance with the Act, quantitative targets and deadlines for reducing the total amount of waste disposed to

		non-compliant landfills are defined.
Increasing the amount of separately collected and recycled solid municipal waste	Sustainable Waste Management Act (OG Nos. 94/13, 73/17, 14/19, 98/19), Waste Management Plan of the Republic of Croatia for the period 2017- 2022 (OG No. 3/17)	By 2020, it is necessary to secure the preparation for reuse and recycling of the following waste materials: paper, metal, plastic and glass from households and possibly from other sources if these waste streams are similar to household waste, at a minimum share of 50% of waste weight.
Methane flaring	Ordinance on the methods and conditions for waste disposal, categories and operational requirements for landfills (OG 114/15, 103/18, 56/2019), Ordinance on waste management (117/17)	At landfills where landfill gas occurs it is necessary to secure a gas collection system, whereby the gas must be treated and used. If collected landfill gases cannot be used for energy production, they should be burned in the area of the landfill and the emission of methane into the atmosphere should be prevented.
Reducing the amount of disposed biodegradable municipal waste	Sustainable Waste Management Act (OG Nos. 94/13, 73/17, 14/19, 98/19), Waste Management Plan of the Republic of Croatia for the period 2017- 2022 (OG No. 3/17)	The aim of this measure is to reduce the amount of biodegradable fraction of waste disposed at landfills. By the end of 2020, the share of biodegradable municipal waste disposed of in landfills must be reduced to 35% of mass fraction of biodegradable municipal waste produced in 1997.
Use of biogas for electricity and heat generation.	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	The measure is associated with measure "Feed-in tariffs and premium system for the support of the use of renewable energy sources in electricity generation and for highly efficient cogeneration" in the section "Renewable energy sources".
Agriculture		
Change in diet of cattle and pigs and animal feed quality	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Specific sub-measures within this set of measures which relate to further improvement of animal husbandry, animal waste management systems, level of production as well as their diet (digestibility): the change of ratios of certain types of forage in the diet and the use of fat supplements as an energy source for animals and improving the quality of voluminous forage and improving grazing systems. These measures refer to the potential reduction of methane

		and nitrogen compounds emissions from enteric fermentation and animal waste management.
Anaerobic decomposition of manure and biogas production	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	With the introduction of biogas plants, reduction in emissions is achieved through elimination of methane emissions that occur as a result of disposal of used waste and generation of electricity from renewable sources. The measure is linked to measures for promoting the use of renewable energy sources. Anaerobic decomposition helps biogas plants to reduce the source of easily degradable carbon in the manure that is applied to agricultural land, but also potentially reduces N ₂ O emissions in the nitrification process.
Improving cattle facilities and systems of animal waste management	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Covering manure storage places - creating a natural layer (cortex) with natural (straw) or (porous) artificial materials. This measure reduces direct methane and ammonia emissions, although to a lesser degree they enhance the process of nitrification (porous material) and cause a mild increase in emissions of nitrous oxide.
Improvement of mineral fertilizer application methods	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Application of new slow-release fertilizers suitable for growing crops (fertilizers coated with polymers). Research suggests the possibility of reducing the need for fertilizer application per hectare (resulting in minor losses of nitrogen) with unchanged or increased revenues.
Hydromeliorative interventions and systems of protection against natural disasters	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Construction of drainage and irrigation systems and systems of protection against floods, droughts and other natural disasters may result in a reduced loss of nutrients due to leaching and washing; consequently, there is less need for nitrogen application.
Introduction of new cultivars, varieties and cultures	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Encouraging development, education and implementation of technologies at a national and regional level, encouraging the transition and adaptation of the entire production chain to

		produce new crops or enabling and encouraging the implementation of cultivars and varieties that are more resistant to drought and disease and have a lower carbon footprint. This, among other benefits, is aimed at reducing the need for the introduction of nitrogen into the soil through fertilizers.
Implementation of the rural development programme	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	According to the Rural Development Programme 2014-2020
LULUCF		
Improving reporting in the LULUCF sector	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	Improving the calculation of emissions/sinks in some storage facilities in LULUCF sector (overhead and underground phytonutrients, bark, dead wood, soil and wood products), establishment of a uniform information system of identification of cover and land use or all categories of land in the LULUCF sector as well as improvements related to the preparation of estimates in the LULUCF sector for better and easier future planning of activities in this sector.
Preparation of cost-benefit analysis of afforestation on new areas and natural regeneration of forests as a measure of increasing the sinks in the LULUCF sector	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG No. 139/13)	By analysing the costs and benefits of afforestation on new areas, possibility of increasing greenhouse gas sinks using afforestation activities on the barren productive forest floor will be investigated. This would justify the introduction of possible incentive measures, such as, for example, afforestation of fast-growing species and natural regeneration of forests, equivalent to measures for reduction in greenhouse gas emissions.

Dimension 'Energy Efficiency'

Energy efficiency in the Republic of Croatia is regulated by:

- Energy Efficiency Act (OG Nos. 127/14, 116/18),
- Building Act (OG Nos. 153/13, 20/17, 39/19),
- Act on Protection against Light Pollution (OG No. 14/19),
- by-laws that follow from these Acts.

The national targets for increasing energy efficiency by 2020 are defined in the 3rd National Energy Efficiency Action Plan (NAPEnU) 2014-2016 and revised in the 4th NAPEnU until the end of 2019. The indicative national target of increase in energy efficiency expressed as the absolute amount of final energy consumption in 2020 is **291.3 PJ (6.96 Mten)**. The corresponding target expressed as the absolute amount of primary energy in 2020 is **448.5 PJ (10.71 Mten)**. Targets expressed as the absolute amount of primary and final energy consumption are shown in Figure 1-4.

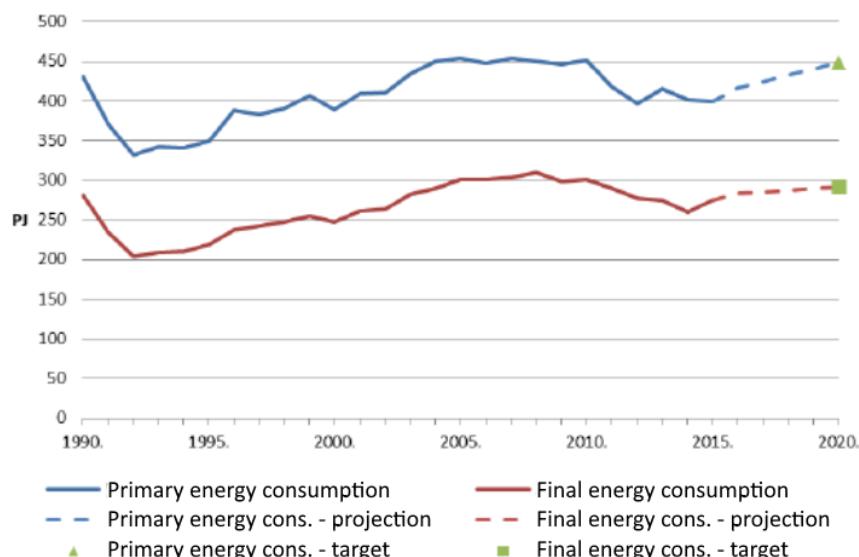


Figure 1-4. Indicative national energy efficiency targets in 2020

Source: 4th National Energy Efficiency Action Plan

An overview of the regulatory measures defined in the aforementioned laws and relevant by-laws is shown in Table 1–5. The said laws 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 25th October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC;
- Directive 2010/31/EU of the European Parliament and of the Council of 19th May 2010 on the energy performance of buildings;
- Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, and

- Regulation 2017/1369 setting a framework for energy labelling and repealing Directive 2010/30/EU;
- 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.

Table 1–5. Overview of existing regulatory measures for energy efficiency

Overview of regulatory measures for energy efficiency in the Republic of Croatia
Energy Efficiency Act
Obligation of the Government of the Republic of Croatia to adopt the National Energy Efficiency Action Plan for a three-year period with measures to be implemented on the entire territory of the Republic of Croatia
Obligation of counties and large cities (> 35,000 inhabitants) to adopt (three-year) Action Plans and annual energy efficiency plans
Obligation of the Government of the Republic of Croatia to adopt the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia and update it every three years
Energy efficiency obligation system for energy suppliers
(Ordinance on the Energy Efficiency Obligation System (OG No. 41/19))
Obligations of the supplier on measuring and calculating consumption and informing customers of past consumption, which includes a comparison with the average normal or reference end customer from the same category of end customers of the supplier (H.1 [15]; MEN-7 [1])
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 on a monthly basis and provide individual meters to end customers
Obligations of the energy regulatory authority to ensure the promotion of energy efficiency through tariffs and to provide incentives to improve efficiency in planning and operation of natural gas and electricity infrastructure
Obligations of transmission and distribution system operators to enable network access, transmission and distribution of electricity produced from highly efficient cogeneration
Obligations of large companies to carry out energy audits every 4 years or introduce an energy management system (MEN-15 [1])
(Ordinance on the Energy Audit for Large Companies (OG No. 123/15))
Obligation of the public sector to carry out energy audits of the public lighting system every 5 years and to maintain and reconstruct public lighting in such a way that it reduces electricity consumption and meets all other requirements stipulated by the Act on Protection against Light Pollution and the regulations arising therefrom
Obligation of the public sector to manage energy systematically, which implies the appointment of a responsible person for energy management, regular monitoring of energy consumption, and entry of energy consumption data in the national Information System for Energy Management (ISEM) (Ordinance on Systematic Energy Management in the Public Sector (OG Nos. 18/15, 06/16))
Obligation to record all energy efficiency activities and achieved savings in the national system for monitoring, measurement and verification of savings for the public sector, energy service providers and subsidizers
(Ordinance on the system for monitoring, measurement and verification of energy savings (OG No. 71/15))
Obligation of competent ministries and the National Coordination Body to establish and manage the energy efficiency information platform (National Energy Efficiency Portal: https://www.enu.hr/)
Obligation of labelling energy efficiency of appliances (MEN-8 [1]) (relevant EU regulations for particular groups of appliances)
Regulation of energy services (energy performance contracting) in the public sector (Regulation on contracting and implementation of energy services in the public sector OG No. 11/15))

Regulation of contracting of energy services and energy renovation of apartment buildings and determining the adoption of the decision on energy renovation on the basis of the majority of votes of co-owners calculated by co-ownership shares of the building and the number of co-owners
Obligation to use energy efficiency criteria in public procurement procedures for energy-related products (Ordinance on energy efficiency requirements for energy-related products in public procurement procedures (OG No. 70/15))
Obligation to meet eco-design requirements of energy-related products when placing them on the market (MEN-9 [1]) (Ordinance on defining eco-design requirements of energy-related products (OG No. 50/15))
Act on Protection against Light Pollution
In the process of planning, design, construction, maintenance and reconstruction of outdoor lighting approved under the law governing construction, technical solutions selected by the lighting project must ensure energy efficiency; local self-government units are obliged to adopt a lighting plan as well as an action plan for construction/reconstruction of lighting; energy efficiency criteria for lighting are laid down in an ordinance
Building Act
Energy management and heat preservation as one of the fundamental building requirements - The Technical regulation on the rational use and heat retention of buildings (OG No. 128/15, 70/18, 73/18, 86/18) stipulates the minimum energy performance for new buildings and buildings undergoing major reconstruction, the manner of determining the energy performance of the building, preparation of the study on the use of alternative energy systems, and requirements for nearly zero energy buildings.
Obligation of regular inspections of heating systems and cooling or air conditioning systems in buildings and energy certification of buildings (Ordinance on energy audit of buildings and energy certification (OG No. 88/17); Ordinance on control of energy certificates of buildings and reports on regular inspection of heating and cooling or air conditioning systems in buildings (OG No. 73/15); Ordinance on persons authorized for energy certification, energy audit of buildings and regular inspection of heating and cooling or air conditioning systems in buildings (OG No. 73/15, 133/15))
Amendments to the Building Act are currently underway to address the adoption and implementation of the new Long-Term Strategy of Renovation of the National Building Stock by 2050, promoting electromobility through the installation of infrastructure for charging electric vehicles in buildings and on parking lots adjacent to buildings, simplifying regular controls of heating and cooling or air-conditioning systems in buildings, setting up and supervising technical systems for buildings, defining requirements related to the installation of self-regulation devices, building automation and management systems, as well as changes to the system of issuing authorizations for energy certification of buildings.

In addition to regulatory measures, other energy efficiency measures are being implemented in Croatia, according to three-year national action plans. The most recent 4th National Energy Efficiency Action Plan has been prepared for the period until the end of 2019 [15]. Measures from the 4th National Energy Efficiency Action Plan which are being implemented in Croatia at the time of preparation of this Plan are shown in

Table 1–6. These are mainly measures of financial incentives by grant mechanisms or financial instruments from national sources (the Environmental Protection and Energy Efficiency Fund) and EU funds (European Regional Development Fund, ERDF), in accordance with the measures defined in the Operational Programme Competitiveness and Cohesion 2014 - 2020. (OPCC). It should be noted that these measures were also reported in the 7th National Report and the Third Biennial Report of the Republic of Croatia to the United Nations Framework Convention on Climate Change (UNFCCC). Therefore, next to the name of each measure, their references in these two documents are specified.

Measures in the building construction sector are aligned with the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia [18]. The first Long-Term Strategy was adopted in 2014 (OG No. 74/14) and amended in 2017 and adopted in early 2019 (OG No. 28/19). The Long-term Strategy includes an overview of the National Building Stock of the Republic of Croatia, an analysis of key elements of the building renovation programme, policies and measures to encourage cost-effective integral building renovation, a long-term perspective to guide individual, construction industry and financial investment decisions by 2050, and **estimates of expected energy savings and wider benefits based on calculation and model data**. Pursuant to Directive 2018/844, which will be transposed into national law through the Building Act, the Long-Term Strategy of Energy Renovation of the National Building Stock by 2050 shall be adopted every 10 years in accordance with Regulation (EU) 2018/1999. The first strategy will be adopted by 10th March 2020.

Table 1–6. Overview of existing non-regulatory energy efficiency measures by sectors of direct consumption (excluding transport).

Name of the measure	Category of measure	Short description
Households		
Promotion of integral renovation of apartment buildings (B.3 [15]; MEN-2 [1])	Financial - Grants	In the period from 2014 to 2016, the programme was financed by the funds raised in auctions and implemented through the Environmental Protection and Energy Efficiency Fund; at the end of 2016, the Ministry of Construction and Physical Planning issued a call for applications and allocated HRK 539.23 million for energy renovation of 556 buildings; it is estimated that all projects within the framework of this programme will be completed by the end of 2023. A new call for energy renovation of apartment buildings is planned for the end of 2019. The grant funds would be secured from an allocation earmarked for energy renovation of family houses.
Programme for Energy Renovation of Family Houses 2014-2020 (B.5 [14]; MEN-4 [1])	Financial - Grants	In the period from 2014 to 2016, the Programme was financed by the national funds from auctions through the Environmental Protection and Energy Efficiency Fund; the ERDF funds available under OPCC amount to HRK 200 million, but due to complex procedures, these funds are not expected to be utilized for energy renovation of family houses - the plan is to reallocate them for energy renovation of public and apartment buildings, whereas from 2019 onwards this Programme will continue to be co-financed by the funds collected from the sale of emission allowances in auctions, through the Environmental Protection and Energy Efficiency Fund (EPEEF)
Public sector		
Program for Energy Renovation of Public Sector Buildings 2014-2015 (P.1 [14])	Financial - ESCO model and grants	The programme is implemented by contracting energy services in public sector buildings by the Agency for Transactions and Brokerage in Real Property on behalf of and for the benefit of the public sector, and the Environmental Protection

		and Energy Efficiency Fund provides grants covering up to 40% of eligible costs of energy renovation.
Program for Energy Renovation of Public Sector Buildings 2016-2020 (P.2 [14]; MEN-5 [1])	Financial - Grants Affordable loans Energy service	Available ERDF funds within the OPCC amount to EUR 211 million for energy renovation of public sector buildings, and so far around HRK 1.499 billion have been awarded for energy renovation of 866 buildings; the projects within this programme are expected to be completed by the end of 2023. A FI ESIF energy efficiency loan for public buildings in the amount of HRK 190 million is also foreseen.
Systematic energy management in the public sector (P.3 [14]; MEN-6 [1])	Informative	The programme is implemented by the Agency for Transactions and Brokerage in Real Property and is based on the public sector's obligation of systematic energy management; the savings in this programme are the result of organizational and informative measures
Programme "Energy Efficient Public Lighting" (P.4 [14]; MEN-13 [1])	Financial - Affordable loans	Available ERDF funds within the OPCC amount to HRK 152 million (EUR 20 million) for energy renovation of public lighting systems; the programme is implemented through loans secured by the CBRD; the projects within this programme are expected to be completed by the end of 2023
"Green" Public Procurement (P.5 [14]; MEN-14 [1])	Voluntary agreements and cooperative instruments	Preparation and implementation of national action plans for green public procurement - the objective is that by 2020 the criteria of green public procurement are applied in at least 50% of public procurement procedures
Commercial service sector		
Increasing energy efficiency and use of RES in the commercial service sector (tourism and trade) (B.4 [14]; MEN-3 [1])	Financial - Grants Affordable loans	Available ERDF funds within the OPCC amount to HRK 300 million (EUR 40 million); around HRK 190 million have been allocated for energy renovation of 77 buildings; utilization of these funds is expected by the end of 2023
Industry		
Increasing energy efficiency and use of RES in manufacturing industries (I.2 [14]; MEN-17 [1])	Financial - Grants Affordable loans	Available ERDF funds within the OPCC amount to HRK 450 million (EUR 60 million) - the utilization of these funds is expected by the end of 2023; the implementation of the measure started with a public call of the Ministry of the Environment and Energy on the basis of which around HRK 303 million was allocated for 90 projects
CO ₂ emission tax for the non-ETS stationary sources (MEN-22 [1])	Tax	The Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon dioxide into the environment (OG 73/07, 48/09, 2/18) stipulates the obligation to pay the CO ₂ emission tax for all stationary sources emitting more than 450 tons of CO ₂ per year. The obligated parties investing in energy efficiency, renewable energy and other measures to reduce CO ₂ emissions and other greenhouse gas emissions pay a lower tax.

In addition to the above measures, the existing documents define a number of measures aimed at providing information and education, which are shown in Table 1–7.

Table 1–7. Overview of existing intersectoral measures for energy efficiency

Name of the measure	Category of measure	Short description
Programme for promotion of construction of new and renovation of existing buildings according to the nearly zero energy standard (B.2 [14]; MEN-1 [9])	Informative	This measure supports the legal obligation and implies education and informing of participants in construction projects and the general public about the standard of construction and renovation of nearly-zero energy buildings
Informative calculations (H.1 [14]; MEN-7 [9])	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 (H.2 [14]; MEN-10 [9])	Informative	Implementation of targeted promotional campaigns related mainly to programmes for co-financing energy renovation of buildings and promotion of energy services through the national energy efficiency portal
Energy efficiency education (H.4 [14]; MEN-12 [9])	Educational	Establishment of a certification system and lifelong learning of construction workers on the subject of energy efficiency
Integrated information system for monitoring energy efficiency (H.6 [14]; MCC-2 [9])	Informative - Monitoring the implementation and achieved energy savings	A comprehensive system for monitoring the implementation 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 1–8. It should be noted that the Croatian Energy Regulatory Agency (CERA), on the basis of the Energy Efficiency Act, is obliged to take into account energy efficiency in relation to its decisions on the operation of gas and electricity infrastructure when carrying out regulatory tasks in accordance with 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.

In order 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" [17]. The study has analysed measures that affect technical losses (decrease and increase), which

are covered in the ten-year development plans for the transmission and distribution system for the period from 2019 to 2028.

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 potential for increasing energy efficiency of the electricity infrastructure and determine deadlines for the introduction of advanced measures.

Table 1–8. Overview of existing energy efficiency measures for energy infrastructure

Name of the measure	Category of measure	Short description
Revitalization and energy efficiency in existing thermal and hydro power plants (E.1-E.4 [14]; MEN-23 [1])	Electricity generation	The activities within this measure are related to HEP, and are further elaborated in the 4 th National Energy Efficiency Action Plan. Activities include: reconstruction of water management systems, new steam boilers, optimization and automation of hydro power plants, revitalization of hydro power plants, reductions in own use of heat, new measurement systems, replacement of older primary equipment in power plants with higher efficiency equipment, construction of energy reservoirs (increase of reservoirs of HPPs, heat accumulators for TPPs-HPs), application of new technologies in energy transformations (electric boilers, heat pumps, solar collectors), reduction of own consumption, construction of solar plants at the locations of existing HPPs, TPPs and TPPs-HPs, etc.
Reconstruction and renovation of hot water pipelines and steam pipelines (E.7 [14]; MEN-24 [9])	Distribution of thermal energy	Aging and damaged hot water and steam pipelines result in high losses of energy. Investments in the forthcoming period are secured by utility companies and through ESI Funds within the OPCC in the amount of EUR 80 million.
electricity system management and development of the transmission grid (E.8 [14]; MEN-25 [9])	Power grids	The measure implies the optimization of the transmission grid topology and loss reduction, as well as grid capacity development by the Croatian Transmission System Operator.
Reduction of losses in the distribution power grid (E.9 [14]; MEN-25 [9])	Power grids	The measure involves the reduction of losses in the distribution grid and introduction of advanced meters for end customers by HEP-DSO. For the pilot project "Introduction of smart grids in pilot areas", EUR 20 million has been provided to HEP-DSO from ESI Funds within the OPCC.

Dimension "Energy security"

Key legislation relevant for the dimension of energy security:

- Energy Act (OG Nos. 120/12, 14/14, 102/15, 68/18),
- Electricity Market Act (OG Nos. 22/13, 102/15, 68/18),
- Gas Market Act (OG No. 18/18),
- Oil and Petroleum Products Market Act (OG Nos. 19/14, 73/17),
- Act on the Liquefied Natural Gas Terminal (OG No. 57/18),
- Act on the Regulation of Energy Activities (OG No. 120/12, 68/18),
- Act on Exploration and Exploitation of Hydrocarbons (OG Nos. 52/18, 52/19).

The most important measures currently being implemented for the purpose of ensuring energy security are shown in Table 1–9.

Table 1–9. Existing measures to ensure energy security

Name of the measure	Documents	Short description
Preparing and publishing the report on security of electricity supply	Electricity Market Act (OG 22/13, 102/15, 68/18)	The Transmission System Operator and the Distribution System Operator shall no later than 30th April of the current year publish, with prior consent of the Agency, an annual report on the security of supply in the transmission or distribution system for the previous year. Based on these reports, the Ministry prepares its own annual report on the security of electricity supply and expected electricity demand in the Republic of Croatia. On the basis of these reports, the Agency may in cooperation with the Ministry ask the transmission system operator, distribution system operator and other power operators to implement certain measures in order to improve the security of electricity supply.
Preparing and publishing the report of the transmission system operator	Gas Market Act (OG No. 18/18),	PLINACRO shall by 1st March of the current year prepare and submit to the CERA a report for the previous year, which must include a report on reliability, security 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 realization of the rights under this Act
Plan of protection of the power system from large disturbances	Electricity Market Act (OG 22/13, 102/15, 68/18)	The Croatian Transmission System Operator (hereinafter referred to as: HOPS) is responsible for the reliability and availability of the electricity supply system and proper coordination of the generation, transmission and distribution system with the responsibility for managing the power system in a way that ensures the security of electricity supply. HOPS prepares the Annual report on the security of supply of the Croatian power system, which is subject to approval by the Croatian Energy Regulatory Agency. The measures from the Plan of protection are implemented by all users of the transmission system and are obligatory for them.
Intervention plan of measures for the protection of gas supply security of the Republic of Croatia	Regulation (EU) No. 994/2010 of the European Parliament and of the Council of 20th October 2010 concerning measures to safeguard security of gas supply	The intervention plan regulates measures to ensure reliable and efficient natural gas supply, criteria and the method of determining sufficient quantities of natural gas to ensure reliable supply of natural gas to protected customers, schedule of reduction in or suspension of natural gas supply to individual categories of customers in the event of a crisis situation and the contents of the gas supplier's report on the security of natural gas supply.
Building and holding compulsory stocks of oil and petroleum products	Oil and Petroleum Products Market Act (OG Nos. 19/14, 73/17)	The Croatian Hydrocarbon Agency as the Central Authority of the Republic of Croatia for compulsory stocks of oil and petroleum products is obliged to hold stocks in the quantity of at least 90 days of average daily net import or 61 days of average daily domestic consumption of petroleum products in the previous calendar year, whichever is higher. Compulsory stocks of oil and petroleum products are built in order to secure supply of oil and petroleum products in the event of a threat to national energy security, due to extraordinary supply disruptions in the oil and petroleum products market.

Dimension of "the Internal Energy Market"

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

- Energy Act (OG Nos. 120/12, 14/14, 102/15, 68/18),
- Electricity Market Act (OG Nos. 22/13, 95/15, 102/15, 68/18),
- Gas Market Act (OG No. 18/18),
- Oil and Petroleum Products Market Act (OG Nos. 19/14, 73/17),
- Act on the Regulation of Energy Activities (OG No. 120/12, 68/18),
- Act on Exploration and Exploitation of Hydrocarbons (OG Nos. 52/18, 52/19).

With regard to 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 already meets and exceeds that target many times over. The same applies if the existing electricity interconnection capacity is compared with the peak load of the system or the installed power of RES in the territory of the Republic of Croatia.

The most important measures regarding the energy transmission infrastructure are shown in Table 1–10.

Table 1–10. 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 (OG Nos. 22/13, 102/15, 68/18)	The Croatian Transmission System Operator (HOPS) is the energy operator responsible for the management, operation, maintenance, development and construction of the electricity transmission grid. Pursuant to the Electricity Market Act, HOPS is the owner of the transmission grid 110 kV to 400 kV, and is obliged to prepare and adopt, with the prior CERA consent, ten-year, three-year and one-year investment plans for the development of the transmission grid
Preparation and implementation of power distribution grid development plans	Electricity Market Act (OG Nos. 22/13, 102/15, 68/18)	Pursuant to the Electricity Market Act and the Distribution System Grid Code, the methodology and criteria for planning the distribution grid development are stipulated.
Preparation and implementation of gas transport system development plans	Gas Market Act (OG No. 18/18)	The transport system operator is obliged to prepare a ten-year transport system development plan and to manage, maintain and develop a safe, reliable and efficient transport system, in accordance with the ten-year development plan.

The level of capacity reserve in the production part of the electric power system, in Croatia and in the neighbouring systems with which the Croatian power system is interconnected, enables

safe and reliable system operation. The current power system capacity is at a satisfactory level, with potential threats due to the lack of available domestic production capacity, which are currently compensated by high levels of cross-border exchanges, which makes the capacity and security of electricity supply dependent on the availability of cross-border transmission capacity and possibility of power generation in broader regional markets.

Flexibility can be defined as a change in the production pattern or power consumption due to a response to stimulus (price signal or activation) in order to provide ancillary services to the power system, most commonly to the system operator. A market research pilot project is currently underway with regard to ensuring active capacity reserve of tertiary control through manageable consumption for the needs of HOPS. Within the framework of this project, by entering into a contractual relationship with HOPS for the provision of ancillary services of ensuring active capacity reserve of tertiary control, the end customer participates directly in the system balancing mechanism and receives a 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 services and services of flexibility that distribution grid users provide to the distribution system operator are not currently used in the Republic of Croatia. The Distribution System Grid Code that came into effect in 2018 (OG No. 74/18) regulates new services that could be of use 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 (OG Nos. 100/15, 123/16, 131/17, 111/18). It consists of electricity producers and other entities performing the activity of electricity generation, which are entitled to incentive pricing in accordance with the agreements on the purchase of electricity with the Croatian Energy Market Operator (CEMO).

Pursuant to the Renewable Energy Sources and High Efficiency Cogeneration Act, 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 members of the ECO balance group in the electricity market in a transparent and impartial manner.

With regard to consumer protection, competitiveness and development of the retail electricity market, one of the key indicators is the rate of supplier switching by end customers. The rate of supplier switching by end customers in the entrepreneurship category 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 regularly issue tenders for selection of the most favourable electricity supplier.

The Herfindahl-Hirschman Index (HHI) for measuring points from the household and entrepreneurship category in the Republic of Croatia is currently higher than 2,000, which means that the concentration on the retail electricity market (from the shares of individual suppliers) is satisfactory according to the assessment of the European Commission.

The basic prerequisite for enabling and developing energy management is the introduction of an advanced measurement system.

Measures in the area of consumer protection are shown in Table 1–11.

Table 1–11. Existing consumer protection measures

Name of the measure	Documents	Short description
Informative calculations	Energy Efficiency Act (OG Nos. 127/14, 116/18)	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
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) on a monthly basis and provide individual meters to end customers	Energy Efficiency Act (OG Nos. 127/14, 116/18)	Energy distributors ensure that, to the extent technically feasible, financially justified and proportional to potential energy savings, individual meters are provided to energy and hot water end customers in households at competitive prices that accurately reflect the actual energy consumption of end customers.

Existing measures to alleviate energy poverty are shown in Table 1-12.

Table 1-12 Existing measures to alleviate 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 (OG No. 95/15)	Electricity customers from the household category pay an additional charge on the electricity price. The supplier charges it to the customers in accordance with the end-customer supply agreement and pays the collected funds to the state budget. These funds are used for financing vouchers in the amount of HRK 200.00 for vulnerable customers.
Capacity building for eliminating energy poverty (H.3 [14])	4th National Energy Efficiency Action Plan	In 15 cities with more than 30,000 residents, consulting mechanisms for vulnerable customers will be established and energy efficiency measures in households at risk of energy poverty will be implemented.
Programme for elimination of energy poverty (H.5 [14])	4th National Energy Efficiency Action Plan	Planning and launching a systematic programme to combat energy poverty through implementation of energy efficiency measures. The Program will define a list of available measures and co-financing rates for individual measures.

Dimension "Research, Innovation and Competitiveness"

The most important national documents pertaining to the dimension "Research, Innovation and Competitiveness" are:

- Education, Science and Technology Strategy of the Republic of Croatia (2014),
- Smart Specialization Strategy of the Republic of Croatia for the period from 2016 to 2020,
- Innovation Promotion Strategy of the Republic of Croatia 2014-2020 and
- Research Infrastructure Development Plan in the Republic of Croatia (2016).

In order to define the scope of work, work methods, funding sources and the institutional framework in the field of research and innovation, clear and comprehensive legal regulations are required. National legislation transposes all relevant regulations, directives and other EU legal acts to ensure that the legal framework of the Republic of Croatia complies with the basic operational principles of other EU Member States. The legal framework encompasses legal acts related to research and innovation in general and specific legal regulations governing the area of energy and climate.

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

- Act on Investment Promotion and Improvement of Investment Climate (OG Nos. 111/12, 28/13),
- Act on State Aid for Research and Development Projects (OG No. 64/18)
- Public Procurement Act (OG No. 120/16) and
- Small Business Development Promotion Act (OG Nos. 29/02, 63/07, 53/12, 56/13, 121/16).

The Act on Investment Promotion and Improvement of Investment Climate regulates the promotion of investments and improvement of the investment climate in the Republic of Croatia, as well as other related issues. The objective of the Act is to stimulate economic growth and implement the economic policy of the Republic of Croatia, to include it in international trade and to strengthen the investment and competitive capacity of Croatian entrepreneurship.

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 competences of the bodies of the Republic of Croatia with regard to 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 organizations for research and dissemination of knowledge in research and development projects, whereby research and development includes creative and systematic work undertaken for the purpose of increasing

knowledge - including knowledge of humanity, culture and society - and developing new applications of existing knowledge. Research and development activities must include five basic criteria: **new knowledge** (as the objective of 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 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, provided that they are consistent with performance levels and maximum costs agreed between the public contracting authority and participants. This instrument stimulates innovations that affect demand for innovation, while grants to enterprises affect the supply of innovation.

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

In addition to the said acts, the area of research, development and innovation is regulated in more detail by various ordinances and guidelines.

Efficient infrastructure is required to conduct research and development. It encompasses primarily public and private institutions that facilitate the implementation of these activities, followed by R&D segments in the private sector and additionally individual communication channels. These channels mutually connect individual institutions and research and development institutions with the real sector which enables commercialization and actual use of innovations and patents.

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 and Education and the Ministry of Economy, Entrepreneurship and Crafts, which propose specific legal measures and incentives and are responsible for the implementation of stipulated measures. In addition, the Ministry of Regional Development and EU Funds provides support in the use of EU funds for research, development and innovation through various structural and investment funds and programmes. The Ministry of the Environment and Energy, through funds from auctions within the system of emissions trading, supports research and development in the area of mitigation of and adaptation to climate change. The institution that supports scientific, higher education and technology programmes is the Croatian Science Foundation, for the purposes of development of science, higher education and technological development in the Republic of Croatia, with the ultimate goal of ensuring social and economic development and promoting employment.

The most significant business entity in charge of providing support for research, development and innovation projects is the Croatian Agency for Small Business, Innovation and Investment

(HAMAG-BICRO) which provides support to entrepreneurs during all developmental phases of business ventures - from idea research and development to commercialization and placement on the market. Additional support to research, development and innovation is provided by the Croatian Chamber of Economy, which established the Innovation Council for Industry, the Croatian Chamber of Trades and Crafts and the Croatian Employers' Association. It is also important to mention the Agency for Mobility and EU Programmes (AMPEU), which has been implementing EU lifelong learning programmes since 2009 and is currently the national contact point for Horizon 2020.

In order to stimulate the development and growth of the Croatian economy, the Government of the Republic of Croatia has decided to group all public, private and science and research representatives in innovative sectors, with the aim of strengthening the competitiveness of Croatian companies, and consequently the Croatian economy and society. **Competitiveness clusters** in the Republic of Croatia are designed as non-profit organizations that bring together the best businesspeople in a particular sector - small, medium and large entrepreneurs, representatives of regional and local self-government and science and research institutions, in order to create synergy and establish cooperation with the aim of strengthening the competitiveness of economic sectors at the national level. So far 13 competitiveness clusters have been established.

iii. Key issues of cross-border relevance

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 structure of implementing national energy and climate policies

The umbrella institution for the implementation of national energy and climate policies is the Ministry of the Environment and Energy, its Energy Directorate and Directorate for climate, sustainable development and air, soil and light pollution protection, and the Institute for the Protection of the Environment and Nature.

The preparation and management of the GHG inventory in Croatia is the responsibility of the Ministry of the Environment and Energy (MEE), the national contact point under the UN Framework Convention on Climate Change (UNFCCC). The Institute for the Protection of the Environment and Nature within the MEE 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 and reporting on authorized legal entities participating in the flexible mechanisms of the Kyoto Protocol, selecting the authorized persons to prepare the inventory of greenhouse gases and ensuring access to data and documents for the purpose of technical inspections of the inventory. In addition, the Institute for the Protection of the

Environment and Nature plays an important role in the administration of user accounts of Croatian participants in the EU Emissions Trading System (EU ETS).

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

In addition to the Ministry of the Environment and Energy, the Ministry of Construction and Physical Planning also has an important role in the implementation of national energy and climate policies and is responsible for creating policies and measures to achieve the set energy savings targets in buildings. The Ministry of Construction and Physical Planning prepares laws and regulations, strategies and programmes in connection to long-term integral renovation of buildings: family houses, apartment buildings, commercial non-residential buildings and public sector buildings. The Ministry also performs activities as a Level 1 Intermediate Body for the use of ESI funds within the OPCC.

The Ministry of the Sea, Transport and Infrastructure is responsible for national policy, action plans and strategies related to the development of infrastructure to encourage the use of 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 of measures defined in the national energy and climate plans, and acts as an intermediate body level 2 for the use of ESI funds under the Operational Programme Competitiveness and Cohesion 2014 - 2020, in parts relevant to energy and climate. The EPEEF also allocates the funds collected from emissions through auctions in the EU market according to the Plan for the use of funds acquired from the sale of emission allowances through auctions in the Republic of Croatia for the period from 2017 to 2020 (OG No. 19/18). 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 important role in the implementation of the energy renovation programme for public sector building on the energy service model and systematic energy management in the public sector, all in accordance with the powers defined by the Energy Efficiency Act (OG Nos. 127/14, 116/18).

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

The Croatian Hydrocarbon Agency provides operational support to competent bodies in activities of hydrocarbon exploration and exploitation, geothermal waters for energy purposes,

underground storage of natural gas, as well as in permanent disposal of gases in geological structures and activities for ensuring compulsory stocks of oil and petroleum products.

The Croatian Energy Market Operator (HROTE) 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 the system of incentives for electricity production from renewable energy sources and cogeneration, which involves collecting compensation from suppliers and calculating and allocating funds on the basis of concluded contracts with eligible producers entitled to an incentive price.

The transmission/distribution system operators (HOPS/HEP-ODS) are responsible for transmission and distribution of electricity within the grid, the gas transmission network operator is PLINACRO d.o.o., whereas the oil storage system operator (JANAF) has the role of transport and storage of oil and petroleum products.

It should also be noted that energy suppliers are the stakeholders that will play a key role in achieving the targets of energy efficiency policy in the future. As from 2019 suppliers will be required to achieve energy savings by investing in and stimulating energy efficiency improvements by end customers or by payments to the EPEEF.

1.3 Consultations and involvement of national and Union entities and their outcome

i. Involvement 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.

ii. Involvement of local and regional authorities

Local and regional bodies participated in the preparation of the Draft of the National Integrated Energy and Climate Plan, but also in the preparation of 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 in the process of preparation of the Draft of the National Integrated Energy and Climate Plan held in November and December 2018. The second round of workshops was organized upon the completion of 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.

iii. Consultations of stakeholders, including the social partners, and engagement 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 related to the preparation of the draft and completion of the final version of the National Integrated Energy and Climate Plan. The first round of workshops related to the preparation of the draft was organized in November 2018. The second round of workshops related to the preparation of the final version of the plan 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 during December 2018, when 90 comments were received. The revised draft of the plan was submitted for e-consultation in October 2019.

iv. Consultations of 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 MEE 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 direct presentation of the draft and the final version of the plan. 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 meeting of the Technical Working Group on Energy and Climate held on 9th October 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.

Also, 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 aim of the workshop was to identify possible areas for cross-border and regional cooperation. Results of regional cooperation are presented in chapter **1.4 Regional cooperation in the preparation of the plan**.

v. Iterative process with the Commission

Representatives of the MEE 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 the evaluation of impact of measures and for the dimension 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 draft of the national integrated energy and climate plan at the end of June 2019⁶.

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.

⁶ https://ec.europa.eu/energy/sites/ener/files/documents/hr_rec_en.pdf

1.4 Regional cooperation in preparing of the plan

i. Elements 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,
- 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 held 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 of the topics subject to joint or coordinated planning with other Member States are already being addressed at EU level. This primarily includes the integration of the energy market and the implementation of 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 of particular importance 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 also important in the implementation of projects and exchange of 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 of these topics must serve to strengthen joint activities in the future, which should be primarily promoted through regional workshops that would present examples of good practice and serve as meeting points for particular 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 of how regional cooperation is being considered in the plan

In order to establish regional cooperation on finalization and subsequent implementation of the plan, the first regional workshop organized by the Ministry of Infrastructure of the Republic of Slovenia was held in Ljubljana in July 2019. 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 a particularly good cooperation with the Republic of Slovenia and Hungary, in terms of establishment of 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 of the cooperation between transmission system operators. It is particularly important 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 issues such as hydrogen, battery development, and CO₂ capture and storage as particularly important, with the willingness to extend cooperation to other areas in the future. The establishment of 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 completion of the National Integrated Energy and Climate Plan, the Republic of Croatia will make available to all EU Member States the text of the plan in Croatian and English and will be available for consultations on the contents of the document. This will further foster regional cooperation with already identified Member States and other interested Member States.

2. NATIONAL OBJECTIVES AND TARGETS

2.1 Dimension decarbonisation

2.1.1 GHG emissions and removals

i. The elements set out in point (a)(1) of Article 4

The European Union ratified the Paris Agreement and committed itself to reducing greenhouse gas emissions by at least 40% by 2030 compared to 1990 emissions. Croatia ratified the Paris Agreement in May 2017 and shares the common EU goal. This common EU objective is divided into two units, of which the first includes large sources of greenhouse gas emissions that are obligated parties of the European Emissions Trading System (ETS sector), and the second for non-ETS sectors, including other relatively smaller emission sources, such as: road and off-road transport (excluding air transport included in the ETS sector), small energy and industrial facilities not included in the ETS sector, households, services, agriculture, waste management, changes in land use and forestry.

The Republic of Croatia has set the following targets for reducing greenhouse gas emissions by 2030:

- in the ETS sector: at least 43% compared to the 2005 level⁷,
- for non-ETS sectors: at least 7% compared to the 2005 level.

The reduction in emissions for the ETS sector is at least 43% by 2030 compared to 2005, with an annual reduction of the total EU quota of 2.2% for the period from 2021 to 2030 as defined by Directive (EU) 2018/410 (the target for Croatia is indicative, and binding on the level of the EU ETS). For the non-ETS sectors, a common target of at least 30% reduction in emissions by 2030 compared to 2005 (Regulation (EU) 2018/842) has been set, and the commitments ranged from -40 to 0% for different EU Member States (-7% for Croatia). In accordance with Article 8, paragraph 3 of Regulation (EU) 2018/841 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, the Republic of Croatia, like all other Member States of the European Union, had an obligation to develop a National Forestry Accounting Plan (NFAP) for the period from 2021 to 2025, which was submitted to the European Commission on 31st December 2018. The mentioned plan also proposes the Forest Reference Level (FRL) for the Republic of Croatia. An NFAP review is currently underway and is carried out by a group of experts for the sector of Land Use, Land Use Change and Forestry (Land Use, Land Use Change and Forestry Expert Group, LULUCFEG), which were appointed by Member States and which

⁷ The target for Croatia is indicative, and binding on the level of the EU ETS

includes an expert from the Republic of Croatia. The domain of greenhouse gas removal from the forestry sector will be addressed subsequently.

In addition, Croatia joins the EU in its efforts to contribute to other international goals, in particular the UN Sustainable Development Agenda, which defines 17 Sustainable Development Goals⁸ and the new Urban Agenda for the EU⁹.

ii. Where applicable, other national objectives and targets consistent with the Paris Agreement and the existing long-term strategies. Where applicable for the contribution to the overall Union commitment of reducing the GHG emissions, other objectives and targets, including sector targets and adaptation goals, if available

National targets for climate change adaptation

Adaptation measures that contribute to the decarbonisation dimension are elaborated in the Draft of the Strategy on Climate Change Adaptation in the Republic of Croatia for the period until 2040 with an outlook to 2070 with an action Plan [4]. The Draft of the Strategy has undergone consultations with the competent bodies and institutions and with the interested public and will be submitted to the Croatian Parliament for adoption.

The vision of the Draft of the Adaptation Strategy is "Republic of Croatia resilient to climate change", on the basis of which the following goals have been set:

- to reduce the vulnerability of natural systems and society to the negative impacts of climate change,
- to increase the ability to recover from the effects of climate change,
- to exploit the potential positive effects that may also be due to climate change.

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.

When it comes to the environmental and climate ambition of the Common Agricultural Policy, it is important to highlight the contribution already made by the agricultural sector and the positive solutions implemented at the national and EU level, such as the introduction of good agricultural practices, improving agro-technology, stimulating innovation in the sector, increasing the level of cooperation between scientific and research institutions, legislators, and manufacturers.

⁸ https://ec.europa.eu/environment/sustainable-development/index_en.htm

⁹ <https://ec.europa.eu/futurium/en/urban-agenda>

Climate change impacts on security of energy supply and adaptation measures are outlined in Chapters 2.3 and 3.3, which address the national targets for the energy security dimension and the measures needed to achieve them.

2.1.2 Renewable energy

i. The elements set out in point (a)(2) of Article 4

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

Table 2–1. Indicative national targets for RES shares by 2030

RES share, %	Estimates 2020	Targets 2030
In the gross direct consumption of energy	28.6	36.4
In the gross direct consumption of electricity	47.0	63.8
In the gross direct consumption of energy for heating and cooling	33.3	36.6
In the direct consumption of energy in transport	5.2	13.2

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

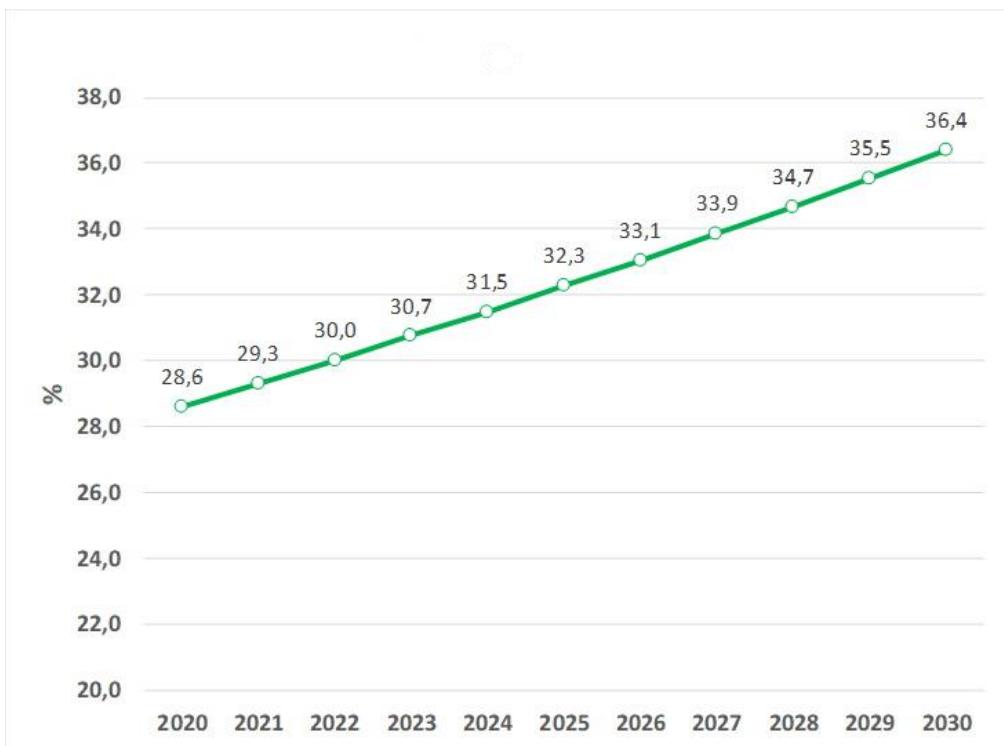


Figure 2-1. Indicative trajectory of RES shares in the gross final consumption of energy

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

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

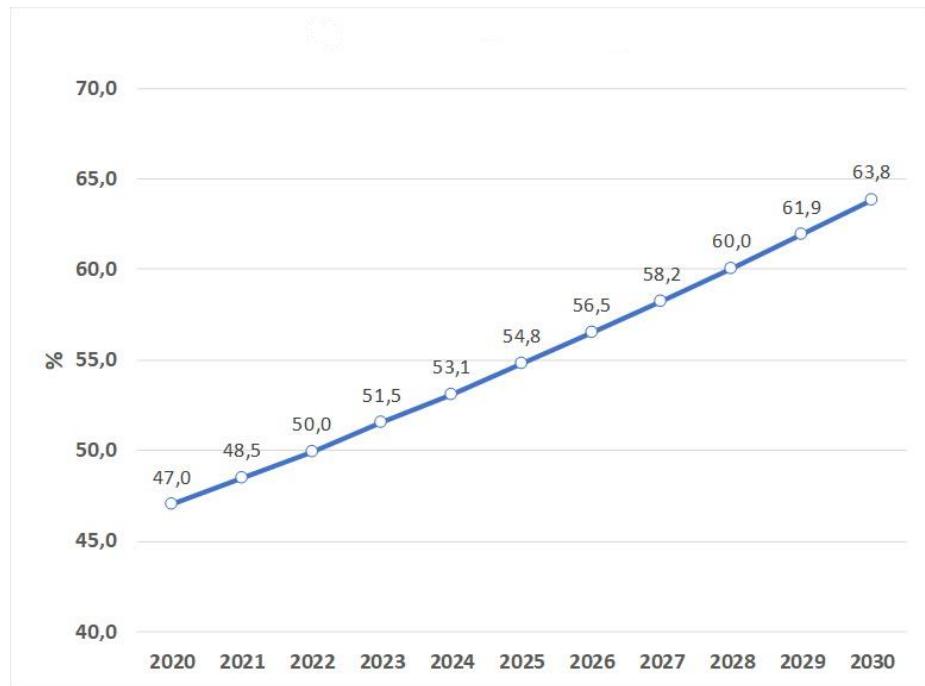


Figure 2-2. Indicative trajectories of RES share in electricity

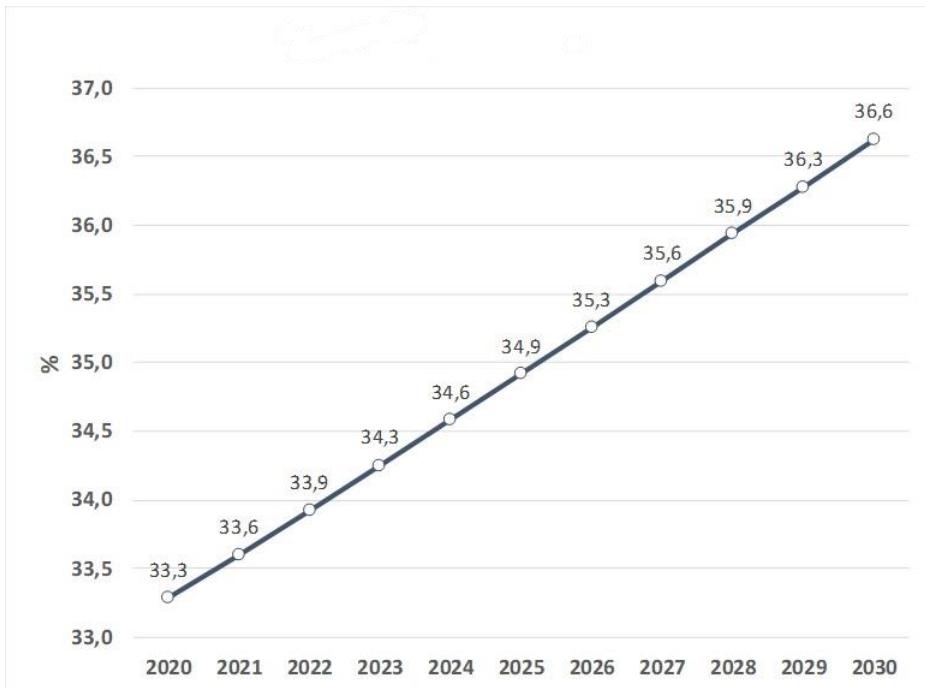


Figure 2-3. Indicative trajectories of RES share in heating and cooling

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.

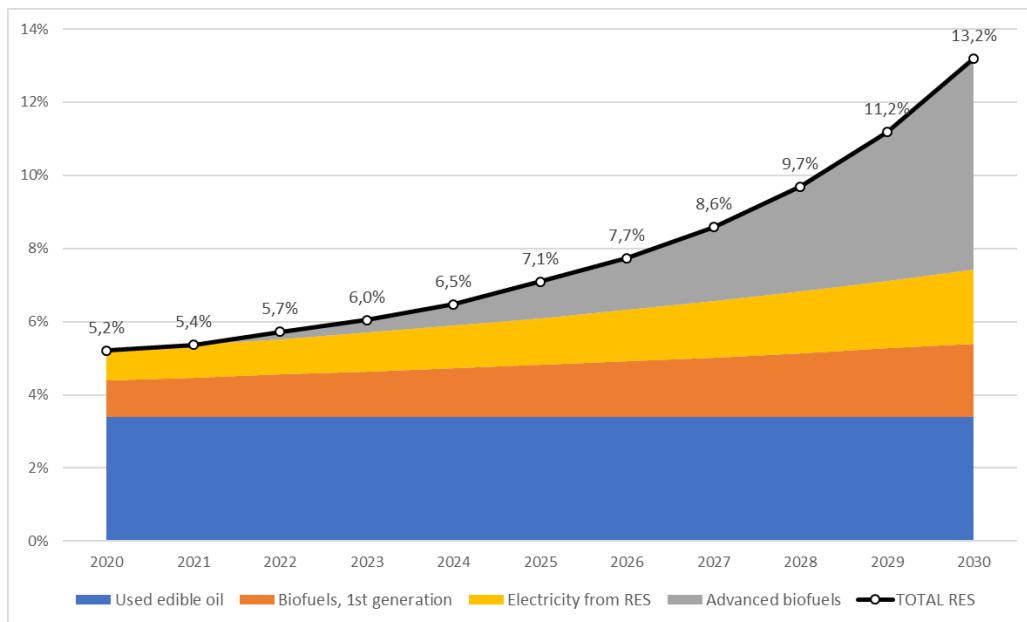


Figure 2-4. Indicative trajectories of RES share in transport

With regard to RES share in transport, the figure shows shares of electricity from RES, biofuels I and advanced biofuels and biogas produced from the feedstocks listed in Annex IX, Part A of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources and waste cooking oil. It should be noted that the estimated contributions are the result of 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 direct consumption in transport, and the contributions of individual technologies can be expected to be higher or lower than presented here.

iii. Estimated trajectories by renewable energy technology that the Member State projects to use to achieve the overall and sectoral trajectories for renewable energy from 2021 to 2030, including expected total gross final energy consumption per technology and sector in Mtoe and total planned installed capacity (divided by new capacity and repowering) per technology and sector in MW

Estimated contributions of renewable energy technologies are shown in Figure 2-5., and Tables 2-2. to 2-5.

Table 2–2. Estimated contribution of RES technologies to gross final consumption

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gross final RES consumption	2014,6	2073,0	2131,4	2189,8	2248,2	2306,6	2365,0	2423,3	2481,7	2540,1	2598,5
Solar energy	19,5	20,9	22,3	23,8	25,2	26,7	28,1	29,5	31,0	32,4	33,8
Solid biofuels	1107,4	1114,1	1120,9	1127,7	1134,4	1141,2	1148,0	1154,7	1161,5	1168,3	1175,0
Gaseous biofuels	0,0	0,2	0,3	0,5	0,7	0,8	1,0	1,2	1,3	1,5	1,7
Liquid biofuels	56,9	64,3	71,7	79,2	86,6	94,0	101,4	108,8	116,2	123,6	131,0
Geothermal energy	9,4	12,2	15,0	17,9	20,7	23,5	26,3	29,2	32,0	34,8	37,6
Thermal energy from RES	45,5	50,6	55,7	60,8	65,9	71,0	76,1	81,2	86,3	91,4	96,5
Electricity from RES	776,0	810,7	845,4	880,1	914,7	949,4	984,1	1018,8	1053,5	1088,1	1122,8

Table 2–3. Estimated contribution of RES technologies in electricity

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final RES-e	776,0	810,7	845,4	880,1	914,7	949,4	984,1	1018,8	1053,5	1088,1	1122,8
HPP	566,2	571,0	575,8	580,6	585,5	590,3	595,1	599,9	604,7	609,5	614,3
WPP	148,1	163,8	179,5	195,2	210,9	226,6	242,3	258,0	273,7	289,4	305,1
PV	11,5	19,1	26,6	34,2	41,8	49,3	56,9	64,4	72,0	79,6	87,1
GE	6,5	7,0	7,4	7,9	8,3	8,8	9,2	9,7	10,2	10,6	11,1
TPP - solid and gaseous biofuels	43,7	49,8	56,0	62,1	68,3	74,4	80,6	86,7	92,9	99,0	105,2

Table 2–4. Estimated contribution of RES technologies in heating and cooling

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final RES-h&c	1181,7	1197,8	1214,0	1230,1	1246,2	1262,3	1278,5	1294,6	1310,7	1326,9	1343,0
Solar energy	19,5	20,9	22,3	23,8	25,2	26,7	28,1	29,5	31,0	32,4	33,8
Solid biomass	1107,4	1114,1	1120,9	1127,7	1134,4	1141,2	1148,0	1154,7	1161,5	1168,3	1175,0
Geothermal energy	9,4	12,2	15,0	17,9	20,7	23,5	26,3	29,2	32,0	34,8	37,6
Thermal RES	45,5	50,6	55,7	60,8	65,9	71,0	76,1	81,2	86,3	91,4	96,5

Table 2–5. Estimated contribution of RES technologies in transport

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final RES-t	68,4	70,9	74,5	78,6	83,9	91,1	98,5	107,7	119,6	135,2	156,0
Biofuels	56,9	58,3	60,6	63,6	67,8	73,8	79,9	88,0	98,7	113,1	132,7
Electricity from RES	11,4	12,6	13,8	15,0	16,2	17,4	18,6	19,7	20,9	22,1	23,3

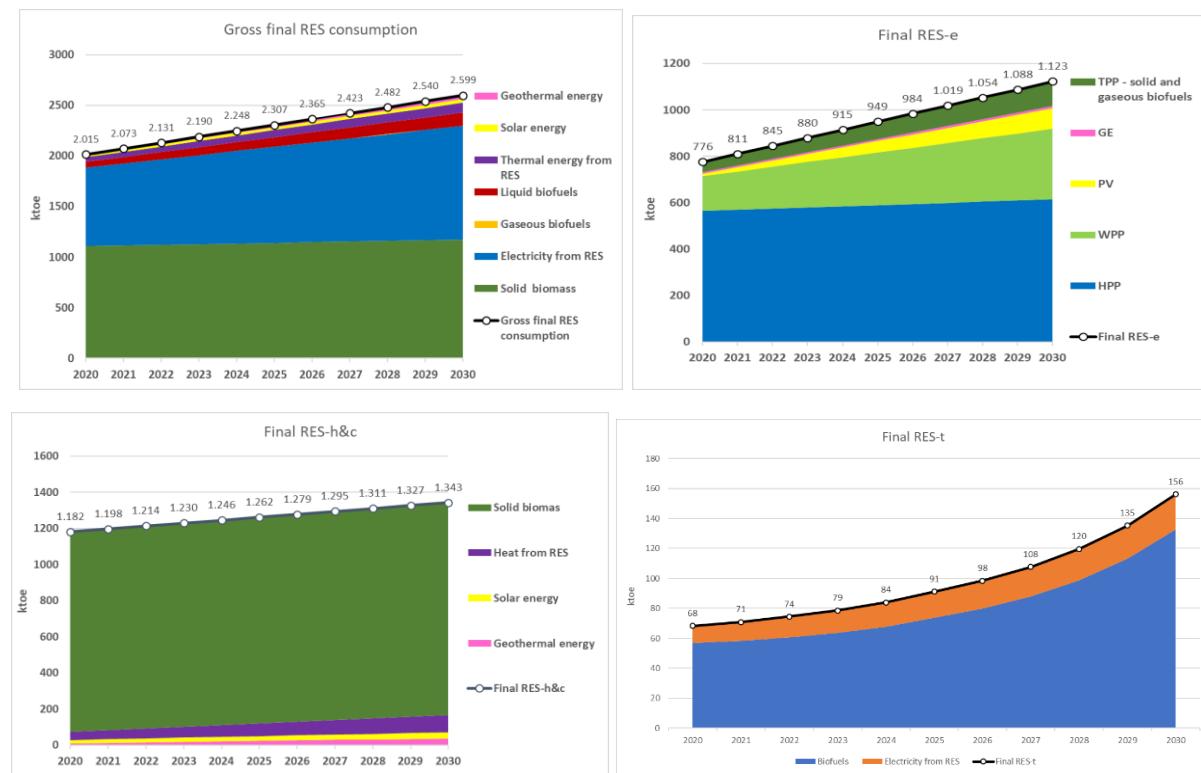


Figure 2–5. Estimated contributions of RES technologies by sectors

Expected electricity generation capacity structure is shown in Table 2–6 and in Figure 3.3¹⁰.

Table 2–6. Expected power plants capacities

MW	Hydro	Gas ¹¹	Fuel oil ¹²	Coal	Nuclear	Biomass	Geothermal	Wind	Sun	Total
2020	2,125	997	303	192	348	154	10	734	96	4,959
2021	2,125	997	303	192	348	171	10	769	134	5,049
2022	2,125	997	303	192	348	170	10	804	174	5,122
2023	2,125	1,147	303	192	348	166	10	839	215	5,345
2024	2,158	1,147	303	192	348	161	10	874	266	5,459
2025	2,158	1,147	303	192	348	156	17	909	316	5,546
2026	2,536	899	0	192	348	156	17	962	369	5,478
2027	2,536	899	0	192	348	155	17	1,014	421	5,582
2028	2,686	1,199	0	192	348	151	17	1,084	474	6,150
2029	2,686	1,199	0	192	348	151	17	1,154	526	6,273
2030	2,686	1,048	0	192	348	148	17	1,364	768	6,570

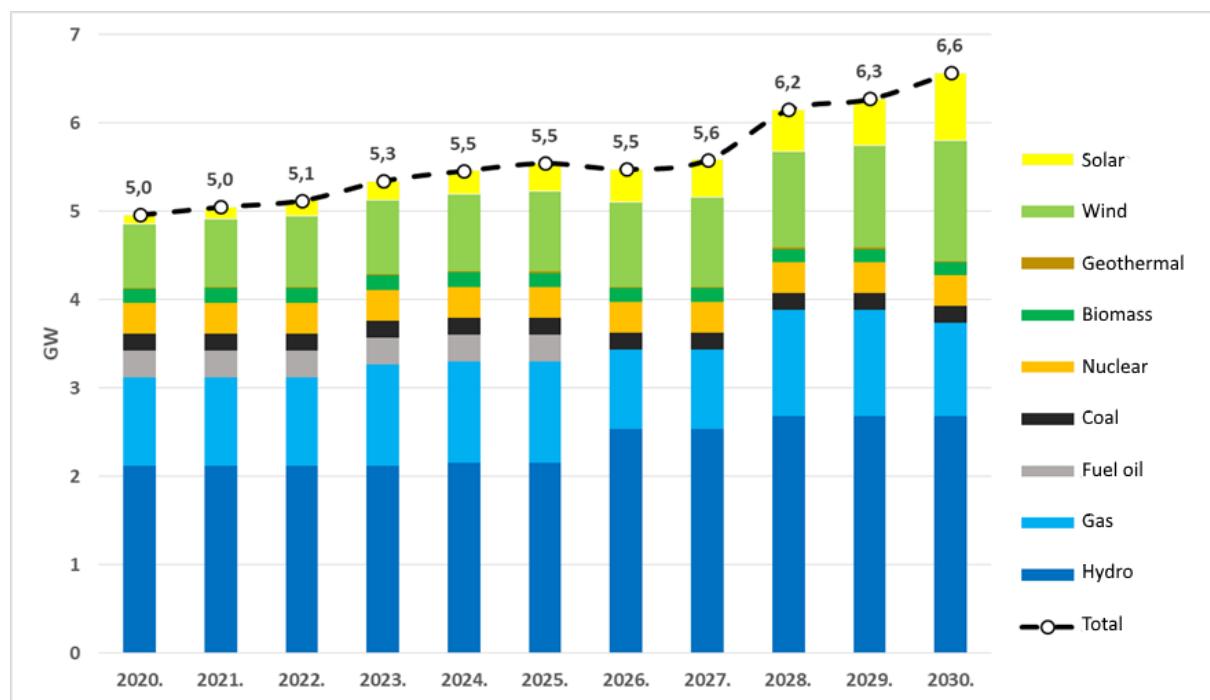


Figure 2-6 Expected power plants capacities

The total capacity of hydropower plants in Croatia is approximately 2,200 MW¹³. Of these, 9 are accumulation power plants with a total capacity of 1,509 MW, 7 are run-of-the-river hydropower plants with a total capacity of 407 MW, 36 are small hydropower plants with a total

¹⁰ Targets are indicative - discrepancies between individual RES technologies are expected

¹¹ By 2030, at least 50% of the installed capacity is foreseen in cogeneration power plants.

¹² Not available and not planned for use

¹³ one aggregate at HPP Dubrovnik (126 MW) is directly connected to the transmission grid of the BiH electricity system

capacity of 45 MW and one is a pumped-storage hydropower plant with a capacity of 276 MW in turbine operation and 240 MW in generator operation.

By 2030, the construction of two to three large hydropower plants, several small hydropower plants (on watercourses and water supply systems) and one pumped-storage hydropower plant is expected. Revitalization of existing plants is expected to extend their life cycle with a slight increase in the power of hydropower plants.

It should be noted that the estimated installed capacities are the result of 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 direct consumption, and the installed capacity in some technologies can be expected to be higher or lower than estimated.

iv. Estimated trajectories on bioenergy demand, disaggregated between heat, electricity and transport, and on biomass supply by feedstocks and origin (distinguishing between domestic production and imports). For forest biomass, an assessment of its source and impact on the LULUCF sink

The estimated trajectory of demand for biomass energy broken down into heat and electricity and transport is shown in Figure 2-7.

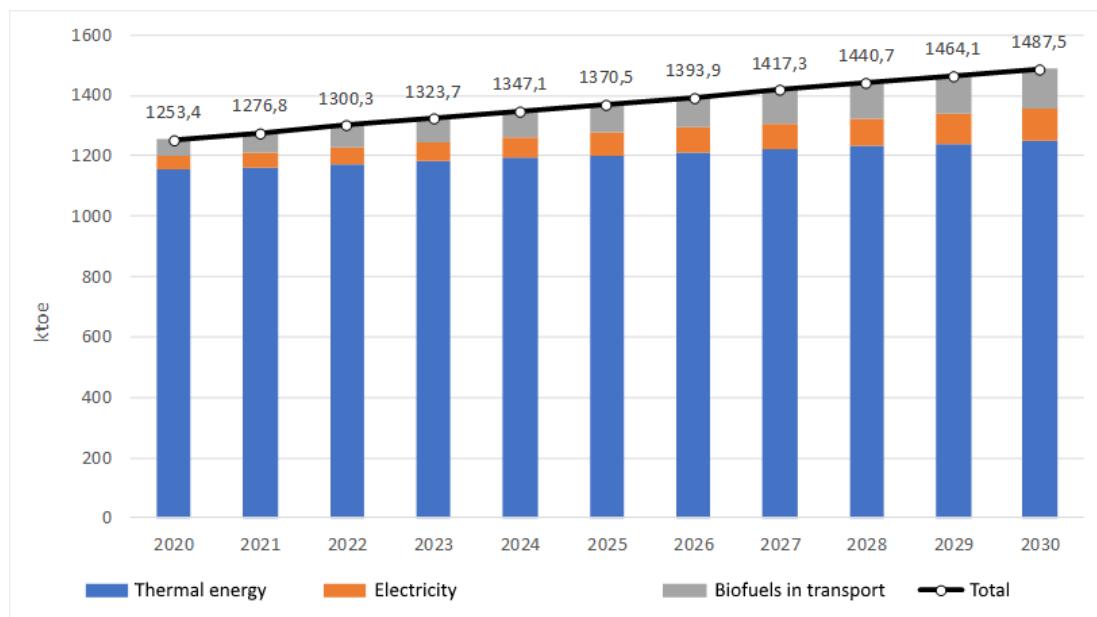


Figure 2-7 Estimated trajectory of demand for biomass energy

A study "Analysis of all data and the existing biomass balance and opinions for their improvement" is currently being developed, within the framework of which a detailed analysis of biomass consumption and origin is being carried out. The focus of the analysis is the production and use of biomass for energy generation. The results are expected at the end of 2019.

v. Where applicable, other national trajectories and objectives, including those that are long term or sectoral (e.g. share of renewable energy in district heating, renewable energy use in buildings, renewable energy produced by cities, renewable energy communities and renewables self-consumers, energy recovered from the sludge acquired through the treatment of wastewater)

Under the new Directive on the promotion of the use of energy from renewable sources 2018/2001 of 11th December 2018, 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.

Focusing on the sector of district heating and cooling, an increase in RES share is required at the level of 1.0 percentage points per year in the period 2021-2025 and in 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 heat production in cogeneration is more than 60%. As the estimated share of cogeneration in Croatian district heating and cooling systems is 79%, Croatia fulfils the requirement referred to in Article 24 of the Directive on the promotion of the use of energy from renewable sources.

Also, the increase in energy efficiency in district heating and cooling systems is already being implemented in the period until 2020 as part of the State Aid Programme for increasing the efficiency of district heating systems, and 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 relative 4% points on the national level by the end of 2023, and 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 ESI funds, will continue in the period until 2030.

In terms of electricity generation for own needs, the largest contribution is expected from photovoltaic systems integrated in buildings. According to estimates, the installed capacity of such systems is expected to be around 300 MW in 2030.

In the context of the low carbon transition, it will be particularly important to take into account a fair energy transition as well as 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. At the heart of these efforts is the Declaration on Clean Energy for EU Islands, which recognized the importance of European islands in the decarbonization of the economy

and the role they could play under the Paris Agreement. Croatia, as a signatory to this document, focused on the process of decarbonisation on islands.

Croatia has taken a role in exploring options to continue working on the Declaration during the EU Presidency in the first half of 2020. The main objective will be precisely defining the needs related to the energy transition and the transition to clean energy, taking into account that self-supply is promoted on the islands (both for individuals and larger 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 additionally promoted on islands, including shipping lines which will enable better connectivity between islands and land while reducing CO₂ emissions related to ship transport.

Therefore, it is important that the measures proposed in the plan specifically address the islands and the needs that the islands have in terms of electricity generation, energy efficiency and decarbonisation. This is extremely important because it encourages self-supply and the creation of renewable energy and energy communities in areas that are geographically separated from the rest of the country, while also solving 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 special emphasis on the islands, additional sources of financing need to be found for the purposes of 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, taking into account the people living there.

2.2 Dimension energy efficiency

i. The elements set out in point (b) of Article 4

Indicative national target of increase in energy efficiency by 2030 according to Article 3 of Directive 2012/27/EU [revised Directive]

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

Table 2-7: Indicative national energy efficiency targets in 2030

Targets 2030	PJ	Mten
Primary energy consumption¹⁴	344.38	8.23
Final energy consumption	286.91	6.85

Source: Analyses and backgrounds for preparation of the Energy Strategy of the Republic of Croatia

Figure 2-8. shows energy consumption trends by years in the period from 2020 to 2030.

¹⁴ total energy consumption without non-energy consumption

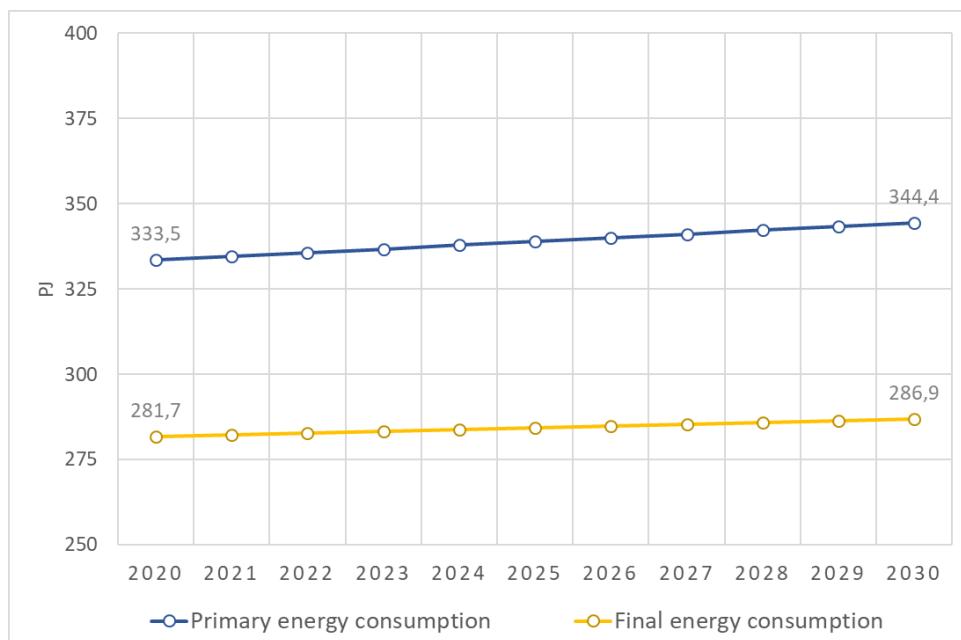


Figure 2-8. Energy consumption trends in the period from 2020 to 2030

Cumulative energy savings in the period 2021-2030 in accordance with 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 **1,289.8 ktoe (54.0 PJ)** is calculated with the assumed maximum allowable target reduction of 35%, in accordance with Article 7 (3a), item (b) of Directive 2018/2002.

Table 2-8: Indicative national energy efficiency targets in 2030

Targets 2030	Annual savings		Cumulative savings	
	PJ	ktoe	PJ	ktoe
According to Article 7 (1) (b)	2.2	53.7	123.6	2,953.1
With the exceptions referred to in Articles 7 (2) and (4) (b) to (g)	1.0	23.5	54.0	1,289.8

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

Pursuant to Article 4 of Directive 2012/27/EU on energy efficiency, the Republic of Croatia adopted its first Long-term strategy for promotion of investment in the renovation of the national building stock in 2014 (OG No. 74/14), and revised it in 2017 [18]. The building stock and the possibilities for its renovation have also been analysed in the document "Analyses and backgrounds for preparation of the Energy Strategy of the Republic of Croatia", which was prepared in October 2018 for the purpose of adopting the Energy Development Strategy of the Republic of Croatia by 2030 with an outlook to 2050. The conclusions in this document related to construction of buildings are presented below, which need to be implemented in order to achieve the national energy efficiency targets shown in Table 2-8.

After 2020, in accordance with the Technical Regulation on Rational Use of Energy and Thermal Insulation in Buildings, all newly constructed buildings will be nearly-zero energy (nZEB). It is expected that the total residential stock will 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. In order to achieve this growth of the total stock, 10,930,698 m² of new buildings and 8,630,863 m² of renovated buildings are expected in the period from 2021 to 2030 (around 30,000 new and renovated housing units per year, with a very high rate of abandonment and demolition of old poor-quality units of about 11,200 units per year). From 2031 to 2040, the area of newly-built residential buildings will amount to 14,721,602 m², with 9,022,863 m² of renovated residential buildings. This area of renovated buildings per year corresponds to the annual rate of renovation of 1.6%, with a gradual increase from 1% in 2021 to 3% in 2030.

The average final energy consumption in the residential sector will be 30 kWh/m²a for newly-built and renovated buildings, and it is expected that there will be no significant variations for the non-residential sector.

It should be noted that, pursuant to Article 2a of Directive 2018/844 amending Directive 2010/31/EU on the energy performance of buildings, the Republic of Croatia will adopt a new Long-term strategy for promotion of investments in the renovation of the national building stock with a plan of measures and indicators for 2030, 2040 and 2050, which will be aligned with the Energy Development Strategy of the Republic of Croatia.

The total area of public administration buildings that are being renovated or equivalent savings in the period 2021-2030 pursuant to Article 5 on the leading role of the public sector of Directive 2012/27/EU

A total of 13.8 million m² of useful heated area of public sector buildings was recorded in the Republic of Croatia in 2010, according to the data from the National Information System for Energy Management. In order 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 year¹⁵in equivalent savings. This approach will also be applied in the period until 2030.

¹⁵ Source: 4th National Energy Efficiency Action Plan for the period until the end of 2019, MEE, January 2019.

- ii. The indicative milestones for 2030, 2040 and 2050, the domestically established measurable progress indicators, an evidence-based estimate of expected energy savings and wider benefits, and their contributions to the Union's energy efficiency targets as included in the roadmaps set out in the long-term renovation strategies for the national stock of residential and non-residential buildings, both public and private, in accordance with Article 2a of Directive 2010/31/EU

Pursuant to Article 2a of Directive 2018/844 amending Directive 2010/31/EU on the energy performance of buildings, the Republic of Croatia will adopt a new Long-term strategy for promotion of investments in the renovation of the national building stock with a plan of measures and indicators for 2030, 2040 and 2050, which will be aligned with the Energy Development Strategy and Low-Carbon Strategy of the Republic of Croatia.

- iii. Where applicable, other national objectives, including long-term targets or strategies and sectoral targets, and national objectives in areas such as energy efficiency in the transport sector and with regard to heating and cooling

Estimates made in the framework of the development of analytical backgrounds for the purposes of development of the Energy Development Strategy show that a significant reduction in direct consumption in transport may be expected in the long term ([2], [4]). Energy consumption estimates in **the transport sector** by 2050 are shown in Figure 2-9..

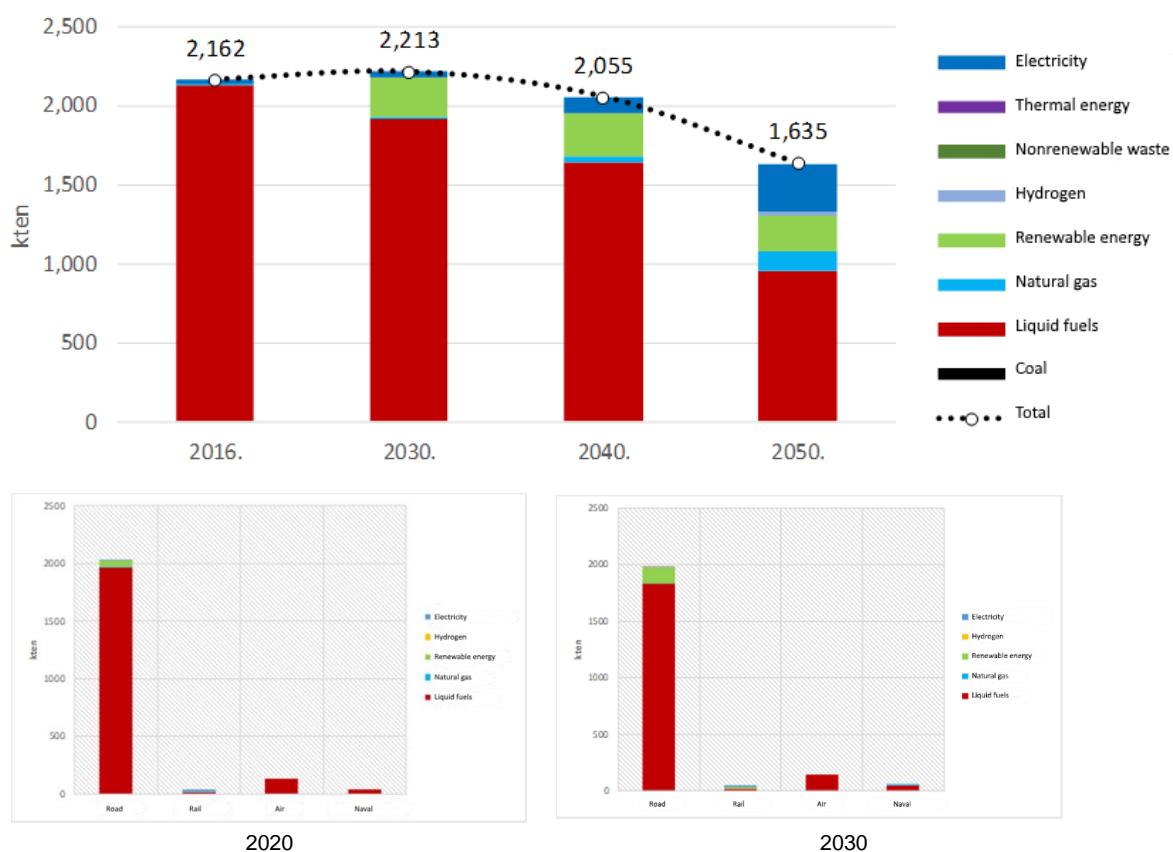


Figure 2-9. Energy consumption estimate in the transport sector

It is expected that the total energy consumption will be reduced by one quarter compared to 2016, and the structure of used energy-generating products will change. It is expected that, in 2050, electricity will account for around 20 percent and liquid fuel for around 35 percent in the structure of energy-generating products.

2.3 Dimension energy security

i. The elements set out in point (c) of Article 4

The most important objective within the dimension of energy security is to ensure a lasting, secure and quality supply of all energy-generating products. In order to achieve this objective, it is necessary to introduce integral and systematic planning of supply of all energy-generating products and forms of energy.

Other national energy security objectives are:

- diversification of supply routes of energy and energy-generating products
- increasing gas and energy storage capacity in the energy system
- increasing the flexibility (and thus resilience) of energy systems
- protection of critical infrastructure and mitigating risks related to cyber security and climate change.

In terms of gas supply security, it is necessary to ensure domestic operational security of gas supply as well as the security of gas delivery. Croatia is currently supplied with gas from domestic production and from imports through the Slovenian and Hungarian delivery routes, and peak demand is met through supply from the underground gas storage facility Okoli. One of the objectives in the context of energy security is to increase the capacity of gas storage facilities, diversify supply routes and fulfil obligations of security of supply according to the infrastructure standard (N-1 criterion) pursuant to Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply.

In order to maintain the security of natural gas supply, it is in the interest of the Republic of Croatia to ensure the realization of the liquefied natural gas (LNG) terminal project on the island of Krk in accordance with the Energy Development Strategy of the Republic of Croatia, the Natural Gas Storage Strategy of the European Union and the Energy Security Strategy of the European Union. The realization of the LNG terminal project on the island of Krk will provide a new delivery route for natural gas and will diversify the natural gas supply routes and sources on the markets of the Republic of Croatia and European Union, which will significantly affect the security of natural gas supply.

For the purposes of diversification of gas supply routes, in addition to the construction of the LNG terminal, it is planned to connect to the Ionian Adriatic gas pipeline. For the purposes of diversification of electricity supply routes, construction of interconnectors to Bosnia and Herzegovina, Hungary and Serbia is being considered.

For the purposes of increasing the gas storage capacity, it is planned to develop a gas storage system (extension of existing storage facilities and construction of a new underground storage facility). Energy storage within the power system will be enabled by the construction of pumped-storage power plants, which will also provide greater system flexibility and greater integration of variable renewable energy sources, primarily the sun and wind. In addition to energy storage, the possibility of participation of demand response in the operation of the power system will also contribute to system flexibility.

ii. National objectives with regard to increasing: the diversification of energy sources and supply from third countries for the purpose of increasing the resilience of regional and national energy systems

Increasing the share of RES in the structure of used energy-generating products will contribute to reducing dependence on imports, including imports from third countries. Also, in order to reduce imports of energy-generating products from third countries, potential hydrocarbon deposits in Slavonia, the Dinarides and the Adriatic should be explored.

iii. Where applicable, national objectives with regard to reducing energy import dependency from third countries, for the purpose of increasing the resilience of regional and national energy systems

Power sector

National goals regarding the security of electricity supply are as follows:

- creating a favourable investment climate for investments in new electricity generation facilities and revitalization of existing facilities in order to reduce the dependence on electricity imports from the market, increasing the competitiveness of power plants located in the territory of the country and for the purposes of increasing possibilities for electricity generation in the territory of the country and relieving the grids.
- construction of different types of power plants with respect to the characteristics of the system as a whole (basic, regulation-peak, other), for the purposes of proper technical functioning of the power system as a whole and ensuring sufficient reserves for balancing production and consumption of electricity at all times (short period),
- diversification of power plants according to the types of primary energy-generating product used, in order to avoid major disruptions in electricity generation during periods of unavailability of particular primary energy-generating products,
- timely implementation of investment plans of the transmission and distribution system operators with regulatory supervision, in order to avoid disruptions in customer supply during grid failures,
- implementation of energy efficiency measures to reduce electricity consumption, in order to reduce electricity demand, and
- construction of distributed power sources with a medium-voltage and low-voltage grid connection near the point of consumption in order to further increase the power generation capacity in the territory of the country and relieve stress on grids.

Gas sector

The basic framework for regulating the security of natural gas supply in the Republic of Croatia is stipulated by Regulation No. 1938/2017 of the European Parliament and of the Council concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No. 994/2010. This Regulation aims to ensure that all necessary measures are undertaken to safeguard an uninterrupted gas supply, in particular supply to protected customers in the event of difficult climatic conditions or disruptions in gas supply.

Regulation 1938/2017 entered into force on 1st November 2017, and the purpose of the Regulation is to increase solidarity and trust among Member States and to establish measures needed to achieve those objectives by cost-effective measures and in a way that will not destabilize gas markets. The main improvements in relation to the previous Regulation 994/2010 are:

- introduction of the solidarity mechanism, according to which, in the event of a serious crisis situation, neighbouring member states will assist in ensuring supply to households and key public services,
- strengthening regional cooperation through regional risk groups, and joint assessment of security risks and agreed joint preventive and crisis measures, and
- greater transparency through the introduction of an obligation of disclosure to the competent body of the contract between the supplier and customer covering 28% or more of annual gas consumption on the national market.

In accordance with the provisions of the Gas Market Act, gas market participants are responsible for the security of gas supply within the scope of their activity. The competent body responsible for the implementation of measures listed in Regulation 1938/2017 is the ministry responsible for energy, which has the following tasks:

- monitoring the ratio of supply and demand on the gas market,
- preparing estimates of future consumption and available supply,
- planning the construction and development of additional capacity of the gas system and
- proposing and undertaking measures in the event of a crisis situation.

Regional self-government units are responsible for:

- monitoring the ratio of gas supply and demand in their area,
- preparing estimates of future consumption and available supply,
- planning the construction of additional capacity and development of the distribution system in their area and
- proposing and undertaking measures within their competence as established by law.

Furthermore, Regulation (EU) 1938/2017 establishes the obligation of competent institutions to prepare:

- preventive action plans with measures to eliminate and mitigate the identified risks,

- emergency plans with measures to remove or mitigate the effects of gas supply disruptions.

In order to define a preventive action plan with measures to remove and mitigate the identified risks, in accordance with the risk assessment carried out pursuant to Article 9 of Regulation (EU) 994/2010 and an emergency plan with measures to remove or mitigate the effects of gas supply disruptions in accordance with Article 10 of Regulation (EU) 994/2010, the Government of the Republic of Croatia adopted the Emergency Plan on measures to safeguard the security of gas supply of the Republic of Croatia (OG No. 78/14), which, among other things, defines obligations of the gas storage system operator regarding security of supply (e.g. to ensure maximum capacity of gas storage facility before the heating season).

In order to identify the criteria for acquiring the protected customer status and protection measures with the aim of reliable supply of protected customers, the Government of the Republic of Croatia adopted the Regulation on criteria for acquiring the status of protected customer in conditions of crisis situations in gas supply (OG No. 65/15).

Preventive action plans and emergency plans prepared in accordance with Regulation 994/2010 shall remain in force until new preventive action plans and emergency plans are prepared in accordance with Regulation 1938/2017.

According to Regulation (EU) 1938/2017, preventive measures for security of supply also include diversification of natural gas supply routes and sources, and the realization of the LNG terminal project on the island of Krk has been identified as the key measure to diversify natural gas supply routes and sources.

In order to ensure this measure, in accordance with the LNG Terminal Act (OG No. 57/18), CERA may issue a decision determining the amount and method of collecting the fee for security of supply upon request of the transmission system operator and upon proposal of the LNG terminal operator. The transmission system operator collects the fee for security of supply and directs the funds to the LNG terminal operator.

Heating sector

It is necessary to ensure the role of the heating sector for meeting heating needs. For this purpose, it is desirable to introduce zoning in the heating sector, as has already been done in other EU Member States.

Oil sector

The establishment and implementation of measures for secure and reliable supply of oil and petroleum products is regulated by the Oil and Petroleum Products Market Act (OG Nos. 19/14, 73/17). On the basis of the aforementioned Act, the Emergency Plan in the event of an extraordinary disruption in the oil and petroleum products market supply was adopted (OG No. 111/12). The Emergency Plan defines:

- procedures and criteria for identifying an extraordinary disruption of the oil and petroleum products market supply,
- competences and responsibilities in case of supply disruption,
- procedures for normalization of the oil and petroleum products market supply and
- procedures in the event of an international decision on the release of compulsory stocks of oil and petroleum products on the market.

Apart from creating and holding compulsory stocks in order to increase the security of supply, the objective is a continuous analysis of the oil sector, both in terms of market supply and existing and future consumption, for the purposes of timely assessment of possible risks related to supply security. Furthermore, item 1 of Article 1 of the Oil and Petroleum Products Market Act, which regulates the rules and measures for the secure and reliable transportation of oil and petroleum products and the storage of oil and petroleum products, imposes the obligation of continuous maintenance and investment in the security of transport and storage of oil and petroleum products. It is also necessary to further develop the methodology and tools for assessing the supply security.

iv. National objectives with regard to increasing the flexibility of the national energy system, in particular by means of deploying domestic energy sources, demand response and energy storage

According to the goal of implementing the energy transition, total energy consumption by 2050 is reduced by about 16% compared to 2017. Own supply capacity first increases to 55.2% in 2030, and decreases to 51.7% in 2050.

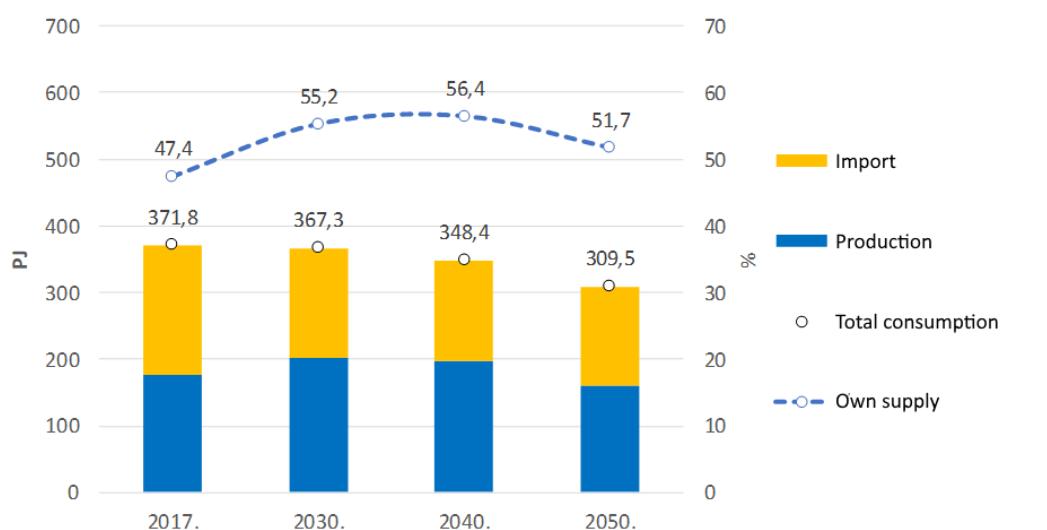


Figure 2-10. Total energy consumption and own supply capacity

The estimates show a strong increase in the share of variable RES (wind farms and solar plants), and in the period until 2030, anticipate activities aimed at increasing the flexibility of the system that will be ensured from existing and planned impoundment hydroelectric power

plants, existing and planned reversible hydroelectric power plants, battery systems at the system and consumption level, gas plants, organizing a balancing market (for the supply of services from domestic sources and other systems; introducing balancing responsibilities for market participants, etc.), improving forecasts of production from variable RES, enhancing transmission grid elements and developing advanced grid systems and system management.

The analyses performed so far suggest that up to the integration level of around 1,000 MW, major interventions in the transmission grid in terms of construction of new mains and substations will not be required (for higher levels of integration, HOPS plans to apply the principle of "zone connection"), but the requirements for the balancing mechanism and providing ancillary services of secondary and/or fast tertiary regulating reserve (power and frequency regulation) are significantly increasing.

Oil sector

Exploration of new deposits and hence increasing hydrocarbon production from domestic sources is one of the key factors for increasing domestic oil and gas supply capacity. The figures below show the existing production of oil, condensate and natural gas, and provide production estimates from existing fields and new production as a result of additional investments in the exploration of new hydrocarbon reserves 2.

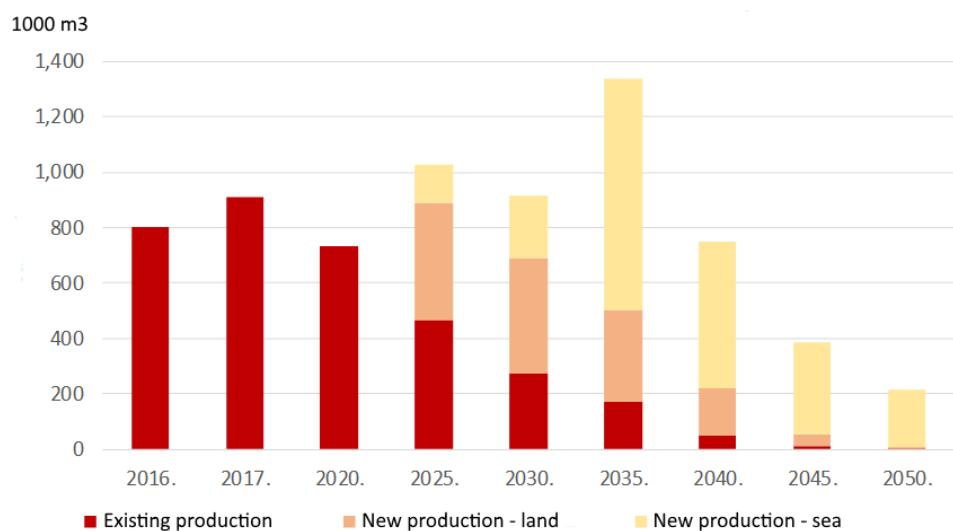


Figure 2-11. Oil and condensate production estimate by 2050

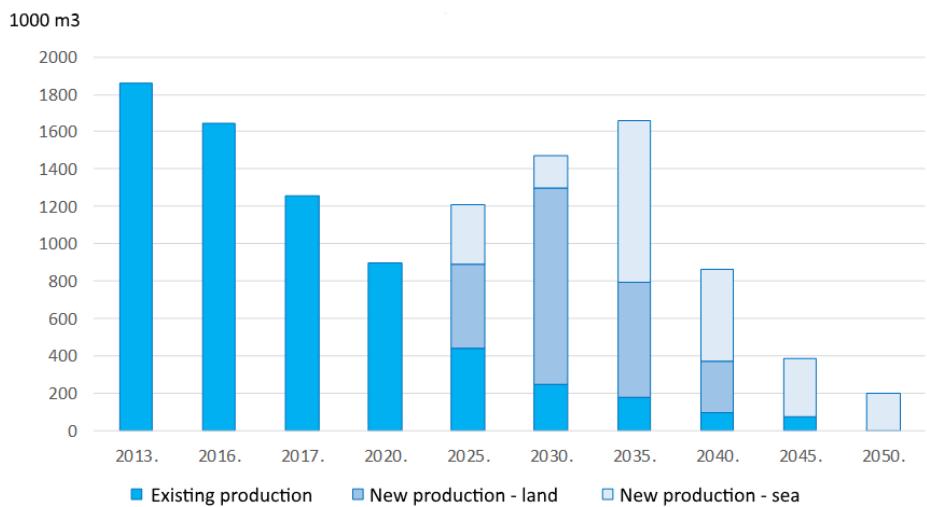


Figure 2-12. Natural gas production estimate by 2050

2.4 Dimension internal energy market

2.4.1 Electricity interconnectivity

i. Level of electricity interconnectivity

With regard to the EU targets related to the desired level of electricity interconnection of at least 15% compared to installed power of 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 peak load of the system or the installed power of RES in the territory of the Republic of Croatia. Namely, the sum of installed transmission capacities of existing interconnectors/interstate powerlines is about 13,450 MVA, which is 290% in relation to the total installed capacity of power plants of 4,639 MW (at the end of 2016), while compared to the peak system load of about 3,100 MW this amounts to 434%. The total available cross-border capacity for import is estimated at 4,210 MW, while the total cross-border capacity for export is estimated at 3,830 MW, and in relation to the sum of transmission capacity of interconnectors, it is limited by potential congestion in the internal grid in terms of meeting the operational safety criteria.

With regard to further increase of cross-border capacity by 2030, no specific requirements are set. The development of new interconnection projects will be based on technical and economic considerations and based on cost-benefit analysis in accordance with the ENTSO-E methodology. 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.

With regard to further enhancement of possibilities of existing cross-border capacity exchanges, the aim is to continuously increase the net transmission capacity values at the borders by eliminating congestion/limitations primarily in the internal grid.

2.4.2 Energy transmission infrastructure

i. Key electricity and gas transmission infrastructure projects, and, where relevant, modernisation projects, that are necessary for the achievement of objectives and targets under the five dimensions of the Energy Union Strategy

Key targets for the electricity transmission infrastructure

- maintaining a high reliability of the transmission system and the security of electricity supply of stipulated quality to customers,
- accelerated integration of variable RES into the power system, and increased availability of regulatory reserves to balance their production,
- timely realization of investment plans, in particular capital investments that enable the integration of RES into the power system,
- supporting market transactions in the territory of the state and the region so that the transmission network does not represent a constraint on competitiveness,
- revitalization and replacement of old/deteriorated grid units,
- increasing the transmission capacity of individual lines planned for revitalization 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 existing transmission grid and interconnection capacity to neighbouring countries enable the integration of significant installed power of RES. Given the climate characteristics, the region of Dalmatia is particularly suitable for the development of wind and solar power plants, and there is a strong investor interest in the construction of new facilities in the region. At the moment when the installed capacity of wind power plants exceeds around 1,000 MW (the existing wind power plant capacity in the Republic of Croatia is around 600 MW), it will be necessary to upgrade the internal 400 kV grid on the route Konjsko substation (Split) - Melina substation (Rijeka) so that the energy generated from RES could be transmitted to remote consumption areas. The preparations for the construction of this line has begun, and detailed studies are currently being carried out on the necessity of its construction, definition of the route and environmental impact assessment.

In accordance with Regulation (EU) No. 347/2013, a list of projects of common interest of the EU is defined every two years. The current list of projects of common interest, as set out in

Annex VII to Regulation (EU) 347/2013 of 23rd November 2017, includes the following groups of projects of common interest related to electricity in the territory of the Republic of Croatia:

- SINCRO.GRID (Slovenia, Croatia) - An innovative integration of synergetic, mature technology-based solutions in order to increase the security of operations of the Slovenian and Croatian power systems simultaneously
- Interconnection between Žerjavinec (HR)/ Hévíz (HU) and Cirkovce (SI).

Key goals for the gas transmission infrastructure

The development of the gas storage system is expected, primarily for the purpose of domestic natural gas consumption, but also for the purpose of new delivery projects. The development of the gas storage system encompasses the expansion of the existing underground gas storage facility Okoli (ongoing), the construction and commissioning of a new (peak) underground gas storage facility in Grubišno Polje (planned in 2022) and the potential construction of a new seasonal gas storage facility in accordance with the capabilities and needs.

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 important 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 in order to implement priorities in the area of energy infrastructure of common interest is defined in the 10-year plan for the development of the gas transport system.

In accordance with Regulation (EU) 347/2013, a list of projects of common interest of the EU is defined every two years.

ii. Where applicable, main 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 important for 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) in accordance with Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply.

2.4.3 Market integration

- i. **National objectives related to other aspects of the internal energy market such as increasing system flexibility, in particular related to the promotion of competitively determined electricity prices in line with relevant sectoral law, market integration and coupling, aimed at increasing the tradeable capacity of existing interconnectors, smart grids, aggregation, demand response, storage, distributed generation, mechanisms for dispatching, re-dispatching and curtailment, and real-time price signals, including a timeframe for when the objectives shall be met**

Connecting the day-ahead markets at the border between the Republic of Croatia and the Republic of Slovenia had significant effects on increasing the liquidity of the Croatian Power Exchange (CROPEX), increasing the possibilities of energy placement and price harmonization. The existing market integration activities should continue with the aim of achieving full integration into the EU internal market, primarily through integration with the Hungarian day-ahead market. The markets of South-Eastern Europe are very significant for Croatia given its good cross-border connectivity and energy availability, but market integration is limited by the level of development of national electricity markets in these countries. Bosnia and Herzegovina does not yet have a power exchange in place, while connecting the day-ahead market with Serbia can be achieved in a relatively short time. The project of connecting day-ahead markets in the WB6 countries is expected to result in full integration of markets in the region by 2025.

The second phase of the expansion of the intraday market through the XBID project is expected, which includes the following countries: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania and Slovenia, along with the already operational countries with which they border.

Although the wholesale electricity market in Croatia is fully open, it is characterized by the existence of a dominant electricity producer. It is necessary to increase the number of participants in the wholesale market, especially in the area of electricity generation, in order to increase competitiveness on the supply side.

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

It is necessary to enable aggregation of end customers as well as participation of demand response in the electricity market.

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

ii. Where applicable, national objectives related to the non-discriminatory participation of renewable energy, demand response and storage, including via aggregation, in all energy markets, including a timeframe for when the objectives are to be met

In the segment of ancillary services and system balancing, it is necessary to establish market mechanisms that will enable more market participants, as well as end consumers, to provide such services.

Objective: To develop a competitive market for balancing and ancillary services

iii. Where applicable, national objectives with regard to ensuring that consumers participate in the energy system and benefit from self-generation and new technologies, including smart meters

Analytical backgrounds developed for the purposes of adopting the Energy Development Strategy ([2], [4]) define the introduction of advanced metering systems by 2025 as priorities for investment in the distribution system. Also, pilot projects for advanced grids are envisaged, on the basis of which additional insights will be gained into the characteristics of grid users and possibilities of their active participation in the power system will be explored.

iv. National objectives with regard to ensuring electricity system adequacy, as well as for the flexibility of the energy system with regard to renewable energy production, including a timeframe for when the objectives are to be met

With regard to the future adequacy of the power system, it is necessary to take into account the expected changes in the power system. According to the estimates of the share of RES in Chapter 2.1.2, it is necessary to secure appropriate investments in the transmission network and the management system, and sufficient (available) possibilities of system balancing, in order to ensure the satisfactory adequacy of the power system 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 power system.

It is necessary to prepare the analysis of the impact of climate change on the adequacy of the power system, which may be reduced due to the failure of key 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 limited operation of thermal power plants due to a decreased availability of the cooling medium of a reduced flow.

Given the existing capacities of cross-border lines, it is expected that cross-border exchange of electricity will contribute significantly to the adequacy of the power system in the context of

growing intermittent production from RES. It will be necessary to further strengthen the cross-border and regional cooperation between electricity transmission system operators in order to ensure the quality and security of the system's operation.

v. Where applicable, national objectives to protect energy consumers and improve the competitiveness of the retail energy sector

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

The Croatian goal in terms 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.

2.4.4 Energy poverty

i. Where applicable, national objectives with regard to energy poverty, including a timeframe for when the objectives are to be met

Before the start of the implementation of the Integrated National Energy and Climate Plan, the Programme for Elimination of Energy Poverty will be prepared, within the framework of which a model of support to affected households will be developed. The implementation of the Programme for Capacity Building for Eliminating Energy Poverty, in accordance with the 4th National Energy Efficiency Action Plan for the period until the end of 2019, will also start before the implementation of this Plan.

It should be noted that the MCPP has so far developed two Programmes that took into account energy poverty: "Programme for the Elimination of Energy Poverty involving the use of renewable energy sources in residential buildings in assisted areas and areas of special state concern for the period 2019-2021", which was developed in collaboration with the State Office for Reconstruction and Housing and "Amendments to the Programme of Energy Renovation of Family Houses for the period 2014-2020 with a detailed plan for the period 2014-2016", which will for the first time include measures for elimination of energy poverty, so that the co-financing rate for this group of citizens would be 100%. In addition to these programmes, under the Building Act, the Government of the Republic of Croatia, upon the proposal of the MCPP, will adopt a Long-Term Strategy for the Renovation of the National Building Stock by 2050, which will propose national measures to alleviate energy poverty, which will be achieved through deep renovation of buildings.

Furthermore, in the period from 2021 to 2030, measures to eliminate energy poverty will be implemented under the Programme for Elimination of Energy Poverty, with the following goals:

- to provide energy consulting for all energy-poor citizens of the Republic of Croatia,

- to establish a system of measuring and monitoring energy poverty indicators at the national level and
- to 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 the implementation of technical measures, the degree of co-financing and sources of funding will be elaborated in the Programme for Elimination of Energy Poverty, whose preparation is foreseen in the 4th National Energy Efficiency Action Plan for the period until the end of 2019. The plan for the use of funds obtained from the sale of emission allowances through auctions in the Republic of Croatia for the period until 2020 (OG No. 19/18, OG No. 84/2019) includes co-financing of measures to eliminate energy poverty.

2.5 Dimension research, innovation and competitiveness

i. **National objectives and funding targets for public and, where available, private research and innovation relating to the Energy Union, including, where appropriate, a timeframe for when the objectives are to be met**

By 2020, the Republic of Croatia has committed to increasing its investment in research, development and innovation to 1.4% of GDP. Investment in the science and technology system should steadily increase and ultimately reach the EU average of 3% of GDP at the national level. The Smart Specialization Strategy of the Republic of Croatia, which covers the period until 2020, defines, in addition to five thematic priority areas, two horizontal themes representing cross-sectoral technologies and processes and serving as drivers of growth within the thematic priority areas, the so-called key development technologies and information and communication technology.

Key development technologies enable the transition from a traditional economy to a low carbon economy based on knowledge. They play an important role in the development, innovation and strengthening the competitiveness of the industry, and include biotechnology, micro- and nano-electronics and photonics, and other advanced materials and technologies. Since the Smart Specialization Strategy is one of the basic strategic documents in the field of technological development and innovation, this created the initial preconditions for the transition to a low carbon economy and for the participation of institutions responsible for supporting business investments in research, development and innovation (Ministry of the Economy, Entrepreneurship and Crafts, HAMAG-BICRO). The majority of the funds for the implementation of the Smart Specialization Strategy will be secured from the European Structural and Investment Funds.

It is expected that in the forthcoming financial period the main source of financing will also be ESI funds and funds from auctions of CO₂ emission allowances and ETS funds dedicated for modernization. The revision of the ETS Directive established a financial mechanism to support the modernization of the energy sector and industrial plants for the period 2021-2030, in the ten

EU Member States whose GDP per capita according to market prices was below 60% of the EU average, including the Republic of Croatia (Modernisation Fund). The funds of the Modernisation Fund will be used for investments in: modernization of industrial production, production and use of electricity from renewable sources, improvement of energy efficiency, energy storage and modernization of energy grids, energy efficiency in transport, buildings, agriculture and waste management. The European Union has a leading role in the world in efforts to mitigate climate change and is focusing its economy on low-carbon development based on new technologies. Therefore, the revision of the ETS Directive also establishes the Innovation Fund, which is available to all Member States. It will fund projects to support innovation in low-carbon technologies and processes, environmentally friendly carbon capture and use, innovative technologies for renewables and energy storage. The use of cohesion funds will be programmed on the basis of strategic objectives and key areas of intervention to be defined in the National Development Strategy for the period until 2030, which will be prepared by the end of 2019.

The Republic of Croatia currently has no defined national goals for financing public and private research and innovation related to the Energy Union. Therefore, national goals, indicators needed to monitor the achievement of goals and data sources will be defined by the Committee for Intersectoral Coordination for Policies and Measures for Climate Change Mitigation and Adaptation (envisaged by measure MS-1), in cooperation with the MEE, the National Competitiveness Council, the MSE and the MEEC.

ii. Where available, national 2050 objectives related to the promotion of clean energy technologies and, where appropriate, national objectives, including long-term targets (2050) for deployment of low-carbon technologies, including for decarbonising energy and carbon-intensive industrial sectors and, where applicable, for related carbon transport and storage infrastructure

The Republic of Croatia has no specific national goals for 2050 for the implementation of low carbon technologies other than those set out in other parts of this document. The introduction of specific technologies should primarily be market driven. The state will increase investment in research, development and innovation, and investment in the transfer of knowledge and technologies and the development of knowledge and innovation based technologies through various programmes - from grants, conditional loans to state aid programmes.

The following areas with most significant capacities of both industry and scientific community have been identified:

- development of new and improvement of existing primary and secondary equipment for power system (primary equipment: turbines, generators, motors, transformers, switches, power lines and cables, secondary energy equipment: control, measurement, protection, supervision, management)
- new technologies and improvements related to power plants, substations, components and systems related to renewable energy sources

- new research related to increasing the efficiency and production capacity of industrial, agricultural and forestry plants and machinery
- advanced energy storage systems
- diagnostics and better management of energy equipment
- energy management systems for planning, investment, real-time management and monitoring energy efficiency and reducing CO₂ emissions
- systems for energy management and support to functioning of the energy market at the levels of microgrids, advanced grids and smart cities
- advanced conventional energy solutions
- application of advanced grids and complex energy systems
- energy-efficient lighting
- sustainable conversion of biomass into energy
- biogas technologies for electricity and heat generation
- systems for CO₂ capture, transport, use and storage.

iii. Where applicable, national objectives with regard to competitiveness

Competitiveness is a broad issue that goes beyond the scope of the National Energy and Climate Plan. The National Competitiveness Council, which acts as an advisory body and brings together representatives of the economy, government, trade unions, science and education, operates in seven priority areas, namely:

- Education for growth and development
- EU-compliant rule of law
- Cost and price competitiveness
- Development of innovation and technology
- Strengthening small and medium-sized enterprises
- Regional development and cluster development
- Creating a positive attitude and leadership.

The objective of this Council is to make the Republic of Croatia one of the 40 most competitive economies in the world. Croatia is currently ranked 60th out of a total of 63 global economies, up one position from the previous year, 2018 [16].

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

3. POLICIES AND MEASURES

3.1 Dimension decarbonisation

3.1.1 GHG emissions and removals

- i. Policies and measures to achieve the target set under Regulation (EU) 2018/842 as referred in point 2.1.1 and policies and measures to comply with Regulation (EU) 2018/841, covering all key emitting sectors and sectors for the enhancement of removals, with an outlook to the long-term vision and goal to become a low emission economy and achieving a balance between emissions and removals in accordance with the Paris Agreement

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

Cross-sectoral measures are specified below.

MS-1: Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change

Regulatory measure; implementation: 2021-2030

Objective and description of the measure: Pursuant to the Air Protection Act (OG Nos. 130/11, 47/14, 61/17, 118/18), 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 2014 (OG Nos. 114/14, 9/18). The Committee gives recommendations to the Government of the Republic of Croatia on the overall policy and measures for mitigation of and adaptation to climate change and ensures political support to the implementation of the policy and measures for mitigation of and adaptation to climate change. The Committee also proposes to the Government of the Republic of Croatia the adoption of strategic planning documents and regulations pertaining to policies and measures for climate change mitigation and adaptation, proposes public policy objectives, measures and activities and monitors their effects and outcomes in implementation, and proposes and supports the promotion of interdisciplinary and synergistic public policy objectives, measures and activities. The composition, tasks and the 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. The task of the Committee will be to monitor the implementation of the Integrated Energy and Climate Plan and the achievement of set targets, both in terms of reducing greenhouse gas emissions and other targets by dimensions.

Funds needed for implementation: regular work of state bodies

Sources of financing: /

Executive body: MEE

Monitoring (supervisory) bodies: MEE

Impact: Indirect contribution to reduction in greenhouse gas emissions

Monitoring method: Number of meetings and number and structure of participants

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

Connection to climate change adaptation: The Committee is also responsible for climate change adaptation.

Research and development: Has impact, in the context of monitoring the implementation and achieving goals.

MS-2: Supporting the establishment and capacity building of regional energy and climate agencies

Organizational 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 and their transformation into energy and climate agencies is needed. The aim of this measure is to encourage the establishment of regional energy agencies for the areas of the Republic of Croatia where they do not operate, and the transformation of existing energy agencies into energy and climate agencies.

Funds needed for implementation: approximately HRK 1 million annually for a period of 3 years for the establishment of one regional energy and climate agency

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

Executive body: MEE

Monitoring (supervisory) bodies: MEE

Impact: Establishment of an energy and climate agency and transformation of existing regional energy agencies into regional energy and climate agencies

Monitoring method: Number of newly established energy and climate agencies, number of agencies transformed

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

Connection to climate change adaptation: Regional energy and climate agencies will implement energy and climate change adaptation projects.

Research and development: /

MS-3: Promoting the use of innovative information and communication technologies (ICTs) to reduce GHG emissions

Information measure; implementation 2021-2030

Objective and description of the measure: Innovative information and communication technologies play an increasingly important role in reducing greenhouse gas emissions and improving energy efficiency. By intensifying their use in public administration, services and manufacturing processes, work productivity and efficiency will increase, while simultaneously reducing energy consumption and the resulting greenhouse gas emissions. It is expected that the measure will increase the use of innovative ICTs and monitoring of real energy savings as well as reduction in greenhouse gas emissions.

MS-4: 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 the activities listed in Annex I to the Regulation on the method of greenhouse gas emissions trading (OG Nos. 69/12, 154/14), and operators of facilities included in the system are responsible for reducing greenhouse gas emissions. Through an even allocation of emission allowances, participants in the system from all Member States took on an obligation of reducing emissions for the purposes of contributing to a reduction in emissions by at least 21 % by 2020 and by at least 43% by 2030 compared to 2005 levels. Therefore the reduction in emissions within the framework of the EU ETS is regulated at the EU level. Since 1st January 2013, the Republic of Croatia is integrated into the EU ETS. Operators of facilities in the Republic of Croatia, in accordance with the EU ETS rules, received greenhouse gas emissions permits and established a regime for monitoring emissions and delivering verified reports to the competent authority. The greenhouse gases covered by the EU ETS are: carbon dioxide (CO₂) for all activities and additionally for specific activities, nitrous oxide (N₂O) and perfluorocarbon (PFC). Additional activity included in the EU ETS is aviation. Aircraft operators in the Republic of Croatia have been included in the EU ETS since 2012 for flights to the EU and since 2014 for flights within the Republic of Croatia. All operators except for electricity producers have submitted their requests for issuing free emission allowances for sale to third parties. Free emission allowances are distributed free of charge to facilities at risk of carbon leakage in third countries, based on benchmarks defined in accordance with the reference value for 10% of the most efficient facilities in the same sector. Operators who will not have enough allowances to cover their greenhouse gas emissions have the option of purchasing emission allowances through auctions or on the secondary ETS market.

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

- preparations for phase 4 of the greenhouse gas emission allowances trading (2021-2030) within the framework of the EU ETS, pursuant to Directive (EU) 2018/410 amending Directive 2003/87/EC, for the purposes of implementing a cost-effective reduction in emissions and low-carbon investments;
- continuation of activities of EU ETS participants (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 (MEE, verifiers, brokers...)

Funds needed for implementation: mainly funds of facility owners and airlines

Sources of financing: /

Executive body: MEE

Monitoring (supervisory) bodies: MEE

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

Monitoring method: Preparation and verification of GHG emission reports

Connection to other dimensions: The use of renewable energy sources (decarbonisation) and the increase of energy efficiency are encouraged, with the aim of reducing greenhouse gas emissions of facilities and airlines included in the EU ETS.

Connection to climate change adaptation: When deciding on measures to reduce greenhouse gas emissions, it is necessary to take into account the impact and adaptation to climate change (it is possible that climate change will make it difficult to implement certain measures to reduce greenhouse gas emissions).

Research and development: Innovation Fund and Modernization Fund, within the EU ETS, co-finance research and development of emission-free or low-greenhouse gas emission technologies.

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

Regulatory and fiscal measure; implementation 2021-2030

Objective and description of the measure: The Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon dioxide into the environment (OG Nos. 73/07, 48/09, 2/18) stipulates the obligation to

pay the CO₂ emission tax for all stationary sources emitting more than 30 tons of CO₂ annually from 2007 - 2014, or 450 tons of CO₂ annually since 2015. The obligated parties investing in energy efficiency, renewable energy sources and other measures to reduce CO₂ emissions and other greenhouse gas emissions pay a lower tax. The Environmental Protection and Energy Efficiency Fund is authorized to calculate and charge the costs. From 2013 onwards, the obligation to pay the CO₂ emission charge applies only to non-ETS sources. The Act on Amendments to the Act on the Environmental Protection and Energy Efficiency Fund (OG No. 144/12) stipulates that as of 1st January 2013, legal or natural persons possessing or using at least one source of CO₂ emissions for which greenhouse gas emission permits have been issued, which have been excluded from the emissions trading system based on the decision issued pursuant to a special regulation on air protection, should pay the annual tax on greenhouse gas emissions. The implementation of the measure is expected to continue in the period from 2021 to 2030 with modifications aimed at increasing efficiency. The possibility of including CO₂ emission tax in the price of fossil fuels for all non-ETS sectors will be considered, instead of the current CO₂ emission tax for stationary sources.

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

- study analysis of the effects of changing the CO₂ emission taxation model, which would consider the positive and negative effects of introducing a tax instead of the current CO₂ emission charge;
- if the analysis confirms the feasibility and cost-effectiveness of introducing a CO₂ tax, preparation of a by-law in 2022 which will define the amount of CO₂ emission tax for different types of fossil fuels and different energy sectors outside the ETS;
- introduction of a tax instead of a CO₂ emission charge from 2023 onwards;
- annual update of the amount of the CO₂ emission tax for different types of fossil fuels and different energy sectors outside the ETS;
- maintaining and upgrading the Environmental Pollution Register database.

Funds needed for implementation: HRK 1,000,000 for study analysis, preparation of the draft of the by-law and annual update of the amount of the CO₂ emission tax

Sources of financing: Funds collected through auctions

Executive body: MEE

Monitoring (supervisory) bodies: MEE

Impact: Reduction in fossil fuel use and consequent reduction in emissions of CO₂ and other greenhouse gases.

Monitoring method: /

Connection to other dimensions: The CO₂ emission tax discourages the use of fossil fuels, which is indirectly linked to the use of RES (decarbonisation) and increasing energy efficiency.

Connection to climate change adaptation: The measure is not related to adaptation to climate change.

Research and development: The research will be conducted in preparatory study analyses.

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

Organizational measure; implementation 2021-2030

Objective and description of the measure: The European Covenant of Mayors for Climate and Energy brings together more than 9.5 thousand local and regional authorities in 59 countries who have voluntarily committed themselves to the implementation of the EU's climate and energy goals, taking advantage of a movement that unites many stakeholders around the world and the methodological and technical support provided by competent offices. The signatories of the Covenant support a joint vision for 2050: accelerating decarbonisation of their territories, strengthening capacity to adapt to the inevitable impact of climate change and allowing citizens to access safe, sustainable and affordable energy. The signatory cities are committed to action that will support the reduction in greenhouse gas emissions by 40% by 2030 and the adoption of a common approach to mitigating and adapting to climate change. In order to transfer their political efforts into practical measures and projects, the signatories of the Covenant undertake to submit the Sustainable Energy and Climate Action Plan (SECAP). This initiative was endorsed by 82 cities and municipalities in the Republic of Croatia, so that the Covenant of Mayors covers over 2 million inhabitants in the Republic of Croatia.

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

- Development of Sustainable Energy and Climate Action Plans (SECAP) for cities and municipalities signatories to the Covenant of Mayors and adopting a common approach to addressing climate change mitigation and adaptation within two years of accession to the Covenant;
- Monitoring progress towards the SECAP target of at least 40% reduction in greenhouse gas emissions (reporting on progress of plan implementation every two years);
- Coordination of monitoring and implementation of activities envisaged in individual SECAPs and within the Integrated Energy and Climate Plan;
- Use of data on activities and projects carried out within each SECAP during each subsequent revision of the Integrated Energy and Climate Plan.

Funds needed for implementation: /

Sources of financing: Budget of cities and municipalities

Executive body: Cities and municipalities

Monitoring (supervisory) bodies: Covenant of Mayors, MEE

Impact: Reducing energy consumption and greenhouse gas emissions

Monitoring method: Number of municipalities and cities signatories to the Covenant, number of SECAPs produced, reports on the progress of implementation of the plan at the municipality or city level.

Connection to other dimensions: The Covenant of Mayors encourages the use of renewable energy sources (decarbonisation) and increases energy efficiency, with the aim of reducing greenhouse gas emissions.

Connection to climate change adaptation: Climate change adaptation and climate change risk and vulnerability assessment of cities and municipalities are part of SECAP.

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

MS-7: Charter of Cooperation for the Decarbonisation of Buildings by 2050

Information, educational, regulatory measure; implementation 2021-2030

Objective and description of the measure: The Charter of Cooperation for the Decarbonisation of Buildings by 2050, initiated by the Ministry of Construction and Physical Planning, which supports the EU's vision of decarbonisation of buildings by 2050, was initiated to improve cross-sectoral communication and cooperation between state administration bodies and the private sector. The aim is to create, through workshops and the Open Partner Dialogue, a broad network of connected professionals who are ready to engage in dialogue and contribute to the decarbonisation of 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 organized by the Ministry of Construction and Physical Planning. The contents of the Charter include the achievement of energy and climate targets at the national and EU level through the decarbonisation of the building stock, renovation of buildings and construction of nearly zero energy buildings, aware of the importance of further 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.

MS-8: Establishing a platform for the collection, use and storage of CO₂

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

Objective and description of the measure: The carbon capture and storage technology for large emission sources is not yet commercially available. According to Directive 2009/31/EC on geological storage of carbon dioxide, that is, Article 36 of the Industrial Emissions Directive 2010/75/EU, for power plants of more than 300 MW which have been granted a construction permit after the entry into force of Directive 2009/31/EC on geological storage of carbon dioxide, it is necessary to evaluate whether the following conditions are met: a) availability of a suitable location for storage, b) transport facilities are technically and economically feasible and c) upgrade of facilities for CO₂ capture is technically and economically feasible. If these conditions are met, the competent authority shall ensure at the site of the facility the appropriate space for equipment for CO₂ capture and compression. This is regulated by the Hydrocarbon Exploration and Exploitation Act (OG Nos. 52/18, 52/19), which enables CO₂ storage on the territory of the Republic of Croatia. This method should be further developed and the potentials and possibilities for this technology should be considered at the national level. In view of this, there are plans for the development of a storage capacity evaluation study, as well as the National Feasibility Study with the action plan for preparatory activities for carbon capture and storage projects. This study will cover the capture stages on emission sources, transport, injection and storage of CO₂, and the interconnection of the CO₂ transport system with other EU countries.

There are also plans to inform the public about carbon dioxide capture and storage technology.

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

- Conducting research into the potential for geological storage of CO₂ in the Republic of Croatia;
- Developing/amending the evaluation study of storage capacities available in the territory of the Republic of Croatia
- Implementation of CO₂ geological storage projects in the Republic of Croatia in accordance with expressed potentials;
- Informing the interested public about CO₂ capture and storage technology.

Funds needed for implementation: HRK 1,000,000 for the study and action plan, and for the implementation of projects the amount will be determined after the analysis of potentials

Sources of financing: CHA, Universities, EU funds

Executive body: MEE, CHA

Monitoring (supervisory) bodies: MEE, CHA

Effect: Reduction in greenhouse gas emissions.

Monitoring method: The research will be monitored through publications, and the CO₂ geological storage projects will be monitored through reports submitted by the bodies

implementing the projects to the competent authority and reports sent by the competent authority to the EC.

Connection to other dimensions: The implementation of the measure has a direct impact on research, innovation and competitiveness.

Connection to climate change adaptation: The measure directly affects CO₂ reduction.

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

MS-9: Improving sustainability of urban areas

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

Objective and description of the measure: The MCPP is in the process of developing new national Programmes of Green Infrastructure Development in Urban Areas and the Circular Spatial and Building Management Development Programme, which achieve the environmental, economic and social benefits of sustainable development. The Programme of Green Infrastructure Development in Urban Areas elaborates the goals and measures for the development of green infrastructure which, among other things, affect the increase of energy efficiency of buildings and construction areas, the development of green infrastructure in building construction, urban transformation and urban rehabilitation and the reduction of temperature in urban heat islands. The Circular Spatial and Building Management Development Programme elaborates goals and measures for circular spatial and building management that, among other things, encourage measures of circularity when planning new buildings, reusing abandoned and/or neglected buildings and extending the durability of existing spaces and buildings, reducing the amount of construction waste, and increasing the energy efficiency of buildings. The aim of this measure is to encourage cities and municipalities to build projects for revitalization and development of new urban environments on sustainability principles. The first step is to develop urban development plans, which, based on the assessment of sustainability indicators, will define development projects that will improve these indicators. In addition, co-financing from ESI funds will be provided for these projects in the period 2021-2027 (2030).. The Ministry of Construction and Physical Planning, as the ministry responsible for sustainable urban development issues, will define key sustainability indicators, which will include indicators in the areas of built space, economy, energy, emissions into the atmosphere, use of natural resources, environment and social aspects, which will need to be monitored both at the national and local level. The measure will facilitate sustainable development by linking strategic and spatial planning documents more directly and introducing performance measurements for planned and implemented projects. The measure will also provide financial support for such projects from ESI funds, in line with the target for the period 2021-2027. PO2 - "Greener Europe with low carbon emissions by promoting the transition to clean and equitable energy, green and blue investments, a circular economy, climate change adaptation and risk management and prevention".

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

- Development of the Programme of Green Infrastructure Development in Urban Areas;
- Development of the Circular Spatial and Building Management Development Programme
- Implementation of green infrastructure and circular spatial management projects through EU co-financing programmes.

Funds needed for implementation: EUR 375,000,000.00 project financing and HRK 762,000.00 (excluding VAT) programme development

Sources of financing: MCPP, EU funds

Executive body: MCPP, Faculty of Architecture (AF)

Monitoring (supervisory) bodies: MCPP

Effect: Reduction of heat demand and energy consumption in public and residential buildings and increase in RES usage and consequently reduction in CO₂ emissions;

Monitoring method: The survey will be conducted through the Questionnaire sent to the LGUs

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

Connection to climate change adaptation: With the development of green infrastructure in urban areas, buildings and construction areas become more resilient to some of the effects of climate change (e.g. extreme temperature conditions, urban heat islands, etc.)

Research and development: The measure is directly linked to research and development and innovative measures to improve the sustainability of urban areas

MS-10: Establishing of Programme for Carbon Footprint Calculation and Reduction in Businesses

Regulatory measure; implementation: 2021-2030

Objective and description of the measure: The objective of the measure is to establish a Programme for the calculation and reduction of carbon footprints of non-ETS economic operators, in order to reduce the total greenhouse gas emissions for all activities which the economic operator is responsible for or dependent upon. It is necessary to calculate direct greenhouse gas emissions and their removal at the location of the economic operator, whether due to combustion of fuel in the thermal power plant, from the production process and/or from

the company vehicles, then indirect emissions that occur outside the economic operator's location, related to the procurement and consumption of electricity, heat and cooling energy, but also other indirect emissions/removals related to human, material, waste and final product flows. The carbon footprint calculation will enable businesses to familiarize themselves with the structure of greenhouse gas emissions, and to identify activities that most significantly contribute to the reduction in emissions, which is a good basis for the development and implementation of the Action Plan for the carbon footprint reduction. The implementation of the Action Plan would lead to a reduction in greenhouse gas emissions and mitigation of climate change, which would mean easier fulfilment of commitments under the Paris Agreement.

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

- improving the national model for the calculation of the carbon footprint of businesses with an integrated database of national greenhouse gas emission factors;
- establishment and implementation of a voluntary programme to calculate and reduce the carbon footprint of businesses from 2021;
- monitoring and analysis of the achieved reduction in the carbon footprint of businesses;
- the adoption of a by-law that will establish the obligation to calculate carbon footprints and develop an action plan to reduce the carbon footprint of businesses will be considered.

Funds needed for implementation: /

Funding Sources: EPEEF (co-financing of carbon footprint calculations and development of action plans for non-ETS economic operators), regular work of state bodies

Executive body: MEE, EPEEF

Monitoring (supervisory) bodies: MEE

Effect: 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 economic operators calculating the carbon footprint, developing an action plan, implementing measures and monitoring the impact of measures by reducing greenhouse gas emissions; calculating the annual reduction in greenhouse gas emissions for all economic operators participating in the voluntary/ mandatory programme of carbon footprint calculation and reduction.

Connection to other dimensions: The calculation and reduction of carbon footprint of economic operators contributes to other dimensions, in particular to increasing energy efficiency and greater use of RES (decarbonisation). The implementation of the measure also has an indirect impact on increasing energy security and on research, innovation and competitiveness.

Connection to climate change adaptation: The implementation of measures to reduce the carbon footprint of economic operators is planned along with the integration of climate change adaptation measures and strengthening of resilience, i.e. reduction of vulnerability of RES technologies to climate change.

Research and development: The implementation of innovative measures to reduce carbon footprints as a result of research and development is encouraged.

MS-11: Establishing of platform for circular economy

Informative, educational, regulatory measure; implementation: 2021-2030

According to the 2018 Circular Economy Package, the EC elaborated 54 measures in the Circular Economy Action Plan COM (2015) 614 and the Circular Economy Monitoring Framework COM (2018) 29 final. A systematic approach needs to be developed in all value chains relevant to the Croatian economy, addressing the aforementioned measures in the Action Plan, on the basis of which the Commission integrates the principles of circular economy into the production and consumption of plastics, water management, food systems and special waste flow management. It is necessary to set up a cross-sectoral thematic working group to identify the stakeholders in the circular economy (focus on industry and suppliers of raw materials, energy-generating products and packaging) and draw up a national action plan for the transition to circular economy. The inclusion of the representatives of the Republic of Croatia in the Stakeholder Platform for the European Circular Economy provides direct access to innovations and best practices, as well as cooperation. The measure is related to MS-12 and all measures in GO.

MS-12: Establishing a platform for bioeconomy

Informative, educational, regulatory measure; implementation: 2021-2030

In the context of bioeconomy development, it is necessary to link three key aspects: the development of new technologies and processes; market development and the competitiveness of biomass-based sectors and the political will to co-operate with policy and stakeholders to achieve the bioeconomy in the Croatian context. This should ensure the transformation of existing "traditional" stakeholders of the bioeconomy (farmers, family farms, food processing, wood processing, pharmaceutical and chemical industries...) into new, modern stakeholders whose products are no longer based on non-renewable carbon (bioplastics, biofuels, biochemicals, products of "traditional" stakeholders with a smaller carbon footprint...) and prepare them for the announced EU funds for the transition to bioeconomy. In order to move to bioeconomy, it is necessary to adapt the sectors of agriculture, forestry and waste management in order to balance the supply and demand for biomass, which includes the establishment of collection and logistics centres for biomass and bio-refineries. The measure is related to POLJ-4,7,9 and TR-5,9 and 12. Through this platform, national stakeholders will connect with initiatives in the EU.

MS-13: Establishing a platform for hydrogen technologies

Economic and environmental measures; implementation: 2021.-2030

The role of hydrogen in energy and transport systems of the future is expected to be more significant, especially as the goals for reducing greenhouse gas emissions are more ambitious. It is therefore necessary to identify, in a timely manner, the opportunities associated with the use of hydrogen, to consider its use in the coming decade, and to 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 level and serving as a link between national, EU and international levels.

The measures related to **industrial processes** are presented below. In monitoring the effectiveness of these measures, an important role will be played by the Nature Protection Information System, run by the State Institute for Nature Protection, within the MEE.

IP-1: Reduction of clinker content in cement production

Economic and environmental measures; implementation: 2021.-2030

Of the total direct carbon dioxide (CO₂) emission from cement production, about 60 percent is related to the clinker production process, and the other 40 percent is due to fuel combustion in a rotary kiln and for other needs in the cement production process. By reducing the clinker content, i.e., by increasing the proportion of mineral additives in cement production, the required amount of clinker produced is reduced, which contributes to the reduction of total CO₂ emissions in cement production.

The clinker content in cement is defined by the standard 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 on the market requirements for certain types of cement with a higher proportion of additives and a smaller proportion of clinkers.

IP-2: Limiting fluorinated greenhouse gas emissions

Regulatory, economic, educational measure; implementation: 2021.-2030

Implementation of Regulation (EU) No. 517/2014 in the Republic of Croatia is regulated by the Law on Implementation of the Regulation (EU) No. 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 517/2014 842/2006 (OG 61/17, 118/18), effective from 1st January 2019.

The measure defines activities and procedures for the prevention of fluorinated greenhouse gas emissions, conducting equipment leakage checks, use of 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.

IP-3: Gradual decrease in the amount of fluorocarbons that can be placed on the market

Regulatory, economic, educational measure; implementation: 2021-2030

The measure refers to the gradual limitation of the amount of hydrofluorocarbons available on the EU market by 2030 to 21% of the total quantity of hydrofluorocarbons placed on the market during the reference period 2009 to 2012, as laid down in Regulation (EU) No. 517/2014.

Regulation (EU) No. 517/2014 introduces a system of quotas for the placing of hydrofluorocarbons on the market. The calculation of the benchmarks and the allocation of quotas should be based on reported quantities of hydrofluorocarbons placed on the market during the reference period 2009-2012. The quotas for the placing hydrofluorocarbons on the market shall be allocated to each producer and importer for each year, beginning in 2015, on the basis of benchmarks, applying defined percentages to calculate the maximum amount of hydrofluorocarbons to be placed on the market and the allocation mechanism.

IP-4: Restricting and prohibiting market placing of certain products and equipment

Regulatory, economic, educational measure; implementation: 2021-2030

Fluorinated greenhouse gases with high greenhouse potential are restricted for use in new refrigeration and air-conditioning equipment, fire extinguishing systems, foam suppressants and aerosols.

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

Regulatory measure; implementation: 2021.-2030

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

The measures related to **waste management** are presented below.

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

Regulatory, economic, educational measure; implementation: 2021-2030

It is the first priority in waste management, according to the Act on Sustainable Waste Management (OG 94/13, 73/17, 14/19). Prevention and reduction of the amount of waste include municipal waste, production waste and sludge from wastewater treatment plants.

This measure should be achieved through cleaner production, nurture, and education, economic instruments, implementation of waste management regulations and investment in modern technologies. In accordance with the Act, quantitative targets and deadlines for reducing the total amount of waste disposed of at non-compliant landfills are defined. Disposal of waste at non-compliant landfills in Croatia is prohibited after 31st December 2017.

Under Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31 / EC on landfills, Member States should take the necessary measures to reduce the amount of municipal waste disposed of by 2035 to 10 % of the total amount (by mass) of municipal waste produced or less. Croatia has been given a five-year delay in meeting this target, as it is among the Member States that dumped more than 60% of municipal waste in landfills in 2013. Accordingly, Croatia must take the necessary measures to reduce by 2035 the amount of municipal waste disposed of to 25% of the total amount (by weight) of municipal waste generated or less.

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

Regulatory, economic, educational measure; implementation: 2021-2030

Apart from the Sustainable Waste Management Act, the quantitative targets and deadlines for increasing the amount of separately collected and recycled municipal waste are also defined by the Waste Management Plan of the Republic of Croatia for the period 2017 - 2022 (OG No. 3/17). By 2020, it is necessary to secure the preparation for reuse and recycling of the following waste materials: paper, metal, plastic and glass from households and possibly from other sources if these waste streams are similar to household waste, at a minimum share of 50% of waste weight.

According to Directive (EU) 2018/851 of the European Parliament and of the Council of 30th May 2018 amending Directive 2008/98 / EC on waste, Member States should take the necessary measures to increase the preparation for re-use and recycling of municipal waste to at least 55 % mass by 2025, 60% mass by 2030 and 65% mass by 2035. Croatia has been given a five-year grace period to meet these targets, as it recycled less than 20% of municipal waste in 2013 among Member States. Accordingly, Croatia must take the necessary measures to increase preparation for the reuse and recycling of municipal waste to at least 50% by 2025, 55% by 2030 and 60% by 2035.

GO-3: Assuring a system for the treatment and use of landfill gas

Regulatory, economic, educational measure; implementation: 2021-2030

The Ordinance on the methods and conditions for waste disposal, categories and operational requirements for landfills (OG 114/15, 103/18, 56/19) and Ordinance on waste management (OG 117/17) stipulate strict technical operating requirements for landfills, which reduce possible adverse effects of landfills on the environment. At landfills where landfill gas occurs it is necessary to secure a gas collection system, whereby the gas must be treated and used. If collected landfill gases cannot be used for energy production, they should be burned in the area of the landfill and the emission of methane into the atmosphere should be prevented.

The application of binding targets for the reduction of disposal and recycling of waste, described in the measures Preventing generation and reducing the amount of solid municipal waste and Increasing the amount of separately collected and recycled solid municipal waste, affects the amount of landfill gas generated.

GO-4: Reducing the amount of disposed biodegradable waste

Regulatory, economic, educational measure; implementation: 2021-2030

The aim of this measure is to reduce the amount of biodegradable fraction of waste disposed at landfills, which reduces emissions of methane produced by anaerobic waste decomposition processes. In accordance with the Sustainable Waste Management Act, quantitative targets have been identified for reducing the share of biodegradable municipal waste disposed at landfills. By the end of 2020, the share of biodegradable municipal waste disposed of in landfills must be reduced to 35% of mass fraction of biodegradable municipal waste produced in 1997.

The application of binding targets for the reduction of disposal and recycling of waste, described in the measures Preventing generation and reducing the amount of solid municipal waste and Increasing the amount of separately collected and recycled solid municipal waste, affects the reduction in the amount of disposed biodegradable waste.

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

Regulatory, economic, educational measure; implementation: 2021-2030

The measure is related to measure RES-3: Encouraging the use of RES for electricity and heat production, within the framework of renewable energy sources and TR-5: Obligation to use renewable energy sources in transport, TR-12 and TR-9:. Within the waste management sector, the potential for reducing greenhouse gas emissions represents the potential for reducing methane emissions (produced by anaerobic decomposition of biodegradable fraction of waste), which is used for electricity and heat generation. Biomethane injection into the gas network is also envisaged.

The measures related to the **agricultural sector** are presented below.

POLJ-1: Change in diet of cattle and pigs and animal feed quality

Information, educational, economic measures; implementation 2021-2030

The objective of the measure is to reduce methane emissions from intestinal fermentations and the extraction of methane and nitrogen from manure management through changes in diet and changes in the composition of animal feed; improving the emissions reporting system. Emissions of greenhouse gases from livestock production are a direct consequence of the intestinal fermentation and decomposition processes of manure or are indirectly generated during food preparation or other farm operations. Therefore, the measures taken to reduce greenhouse gas emissions are aimed at regulating digestive processes. In practice, many measures are most often applied at the same time, some of them acting simultaneously on intestinal fermentation but also reducing emissions during the handling of manure. There are various measures that can have a significant impact on emission reductions, some of which are already being implemented and some are expected in the reference scenario. By 2020, further work is expected on the implementation and synergy of dietary change activities, the treatment of feeds with a view to increasing their digestibility and the use of additives (additives) in animal feed. It is further possible to further reduce greenhouse gas emissions by implementing targeted sub-measures of dietary change, as well as improving the quality of bulk feeds and improving the grazing system.

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

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: The measure aims to reduce methane, nitrogen, and ammonia emissions through improvements in animal nutrition and manure collection and storage systems. The manure management category is the source of emissions of nitrogen compounds, ammonia and particulates. Emissions come from the excreta 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 manures. Emissions come from animal housing and the yard, from storage areas and from the application of manure on the soil and during grazing.

POLJ-3: Modification of the livestock farming system

Information, educational, economic measures; implementation 2021-2030

Aim and description of the measure: The aim of the measure is to indirectly reduce methane and nitrous oxide emissions by increasing the share of cattle in the "cow-calf" system.

Measures to achieve indirect effects on the reduction of greenhouse gas emissions refer to measures that increase the intensity of production (greater quantity of animal products - milk, meat, eggs, etc., per animal and per unit of time), and thus indirectly affect the emission in

the process of intestinal fermentation or from manure. Their effect depends largely on the livestock farming system (technology).

It should be noted that raising cattle on pastures results in increased NO₂ emissions compared to other farming methods, therefore any increase in the share of cattle in pastures should be accompanied by enhanced activities through other measures or in the livestock fund itself.

In Croatia, the problem is unused pastures and meadows with a large amount of agricultural land. To reduce costs, extensive pasture fattening is becoming increasingly important.

Numerous variables are involved in determining the number of animals (conditional heads / ha) that can be on pastures without causing damage to natural resources: soil, climate, plant assemblage, species and age of livestock, water availability, sensitive areas (slope too steep, endangered species, wetlands, etc.), general soil condition and type of livestock production.

Considering the import of a large number of calves for fattening or fattened young cattle and meat, the establishment of a cow-calf system is imposed as a logical solution and a source of calves that can later be fed on the same holdings (pasture fattening) or fattening in specialized fattening establishments.

POLJ-4: Anaerobic decomposition of manure and biogas production

Information, economic, regulatory measure; implementation 2021-2030

Objective and description of the measure: The objective of the measure is to reduce methane emissions from the manure management system for cattle and pigs by increasing the share of biogas plants.

The introduction of biogas plants results in the reduction of CO₂ emissions resulting from the elimination of methane emissions due to the disposal of used detritus and due to electricity from renewable sources. Greenhouse gas emissions from transportation do not make much of a difference considering the small distances travelled to the plant or landfill.

The biogas plant is divided into two parts. One is the digestor in which the process of anaerobic digestion generates biogas (gas obtained by the decomposition of organic matter under anaerobic conditions) and the other is the aggregate where that biogas is converted into electricity. The digestor has the highest investment costs for the biogas plant and also incurs operating costs resulting from the consumption of energy for heating the digestor and water.

The main mechanism for encouraging the use of biogas for electricity generation and for encouraging the construction of cogeneration biogas plants are the incentive prices (tariffs) that depend on the installed power of the plant. A common classification of biogas plants is large biogas plants, codigestion and farm. For small farmers, this is an expensive process, so the basis could be farmers' associations with the aim of reducing the installation cost of the plant.

In addition to reducing the source of readily degradable carbon in manure applied to agricultural land by anaerobic digestion in biogas plants, the nitrification process and N₂O emissions are also potentially reduced.

It is also envisaged to use biogas in transport and to inject biomethane into the gas network.

POLJ-5 Improvement of the breeding program, animal health and welfare

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Indirect reduction of methane and nitrous oxide emissions through breed improvements and enhancement of genetic potential.

The breeding programme is a set of selection procedures that achieve the genetic improvement of certain species and breeds of animals with the aim of reducing methane emissions from dairy cows, as well as increasing production intensity. This indirect effect on reducing greenhouse gas emissions depends largely on:

- Genetic potential and species (breeding selection work) - Intensive selection to increase productivity (higher production of milk, meat, eggs, etc., higher daily growths, number of offspring) has indirect effects, since more animal products are produced with fewer animals and with less consumption food, while excreting less nutrient excreta. Furthermore, greater utilization of food results in reduced excretion of N compounds in faeces and urine, but also decreases the excretion and thus their potential emission. A positive genetic correlation between PME (predicted methane emission) and RFI (residual feed intake) indicates that cows with lower RFIs also have lower potential emissions. Thus, it is possible to reduce methane production in cows by selecting genetically more suitable cows with respect to methane emissions. Genetic variability assumes a decrease of 11-26% over a ten-year period, but may be greater by applying a selection programme. However, there are several doubts, such as the lack of accurate methane measurements (and the main assumption is that methane produced per unit of food does not affect RFI levels), as well as predicting the potential consequences of genetic selection. To overcome these limitations, it is necessary to collect data on feed intake and methane emissions from dairy cows.
- Health status and mortality rate - preserving health is a prerequisite for efficient livestock production. Positive effects are evident through increased food intake and utilization, higher production, reduced mortality and greater animal welfare. This has an indirect effect on emissions.
- Duration of production cycle (days of fattening, feeding days) - has an indirect effect in species categories of livestock used for meat production, and is closely related to the genetic potential of individual units as well as the composition of the meal (meeting nutritional needs).

POLJ-6 Improvement and change of soil tillage system (reduced tillage)

Information, educational, economic measures; implementation 2021-2030

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 that are important for the storage of soil water, in general water-air relationships, water losses by evapotranspiration, soil thermal state, and thus microbial activity and soil respiration. The issue of reducing CO₂ emissions from agricultural soils in Croatia has not been sufficiently investigated in local conditions.

Reduced tillage is the application of the results of scientific research and practical checks that result in a change to 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 completely omitting tillage.

Thus, reduced tillage can be divided into basic concepts:

- Reducing classic tillage systems
- Minimum tillage
- No-till
- Conservation tillage
- Rational tillage

Detailed pedological surveys conducted in Croatia are only one of the input parameters for the general assessment of the suitability of land for the application of no-tillage systems, but a project is needed that would provide detailed answers to the question of the suitability of soils for no-tillage in Croatia.

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 task of reduced tillage becomes the accumulation and storage of water in the soil. At the same time, in years of abundant rainfall, which have also been occurring lately, there is often excessive saturation of the soil with water, which makes the problem of tillage even more difficult to solve. Other reasons for applying these tillage systems are related to improvements in the biological, chemical and physical properties of the soil and to 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. have a positive impact on the uplift of organic matter in the soil, which plays a key role in maintaining all soil roles. The direct impact on greenhouse gas emissions from a reduced tillage system is primarily related to a significant impact 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 standpoint of weed control, establishing optimal soil functioning and optimal crop height per unit of production area - i.e., a total reduction in production costs.

Agrotechnical interventions, as well as processes by which the content of organic matter in the soil can be maintained or even increased in Croatia are not satisfactorily implemented. Problems in the reduction of soil fertility are caused by the apparent decrease in the yield of cultivated crops, as well as difficult cultivation of the soil, the reduced utilization of applied fertilizers, and the overall efficiency of production.

The use of different tillage systems also alters current established understandings about the relationship between tillage and fertilization, which requires additional analysis to avoid acidification and excessive fertilization with nitrogen fertilizers, especially in the initial establishment of conservation treatments.

POLJ-7 Extension of crop rotation with higher share of legumes

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Defining the potential for organic matter content change / increasing soil carbon sequestration through crop rotation.

Fertilization is a system of plant production practiced on arable land, which represents the regular, spatial (swapping fields) and temporal (swapping crop) crop rotation. 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 basic groups of plants - arable crops, cereals and legumes.

Practiced crop rotation, today, together with soil treatment systems, strongly influence changes in the content of organic matter in the soil. Narrow crop rotation in which corn and winter wheat are almost necessarily included, without intensifying crop rotation, with the illicit burning of harvest residues, is a practice that cannot have a favourable effect on increasing the content of organic matter in the soil. The crop rotation intended to have a long-term effect on maintaining the same humus level should include leguminous crops, clovers, clover grass mixtures, and should, where possible, include the sowing of second crops for green harvests. According to the results of Butorac et al. (1995), average humus content of soil for different crops, from tobacco monoculture, over two two-field, three-field, two four-field, and one five and six-field crop rotation, varied from 1.3 to 1.6%, but in the 10-year period there was a significant differentiation in terms of differences in humus content according to crop rotation types. From this it can be seen that the studies which study the effect of practiced crop rotation on the changes in the chemical, as well as the physical and biological characteristics of the soil, must last for a long time, since even a 10-year period is not considered long enough to study such changes.

Sowing leguminous crops has many beneficial effects for 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 favourable physical, chemical and biological properties of the soil. 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 to be applied. As a rule, they do not need to be fertilized except only in small amounts at the beginning of their vegetation for initial growth and development until they form root knots and until the process of nitrogen fixation begins.

POLJ-8 Intensification of crop rotation by using intermediate crops

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Changes in organic matter content / increase of carbon sequestration in soil and reduction of nitrate leaching by sowing of 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 plow 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 in the soil 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 that arise in this process concern the time and organization of work on the farm, but 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.

POLJ-9 Improvement of mineral fertilizer application methods

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Reduction of nitrous oxide emissions from agricultural soils due to optimization of mineral fertilizer application.

Mineral fertilization has a very complex effect on soil organic matter. As a rule, intensive fertilization can affect the higher production of biomass of crops, weeds, but also microorganisms of the soil, which is especially true for soils that have no other fertility restrictions other than a lack of nutrients. The modern development of agriculture in Croatia implies the introduction of new technologies, of which for agricultural production the so-called

"Variable liming" and "variable fertilization rate" or "site-specific management" are very interesting. The basis for fertilization are soil fertility maps that are made using the kriging method. This creates the preconditions for much better sustainable soil management. Modern machines for the precise distribution of materials are already sold in Croatia today, but they cannot be used without knowing the differences in soil fertility. The introduction of information technology, remote sensing with applications in agriculture, and the production of yield maps are nowadays commonplace. In this way, the income of users of new technologies is generated, as well as the savings of farmers in the application of fertilizers, and thus a favourable environmental impact. The basis for fertilization is the results of soil analysis, which should be provided on each farm over a 4-5 year period.

Subjective, "experiential" or visual assessments most often result in minimal increase or even decrease in crop yields and quality, as well as increased consumption of mineral fertilizers - which in addition to increased production costs also entails an increased loss of unused nitrogen from the soil as well as unnecessary acidification of the soil.

In addition to optimizing the application of conventional mineral fertilizers to reduce nitrogen loss from the soil, the application of slow-acting fertilizers has a positive effect. Controlled or slow-acting nitrogen fertilizers find their use today primarily in high-income production (horticulture, etc.). The older generation of such fertilizers is not economically viable in the production of cereals because of the high cost of fertilizers and the low income per crop. The emergence of new crop fertilizers suitable for growing crops (especially polymer-coated fertilizers) has, through research, shown the possibility of reducing the need for fertilizers per hectare by up to 35%, with unchanged or increased revenues, making them economically viable and cost-effective.

The application of limestone materials, together with fertilization and soil treatment, is crucial in the overall solution of the problem of agricultural soils management because of the need to correct the excess acidity of soils in many agricultural holdings.

POLJ-10 Improvement of organic fertilizer application methods

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Research on increasing carbon sequestration in soil by improving the methodology of application of organic fertilizers

The use of organic fertilizers is important for the circulation of soil organic matter, of which there is a relatively large database on the global scale. Unfortunately, there are no stationary studies of such lengths on agricultural land in Croatia. Bertić et al. (1998) found in some soils in Baranja certain changes in the humus content during the 24-year period of intensive plant production from 1967 to 1990. In almost all soils the humus content increased (0.1-1.64%), depending on the amount of solid manure used.

Organic fertilizers stimulate the activity of soil microbes much more strongly than mineral fertilizers and bring much less salt and acid into the soil. Efficiency depends on the microbial activity in the soil, i.e. at what rate they are degraded and transformed into nutrients suitable for adoption. Organic fertilizers have a much longer degradation time, so their effect extends over many years. Regular application of organic fertilizers increases the amount of humus in the soil, improves soil properties, in particular the structure resulting in a better water-air ratio, higher water retention, greater availability of all nutrients and greater erosion resistance on sloping surfaces.

Underground application - direct injection into the soil by the use of an injector prevents the loss of ammonia and reduces or completely eliminates the spread of unpleasant odours. The method is applicable to the application of liquid form of bovine and porcine manure, with NH₃ emissions lower by up to 30%.

When using the injector, even though the loss due to volatilization or 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 dosing and application of fertilizers (organic and mineral) is further increased.

The limiting factor for increasing the use of specialized equipment for the injection of organic fertilizer is the relatively high cost of the equipment itself, and therefore such investment is indicated for larger (or enlarged) farms with the need for large fertilization capacities.

POLJ-11 Agroforestry

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Defining the potential and benefits of various agroforestry technologies to increase soil carbon sequestration

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 the cultivation of crops and / or animals on the same area unit. The integration can be of a spatial character or in a time sequence. Ecological-economic interaction between forestry and agricultural components is common. 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, but at the same time a balance is reached between economic viability and habitat protection on the basis of 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 worldwide to agricultural and forest land; including areas with degraded habitats (erodible areas, economically poorly valued devastated and degraded areas. Through experiments, agroforestry should show its applicability in our conditions with

respect to different forms and divisions, but also to different needs. It is important to point out that some elements of agroforestry have been recorded throughout history in the coastal and littoral areas of our country. First of all, the cultivation of land on terraces that were used to raise perennial plantations; olive groves, vineyards, various fruit trees and could only be used for animal husbandry in a limited manner.

POLJ-12 Hydromelioration interventions and systems of protection against natural disasters

Information, educational, economic measures; implementation 2021-2030

Objective and description of the measure: Increasing the share of agricultural soils under irrigation and the consequent reduction of nitrate leaching from agricultural soils.

Agriculture, more than any other activity, pollutes the water with nitrogen (nitrates), phosphates and plant protection products (pesticides). The intensification of agriculture has led to the intensification of agrochemical pollution. Environmental 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 has the function of draining excess amounts of water from a green surface, which most often occurs after heavy rain. Also, changes in soil air-water relationships also affect the activity of beneficial microorganisms

Microorganisms, with proper irrigation and drainage of excess water, have enhanced activity that reduces soil degradation and thus CO₂ losses. The activity of earthworms is also increased, who transfer carbon into deeper layers where it is longer lasting.

In Croatia, surface drainage systems are built on an area of about 1050000 ha, and underground drainage systems are built on an area of about 149000 ha. The age of most of the system is over 25 years.

Hydro-amelioration systems play a major role in sustainable development. Significantly improve the properties of existing hydro-amelioration systems. Human interventions in water control include the application of technologies and new management to ensure adequate quantities of water for plants; preventing excessive soil moisture and salinization; protecting the soil from flooding and maximizing profits by using water. These interventions take place within economic, social, and environmental constraints.

Croatia is in a good position because it has sufficient water supply, but successful technological innovations in drainage and irrigation systems depend to a large extent on research programmes and personnel education in the sector. The main goals are therefore the growth of agricultural production and the sustainability of the system.

POLJ-13 Introducing new cultivars, varieties and species

Information, educational, economic measures; implementation 2021-2030

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 important to encourage the development, education, and implementation of technologies at the national and regional levels, including encouraging the transition and adaptation of producers (as well as consumers, and therefore of the entire production chain) to the production of new agricultural crops, or by enabling and encouraging the use of cultivars and varieties who 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 lack of protein in animal feed, the need to reduce the use of mineral fertilizers and to reduce soil fertility.

Due to their considerable amounts of protein, 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 the use of 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.

POLJ-14 Changes in human nutrition

Information measure; implementation 2021-2030

Objective and description of the measure: Gathering data on the potential for reducing greenhouse gas emissions from changes in diet

The inefficient production of cereals as animal feed as well as the direct emission of methane from the intestinal fermentation of ruminants mean that the greenhouse gas emissions are significantly higher in the production of foodstuffs of animal origin compared to those of plant origin. By switching a significant portion of the population to a low-meat diet (in favour of fish), a vegetarian or wholly vegan diet, it is possible to achieve significant reductions in emissions - both due to lesser use of mineral fertilizers (and consequently less nitrogen compounds) required for animal feed production, and also due to the reduction of methane emissions from the intestinal fermentation of livestock. The additional benefits are significantly lower water and fuel consumption in agricultural production.

These emission savings can be expressed as an individual's carbon footprint based on all the factors mentioned, depending on their diet. Although the Republic of Croatia is one of the countries with less consumption of meat, it still represents a significant component in the diet of the average population. Thus, for example, the emission of a kilogram of CO₂ equivalents in an adult (with a diet of 2000 kcal, which is the average daily need for energy from food), whose diet contains a significant proportion of meat (more than 100 grams per day) will be from 5.66 to 7.19 kg per day, while in the vegetarian diet this amounts to 2.89 kg of CO₂ equivalents per day. The estimated carbon signature of residents over the age of 10 is about 7,500 kilotonnes of CO₂ equivalents for 2012. It should be noted that the Republic of Croatia does not meet all its meat needs, and that a significant part of red meat (up to 65% of beef and 40% of pork) comes from imports. Therefore, the total dietary carbon footprint is greater than the estimated total emission. The first step is certainly the research on the current dietary habits of the inhabitants of the Republic of Croatia.

POLJ-15 Collection and treatment of agricultural plantings and residues for energy use

Information measure; implementation 2021-2030

Energy exploitation of post-harvest residues (with emphasis on crop production) is one of the most significant ways of producing biomass energy in the Republic of Croatia. Other possible sources are the remnants of the winter harvest of almost all horticultural species, as well as the fast-growing energy-producing crops that are planted / sown solely for the production of biomass for its conversion to energy.

In order to develop the biomass market, and starting from the fact that Croatian farms are the smallest in the EU, biomass collection and logistic centres will be established using the existing infrastructure (utility companies, competence centres, business zones) in order to reduce the unit cost of production of biomass products, and capitalize on innovation capacity and equipment necessary for innovative biomass products for bioeconomics. Collection and logistic centres will link farmers who possess biomass, processing of biomass into new products with higher added value, development of new products and placing these new products on the market.

The measures related to the **land use, land-use change and forestry sector (LULUCF)** are presented below.

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

Regulatory, economic, information measure; implementation: 2021-2030

By 2027, it is necessary to develop a Land Management Strategy of the Republic of Croatia. For its development, it is necessary to implement projects that:

1. Establishes 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 for each land conversion type from one land category to another
2. Conducts analysis of all LULUCF land categories depending on cover, land use and management practices used on each land and associated emissions / outflows to consider the potential of each of the storage sites within each LULUCF land category to reduce emissions and increase greenhouse gas outflows
3. Make detailed projections for the development of future emissions / outflows in the LULUCF sector after carrying out the above analysis

The calculation of emissions / outflows in the LULUCF sector and these projects should form the basis for planning the cover, use, and management of LULUCF land categories for each of the storage sites in order to develop a Land Management Strategy and to properly define the measures to be implemented in each land category, which will reduce emissions and increase greenhouse gas outflows in the Republic of Croatia. Improving and defining forest fire protection measures should be an integral part of this strategy.

LUF-2: Carbon accumulation on forests areas

Economic measure; implementation: 2021-2030

Carrying out activities that contribute to increasing the stores of carbon of forests, in particular in biomass storage and ensuring that removals in a given period exceed those defined by the Forest Reference Level (FRL). These activities are, for example, reforestation, transfer of forest stands to a higher cultivation form, selection of species for replenishment, etc. Maintaining an outflow larger than that defined by the FRL also ensures an increase in emission units that can be transferred to sectors outside the ETS as well as the use of flexible mechanisms. Further assessment of the effectiveness of the implemented measures and activities from the Rural Development programme to reduce / contain emissions and increase / contain greenhouse gas outflows and develop new guidelines for further management in the forestry and agricultural sector with the application of measures to mitigate and adapt to climate change. It is necessary to promote the management of land categories that are beneficial to the climate and the environment, and to develop further development guidelines based on the knowledge and experience gained from the implementation of this measure.

LUF-3: Reforestation works

Economic measure; implementation: 2021-2030

Afforestation on non-forested areas (in terms of IPCC methodology) is an activity that generates outflows. Due to the regulations in the field of nature protection governing the establishment of Natura 2000 sites, the Republic of Croatia is not able to dispose of all lawn areas (according to the national regulation: non-overgrown production forest land) for afforestation purposes. Considering that there are non-cultivated agricultural areas in the Republic of Croatia that have been neglected for many years, the problem of these areas must be adequately addressed when developing the Land Management Strategy. The justification of converting these areas to forested areas by afforestation needs to be assessed. It should be borne in mind that there is no restriction on the application of the amount of outflows in the calculation of outflows due to afforestation, and that these outflows are fully taken into account in the calculation. An assessment of the effects of afforestation of additional non-overgrown, productive forest land on the fulfilment of Croatia's obligations related to the use of renewable energy sources is also needed. Guidelines for further development need to be drawn up based on the knowledge and experience gained from the implementation of afforestation activities. In case of introduction of afforestation measures on neglected agricultural land, the measure will require strengthening of seed production and nursery services in the forestry sector and cultivation of planting material necessary for the implementation of these works.

LUF-4: Manufacture and use of wood and wood products

Regulatory, economic, educational, information measure; implementation: 2021-2030

Harmonize the available data and statistical reports and use new research to harmonize the information available for the purposes of different reporting to international organizations in order to provide accurate, transparent, and high quality reporting, as well as to create harmonized bases for the adoption of medium and long-term strategies in the forestry and wood processing sector. It implies mapping of forestry and timber industrial production. Encourage the use of wood products in traditional and new products in order 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 need to be drawn up based on the knowledge and experience gained from the implementation of this measure.

LUF-5: Agricultural land management

Economic measure; implementation: 2021-2030

Conducting activities in the management of agricultural land in a way that contributes to reducing the emission factor is of interest to family farms, since the EC CAP regulations state that the level of incentives increases if the emission factor is lower due to the way they are managed. Land management practices that can affect emissions and outflows, for example in soil storage, are: soil treatment methods, plantation/crop life (rotation period) and crop / plantation type, fertilizer application, residue management, erosion control, application of irrigation systems etc. Activities 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 the implementation of this measure.

LUF-6: Pasture management

Economic measure; implementation: 2021-2030

Conducting activities in the management of pastures in a way that contributes to reducing the emission factor is of interest to family farms, since the EC CAP regulations state that the level of incentives increases if the emission factor is lower due to the way they are managed. Activities 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 the implementation of this measure.

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

In the period of up to 2030 and 2050, it is necessary to provide funding for the implementation of technical and scientific projects in the LULUCF sector. Scientific projects should enable the development of different models for the purposes of moving to a higher level of IPCC methodology (Tier 3) with the aim of determining as accurately as possible the GHG emissions / outflows and, consequently, the planning of measures to reduce emissions and increase outflows.

The following are measures related to **reducing fugitive emissions**.

FUG-1: Refinery modernization

Implementation of investments in the modernization and improvement of production in order to maintain the competitiveness of refineries and decrease fugitive emissions from refineries.

FUG-2: Measures to increase energy efficiency by improving processes and process units

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

FUG-3: Methane flaring

In order to reduce fugitive emissions, instead of fuming methane, methane is burnt on a flare. In this way, methane emissions are reduced by 95-99% depending on the efficiency of the flares.

ii. Where 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 soil),
- scientific cooperation in the study of hydrogen, the removal and storage of greenhouse gases
- exchange of experiences related to greenhouse gas emissions and removals and adaptation to climate change.

Countries participating in informal regional coordination are considering the proposals made and will agree on next steps.

iii. Without prejudice to the applicability of State aid rules, financing measures, including Union support and the use of Union funds, in this area at national level, where 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, auction funds, the Modernization Fund and extra-budgetary funds, and the use of EU funds is expected, namely cohesion policy funds through technical assistance to national bodies administration and direct support from future operational programmes.

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, and so far there is limited experience in this area and no information on the cost of these units of emission.

3.1.2 Renewable energy

- i. Policies and measures to achieve the national contribution to the binding 2030 Union target for renewable energy and trajectories referred to in Article 4, item (a), subitem 2 and, if applicable and available, elements from section 2.1.2, including sector-specific measures and technology-specific measures**

The expected impact of a group of measures (OIE-1, OIE-2, OIE-3 and OIE-4) to encourage the use of RES is equal to an increase in the immediate consumption of RES in projections for the scenario with additional measures compared to the scenario with existing measures, which is 3. 59 PJ in 2030.

OIE-1: Information, education and capacity building for RES use

Information measure; implementation 2021-2030

Objective and description of the measure: Dissemination of information to the general public and target groups will be conducted through the organization of targeted informational campaigns related to investments in systems using renewable energy sources, especially in systems for own needs. Information, education, and capacity building for use of RES will be implemented at the national level and 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). If necessary, additional analyses of the possibilities of decarbonisation of the system will be carried out and the results will be introduced to the expert and general public.

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

- education and promotion of good practice, especially regarding small projects (up to 500 kW);
- implementation of educational programmes on the use of RES in kindergartens and schools;
- setting up and organizing an advisory service with experienced practitioners involved, especially for small projects (up to 500 kW);
- available information on administrative procedures, accredited equipment and certified installers;

- promotion of the use of systems in buildings (photovoltaic systems, solar thermal systems, heat pumps, biomass stoves and boilers);
- promotion of reconstruction of old mills and water mills into small hydropower plants;
- promoting the use of RES on islands;
- promoting the use of biomethane in transport and its injection into the gas network;
- development of a guide for integration of biomass projects into the bioeconomy for small projects (up to 500 kW);
- capacity building for the bioeconomy;
- designing and implementing new business models for the realization of anaerobic digestion (AD) plants for the production and use of biogas and biomass cogeneration;
- integration with the waste management system - use of biodegradable waste component as energy resource;
- capacity building and enhancement for all market players (active customers, energy communities, renewable energy communities, energy suppliers, aggregators, system operators, installers);
- promotion of corporate power purchase agreements (*corporate PPA*) for larger price-related projects;
- consulting with the financial sector, promoting good practice and education, for larger projects.

Funds needed for implementation: about HRK 5 million a year

Funding sources: Emission allowance auction assets (EPEEF) and EU funds.

Executive body: MEE - implementation and patronage of education and promotion programmes, organization of advisory service, design of new business models for realization of biogas plants and biomass cogeneration; EPEEF - providing part of the funds, participating in promotion and education activities; MCPP - promotion of the use of RES in buildings; CCE - promotion of the use of RES systems to entrepreneurs

MA 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; MEE in collaboration with LGUs - with programmes to promote RES in kindergartens and schools

Monitoring Bodies: MEE

Effect: 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.

Tracking method: Number of events, number of users

Connection to other dimensions: The measure is related to the dimension of 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.

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. reduction of vulnerability of RES technologies to climate change.

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- 2024

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.

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

- analysis of spatial plans with review of planned locations, mapping of resource potential for individual renewable sources (wind, solar, hydropower, geothermal water for energy purposes) with respect to existing and advanced energy conversion technologies and adaptations to climate change based on ecosystem characteristics within specific space for utilization of RES (planned and potential space), possibilities of energy storage from RES and integration into the existing distribution system;
- 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 utilization technologies;
- 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 utilization 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 sensitivity of space to the construction of RES facilities (generating plants using RES with associated infrastructure).

Funds needed for implementation: initial funds HRK 1 000 000 + funds earmarked for implementation of the strategy and action plan for the application of protection measures in procedures under special laws + regular work of state bodies + a new generation of spatial plans

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: MCPP and MEE, in cooperation with the Ministry of Agriculture; counties, cities and municipalities

Monitoring (supervision) bodies: MCPP, MEE

Effect: Increasing the installed capacity of RES in the next generation PPs with sustainable use of space and natural resources (acceptable environmental impacts) and reducing greenhouse gas emissions.

Tracking method: Number of counties that have defined the conditions for the location and construction of RES plants, on the basis of 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; installed capacity of RES facilities (production facilities using RES with associated infrastructure).

Connection to other dimensions: The measure is related to the dimension of increasing energy security (conditions for increasing energy production) and developing the internal energy market. Within this measure, some research needs to be carried out, so the measure is related to the research and development dimension.

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. reduction of vulnerability of RES technologies to climate change.

Research and development: Yes. Link through exploration of resource potential and mapping of spatial, environmental and infrastructural constraints and sensitivity of space for plant construction and operation.

OIE-3 Promoting the RES use for production of electricity and thermal energy

Financial measure; implementation 2021 -2030

Objective and description of the measure: Provide financial incentives for the development of RES projects for electricity and heat production. Encouraging the use of RES for electricity and heat production will be implemented at the national level.

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

- The Croatian energy market operator (CEMO) continues to pay incentives to generate electricity to RES-using power plants for the duration of the purchase agreement;
- CEMO prepares three-year RES plans and announces tenders for assigning market premiums;
- CEMO establishes the functioning of the premium system under the Renewable Energy Sources and High Efficiency Cogeneration Act with system modifications made possible by changing the market status of individual RES technologies and developing day-ahead and within the daily electricity market solely to mitigate the market risks of new RES projects; the premium system is implemented to a minimum extent as a transition measure to full market integration of RES;
- 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;
- 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 participates with financial incentives on the investment side for RES projects for the production of heat energy, and for smaller systems using RES;
- The EPEEF allocates part of the proceeds from the sale of emission units through EU ETS auctions for measures to stimulate RES on the investment side and to relieve end customers from increasing the RES incentive fee;
- The Ministry of Agriculture, through the Rural Development Programme, ensures the financing of investment grants for biomass and other RES projects.

Funds needed for implementation: HRK 6-8 billion for the entire observed period

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

Funding Sources: RES fee (CEMO); proceeds from the sale of renewable energy in the market; proceeds from trade in guarantees of origin; the proceeds from the auctioning 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, establishment of a premium model with a protective price and a shortened duration of premium agreements, invitation to tender; MEE - making plans; EPEEF - participation in RES investment grants and as support of operational incentive systems; MA - implements the Rural Development Programme and participates in RES investment grants; HA (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: MEE

Effect: 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 preconditions for the establishment of a monitoring system to meet the sustainability criteria and the expected reductions in greenhouse gas emissions from biomass plants.

Tracking method: Energy balance, namely: 1) the amount of electricity generated from RES, according to the reports of CEMO and the system operator; 2) the amount of energy produced for heating and cooling, according to statistical reports. Monitoring the effects will also take place through the measurement of soil organic matter and carbon content.

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 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. reduction of vulnerability of RES technologies to climate change.

Research and development: The measure is related to the research and development of RES technologies and the integration of RES into energy systems.

OIE-4 Developing a regulatory framework for RES use

Regulatory measure; implementation: 2021–2022

Objective and description of the measure: The existing legal framework needs to be supplemented and procedures and practices developed. The goal by 2022 is to fully adopt the regulatory framework and established procedures at national level.

The current regulatory framework for the use of renewable energy sources is covered by several laws. The Renewable Energy Sources and High Efficiency Cogeneration Act with a series of by-laws is worth mentioning as a key piece of legislation. The existing legal solutions need to be complemented by the development of a regulatory framework for active customers, aggregators, energy communities, renewable energy communities (participation in local energy production, distribution, storage and supply and provision of energy and aggregation services) and energy production for own needs, in accordance with the provisions of the renewable energy promotion directive, the electricity directive and the internal electricity market regulation. If necessary, an action plan will be developed for the development of energy and renewable energy communities. It is also necessary to establish a regulatory framework and conditions for establishing sustainability criteria, reducing greenhouse gas emissions for biofuels, bioliquids and biomass fuels and the use of digestates for fertilization, thereby enabling the decarbonisation of agriculture through greater use of organic fertilizers, increasing organic matter in soil and reducing agro-input costs. A regulatory framework needs to be put in place to link the processes of geothermal energy use, which include the exploration phase in accordance with the Act on the Exploration and Exploitation of Hydrocarbons and the electricity and heat production phase in accordance with the Renewable Energy Sources and High Efficiency Cogeneration Act.

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

- MEE regulates the regulatory framework for on-site production by defining connection rules, redemption obligations and net metering;
- MCPP regulates and introduces obligations for the use of RES in new buildings (construction-related regulations);
- CERA and HEP-DSO are developing new methodologies for determining distribution grid charges that would take into account distributed generation by energy customers;
- MCPP ensures the continued functioning of certified installer systems for small RES systems¹⁶;
- All participants are tasked with ensuring the general simplification, development and maintenance of administrative procedures;

¹⁶ Refers to securing a certification programme or equivalent qualification programme for installers of renewable energy systems: photovoltaic systems, solar thermal systems, shallow geothermal systems and heat pumps, and smaller biomass boilers and stoves

- The Ministry of State Property (MDI) makes it easier to regulate state land use and reduce fees;
- The MA ensures the establishment and monitoring of sustainability and digestate use criteria;
- Arranging the area of bilateral contracting (corporate power purchase agreement).

Funds needed for implementation: -

Funding sources: Budgetary funds

Executive body: MEE - general arrangement of the legislative framework, supplementing the existing one with new solutions; MCPP - arrangement of obligations to use RES in new buildings, continuation of the functioning of the system of certified installers; MSP - regulates simpler use of state land; CERA - development of methodology for determining distribution grid fee and development plans.

Monitoring Bodies: MEE

Effect: The result of the implementation of the measure is a functional RES market and an increase in energy production and a share of RES in total energy consumption.

Tracking 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).

Connection to climate change adaptation: The use of RES is planned with the integration of climate change adaptation measures and strengthening of resilience, i.e. reduction of vulnerability of RES technologies to climate change.

Research and development: /

ii. Where relevant, specific measures for regional cooperation, as well as, as an option, the estimated excess production of energy from renewable sources which could be transferred to other Member States in order to achieve the national contribution and trajectories referred to in point 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,
- cooperation 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 next steps.

iii. Specific measures on financial support, where applicable, including Union support and the use of Union funds, for the promotion of the production and use of energy from renewable sources in electricity, heating and cooling, and transport

The required amount of RES support for electricity is estimated in the next section.

iv. Where applicable, the assessment of the support for electricity from renewable sources that Member States are to carry out pursuant to Article 6(4) of Directive (EU) 2018/2001

It is estimated that support of HRK 6 to 8 billion is required in the observed period.

The aforementioned amount of aid was calculated on the basis of the investment subsidy required to make the levelling cost of electricity 55 EUR / MWh. This calculates the amount of subsidy required for all the technologies envisaged per MW of installed capacity. That amount was multiplied by the projected power installed in power plants, by technology.

The final amount of support required will depend primarily on the development of technology.

v. Specific measures to introduce one or more contact points, streamline administrative procedures, provide information and training, and facilitate the uptake of power purchase agreements

This is stated in RES-1 “Information, education and capacity building for RES use”.

vi. Assessment of the necessity to build new infrastructure for district heating and cooling produced from renewable 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 connection and operation of production plants for the production of 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 maximize 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, which will consequently create 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. The use of geothermal energy reduces the consumption of conventional energy sources (e.g. fossil fuels), resulting in a positive environmental impact. The use of RES in district heating systems will be supported by the implementation of the ENU-17 measure Increasing the efficiency of the heating system.

vii. Where applicable, specific measures to encourage the use of energy from biomass, in particular for the production of new biomass, taking into account 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 encourage the use of biomass energy are measures POLJ-4 Anaerobic manure decomposition and biogas production, POLJ-15 Collection and treatment of agricultural plantations and residues for energy use and TR-13 Advanced biofuel market development plan. Sustainability of biomass production and use will be promoted under measure MS-11 Establishing a bioeconomy platform.

3.1.3 Other elements of the dimension

i. Where applicable, national policies and measures affecting the EU ETS sector and assessment of the complementarity and impacts on the EU ETS

Based on the *Decision on the Fee for Renewable Energy Sources and High-Efficiency Cogeneration* (OG 87/17), ETS payers pay a lower fee for renewable energy and high-efficiency cogeneration in the amount of HRK 0.007 / kWh, while the fee for other end customers of electricity is 0.105 HRK / kWh.

Croatia introduced CO₂ emission allowances in 2007 based on the *Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon dioxide into the environment* (OG 73/07, 48/09, 2/18). The payers are individual stationary sources, which emit CO₂ in excess of 450 tonnes per year and the unit charge is HRK 14 / tCO₂. ETS participants are exempted from the obligation to pay CO₂ emission allowances, to avoid the double financial burden due to greenhouse gas emissions.

Reducing the amount of the Fee for Renewable Energy Sources and High-Efficiency Cogeneration and waiving the CO₂ emission payment obligation facilitates business operations for ETS participants from Croatia, on the other hand, the relatively high price of emission units on the ETS market (secondary EEX spot market on 12/06/2019 at 10:23 am: EUR 24.63 / tCO₂e) stimulate the implementation of measures to reduce greenhouse gas emissions.

ii. Policies and measures to achieve other national targets, where applicable

Climate change mitigation and adaptation are considered pillars of climate policy implementation. In terms of adaptation to climate change, adoption of the *Strategy on Climate Change Adaptation in the Republic of Croatia for the period until 2040 with an outlook to 2070*, the first document of its kind in the Republic of Croatia, is underway. 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 certain sectors and the entire economy and society to climate change.

According to the Draft Adaptation Strategy, the vulnerability of the Republic of Croatia to the effects of climate change is high, especially for the sector of agriculture, forestry, fisheries, energy and tourism, because the success of all these sectors depends largely on climatic factors.

Five national priorities have been identified under which climate change adaptation measures need to 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 Draft Adaptation Strategy identifies a set of measures for each sector as well as cross-sectoral measures. By their nature, the measures are regulatory and administrative, implementing, public education and awareness measures, and research and development measures. In addition to character, measures are also prioritized (measures of very high importance, high importance and medium importance).

The adaptation strategy will be implemented through implementation action plans, which will include the elaboration of concrete measures and activities for a specific five-year period..

iii. Policies and measures for achieving low-emission mobility (including transport electrification)

The expected effects of a group of low-emission mobility incentives are:

- reduction of final energy consumption in transport in projections for the scenario with additional measures compared to the scenario with existing measures, which amounts to 4.48 PJ in 2030;
- RES share in transport of 13.2%.

TR-1: Providing information to consumers on fuel cost-effectiveness and CO₂ emission of new passenger cars

Regulatory measure; implementation: 2015 – 2030

Objective and description of the measure: According to the Ordinance on availability of information on fuel cost-effectiveness and CO₂ emissions from new passenger cars (OG 7/15), each supplier of new passenger cars intended for sale is obliged to provide consumers with available information on fuel consumption levels and specific emissions of CO₂ of passenger cars. On the basis of the Ordinance, the Ministry of the Interior as the central state administration body responsible for road traffic safety shall once a year and no later than 31st March of the current year prepare the Guidelines on cost-effectiveness of fuel consumption and CO₂ emissions of new passenger cars available for purchase on the market in the Republic of Croatia. The Guidelines contain required information for each model of new passenger cars available on the domestic market.

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

- Extension of information to other categories of motorized road vehicles.

Funds needed for implementation: The Ministry of Internal Affairs plans to finance the implementation of these activities within its annual budgets as an integral part of its regular activities.

Funding Sources: State Budget (Ministry of the Interior)

Executive body: MOI

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions

Monitoring method: /

Connection to other dimensions: a direct link to the energy efficiency dimension as it also informs fuel economy

Connection to climate change adaptation: /

Research and development: /

TR-2: Special environmental fee for motor vehicles

Regulatory, para-fiscal measure; implementation 2014 - 2030

Objective and description of the measure: The existing system of payment of a special environmental fee for motor vehicles is regulated by the Act on the Environmental Protection and Energy Efficiency Fund (OG 107/03, 144/12), and the Regulation on unit charges, corrective coefficients and detailed criteria and standards to determine the special environmental fee for motor vehicles (OG 114/14, 147/14). The special fee is charged taking into consideration the type of engine and fuel, engine operating volume, type of vehicle, CO₂ emissions and vehicle's age.

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

- Conducting a detailed analysis to determine the need to modify and improve the existing payment system. The possibility of additional taxation of vehicles of certain environmental categories will be considered.

Funds needed for implementation: The Ministry of Environment and Energy plans to finance the implementation of these activities within its annual budgets as an integral part of its regular activities.

Funding Sources: State budget (MEE)

Executive body: MEE, EPEEF

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions

Monitoring method: /

Connection to other dimensions: a direct link to the energy efficiency dimension, as fees can be marketed and channelled towards more energy efficient vehicles

Connection to climate change adaptation: /

Research and development: /

TR-3: Special tax on motor vehicles

Regulatory, fiscal measure; implementation 2014 - 2030

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

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

- Conducting a detailed analysis to determine the need to modify and improve the existing payment system. This will consider the possibility of additional taxation of vehicles of certain environmental categories, the possibility of eliminating the depreciation of the calculated special tax on used vehicles, and the possibility of redefinition of fees in view of the declared measurement cycle of fuel consumption and exhaust emissions (WLTP or NEDC) of a specific vehicle.

Funds needed for implementation: The Ministry of Energy and the Environment plans to finance the implementation of these activities within its annual budgets as an integral part of its regular activities.

Funding Sources: State budget (MEE)

Executive body: MEE, MFIN

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions

Monitoring method: /

Connection to other dimensions: a direct link to the energy efficiency dimension, as the tax policy can be marketed and channelled towards more energy efficient vehicles

Connection to climate change adaptation: /

Research and development: /

TR-4: Monitoring, reporting and verification of greenhouse gas emissions in the life cycle of fuels and energy

Regulatory measure; implementation: 2017 – 2030

Objective and description of the measure: In accordance with the Air Protection Act (OG 130/11, 47/14, 61/17), the supplier placing fuel on the domestic market will monitor greenhouse gas emissions per unit of energy during the fuel life cycle. Suppliers should draw up a report to be verified and submitted to the Ministry of Environment and Energy - Institute for Environmental and Nature Protection. In accordance with the Act, the Regulation on the quality of liquid petroleum fuels and the method of monitoring and reporting and methodology for calculation of greenhouse gas emissions in the life cycle of delivered fuels and energy (OG 57/17) stipulates the method and deadlines for delivering reports on the quality of liquid petroleum fuels and reports on greenhouse gas emissions in the life cycle of fuels and energy to the Ministry of Environment and Energy, method of monitoring and reporting, methodology for calculating greenhouse gas emissions in the life cycle of fuels and energy, methodology for determining the level of greenhouse gas emissions in the life cycle of fuels per unit of energy for the baseline year 2010, methodology for calculating the contribution of electric road vehicles to the reduction in greenhouse gas emissions, format of the report and retention period, and manner of data delivery to the competent bodies of the European Union.

Activities: The implementation of legal obligation will continue within the framework of the measure.

Funds needed for implementation: The Ministry of Environment and Energy plans to finance the implementation of these activities within its annual budgets as an integral part of its regular activities.

Funding Sources: State budget (MEE)

Executive body: MEE

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions

Monitoring method: Preparation and verification of GHG emission reports in the fuel lifecycle

Connection to other dimensions:/

Connection to climate change adaptation: /

Research and development: /

TR-5: Regulatory framework development for cleaner transport

Regulatory measure; implementation: 2021 – 2030

Objective and description of the measure: Amend laws and by-laws to ensure the development of alternative fuel infrastructure, to increase the share of renewable sources in final energy consumption in transport, and to promote clean and energy-efficient vehicles in road transport. The objectives of the measure are to increase the share of RES in traffic by 2030, 37% of the share of light vehicles meeting the set requirements in the overall public procurement of light vehicles at the national level by 2030, 13% of the share of light vehicles meeting the set requirements in the total public procurement of heavy vehicles at the level states by 2030 and 65% of the proportion of buses that meet the set requirements in the total public procurement of buses at the state level by 2030.

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

- Laws and by-laws should be adopted at the national level to regulate the conditions for the construction of electric vehicle charging stations (including charging stations with the associated photovoltaic system), the conditions of distribution, billing and the unit price of alternative energy used in transport, the conditions for charging stations for LNG and CNG / CBM and consider the requirements of the new Energy Performance of Buildings Directive. It is necessary to anticipate amendments to the laws by stipulating obligations to establish infrastructure for alternative fuels for entities managing the transport infrastructure and amendments to the laws regulating the conditions for construction of parking spaces so that the obligation of establishment of filling stations for alternative fuels is introduced. Fulfilment of this obligation is a prerequisite for further development of the alternative fuels infrastructure.
- The basic document that regulates and promotes the use of biofuels is the Act on Biofuels for Transport (OG 65/09, 145/10, 26/11, 144/12, 14/14, 94/18). In 2010, the National Action Plan that promotes the production and use of biofuels in transport for the period 2011 - 2020 was prepared in accordance with this Act. The plan establishes a policy that promotes increased production and use of biofuels in transport in the Republic of Croatia. The plan includes an overview and assessment of the conditions on the market of fuels for transport and air protection, comparative analysis, long-term goals, including the targeted biofuels market and measures to promote increased production and use of biofuels in transport. The measures stipulated by the action plan include measures promoting the production of feedstock for biofuels, measures promoting biofuel production with regard to the fee for promotion of production, measures promoting biofuel consumption with regard to distributors of liquid petroleum products for placing biofuels on the market, administrative measures and research and development activities. The 2013 National Renewable Energy Action Plan identified the goals and policies related to increasing the share of RES in final energy consumption by 2020 and the specifically estimated contribution of energy of biofuels in transport.
- In the forthcoming period, Croatia will transpose the obligations under the Renewable Energy Promotion Directive, adopted in December 2018. 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 renewable electricity in transport. In order to ensure that the expected increase in electricity demand above the current baseline in the transport sector is ensured through the use of additional renewable energy production capacities, the framework for the additionality in the transport sector developed by the Commission will be transposed into the Croatian regulatory framework.

- For the purpose of analysing the feasibility of meeting the target of 3.5% of advanced fuels by 2030 (Article 25 (1) of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources) from domestic raw materials and the development of domestic technological capacity, research and analysis of advanced biofuel production opportunities. The aim of the mentioned analysis is to determine the possible capacities for domestic production based on the availability of raw materials and technological parameters. As part of the elaboration of the regulatory framework, financial mechanisms will be established to support the development and use of favourable options identified in the analysis. The establishment of a regulatory framework and conditions for establishing monitoring of sustainability criteria and greenhouse gas savings for biofuels, bioliquids and biomass fuels is foreseen within the OIE-4 measure.
- The Act on the Promotion of Clean and Energy-Efficient Vehicles in Road Transport (OG 127/13) is currently in force, which stipulates that all purchasers and carriers performing public liner transport on the basis of a public service contract, when purchasing vehicles for road transport, must take into account their energy and environmental effects during the period of vehicle utilization. It is necessary to transpose the revised obligations under the Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles (EU 2019/1161) in order to support low-emission mobility in the context of the purchase, leasing, rental or leasing of publicly contracted road vehicles or contracting authorities if they are obliged to apply procurement procedures and operators to fulfil public service obligations under a public service contract.
- In addition to the transposition of obligations from the directives in question into legislation, the Republic of Croatia will define an action plan and prescribe a timeframe for the gradual introduction of low-carbon solutions in the context of the provision of public services. In the near future, all public service providers will have the obligation to use only energy efficient low- or no- emission fleets.

Funds needed for implementation: Funding for the implementation of these activities is planned by the competent ministries (for transport infrastructure, energy, interior, construction and spatial planning and environment) within their annual budgets as an integral part of their regular activities.

Funding Sources: State budget (competent ministries)

Executive body: competent ministries

Monitoring bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency and other relevant ministries

Effect: Accelerating the development of the alternative energy market, increasing the share of RES in final energy consumption in transport, increasing the share of clean vehicles in road transport

Tracking method: RES reports on the market in the transport sector, reports on energy consumption in transport

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: Sustainable mobility and alternative fuels in transport require the development of new technologies in the field of vehicles, infrastructure and advanced management systems based on information and communication technologies.

TR-6: Financial incentives for energy-efficient vehicles

Financial measure; implementation 2014 - 2030

Objective and description of the measure: In the context of co-financing of cleaner transport projects, it is necessary to define specific co-financing lines for specific purposes, for the purchase of vehicles of all categories with electricity, CNG / SBP, LNG / LBG and hydrogen. Incentives for co-financing the purchase of vehicles should be conducted consistently, transparently and continuously, and 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 and will be time-limited until the minimum representation of vehicles is achieved. The minimum degree of market development shall be considered to be 1 percent of alternative fuel vehicles in the total number of vehicles registered in the country.

Activities: As part of the measure, co-financing activities for energy efficient vehicles will be implemented through public calls from the EPEEF.

Funds needed for implementation: HRK 900 million

Funding Sources: EPEEF from the proceeds from the auctioning of emission units, from the funds collected from the special vehicle fee and from the special environmental fee for the marketing of biofuels, ESI funds

Executive body: EPEEF

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions; estimated savings in 2030 0.25 PJ (decrease in consumption of gasoline and diesel fuel) and 0.1 PJ (increase in consumption of electricity); estimated CO₂ emission reductions in 2030. 18.3 ktCO_{2e}; cumulative energy savings in 2021-2030 1.39 PJ; cumulative CO₂ emission reductions in the period 2021-2030, 101.8 ktCO_{2e}

Tracking method: This measure will be monitored by the Energy Saving Monitoring, Measurement and Verification System (SMIV) estimation method.

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: Sustainable mobility and alternative fuels in transport require the development of new technologies in the field of vehicles, infrastructure and advanced management systems based on information and communication technologies.

TR-7: Development of alternative fuels infrastructure

Financial measure; implementation 2019 - 2030

Objective and description of the measure: The aim of this measure is to facilitate the acceptance of alternative fuels by users/ consumers by strengthening the infrastructure for the distribution of alternative fuels and implementing common technical specifications for this infrastructure. This infrastructure measure will not directly affect the reduction of fuel consumption in transport, but certainly the development of infrastructure is a necessary prerequisite for the development of markets for vehicles and vessels using electricity, CNG / SBP, LNG / LBG and hydrogen in Croatia.

Incentives for co-financing infrastructure will be primarily geared towards alternative fuels for which the assessment of the existing situation has shown an inadequate development of infrastructure and will be time-limited until the minimum infrastructure development is achieved. The minimum infrastructure development shall be considered to be one that corresponds to the minimum infrastructure targets from the NPF.

In addition, the measure provides for the establishment of a central register of alternative fuel infrastructure that will facilitate the user experience for drivers and ultimately provide a realistic insight into energy consumption for analytical purposes.

Activities: The measure will co-finance alternative fuel distribution infrastructure through public call for proposals from the EPEEF.

Funds needed for implementation: HRK 370 million

Funding Sources: EPEEF from the proceeds from the auctioning of emission units, from the funds collected from the special vehicle fee and from the special environmental fee for the marketing of biofuels, the Modernization fund, ESI funds, and other sources

Executive body: EPEEF (co-financing), MSTI (Central Infrastructure Register)

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Accelerating the development of alternative energy-generating product markets

Monitoring method: /

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: Sustainable mobility and alternative fuels in transport require the development of new technologies in the field of vehicles, infrastructure and advanced management systems based on information and communication technologies.

TR-8: Promotion of integrated freight transport

Regulatory measure; implementation: 2016 – 2030

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

Activities: Implementation in accordance with the Law will continue. An analysis will be made to identify the need to modify and improve the existing system. In doing so, the possibility of including other road vehicles (except trucks) in the incentive system will be analysed.

Funds needed for implementation: The fees are provided for in the Ordinance on Incentives in Combined Freight, and are provided from the state budget.

Funding Sources: State Budget

Executive body: Ministry of the Sea, Transport and Infrastructure

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions

Tracking method: Reports on assigned incentives

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: /

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

Information and organizational measure; implementation 2019 - 2030

Objective and description of the measure: The measure builds on the general and specific objectives defined in the Transport Development Strategy of the Republic of Croatia (2017-2030) in the context of energy efficiency/intramodality for rail, road, maritime, inland waterway

and urban, suburban and regional traffic (track modernization, signalling system, refurbishment of rolling stock, wagons, vessel fleet, logistic intermodal platforms, integrated public transport of passengers, etc.) Rail and generally multimodal infrastructure are lagging behind in comparison to highway infrastructure in terms of quality and connectivity. Investments are planned to develop a sustainable, integrated trans-European climate-resilient transport network. In maritime and inland waterway transport, the Republic of Croatia, in consultation with other Member States, will analyse the feasibility of introducing appropriate mechanisms to ensure the transition to low carbon solutions, in particular with regard to the application of alternative energy sources for navigation. In this context, an action plan for shipping will be defined, *inter alia*, defining appropriate emission standards for the coming period. Also, in air transport, the Republic of Croatia will define a plan and elaborate detailed guidelines for achieving significant reductions in greenhouse gas emissions. All activities related to defining the plan and guidelines will be developed jointly at the EU level, taking into account the views to be taken at the level of the International Civil Aviation Organization (ICAO).

Activities: Within the measure, activities envisaged by the Strategy will be elaborated and implemented.

Funds needed for implementation: Not estimated

Funding Sources: ESI Funds - Depending on plans and projects; Ministry of the Sea, Transport and Infrastructure

Executive body: Ministry of the Sea, Transport and Infrastructure

Monitoring bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency in coordination with MSTI

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions

Tracking 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

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: Sustainable mobility and alternative fuels in transport require the development of new technologies in the field of vehicles, infrastructure and advanced management systems based on information and communication technologies.

TR-10: Promotion of intermodal and intelligent transport and development of alternative fuels infrastructure at local and regional level

Information and organizational measure; implementation 2019 - 2030

Objective and description of the measure: It is necessary to promote sustainable development of urban transport systems through the optimization of logistics of transport of goods and intelligent management of public parking spaces (ICT), introduction of integrated passenger transport, introduction of car-sharing schemes in cities, introduction of low emission zones in cities, introduction of public city bicycles systems (with and without electrical drive) and construction of the accompanying cycling infrastructure, intelligent traffic control (upgrade, adaptation and replacement of obsolete signalling devices and equipment, installation of advanced traffic equipment and intelligent traffic lights equipped with the autonomous power supply system from renewable sources, constructing and equipping central operating centres for monitoring and management of intersections with installed traffic lights). At the local level, it is necessary to continuously prepare and implement Sustainable Mobility Plans in cities, as well as strategic plans that build on the existing planning practices, and take into account integration, participation and evaluation principles to meet the citizens' mobility needs now and

in the future, and ensure better quality of life in cities and their surroundings. The activities will be accompanied by appropriate outreach campaigns. The objective of these measures is 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.

Activities: Within the measure, co-financing activities will be implemented through public calls from the EPEEF as well as activities undertaken independently by the LGUs in accordance with their plans for the sustainable development of transport systems.

Funds needed for implementation: HRK 85 million

Funding Sources: EPEEF from the proceeds from the auctioning of allowances, from the special vehicle fee and from the special environmental fee for the placing on the market of biofuels, the Modernization Fund, ESI Funds, LGU budgets, EU funds - depending on plans and LGU projects

Executive body: EPEEF (Co-financing and Call for Proposals), LGUs - planning through annual and Action plans and implementation

Monitoring bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency in coordination with MSTI

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions; estimated savings in 2030 0.15 PJ; estimated CO₂ emission reductions in 2030. 11.0 ktCO_{2e}; cumulative energy savings in 2021-2030 1.19 PJ; cumulative CO₂ emission reduction in the period 2021-2030. 87.1 ktCO_{2e}

Tracking 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

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: Sustainable mobility and alternative fuels in transport require the development of new technologies in the field of vehicles, infrastructure and advanced management systems based on information and communication technologies.

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

Information measure; implementation 2011 - 2030

Objective and description of the measure: The aim of the measure is to raise awareness of the benefits of energy-efficient driving. Education on the eco-driving elements is carried out in short trainings (of around 60-120 minutes per candidate) among the drivers who received their driver's license prior to the entry into force of the Ordinance on Training of Driver's License Candidates (OG 13/09, 132/17), which introduced an obligation for all driving schools and instructors to carry out training on the elements of eco-driving during the standard training of candidates. It should be noted that the proposed measure does not apply to new drivers, which receive eco-driving training in accordance with the statutory obligations set out in the said Ordinance. Special elements of the national campaign should be devoted to eco-driving education for drivers of passenger cars, buses, commercial and heavy duty vehicles. It is planned to introduce a special educational module related solely to electric vehicles (driving education and charging habits). The measure plans to cover 1,000 drivers a year.

Activities: As part of the measure, co-financing activities for energy efficient vehicles will be implemented through public calls from the EPEEF.

Funds needed for implementation: HRK 18 million

Funding Sources: EPEEF from the proceeds from the auctioning of emission units, from the funds collected from the special vehicle fee and from the special environmental fee for the marketing of biofuels, ESI funds

Executive body: EPEEF

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Save energy, reduce CO_{2e} emissions and reducing pollutant emissions; estimated savings in 2030 0.03 PJ; estimated CO₂ emission reductions in 2030. 2.2 ktCO_{2e}; cumulative energy savings in 2021-2030 0.3 PJ; cumulative CO₂ emission reduction in the period 2021-2030. 22,0 ktCO_{2e}

Tracking method: This measure will be monitored by the Energy Saving Monitoring, Measurement and Verification System (SMIV).

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: /

TR-12 Promotion of boat transport using alternative fuels

Financial measure: implementation 2019-2030

Objective and description of the measure: Under the "Alternative Fuels Infrastructure Establishment Act", alternative fuels are defined as fuels or energy sources that can at least partially replace fossil fuels. These include electricity, including battery, hydrogen, biofuels, synthetic and paraffin fuels, natural gas, including biogas, in gaseous (CNG) and liquefied natural gas (LNG) and liquefied petroleum gas (LPG). In accordance with the "National Coastal Line Maritime Traffic development plan" and considering that the Republic of Croatia is a maritime country with developed coastal line traffic, and in addition has navigable river routes and lakes, this measure would co-finance the projects of gradual transition of the existing obsolete fleet to alternative and / or hybrid solutions and new construction. Ships using alternative fuels are generally more expensive than ships using conventional fuels, so there is no expressed interest of shipowners to invest in such ships. Therefore, it is necessary to financially support the conversion / construction of such vessels to the extent that the purchase price is equalized, or that shipowner is put in the same position as a shipowner using conventional fuel ships. This measure builds on the measure related to the development of alternative fuel infrastructure in terms of permanent users / consumers on that infrastructure, while significantly affecting the potential reduction of pollution of the sea, rivers and lakes.

Activities: The measure will co-finance the conversion of the existing fleet of ships and the construction of new alternative fuel vessels through public calls from the EPEEF.

Funds needed for implementation: HRK 300 million

Funding Sources: EPEEF from proceeds from the sale of emission units through auctions, ACLMT tenders, ESI funds and other sources

Executive body: EPEEF

Monitoring Bodies: MSTI - National Coordination Body

Effect: Accelerating the development of active users of alternative energy, saving energy and reducing CO₂ emissions and reducing pollutant emissions

Tracking method: Reports on the number of alternative fuel vessels via the Croatian Register of Shipping

Connection to other dimensions: direct connection to the energy efficiency dimension

Connection to climate change adaptation: /

Research and development: Opportunity for research and development from the design phase to finished crafts.

TR-13: Advanced biofuels market development plan

Regulatory, promotional measure; implementation: 2021-2030, updated every 2 years

Objective and description of the measure: increase of RES share in transport by 2030, through development of the advanced fuels market and achievement of the planned share of advanced fuels in final energy consumption in transport through the least cost criteria and the largest multiplier. The implementation of the measure is based on amendments to the relevant laws and bylaws based on the Directive on the promotion of the use of energy from renewable sources, and in particular to establish conditions for monitoring the sustainability of biofuels and greenhouse gas savings.

Activities:

- Analysis and exploration of the scenario for meeting the share of advanced fuels by 2030 through the development of technological capacities that have the highest value added and multiplier effect on the domestic economy. The aim of this analysis is to identify possible capacities with domestic production sites based on the availability of raw materials and technological capabilities (existing and possible) and to identify stakeholders, needs and barriers to the development of the advanced fuel market.
- Development, adoption and implementation of the Plan and Programme for the production and use of biofuels in transport. The plan is based on the adapted legislative framework (OIE-4 and TR-5) and the results of the analysis in item 1. The plan will set out a policy to promote the production and use of advanced biofuels in transport in the Republic of Croatia. The plan will include an immediate review and assessment of the state of the biofuels market, new business models, stakeholders, measures to promote increased production and use of advanced biofuels in transport, and a trajectory to achieve the goal of advanced fuels in transport by 2030. The measures prescribed by the plan will include measures aimed at the production of advanced biofuels from raw materials under Part A of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, measures for the use of advanced biofuels, R&D measures, market strengthening, administrative measures. The plan will help attract the announced investments for a zero-pollution Europe.
- Establishment of a model for the promotion and development of the advanced biofuel transport market by the Ministry, including the establishment of financial support through existing programmes (e.g. Rural Development Programme, HAMAG-BICRO, BBI JU) for advanced biofuel projects

Funds needed for implementation: The competent ministries (MEE, Ministry of Agriculture) plan to finance the implementation of these activities within its annual budgets as an integral part of its regular activities. Cost of analysis from item 1: HRK 1 million.

Funding Sources: State budget (competent ministries), EU funds

Executive body: MEE in cooperation with the Ministry of Agriculture, Ministry of Economy and Entrepreneurship and Ministry of Finance

Monitoring (supervisory) bodies: MEE

Effect: Accelerating the development of the advanced fuel market and increasing the share of RES in final energy consumption in transport and reducing transport emissions. Reducing the carbon footprint of bioeconomy stakeholders.

Tracking method: Reports on RES quantity placed on the market in the transport sector

Research and development: In order to achieve this objective, it is necessary to improve existing and develop new technologies for the production of advanced fuels in transport, as well as new business models for increasing the use of advanced biofuels.

Connection with other dimensions: The measure can be linked primarily to the dimensions of 3) energy security and 5) research on innovation and competitiveness.

The connection with climate change adaptation: The development of the advanced fuel market is planned with the integration of climate change adaptation measures and the strengthening of resilience and / or reduction of market vulnerability to climate change.

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 immediate energy consumption in projections for the scenario with additional measures compared to the scenario with existing measures, which amounts to 10.76 PJ in 2030.

Planned policies, measures and programmes for the achievement of the national target of increase in 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 financial nature) for the promotion of energy performance of buildings, are listed below, according to specific areas.

i. The energy efficiency obligation and alternative measures system referred to in Articles 7a and 7b of Directive 2018/2002 on the amendments to Directive 2012/27/EU on energy efficiency

ENU-1: Energy efficiency obligation scheme 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 (OG 127/14, 116/18), and its functioning is further defined by the Ordinance on the Energy Efficiency Obligation System (OG 41/19). Obligated entities of the energy efficiency obligation system are supplied by energy suppliers. The system has been operational since 2019, when it was entered by suppliers that have delivered more than 300 GWh of energy to the market during 2017. In 2020, the suppliers who delivered more than 100 GWh of energy to the market in 2018 enter 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. The objective is to achieve 50% savings under Article 7 of the Energy Efficiency Directive through the energy efficiency obligation scheme. It was assumed that savings would be achieved in each year in the amount of 0.5 PJ (11.7 ktoe) per annum.

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

- The MCPP determines the exact annual amount of energy savings obligation in kWh for the following year for each obligated party until 30th of June of the current year, allocating to all obligated parties a part of the national framework energy savings goals for the next year realized through the obligation system as well as the cumulative energy savings goal until the end of the current cumulation period;
- Suppliers can fulfil their obligation in one of the following three key ways: investing in and stimulating energy efficiency improvements in immediate consumption; by buying savings from another obligated party or by paying contributions to the

Environmental Protection and Energy Efficiency Fund. Suppliers are not prescribed neither eligible investment sectors nor eligible investment measures, while the savings from such investments can be demonstrated by methods from the Ordinance on the system for monitoring, measurement and verification of energy savings. Investments should not relate to activities previously covered by alternative measures.:

- It is necessary to amend and regularly improve the Ordinance on the system for monitoring, measurement and verification of energy savings, in order to extend its scope to most measures implemented by suppliers;
- In the light of past experience and the provisions of Directive 2018/2002 on energy efficiency, legislative changes should also be considered in order to improve the functioning of the system, especially in the area of savings trading;
- Revenues from fees collected on the basis of the obligation system shall be used by the Fund purposefully. 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 from 2021. Creating such a Schedule is absolutely necessary to ensure the optimal allocation of funds from all available sources and to ensure that the Fund has clear guidelines on how to invest these resources. In view of 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.

Funds needed for implementation: Not estimated

Funding Sources: Energy Efficiency Obligation Scheme payer funds

Executive body: Obligated entities of the Energy Efficiency Obligation System (Suppliers)

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reduction of final energy consumption and consequent reduction of CO₂ emissions: estimated savings in 2030. 5.00 PJ (117.0 ktoe); estimated CO₂ emission reductions in 2030. 137.62 ktCO_{2e}; cumulative energy savings in 2021-2030 27.0 PJ (644.9 ktoe); cumulative CO₂ emission reductions in the period 2021-2030 769.16 ktCO_{2e}

Monitoring method: The realized 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

Connection to climate change adaptation: /

Research and development: /

The Republic of Croatia also envisages the implementation of alternative measures, including measures described as follows: ENU-3, ENU-4, ENU-5, ENU-7 i ENU-8. In addition, alternative measures include the following measures in transport: TR-6: Financial incentives for energy efficient vehicles, TR-10: Promoting integrated and intelligent transport and development of alternative fuel infrastructure at the local and regional level and TR-11: Training for drivers of road vehicles for eco-driving, as well as the implementation of the Programme for the Elimination of Energy Poverty (UET-4).

ii. Long-term strategy for the renovation of the national stock of residential

and non-residential buildings, both public and private

Key to this area is the Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia by 2050. To achieve the strategic goals of reducing energy consumption in construction of buildings, three key energy renovation programmes for the period between 2021 and 2030 are expected to be adopted for apartment buildings, family houses and public buildings, and the guidelines for the preparation of these programmes are provided below. A new programme for commercial buildings that would be based on co-financing will not be adopted, but 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, the implementation of a comprehensive programme for the promotion of nZEB standards for construction and renovation is planned, which is also outlined below.

ENU-2: Promoting nearly-zero energy standard in buildings construction and refurbishment

Information measure; implementation 2019 -2030

Objective and description of the measure: After 31st December 2018, all public buildings in the Republic of Croatia used or owned by public authorities shall be constructed according to the nZEB standard, and the obligation for all other newly built buildings shall enter into force after 31st December 2020. These statutory provisions ensure that all newly built buildings from 2021 onwards comply with the nZEB standard. However, in order to ensure the correct implementation of these provisions, and also to encourage energy renovation of buildings in line with the nZEB standard, a number of informational and educational activities for the promotion of construction and renovation according to the nZEB standard are planned in the next period.

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

- Open partner dialogue - workshops that will bring together stakeholders from state administration bodies, local authorities, the construction sector, the energy sector and educational and other public institutions, to develop through joint dialogue an adequate national definition of a building with nearly zero energy consumption and a roadmap for the transformation of the existing building stock into an energy-efficient and decarbonized building stock by 2050;
- Creating guidelines for nZEB buildings for investors and design engineers - the guidelines will provide expert, coherent and clear information on nZEB buildings, with two target groups: general public and experts in the field;
- Media campaigns for energy certification and promotion of nZEB standards - campaigns will provide information to the general public to raise awareness of the significance of energy certificates and their relevance for energy renovation and demonstration of nZEB standards, availability of information in the Information system of energy certificates (IEC), and also a targeted campaign for informing and raising awareness of the nZEB standard for new construction and energy renovation of buildings will be carried out.

Funds needed for implementation: The MCPP plans to finance the implementation of these activities within its annual budgets as an integral part of its regular activities.

Funding Sources: State Budget (MCPP)

Executive body: MCPP - implementation of all Programme activities

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

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

Tracking method: Reports on information and educational activities carried out

Connection to other dimensions: Direct connection to decarbonisation, as the nZEB standard implies with reduced energy consumption and increased 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: NZEB standard creates the need to develop new building materials, improve technical systems in buildings, and control and automation systems based on information and communication technologies

ENU-3: Energy renovation programme for multi-apartment buildings

Financial measure; implementation 2021 - -2030

Objective and description of the measure: The programme should be conceptualized as a continuation of the implementation of the Energy renovation programme for apartment buildings for the period from 2014 to 2020. For this purpose, funds from ESI funds should be planned for the next programming period 2021-2027 (with implementation until 2030), and implementing procedures need to be significantly facilitated, especially in the area of implementation of public procurement. Deep renovation of buildings should be encouraged. The renovation up to the nZEB standard should be further encouraged. In addition, it is necessary to consider the establishment of a special fund from which the costs will be reimbursed to energy poor households or households at risk of energy poverty, in order to remove the obstacle to securing a sufficient number of co-owners' consents for energy renovation. The implementation of the Programme must be accompanied by strong promotional activities, assured technical assistance to applicants, and it is necessary to ensure that energy consumption is monitored before and after energy renovation, which requires the creation of prerequisites under ISEM. It is expected to be renewed at about 520,000 m² apartment buildings annually. Savings were calculated assuming the energy renovation of buildings to the level of meeting 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 0.148 PJ. The estimated cost of energy renewal is 1,500 HRK / m²

Note: the objectives, conditions and activities and the stated numerical values are indicative and will be specified in detail in the Energy Renovation programme for apartment buildings for the period 2021 to 2030.

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

- In 2020, the MCPP will develop an energy renovation programme for multifamily buildings for the period 2021 to 2030, adopted by the Government, which is the basis for the use of ESI funds in the 2021 to 2027 programming period.
- Implementation in the manner established by the Programme

Funds needed for implementation: Estimated investment cost in the period 2021-2030 is HRK 7.80 billion.

Funding Sources: Grants from the ESI Funds should be provided up to 60% of eligible costs, with maximum co-financing of energy audits, energy certificates, project documentation and technical assistance in project preparation and implementation. Consideration should be given to using national funds and other sources of funding.

Executive body: MCPP- Level 1 Intermediate Body (PT1) in the ESI Fund Management and Control System; MCPP - operational monitoring of programme implementation; EPEEF - Level 2 Intermediate Body (PT2) in the Management and Control System for the use of ESI Funds

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reducing heat demand and energy consumption in apartment buildings and increasing RES usage and consequently reducing CO₂ emissions; estimated savings in 2030 1.48 PJ (35.40 ktoe); estimated CO₂ emission reductions in 2030 40.74 ktCO_{2e}; cumulative energy savings in 2021-2030 8.15 PJ (194.70 ktoe); cumulative CO₂ emission reductions in the period 2021-2030. 232.17 ktCO_{2e}

Tracking 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, especially 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 single family houses

Financial measure; implementation 2021 - -2030

Objective and description of the measure: The programme needs to be conceptualized 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 the period 2021-2030. The primary sources of co-financing should be revenues from the auctioning of greenhouse gas emission units and revenues from the fees paid by suppliers in the energy efficiency obligation system in the event of default of obligations. The Programme should allow for the possibility of implementing individual measures, but taking into account the order of measures (e.g. replacing the heating system by a more efficient systems that uses RES should only be

possible for those houses that have good thermal characteristics and do not require any interventions on the building envelope). The renovation up to the nZEB standard should be further encouraged. The implementation of the Programme must be accompanied by strong promotional activities. It is expected to be renewed around 350,000 m² family homes annually. Savings were calculated assuming the energy renovation of buildings to the level of meeting 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 0.191 PJ. The estimated cost of energy renewal is 1,500 HRK / m²

Note: the objectives, conditions and activities and the stated numerical values are indicative and will be specified in detail in the Energy Renovation programme for family homes for the period 2021 to 2030.

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

- In 2020, the MCPP will develop an Energy renovation programme for family homes for the period 2021 to 2030, approved by the Government;
- In 2020, the Government shall adopt a new Plan for the use of funds obtained from the sale of emission units through auctions in the Republic of Croatia for the period from 2021, which shall provide sufficient funds for the implementation of this measure, as well as the Plan for the use of funds from the fee paid by suppliers in the system of energy efficiency obligation;
- The EPEEF is responsible for the full implementation of this measure by announcing annual public calls, the criteria of which it develops in cooperation with the MCPP.

Funds needed for implementation: Estimated investment cost in the period 2021-2030 is HRK 5.25 billion.

Funding Sources: A grant from the EPEEF of up to 60% of the eligible costs of equipment and energy renovation work must be provided. EPEEF provides funds from the proceeds from the sale of emission units through auctions and revenues from the energy efficiency obligation system as well as from other sources of income from the EPEEF.

Executive body: MCPP - 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: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reducing heat demand and energy consumption in apartment buildings and increasing RES usage and consequently reducing CO₂ emissions; estimated savings in 2030 1.91 PJ (45.60 ktoe); estimated CO₂ emission reductions in 2030 52.57 ktCO_{2e}; cumulative energy savings in 2021-2030 10.50 PJ (250.80 ktoe); cumulative CO₂ emission reductions in the period 2021-2030 299.12 ktCO_{2e}

Tracking method: Energy Saving Monitoring, Measurement and Verification (SMiV) system using the bottom-up method for integral building renovation or other appropriate method, 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

Connection to 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, especially 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; implementation 2021 - 2030

Objective and description of the measure: The measure is a continuation of the implementation of the Public Sector Buildings Renovation Programme 2016-2020. For this purpose, funds from ESI funds should be planned for the next programming period 2021- 2027 (with implementation until 2030). Funding needs to be planned to ensure the activation of private capital and ESCO markets, especially for buildings that are suitable for such financing models (continuous operation buildings such as hospitals, penitentiary homes, senior citizens' homes, etc.) and belong to the category of central government buildings, for which the Energy Efficiency Directive 2012/27/EU stipulates the renovation obligation. Market models need to be combined with grants with the aim of meeting the nZEB standard. In addition to ESI funds, the EPEEF is also required to plan funds for this Programme in the part related to the co-financing of energy renovation of central government buildings under the ESCO model. For buildings that are not suitable for market models, it is necessary to provide grants under the same conditions as in the current programme. The renovation of the public sector building must be directed to the nZEB standard wherever technically feasible. It is expected to be renovate around 350,000 m² of public buildings annually. Savings were calculated assuming the energy renovation of buildings to the level of meeting 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. The estimated cost of energy renewal is 2,500 HRK / m²

Note: the objectives, conditions and activities and the stated numerical values are indicative and will be specified in detail in the Energy Renovation programme for public sector buildings for the period 2021 to 2030.

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

- During 2020, the MCPP will develop a Public Sector Buildings Energy Renovation Programme for the period 2021 to 2030, adopted by the Government, which is the basis for the use of ESI funds in the 2021-2027 programming period, as well as the basis for planning for the funds of the EPEEF;
- 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 EPEEF and other sources including ESI funds - this segment of the Programme is necessary in order to mobilize private capital, develop the energy services market and achieve the objectives without additional public sector borrowing.

Funds needed for implementation: Estimated investment cost in the period 2021-2030 is HRK 8.75 billion.

Funding Sources: Grants from ESI Funds as in the previous Climate zone dependence programme (Coastal or Continental) and the Development Index should be provided, with maximum co-financing of energy audits, energy certificates, project documentation and technical assistance in project preparation and implementation. EPEEF provides funds for the ESCO model from the proceeds from the sale of emission units through auctions and revenues from the energy efficiency obligation system as well as from other sources of income from the EPEEF.

Executive body: MCPP - Level 1 Intermediate Body (PT1) in the ESI Fund Management and Control System; MCPP - operational monitoring of programme implementation; EPEEF - Level 2 Intermediate Body (PT2) in the management and control system for the use of ESI funds / co-financing projects from own resources; ATMIP - implementation according to the energy service contracting model

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reducing heat demand and energy consumption in public sector buildings and increasing RES usage and consequently reducing CO₂ emissions; estimated savings in 2030 1.69 PJ (40.40 ktoe); estimated CO₂ emission reductions in 2030 46.52 ktCO_{2e}; cumulative energy savings in 2021-2030 9.30 PJ (222.20 ktoe); cumulative CO₂ emission reductions in the period 2021-2030 264.93 ktCO_{2e}

Tracking 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, especially 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 program for heritage buildings

Financial measure; implementation 2021 - -2030

Objective and description of the measure: Protected buildings within the meaning of this Programme are those which can be classified into two categories: Individually protected cultural property (individual buildings and building complexes) and Buildings within a protected cultural and historical entity. The programme does not cover buildings protected as a preventively-protected cultural property, nor buildings protected as a registered cultural property. The Programme has developed two basic approaches to the energy renovation of buildings that are the subject of this Programme: a holistic (integral) approach and an approach with the application of individual energy renovation measures.

In accordance with the draft programme, the following needs were given:

- Total investment (HRK): 13.674 billion
- Maintenance cost (HRK): 5.066 billion
- Average annual renewal rate (%): 3.5

- Total renovated area (m²): 8,975,943
- Energy Savings (GWh): 5,073,234.38
- Financial Savings (HRK): 1.393 billion
- CO₂ emission reduction (kt): 709.02

The total needs for the implementation of energy renovation programmes for buildings that have the status of cultural property and for the purpose of achieving national goals amount to HRK 18.74 billion in the period from 2021 to 2030. This amount includes required investments of HRK 13.67 billion and maintenance costs of HRK 5.07 billion. 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 recognized as sources of funding for grants. Considering the total investment needs, the total required investments amount to approximately HRK 1.37 billion annually over the period 2021 to 2030, of which the required co-financing would amount to HRK 1.02 billion. Given that around HRK 100 million is collected annually from the monumental annuity, the remaining amount of about HRK 920 million annually needs to be secured from EU Funds. In order to encourage the energy renovation of buildings that have the status of cultural property, it is necessary to co-finance the same with grants, with a considerable share of the same in the total investment.

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 introduction of energy efficiency contracts and other models of energy efficiency services

According to Article 25 of the *Energy Efficiency Act* (OG 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* (OG 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.

The content of the energy performance contract is, according to the *Act on Amendments to the Energy Efficiency Act*, defined only for public buildings, and in the private sector access to this issue is being liberalized, so a positive impact on the market can be expected.

The Ordinance on the system for monitoring, measurement and verification of energy savings (OG 71/15) needs to be fully revised, as the final proposal of the *Act on Amendments to the Energy Efficiency Act* stipulates a detailed elaboration of the method of verification of savings defined in the said Ordinance. Key objections are outdated reference data used to calculate savings (especially for technologies that achieved a significant technological progress over the past period), limited number of processed measures and, most importantly, lack of methods or reference to methods of verification of savings according to actual measurements.

The Act on Amendments to the Energy Efficiency Act corrects most of the observed shortcomings, such as value added tax, inclusion of professional services without investment or reducing only energy-related costs.

Legislation and the implementation policy so far provide incentives for implementing energy efficiency measures through financial instruments, especially through energy services. It is also necessary to secure the inclusion of financial resources from the European structural and investment funds with a combination of energy service or public-private partnership. It is also necessary to further align secondary legislation (ordinances) 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 section 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.

ENU-7: Energy management system in the public sector

Information measure; implementation 2014 -2030

Objective and description of the measure: The public sector in Croatia is obliged to systematically manage energy, which is specifically stipulated by the Energy Efficiency Act, and the Ordinance on Systematic Energy Management (Official Gazette 18/15, 06/16). The measure is based on the information system for energy management (ISEM). 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 4th NEEAP). Given that 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 as a result of renovation, as well as fulfilling the default regime of use of the building for the purpose of achieving and maintaining the level of comfort. The goals are: to remotely read all locations in the public sector whose energy and water consumption exceeds HRK 400,000.00/year by 2020, to connect supplier databases with the ISEM database for automatic data collection and to connect ISEM with all relevant energy databases. In addition, by 2021, plans are being implemented for measures that include: potential analysis and optimization of peak electricity contracting, reduction of excess reactive energy, and potential analysis and optimization 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, taking into account the default building usage regime;
 4. Extend the use of ISEM to all sectors (private, industrial...) on a voluntary basis and/or as an obligation related to receiving financial assistance for renovation or implementation of energy efficiency measures;
 5. Upgrading the ISEM so that it can carry out a financial analysis of cost-effectiveness of renovation on the basis of actual data;
 6. The development of ISEM in the direction of so-called artificial intelligence, whereby the system would propose measures to increase energy efficiency according to input parameters.
 7. Introduction of 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 institutions of the public and other sectors, 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 is introduced in public institutions.

Funds needed for implementation: The funds needed to carry out all the activities envisaged are planned by the ATMIP as part of its regular activities and budget

Funding Sources: State Budget (ATMIP)

Executive body: ATMIP

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: 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 CO₂ emission reductions in 2030 5.50 ktCO_{2e}; cumulative energy savings in 2021-2030 1.90 PJ (45.41 ktoe); cumulative CO₂ emission reductions in the period 2021-2030 54.13 ktCO_{2e}

Tracking method: Up to now, monitoring of energy savings has been made possible through the ISEM system with basic and advanced database analyses. The savings achieved are based on measured data on the consumption of all forms of energy. Database synchronization provides verified data and, by connecting to metering systems, provides 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: through systematic monitoring and understanding of energy consumption, the public sector will be able to become an informed player in the energy market

Connection to climate change adaptation: /

Research and development: the obligation of systematic energy management in the public sector is stimulating for research and development in the field of monitoring and managing energy consumption in buildings based on information and communication technologies

ENU-8: Energy renovation programme for 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 ESI funds from the European Regional Development Fund, using the financial instrument of loan at favourable interest rates offered by the CBRD to units of local and regional self-government. To this end, HRK 152 million are available and the loan covers up to 100% of eligible project costs. It is expected that this financial allocation will be utilized by 2020, and no later than 2023. The estimated savings in this first phase of the Programme are around 15 GWh in 2020 (2023). Considering the significant potential that exists in public lighting systems, ESI funds are planned to be used in the next programming period 2021-2027. By programming a larger allocation of funds for this purpose, the existing potential could be utilized by the end of 2030, which is estimated at around 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 mobilization of private capital through energy services or public-private partnerships in order 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, and for projects requiring investment in new public lighting infrastructure (columns, additional lamps and the like), in order to meet the standardized technical requirements, it is necessary to secure grants. It has been assumed that by the end of 2030, all the estimated potential for improving the energy efficiency of the public lighting system would 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 specified in detail in the Energy Renovation Programme of Public Sector Buildings for the period 2021-2030).

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

- In 2020, the MEE will develop the Energy Renovation Programme for Public Lighting Systems for the period 2021-2030, adopted by the Government, which is the basis for the use of ESI funds in the 2021-2027 programming period.
- The implementation of the Programme itself should begin in 2021 by applying the selected financing model, which includes energy services and public-private partnerships and is in line with the rules for the use of ESI funds.

Funds needed for implementation: The estimated investment cost in the period 2021-2030 is HRK 2.88 billion.

Funding Sources: ESI funds should be provided for the selected financing model, preferably subsidies for commercial loan interest rates, guarantees for service providers and grants for projects that are not profitable within an acceptable timeframe.

Executive body: MEE - establishes the implementation model; defines eligibility criteria for projects, concludes an agreement with CBRD/EPEEF on the implementation of the Programme; CBRD/EPEEF - cooperation with commercial banks; operational implementation of the Programme; LGUs - launching projects, contracting energy service/PPP

Monitoring (supervisory) bodies: MEE - NCB

Effect: Reduction of electricity consumption in public lighting systems, reduction of light pollution; estimated savings in 2030 0.90 PJ (21.50 ktoe); estimated CO₂ emission reduction in 2030 - 19.60 ktCO_{2e}; cumulative energy savings in 2021-2030 4.95 PJ (118.25 ktoe); cumulative CO₂ emission reduction in the period 2021-2030 - 157.95 ktCO_{2e}

Monitoring method: Energy Saving Monitoring, Measurement and Verification System, using the bottom-up method for replacement of public and outdoor lighting

Connection to other dimensions: with the potential integration of photovoltaic power generation systems for public lighting, there is a direct link with the decarbonisation dimension

Connection to climate change adaptation: /

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, but also for the integration of 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: The Government of the Republic of Croatia adopted in 2015 the first National Action Plan for Green Public Procurement for the period from 2015 to 2017 with an outlook to 2020, and green public procurement was also accepted as a measure in the 4th NEEAP, which sets the target that by 2020 green public procurement criteria are applied in 50% of implemented public procurement procedures. A national Green Public Procurement Committee was set up to monitor the implementation of Green Public Procurement through a survey questionnaire and an electronic public procurement bulletin. This measure is a continuation of the initiated measures and further greening of public procurement procedures. Green public procurement will favour innovative low-carbon products and services, further boosting their entry into the market, with the public sector serving as a good example. The objective is to have 75% of implemented public procurement procedures that apply green public procurement criteria in 2030.

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

- Training of participants in public procurement and promotion of green public procurement criteria;
- Improving the monitoring of the implementation of green public procurement for the purposes of quantifying the effects - public procurement clients are obliged to publish their public procurement plans on the website at the beginning of the year, however the statistical public procurement report generated from the EPPC also contains information on whether the green public procurement criteria have been used and will be drafted for year 2017 as late as the beginning of 2018, however without specifying

details - therefore, it is not possible to calculate energy savings without elaborating how green public procurement is monitored in the EPPC and it is mandatory to improve the monitoring system;

- Ongoing development of new criteria and benchmarks for green public procurement, including energy efficiency.

Funds needed for implementation: The funds needed to carry out all the activities envisaged are planned by the MEE as part of its regular activities and budget

Funding Sources: State budget (MEE)

Executive body: MEE in cooperation with the members of the Green Public Procurement Committee; State Office for Central Public Procurement; State administration bodies, L(R)SGUs and other public procurement clients

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reducing energy consumption in public buildings; changes in the habits and behaviour of users of public sector buildings

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. It is expected that the largest number of purchases will be related to computer and office equipment and motor vehicles. The State Central Public Procurement Office monitors the data on the quantities and types of equipment purchased and submits the data to the NCB, which enters them into 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.)

Connection to climate change adaptation: /

Research and development: Public procurement can be a major driver of development activities by continuously increasing 'green' requirements for devices, equipment and buildings.

Measures to promote energy audits and the energy management system

The implementation of energy audits and promotion of systematic energy management in the period from 2021 to 2030, apart from the leading role of the public sector (continued implementation of Measure P.3, MEN-6), will be ensured through continued implementation of legally binding provisions. Namely, based on the Energy Efficiency Act and the Building Act, the following obligated parties in Croatia have the legal obligation to perform energy audits:

- large enterprises (assets > 130 mil HRK, revenue > 260 mil HRK, > 250 employees) every 4 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 10 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;
- heating systems in buildings with boilers using liquid (> 100 kW every 2 years) or gaseous fuel with a total nominal power of 20 kW (every 10 years) and larger (every 4 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 10 years).

These statutory obligations shall remain in force in the period 2021-2030, and their further development is expected, particularly in the light of the amended Energy Performance of Buildings Directive.

In addition, for the period from 2021, the introduction of a new fiscal measure for the promotion of systematic energy management in the business sector is expected.

ENU-10: Energy management system in business (service & production) sector

Fiscal measure; implementation 2021-2030

Objective and description of the measure: Although large companies are obliged to regularly carry out energy audits, this obligation does not ensure continuous consideration of energy consumption in the company, nor does it include small and medium-sized enterprises. In order to encourage companies to introduce certified energy management systems (ISO 50001), by 2020 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.

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

- In cooperation with the Ministry of Finance, the MEE shall in 2020 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;
- The recommendations of the analysis are incorporated into the laws and regulations related to the tax solutions that are proposed to be used and their implementation begins.

Funds needed for implementation: The funds needed 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 MEE as part of its regular activities and budget; the implementation of the tax policy itself does not require additional funds

Funding Sources: State budget (MEE)

Executive body: MEE - preparation of analysis and proposal of solution; MFIN - integration of proposed solutions into the tax system

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reducing the energy consumption of businesses 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 will be able to become an informed participant in the energy market and to choose solutions that will contribute to decarbonisation

Connection to climate change adaptation: /

Research and development: encouraging systematic energy management opens up 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 through the improvement of the implementation of existing regulatory and informational measures.

ENU-11: Informative bills

Information measure; implementation 2014-2030

Objective and description of the measure: One of the fundamental measures of informing consumers is the legal obligation of the supplier to provide them at least once a year with informative calculations and energy billing information to consumers and the previous consumption of the final customer for measuring points that are the subject of a contractual relationship, including a comparison with the average normal or reference end customer from the same category of end customers of the supplier. The frequency of application of this statutory provision should be reduced to a monthly level, and it is absolutely necessary to ensure that the energy regulatory authority (CERA) carries out control over these obligations of the energy supplier. In addition, based on these regulatory provisions, it is also necessary to additionally inform consumers about the contents and meaning of the bill, which is the task of the National Coordination Body (NCB) for Energy Efficiency.

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

- MEE - NCB will in 2020:
 - develop a guidance for suppliers that will define all the necessary information to be displayed on monthly invoices for the purpose of informing consumers;
 - develop and publish explanations of bills on the national energy efficiency portal;
- Throughout the period, the MEE - NCB will systematically work to inform both suppliers and consumers of their rights and obligations.

Funds needed for implementation: The funds needed to carry out all the activities envisaged are planned by the MEE as part of its regular activities and budget

Funding Sources: State budget (MEE)

Executive body: MEE - NCB - developing a guide that will define how to inform users on monthly bills; developing and publishing explanations of bills on the national energy efficiency portal; CERA - supervising the implementation of legal obligations of suppliers

Monitoring (supervisory) bodies: MEE-NCB

Effect: Increasing consumer awareness of energy consumption and consequently changing behaviour along with reduced energy consumption

Monitoring method: The effects of this measure can only be monitored by top-down indicators.

Connection to other dimensions: informative calculations empower the customer in the energy market

Connection to climate change adaptation: /

Research and development: /

ENU-12: Providing information on energy efficiency

Information measure; implementation 2014-2030

Objective and description of the measure: Providing information to the general public and target groups shall be conducted through the organization of targeted information campaigns related to specific programmes of encouraging energy efficiency, particularly energy renovation of buildings. The NCB will maintain the national energy efficiency portal and provide up-to-date information to ensure continued promotion of energy efficiency and energy services. Particular attention should be given in the following period to informing consumers of the obligations of the supplier 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 in the field of energy savings in the Republic of Croatia. The content of the portal is grouped around three fundamental drivers of change: citizens, the public sector, the commercial sector along the EE heading in Croatia, which contains all important 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. MEE - NCB 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 needed to carry out all the activities envisaged are planned by the MEE as part of its regular activities and budget

Funding Sources: State budget (MEE)

Executive body: MEE - NCB; Bodies responsible for the implementation of other measures (MCPP, EPEEF, LGUs, etc.)

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: 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

Monitoring method: Monitoring the impact of this measure is possible by applying top-down methods on the sectoral level. Before conducting each info campaign, a market research should be done and the effects proven by repeating the same survey after the campaign.

Connection to other dimensions: /

Connection to climate change adaptation: Information should be provided about the link between energy consumption and climate change as well as the benefits of energy efficiency in terms of adaptation to climate change (increased resilience to, for example, extreme temperature conditions, etc.)

Research and development: the measure encourages innovation in the information segment (use of information and communication technologies)

ENU-13: Energy efficiency education

Educational measure; implementation 2017-2030

Objective and description of the measure: Training will be achieved by continuing the implementation of the existing measure and adapting the activities to the needs and the actual situation. It is especially important to systematically work on attracting young people to construction and other technical occupations, which will contribute to the availability of professional staff for the implementation of 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. 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:

- 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. This should lead to increased use of energy efficiency and renewable energy sources in everyday construction practice and increased demand for educated workforce, by increasing the practical knowledge of on-site workers who specialize in all phases of construction and maintenance procedures
- The implementation of educational activities focused on the principles of green building is envisaged (activities in the previous period will produce a Guide and guidelines on green and sustainable construction and guidelines for the Croatian Green Building Certificate, so all activities in the period from 2021 onwards will be based on these guidelines)

Funds needed for implementation: The funds needed to carry out all the activities envisaged should be determined on the basis of the results and recommendations of CROSKILLS training centres

Funding Sources: ESI funds for strengthening human resources, with the aim of integrating the principles of green and sustainable construction and circular economy into existing systems of vocational, adult education and lifelong learning.

Executive body: AVETAЕ - 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; MCPP - setting up and applying the principles of green building in cooperation with the Croatian Green Building Council and the Faculty of Architecture (AF)

Monitoring (supervisory) bodies: MCPP and MEE-NCB

Effect: Available expert capacities for implementation of 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

Connection to climate change adaptation: through education on green building, which includes the promotion of green infrastructure on buildings (green roofs, green facades, etc.), capacity to implement these measures is strengthened, which represent significant measures for adaptation to climate change (e.g. reduction of urban heat islands, etc.)

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)

ENU-14: Integrated information system for monitoring energy efficiency

Information measure; implementation 2014-2030

Objective and description of the measure: The national system for monitoring, measurement and verification of savings (SMIV) has been established, based on the Energy Efficiency Act and the Ordinance on the system for monitoring, measurement and verification of energy savings. The system is extremely important because it monitors energy savings and the resulting reduction in greenhouse gases and the system data are used for reporting. In the next period, it is necessary to maintain and improve the functionality of the system, connect it to other systems (ISEM), and inform and educate obligated parties about the correct data entry required to calculate and verify energy savings.

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

- further upgrading, development and adaptive maintenance of SMIV, its integration with other systems in order to build an integrated information and computer system for monitoring the implementation of energy efficiency policy

Funds needed for implementation: The funds needed to carry out all the activities envisaged are planned by the Ministry of Environment and Energy as part of its regular activities and budget

Funding Sources: State Budget (Ministry of Environment and Energy)

Executive body: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Systematic monitoring of the implementation of ENU measures and quantification of their effects; facilitated reporting at all levels; facilitated planning of new measures and revision of existing ones based on evidence of implementation effects

Monitoring method: /

Connection to other dimensions: /

Connection to climate change adaptation: /

Research and development: /

Measures in the process industry sector

In the period 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 CO₂ emission fees (MS-5: CO₂ emission tax for the non-ETS stationary sources), 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 73/07, 48/09, 2/18) and the decisions on the amount of the unit fee for greenhouse gas emissions for operators of non-ETS facilities.

In addition, it is expected that the system of suppliers' obligations will also contribute to improving energy efficiency in this sector through the exploitation of cost-effective energy efficiency potentials and the use of market models, such as energy efficiency contracting. Therefore, in the period from 2021 to 2030, new financial incentives from public sources are not foreseen.

v. If applicable, a description of policies and measures to promote the role of local RES energy communities in contributing to the implementation of the policies and measures referred to in subitems i., ii., iii. and iv.

Energy communities will be promoted under the RES-1 measure, and the regulatory framework necessary for their functioning under the RES-4 measure.

vi. Description of the measures to exploit potential for increasing energy efficiency of the gas and electricity infrastructure

Measures for increasing the energy efficiency of the electricity infrastructure (transmission and distribution grids) are based on ten-year development plans of the transmission and distribution grid for 2016-2025 and the CERA Decision on Implementation of Energy Efficiency Measures (more details in Chapter 1.2.2). The measure to increase the energy efficiency of the gas transmission system, is based on Plinacro's 10-year plan. It is also important for the Republic of Croatia to improve the infrastructure for production, transmission, and distribution of energy for heating and cooling.

ENU-15: Energy efficiency of the electricity transmission system

Financial and organizational measures; implementation 2021-2030

Objective and description of the measure: Current levels of 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 important feature of the Croatian transmission grid, both in terms of plant safety and support of market activities, as well as in terms of losses, is the extremely strong connection with neighbouring power systems (interconnections). While, on the one hand, this significantly increases the safety of the plant, on the other hand, the transmission increases the grid losses. HOPS (Croatian Transmission System Operator) will continue to implement measures related to the operation of the power system operation development and measures related to the development of the transmission grid by 2030, with the aim of further reducing technical losses in the grid. For this measure, along with provision of funds by HOPS, it is proposed to programme the use of ESI 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 HOPS and optimization of operation of transformers with oblique control (TS Žerjavinec, TS-HPP Senj); voltage management and optimization of power flows in the grid; optimization of generator operation (operating points with power factor in the range 0.95 -1).
- Measures related to the short and long term development of the transmission grid include: replacement of old energy transformers with new transformers that have smaller losses (replacement of 10% of the oldest transformers in the grid responsible for about 20% of total fixed losses in transformations and about 15% of total variable losses in transformations); revitalization of old powerlines via a replacement of conductors (replacement of existing lines with new ones with a larger cross section directly reduces the resistance of the conductor, thus positively reducing the amount of technical losses due to load (variable part of losses), using HTLS conductors with a larger aluminium sheath cross section i.e. smaller losses; planned reinforcement of the transmission grid (construction of new lines).

Replacing older equipment with new one which has a reduced amount of loss results in a reduction in overall system-level losses. Further reduction of losses in the future can be achieved by the development of new and more energy-efficient technologies, and the further revitalization and construction of the grid using the latest generation conductors with a smaller electrical resistance, i.e. smaller losses.

Funds needed for implementation: The funds needed to carry out all the activities envisaged according to the source of the funds and by activities envisaged are shown in the following tables:

HOPS Funds:

Increasing transmission power - potential use of HTLS conductors	270.820.000
Planned grid reinforcement (TS revitalization)	631.623.051
Planned grid reinforcement (investments in new facilities)	714.870.212
Planned replacement of power transformers	178.250.000
Planned cabling of 110 kV overhead lines	35.600.000
TOTAL (HRK)	1.831.163.263

ESI Funds:

Electricity connection of the Croatian south	1.085.000.000
Planned replacement of submarine cables	490.000.000
Construction of DV 400 kV Konjsko - Lika - Melina with construction of TS 400 kV Lika	800.000.000
DV 2x400 kV Tumbri - Veleševac	98.000.000
Increasing the transmission power of the 220 kV Konjsko - Brinje	210.000.000
TOTAL FOR SUBMISSION TO ESI FUNDS (HRK)	2.683.000.000

Expected contribution from ESI funds is 25 to 50%, which means between 670.750.000 and 1.341.500.000 HRK.

Funding Sources: HOPS, ESI funds

Executive body: HOPS

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency, Croatian Energy Regulatory Agency

Effect: The following table shows the reduction of losses in the transmission system:

Measure	Estimation of potential savings in losses (GWh/year)		
	2019-2021	2022-2024	2025-2028

Replacement of conductors in the overhead lines (HTLS conductors)	0,26	0,39	0,6
Replacement of 110 kV submarine cables	0,6	1,4	1,7
Planned grid reinforcement	7	15	25
Installation of compensation devices (2xVSR + 1xSVC)	0	-3,5	-3,5
Planned replacement of power transformers	0,2	0,3	0,4
Planned cabling of 110 kV overhead lines	0	0,4	0,5
Optimizing power flows	0,7	0,7	0,7
Optimizing generator performance	2,0	3,7	5
Optimizing the operation of power transformers	5,1	6,6	7,3
TOTAL APPLICATION OF ALL MEASURES (GWh/year)	15,9	25	38

According to the data in the table above, the savings that will be made at the end of 2028 are 20.9 ktoe (0.9 PJ; 242.9 GWh) and are 'alive' in 2030; estimated CO₂ emission reductions in 2030 19.0 ktCO_{2e}; cumulative energy savings in 2021-2030 124.1 ktoe (5.2 PJ; 1.443 GWh); cumulative CO₂ emission reductions in the period 2021-2030 165.8 ktCO_{2e}

The estimate of the savings is entirely based on the assumptions given in the 10-Year grid Development Plan 2019-2028. made by HOPS.

Monitoring method: The monitoring of the effects of this measure is achieved on the basis of data on realized losses of electricity before and after the implementation of the measure with normalization according to the amount and duration of the load.

Connection to other dimensions: Investments in the transmission grid directly affect the dimensions of energy safety and the internal energy market, while reducing losses also achieves decarbonisation goals.

Connection to climate change adaptation: /

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-16: Reduction of losses in the distribution network 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 ESI funds, it is necessary to programme the continuation of the use of ESI 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 overdimensioning
- 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 the emphasis on detecting unauthorized electricity consumption
 - and continued reconstruction of existing connections and measuring points, which are located in the customers' premises.

Funds needed for implementation: HEP-DSO funds: The total investment cost of installing advanced metering devices in all of 2.4 million measuring points in the period 2021 to 2030 is approximately HRK 2,356,000,000.

As EU directives require the transition from conventional metering to advanced metering devices, the use of ESI funds in the area of adaptation of the existing metering system to the system for working with advanced metering devices was foreseen. First of all, it is an investment in the adaptation of 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 additionally required to make available the support to work with new technologies, above all solving of communication problems (G3 PLC) and computing process problems (upgrades of FW meters and hubs, data acquisition, transmission and processing).

The foreseen funds for the adaptation of the existing metering system to the system with advanced meters are estimated at around 110,000,000 HRK.

In the next ten-year period, HEP-DSO plans to invest funds in the amount of HRK 6,696,197,000, of which it is planned to invest in energy facilities as follows:

- investments in 110 kV energy facilities HRK 1,227,481,000
- investments in 35 kV energy facilities HRK 602,610,000
- investments in 10 kV and 20 kV energy facilities HRK 1,771,766,000
- investments in low-voltage facilities HRKJ 656,895,000
- investments in Smart grid pilot projects (co-financing from EU funds) HRK 233,745,000

The following table provides an overview of the financial resources invested in Smart grid pilot projects:

No.	Type of Investment	Total 10Y 2019-2028
1	Advanced metering infrastructure	90,918,000
2	Development and optimization of conventional network	40,618,000
3	Distribution grid automation	102,209,000
	Total	233,745,000

Funding Sources: HEP-DSO, ESI funds

Executive body: HEP-DSO

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency, Croatian Energy Regulatory Agency

Effect: Reduction of losses in the electricity distribution grid - The HEP-Distribution System Operator prepares a balance sheet for the previous year, which separately shows losses of electricity.

Total electricity losses consist of technical and non-technical losses. Technical losses are due to the operating state of the distribution grid and the technical characteristics of the grid elements. They can be divided into:

- voltage-dependent i.e. permanent losses resulting from the maintenance of the power system 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 power system.

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, average annual 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. E.g. the number of transformers with reduced losses will be significantly higher at the end of the ten-year period, therefore the annual savings at the end of the ten-year period 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 the purposes of the assessment of 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.

<i>Projection of electricity losses in TWh</i>		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

The implementation of advanced metering devices and systems for their networking has the effect of reducing non-technical losses of electricity with end customers. Advanced meters are equipped with indicators for power outages and parameter changes, which enable the detection of unauthorized power consumption by signalling unauthorized access to the device and its unauthorized use, and, ultimately, remote shutdown of power to the customer at whose 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.

A number of cost-benefit analyses for the installation of advanced measuring devices, carried out in EU Member States, have identified an expected reduction in unauthorized consumption of 50% of non-technical losses (Lithuania, Slovenia), which is in line with the experience of other international pilot projects. Based on the above, the forecast for the reduction of unauthorized consumption in the case of 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 on the basis of 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.

<i>Projection of electricity losses with the implementation of advanced metering devices and systems for their networking, in TWh</i>										
	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 CO₂ emission reductions in the period 2021-2030 32.6 ktCO_{2e}

The estimate of the savings is entirely based on the assumptions given 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, specifically showing electricity losses.

Monitoring method: HEP-Distribution System Operator prepares a balance sheet for the previous year, which specifically shows 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 also achieves decarbonisation goals. Advanced measurements strengthen the customer's role in the energy market.

Connection to climate change adaptation: /

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-17: Increasing efficiency of district heating system

Financial and organizational measures; implementation 2021-2030

Objective and description of the measure: In the existing large centralized heating systems, a large 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. In view of the provisions of Directive 2018/2002 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.
- Introducing 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, ESI Funds

Executive body: Manufacturers, distributors and suppliers of heat from DHS

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency

Effect: Reducing losses in DHSs

Monitoring method: The monitoring of the effects of this measure is achieved on the basis of data from distributors of thermal energy on losses before and after application of the measures.

Connection to other dimensions: decarbonisation, energy safety, energy markets

Connection to climate change adaptation: Taking into account the consequences of climate change in infrastructure planning

Research and development: Transition to the fourth and fifth generation of district heating and cooling; energy storage; flexibility of energy systems

ENU-18 Increasing efficiency of the gas transport network

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 smaller 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 in accordance with the Ten-Year Plan for the Development of the Croatian Gas Transmission System 2018-2027.

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 ones. This preheating is carried out at reducing metering stations and reducing metering nodes through gas boilers and associated heat exchangers and heating cables. In the next period, Plinacro will continue with the systematic replacement of boiler equipment (boilers, burners, boiler management system).
- One of the measures will be to reduce the preheating temperature of the exhaust gas from the previous 15° C to 12° C, which will generate additional savings. However, the stated temperature reduction will only be possible for those facilities where a reduced outlet gas temperature will not affect the safety of gas supply and the safety of customers.
- There is room for increased energy efficiency in the optimal management of the gas transmission system in relation to system pressures, since lower transmission system pressure means less gas reduction for the user and less preheating, and thus less energy and gas consumption. Of course, these possibilities are limited at the moment 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 which will be a significant buyer of propulsion energy, optimal operation and management of the system will have to be given great attention. When maintaining the system, every effort should be made to minimize technological gas emissions.

- Electricity in the gas transmission system is used to drive electrical appliances, cathodic protection and, of course, 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.

Funds needed for implementation: Estimate made by Plinacro

Funding Sources: Plinacro

Executive body: Plinacro

Monitoring Bodies: Ministry of Environment and Energy - National Coordination Body for Energy Efficiency, Croatian Energy Regulatory Agency

Effect: Reducing losses in the gas transportation system

Monitoring method: The effects of this measure are monitored on the basis of Plinacro data

Connection to other dimensions: Reducing losses in the gas system contributes to the goals of safety of supply and decarbonisation

Connection to climate change adaptation: Taking into account the consequences of climate change in infrastructure planning

Research and development: Energy storage; flexibility of energy systems

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 the development of efficient public transport (rail, bus, green tourism).

Countries participating in informal regional coordination are considering the proposals made and will agree on next steps.

viii. Financial measures in this area at the national level, including EU support and the use of EU funds.

For the period up to 2020, the following financial resources are available to stimulate energy efficiency in Croatia:

- funds that the Environmental Protection and Energy Efficiency Fund collects from the sale of greenhouse gas emission allowances in auctions and distributes in accordance with 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, in particular the European Regional Development Fund (EFRR) in accordance with the Operational Programme Competitiveness and Cohesion 20142020.

The funds and financial measures for which they are used are shown Table 3–1 and Table 3–2, and it should be noted that the funds from the EFRR and related measures are being

implemented by the end of 2023. The tables provide a proposal for the use of these resources for 2021-2030 for the continuation of the implementation of existing measures or the introduction of new measures. **It should be made clear that the tables do not give an estimate of the necessary funds for the implementation of these measures for 2021-2030.**

Table 3–1: Estimated disposable financial assets from the sale of greenhouse gas emission allowances for energy efficiency investments by 2020 with proposed measures up to 2030.

Funds source	Investment priority	Available allocation	Existing financial measure	Measure for 2021 - 2030
EU-ETS	HRK 165,000,000	HRK 70,000,000	Energy Sector Renovation Programme for Public Buildings for 2014 - 2015 (P.1)	/
		HRK 23,000,000	Programme for Energy Renovation of Public Sector Buildings 2016 - 2020 (P.2; MEN-5)	/
		HRK 44,108,000	Energy renovation programmes for multi-storey buildings and family houses (B.3; MEN-2 and B.5; MEN-4)	Energy Renovation Programme for Family Houses (ENU-4)
		HRK 1,050,000	Integrated information system for monitoring energy efficiency (H.6; MCC-2)	Information and educational measures (ENU-11 to ENU-14)
		HRK 90,000	Industrial Energy Efficiency Network (I.1; MEN-16)	/
		HRK 4,000,000	Enhancement of energy efficiency and use of RES in manufacturing industries (I.2; MEN-17) - introduction of energy management system and energy audits	/

Table 3–2: Available funding from ESI funds and energy efficiency measures by 2020 (2023) with a proposed measure until 2030.

Funds source	Investment priority	Available allocation	Existing financial measure	Measure for 2021 - 2030
ERDF	4b - Promoting energy efficiency and using RES in companies	EUR 60,000,000	Enhancement of energy efficiency and use of RES in manufacturing industries (I.2; MEN-17)	/
		EUR 40,000,000	Increasing energy efficiency and use of RES in the commercial service sector (tourism and trade) (B.4; MEN-3)	/
ERDF	4c - Support for energy efficiency, smart energy management and use of RES in public	EUR 211,810,805	Programme for Energy Renovation of Public Sector Buildings 2016-2020 (P.2; MEN-5)	Programme for Energy Renovation of Public Sector Buildings 2016-2020 (ENU-5)
		EUR 100,000,000	Promotion of integral renovation of apartment buildings (B.3; MEN-2)	Energy Renovation Programme for Family Houses (ENU-3)

	infrastructure, including public buildings and the housing sector	EUR 30,000,000	Programme for Energy Renovation of Family Houses 2014-2020 (B.5; MEN-4)*	/
		EUR 80,000,000	Increasing the efficiency of the heating system (E.7; MEN-24)	Increasing the efficiency of the heating system (ENU-17)
		EUR 20,000,000	"Energy efficient public lighting" programme (P.4; MEN-13)	Energy Renovation Programme of public lighting (ENU-8)
ERDF	4d - Development and implementation of smart distribution systems at low and medium voltage levels	EUR 20,000,000	Pilot project of introduction of smart grids in pilot areas (E.9; MEN-25)	Smart Grid Implementation Programme (ENU-16)
				Transmission Grid Development (ENU-15)

* Amendments to the said Operational Programme are underway, according to which family homes are from EU funding for energy renovation of buildings (which are transferred to national co-financing by the EPEEF) and increase the available allocation for energy renovation of multi-family buildings (additional EUR 40 million) and public sector buildings (additional EUR 40 million + EUR 28 million for financial instruments).

In the period 2021-2030, for the financial measures envisaged by this Plan, national funds from sale of emission allowances will be used, along with other revenues from the Environmental Protection and Energy Efficiency Fund, as well as ESI funds for the new programming period 2021 - 2027, with implementation until 2030. **It is necessary include in all programme and planning documents that determine the operation of the Environmental Protection and Energy Efficiency Fund and the use of ESI funds the measures proposed herein and plan for sufficient funds for their implementation.** As a basis for the financial planning of these funds, the table of measures describes the total investment costs of each measure.

3.3 Dimension energy security

i. Policies and measures relating to the elements referred to in Section 2.3.

Policies and measures relating to the elements referred to in Section 2.3. are classified by sectors: electricity, district heating systems, gas and oil and petroleum products and are presented below.

ES-1: Integrated planning of energy security and energy products supply

Regulatory measure; implementation: 2021 – 2030

An umbrella measure to increase energy security is integrated security of supply planning, in the context of all energy products and all energy systems. Integrated planning must be harmonized at local, regional and national levels, and in accordance with energy planning carried out by energy entities for energy infrastructure across the territory of the Republic of

Croatia. In addition, integrated planning needs to be aligned with alternative fuel planning and alternative fuel infrastructure. This planning will be carried out as part of the revision of the Integrated Energy and Climate Plan, which must be completed by 23rd June 2023, and in the framework of the preparation and revision of the subsequent plans. To this end, it is necessary to supplement the existing regulatory framework.

ES-2: Construction and use of energy storage facilities

Financial measure; implementation 2021 - 2030

In order to increase the energy storage capacity of the system and increase the regulatory capacity of the electricity system, it is planned to build additional reversible power plants with a capacity of 150 MW before 2030, then the development of heat storage tanks for end customers, the development of battery tanks, the introduction of charging stations for electric vehicles that allow energy storage, the development of underground energy storage in the form of compressed gas, and the use of other innovative energy storage technologies (EU-funded).

ES-3: Improvement of power system management

Further development of techniques and procedures for managing the electricity system is expected, with the application of a number of 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 increasing the share of renewable sources in the structure of electricity production, the need for sufficient regulatory capacity for the purposes of running the electricity system is also increased. It will be of particular relevance to maintain a high level of security of the overall management system in order to prevent cyberattacks that could endanger the electricity system and power supply. The planning will also take into account the risks of extreme weather, which are increased by climate change.

District heating system

ES-4: Development and maintenance of centralised thermal systems

District heating systems have been identified as one of the priorities of the energy policy of the Republic of Croatia. The most significant potential for the development and improvement of existing district heating systems is primarily to increase the energy efficiency of production units, infrastructure and equipment at end-users and to increase reliability and security of energy supply. 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 electricity, and using RES for DHS and replacing existing DHS production with renewable sources (e.g. biofuels) as well as use of heat pumps.

Gas

ES-5: LNG terminal construction

The size of the liquefied natural gas terminal depends on the interest of the market. In the first phase, the construction of the FSRU vessel (Floating Storage Regasification Unit) is planned, whose maximum annual natural gas supply will amount up to 2.6 billion cubic meters. The planned maximum capacity of natural gas supply from the terminal, and indirectly its size and capacity, is conditioned by the maximum capacity of the gas pipeline system that, with the construction of the first part of the evacuation gas pipeline system - Omišalj-Zlobin gas pipeline, would amount to 7.2 million m³/day. By building an extension of the Zlobin-Kozarac evacuation gas pipeline, the total capacity of the LNG terminal would increase to 12 million m³/d, and by building the Kozarac-Slobodnica gas pipeline, the capacity would increase to 19 million m³/d. It is estimated that the total investment in the first phase of construction of the liquefied natural gas terminal would amount to slightly more than HRK 1.7 billion, and the commissioning is planned for 1st January 2021.

ES-6: Gas transport system construction and management improvement

This measure envisages construction of new supply routes, interconnections and gas storage facilities in accordance with the 10-Year Transmission Grid Development Plan, which will increase the security of natural gas supply.

Oil and petroleum products

ES-7: Development of the Adriatic oil and derivatives market with oil and derivatives storage capacities optimization

In the coming period of the decarbonisation policy of the energy sector, the oil sector will be strongly influenced by an increase in the use of alternative fuels such as biofuels, hydrogen, electricity, etc., as well as an increase in energy efficiency. This will particularly affect the operation of refineries, the transportation and distribution of oil and petroleum products and the storage market.

Regardless of the projected reduction in consumption of petroleum products by 2030/2050, their share in total energy consumption will still be significant and their uninterrupted supply needs to be ensured. The establishment and implementation of measures for secure and reliable supply of oil and petroleum products is regulated by the Oil and Petroleum Products Market Act (OG Nos. 19/14, 73/17). One of the important obligations is to continuously maintain and invest in the safety of transportation and storage of oil and petroleum products. It is also necessary to further develop the methodology and tools for assessing the supply security.

ES-8: Exploration of potential hydrocarbon deposits in Slavonia, Dinarides and Adriatics

For the purpose of preparing the basis for the energy strategy, a projection of oil and gas production by 2050 was made, provided that further investment to replenish reserves is

made. Accordingly, it is expected that commercial discoveries will occur that will enter the exploitation stage after 2022, and the full production potential of oilfields will be reached in the period between 2030 and 2035. After 2035, a continued decrease in oil production is expected, that in 2050 would be around 220,000 m³. Similar to oil production, a decrease in natural gas production is expected by 2020, after which an increase in production is expected as a result of the exploitation of new gas fields. An increase in gas production is expected by 2035, after which a decrease in production will occur.

ii. Regional cooperation in this area

Regional cooperation in the field of energy security has existed for many years, within which neighbouring countries jointly plan 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.

In accordance with the Regulation on risk preparedness in the electricity sector 2019/941, regional risk preparedness plans will be jointly developed and bilateral measures will be proposed and implemented as necessary.

At a regional workshop held in Ljubljana in July 2019, the additional proposed topics for regional cooperation within the energy security dimension were

- joint consideration and planning of the construction of new interconnections,
- joint consideration and management of RES systems,
- joint consideration and management with connected systems.

Countries participating in informal regional coordination are considering the proposals made and will agree on next steps.

iii. Financial measures in this area at the national level, including EU support and the 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 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 section 2.3, with regard to further increase of cross-border capacity by 2030, no specific requirements are set. The possible construction of new interconnections will depend on market opportunities and positive cost-benefit analyses.

Further increase of NTC values at individual borders will be achieved by planned removal of restrictions on the internal network. The economic operator is HOPS, and investments in internal grid enhancements are approved by CERA.

ii. Regional cooperation in this area

Described in the context of regional cooperation in the "energy security" dimension.

3.4.2 Energy transmission infrastructure

iii. Financial measures in this area at the national level, including EU support and the use of EU funds, if applicable.

Described in the context of financial measures in the "energy security" dimension.

i. Policies and measures relating to the elements of section 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 network

Financial measure; implementation 2021 - 2030

Objective and description of the measure: The Croatian Transmission System Operator d.o.o. (hereinafter: HOPS) is, according to the Energy Act (OG 120/12; 14/14; 95/15; 102/15, 68/16), the energy entity responsible for management, operation and governance, maintenance, development and construction of the electricity transmission grid. Pursuant to the Electricity Market Act (OG 22/13, 95/15 and 102/15, 68/18, 52/19), HOPS, as the owner of the 110 kV to 400 kV transmission grid, shall be obliged to produce and adopt, with the prior consent of the Croatian Energy Regulatory Agency (hereinafter: CERA), ten-year, three-year and one-year investment plans for the development of the transmission grid. 10-year development plans are updated annually. At the time of adoption of this document, the 10-Year Transmission Grid Development Plan 2019--2028, detailing the initial three-year and one-

year periods approved by CERA in July 2019. The plan will be continuously updated throughout the implementation period of this document.

Activities: according to the 10-Year Transmission Grid Development Plan

Funds needed for implementation: 8 billion

Funding Sources: electricity transmission fee; participation of new users in creating technical conditions in the grid for connection of their plants; EU funds (Structural, Innovation and Modernization Fund)

Executive body: HOPS

Monitoring body: MEE

Effect: safe and reliable operation of the transmission grid

Monitoring method: reports to CERA

Connection to other dimensions: decarbonisation - RES, energy efficiency, energy security

Note: In addition to the financial resources necessary to cover the costs of the construction of the transmission grid, it is also necessary to secure funds for the balancing of the system (through the balancing mechanism and partly through the electricity transmission fee), or for the procurement of part of the ancillary services of the system (primarily frequency and power regulation), which can be preliminarily estimated at the amount of HRK 375 to 425 million per year, and the funds needed for redispatching production facilities to eliminate periodic restrictions in the transmission grid.

UET-2: Development of the gas transport network

Financial measure; implementation 2021 - 2030

Objective and description of the measure: Planning for the development of the transmission system is carried out through the development of a 10-Year Gas Transmission Grid Development Plan, the development of which is the obligation of the gas transmission system operator pursuant to the Gas Market Act (OG 18/18). The gas transmission system operator is Plinacro d.o.o. 10-Year Gas Transmission Grid Development Plans are updated annually and approved by CERA. At the time of adoption of this document, the 10-Year Gas Transmission Grid Development Plan of the Republic Croatia 2018-2027 was relevant. The plan will be continuously updated throughout the implementation period of this document.

Activities: according to the 10-Year Transmission Grid Development Plan

Funds needed for implementation: 8 billion

Financing sources:

Executive body: Plinacro

Monitoring body: MEE

Effect: safe and reliable operation of the gas transmission system

Monitoring method: reports to CERA

Connection to other dimensions: decarbonisation - RES, energy efficiency, energy security

ii. Regional cooperation in this area

Due to the fact that 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, and already in the preparatory phase of interconnection projects, the gas transmission system operator is intensively cooperating with the transmission system operators of 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 the use of EU funds, if applicable.

Described in the context of financial measures in the "energy security" dimension.

3.4.3 Market integration

i. Policies and measures relating to the elements referred to in Section 2.4.3.

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 activities initiated by the Transmission System Operator (HOPS) and the Electricity Exchange (CROPEX) through IBWT and EU XBID projects are expected to continue. The course and speed of implementation of regional market integration in Southeast Europe will depend on the readiness of institutions in neighbouring countries, especially in neighbouring non-EU countries (Serbia and BiH).

Market integration will also significantly contribute to the goal of increasing the competitiveness and liquidity of the wholesale market. 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 area of supply.

Additional measures and activities need to be taken to enable the active participation of end consumers (customers) and other grid users in the electricity market, in particular in the provision of flexibility services.

ii. If applicable, measures to increase the flexibility of the energy system with regard to the production of energy from renewable sources, including the introduction of intraday pairing of markets and cross-border balancing markets

Contributing to this objective is the measure ES-6: Construction and use of energy storage facilities.

iii. Measures to ensure priority access and delivery of electricity produced from renewable energy sources or high efficiency cogeneration and prevention of limitation or redistribution of such electricity

Contributing to this objective is the measure UET-1 Development of the electricity transmission grid.

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

The vulnerable consumer protection measure (UET-5) is elaborated in Chapter 3.4.4. UET-3 is envisaged as a measure to strengthen competitiveness.

v. Description of measures to enable and develop demand response including those addressing tariffs to support dynamic pricing

UET-3: Elaboration of a regulatory framework for active participation of customers in the electricity market

Regulatory measure; implementation: 2020 - 2022

Objective and description of the measure: In order to enable the active role of grid users in the electricity market, the existing regulatory framework should be appropriately amended, in particular by introducing an aggregator as a market player and by facilitating the launch of ancillary service pilot projects. Pilot projects will analyse in detail the services that users can provide to the distribution or transmission system operator. The possible types, extent, manner and period of the provision of ancillary services will be analysed. Obstacles to the use of ancillary services will be identified and ways to remove them will be suggested. The analysis of the potential to provide ancillary services and flexibility services with demand response will be carried out beforehand, which will define the manner and model of the provision of ancillary services and demand response by grid users. The implementation of this measure will also take into account new technologies (battery tanks, electric vehicle charging stations, etc.), whose wider 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 the provision of ancillary services

Funds needed for implementation: regular work of state bodies

Funding Sources: /

Executive body: MEE

Monitoring body: MEE

Effect: The emergence of aggregators in energy markets; the emergence of new energy markets

Monitoring method: reports to CERA

Connection to other dimensions: decarbonisation - RES, energy security

Connection to climate change adaptation: /

Research and development: user involvement; advanced technologies for users; development of RES; energy storage; system flexibility

UET-4: Introduction of advanced metering and data management systems

In order to enable the further development of energy markets and the active role of energy buyers in energy markets, it is planned to introduce advanced metering devices and systems at the consumption level.

3.4.4 Energy poverty

i. If applicable, policies and measures for the achievement of objectives set out in 2.4.4.

In order to achieve the objectives set out in 2.4.4, the following measure will be implemented in the period from 2021 to 2030:

UET-5: Adoption and implementation of the Programme for energy poverty alleviation

Information and financial measures; Implementation 2021 - 2030

Objective and description of the measure: alleviation of energy poverty and its degree of vulnerability; setting up an energy poverty monitoring system

Activities: Within the Programme for the reduction of energy poverty, capacity building will be continued through local info centres, and energy poor citizens as well as citizens at risk of energy poverty will be provided with adequate information and advice on energy efficiency measures that contribute to the reduction of energy poverty and on opportunities of co-financing activities in this area. Furthermore, indicators necessary to monitor the energy poverty will be identified and a monitoring system will be established through the already existing system for collecting data on household consumption and habits (Croatian Bureau of Statistics). On the basis of data, a possible extension of criteria for gaining the status of vulnerable energy customers will be analysed. Also, the implementation of energy efficiency measures in energy poor households will be co-financed, such as replacement of household appliances by "old for new" system, upgrade or replacement of heating systems (improvement of the efficiency of heating systems and replacement of energy generating products (in particular electricity and fuel oil) with systems that are environmentally and economically more favourable and more energy-efficient, and above all, with systems that use renewable energy sources, and the implementation of other technical energy efficiency measures will also be co-financed. The programme will elaborate in detail the above-mentioned measures and, if necessary, develop other measures as well as the possibility of their implementation within the energy efficiency obligation system for suppliers. A model to cover energy costs will be developed and implemented within the Programme. The model will determine the level of assistance needed for households facing the problem of meeting energy costs, based on the amount of energy required to meet the minimum standard of living. The Long-term Renovation Strategy (2050) will provide measures to combat energy poverty through the energy renovation of buildings, as well as criteria for identifying vulnerable groups of citizens at risk of energy poverty. These measures will be further elaborated in the Programme of Energy Renovation

of Multifamily Housing 2021-2030 and in the Programme of Energy Renovation of Family Houses 2021-2030

Funds needed for implementation: Not estimated

Funding Sources: Energy Efficiency Obligation Scheme payer funds, EU funds

Executive body: the ministry responsible for energy and the ministry responsible for social welfare, CBS

Monitoring (supervisory) bodies: the ministry responsible for energy and the ministry responsible for social welfare

Effect: Establishment of a system for monitoring energy poverty and the vulnerability to it; capacity building to alleviate energy poverty; the establishment of models to cover energy costs; reduction of immediate energy consumption and consequent reduction of CO₂ emissions in energy-poor and at-vulnerable households

Monitoring method: CBS publications; The realized 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: decarbonisation - emissions; decarbonisation - RES; energy efficiency

Connection to climate change adaptation: /

Research and development: energy efficiency in buildings; energy efficiency in heating and cooling; smart cities and communities

3.5 Dimension: research, innovation and competitiveness

i. Policies and measures relating to the elements referred to in Section 2.5.

The state will increase investment in research, development and innovation, and investment in the transfer of knowledge and technologies and the development of knowledge and innovation based technologies through various programmes from grants, conditional loans to state aid programmes. The introduction of concrete technologies will be driven primarily by the market. A three-year action plan for research, innovation and competitiveness relevant to the dimensions of the Energy Union will be drawn up.

IIK-1: Research, innovation and competitiveness status quo analysis and determining targets, indicators and monitoring system

Regulatory measure; implementation: 2020 - 2022-2030

Objective and description of the measure: Elaboration of monitoring objectives and systems, and establishment of a monitoring system for achievements in the field of energy-related research and development, innovation and competitiveness; defining key technologies for low carbon transition, elaborating a three year action plan

Activities: In cooperation with MEEC and MSE, MEE will further elaborate criteria and indicators relevant to the areas of the Energy Union. It will propose relevant data sources and an indicator monitoring system. It will propose key low-carbon transition technologies, monitor the achievement of set goals, and propose corrective and other measures as needed. If necessary, thematic subgroups will be established for areas of research, innovation and competitiveness.

Funds needed for implementation: regular work of state bodies

Executive body: MEE, MEEC, MSE, CBS, SIPO

Monitoring (supervisory) bodies: MEE

Effect: Defined national development goals in the context of low carbon transition, established system for monitoring of implementation, defined key technologies

Monitoring method: MEE reports

Connection with other dimensions: The measure is linked to all dimensions of the Energy Union as it encourages and monitors research in all areas relevant to the Energy Union

Connection to climate change adaptation: Among other topics, the measure encourages and monitors research relevant to climate change adaptation.

IIK-2: Co-financing industrial research and experimental development projects aligned with the National Development Strategy

Financial measure; implementation 2021 --2030

Objective and description of the measure: The measure promotes research and development of products and services relevant to low-carbon development by co-financing research projects under priority topics.

Activities: Tenders will be announced on an annual basis for research projects to be carried out within the Republic of Croatia. Co-financing of the participation of Croatian scientific organizations and SMEs in international research projects dealing with priority topics for the Republic of Croatia will be provided. Also, project participation of Croatian scientific institutions and SMEs in relevant programmes (SET Plan, ETIP, EERA, Horizon 2020 LIFE, Eureka, etc.) will be co-financed, European Partnerships under the EU Framework Programme for Research and Innovation and in relevant Pan - European networks and consortia, in accordance with the rules of a particular programme. Scientific and research and commercial cooperation will be encouraged and private R&D investment. The number of patents applied for and granted will be monitored. Projects whose objectives are aligned with national priorities will be provided with funding for part of the costs not funded by donor funding.

Funds needed for implementation: : approximately HRK 45 million a year

Executive body: CSF, MEE, MSE, MEEC, HAMAG-BICRO

Monitoring (supervisory) bodies: National Innovation Council

Effect: Research and scientific projects of priority for the Republic of Croatia were conducted

Monitoring method: MEE reports

Connection with other dimensions: The measure is linked to all dimensions of the Energy Union as it encourages research in all areas relevant to the Energy Union

Connection to climate change adaptation: The measure encourages and monitors research relevant to climate change adaptation.

IIK-3: Supporting low carbon entrepreneurship development

Financial measure; implementation 2021 --2030

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

Activities: It will continue to support entrepreneurs throughout the development stages of their business - from the research and development of the idea through to commercialization and marketing, all in the area of low carbon products and services. Cooperation with scientific and research institutions and increased private investment in R&D will be encouraged. One

possible activity is to fund the Proof of Concept as a mechanism to support the transfer of research results from the public to the private sector to create new products and services. The number of patents applied for and granted and the number of new products will be monitored. Workforce needs and additional workforce qualifications will be monitored, and ongoing communication with government education and employment authorities established.

Funds needed for implementation: to be determined subsequently

Executive body: HAMAG-BICRO, MSE, MEEC

Monitoring body: MEE and the Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change

Effect: Low carbon products and services marketed

Monitoring method: reports of the Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change

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

Connection to climate change adaptation: The measure encourages entrepreneurship in areas relevant to climate change adaptation.

IIK-4: Supporting knowledge and technology transfer from science to economy with focus on low carbon technologies

Financial measure; implementation 2021 --2030

Objective and description of the measure: The measure encourages the development of established technology transfer offices or related organizational units in public scientific organizations and science and technology parks with the aim of transferring knowledge and developing technologies that will contribute to the development of a low carbon economy.

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

The number of collaborations between the systems of science and industry in the field of low carbon technology, the number of business plans prepared; the number of further investments secured after the PoC phase; number of intellectual property rights protection requests submitted; the number of newly established development companies or subsidiaries in the 5 year period since its inception, and business success will be monitored. Also, an invitation will be issued annually for the PoC phase of projects to be implemented by technology transfer offices.

Funds needed for implementation: Up to HRK 5 million annually

Executive body: MSE

Monitoring (supervisory) body: MSE

Effect: Low carbon products and services marketed

Monitoring method: Reports on the work of technology transfer offices and science and technology parks.

IIK-5: Supporting further work of excellence centres active 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 with a view of a further development a low carbon economy.

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

Funds needed for implementation: to be determined subsequently

Executive body: MSE

Monitoring (supervisory) bodies: ASHE

Effect: results of industrial and experimental research in the field of low carbon development

Monitoring method: Reports on the work of the CRE, which are submitted annually to the MSE and the ASHE.

IIK-6: Capacity building for stimulating research and innovation and increasing competitiveness in the low carbon economy

Information measure; 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: Representatives of all bodies involved in the implementation of measures IIK 1-5 will be supported to participate in lectures, workshops, working group meetings, study tours with the aim of international integration and capacity building in setting goals, defining indicators and monitoring the achievement of set goals in the context research, innovation and competitiveness in the low carbon economy. Support for participation in working bodies and working groups and committees of relevant European and international organizations (IEA, etc.), programmes (SET Plan, ETIP, EERA, Horizon 2020 LIFE, Eureka, etc.), European Partnerships under the EU Framework Programme for the research and innovation in relevant Pan-European networks and consortia. If necessary, the transfer of know-how with other EU Member States and other stakeholders within the Republic of Croatia will be organized.

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

Funds needed for implementation: HRK 50 million / year

Funding sources: technical assistance, funds gained from the auction of emission allowances (EPEEF), ESI funds

Executive body: HAMAG-BICRO, MSE, MEEC

Monitoring body: MEE and the Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change

Effect: Capacities in bodies responsible for stimulating research, innovation and competitiveness in the area of low carbon technologies

Monitoring method: reports of the Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change

Connection to other dimensions: /

Connection to climate change adaptation: /

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, as the topic of regional cooperation within the dimension of research, innovation and competitiveness scientific and research cooperation with the possibility of expanding were proposed, regarding the following topics:

- 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 CO₂,
- hydrogen,
- energy poverty
- consumer behaviour.

Countries participating in informal regional coordination are considering the proposals made and will agree on next steps.

iii. Financial measures in this area at the national level, including EU support and the use of EU funds

Scientific and research project stimulating entrepreneurship will be funded from national, European Structural and Cohesion Funds for the period 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 topics of the projects will be determined in accordance with national priorities, to be determined by the Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change (foreseen under measure MS-1), in cooperation with the competent ministries. 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. The proceeds from the emissions trading will be used for this purpose.

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 important factors influencing energy system and GHG emission developments are demographic and economic movements.

The number, dynamics and spatial distribution of population according to different demographic and economic characteristics are the basic determinant of steering overall development. Three population projections have been made (low, medium, and high). In addition, projections of main economic parameters were made for the period by 2050. These include projections of gross domestic product (GDP). *Gross Domestic Product, GDP*) and *Gross Value Added, (GVA)* of the Republic of Croatia by sector of economic activity: industry, agriculture, transport, hotels and restaurants, other services and households.

By using the medium population projection, the projections of GDP growth for the basic and increasing productivity are made (Figure 4-1.).

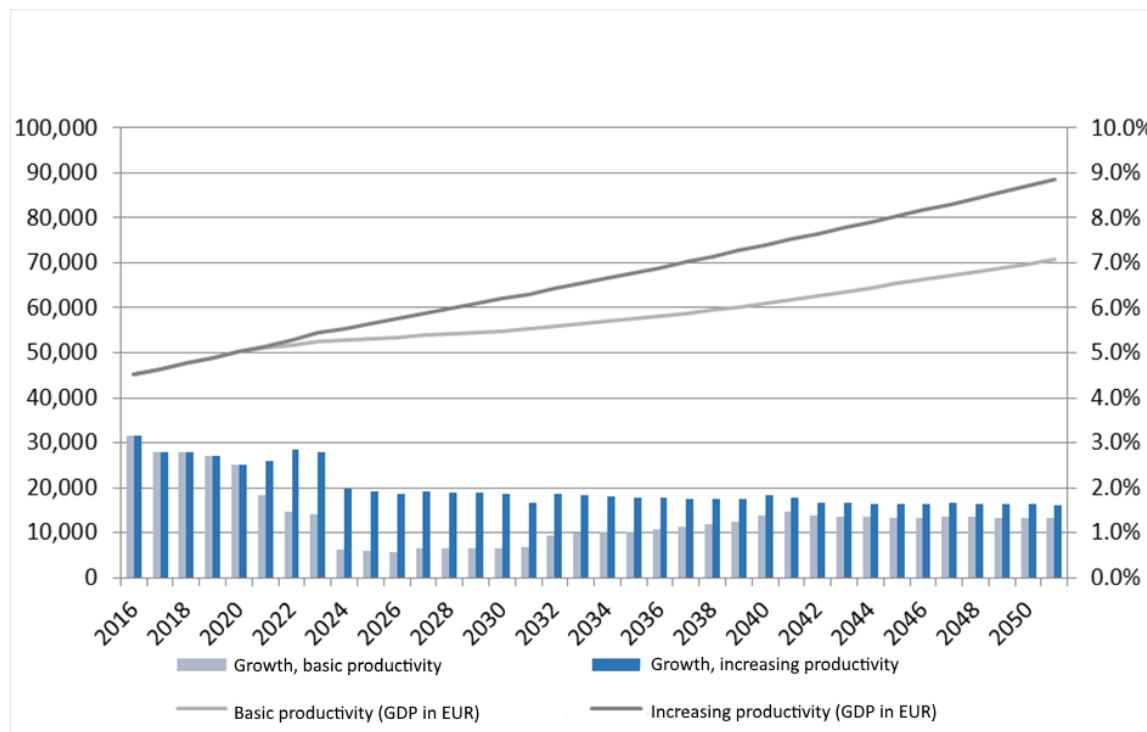


Figure 4-1. The GDP projection based on medium demographic projections (for the basic and increasing productivity)

The convergence scenario allows Croatia to reduce the gap in the level of development vis-à-vis other EU members to some degree, although this speed does not ensure reaching the EU average. However, convergence of *total factor productivity*(TFP) enables to catch up with new members that have already passed the transformation period of economy and for most of which it is expected that they will reach around 90% of EU28 average by the end of the projected period.

Table 4–1.: Projections of economic parameters on the basis of medium demographic projections

	2016	2020	2030	2040	2050
Base productivity					
GDP, constant prices 2010, billion HRK	335.902	373.595	408.987	454.649	520.277
BDP, index, 2016. = 100	100.0	111.2	121.8	135.4	154.9
GDP per capita, constant 2010 prices, thousand HRK	82	94	109	129	158
GDP per capita, index 2016 = 100	100.0	114.4	132.9	157.1	192.7
Population, in millions	4.099	3.984	3.755	3.532	3.295
Number of employees, constant activity, in millions	1.550	1.559	1.434	1.315	1.191
Convergence of productivity					
GDP, constant prices 2010, billion HRK	335.902	373.595	462.111	551.311	649.695
BDP, index, 2016 = 100	100.0	111.2	137.6	164.1	193.4
GDP per capita, constant 2010 prices, thousand HRK	82	94	123	156	197
GDP per capita, index 2016 = 100	100.0	114.4	150.2	190.5	240.6
Population, in millions	4.099	3.984	3.755	3.532	3.295
Number of employees, growing activity, in millions	1.550	1.576	1.502	1.429	1.342

The projection of GDP and economic structure movements is based on the existing observed trend of GDP movements, employment and labour productivity, demographic projections and the existing economy structure.

ii. Sectoral changes expected to affect the energy system and greenhouse gas emissions

The projection of direct consumption of all forms of energy (e.g. fossil fuels, biomass, solar energy, electricity, etc.) 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. The MAED model was used (*Model for Energy Demand Analysis*) to analyse immediate energy consumption.

The main determinants of changes in the energy sector applied in making projections of direct 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;
- 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, due to the expected fall in the prices of these technologies and the rise in the prices of emission permits.

In addition to sector-specific measures, the analysed scenario for the development of the energy sector also takes into account the effects of regulatory measures, which will have cross-sectoral effects. This primarily concerns the establishment of a functional system of energy efficiency obligations for energy suppliers in accordance with Article 7. Directive 2012/27 / EU on energy efficiency, which is due to enter into force in 2019. In conclusion, it can be stated that energy efficiency in the area of energy consumption is the basis development scenario of the energy sector. In addition, energy efficiency is also expected to be increased on the energy production side by the construction of new cogeneration plants and gas-fired power plants (TPPs) with higher efficiency and an increase in the share of RES. In the area of transmission and distribution of electricity and heat, further losses are expected to be reduced to the level of developed energy systems by 2030.

Projections of immediate consumption of all forms of energy take into account the feedback of expected climate change on the modes and dynamics of consumption of different forms of energy (e.g. changes in seasonal energy use, changes in space heating and cooling needs, etc.). Energy consumption and driving parameters (e.g. population and population structure, GDP structure, etc.) were analysed by dividing the territory of the Republic of Croatia into two geographical areas - Continental Croatia and Adriatic Croatia (official statistical regions).

Starting from the availability of local resources and sources of primary forms of energy, the possibilities of meeting the needs of all forms of energy (e.g. thermal, electric, natural gas, biomass, etc.) were analysed. 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 system elements (e.g. power plants, powerlines, pipelines, etc.) were taken into account.

The MESSAGE model was used to optimize electricity systems and district heating systems (in the part of thermal energy production), as well as the PLEXOS model to analyse/confirm the feasibility of operating the power system on an hourly basis in selected characteristic years.

The conversion factors are presented in the table below.

Table 4–2 Overview of conversion factors used

	Unit	MU	kgoe
Bituminous coal	kg	24.28-29.31	0.580-0.700
Bituminous coal for coking	kg	29.31	0.700
Brown coal	kg	16.75-19.26	0.400-0.460
Lignite	kg	9.63-12.56	0.230-0.300
Coke	kg	26.38-29.31	0.630-0.700
Firewood	dm ³	9.00	0.215
Biodiesel	kg	36.90	0.884
Bioethanol	kg	26.67	0.637
Landfill gas	m ³	17.00	0.406
Biogas	m ³	18-20	0.430-0.478
Natural gas	m ³	34 -35.88	0.812 -0.857
Crude oil	kg	42.40	1.013
Liquefied gas	kg	46.89	1.120
Motor gasoline	kg	44.59	1.065
Naphtha	kg	44.59	1.065
Kerosene	kg	43.96	1.050
Jet fuel	kg	43.96	1.050
Extra light fuel oil	kg	42.71	1.020
Diesel fuel	kg	42.71	1.020
Fuel oil	kg	40.19	0.960
Petroleum coke	kg	31.0	0.740
Other derivatives	kg	33.49 - 40.19	0.800 -0.960
Refinery gas	kg	48.57	1.160
Ethane	kg	47.31	1.130
Gas coke	m ³	17.91	0.428
Town gas	m ³	27.76	0.663
Blast furnace gas	m ³	3.60	0.086
Electricity	kWh	3.60	0.086

iii. Global energy trends, international fossil fuel prices, carbon pricing within the EU ETS

Fossil fuel prices by 2050 have been assumed in line with the forecasts of the International Energy Agency (IEA, World Energy Outlook 2017). The so-called *New Policies Scenario*).

Table 4–3.: Fossil Fuel Prices by 2040

IEA - New Policies Scenario								
USD 2016	Fuel	2000	2010	2016	2025	2030	2035	2040
USD / barrel	Crude oil	38	86	41	83	94	103	111
USD/Mbtu	Natural gas (EU)	3.8	8.2	4.9	7.9	8.6	9.1	9.6
USD/ton	Coal (EU)	46	101	63	77	80	81	82

Source: IEA WEO 2016/2017

Prices for the post-2040 period have been extrapolated and reduced to the 2015 euro for analysis purposes. Figure 4-2. shows the level of prices thus assumed for fossil fuels in EUR / GJ.

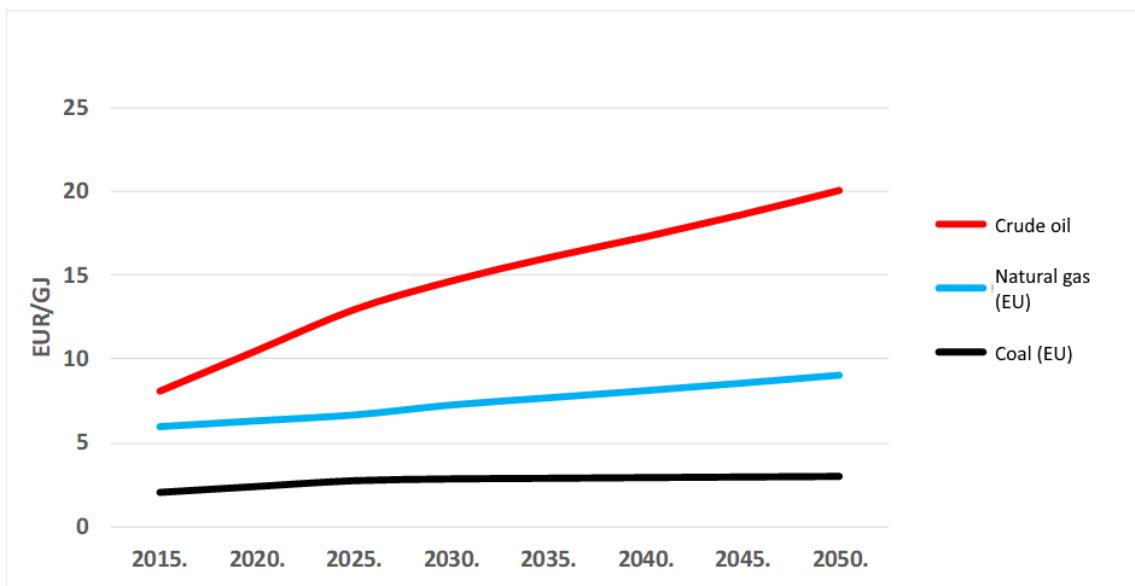


Figure 4-2. Fossil fuel prices by 2050

Source: IEA WEO 2016/2017 and EIHP elaboration

For natural gas and coal, prices relevant to the EU were taken. For nuclear fuel, fixed price of 0.74 EUR/GJ is assumed, and for biomass 4.6 EUR/GJ.

For all power plants using fossil fuels, it is assumed that they participate in the European Emissions Trading System. For the purpose of the preparation of the national energy climate plans, the European Commission prepared recommended price levels of emission allowances by 2050, which is presented in Table 4–4. Basic prices are expressed in EUR from 2013, amounts are converted to the level of 2015 (values used in the analyses) and in EUR from 2016 (values also stated in documents of the European Commission).

Table 4–4.: Prices of emission allowances

Prices of emission allowances	2015	2020	2025	2030	2035	2040	2050
NECP – EC Recommendation EUR'13/t CO ₂	7.5	15.0	22.5	33.5	42.0	50.0	90.0
NECP – EC Recommendation EUR'16/t CO ₂	7.8	15.5	23.3	34.7	43.5	51.7	93.1
NECP and correction of historical prices EUR'16/t CO ₂	7.8	25.9	30.3	34.7	43.5	51.7	93.1
NECP and correction of historical prices EUR'15/t CO ₂	7.7	25.6	29.9	34.3	43.0	51.1	92.1

Source: EU Reference Scenario 2016 and EIHP analysis

Current market prices also show higher values than those recommended by the EC. On the basis of such developments, an alternative price trajectory to 2030, reduced to the 2015 euro, has been estimated. These values were used to optimize the electricity generation system (Figure 4-3.).

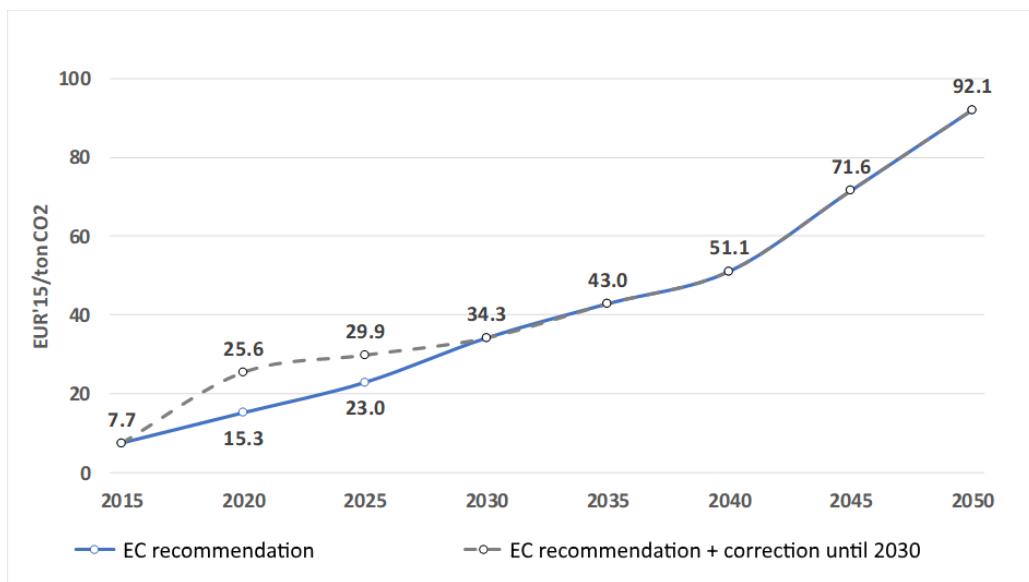


Figure 4-3. Expected emission allowances price by 2050

Source: EU Reference Scenario 2016 and EIHP analysis

iv. Changes in technology cost

Expected development of specific investment costs in individual technologies for the period 2015-2050 was taken from [20] [21] and internal estimates, especially in the area of wind farms (Figure 4-4. and Figure 4-5.).

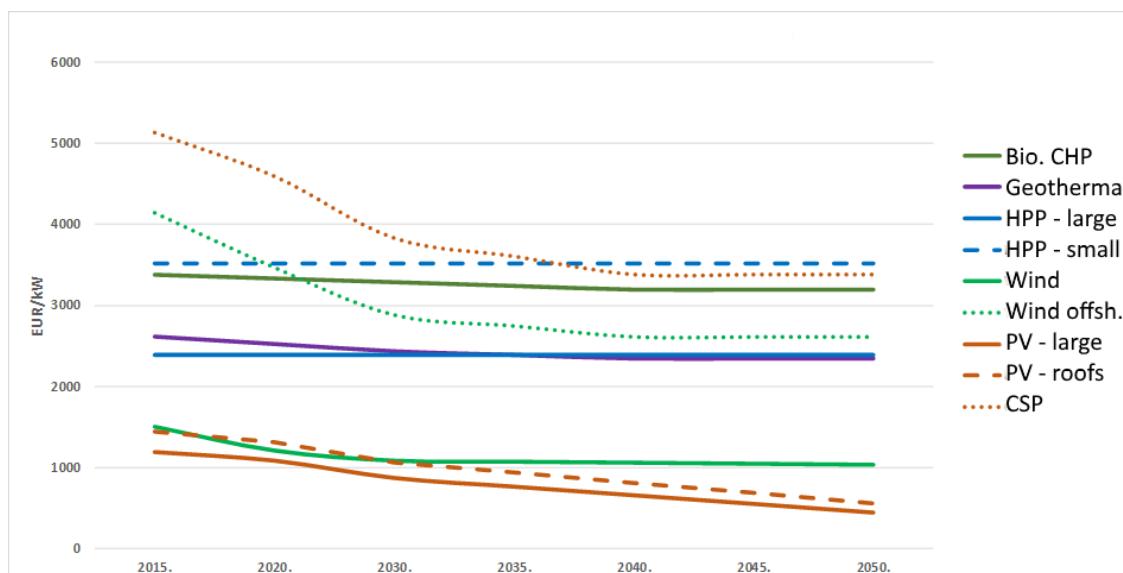


Figure 4-4. Specific investment in RES technologies

Specific cost reductions are expected for RES sources, especially for solar power plants and offshore wind farms. No significant technological/cost progress is expected for large and small HPPs and biomass power plants.

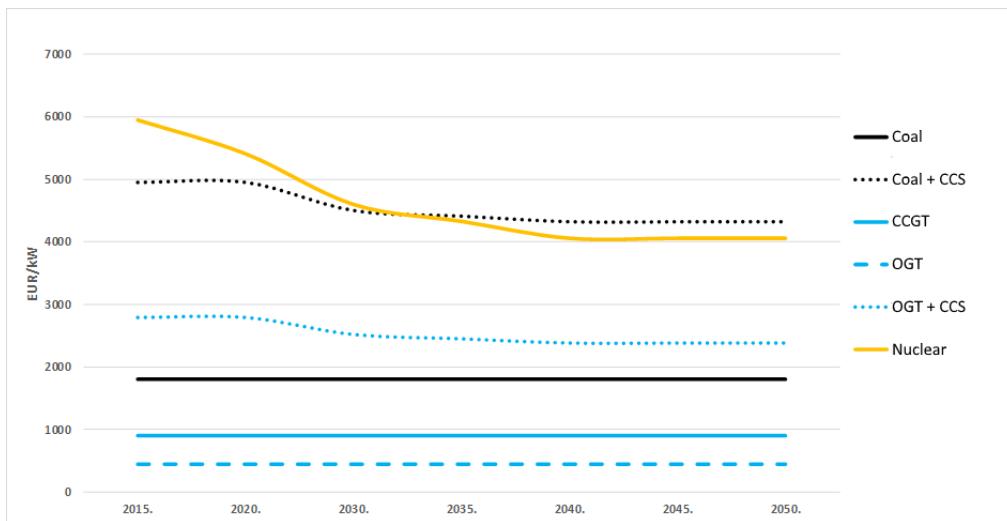


Figure 4-5. Specific investment in fossil fuel and nuclear power plants

Coal and natural gas TPPs are not expected to be technologically advanced except in the context of the development of *carbon capturing and storage*, CCS. For nuclear power plants, the possibility of making greater use of this technology within reaching global emissions reduction targets was assumed (the estimate presented relates to projects to be implemented in Europe).

4.2 Dimension decarbonization

4.2.1 Greenhouse gas emissions and removals

- i. Trends in current GHG emissions and removals within the framework of the EU Emissions Trading System, Effort Sharing Regulation, LULUCF and other energy sectors

The trend of GHG emissions in the Republic of Croatia is presented in Figure 4-6.

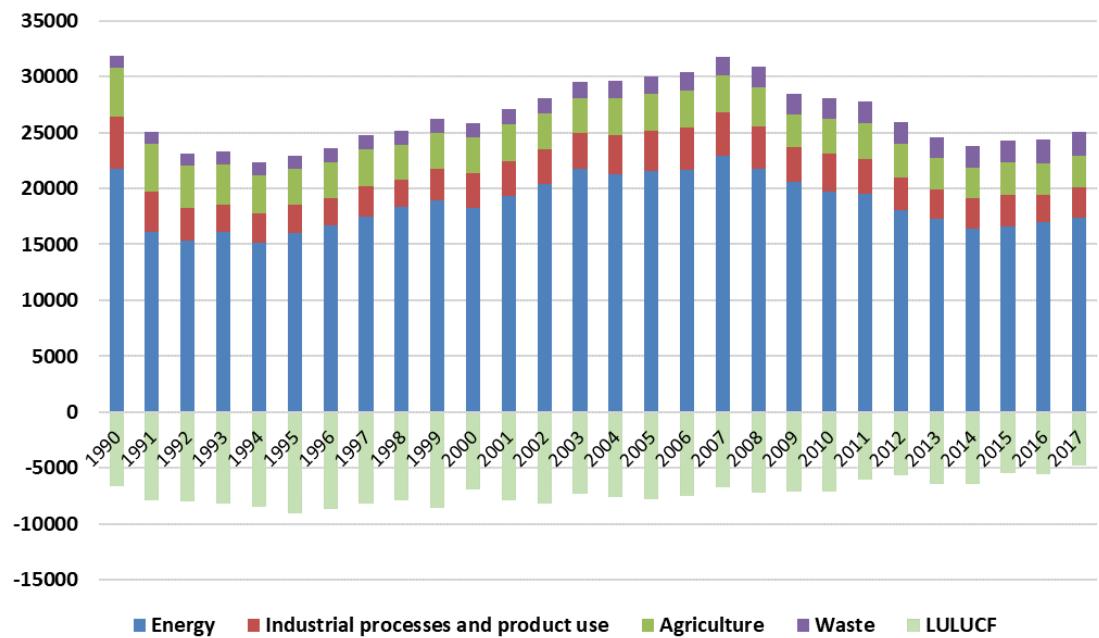


Figure 4-6. Trend of GHG emissions in the Republic of Croatia

Since 1 January 2013, plants in the Republic of Croatia participate in the EU Emissions Trading System for GHG. The emissions from ETS and non-ETS sectors are available for 2005 and for the period from 2013 to 2017 (Figure 4-7).

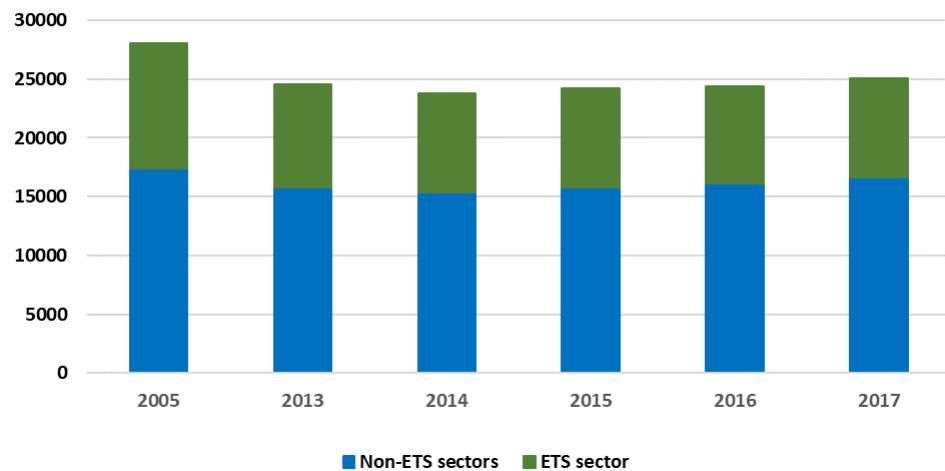


Figure 4-7. Trend of GHG emissions from ETS and non-ETS sectors in the Republic of Croatia

ii. Projections of GHG emissions by sector with existing national policies and measures and EU policies and measures

Projections of GHG emissions by sector with existing national policies and measures and EU policies and measures by 2040 are presented in Figure 4-8.

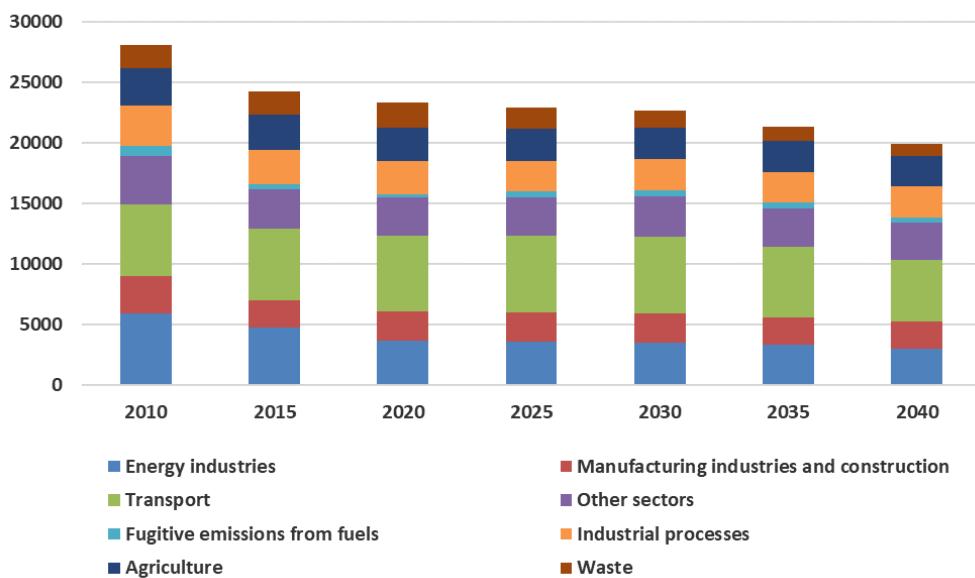


Figure 4-8. Projection of GHG emissions with existing measures

4.2.2 Energy from renewable sources

- i. **Current share of renewable energy in gross final energy consumption and in different sectors (heating and cooling, electricity and transport) as well as per technology in each of these sectors**

In the case of the scenario with existing measures (Scenario S0), RES shares and forecasts with existing measures are presented below.

Table 4–5.: Indicative trajectories of RES shares by 2030 in the scenario with existing measures

RES share, %	Projection 2020	Projection 2030 (Scenario S0)
In the gross final consumption of energy	28.6	34.0
In the final consumption of electricity	47.0	62.2
In the final consumption of energy for heating and cooling	33.3	35.2
In the final consumption of energy in transport	5.2	7.3

- ii. **Projections of sectoral developments in addition to existing national and EU policies and measures, at least until 2030.**

The following figure shows the expected trajectories (shares) for the observed categories: total RES in the gross final consumption (Figure 4-9), RES in electricity (Figure 4-10), RES in

heating and cooling (Figure 4-11) and RES in transport (Figure 4-12) for the scenario with existing measures.

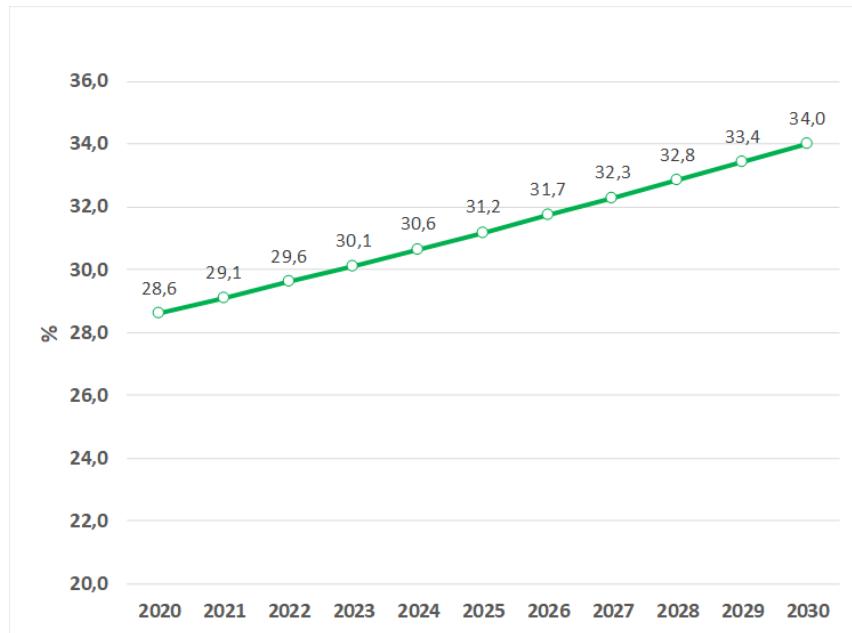


Figure 4-9. Indicative trajectory of RES shares in the gross final consumption of energy in scenario with existing measures

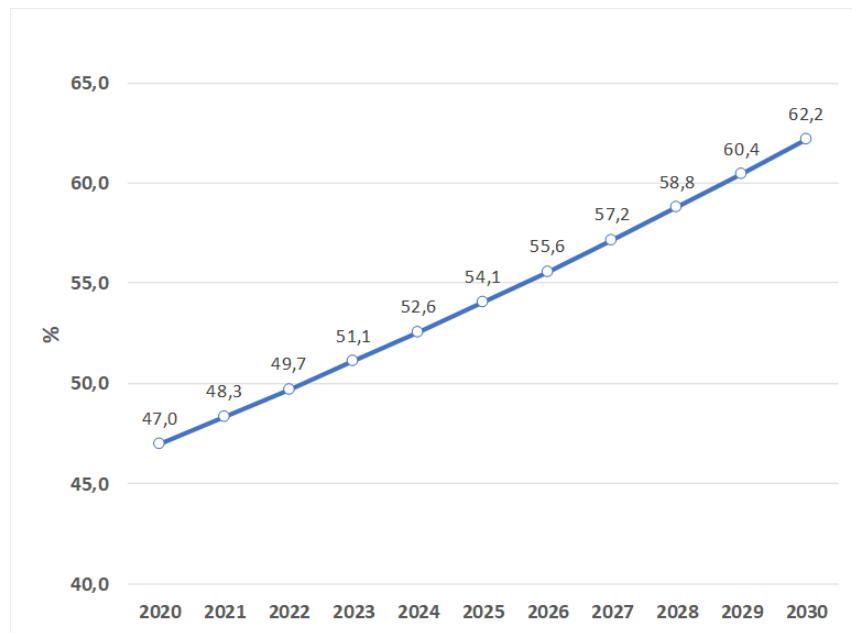


Figure 4-10. Indicative trajectory of RES shares in electricity in scenario with existing measures

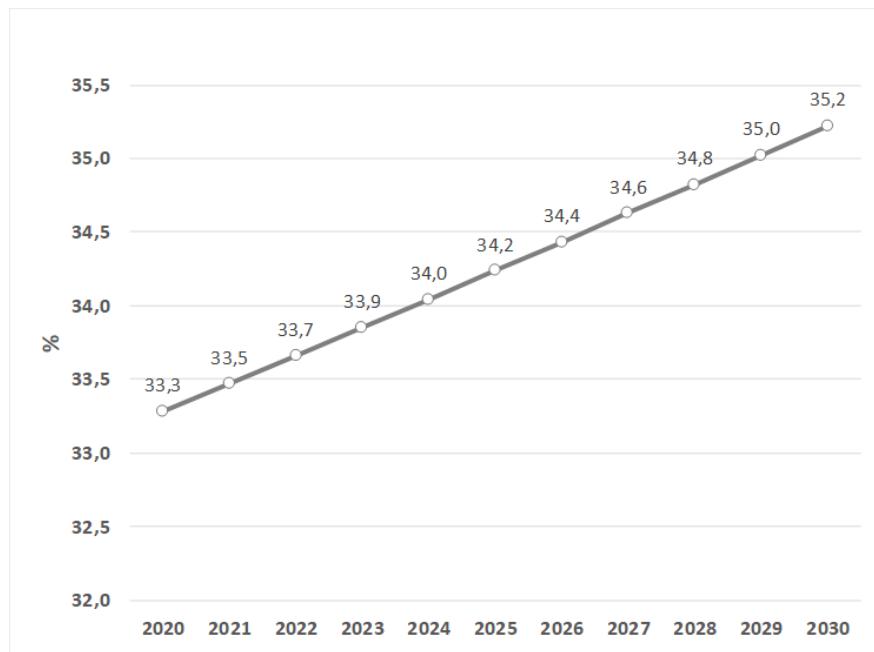


Figure 4-11. Indicative trajectory of RES share in heating and cooling for the scenario with existing measures

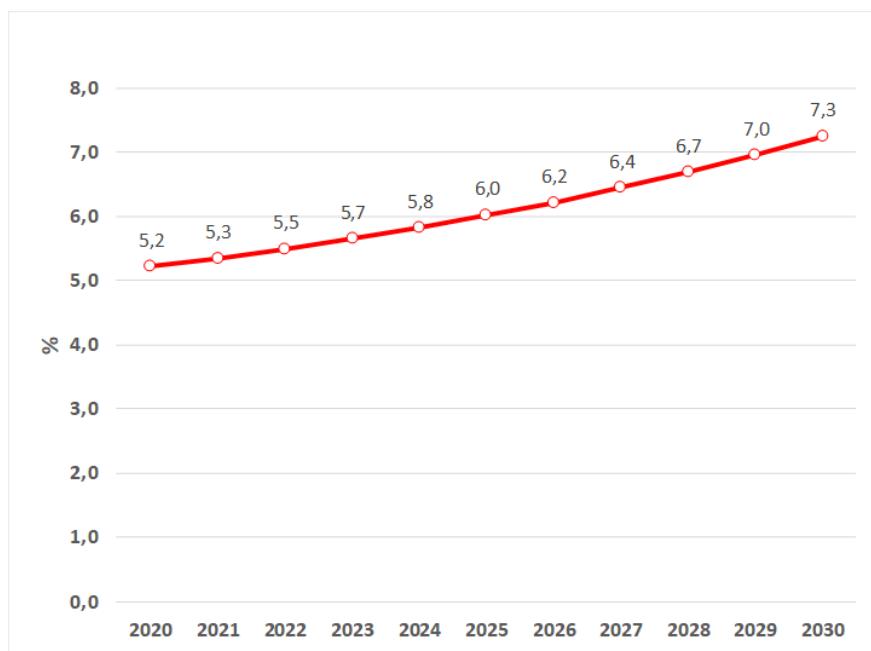


Figure 4-12. Indicative trajectory of RES share in transport for scenario with existing measures

Evaluated contributions of technologies for production of energy from RES for the scenario with existing measures are shown in Figure 4-13.., and Tables 4-6 to 4-9.: .

Table 4-6: Estimated contribution of RES technologies to gross direct consumption- Scenario with existing measures

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gross final RES consumption	2014,6	2064,5	2114,3	2164,1	2213,9	2263,8	2313,6	2363,4	2413,2	2463,1	2512,9
Solar energy	19,5	20,2	20,9	21,6	22,4	23,1	23,8	24,5	25,3	26,0	26,7
Solid biofuels	1107,4	1113,9	1120,5	1127,1	1133,7	1140,3	1146,9	1153,5	1160,1	1166,7	1173,3
Gaseous biofuels	0,0	0,2	0,4	0,6	0,8	0,9	1,1	1,3	1,5	1,7	1,9
Liquid biofuels	56,9	59,0	61,2	63,3	65,4	67,5	69,6	71,7	73,8	75,9	78,1
Geothermal energy	9,4	12,1	14,8	17,4	20,1	22,8	25,5	28,1	30,8	33,5	36,2
Thermal energy from RES	45,5	52,3	59,2	66,1	72,9	79,8	86,7	93,5	100,4	107,3	114,1
Electricity from RES	776,0	806,7	837,3	868,0	898,7	929,3	960,0	990,7	1021,3	1052,0	1082,6

Table 4-7: Estimated contribution of technologies for RES in electricity - Scenario with existing measures

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final RES-e	776,0	806,7	837,3	868,0	898,7	929,3	960,0	990,7	1021,3	1052,0	1082,6
HPP	566,2	570,0	573,8	577,6	581,4	585,2	589,0	592,8	596,6	600,4	604,2
WPP	148,1	159,3	170,5	181,7	193,0	204,2	215,4	226,6	237,8	249,0	260,3
PV	11,5	16,1	20,7	25,4	30,0	34,6	39,2	43,8	48,4	53,1	57,7
GE	6,5	7,6	8,6	9,6	10,7	11,7	12,8	13,8	14,8	15,9	16,9
TPP - solid and gaseous biofuels	43,7	53,7	63,7	73,6	83,6	93,6	103,6	113,6	123,6	133,6	143,6

Table 4-8.: Estimated contribution of technologies for RES in heating and cooling - Scenario with existing measures

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final RES-h&c	1181,7	1198,6	1215,4	1232,3	1249,1	1266,0	1282,9	1299,7	1316,6	1333,4	1350,3
Solar energy	19,5	20,2	20,9	21,6	22,4	23,1	23,8	24,5	25,3	26,0	26,7
Solid biomass	1107,4	1113,9	1120,5	1127,1	1133,7	1140,3	1146,9	1153,5	1160,1	1166,7	1173,3
Geothermal energy	9,4	12,1	14,8	17,4	20,1	22,8	25,5	28,1	30,8	33,5	36,2
Thermal RES	45,5	52,3	59,2	66,1	72,9	79,8	86,7	93,5	100,4	107,3	114,1

Table 4-9.: Estimated contribution of technologies for RES in transport - Scenario with existing measures

ktoe	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Final RES-t	68,4	70,8	72,8	75,7	78,8	82,1	85,6	89,2	93,1	97,3	101,8
Biofuels	56,9	58,3	59,2	61,1	63,2	65,5	67,9	70,5	73,3	76,4	79,9
Electricity from RES	11,4	12,5	13,5	14,6	15,6	16,7	17,7	18,8	19,8	20,9	21,9

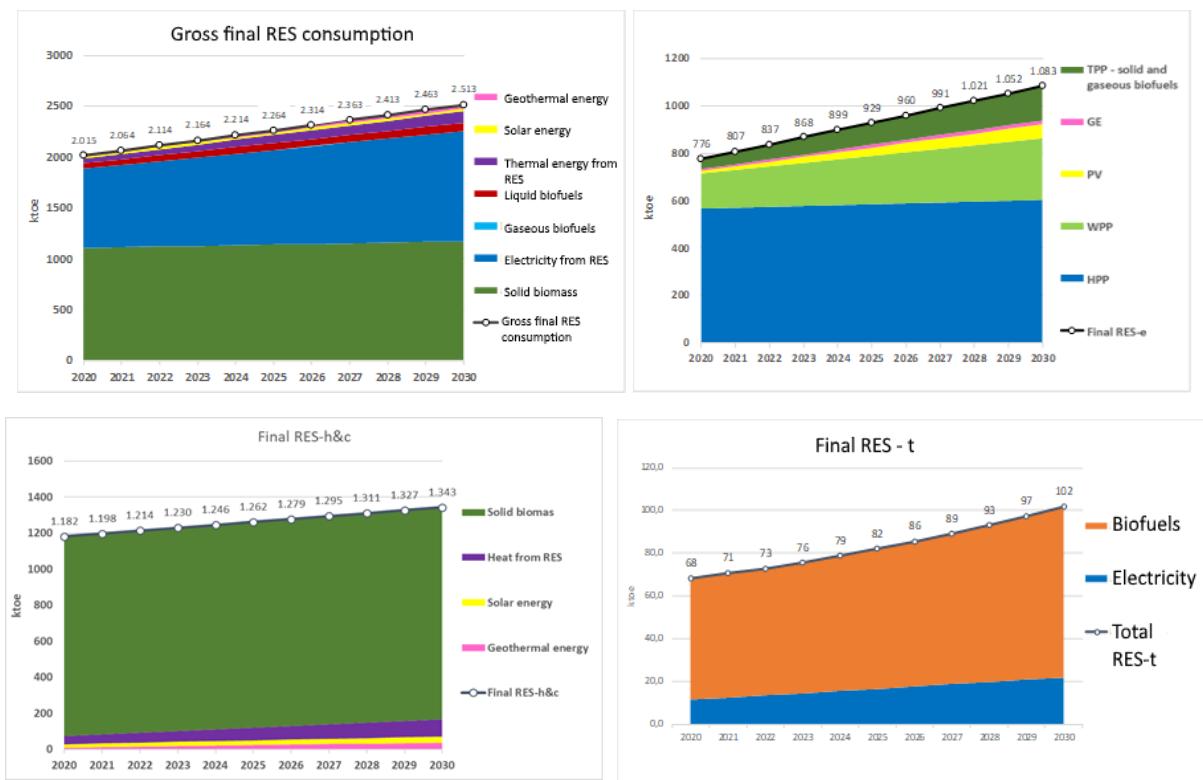


Figure 4-13. Estimated contributions of RES technologies by sector - Scenario with existing measures

The expected structure of power plant capacity for the production of electricity in the Scenario with existing measures is presented in Table 4-10 and in Figure 4-11.

Table 4-10.: Expected power plant capacity in the scenario with existing measures

MW	Hydro	Gas	Fuel oil	Coal	Nuclear	Biomass	Geothermal	Wind	Sun	Total
2020	2125	997	303	192	348	154	10	734	72	4934
2021	2125	997	303	192	348	171	10	759	95	4999
2022	2125	997	303	192	348	170	10	784	117	5045
2023	2125	1297	303	192	348	166	10	809	140	5389
2024	2158	1297	303	192	348	161	10	834	162	5465
2025	2158	1297	303	192	348	156	17	859	185	5514
2026	2536	1049	0	192	348	156	17	897	222	5416
2027	2536	1049	0	192	348	155	17	934	260	5490
2028	2546	1199	0	192	348	151	26	984	297	5742
2029	2546	1199	0	192	348	151	26	1034	335	5830
2030	2546	1048	0	192	348	148	26	1184	507	5998
2035	2611	990	0	192	348	148	48	1434	857	6628
2040	2676	1290	0	0	348	146	48	1684	1245	7436

Note: Nuclear refers to the Krško NPP located on the territory of the Republic of Slovenia and in which the Republic of Croatia holds 50% ownership and uses 50% of available power and energy.

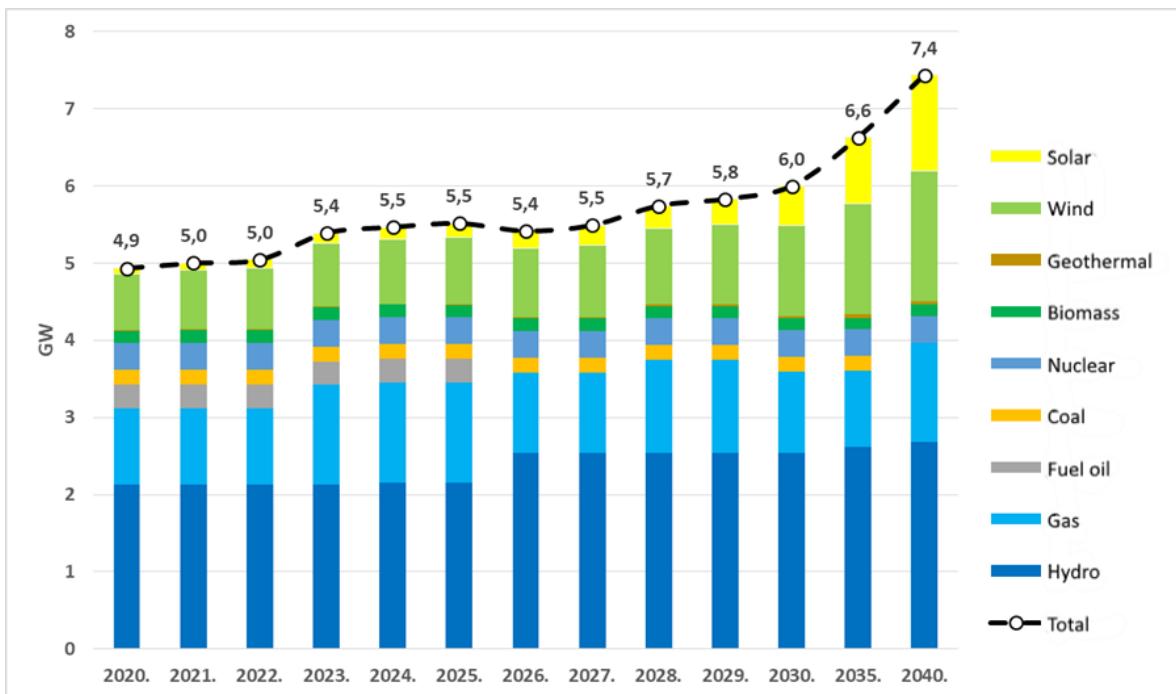


Figure 4-14. Expected power of power plants in the Scenario with existing measures (S0)

4.3 Dimension: energy efficiency

i. Current primary and final energy consumption in the economy and by sector (including industry, residential, service and transport)

Recent data on energy consumption in the Republic of Croatia available at the moment of drafting this plan are for 2017 and they are presented in Table 4-11 and

Table 4-12.

Table 4-11. The structure of primary and final energy consumption by sector in 2017 (balance according to EUROSTAT methodology)

2017	PJ	ktoe
TOTAL ENERGY CONSUMPTION	371.8	8,879.9
Transformation losses	222.8	5,320.3
Operational consumption	25.5	608.9
Transport and distribution losses	9.1	218.0
Non-energy consumption	22.3	533.7
PRIMARY ENERGY CONSUMPTION	349.4	8,346.2
FINAL ENERGY CONSUMPTION	289.9	6,924.0
Industry	49.3	1,178.3
Transport	97.8	2,336.9
Residential	99.5	2,377.1
Service	33.5	801.1
Agriculture and forestry	8.6	204.9
Fishery	1.1	25.7

Table 4–12.: The structure of primary and final energy consumption by energy generating product (balance according to EUROSTAT methodology)

2017	PJ	Ktoe
TOTAL ENERGY CONSUMPTION	371.8	8,879.9
Coal and coke	16.5	393.9
Liquid fuels	145.4	3,471.7
Natural gas	104.4	2,493.3
Renewable energy sources	80.0	1,911.5
Waste non-renewable		
Electricity	25.0	597.9
Thermal energy	0.0	0.0
FINAL ENERGY CONSUMPTION	289.9	6,924.0
Coal and coke	3.1	74.5
Liquid fuels	125.5	2,998.2
Natural gas	45.3	1,081.4
Renewable energy sources	48.3	1,152.9
Waste non-renewable	0.5	11.5
Electricity	57.6	1,374.8
Thermal energy	9.7	230.8

Source: Annual Energy Report - Energy in Croatia 2017, Ministry of Environment and Energy, December 2018

ii. Current potential for the application of high-efficiency cogeneration and efficient district heating and cooling

Indicators of potential for use of high-efficiency cogeneration and efficient district heating and cooling are taken from the document “Programme for use of efficiency potential in heating and cooling for the period 2016-2030” from November 2015, which was prepared for the Ministry of Economy (today under the Ministry of Environment and Energy) in accordance with Article 14, paragraph 1 Directive 2012/27/EC.

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: conservative and optimistic. Scenarios are based on the share of consumers of district heating systems that are assumed based on the determined existing trends (conservative scenario), or optimistic assumptions of positive changes in the economy of the Republic of Croatia (optimistic scenario). Indicators of potential for use of high-efficiency cogeneration and efficient district heating and cooling is presented in Table 4–13.

Table 4–13.: Potentials for use of high-efficiency cogeneration and efficient district heating and cooling

Indicator	Unit	Conservative scenario, 2030	Optimistic scenario, 2030
Total heat demand (theoretical heat demand for 2030)	GJ	18,312,866	29,982,128
	MWh	5,086,907	8,328,369
Required heating capacity (theoretical)	MW _t	3,178	5,262

Share of DHS consumers	%	30.1	55.0
Equivalent heat demand	GJ	5,506,528	16,625,599
	MWh	1,529,591	4,618,222
Equivalent thermal capacity	MW _t	956	2,903
	GJ	8,653,115	26,125,941
Potentially produced electricity	MWh	2,403,643	7,257,206

Source: *Programme for use of efficiency potential in heating and cooling for the period 2016-2030*, Ministry of Economy, November 2015

iii. Projections taking into account 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 in the period from 2020 to 2040, taking into account only existing policies, measures and energy efficiency programmes are presented in Figure 4-15.

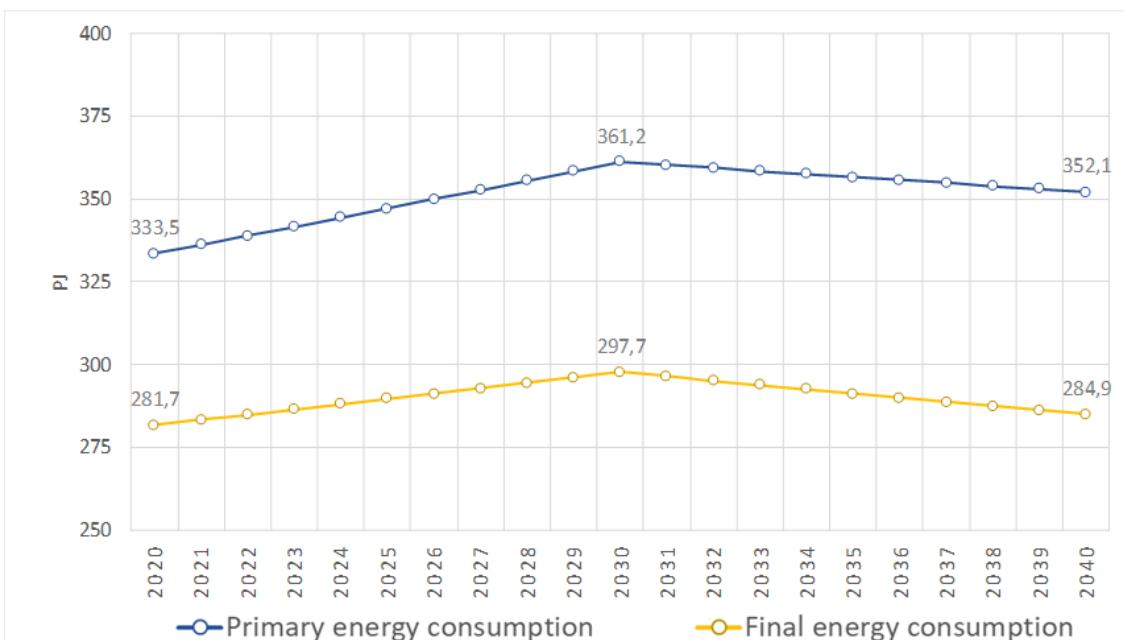


Figure 4-15. Projection of energy consumption by 2040 with existing policies, measures and energy efficiency programmes

iv. Cost-optimal levels of minimum energy performance requirements resulting from national calculations, in accordance with Article 5 of Directive 2010/31/EU

Minimum energy performance requirements of buildings are determined by cost-optimal method in accordance with 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, educational buildings, wholesale and retail trade buildings,

hospitals, hotels, restaurants and halls)¹⁷. The energy performance is determined through maximum permissible primary energy for buildings, using a number of 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 in order to align requirements with market changes and new available technologies and in order to elaborate the calculation method and determine the energy performance of buildings. The results of this cycle should be available and implemented in the regulation by the end of 2019, including the determination of gap in relation to current requirements and measures to bridge that gap.

4.4 Dimension energy security

i. Current energy mix, domestic energy resources, import dependency, including relevant risks

Electrical Grid

The actual responsibility for 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 as the largest 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,
- HOPS for the procurement of electricity needed to cover losses in the transmission grid and the technical works related to the procurement of electricity for balancing the system.

The most significant actual responsibility of HOPS regarding the security of supply and self-sufficiency of the system is to maintain a high level of transmission grid availability, i.e. particularly the interconnection lines, and to maintain/increase the NTC value (Net Transfer Capacity) value (permitted programmed cross-border exchanges) at certain borders in order to technically enable the import of lacking quantities of electricity in the power system of the Republic of Croatia. It should be noted that the possibility of importing energy into the Croatian power system does not depend solely on HOPS, but also on other system operators. Available

¹⁷ All reports under Article 5 (2) of Directive 2010/31 / EU and Article 6 of Regulation (EU) 244/2012 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> (accessed on: 27th November 2018)

NTC can be used by all market participants, not just those who import energy into the Croatian electricity system.

For the purpose of assessing self-sufficiency, the reference power balances of the power system in the period 2018-2022 were formed, as well as the power balances for the winter and summer peak loads. It has been assessed that in the reference scenario it will be necessary to import electricity at an annual level of around 7.4 TWh (in the normal hydrological year), and exceptionally in case of occurrence of one disadvantageous event (any event that results in decreased domestic electricity production capacity or increased electricity demand), imports will increase to 9.3 GWh. In the hours of winter and summer peak loads, the import in the reference scenario is estimated at a maximum of 1,176 MWh/h (winter), and 1,638 MWh/h (summer), and in case of occurrence of one disadvantageous event, these values would increase to 1,561 MWh/h (winter) and 1,983 MWh/h (summer). In case of a combination of up to three disadvantageous events or in extreme situations, imports could increase to 11.6 TWh on an annual level, i.e. up to 2,001 MWh/h (winter) and 2,388 MWh/h (summer) on hourly levels.

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 region, 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 NTC values at borders are high enough to support the expected level of imports, and maintaining NTC at a high level is a prerequisite for secure operation of the Croatian power system.

An exception to the foregoing conclusion may occur only in case of a serious crisis in the broader European area when, due to the simultaneous threat to 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 certain, 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 ($> 100 \text{ €/MWh}$) 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.). In accordance with the requirements of the ENTSO-E and the network rules of the Croatian transmission system, the Croatian Transmission System Operator has adopted a Plan of protection of the electricity system from large disturbances. It is a document with specific technical and organizational measures which need to be taken in order to restore the system from faulty operation or system failure to normal operation, and in total includes:

- a way of announcement of a major disturbance,
- a way to activate a large disturbance protection plan,
- measures and procedures for protection of the electricity system from large disturbances,
- plan for underfrequency load shedding of the electricity system,

- plan for limitation of electricity consumption and emergency load shedding of the electricity system,
- plan for reestablishment 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 major disturbances.

ii. Projections of development with existing policies and measures at least until 2040 (including for the year 2030)

The structure and expected production of primary energy for the Scenario with existing measures are presented in Table 4–14. and Figure 4-16.

Table 4–14. Expected primary energy production - Scenario with existing measures

PJ	Liquid fuels	Natural gas	Renewable energy sources	Non-renewable waste	Total
2016	31,72	57,32	96,04	0,41	185,49
2030	35,85	50,97	120,27	0,45	207,54
2040	29,27	29,88	136,89	0,42	196,45

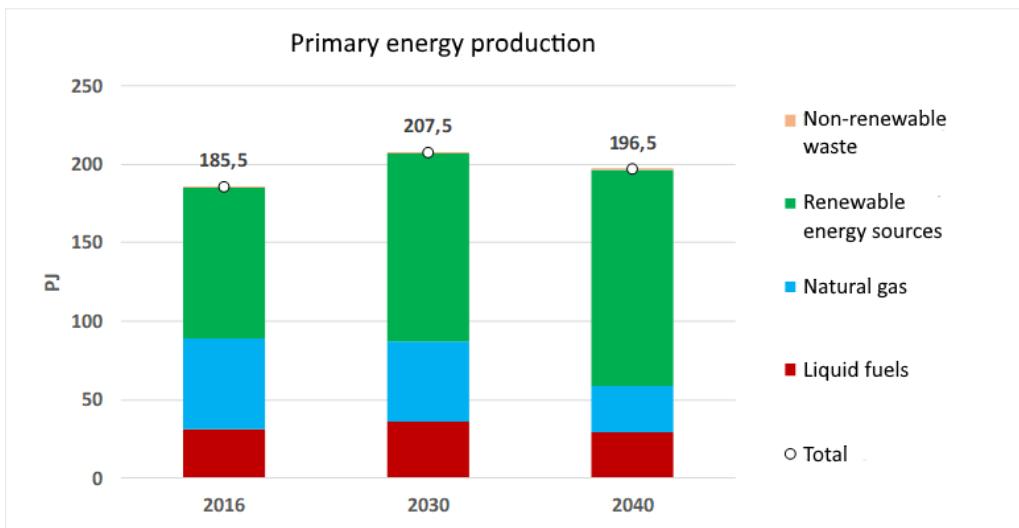


Figure 4-16. Expected primary energy production - Scenario with existing measures

Future domestic production of fossil forms of energy (crude oil and natural gas) will depend on the opening and development of new fields. Without additional production, all current fields will cease operations by 2030/2035.

The structure and expected total energy consumption (production + import - export) for the Scenario with existing measures are shown in the following table and figure.

Table 4-15. Expected total energy consumption - Scenario with existing measures

PJ	Coal	Natural gas	Liquid fuels	Renewable sources	Hydrogen	Non-renewable waste	Electricity	Total
2016	27.24	135.91	90.9	84.36	0.00	0.41	19.91	358.73
2030	10.61	134.11	102.44	122.94	0.00	0.45	14.01	384.55
2040	1.95	117.13	112.89	136.89	0.01	0.42	5.47	374.75

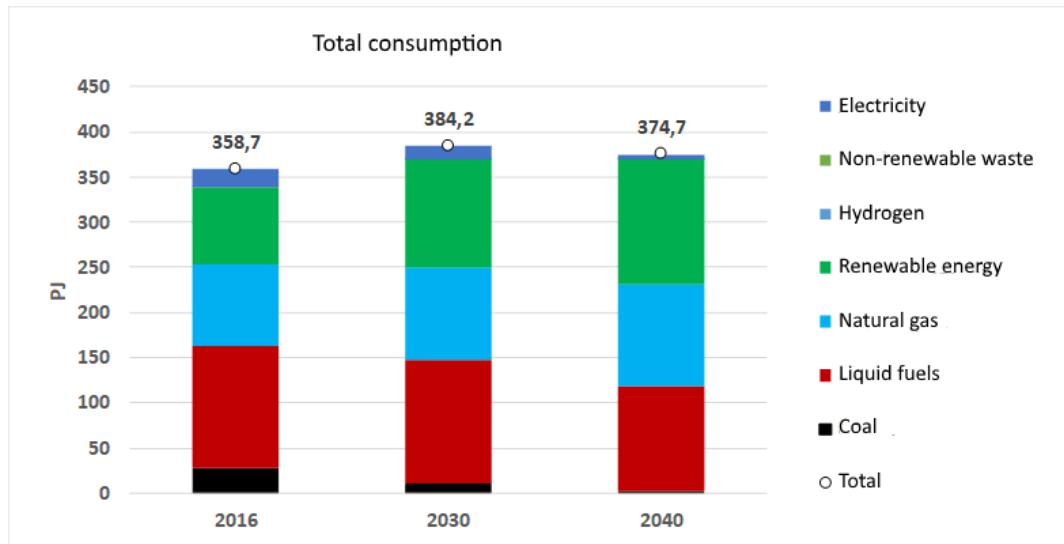


Figure 4-17. Expected total energy consumption - Scenario with existing measures

According to the Scenario with existing measures, energy consumption remains at current levels and decreases slightly towards the end of the period. Own supply first increases and then declines sharply after 2040, due to a decline in domestic oil and natural gas production.

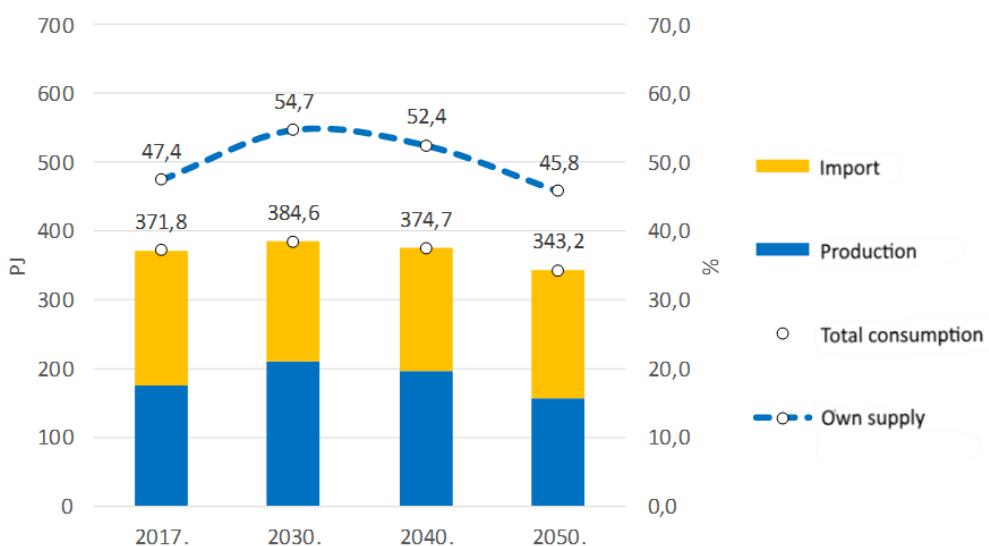


Figure 4-18. Total energy consumption and own supply (Scenario with existing measures)

4.5 Dimension internal energy market

4.5.1 Electricity interconnectivity

i. Current interconnection level and main interconnectors

The Croatian electricity system is connected with 400 kV, 220 kV and 110 kV voltage levels to the systems of neighbouring countries. 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 achieved also with eight 220 kV transmission lines. In addition, the Croatian system is connected to the environment at 110 kV level as well (a total of 18 transmission lines in permanent or periodic operation).

The total installed capacity of all interconnectors is 13,450 MVA. Due to the limitations in the internal transmission grids on both sides of the border, maximum possible exchange capacities at individual borders have been defined in order to preserve the secure operation of the electricity system. These NTCs (Net Transfer Capacity) limits are far less than the installed transmission line power (total at 3,000-3,500 MW at all boundaries), but still more than sufficient for large exchanges of electricity with neighbouring systems and to cover loads of the Croatian electricity system (peak load about 3,000 MW). 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 capacity of exchange, so 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%. Most interconnectors are under a low load most of the time.

In 2018, about 12.7 TWh was entered into the Croatian electricity system, and about 6.5 TWh came out, as shown in the following figure for the period 2016-2018. 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 8 interconnectors. Quantities of

electricity exchanged with neighbouring countries (Slovenia, Hungary, Serbia and Bosnia and Herzegovina) in 2016, 2017 and 2018 shown in Figure 4-19.

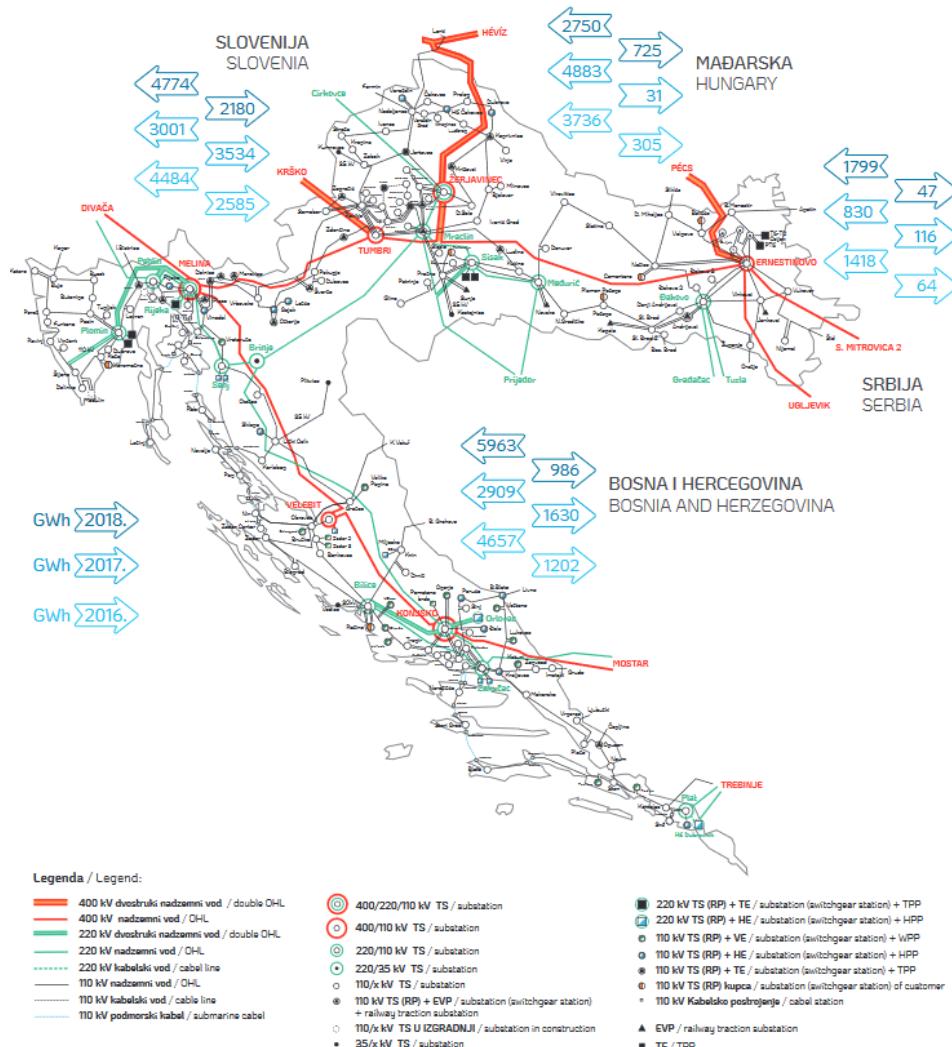


Figure 4-19. Exchange of electricity with neighbouring countries, 2016, 2017 and 2018

Source: HOPS

Good interconnection with neighbouring systems enables significant export, import and transit of electricity through the transmission grid, and places the Republic of Croatia in the position of an important link between the electricity systems of Central and South-eastern Europe.

ii. Projections of interconnector expansion requirements (including for the year 2030)

By 2030, it is possible to build a new 400 kV transmission line Lika - Banja Luka, which would further connect the Croatian power system to the power system of BiH. Technical-economic analyses of the justifiability of its construction are in preparation.

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 Žerjavinec/Drava (Republic of Croatia) – Heviz 2 (Hungary);
- 400 kV transmission line Ernestinovo (Republic of Croatia) – Sombor (Republic of Serbia).

Depending on the development of the future electricity market and the integration of RES in the Croatian power system, in the long-term, the construction of these interconnectors is possible:

4.5.4 Energy transmission infrastructure

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 are in operation 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 with the aim of achieving a satisfactory level of security of supply to customers with the electricity of the prescribed quality.

The total length of high voltage overhead lines and cables of the above-mentioned voltage levels is currently around 7,600 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 400 kV grid that connects the wider Osijek, Zagreb, Rijeka and Split areas, a significant number of large 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 connected also to 110 kV grid.

The transmission grid is managed by HOPS d.o.o. that is also responsible for developing the transmission grid, as well as for guiding and managing the entire electricity system. All this is conducted from the National Dispatch Centre (NDC) and four regional management centres. The balancing of the system is also under the management of HOPS, as well as the supply of ancillary services for the system that enable the achievement of equivalent production and electricity consumption within a specific period, or maintenance of the frequency 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 major disruptions.

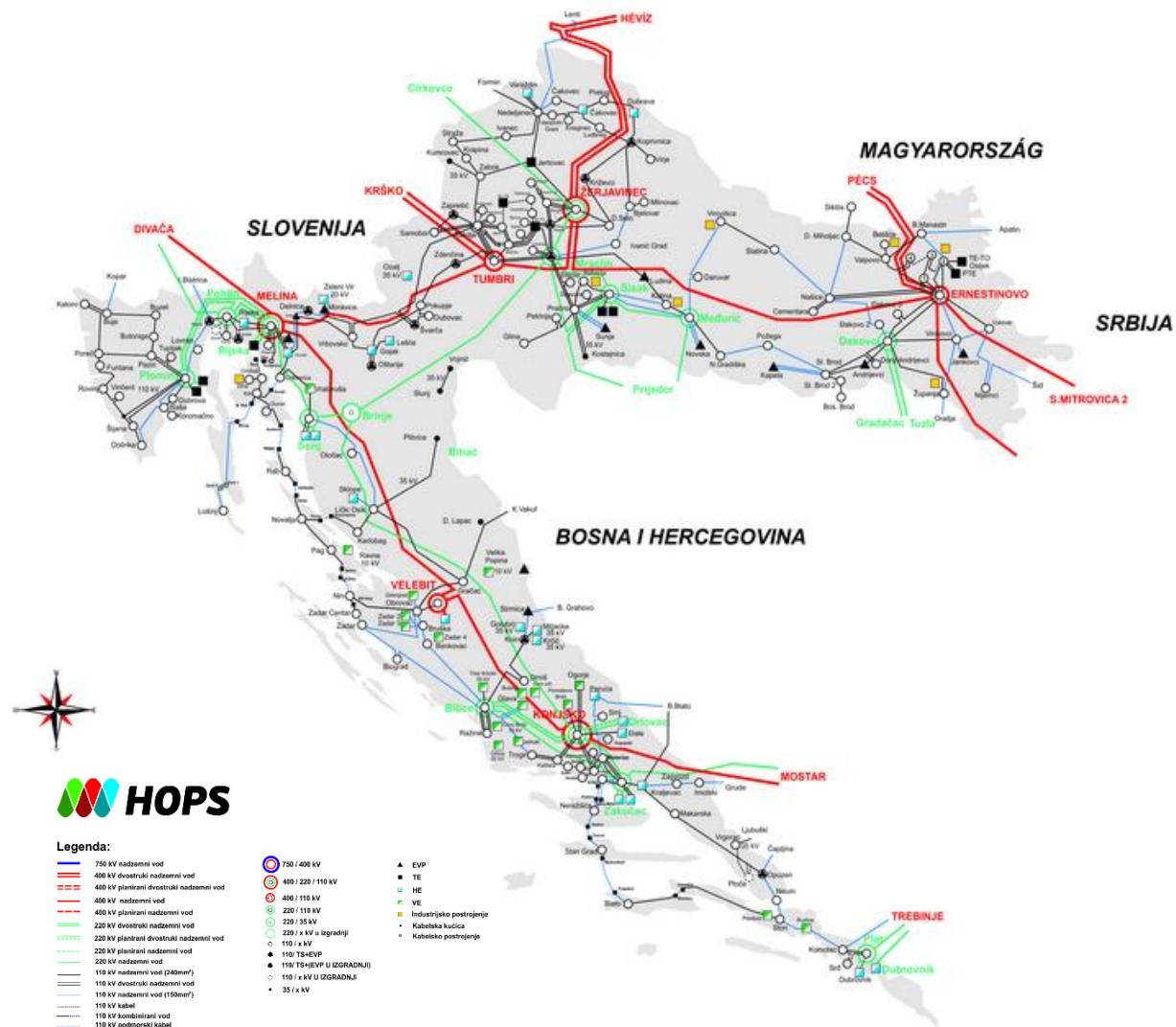


Figure 4-20. Croatian electricity system transmission grid

Source: HOPS

The transmission grid topology (form) is currently determined in accordance with the actual spatial distribution of electricity consumption, locations of existing power plants, market conditions in Croatia and its surroundings, and the prescribed grid planning and operational management of the system. The transmission grid is designed so that in the event of a single disruption of 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 3 100 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 grid can be considered satisfactory, which is manifested

in very rare system disruptions (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 electricity quality from the transmission grid is currently partially deteriorated due to long-term occurrences of high voltage at all three high-voltage levels, but the project of the installation of compensating plants that would solve this problem is currently being implemented. The frequency is stable, and its usual and extraordinary deviations are within the prescribed limits.

The installed transmission capacity of interconnectors is about 15000 MVA, which exceeds the peak load of the electricity system (about 3000 MW) many times over. Figure 4-21. shows the ratios of installed power of interconnectors and the peak load, that is, installed production capacity in European countries. By both of these 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.

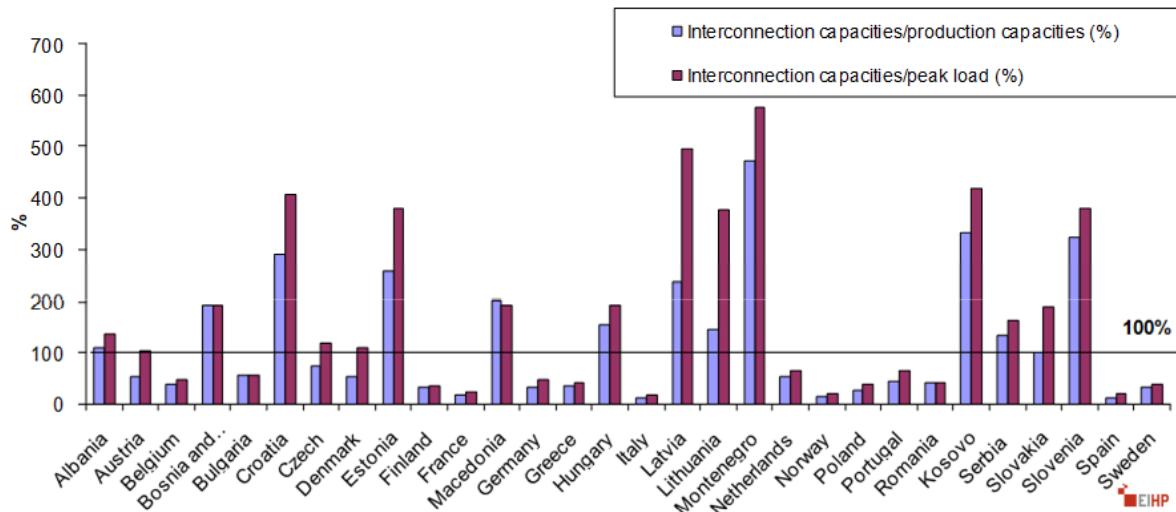


Figure 4-21. Installed power of interconnectors and installed power of production in relation to peak load in European countries

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 HOPS plans to systematically renew and revitalize in the coming period. Nonetheless, the existing reliability indicators are at a very high level with a relatively low amount of annual electricity losses (below 500 GWh) given the high transits to which the grid is exposed.

In recent years, HOPS registered a negative trend in estimates regarding the security of electricity supply for customers due to insufficient production plants in the territory of the Republic of Croatia caused by market reasons (lack of competitiveness of domestic power plants such as TPP Rijeka, TPP Sisak A and B), or large failures and/or environmental reasons (such as TPP Plomin 1 and TPP CHP Zagreb block C). Therefore, the sufficiency/security of supply for customers increasingly 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 HOPS.

The gas transmission system in the Republic of Croatia is composed of a total of 2,693 km of gas pipelines available to the transmission system operator (PLINACRO). Gas in the gas transmission system is withdrawn through nine connectors at input measuring stations, of which six connectors receive gas from the production fields located on the territory of the Republic of Croatia, two connectors receive gas from import supply routes and one connector serves to withdraw gas from the Okoli underground gas storage facility.

The transmission of gas from the transmission system is carried out through 194 connectors at 157 output measuring reduction stations. The gas transmission system of the Republic of Croatia reached a significant level of development regarding capacities and the 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 4-22. Gas transmission system in the Republic of Croatia

Source: PLINACRO

In 2017, 32,348 TWh of natural gas was transported through the system, of which 29,149 TWh from inputs of the transmission system to output measuring reduction stations, and the rest of

3,199 TWh was transported to the Okoli underground gas storage. During 2017, at the system level, the largest transmission was realized in the amount of 158 GWh/day.

ii. Projections of network expansion requirements at least until 2040 (including for the year 2030)

Having regard to the expected accelerated integration of RES and projected energy transition with a view to reducing greenhouse gas emissions, **the electricity transmission grid development** should be determined taking into account the following:

- peak load at the level of transmission grid level is planned in the amount of around 2900 MW in 2020 and around 3200 MW in 2030,
- as regards possible development scenarios, the construction and connector to 110 kV grid of a new HPP (power of ~36 MW) is planned in 2024, connector to 220 kV grid (400 kV) of another HPP (power of ~380 MW) is planned in 2026, and the construction and connector to 110 kV grid of a new pumped-storage HPP (power of ~150 MW) is planned in 2028,
- as regards possible development scenarios, the entry into operation of a new CCGT block of 150 MW in the Zagreb area in 2023 and the construction of new gas blocks/block of 300 MW in 2028 are planned,
- construction of a total of 1364 MW - 1634 MW in wind farms, which represents an increase compared to the existing construction of wind farms from 788 MW to 1,058 MW,
- construction of a total of 144 MW to 387 MW in solar power plants connected to the transmission grid,
- remain in the TPP Plomin 2 until the observed period, and continue to take over the 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 2018-2027), having regard to the above-described input assumptions, in the period by 2030, would amount to approximately HRK 7.9 to 8.2 billion, and assuming equal annual investments, it would be an investment cost from 666-686 million/year

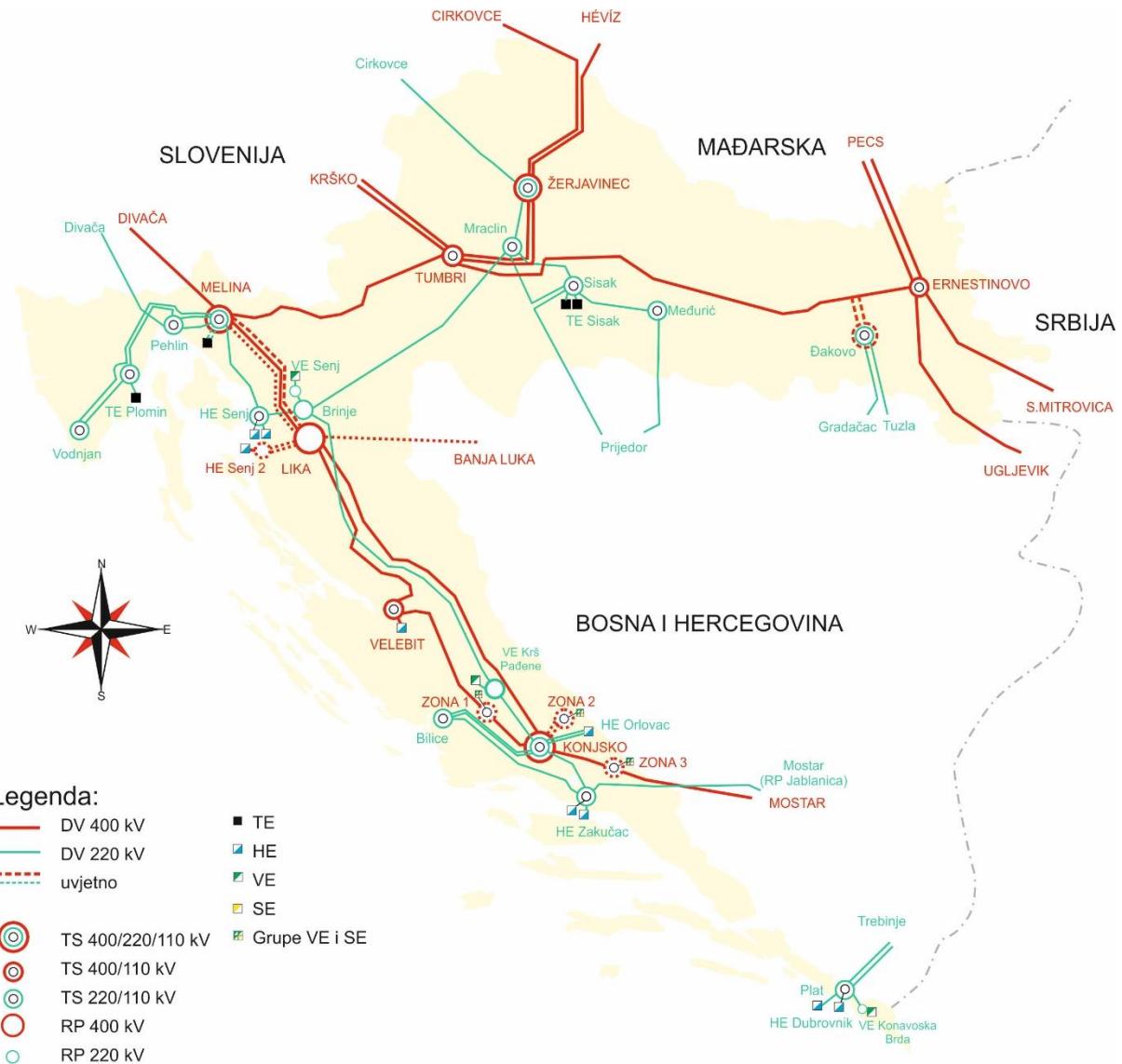


Figure 4-23. Foreseen topology of 400 kV and 220 kV grid on the territory of the Republic of Croatia in 2030

Besides a large part of investments already contained in the official ten-year development plan of the transmission grid for the period 2019-2027, additional grid reinforcements requiring larger investments are the following:

- increase of transmission power of 220 kV transmission line Konjsko - Krš Padene - Brinje in the medium-term (approximately by 2023) by replacing ACSR conductors with HTLS conductors, in order to receive the production of wind and solar power plants in the Dalmatia area,
- construction of new 400 kV transmission line Konjsko - Lika in the long-term (approximately by 2030) in order to continue with the construction of wind and solar power plants, and extension of 400 kV switchyard Lika foreseen as part of the connector to the HPP grid Senj 2 foreseen in 2026,
- construction of (2x)400 kV transmission line Lika - Melina in order to remove possible restrictions in the transmission of production of hydro, wind and solar power plants 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 substation, appropriately connected to 400 kV and 110 kV grid, through which the energy produced by wind and solar power plants 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 wind and solar power plants foreseen for the connection to the transmission grid)
- as regards new interstate/interconnection lines in the period by 2030, the construction of new 400 kV transmission line Lika - Banja Luka is possible if technical-economic analyses demonstrate the justifiability of its construction.

Since HOPS is responsible for the reliability and availability of the electricity supply 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 in a timely manner 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, pursuant to the Electricity Market Act (OG 22/13, 95/15 and 102/15, 68/18, 52/19), HOPS shall be obliged to produce and adopt, with the prior consent of the Croatian Energy Regulatory Agency, a ten-year, three-year and one-year investment plans for the development of the transmission grid. In order for any investment in the transmission grid to be realized, it must become part of these development plans.

Planning for the development of the gas transport system is carried out through the development of a 10-Year Gas Transmission Grid Development Plan, the development of which is the obligation of the gas transmission system operator. The gas transmission system operator is Plinacro d.o.o. 10-Year Gas Transmission Grid Development Plans are updated annually and approved by CERA. At the time of adoption of this document, the 10-Year Gas Transmission Grid Development Plan of the Republic Croatia 2018-2027 was relevant. The plan will be continuously updated throughout the implementation period of this document.

Taking into account 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 expected development of the gas transmission system in the wider and closer environment, 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) in accordance with Regulation (EU) 2017/1938 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:

Depending on the expected scenario of changes in gas consumption and the level of domestic production, in order to meet the infrastructure standard, it is necessary to secure a new supply capacity of at least 3.5 million m³ / day in the shortest possible time, and an additional 4-8 million m³ / day should be built around 2030.

Strategic projects that meet the obligation under the infrastructure standard are projects that increase capacity at the entrance to the transport system, which can be: LNG terminal on the island of Krk, Ionian-Adriatic gas pipeline, Lučko-Sotla gas pipeline system interconnected with Slovenia and Slobodnica-Sotin towards Serbia.

Transmission gas system for the diversification of supply and the increase of efficiency of the transport system:

Almost all gas imports to Croatia come from Russia, and Croatia is at the end of that transmission chain, so gas prices are relatively high. Likewise, the gas system is only used to supply domestic customers with gas. The construction of the LNG terminal, in addition to increasing the diversification of gas supply, will create preconditions for gas transmission to third countries, and indirectly increase the efficiency of the gas transmission system and reduce the average transport tariffs. The same impact will be achieved by building the IAP.

It is therefore imperative to increase activities to strengthen the diversification of gas supply by further developing gas supply projects from the Caspian region or the Eastern Mediterranean. It is also necessary to develop all projects that can increase gas transmission through the Croatian gas transmission system and, consequently, increase the efficiency of the gas transmission system of the Republic of Croatia itself more actively.

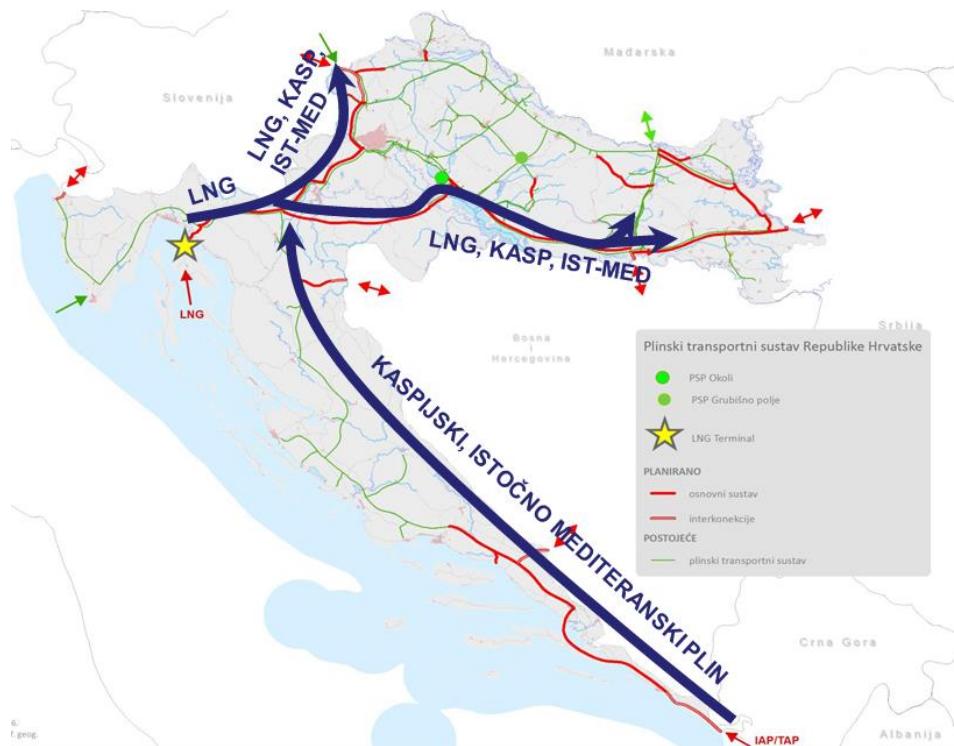


Figure 4-24. Future development of the transmission system and projects in the function of diversification of supply and increase of efficiency of the transmission system

Strategic projects to increase supply diversification and efficiency of the transmission system are the gas pipeline system for the evacuation of gas from the LNG terminals to Hungary, the Ionian-Adriatic gas pipeline, the Lučko-Sotla gas pipeline system to Slovenia and Slobodnica-Sotin for gas transmission to Serbia and potentially supply of Russian gas from TurkStream from Serbia.

The Omišalj-Zlobin gas pipeline, which will connect the LNG terminal on the island of Krk to the existing transmission system, will enable the first gas volumes to be transported from the LNG terminal on the island of Krk to the market in Hungary and further in the east of Europe. Further development of the gas pipeline system from Zlobin to Slobodnica near Slavonski Brod (the Zlobin-Bosiljevo-Kozarac-Slobodnica gas pipeline) will increase the shipping capacity towards southeast Europe up to 7 billion m³ of gas annually.

The development of the Lučko-Zabok-Sutla gas pipeline system will allow gas to be transported from the LNG terminal to Slovenia and further to Central and Western Europe, as well as the access of the terminal users and gas users in the Republic of Croatia to the liquid gas exchange in this part of Europe in Baumgarten, Austria.

The Ionian Adriatic Pipeline (IAP) would allow the supply of gas from the Trans-Adriatic Pipeline to Croatia and countries in the region and possible transport to Hungary, Slovenia and Austria.

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 security of supply.

Gas transmission system for export:

The transmission system in the function of export is referred to as the gas pipeline systems of relatively minor regional influence connecting the gas systems of Croatia, Bosnia and Herzegovina and Slovenia.

The Lička Jesenica - Bihać, Zagvozd - Posušje and Slobodnica - Bosanski Brod gas pipeline systems would provide gas to neighbouring BiH, while the Umag - Koper pipeline would allow for the connection of Istria and southern Slovenia. The construction of these pipelines depends primarily on the interest of neighbouring countries and the economic justification for their construction.

All of the above projects are listed in the 10-Year Gas Transmission Grid Development Plan of the Republic Croatia 2018-2027. The final investment decision is necessary for their realization.

4.5.3 Electricity and gas markets, energy prices

i. Current situation of electricity and gas markets, including energy prices

In Croatia, there is the CROPEX power exchange with 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 participate in the implementation of 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, there is a possibility of connecting to the day-ahead market at the border with Hungary (4M MC), as well as specific initiatives for the development of the regional power exchange in South-eastern Europe based on the Nord Pool exchange model.

Since 19th June 2018, the Croatian day-ahead market has been connected to MRC (Multi-Regional Coupling) day-ahead market, i.e. to the uniform European day-ahead market via the Croatian-Slovenian border. The daily cross-border capacity for the Croatian-Slovenian border is allocated indirectly exclusively through the EU's Price Coupling of Regions exchange

solution for day-ahead markets, whereby the said border became part of the interconnected Multi-Regional Coupling day-ahead market. Croatian institutions participate and support processes within the Energy Community related to the connection of markets in the WB6 countries.

As the electricity market is completely open, all customers are free to choose their preferred supplier and freely negotiate the price of electricity. Achieved electricity prices for household and business (industry) end customers, according to Eurostat consumption categories, are presented below. Achieved electricity prices for household and business final customers are presented below, according to Eurostat data. Prices shown for household customers include taxes and other fees, while prices for business customers do not include taxes and other fees.

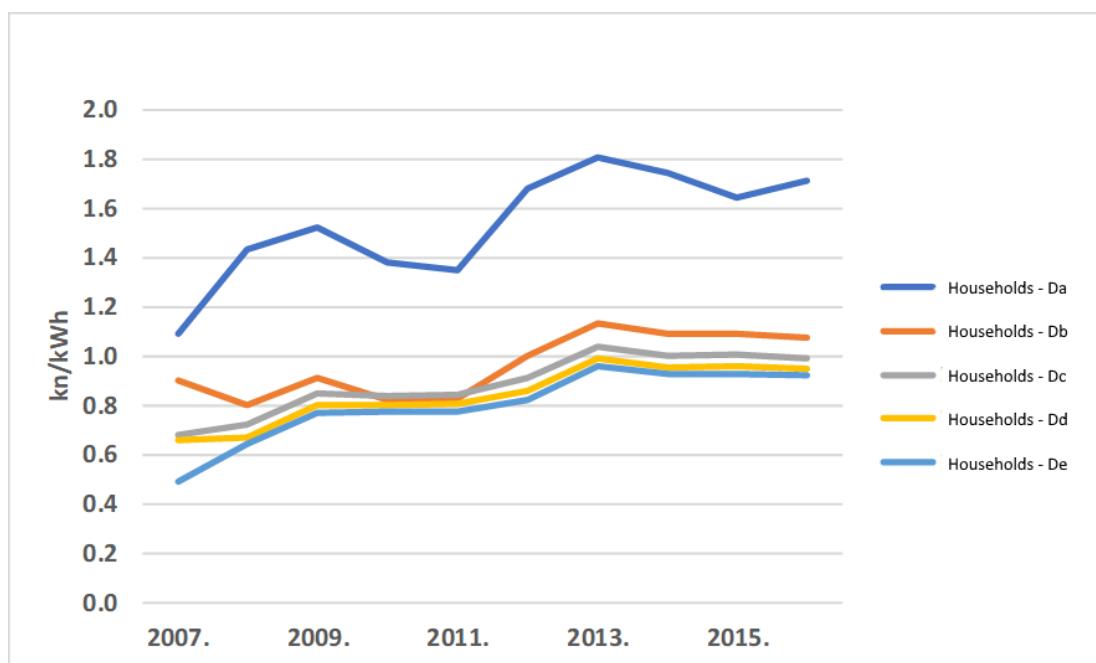


Figure 4-25.: Electricity prices for household end customers in Croatia

Source: Eurostat

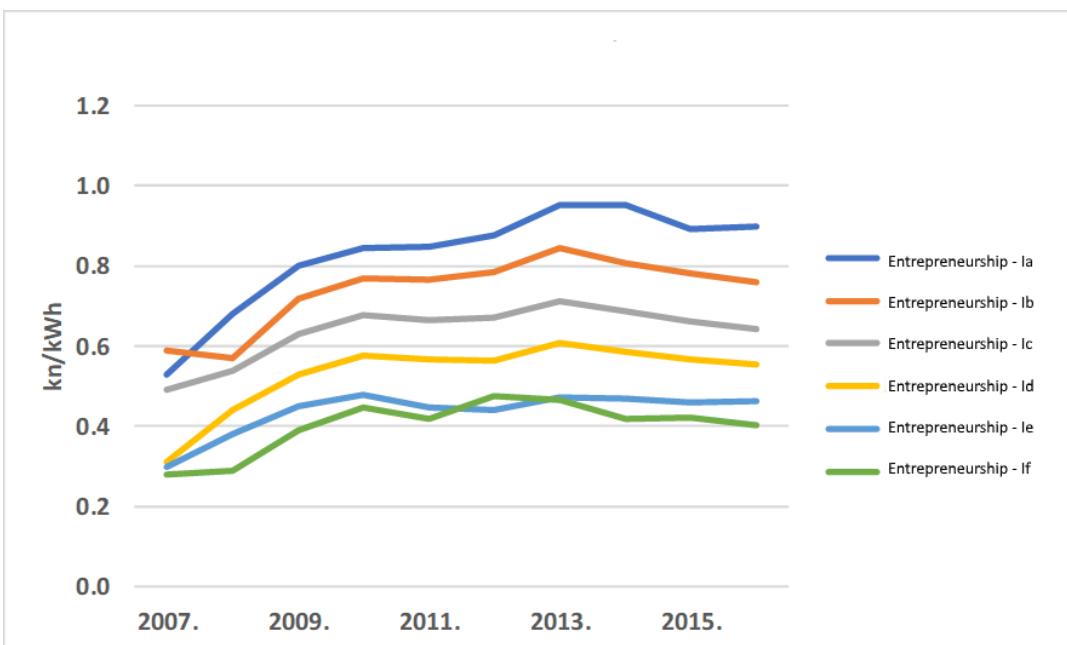


Figure 4-26. Electricity prices for business end customers in Croatia

Source: Eurostat

By establishing the ECO balance group, CEMO will be obliged to cover the balancing energy costs to the transmission system operator due to the divergences of the hourly electricity production plans from the realized hourly deliveries of the electricity ECO balance group. According to the provisions of the Renewable Energy Sources and High Efficiency Cogeneration Act, CEMO will cover the balancing energy costs of the ECO Balance Group from the funds collected in the system for stimulating the production of electricity from RES and cogeneration, except for the part of the costs that are settled from the monthly fee paid by members of the ECO balance group.

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 in accordance with the Methodology for determining the prices for the calculation of balancing electricity to entities responsible for the divergence, which is issued by the CERA.

Historical prices of natural gas for household and business final customers are presented below, according to Eurostat data. Shown natural gas prices for household customers include value added tax (VAT), while natural gas prices for industrial customers are expressed without VAT.

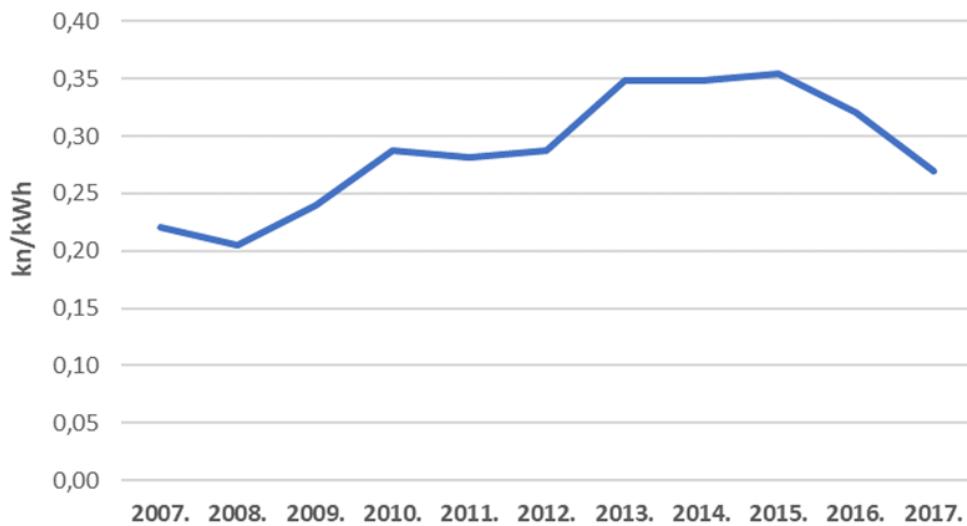


Figure 4-27. Natural gas prices for household customers in Croatia

Source: Eurostat

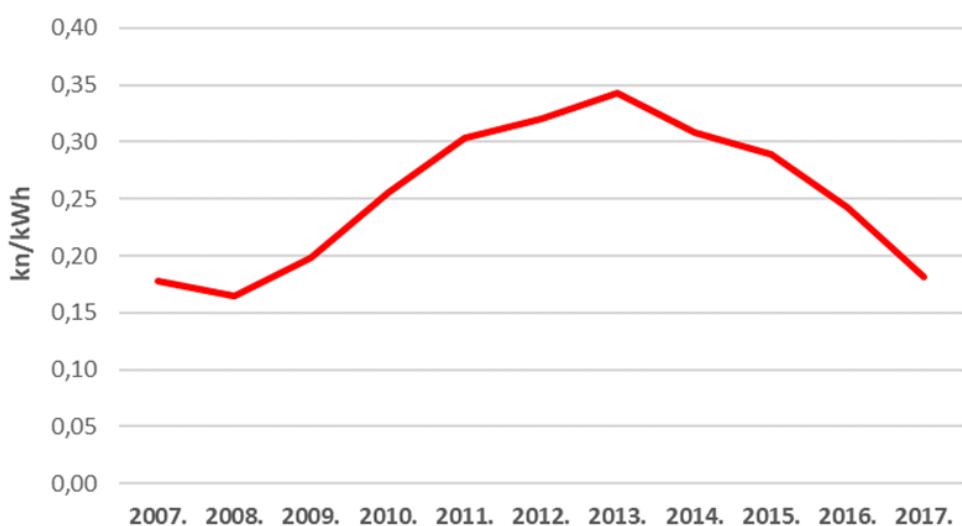


Figure 4-28. Natural gas prices for business customers in Croatia

Source: Eurostat

ii. Projections of development with existing policies and measures at least until 2040 (including for the year 2030)

The estimation of trends of the electricity generation cost for the scenario with existing measures based on the expected development is shown in the following figure. This estimation includes analysed investments in the construction of new power plants, fuel costs and other operating costs of all power plants, as well as the cost of emission allowances. The estimate

does not include the annuities of plants that are already in operation. By 2030, a gradual decrease in electricity import is assumed.

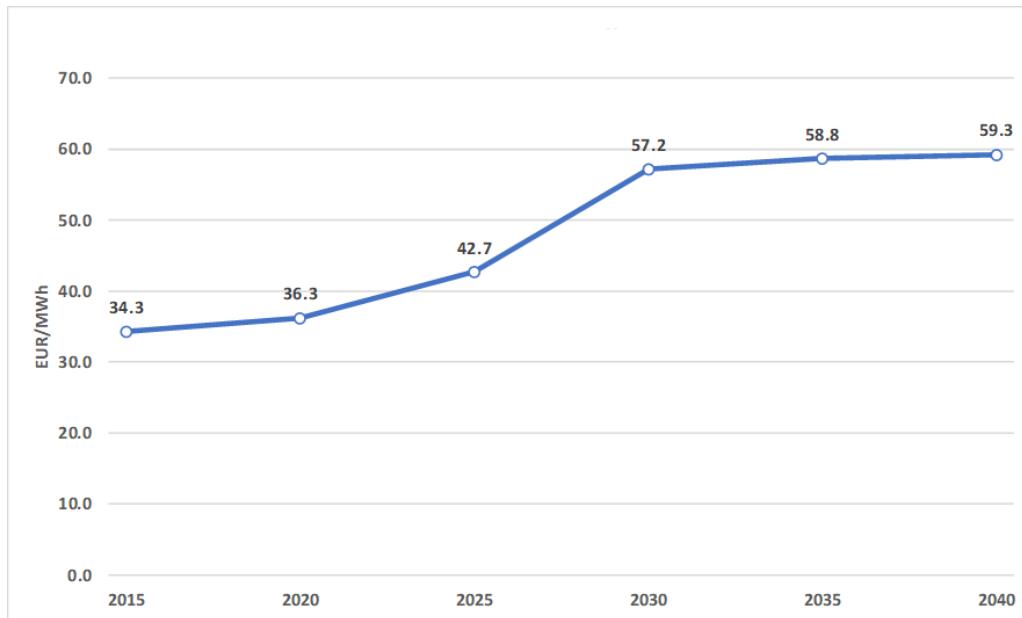


Figure 4-29. Electricity generation cost projections

Below is the estimation of natural gas price trends by 2040 [20].

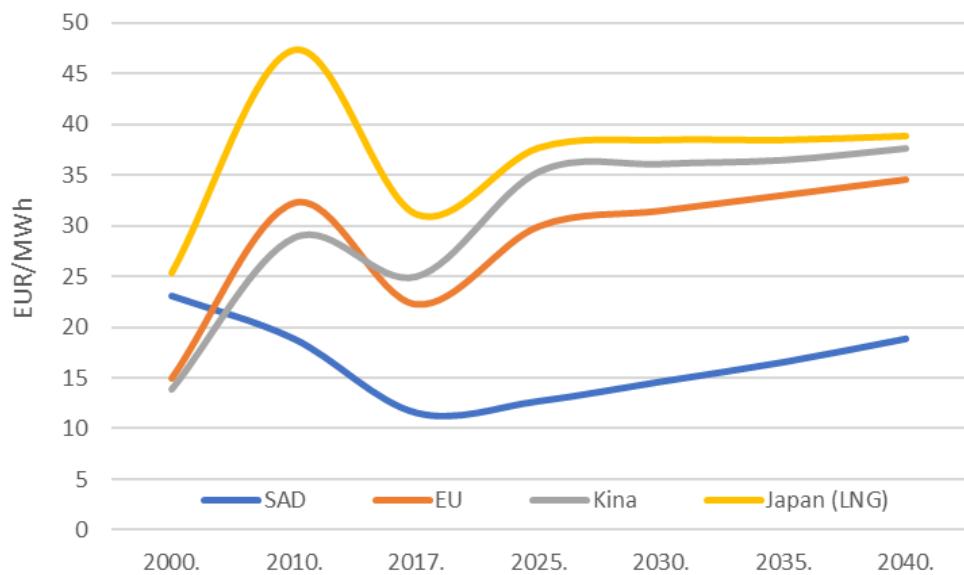


Figure 4-30. Projections of natural gas prices according to the World Energy Outlook 2018

4.6 Dimension research, innovation and competitiveness

i. Current situation of the low-carbon-technologies sector and, to the extent possible, its position on the global market

The area of low-carbon technologies is related, by thematic priority, to the area of energy and environment of the Smart Specialization Strategy of the Republic of Croatia for the period 2016 to 2020 [8]. Within this area, there is a possibility of significant contribution to global challenges in relation to safe, clean and efficient energy, climate change and resource efficiency.

Within this area, the following advantages have been identified:

- industrial capacities related to the electrical equipment for power system (e.g. voltage and distribution transformers, rotary machines, wind turbines, photovoltaic panels) and the accompanying industry for building large structures of metal and concrete (shipyards),
- the tradition and experience in the design and construction of power plants, transmission lines, substations and control systems with very good global export potential,
- the presence of natural resources suitable for the production of energy from renewable sources (water resources - construction and equipment of hydropower plants, biogas plants that can take over residues from the Croatian agricultural sector, wind that can be used for further technological upgrades and investments in wind power plants and similar),
- a number of educational institutions and university programmes where students are educated in the area of production, engineering and maintenance,
- a certain number of public and private research organizations with proven capabilities in this area that can support and enhance the competitiveness of industry through research and development,
- the existing market requiring upgrade and expansion of production capacities.

Within the area, two sub-thematic priority areas have been defined, namely:

- energy technologies, systems and equipment,
- ecologically acceptable technologies, equipment and advanced materials.

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)
- exploration of possibilities for use, storage, transportation and geological storage of CO₂
- 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, 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.

Major technological advances are expected in the application of ICT technologies in all sectors, with particularly great impact in 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.

Croatian Bureau of Statistics collects data on the foreign trade of the Republic of Croatia, and 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 Regulation 2017/1925 on the tariff and statistical nomenclature and on the Common Customs Tariff, 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 estimate for 2017, Gross Domestic Expenditure on Research and Development (GDERD) amounted to 0.86% of GDP. By 2020, the target of 1.4% of shares in GDP was set while the target at the EU level is 3%, which indicates that the Republic of Croatia lags behind in terms of financing research, development and innovation compared to the EU average. In 2017, the share of public expenditure on research and development in GDP during 2017 was 0.43%, while the EU average was 0.69%. During 2017, the share of expenditure by private companies in GDP was also 0.43%, while the EU average was 1.36%.

The Croatian Bureau of Statistics monitors gross domestic expenditure on R&D by sectors and fields of science, as shown in Figure 4-31. [22].

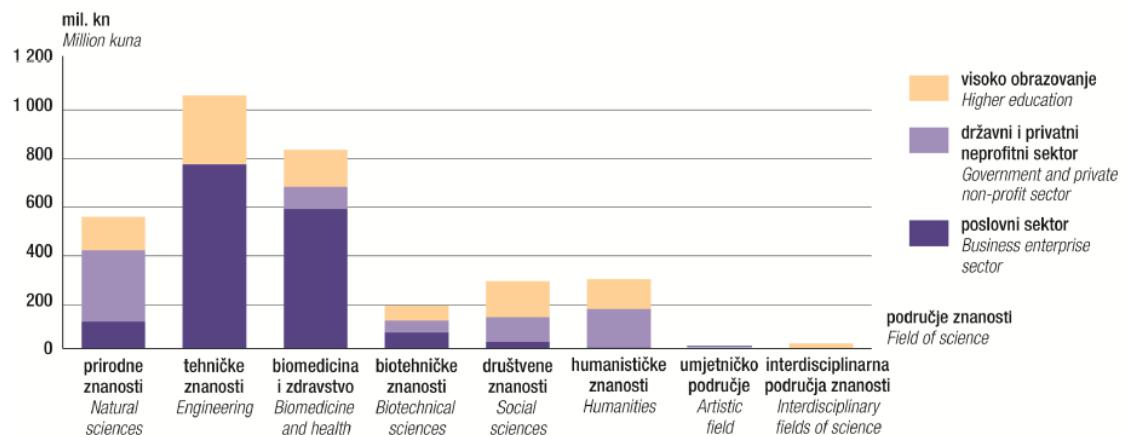


Figure 4-31. Gross domestic expenditure on R&D by sectors and fields of science

Croatian Bureau of Statistics also monitors R&D expenditures by area of science and research of the R&D project and types of research, as shown in Figure 4-31. [22].

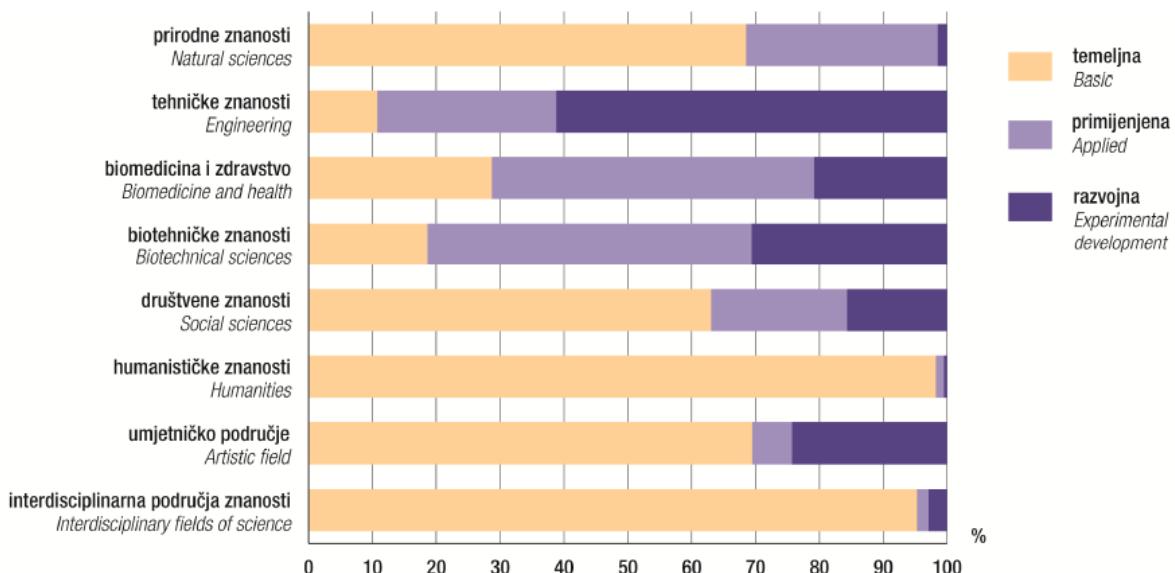


Figure 4-32. Gross domestic expenditure on R&D by sectors and fields of science

Within the data on the basis of which the Croatian Bureau of Statistics publishes this aggregated data, it will be necessary to identify and separately report on the R&D areas relevant to low-carbon development.

In 2018 the number of patent applications submitted to the State Intellectual Property Office (hereinafter referred to as: SIPO) amounted to 136, out of which 121 were filed by resident and 15 by non-resident applicants. Out of the total number of resident applicants, 84.3% were natural persons and 15.7% legal entities, while, concerning the non-resident applicants, natural persons submitted 60.0% of applications and legal entities 40.0%. Given the number of applications in the period from 2013 to 2018, there is a noticeable decrease in patent

applications (in the order 253, 200, 186, 188, 159, 136), which indicates a decrease in patent activity in the Republic of Croatia.

The number of patents according to the International Patent Classification is monitored, as shown in Figure 4-33. [23].

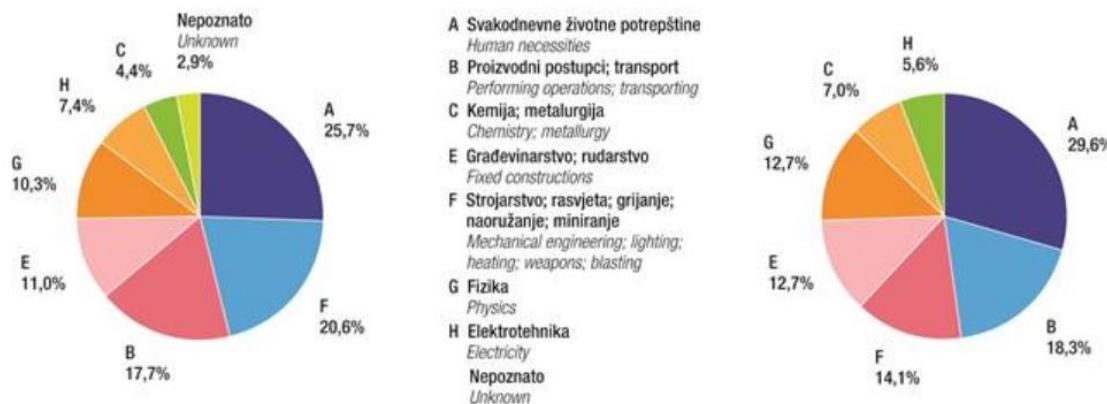


Figure 4-33. Applied and granted patents in the national procedure in 2018

In 2018, the total number of patents granted in the national procedure amounted to 71, out of which there were 57 patents of resident and 14 of non-resident applicants. Out of the total number of patents granted in the national procedure, 84.2% were those invented by natural persons and 15.8% those invented by legal entities.

In the field of technology, the highest share of granted patents in 2018 related to chemistry (47.5%) and mechanical engineering (27.1%), while the lowest one was related to electrical engineering and instruments (both with 5.6%).

In order to track innovations relevant to the low carbon transition, it will be necessary to identify relevant areas and report on them separately. Out of the total number of patent applications of resident applicants in 2018, 64.5% were filed by applicants from Continental Croatia and 35.5% by applicants from Adriatic Croatia.

Patent statistics provide information on the success of research, development and innovation activities in selected areas of technology. 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.

iii. Breakdown of current price elements that make up the main three price components (energy, network, taxes/levies)

Electricity

The structure of the price of electricity consists of the market part and the regulated part (Figure 4-34). The regulated part is prescribed by law and is the same for all suppliers. It applies to charges for the use of 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.

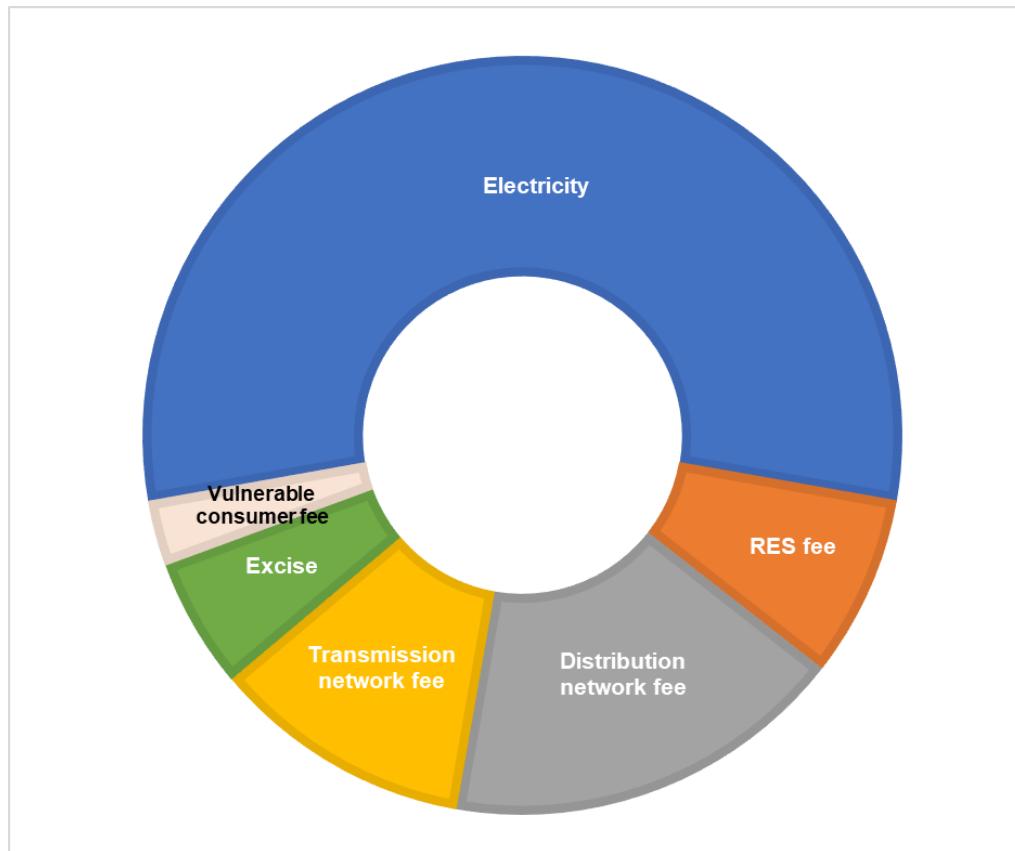


Figure 4-34. Retail electricity price structure

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:

- a higher daily tariff (HT), calculated daily from 7 am to 9 pm in the winter time period and from 8 am to 10 pm in the summer time period;
- a lower daily rate (LT) calculated in the remaining time;
- the unique daily tariff item (UT) lasts between 0 and 24 h every day.

Figure 4-35. shows the structure of the total electricity price for end customers in the Republic of Croatia according to EUROSTAT consumption classes in 2017, where:

- **If** - very large industry with a consumption of 100,000 MWh / year, a peak load of 15 MW and a 60/40 day / night consumption ratio (tariff system Businesses - HV)

- **le** - large industry with consumption of 24,000 MWh / year, peak load of 4 MW and 60/40 day / night consumption ratio (tariff system Businesses - SN 35 kV)
- **id** - medium-sized industry with consumption of 2,000 MWh / year, peak load of 0,50 MW and day / night 65/35 consumption ratio (tariff system Businesses - MV 10 kV)
- **lb** - medium-sized enterprises with consumption of 150 MWh / year, peak load of 0.05 MW and day/night 70/30 consumption ratio (tariff system Businesses - LV red)
- **Dc** - Medium households with consumption of 3.5 MWh / yr. and day / night 70/30 consumption ratio (tariff system Household white).

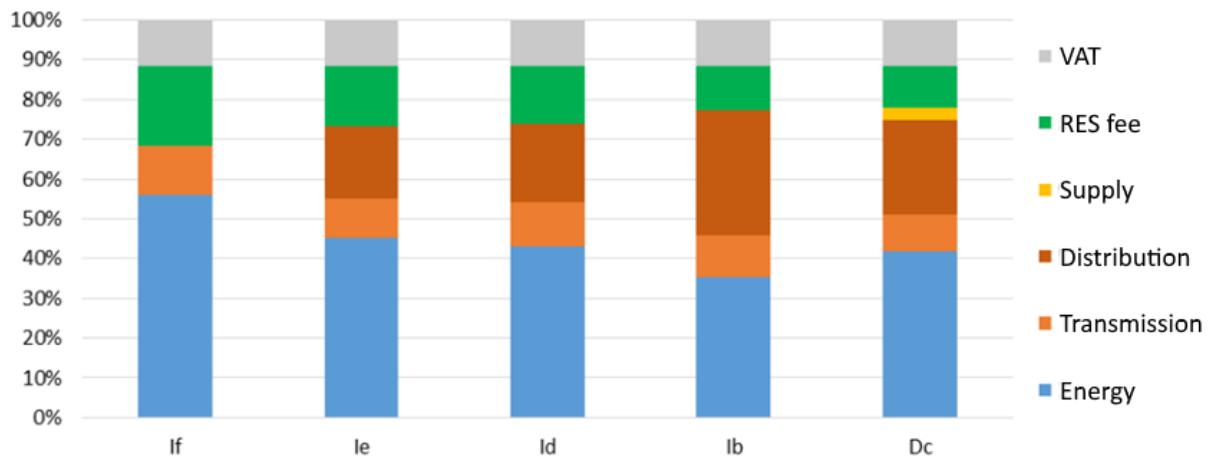


Figure 4-35. Structure of the total electricity price for end customers in the Republic of Croatia according to EUROSTAT consumption classes in 2017

Source: CERA

Pursuant to the Act on Amendments to the Value Added Tax Act (OG 115/16), from 1st January 2017 the new, reduced, value added tax (VAT) rate for the supply of electricity, including fees associated with that delivery, is applied. The current 25% VAT rate, which was valid until 31st December 2016, has changed to the 13% rate, which is valid from 1st January 2017.

Gas

The basic elements of the price of gas are the supply price and the price of gas transmission, the price of gas storage, the price of gas supply and the price of 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.

In accordance with the Methodology of determining the price of balancing energy of the gas system, the gas market operator daily determines the price of positive and negative balancing energy of the gas system.

Wholesale procurement price for public service and guaranteed gas supply

The price of gas procurement, when performed as a public service and a guaranteed gas supply, is determined according to the Methodology of determining the amount of tariff items for the public service of gas supply and guaranteed supply. It is called the gas reference price and represents the highest price at which a wholesale market supplier can sell gas to suppliers in a public service obligation, and is determined as the sum of the gas procurement price and the premium, i.e. the fixed part of the gas reference price.

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 calculation of tariff items for acceptance and dispatch of LNG, the model of the regulatory account for the regulatory period of 20 years from the year of commencement of operation of the LNG terminal will be used, in which the tariff remains unchanged.

Cost of gas transmission

The price of gas transmission is determined on the basis of the Methodology of determining 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 according to the measured quantities of transmitted gas for each user of the transmission system, and the exceedances calculated for each connection, for each gas day, for each user. Capacity can be contracted on an annual, quarterly, monthly, daily and intraday basis.

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 (OG 122/16) issued by CERA on the basis of 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 price of gas supply 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 2018 - 2021 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 operator. The final price of gas distribution 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 selling price of gas without VAT for end customers using the distribution system in the Republic of Croatia in 2017 was HRK 0.2335/kWh, which is 16% less than in 2016.

The average selling price of gas without VAT in the Republic of Croatia in 2017 for end customers using the transmission system was HRK 0.1805 /kWh, which is 1% more than in 2016, having in mind that the price was at its lowest in the second quarter when it was HRK 0.1673/kWh, and the highest in the first quarter when it was HRK 0.1943/kWh.

iv. Description of energy subsidies, including for fossil fuels

In the Republic of Croatia, a system to encourage the use of renewable energy sources for the production of electricity 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, in accordance with the Tariff System for the production of electricity from renewable energy sources and cogeneration (Official Gazette 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, which envisaged the so-called premium system as part of an incentive framework. Since the by-laws have not yet been fully elaborated and adopted, no subsidies have been paid under this Act.

Another type of energy subsidies in the Republic of Croatia is excise duty exemptions, as prescribed by the Excise Duty Act. 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 on the basis of a permit and a fuel card issued by the authority competent for agriculture and fisheries, or 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 provides for the possibility of 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 in the register of beneficiaries of the right to refund of excise duty on diesel fuel in the commercial transport of goods and passengers. The purpose of this type of refund is to reduce the cost of domestic carriers and increase their competitiveness in the European market.

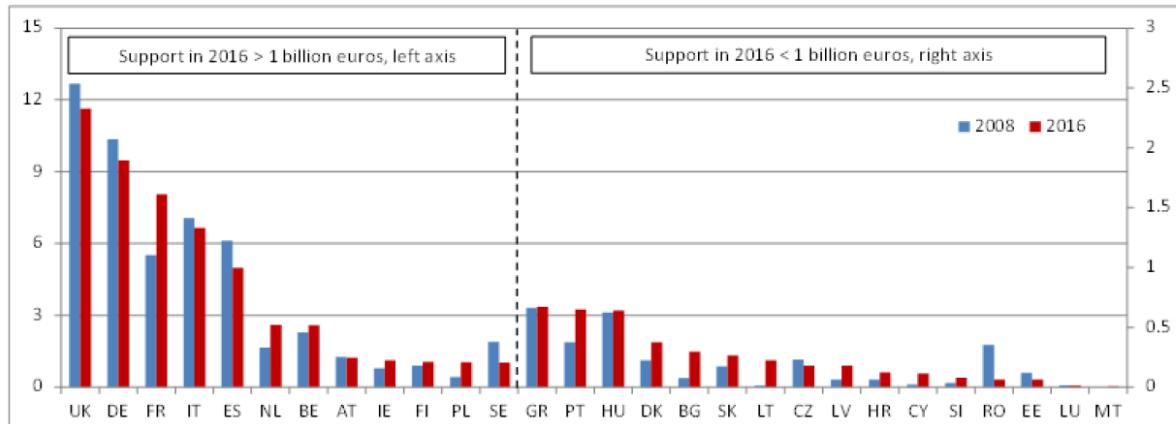


Figure 4-36. Financial support to fossil fuels in the EU (EC, Trinomics)

It can be concluded that most energy subsidies are aimed at increasing energy efficiency and the use of renewable energy sources, which will continue in the future, while respecting state aid restrictions. A smaller part of energy subsidies is related to exemption from excise duties in transport and agriculture, the abolition of which is currently not planned.

5. IMPACT ASSESSMENT OF PLANNED POLICIES AND MEASURES

5.1 Impacts of planned policies and measures described in section 3 on energy system and GHG emissions and removals, including comparison to projections with existing policies and measures (as described in section 4)

- i. **Projections of the development of the energy system and GHG emissions and removals as well as, where relevant of emissions of air pollutants in accordance with Directive (EU) 2016/2284 under the planned policies and measures at least until ten years after the period covered by the plan (including for the last year of the period covered by the plan), including relevant Union policies and measures**

Projections of the most important energy and climate indicators, taking into account the expected sectoral changes by 2030, are presented below:

- Immediate energy consumption is expected to amount to 286.9 PJ in 2030, representing a change of 8.1% and -15% in comparison to 2005 consumption
- The expected reduction in greenhouse gas emissions from energy sources amounts to 31.2% by 2030, compared to 1990 levels
- The renovation rate in the period 2021 to 2030 is growing from the current 0.7% per annum for the period 2014-2019 in steps of 1.1% to 3.0%, reaching a 10-year average of 1.6%. The rate of abandonment of the existing building stock is significantly increased, as evidenced by the increase in temporarily unoccupied units in the period between two consecutive censuses.
- The penetration of electric, hybrid and hydrogen-powered vehicles is expected to reach 3.5% of total road passenger activity in 2030
- Increase in the share of renewable energy sources in gross final energy consumption to 36.4% by 2030
- Decarbonisation of electricity production by increasing the share of renewable energy sources to 63.8% by 2030

Increasing energy efficiency is strongly present in all sectors of consumption, with the strongest effects expected in the building sector and transport.

In the building sector, a continuation of good practices and strengthening of energy efficient 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).

The projections of greenhouse gas emissions from mobile and fixed energy sources in the Republic of Croatia is shown in Figure 5-1. The scenario with existing measures and the scenario with additional measures are presented.

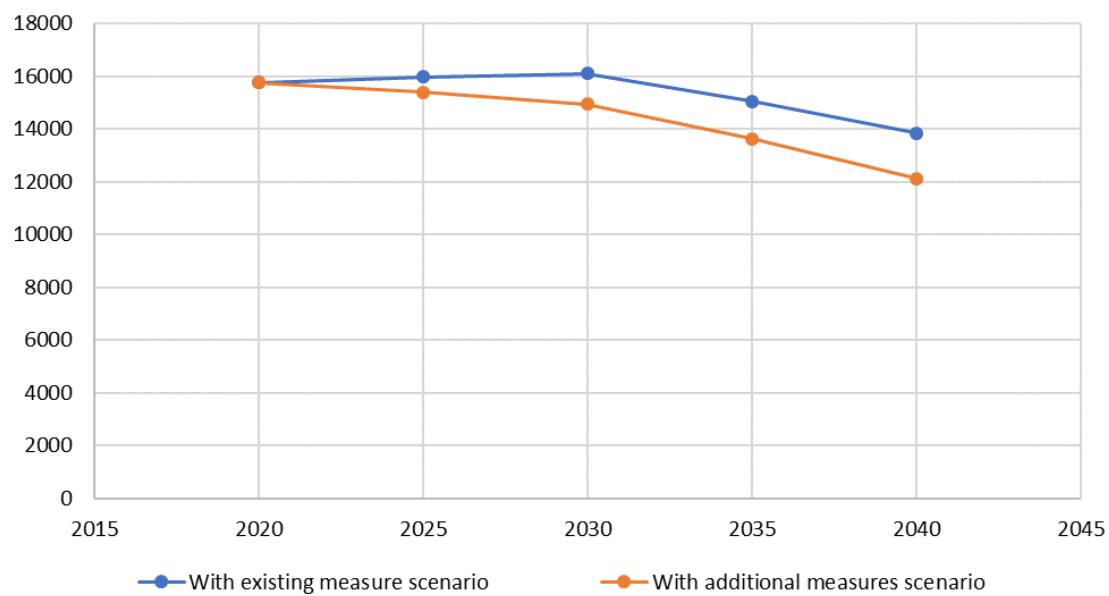


Figure 5-1. Greenhouse emissions projections for the scenario with existing measures and scenario with additional measures - energy sources

The potential of additional measures to reduce emissions by energy sector is illustrated in Table 5-1, and it represents the difference between emissions from scenarios with existing and additional measures.

Table 5-1.: Greenhouse gas reduction potential for additional measures, energy sources

CO ₂ e emission reductions (kt)	2025	2030	2035	2040
<u>Production and transf. of energy</u>				
Key measures: RES-2, RES-3, RES-4 (renewable energy sources), ENU-15, ENU-16, ENU-17 (energy efficiency), ES-2 (energy security), UTE-1 (internal energy market), MS-3 (cross-sectoral measure)	140	271	393	501
<u>Industry and construction</u>				
Key measures: RES-2, RES-3, RES-4 (renewable energy), ENU-9 (energy efficiency), MS-2, MS-3, MS-4, MS-9 (cross-sectoral measure)	38	75	131	182
<u>Transport</u>				
Key measures: TR-5, TR-6, TR-7, TR-12, TR-10, TR-11, TR-9 (transport)	240	483	416	426
<u>General consumption</u>				
Key measures: RES-1, RES-3, RES-4 (renewable energy sources), ENU-2, ENU-3,	165	324	466	585

ENU-4, ENU-5, ENU-7, ENU-8, ENU-10 (energy efficiency), MS-5, MS-9 (cross-sectorial measure)				
<u>Fugitive emissions</u>	3	6	11	18
Key measures: FUG-1, FUG-2, FUG-3 (fugitive emissions)				
Emission reduction potential - energy sources	586	1159	1416	1714

Projections of greenhouse gas emissions from non-energy sources in the Republic of Croatia, in accordance with the proposal of the Low-Carbon Development Strategy of the Republic of Croatia shown in Figure 5-2. For the scenario with existing measures, the reference scenario (NUR) is selected and for the scenario with additional measures the gradual transition scenario (NU1) is selected.

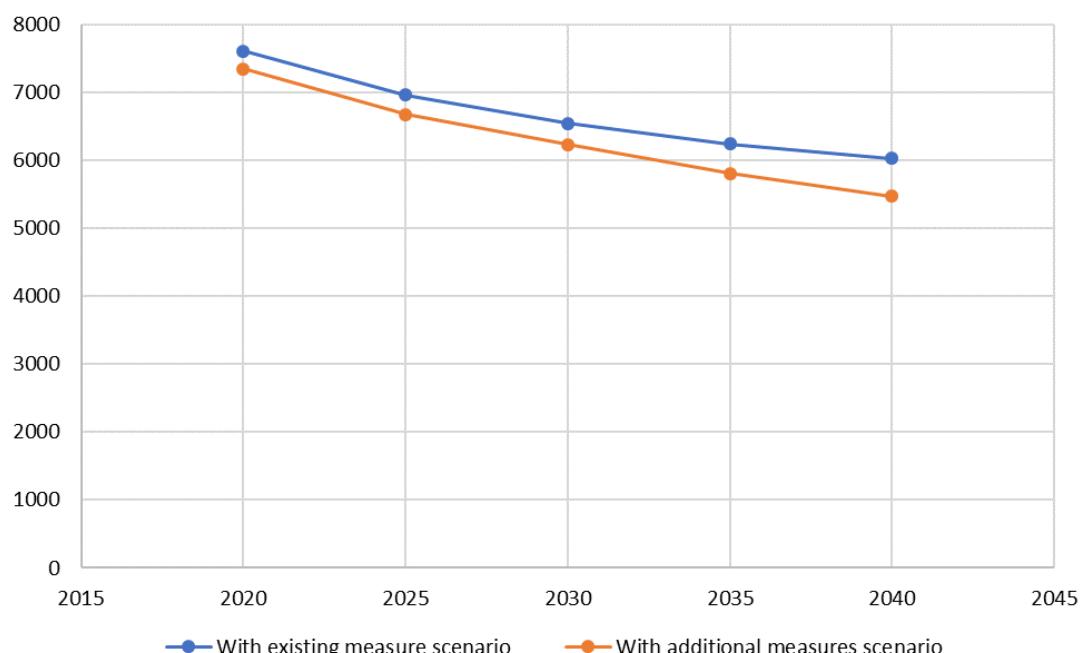


Figure 5-2. GHG projections for the scenario with existing measures and scenario with additional measures - non-energy sources

The potential of additional emission reduction measures for non-energy sectors is shown in Table 5-2, and represents the difference between the greenhouse gas emissions of the NUR and NU1 scenarios.

Table 5-2.: Greenhouse gas reduction potential for additional measures, non-energy sources

CO ₂ e emission reductions (kt)	2025	2030	2035	2040
Industrial processes	163	155	239	323
Agriculture	118	162	200	237
Waste*	0	0	0	0
Emission reduction potential - non energy sources	281	316	439	560

* - The NU1 scenarios are equal to the NUR scenario for the Waste sector, as no additional measures have been identified. Both scenarios involve the implementation of measures to reduce greenhouse gas emissions from solid waste disposal.

The total GHG emissions in the Republic of Croatia are shown in Figure 5-3. The trend of historical emissions and expected emission reductions for the scenario with existing measures and the scenario with additional measures are shown. Greenhouse gas emissions in 2030 would be 28.9-33.5% below 1990 levels.

During 2019, projections of emissions from energy and non-energy sources will be approximated, and adjustments in emissions projections may happen.

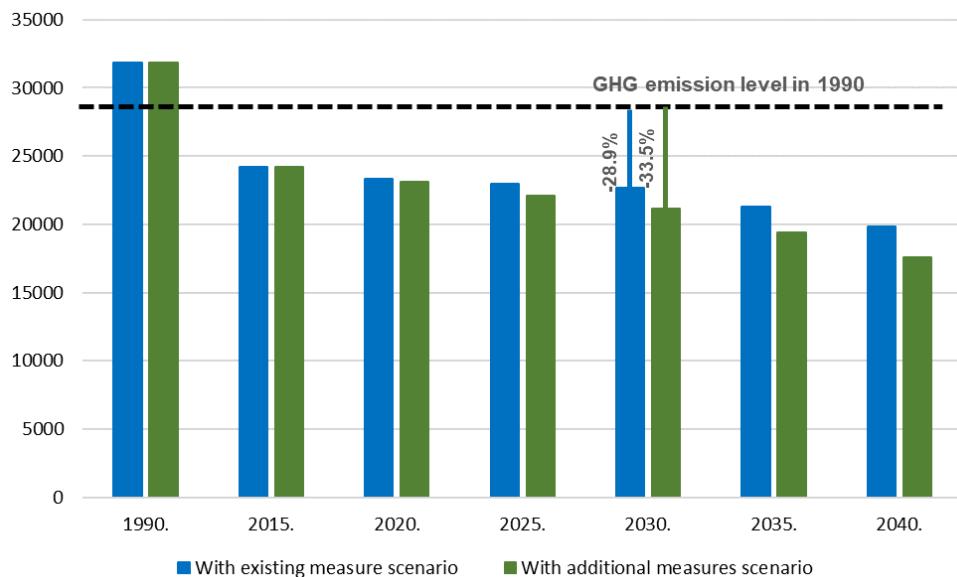


Figure 5-3. Projection of total greenhouse gas emissions, for the scenario with existing measures and the scenario with additional measures

In these scenarios, the Republic of Croatia fulfils its obligation to reduce greenhouse gas emissions from the sectors outside of ETS by 2030. (-7 %). Emission reductions from the sectors outside ETS would be 12.7-18.5% by 2030, compared to 2005 emissions (Figure 5-4.).

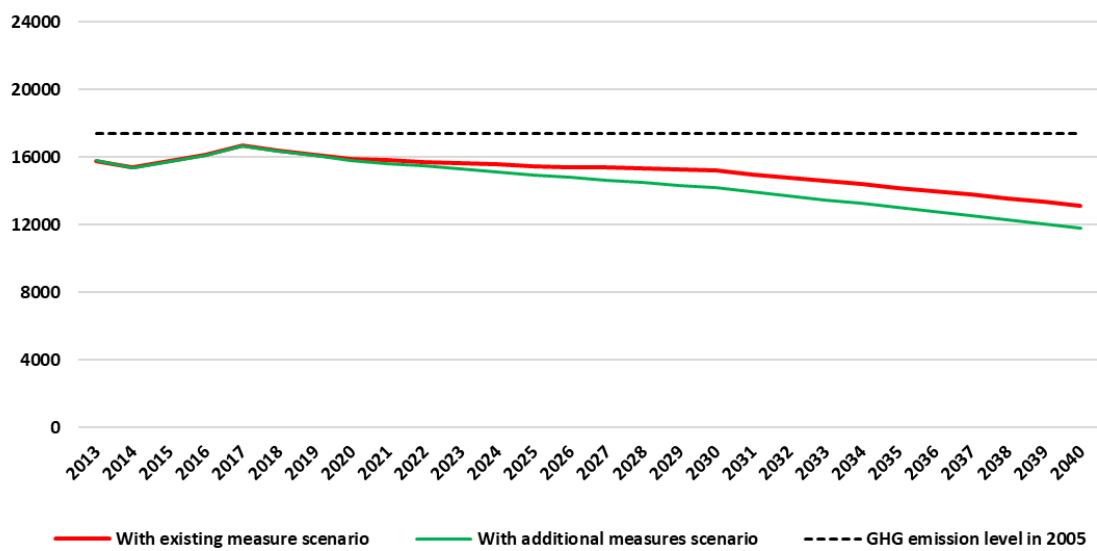


Figure 5-4. Projection of greenhouse gas emissions from sectors outside of ETS, for the scenario with existing measures and the scenario with additional measures

Emission reductions in the ETS sector would be 30.1-34.3% in 2030. The projection of greenhouse gas emissions for the ETS sector is shown in Figure 5-5.

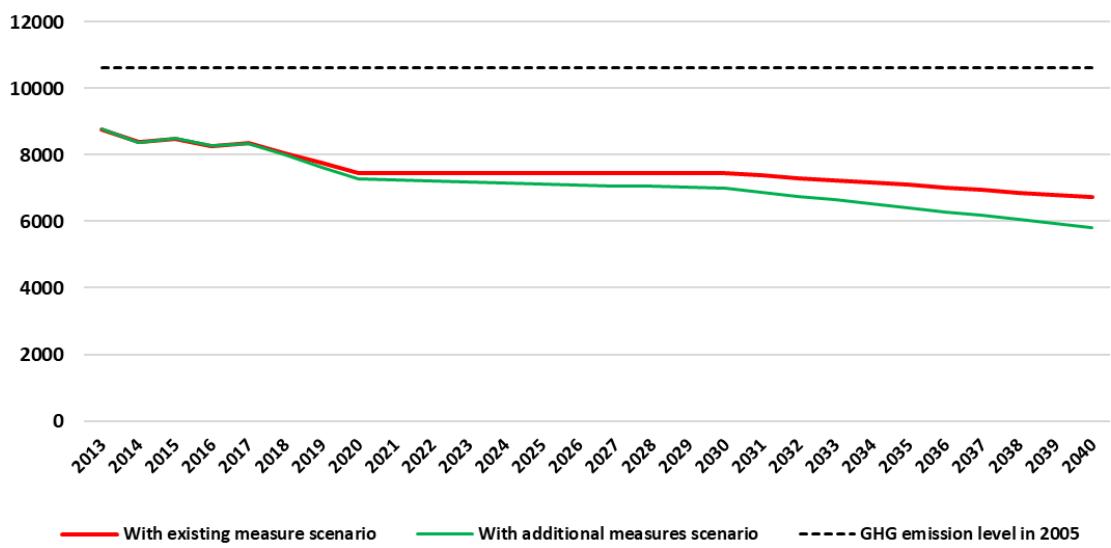


Figure 5-5. Projection of greenhouse gas emissions from the ETS sector, for the scenario with existing measures and the scenario with additional measures

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 2020-2040. The GHG projections are equal for both scenarios analysed (Table 5-3).

Table 5-3.: Greenhouse gas emissions from international air transport

CO ₂ e (kt) emission	2020	2025	2030	2035	2040
International Air Transport (WEM = WAM)	380.7	390.0	399.4	400.9	402.4

- ii. Assessment of policy interactions (between existing policies and measures and planned policies and measures within a policy dimension and between existing policies and measures and planned policies and measures of different dimensions) at least until the last year of the period covered by the plan, in particular to establish a robust understanding of the impact of energy efficiency / energy savings policies on the sizing of the energy system and to reduce the risk of stranded investment in 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 climate and energy policy measures**

The description of each measure indicates the dimensions to which the measure in question has an effect.

5.2 Macroeconomic and, to the extent feasible, the health, environmental, employment and education, skills and social impacts, including just transition aspects (in terms of costs and benefits as well as cost-effectiveness) of the planned policies and measures described in section 3 at least until the last year of the period covered by the plan, including comparison to projections with existing policies and measures

Within the framework of the analysis of the consequences pertaining to the transition to low carbon scenarios, the impact of the transition on the so-called classic pollutants, especially SO₂, NO_x and fine particles (PM2,5) was analysed. The calculations show that by switching to low-carbon scenarios in 2030, the emissions of these pollutants into the air will be reduced from 9% to 32%. Reducing pollutant emissions will have a positive effect on health, especially in cities.

Macroeconomic effects are analysed on the basis of an estimate of total investments in the period 2021 to 2050, as analysed in the "Green Book". Scenario S2 was used to assess the effect, projecting total investment of HRK 378.90 billion, of which HRK 141.47 billion in the period 2021 to 2030, and HRK 237.43 billion in the period 2031 to 2050. The assumption of the analysis is that investments are linearly distributed by year, i.e. that on average, HRK 14.148 billion is invested annually in the first period, or HRK 11.872 billion in the second period.

Macroeconomic effects are calculated by input-output analysis based on the input-output table for the Republic of Croatia for 2015, published in 2019 on Eurostat. The analysis takes into account 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 ratio of imported and domestic components is based on the input-output table for 2015.

The results of the analysis are divided into two periods: 2021 to 2030 and 2031 to 2050. The results of the first period analysis indicate that the total investment projected by the energy plan will have an effect on the increase of GDP (and gross value added) of between 2 and 2.5 percent given 2018 GDP levels. In the growth structure, construction, sector F, has 32%, non-construction industry including agriculture and mining and quarrying 34% along with tertiary services in the amount of 34%. Employment will increase by about 2.4 percent in the first year compared to the total number of employed persons in 2017, i.e. approximately 40 thousand newly employed persons, 44 percent of which in the activity of construction (50 percent of new jobs are the result of investments in the building sector), approximately 33 percent in industry, and the remaining approximately 23 percent in tertiary activities. It is expected that employment growth will not be of equal dynamics in the coming years due to the increase in worker productivity, the deployment of new technologies, the relocation of workers from completed works to new jobs, etc. Considering the historical data on employment trends by sectors with investments made, especially in the building sector, it is expected that the number of employees will increase in the amount between 40 and 80 thousand new employed persons, as a result of investments projected by the Energy and Climate Plan (compared to 2017).

The analyses carried out and the results obtained indicate the significant macroeconomic effects of the integrated national energy and climate plan on the Croatian economy, shown through its impact on GDP and employment, both overall and by sectors.

The conducted analysis is to a certain extent 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 of the input-output table for 2015. Input-output analysis is a static analysis and does not take into account future changes in technological links between different industries. Also, this analysis does not cover the induced effects, which include induced employment, i.e. the income generated by producers of goods and services intended for household consumption.

5.3 Overview of investments needs

i. Existing investment flows and forward investment assumptions with regard to the planned policies and measures

Table 5-4 show an estimate of total investment for the period 2021-2030 as well as for the period 2031-2050.

Table 5-4.: Estimation of total investments for the years 2021 - 2030 and 2031 - 2050.

HRK billions	2021 – 2030	2031 – 2050
Electricity generation	16.32	36.86
Transmission of electricity	7.90	9.90
Electricity distribution	10.0	20.0
Heating	0.60	1.20
Solar thermal systems	3.04	6.08
Natural gas transportation and distribution	10.7	2.80
Oil sector	13.0	9.9
Hydrocarbon prospecting	24.3	14.3
Building sector- energy renovation of buildings	13.06	27.91
Building sector- nZEB new construction	38.26	104.42
Infrastructure of alternative energy forms in transport	0.57	3.34
Production of advanced biofuels	3.73	0.72
Total	141.47	237.43

The largest investments are expected in installations for electricity production (the major part of which will be investments in installations using renewable energy sources) and in the building sector, namely the construction of buildings and houses with nearly zero-energy consumption. In terms of the necessary incentives, the greatest need will be in the energy renovation of the existing building stock.

ii. Sector or market risk factors or barriers in the national or regional context

The most important risks are related to delays in the implementation of regulatory measures and insufficient funds to implement financial measures.

These risks will be minimized by continuous monitoring of the implementation of measures and, if necessary, corrective action.

iii. Analysis of additional public finance support or resources to fill identified gaps identified under point ii

It is expected that the most significant part of the required funds will be provided from the European Structural and Investment Funds (ESIF), the European Fund for Strategic Investments (EFSI), the Modernization Fund, the Innovation Fund, funds from emission allowances auctioning, European research and development and competitiveness programmes and from national sources. Funding from the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) is expected.

5.4 Impacts of planned policies and measures described in section 3 on other Member States and regional cooperation at least until the last year of the period covered by the plan, including comparison to projections with existing policies and measures

i. Impacts on the energy system in neighbouring and other Member States in the region to the extent possible

Cross-border and regional integration of energy markets is expected to lead 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. Impacts on energy prices, utilities and energy market integration

The changes that are expected in the energy sector are economically viable and will not ultimately 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, as well as across sectors - there will be an interconnection of the electricity, heat, gas and transport sectors.

iii. If relevant, impacts on regional cooperation

It will be necessary to further strengthen cross-border and regional cooperation in all dimensions of the Energy Union.

6. REFERENCES

1. 7th National Report and the Third Biennial Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change, MEE, 2018.
2. Analyses and backgrounds for preparation of the Energy Strategy of the Republic of Croatia - Green Book, MEE 2018.
3. Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050, MEE, 2019.
4. Analyses and backgrounds for preparation of the Energy Strategy of the Republic of Croatia - White Book, MEE 2018.
5. Proposal of the Low Carbon Strategy of the Republic of Croatia - for public consultation, MEE, 2018.
6. Draft of the Strategy on Climate Change Adaptation in the Republic of Croatia for the period until 2040 with an outlook to 2070, MEE, 2017
7. Education, Science and Technology Strategy, Ministry of Science, Education and Sports, 2014.
8. Smart Specialization Strategy of the Republic of Croatia for the period from 2016 to 2020, Ministry of the Economy, 2016.
9. Innovation Promotion Strategy of the Republic of Croatia 2014 -2020, MEEC, 2014,
10. Energy in Croatia 2017, MEE, 2018
11. Greenhouse Gas Inventory Report on the territory of the Republic of Croatia for the period 1990 - 2017 (NIR 2019), MEE, 2019th
12. Rural Development Programme of the Republic of Croatia for the period 2014-2020, Ministry of Agriculture, 2015
13. National Renewable Energy Action Plan 2020, MEE, 2013.
14. 3rd National Energy Efficiency Action Plan for the period 2014-2016, MEE, 2014
15. 4th National Energy Efficiency Action Plan for the period until the end of 2019, MEE, 2019
16. World Competitiveness Ranking 2019, Institute for Management Development, 2019.
17. Assessment of the Energy Efficiency Potential for Electricity Infrastructure, EIHP, 2016.
18. Long-Term Strategy for Mobilising Investment in the Renovation of the National Building Stock of the Republic of Croatia , MCPP, 2017.
19. Akrap, A.; Ivanda, K.: Population projections of the Republic of Croatia, 2018.
20. World Energy Outlook 2018, International Energy Agency, 2018.
21. Current and Future Cost of Photovoltaics; Long-term Scenarios for Market Development, System Prices and LCOE of Utility-Scale PV Systems, Fraunhofer-Institute for Solar Energy Systems, 2015
22. Croatian Bureau of Statistics: Research and Development in 2017, Zagreb 2019, statistical reports, ISSN 1337-8247
23. Croatian Bureau of Statistics: Patents in 2018, Zagreb 2019, First release, ISSN 1330-0350

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9. LIST OF ABBREVIATIONS

ACLMT - Agency for Coastal Lines and Maritime Traffic
AMEUP - Agency for Mobility and EU Programmes
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
CHP - Combined Heat and Power
CNG – compressed natural gas
CSF - Croatian Science Foundation
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
FRL - Forest Reference Level
GDP - Gross Domestic Product
GPP – Green Public Procurement
HAMAG-BICRO - Croatian Agency for SMEs, Innovation and Investments
HEP – Croatian Electrical Utility
HHI - Herfindahl-Hirschman Index
HOPS – Croatian Transmission System Operator
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
LNG – Liquefied Natural Gas

LULUCF – Land Use, Land Use Change and Forestry
MAF - Ministry of Agriculture and Forestry
MEE – Ministry of Environment and Energy
MEEC – Ministry of Economy, Entrepreneurship and Crafts
MCPP – Ministry of Construction and Physical Planning
MSE – Ministry of Science and Education
MSP– Ministry of State Property
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
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

10. APPENDICES

Report on Parameters and Variables Used (xls)

Energy balance and indicators

Article 7 Measures and methods for implementing (doc)

Policies and measures (xls)

**Report on Greenhouse Gas Emissions by sector and type of gas
(xls)**

