REPUBLIC OF CROATIA

MINISTRY OF ENVIRONMENT
AND ENERGY

First Draft of the Integrated Energy and Climate Plan for the Period from 2021 to 2030

SECTION A: NATIONAL PLAN

Table of contents

1. INTRODUCTION

In the Strategy for the European Energy Union published by the European Commission in February 2015, it has been emphasized that integrated management is needed to ensure that all energy-related activities at EU level and at national, regional and local level contribute to the objectives of the Energy Union. Thereby the scope will be broadened beyond the Climate and Energy Policy Framework by 2030 and will incorpoorate all five key dimensions of the Energy Union: 1. Energy security, 2. Internal energy market, 3. Energy efficiency, 4. Decarbonisation and 5. Research, innovation and competitiveness.

In the Conclusions of the European Council in November 2015, it has been recognized that governance will be a key tool for the efficient construction of the Energy Union and for the achievement of its goals. It was underlined that the management 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 stakeholders responsible for energy and climate policy at the Union, regional and national level. In this regard, the achievement of the objectives of the Energy Union will be ensured by a combination of Union initiatives and consistent national policies set out in the integrated national energy and climate plans. It was therefore also drafted and in a triangle between the European Council, the European Parliament and the European Commission adopted the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, 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.

The Integrated National Energy and Climate Plan for the period 2021-2030 provides an overview of the current energy system and the state of energy and climate policy. It also gives an overview of national targets for each of the five key dimensions of the Energy Union and appropriate policies and measures for achieving these goals and establishes an analytical basis. In the Integrated Energy and Climate Plan particular attention should be paid to the goals set for 2030, which include the reduction of greenhouse gas emissions as well as increase of renewable energy use, energy efficiency and energy interconnections. It is necessary to ensure that the Integrated Energy and Climate Plan is in line with the sustainable development goals and contributes to them. The Integrated Energy and Climate Plan is complementary to existing national strategies and plans.

2. PLAN REVIEW AND ADOPTION PROCESS

2.1. Summary

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

The Republic of Croatia is a member state of the European Union (EU) since 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) since 1996 and regularly submits greenhouse gas inventory reports as well as national communications to the UNFCCC Secretariat.

Croatia currently has considerably lower rates of economic activity of the population than most EU countries [**Pogreška! Izvor reference nije pronađen.**]. In the overall energy balance of C roatia, there is a significant dependence on oil, gas and electricity import. Significant share of electricity imports is due to market uncompetitiveness of old thermal power plants and their low level of activity because of environmental protection requirements. Industrial production is continuously decreasing, and the highest revenue is realized by the manufacturing industry.

Environmental reports are published by the Croatian Agency for the Environment and Nature. The most recent report published in 2014 covers the period 2009-2012 and contains conclusions on the state and trends in the field of environmental protection, economy and social trends, as well as recommendations for improving the implementation of environmental protection and sustainable development policy [2]. Emissions of major pollutants into the air (SO_2, NH_3, NO_X, NMVOC) 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.

Regarding 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 [2]. 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 [2].

2.1.2. Strategy referring 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. The

decarbonization dimension, which includes emissions by sources and removals by sinks of greenhouse gases, is elaborated in the Draft of the Low-Carbon Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050 [3] (hereinafter: the Low-Carbon Strategy). The preparation of the Low-Carbon Strategy and the Action Plan for the Implementation of the Low-Carbon Strategy for a period of five years is an obligation under the Air Protection Act (OG 130/11, 47/14, 61/17). The Draft of the Low-Carbon Strategy was developed 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 of the Republic of Croatia until 2030 with an outlook to 2050 (hereinafter: the Energy Strategy). The preparation of the Energy Strategy is an obligation under the Energy Act (OG 120/12, 14/14, 95/15, 102/15, 68/18). For the purposes of developing the Energy Strategy, analytical backgrounds have been prepared (the so-called Green Paper [1]) presented to the professional and interested public at workshops held in November 2018. The Green Paper contains elaborated targets for the use of renewable energy sources, energy efficiency, the internal energy market and energy security, which will upon final adoption be integrated into the final version of the Low-Carbon Strategy and are presented in this document. It should be noted that further modifications of both documents can be expected, which may also result in modifications within this document.

One of the objectives within the decarbonisation dimension is to adapt to climate change, as elaborated in the Draft of the Climate Change Adaptation Strategy with the action plan [4]. 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.

The national strategies relevant to the dimension of research, innovation and competitiveness are the Strategy of Education, Science and Technology [5], the Smart Specialization Strategy of the Republic of Croatia 2016-2020 [6] and the Innovation Promotion Strategy of the Republic of Croatia 2014-2020 [7]. Based on these strategies, measures expected to contribute to research, innovation and competitiveness of the Croatian economy in sectors relevant to the energy transition have been outlined here.

2.1.3. Tabular representation of key objectives, policies and measures of the plan

The objective of reducing greenhouse gas (GHG) emissions for the Republic of Croatia in 2030 is set by *Directive (EU) 2018/410* of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814, as well as the *Regulation (EU) 2018/842* of the European Parliament and of the Council of 30 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 of the emissions trading system (ETS sector) and for sectors not participating in emissions trading (non-ETS sectors). These are shown in Table 2-1.

Table 2-1 Objectives for reducing GHG emissions for the Republic of Croatia in 2030

Compared to the year	Scope	Realized in 2015	Target for 2030
2005	ETS sector	-21.1%	-43%*
	Non-ETS sectors	-18.2%	-7%

* the goal for the Republic of Croatia is indicative, it is binding on the EU ETS system level

Within the framework of preparation of the Energy Development Strategy of the Republic of Croatia until 2030 with an outlook to 2050, in November 2018 analytical backgrounds have been developed - the so-called Green Paper [1]. In 2030, the values of the key indicators are shown in Table 2-2.

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

	Target for 2030
RES share in the gross final energy consumption	36.4%
Energy efficiency Primary consumption Direct consumption	 367.76 PJ 286.91 PJ

Measures relevant to individual dimensions of the energy union are shown in Table 2-3.

Table 2-3 Overview of measures

	Name of measures
Decarbonisation	
MS-1	Committee for intersectoral coordination for policy and measures for mitigation of and adaptation to climate change
MS-2	Promoting the use of innovative information and communication technologies (ICTs) to reduce GHG emissions
MS-3	The EU Emissions Trading System (EU ETS)
MS-4	Use of funds acquired from the sale of emission allowances through auctioning within the EU ETS for measures to reduce GHG emissions
MS-5	The CO_2 emission tax for the non-ETS stationary sources
MS-6	Covenant of Mayors for Climate and Energy in the Republic of Croatia
MS-7	Implementation of an interdisciplinary research on the potential for CO_2 geological storage in the Republic of Croatia
MS-8	Improving sustainability of urban areas
IP-1	Reducing emissions of volatile organic compounds in solvent utilization sector

IP-2	Handling of substances that deplete the ozone layer and fluorinated greenhouse gases
IP-3	Technical and organizational measures for collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases
IP-4	Capacity building and strengthening the knowledge of authorized repairers
IP-5	Leakage detection of controlled substances and fluorinated greenhouse gases
IP-6	A fee to cover the costs of collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases
GO-1	Preventing generation and reducing the amount of solid municipal waste
GO-2	Increasing the amount of separately collected and recycled solid municipal waste
GO-3	Methane flaring
GO-4	Reducing the amount of disposed biodegradable municipal waste
GO-5	Use of biogas for biomethane production and electricity and heat generation
POLJ-1	Change in diet of cattle and pigs and animal feed quality
POLJ-2	Anaerobic decomposition of manure and biogas production
POLJ-3	Improving cattle facilities and systems of animal waste management
POLJ-4	Improvement of mineral fertilizer application methods
POLJ-5	Hydromeliorative interventions and systems of protection against natural disasters
POLJ-6	Introduction of new cultivars, varieties and cultures
POLJ-7	Implementation of the rural development programme
POLJ-8	Capacity building of farmers
POLJ-9	Improvement of the regulatory framework for digestate
POLJ-10	Establishment of biomass collection and logistic centers
LUF-1	Improving reporting in LULUCF sector
LUF-2	Preparation of cost-benefit analysis of afforestation on new areas and natural regeneration of forests as a measure of increasing the sinks in LULUCF sector
LUF-3	Implementation of the Action plan for LULUCF sector
OIE-1	Informational and educational measures
OIE-2	Spatial planning prerequisites for use of renewable energy sources
OIE-3	Promoting the use of renewable energy sources for production of electricity and thermal energy
OIE-4	Development of the regulatory framework
OIE-5	Promoting the use of RES at the point of consumption
OIE-6	Encouraging farmers and land owners to grow biomass for energy needs
OIE-7	Promotion of biorefineries
OIE-8	Capacity building for bioeconomy
TR-1	Providing information to consumers on fuel cost-effectiveness and CO_2 emission of new passenger cars
TR-2	Special environmental fee for motor vehicles
TR-3	Special tax on motor vehicles

TR-4	Monitoring, reporting and verification of greenhouse gas emissions in the life cycle of liquid fuels
TR-5	Obligation for the use of renewable energy sources in transport
TR-6	Promotion of clean and energy efficient vehicles in road transport
TR-7	Promotion of intermodal transport
TR-8	Legislative adaptation of provisions on the establishment of infrastructure for alternative fuels
TR-9	Financial incentives for energy-efficient vehicles
TR-10	Development of alternative fuels infrastructure
TR-11	Promoting integrated and intelligent transport and development of alternative fuels infrastructure at the local and regional level
TR-12	Training for drivers of road vehicles for eco-driving
TR-13	Promoting the development of intermodal and integrated transport
Energy Efficiency	
ENU-1	Energy Efficiency Obligation Scheme for Suppliers
ENU-2	Programme for increasing the number of buildings with nearly-zero energy consumption
ENU-3	Energy renovation programme for multi-apartment buildings
ENU-4	Energy renovation programme for single family houses
ENU-5	Energy renovation programme for public sector buildings
ENU-6	Energy management system in the public sector
ENU-7	Energy renovation programme for public lighting
ENU-8	Green public procurement
ENU-9	Energy management system in the business (service & production) sector
ENU-10	Informative bills
ENU-11	Providing information on energy efficiency
ENU-12	Energy efficiency education
ENU-13	Integrated information system for monitoring energy efficiency
ENU-14	Management of power system and development of transmission network
ENU-15	Reduction of losses in the distribution network and introduction of smart grids
ENU-16	Increasing the efficiency of the district heating systems
Energy Security	
ES-1	Integrated planning of security of energy and energy products supply
ES-2	LNG terminal construction
ES-3	Inclusion in the Ionian-Adriatic gas pipeline
ES-4	Pumped-storage hydroelectric power plants construction
ES-5	Expansion of the gas storage facility in Grubišno Polje
ES-6	Introduction of smart metering
ES-7	Launching pilot projects to provide ancillary services
ES-8	Research of potential hydrocarbon deposits in Slavonia, Dinarides and Southern Adriatic
ES-9	Development and management of the power system
Internal Energy Market	

UET-1	Implementation of the ten-year development plan for electricity transmission network
UET-2	Implementation of the ten-year development plan for gas transmission system
UET-3	Ensuring balance of the power system
UET44	Elaboration of the regulatory framework for the active participation of customers on the electricity market
UET-5	Implementation of the Programme for the reduction of energy poverty
Research, Innovation and Competitiveness	
IIK-1	Fostering research and development of clean energy technologies and low-carbon technologies
IIK-2	Thematic working groups for SET-Plan key activities

2.2. Overview of the current state of policies

2.2.1. The national energy system and the EU energy system and the context of the national plan policies

The basic indicators of energy consumption development and economic indicators for the Republic of Croatia in the period from 2011 to 2016 are shown in Figure 2-1 [8].

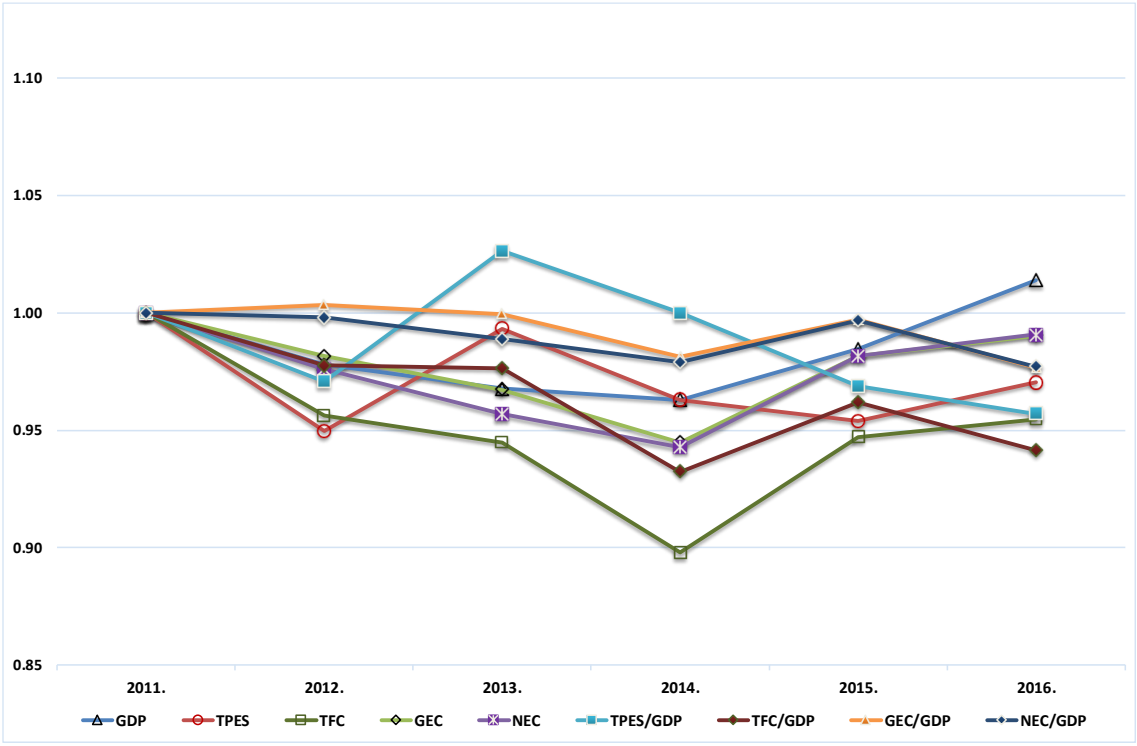

Figure 2-1 Basic indicators of energy consumption development and economic indicators in the Republic of Croatia in the period 2011-2016

Negative rates of electricity consumption have been achieved, so that the total electricity consumption and net electricity consumption have dropped at an average annual rate of 0.2%. Losses of transmission and distribution of electricity also decreased at an average annual rate of 1.3%. In the period from 2011 to 2016, gross and net electricity consumption decreased at an average annual rate of 0.2%, primarily due to the economic crisis.

The trends in the production of primary energy are shown in Figure 2-2 [8]. During the six-year period from 2011 to 2016, primary energy production in Croatia increased at an average annual rate of 0.8%. 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 rate of 7.5%. The fastest growth was achieved in renewable energy production with an annual growth rate of 34.8%, while the energy of utilized water resources increased at an average annual rate of 6.6%. Production of crude oil and thermal energy produced in heat pumps increased at an average annual rate of 2.1%. The production of firewood and other solid biomass increased at the rate of 1.7% per year.

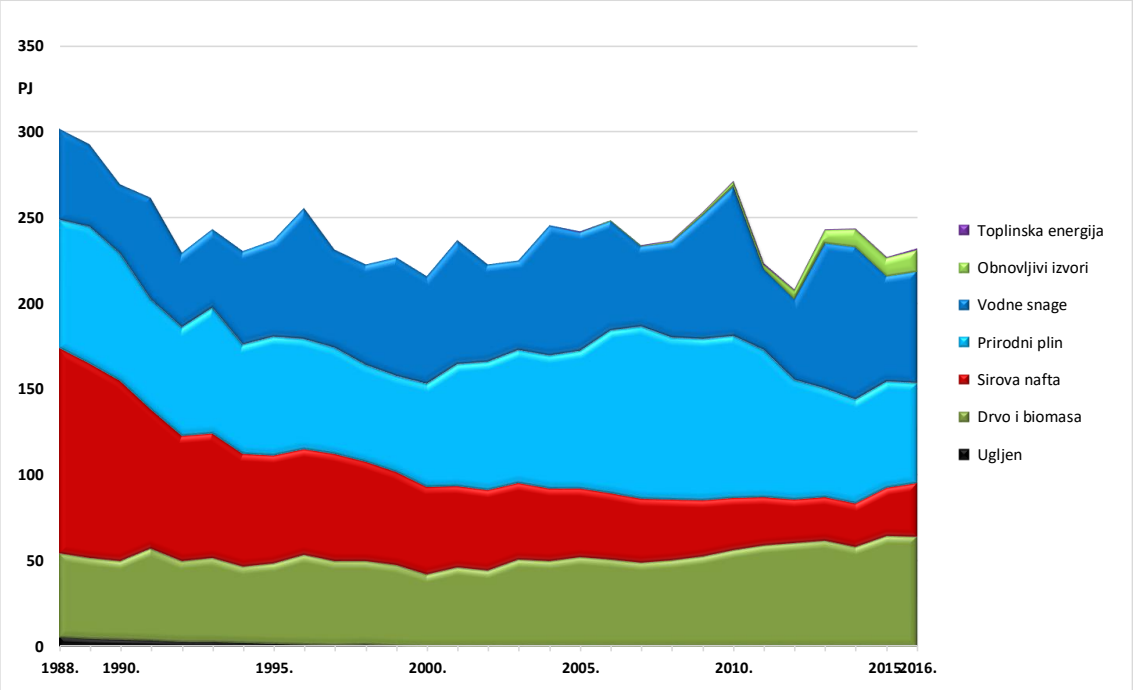

Figure 2-2 Primary energy production

Trends in energy imports during the period from 2011 to 2016 are shown in Figure 2-3 [8]. During this period an upward trend of energy imports into Croatia at an average annual rate of 1.3% was observed. Crude oil imports showed a downward trend at an average annual rate of 2.4%, while imports of electricity remained at approximately the same level. Imports of all other forms of energy showed an upward trend, so that imports of wood and biomass increased at an average annual rate of 39.2%, imports of natural gas 8.1%, imports of petroleum products 4.1% and imports of coal and coke at the rate of 1.6% per year [6]. During this period an upward trend of energy imports into Croatia at an average annual rate of 1.3% was observed.

Crude oil imports showed a downward trend at an average annual rate of 2.4%, while imports of electricity remained at approximately the same level. Imports of all other forms of energy showed an upward trend, so that imports of wood and biomass increased at an average annual rate of 39.2%, imports of natural gas 8.1%, imports of petroleum products 4.1% and imports of coal and coke at the rate of 1.6% per year.

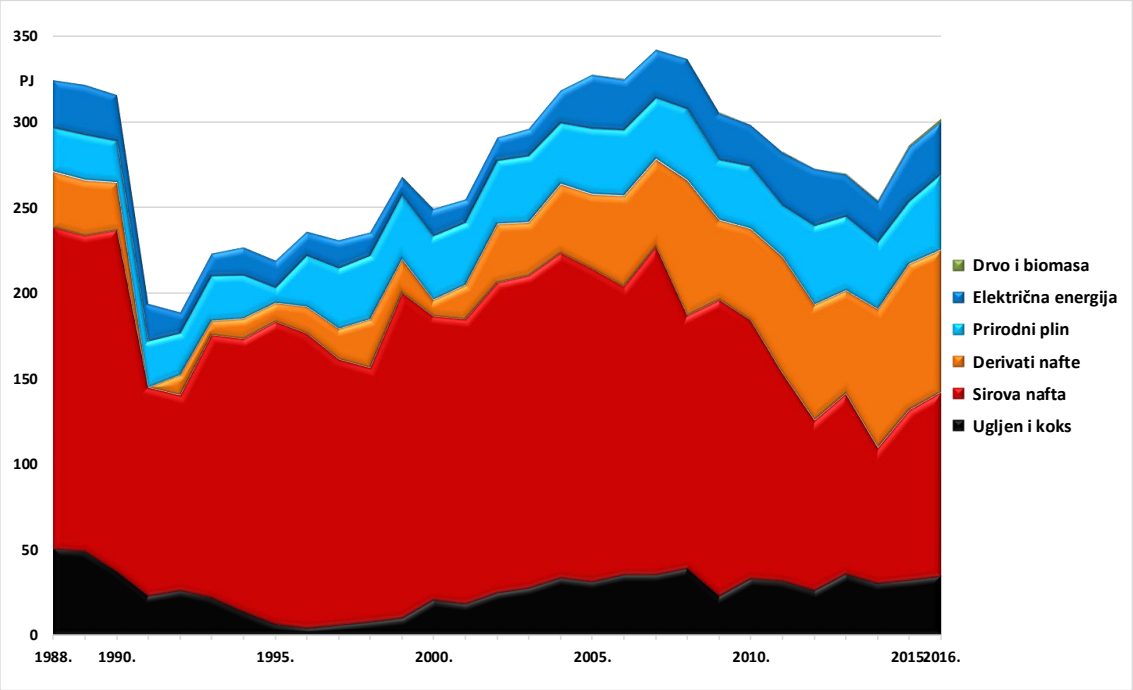

Figure 2-3 Energy imports, Croatia

Energy legislation and climate legislation are aligned with the acquis communautaire. At the implementation level, energy and climate fall within the competence of one ministry - the Ministry of Environment and Energy.

The current energy strategy was adopted in 2009 (OG 130/2009), and in 2018 the competent ministry has started preparing a new energy strategy, taking into account the need for long-term energy planning (even beyond 2030), as well as ever increasing restrictions in greenhouse gas emissions. Upon the adoption of the Energy Strategy, its objectives shall be integrated into the Draft of the Low-Carbon Strategy, which will integrate energy and climate policy at a strategic level.

In order to coordinate policies and measures for mitigation of and adaptation to climate change, in 2014 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.

2.2.2. 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 by sources and removals by sinks;
- renewable energy sources.

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 (OG International Treaties, 2/96). The most important regulation of the Republic of Croatia governing climate change is the Air Protection Act (OG 130/11, 47/14, 61/17).

The Republic of Croatia as a Party to the UN Framework Convention on Climate Change (UNFCCC) prepares and submits every four years a national communication 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) [9].

As a party to the Kyoto Protocol, the Republic of Croatia has set up a national system for monitoring GHG emissions in the country, and on an annual basis prepares the GHG 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 1990-2016 was published in 2018 [10].

In **the transport sector**, the share of alternative fuel vehicles is still relatively small (less than 0.2%). In December 2016, the Republic of Croatia passed the Act on the Deployment of Alternative Fuels Infrastructure (OG 120/2016) transposing into national law the provisions of Directive 2014/94/EU of the European Parliament and of the Council of 22 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 (NPF), which was adopted in Croatia in 2017 (OG 34/17). The NPF has set 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 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.

The basic legal framework for the area of **renewable energy sources and cogeneration of electricity and thermal energy** in the Republic of Croatia is outlined in the Energy Act, the Electricity Market Act, the Act on the Environmental Protection and Energy Efficiency Fund, the Act on Renewable Energy Sources and Highly Efficient Cogeneration, the Air Protection Act, the Environmental Protection Act and by-laws for the implementation of these laws. At the time this document is being prepared, the proposed Act on Amendments to the Act on Renewable Energy Sources and Highly Efficient Cogeneration has been introduced into the Croatian Parliament.

The Act on Renewable Energy Sources and Highly Efficient Cogeneration regulates the planning and promotion of generation and consumption of electricity produced in production plants using renewable energy sources and highly efficient cogeneration, defines incentives for the generation of electricity using renewable energy sources and highly efficient cogeneration, regulates the implementation of the incentive system for renewable energy generation and highly efficient cogeneration and other issues of importance for the use of renewable energy sources and highly efficient cogeneration.

The purpose of this Act is to promote the generation of electricity and heat from renewable energy sources and highly efficient cogeneration, and to increase the share of renewable energy in the total direct energy consumption with the help of incentive mechanisms and a regulatory framework for the use of renewable energy sources and highly efficient cogeneration.

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 [1111] 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 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 relating to the dimension of Decarbonization are shown in Table 2-4. Along with the name of each measure, a document adopting the measure is specified.

Table 2-4 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	Air Protection Act (OG 130/11, 47/14, 61/17), Decision of the Government of the Republic of Croatia (OG 114/14)	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. Representatives of competent state administration bodies and other relevant institutions, agencies and non-

adaptation to climate change		governmental organizations 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. The Committee consists of the Coordination Group and the Technical Working Group.
Promoting the use of innovative information and communication technologies (ICTs) to reduce GHG emissions	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	Innovative information and communication technologies play an increasingly important role in reducing GHG 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 GHG 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 GHG emissions.
The EU Emissions Trading System	Regulation on trading with GHG emission allowances (OG 69/12, 154/14)	ETS (Emissions Trading System) sector includes all activities listed in Annex I of the Regulation on trading with GHG emission allowances (OG 69/12, 154/14) and for the reduction of GHG emissions from these activities alone are responsible plant operators involved in the trading system. Reduction commitments through emission allowances allocated evenly have been distributed to all Member States with the goal to contribute to the reduction of the emissions by 43 % until 2030 compared with the 2005 level. Thus it can be concluded that reduction of emissions of certain activities of the ETS is in fact regulated at EU level.
Use of funds acquired from the sale of emission allowances through auctioning within the EU ETS for measures to reduce GHG emissions	Air Protection Act (OG 130/11, 47/14, 61/17)	Of the total number of allowances designated for the allocation to operators and aircraft operators, in each year of the trading period, a part is distributed free of charge according to the above prescribed method. The remaining part is distributed to the Member States of the European Union and is subject to public auctions. The Air Protection Act (OG 130/11, 47/14, 61/17) stipulates that the Republic of Croatia use 95% of the funds received for the climate related purposes and the funds are paid to the special account of the Environmental Protection and Energy Efficiency Fund and other 5% of the funds are paid in the state budget of the Republic of Croatia. Funds that are paid to a special account in the Environmental Protection and Energy Efficiency Fund should be used for climate change mitigation and adaptation measures.

The CO_2 emission tax for the non-ETS stationary sources	The Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon dioxide into the environment (OG 73/07, 48/09, 2/18)	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 until 1st January 2017. The obligated parties investing in energy efficiency, renewable energy and other measures to reduce CO_2 emissions and other GHG emissions pay a lower tax. The Environmental Protection and Energy Efficiency Fund is authorized for accounting and collecting charges. From 2013 onwards, the obligation to pay the CO_2 emission tax has applied only to non-ETS sources.
Covenant of Mayors for Climate and Energy in the Republic of Croatia	Voluntary agreement	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 70 cities and municipalities, i.e. more than 2 million citizens of the Republic of Croatia.
Renewable energy sources		
Feed-in tariffs and a system of premiums to support the use of renewable energy sources in electricity generation and for highly efficient cogeneration	The Act on Renewable Energy Sources and Highly Efficient Cogeneration (OG 100/15, 123/16, 131/17), National Renewable Energy Action Plan until 2020 [12]	The main mechanism for the development of renewable energy sources has so far been stimulating pricing (feed-in 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	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	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 Croatian Bank for Reconstruction and Development (HBOR)	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	The objective of the loan programme for environmental, 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	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	Funds for financing are secured from the dedicated revenues of the Fund paid by environmental polluters, which include fees for nitrogen oxides, sulphur dioxide and carbon dioxide emissions, fees for burdening the environment with waste, environmental user fees and special fees for the environment 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 Renewable Energy Action Plan [12]	Raising awareness of renewable energy sources with expected results of behavior changes. The target groups are local authorities, interest groups, the public.
Transport		
Providing information to consumers on fuel cost-effectiveness and CO_2 emission of new passenger cars	Ordinance on availability of information on fuel cost-effectiveness and CO_2 emissions from 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 CO_2 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 for drivers of road vehicles for eco-driving	The 7th National Report of the Republic of Croatia to the UNFCCC [9], Draft of the 4th National Energy Efficiency Action Plan, Ministry of the Environment and Energy, November 2017 [13]	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 for the use of biofuels in transport	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. The National Renewable Energy Action Plan (Ministry of the Economy, Entrepreneurship and Crafts, 2013) identified the goals and policies related to increasing the share of the RES in final energy consumption by 2020 and

		the specifically estimated contribution of biofuels in transport.
Special environmental fee for motor vehicles	Act on the Environmental Protection and Energy Efficiency Fund (OG 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 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 in 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 emissions. 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 34/17), Draft of the 4th National Energy Efficiency Action Plan, Ministry of the Environment and Energy, November 2017 [14]	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, 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 34/17), Act on Deployment of Alternative Fuels Infrastructure (OG 120/16), Draft of the 4th National Energy Efficiency Action Plan, Ministry of the Environment and Energy, November 2017	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, 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	Draft of the 4th National Energy Efficiency Action Plan, Ministry of the Environment and Energy, November 2017 [14]	This measure includes 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 road transport	Act on Promotion of Clean and Energy Efficient Vehicles in Road Transport (OG 127/13)	This Act 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.

Promotion of intermodal transport	Act on Combined Transport of Goods (OG 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 130/11, 47/14, 61/17), 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)	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 Croatian Agency for the Environment and Nature.
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	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	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	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	This set of measures defines how the used controlled substances and fluorinated greenhouse gases contained in products and equipment must be collected, reused, recovered or destroyed.
Capacity building and strengthening the knowledge of authorized repairers	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	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	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	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 94/13, 73/17)	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 of at non-compliant landfills are defined.
Increasing the amount of separately collected and recycled solid municipal waste	Sustainable Waste Management Act (OG 94/13, 73/17), Waste Management Plan of the Republic of Croatia for the period 2017- -2022 (OG 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), 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 94/13, 73/17)	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.	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	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	The 7th National Report of the Republic of Croatia to the UNFCCC [9]	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	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	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 litter and generation

		of electricity from renewable sources. This measure is linked to the measures in Renewable sources in the production of electricity and heat and Construction of cogeneration plants in the energy sector. 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_2O emissions in the nitrification process.
Improving cattle facilities and systems of animal waste management	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	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	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	Application of new slow-release fertilizers suitable for growing corn and wheat (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	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	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	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	Encouraging development, education and implementation of technologies at a national and regional level, encouraging the transition and adaptation of the entire production chain to produce new crops or enabling and encouraging the implementation of cultivars and varieties that are more resistant to drought and disease and have a lower overall carbon footprint. 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	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	According to the Rural Development Programme 2014-2020
LULUCF		
Improving reporting in LULUCF sector	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	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 for 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 LULUCF sector	Plan for Air Protection, Ozone Layer Protection and Climate Change Mitigation in the Republic of Croatia for the period 2013-2017 (OG 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.
Implementation of the Action plan for LULUCF sector	The 7th National Report of the Republic of Croatia to the UNFCCC [99]	According to the Action Plan for LULUCF sector

Dimension 'Energy Efficiency'

The issue of energy efficiency in the Republic of Croatia is regulated by the Energy Efficiency Act (OG No. 127/14), the Building Act (OG No. 153/13, 20/17), the Act on Protection against Light Pollution (OG No. 114/11) and by-laws that ensue from these acts. At the time this draft of the Plan is being prepared, amendments to the Energy Efficiency Act have been introduced in the Croatian parliament, and the final draft of these amendments was used in the preparation of this Plan.

An overview of the regulatory measures defined in the aforementioned laws and relevant by-laws is shown in Table 2-5. The said laws and relevant by-laws 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 the setting of ecodesign requirements for energy-related products.

Table 2-5 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 (NEEAP) 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 Investments in the Renovation of the National Building Stock of the Republic of Croatia and update it every three years
Energy Efficiency Obligation Scheme for energy distributors - according to the final draft of the amendments, obligated parties become energy suppliers (**the implementing regulation that would establish a functional obligation scheme has not been adopted yet and only the alternative measures defined in the 3rd NEEAP have been implemented)**
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 [14]; MEN-7 [9])
Obligations of the energy distributor to enter the data on energy measurement and consumption in the public sector into the national Energy Management Information System (EMIS) 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 [9]) (**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 (OG 114/11) 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 Energy Management Information System (Ordinance on systematic energy management in the public sector (OG No. 18/15,))
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 [9]) (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 [9]) **(Ordinance on defining eco-design requirements of energy-related products (OG No. 50/15)**)
Act on Protection against Light Pollution
Obligatory use of lamps that give the same light effect with lower energy consumption; obligatory application of lighting management standards, requirements and maximum levels of outdoor light intensity, illumination, brightness and dispersion; obligatory application of light pollution protection measures that must prevent excessive emissions and light spills into the environment; when planning, constructing, maintaining and reconstructing lighting, it is necessary to choose technical solutions and appreciate the achievements and solutions that ensure that lighting is performed according to the Croatian lighting standards, that energy-efficient solutions are used and that the illumination parameters do not exceed the limit values (**on the basis of this Act, no implementing regulation has been adopted or foreseen that would establish integral requirements for energy-efficient and environmentally-friendly public lighting**)
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)** 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))

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 NEEAP has been prepared for the period from 2017 to 2019 [14]. Measures from the draft of the 4th NEEAP which are being implemented in Croatia at the time of preparation of this Plan are shown in Table 2-6. These are mainly financial measures using 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 from these two documents are specified.

Table 2-6 Overview of existing non-regulatory energy efficiency measures by sectors of direct consumption (excluding transport)

Name of the measure	Category	Short description
Households		
Promotion of integral renovation of multi-apartment buildings (B.3 [12]; MEN-2 [99])	Grants	The programme was implemented in the period from 2014 to 2016 with the national funds of the Environmental Protection and Energy Efficiency Fund. At the end of 2016, MCPP issued a call for applications for the purpose of allocating HRK 560 million for energy renovation of 586 buildings; it is assumed that all projects will be completed by the end of 2019; it is not known whether the scheme will continue
Programme for energy renovation of single family houses 2014-2020 (B.5 [12]; MEN-4 [9])	Grants	The programme was implemented in the period from 2014 to 2016 with the national funds of the Environmental Protection and Energy Efficiency Fund. Available funds from the ERDF within the OPCC are HRK 228 million - the utilization of these funds is expected until the end of 2023; the implementation of the measure is expected to start in 2019.
Public sector		
Programme for Energy Renovation of Public Sector Buildings 2014-2015 (P.1 [12])	ESCO model Grants	The programme is implemented by contracting energy services in public sector buildings by the Croatian Government Real-estate Agency (APN) 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.
Programme for Energy Renovation of Public Sector Buildings 2016-2020 (P.2 [12]; MEN-5 [9])	Grants Affordable loans Energy service	Available ERDF funds within the OPCC amount to EUR 211 million for energy renovation of public sector buildings; the projects within this programme are expected to be completed by the end of 2023
Systematic energy management in the	Informative measures	The programme is implemented by the APN and is based on the public sector's obligation of systematic energy management; the savings in

public sector (P.3 [12]; MEN-6 [9])		this programme are the result of organizational and informative measures
Programme "Energy Efficient Public Lighting" (P.4 [12]; MEN-13 [9])	Affordable loans	Available ERDF funds within the OPCC amount to HRK 150 million (EUR 20 million) for energy renovation of public lighting systems; the programme is implemented through loans secured by the Croatian Bank for Reconstruction and Development; the projects within this programme are expected to be completed by the end of 2023
"Green" Public Procurement (P.5 [12]; MEN-14 [9])	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 [12]; MEN-3 [9])	Grants Soft loans	Available ERDF funds within the OPCC amount to HRK 300 million (EUR 40 million) - the utilization of these funds is expected by the end of 2023; the implementation of the measure started with the currently opened public call of the Ministry of the Environment and Energy
Industry		
Increasing energy efficiency and use of RES in manufacturing industries (I.2 [12]; MEN-17 [9])	Grants Soft 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 270 million was allocated for 77 projects
CO_2 emission tax for the non-ETS stationary sources (MEN-22 [9])	Fiscal	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 2-7 .

Table 2-7 Overview of existing intersectoral measures for energy efficiency

Name of the measure	Category	Short description
Programme of promotion of nearly-zero energy buildings (B.2 [12]; MEN-1 [9])	Informative measures	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 [12]; MEN-7 [9])	Regulatory measures Informative measures	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 [12]; MEN-10 [9])	Informative measures	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 [12]; MEN-12 [9])	Educational measures	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 [12]; MCC-2 [9])	Monitoring 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 2-8. It should be noted that the Croatian Energy Regulatory Agency, based on 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 network infrastructure, including deadlines for their introduction.

In order to carry out the stipulated tasks, the Croatian Energy Regulatory Agency has ensured the preparation of the study "Assessment of Potential for Increasing Energy Efficiency of the Electricity Infrastructure" [15]. 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 2016 to 2025, with detailed elaboration for the initial three-year and one-year period. Based on the Study, the Croatian Energy Regulatory Agency has adopted the following Decision:

- The Croatian Energy Regulatory Agency has assessed the potential for increasing energy efficiency of the electricity infrastructure, which for the period from 2016 to 2025 amounts to 51 GWh per year on average for the transmission network and 25 GWh per year on average for the distribution network and
- The Croatian Energy Regulatory Agency has established that, in order to achieve these savings, the measures, investments and the dynamics (deadlines) of their introduction should follow the ten-year development plans for the transmission and distribution network for the period from 2016 to 2025, with detailed elaboration for the initial three-year and one-year period.

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 Croatian Energy Regulatory Agency will revise its assessment of potential for increasing energy efficiency of the electricity infrastructure and determine deadlines for the introduction of advanced measures.

Table 2-8 Overview of existing energy efficiency measures for energy infrastructure

Name of the measure	Category	Short description
Revitalization and energy efficiency in existing thermal and hydro power plants (E.1-E.4 [12]; MEN-23 [8])	Electricity generation	The activities within this measure are related to HEP and are further elaborated in the 4th NEEAP. 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, etc.
Reconstruction and renovation of hot water pipelines and steam pipelines (E.7 [12]; MEN-24 [8])	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.
Power system management and development of the transmission and distribution network (E.8 and E.9 [12]; MEN-25 [8])	Power grids	The measure implies the optimization of the transmission network topology, loss reduction, grid capacity development by the Croatian Transmission System Operator and the reduction of losses in the distribution network and introduction of advanced meters for end customers by HEP-ODS. For the pilot project "Introduction of smart grids in pilot areas", EUR 20 million is provided from ESI Funds within the OPCC.

Dimension "Energy security"

Key legislation relevant for the dimension of energy security:

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

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 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 currently being implemented for the purpose of ensuring energy security are shown in Table 2-10.Table 1-9.

Table 2-9 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 Croatian Energy Regulatory Agency 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.
Emergency 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 emergency 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 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 120/12, 14/14, 102/15, 68/18)
- Electricity Market Act (OG 22/13, 102/15, 68/18)
- Gas Market Act (OG No. 18/18)
- Oil and Petroleum Products Market Act (OG 19/14, 73/17)
- Act on the Regulation of Energy Activities (OG 120/12, 68/18)

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 2-10.

Table 2-10 Existing measures for energy transmission infrastructure

Name of the measure	Documents	Short description
Preparation and implementation of power transmission grid development plans	Electricity Market Act (OG 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 power transmission grid. Pursuant to the Electricity Market Act, HOPS is the owner of the transmission network 110 kV to 400 kV, and is obliged to prepare and adopt, with the prior consent of the Croatian Energy Regulatory Agency (HERA), ten-year, three-year and one-year investment plans for the development of the transmission network

Preparation and implementation of power distribution network development plans	Electricity Market Act (OG 22/13, 102/15, 68/18)	Pursuant to the Electricity Market Act, the Distribution System Network Code issued by the distribution system operator with the prior consent of the Croatian Energy Regulatory Agency stipulates the methodology and criteria for planning the distribution network development.
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 power reserves in the production part of the power system, in Croatia and in the neighboring 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. Elements of production capacity will continue to be monitored in own territory and in the region, taking into account the structure of production facilities and the share of variable renewable sources. At the same time, the capacity required for energy storage and flexibility of power system operation will be monitored as well.

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 power reserves 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 power reserves 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 network users provide to the distribution system operator are not currently used in the Republic of Croatia. The Distribution System Network Code that has recently come into effect (OG 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 100/2015, hereinafter: Act on RES and HEC). It consists of electricity producers and other persons performing the activity of electricity

generation, who are entitled to incentive pricing in accordance with the agreements on the purchase of electricity with the Croatian Energy Market Operator (HROTE).

Pursuant to the Act on RES and HEC, HROTE 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 favorable 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 2-11.

Table 2-11 Existing consumer protection measures

Name of the measure	Documents	Short description
Informative calculations	Energy Efficiency Act (OG 127/14)	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 on a monthly basis and provide individual meters to end customers	Energy Efficiency Act (OG 127/14)	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 eliminate energy poverty are shown in Table 2-12.

Table 2-12 Existing measures to eliminate energy poverty

Name of the measure	Documents	Short description
Compensation of energy costs of vulnerable customers	Regulation on criteria for acquiring the status of vulnerable energy customers from networked systems (OG 95/2015)	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	Draft of the 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	Draft of the 4th National Energy Efficiency Action Plan	Planning and launching a systematic programme to combat energy poverty through implementation of energy efficiency measures. The Programme 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:

- 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:

- The Act on Investment Promotion and Improvement of Investment Climate (OG No. 111/12, 28/13) regulating investment promotion and stimulating a better investment climate in the Republic of Croatia and other related issues. The objective of investment promotion and stimulating a better investment climate is to stimulate economic growth and the realization of economic policy of the Republic of Croatia, include it in international exchange and strengthen the investment potential and competitiveness of Croatian entrepreneurship.

-The Act on State Aid for Research and Development Projects (OG No. 64/2018) regulating the eligibility criteria for allocation of state aid to research and development projects in the category of horizontal aid for research and development, competences of the bodies of the Republic of Croatia with regard to allocation of state aid for research and development projects, procedure for determining the fulfilment of criteria for exercising rights, record-keeping and reporting as well as other issues related to the realization of the right to assistance 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 a target 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).

- Public Procurement Act (OG No. 120/2016) according to which one of the public procurement procedures is '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 (OG No. 29/02. 63/07. 53/12. 56/13. 121/16) governing the basics for the implementation of incentive measures for small businesses, including assistance for research, development and application of innovations, as well as introduction of modern technologies. In addition to the said acts, the area of research, development and innovation is regulated in more detail through various ordinances and guidelines.

Research and development require an efficient infrastructure involving primarily public and private institutions that enable the realization of these activities, research and development segments in the private sector, and additionally, individual communication channels that connect particular 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 to the Croatian Parliament specific legal measures and incentives in the form of laws and are responsible for the implementation of the measures prescribed by these laws. 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 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.

2.2.3. Key issues of cross-border significance

Not applicable.

2.2.4. Administrative structures for the implementation of 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 its Directorate for climate, sustainable development and air, soil and light pollution protection. The National Energy Efficiency Authority also operates within the Ministry 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 (SMiV), 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: single family houses, multi-apartment buildings, commercial non-residential buildings and public sector buildings.

The Ministry of Maritime Affairs, 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, environment and climate. The EPEEF also manages the funds collected from emissions through auctions in the EU Emission Trading System (ETS) and directs them 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).

In the area of energy efficiency, Croatian Government Real-Estate Agency (APN) 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 No. 127/14).

The Croatian Energy Regulatory Agency (HERA) 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 Hydrocarbon Agency provides operational support to competent bodies in hydrocarbon exploration and exploitation activities, 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) organizes the energy market based on the rules defined by HERA. It also collects fees for promotion of renewable energy sources and cogeneration from suppliers and then forwards them to renewable energy producers with appropriate certificates of origin.

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

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 of end customers or by payments to the EPEEF.

2.3. Consultation and participation of national and EU entities and the outcome of consultation

2.3.1. Participation of the Parliament

Participation of the Parliament is expected upon introducing the final Draft of the Integrated Energy and Climate Plan in the Parliament for enactment. It is expected that the Draft will be discussed by the working bodies of the Parliament and submitted for enactment.

2.3.2. Participation of local and regional bodies

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, at events organized within the public presentation of the Green 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 through e-counseling. The next round of workshops will be organized after the completion of all parts of the Draft of the Plan, in the first quarter of 2019.

2.3.3. Consultation with stakeholders, including social partners, and inclusion of civil society

The stakeholders 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, at events organized within the public presentation of the Green 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, at consultative workshops held within the framework of preparation of the Draft of the Plan and through e-counseling. The next round of workshops will be organized after the completion of all parts of the Draft of the Plan, in the first quarter of 2019.

2.3.4. Consultations with other member states

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 text of the Draft of the Integrated Energy and Climate Plan will be translated into English, submitted to the European Commission and published on the website of the Ministry of the Environment and Energy. It will be further amended according to possible additions and modifications in the Croatian version of the text.

2.3.5. Iterative procedure with the European Commission

Representatives of the Ministry of the Environment and Energy 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 text of the Integrated Energy and Climate Plan will be submitted to the European Commission by 31st December 2018, after which the text will be amended in parts related to the evaluation of impact of measures and for the dimension of research, innovation and competitiveness.

The full draft will be subsequently submitted to the European Commission and amended as needed in accordance with possible comments from the European Commission.

2.4. Regional cooperation on preparation of the plan

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

Not applicable.

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

Regional cooperation is covered through consultation with other member states.

3. NATIONAL TARGETS

3.1. Dimension: decarbonization

3.1.1. Emissions and elimination of greenhouse gases

The European Union ratified the Paris Agreement and committed itself to reducing GHG 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 parts, of which the first includes large sources of GHG emissions that are obligated parties of the European Emissions Trading System (ETS sector), and the second so-called non-ETS sectors, including other relatively lower 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, land use, land use change and forestry (LULUCF).

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) 2018/140 (the goal for the Republic of Croatia is indicative, it is binding on the EU ETS system level). For non-ETS sectors, a common goal 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).

The Republic of Croatia is in the process of reviewing the Forest Management Reference Level (FMRL), which includes recalculation of both historical emissions/removals and estimates. The review is needed because of a series of applied methodological improvements in estimating emissions/removals in activity of Forest Management. Taking into account the significance of this activity, GHG sinks in the LULUCF sector will be processed at a later date.

- If applicable, other national targets in line with the existing long-term low emission strategies. If applicable, other targets, including sectoral targets

Not applicable

3.1.2. Renewable energy

Analytical backgrounds for the preparation of the Energy Development Strategy of the Republic of Croatia set targets for renewable energy sources in the total direct energy consumption for both considered scenarios - Scenario 1 and Scenario 2. In the period until 2030, the two scenarios differ slightly in terms of the expected share of RES, although the ways of achieving the stated targets are different when absolute energy values are compared by types and sectors. Indicative targets by 2030 are shown in the following table.

Table 3-1. Indicative national targets for RES shares by 2030

RES share, %	2020	2030
In gross final consumption	28,3	36,4
In electricity consumption	46,7	63,8
In heating and cooling	33,7	35,3
In transport	1,3	13,2

The figure below shows the trajectories (shares) for all four targets (total RES, RES electricity, RES heating and cooling and RES transport).

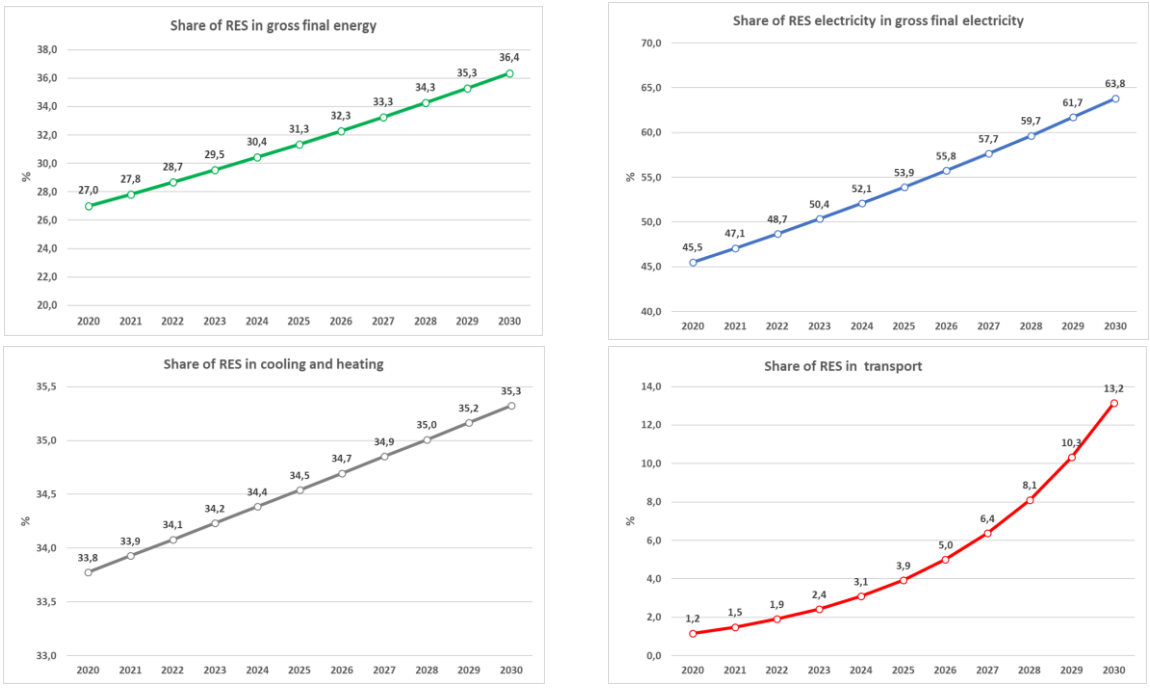

Figure 3-1. Indicative trajectories for targets of RES shares

Evaluated contributions of technologies for production of energy from RES are shown in Figure 3-2.., and Tables 3-2. to 3-5..

Table 3-2. Evaluated contribution of technologies for RES - Scenario 2

kten	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ukupna neposredna OIE potrošnja energije	**1950.0**	**2021.7**	**2093.5**	**2165.2**	**2237.0**	**2308.7**	**2380.4**	**2452.2**	**2523.9**	**2595.6**	**2667.38**
Sunce	**20.3**	21.5	22.8	24.0	25.2	26.4	27.7	28.9	30.1	31.3	**32.55**
Kruta biomasa	**1155.0**	1152.5	1150.0	1147.5	1145.0	1142.5	1140.0	1137.5	1135.0	1132.5	**1129.99**
Plinovita biogoriva	**0.0**	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	**0.98**
Tekuća biogoriva	**2.0**	26.6	51.2	75.9	100.5	125.1	149.8	174.4	199.1	223.7	**248.34**
Geotermalna	**9.8**	12.5	15.1	17.7	20.4	23.0	25.6	28.3	30.9	33.5	**36.18**
Toplina OIE	**30.5**	37.1	43.7	50.3	56.9	63.5	70.1	76.7	83.3	89.9	**96.52**
Električna OIE	**732.3**	771.4	810.4	849.5	888.5	927.6	966.6	1005.7	1044.7	1083.8	**1122.82**

Table 3-3. Evaluated contribution of technologies for RES electricity - Scenario 2

kten	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ukupna neposredna OIE električna energija	755.9	792.6	829.2	865.9	902.6	939.3	976.0	1012.7	1049.4	1086.1	1122.82
Hidroelektrane	566.2	571.0	575.8	580.6	585.5	590.3	595.1	599.9	604.7	609.5	614.28
Vjetroelektrane	148.1	163.8	179.5	195.2	210.9	226.6	242.3	258.0	273.7	289.4	305.14
Sunčane elektrane PV	11.5	19.1	26.6	34.2	41.8	49.3	56.9	64.4	72.0	79.6	87.13
Geotermalne elektrane	6.5	7.0	7.4	7.9	8.3	8.8	9.2	9.7	10.2	10.6	11.07
Termo postrojenja - kruta i plinovita biomasa	23.5	31.7	39.8	48.0	56.2	64.4	72.5	80.7	88.9	97.0	105.20

Table 3-4. Evaluated contribution of technologies for RES heating and cooling - Scenario 2

kten	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ukupna neposredna potrošnja OIE za grijanje i hlađenje	1215.7	1223.7	1231.6	1239.6	1247.5	1255.5	1263.4	1271.4	1279.3	1287.3	1295.24
Sunce	20.3	21.5	22.8	24.0	25.2	26.4	27.7	28.9	30.1	31.3	32.55
Kruta biomasa	1155.0	1152.5	1150.0	1147.5	1145.0	1142.5	1140.0	1137.5	1135.0	1132.5	1129.99
Geotermalna	9.8	12.5	15.1	17.7	20.4	23.0	25.6	28.3	30.9	33.5	36.18
Toplina OIE	30.5	37.1	43.7	50.3	56.9	63.5	70.1	76.7	83.3	89.9	96.52

Table 3-5. Evaluated contribution of technologies for RES transport - Scenario 2

kten	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ukupna neposredna potrošnja OIE u prometu	17.6	43.1	68.6	94.1	119.6	145.1	170.6	196.1	221.6	247.1	272.63
Biogoriva	2.0	26.7	51.4	76.2	100.9	125.6	150.4	175.1	199.9	224.6	249.33
Električna - OIE	15.7	16.5	17.2	18.0	18.7	19.5	20.3	21.0	21.8	22.5	23.31

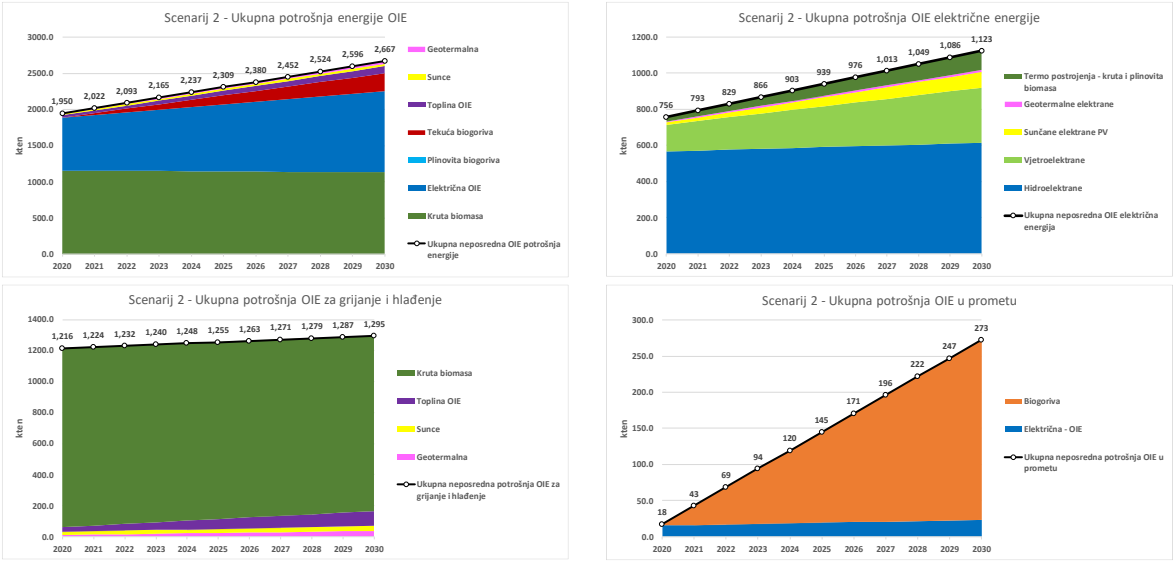

Figure 3-2. Evaluated contributions of RES technologies by sectors

Expected power of power plants for electricity generation is shown in Table 3-6. and Figure 3-3.

Table 3-6. Projected capacity of power plants

MW	Hydro	Gas	Fuel oil	Coal	Nuclear	Biomass	Geothermal	Wind	Sun	Total
2020	2125	799	501	192	348	154	10	734	72	4934
2021	2125	799	501	192	348	171	10	759	95	4999
2022	2125	799	501	192	348	170	10	784	117	5045
2023	2125	1099	501	192	348	166	10	809	140	5389
2024	2158	1099	501	192	348	161	10	834	162	5465
2025	2158	1099	501	192	348	156	17	859	185	5514
2026	2536	1049	303	192	348	156	17	897	222	5719

2027	2536	1049	303	192	348	155	17	934	260	5793
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

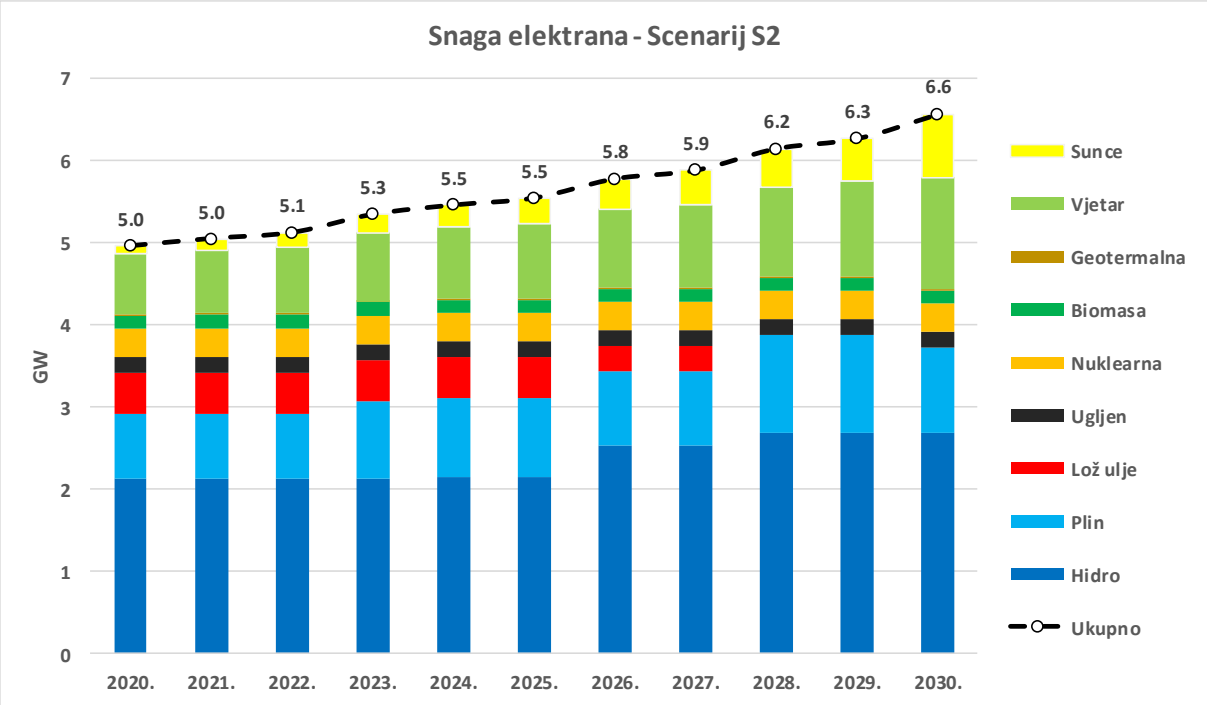

Figure 3-3. Projected capacity of power plants

3.2. Dimension: energy efficiency

i. Elements referred to in Article 4 (b)

*Indicative national energy efficiency target **by 2020** according to Article 3 of Directive 2012/27/EU*

National energy efficiency targets by 2020 are defined in the 3rd NEEAP for the period 2014-2016 and revised in the Draft of the 4th NEEAP for the period 2017-2019. The indicative national energy efficiency target 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 3-4.

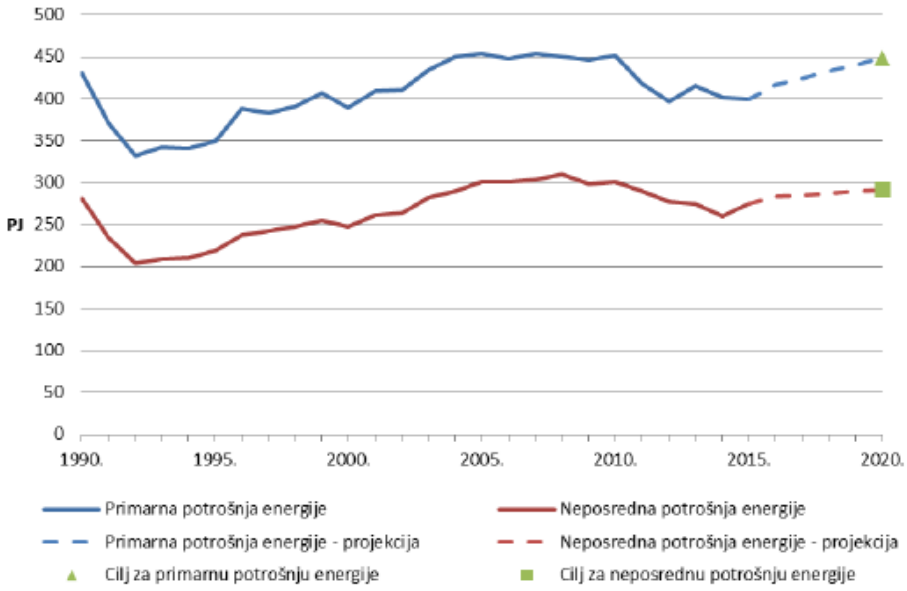

Figure 3-4. Indicative national energy efficiency targets in 2020

Source: Draft of the 4th NEEAP

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

National energy efficiency targets by 2030 shown in Table 3-7.

Table 3-7: Indicative national energy efficiency targets in 2030

Targets 2030	PJ	Mtoe
Primary consumption	367.76	8.78
Direct consumption	286.91	6.85

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

Figure 3-5 shows expected energy consumption trends for each year in the period from 2020 to 2030.

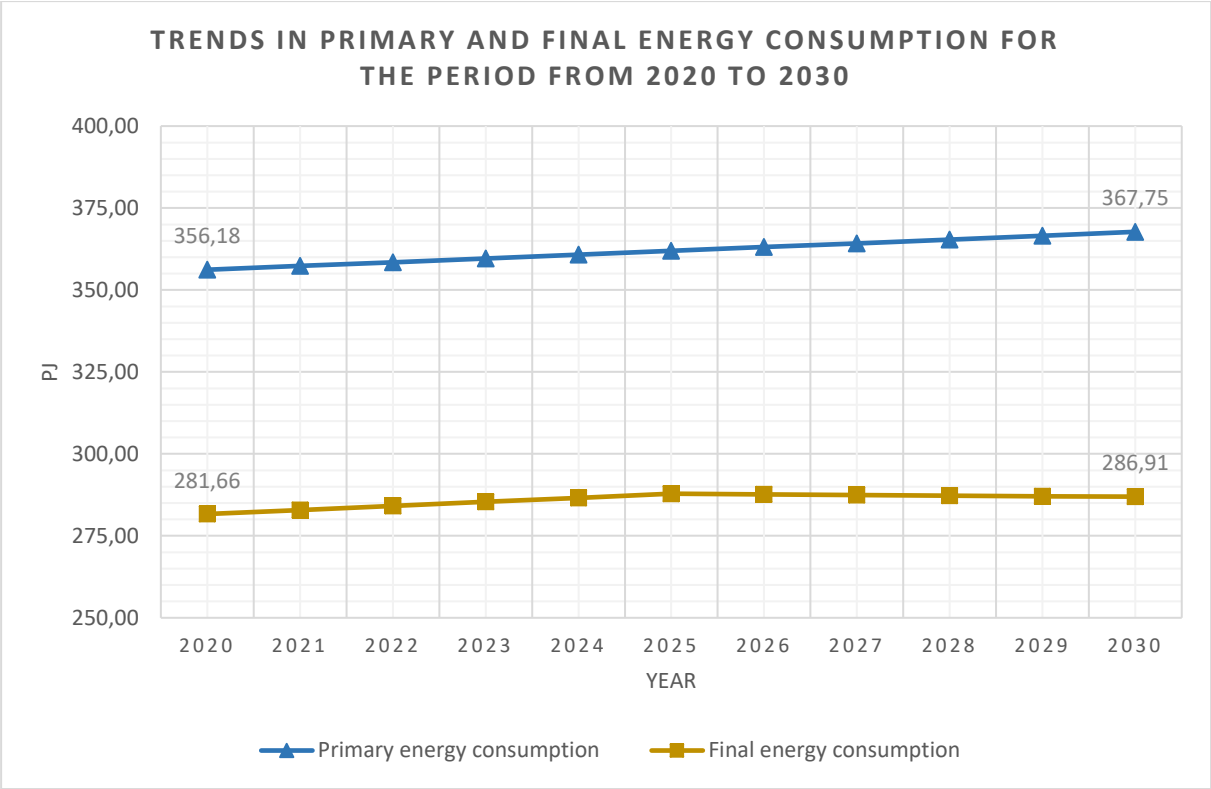

Figure 3-5. Energy consumption trends in the period from 2020 to 2030

Final energy consumption projections for all forms of energy (e.g. fossil fuels, biomass, solar energy, electricity, etc.) were made using a bottom-up approach that allows for the analysis of structural changes on the energy use side in different sectors (eg. industry, household, service sector, transport). Final energy efficiency measures are important for the achievement of climate change mitigation goals. The Model for Analysis of Energy Demand (MAED) was used to analyse the final energy consumption.

The final energy consumption scenarios consider the necessary reduction of greenhouse gas emissions by 2030/2050 year, in all energy consuming sectors, as well as feedback of expected climate change on the ways and dynamics of consumption of various forms of energy (e.g. changes in seasonal mode of energy use, changes in heating and cooling requirements etc.). Energy consumption and driving parameters (e.g. number and structure of population, structure of GDP, etc.) were analyzed for two geographical and climate zones of Croatia - Continental Croatia and Adriatic Croatia (also official statistical regions).

For each of the selected scenarios, based on the availability of local resources and sources of primary forms of energy, the possibilities of meeting the needs for all forms of energy (e.g. thermal, electrical, natural gas, biomass, etc.) have been analysed. For networked systems (e.g. electricity, natural gas), the analysis and optimization of the operation and development of the production, transmission/transport and distribution system to the final beneficiaries under the principle of minimum cost was carried out, and taking into account the environmental impacts (including greenhouse gas emissions), strategic determinants in the area of energy security and the impact of participation in the functioning of the regional market (possible

cooperation in exploiting regional energy potential and sharing of infrastructure). The availability and condition of the existing energy infrastructure, the replacement of elements and the construction of new elements of the system (e.g. power plants, power lines, pipelines, etc.) were also considered.

The MESSAGE model for the optimization of the power system and centralized heat systems (in the part of heat production) was used, as well as the PLEXOS model for analysing / confirming the feasibility of the operation of the electric power system at the hourly level in selected characteristic years.

Conversion factors are shown in Table 3-8.

Table 3-8: Conversion factors

		Net Calorific Values	
	Unit	MJ	kgoe
Hard Coal	kg	24,28-29,31	0,580-0,700
Coking Coal	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 Oven Coke	kg	26,38-29,31	0,630-0,700
Fuel Wood	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 Petroleum Gases	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
Light Heating Oil	kg	42,71	1,020
Diesel Oil	kg	42,71	1,020
Fuel Oil	kg	40,19	0,960
Petroleum Coke	kg	31,0	0,740
Other Products	kg	33,49-40,19	0,800-0,960
Refinery Gas	kg	48,57	1,160
Ethane	kg	47,31	1,130
Coke Oven Gas	m^3	17,91	0,428
Gas Works Gas	m^3	27,76	0,663
Blast Furnace Gas	m^3	3,60	0,086
Electricity	kWh	3,60	0,086

Cumulative energy savings in the period 2021-2030 in accordance with Article 7 (1) (b) on the energy efficiency obligation scheme of amended Directive 2012/27/EU [as proposed by COM(2016)761)

The target for cumulative savings in the period from 2021 to 2030 is shown inTable 3-9. **It should be noted that this target is indicative and will be modified during 2019 in line with the final text of the amended Directive 2012/27/EU, final amendments to the Energy Efficiency Act and new data on energy consumption and achieved savings at least for 2017.** The said target of cumulative savings in the amount of **1,243.99 kten (52.08 PJ)** is calculated with the assumed maximum allowable target reduction of 35%, in accordance with Article 7 (3a), point (b) of the Energy Efficiency Directive.

Table 3-9: Indicative national energy efficiency targets in 2030

Targets 2030	Annual savings		Cumulative savings	
	PJ	kten	PJ	kten
According to Article 7 (1) (b)	1.46	34.80	80.13	1,913.83
With exemptions according to Articles 7 (2), (3) and (3a)	0.95	22.62	52.08	1,243.99

Indicative targets of the long-term strategy for 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 investments in the renovation of the national building stock in 2014 (OG No. 74/2014), and revised it in 2017 [16]. The building stock and the possibilities for its renovation have also been analysed in the document "Analyses and basis 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 management of buildings are presented below, which should be implemented in order to achieve the national energy efficiency targets shown in Table 3-7.

After 2020, according to the Energy Performance in Buildings Directive/Building Act, all newly-built buildings will be nearly-zero energy (nZEB) with a tendency for expansion of the obligation to achieve the nZEB energy consumption standard in the near future, with the final consumption of approximately 34 kWh/m²a. It is expected that the growth of the total residential stock will be at an average rate of approximately 6600 residential units from 2021 to 2030, 6300 from 2031 to 2040 and 6050 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%.

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 m^2 of useful heated area of public sector buildings was recorded in the Republic of Croatia in 2010, according to data from the National Energy Management Information System. 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 0.005523 PJ per year[1]in equivalent savings. This approach will also be applied in the period until 2030.

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

Not applicable.

3.3. Dimension: energy security

- National targets for strengthening the diversification of energy sources and supply from third countries, storage and response to demand;

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. It is necessary to diversify delivery routes and increase gas storage capacity.

[1] Source: Draft of the 4th National Energy Efficiency Action Plan for the period 2017 - 2019, Ministry of the Environment and Energy, November 2017

Energy storage in the power system will contribute to its flexibility. In the forthcoming period, the construction of a pumped-storage hydroelectric power plant is expected, which will enable greater integration of variable renewable energy sources, primarily sun and wind.

It is necessary to enable demand response and participation of end customers with own production on the electricity market.

- If applicable, national targets for reducing dependence on energy imported from third countries

In order to reduce energy imports from third countries, potential hydrocarbon deposits in Slavonia and the Dinarides and gas deposits in the Southern Adriatic should be explored.

- National targets regarding the readiness to deal with limited supply or supply disruption from a particular energy source (including gas and electricity) and, if applicable, the timeframe for achieving these targets

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

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, 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) No. 1938/2017 establishes the obligation of competent institutions to prepare:

- preventive action plans with measures to eliminate and mitigate the identified risks and
- 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) No. 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) No. 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 78/2014), 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 65/2015).

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

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 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.

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 57/2018), the Croatian Energy Regulatory Agency 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.

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 19/2014, 73/2017). 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 111/2012). 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 purpose of timely assessment of possible risks related to supply security. Further, article 1 of the Oil and Petroleum Products Market Act stipulating rules and activities for safe and reliable oil and petroleum products transport and storage prosribes a continuous maintenance and investment into transport and storage security. It is also necessary to further develop the methodology and tools for assessing the supply security.

- If applicable, national targets for the development of national domestic energy sources

The total energy consumption by 2050 is decreasing by 14% compared to the baseline year. Own energy supply capacity first increases to 56% in 2030, stagnates until 2040 and then decreases towards the end of the period.

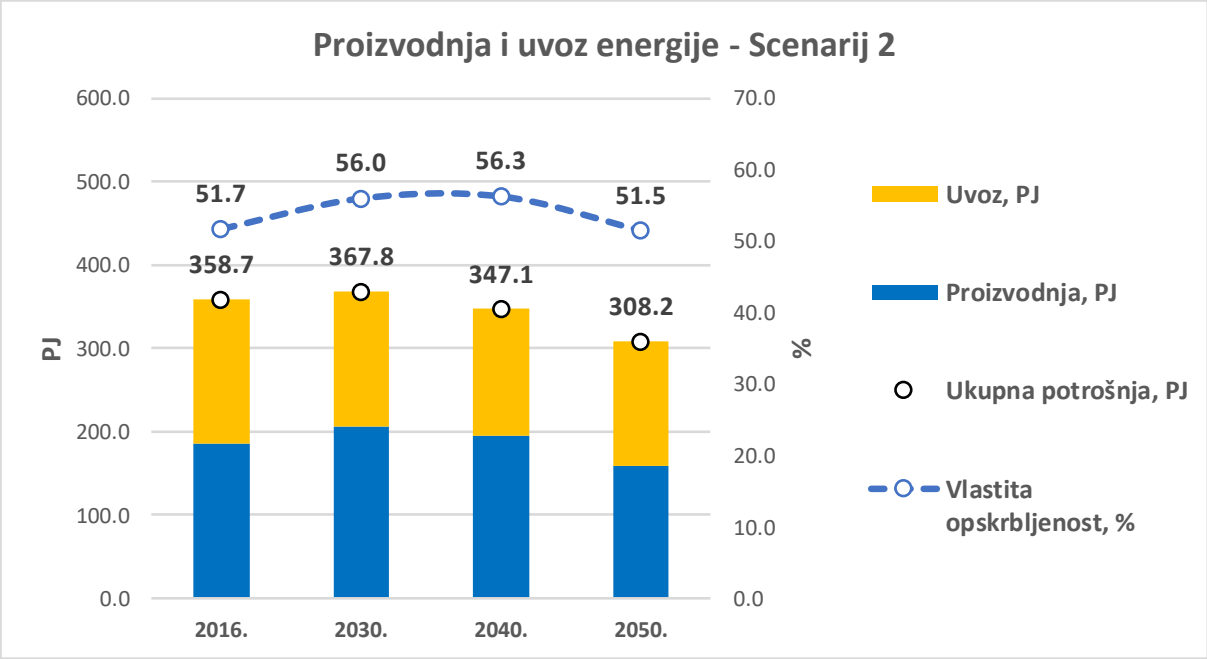

Figure 3-6. Own energy supply capacity

A strong increase in the share of variable RES (wind farms and solar plants) is expected, and in the period until 2030, 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, open cycle 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 network elements and developing advanced network systems and system management.

The analyses performed so far suggest that up to the integration level of 800 MW, major interventions in the transmission network in terms of construction of new lines and substations will not be required (for higher levels of integration, HOPS plans to apply the principle of "zone connection"), but the requirements for 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 deposits.

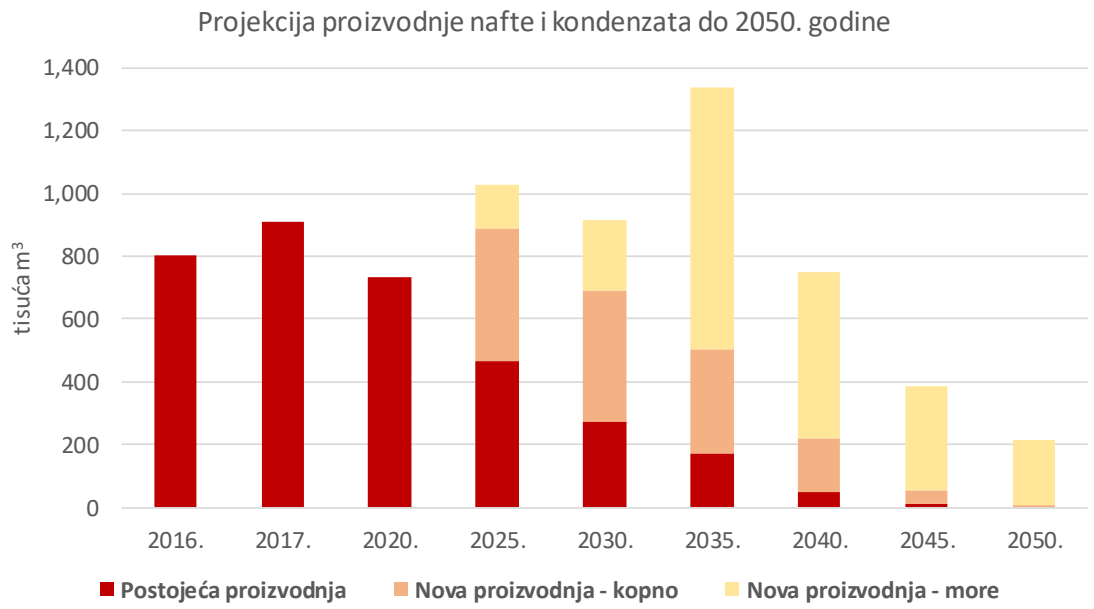

Figure 3-7. Oil and condensate production estimate by 2050

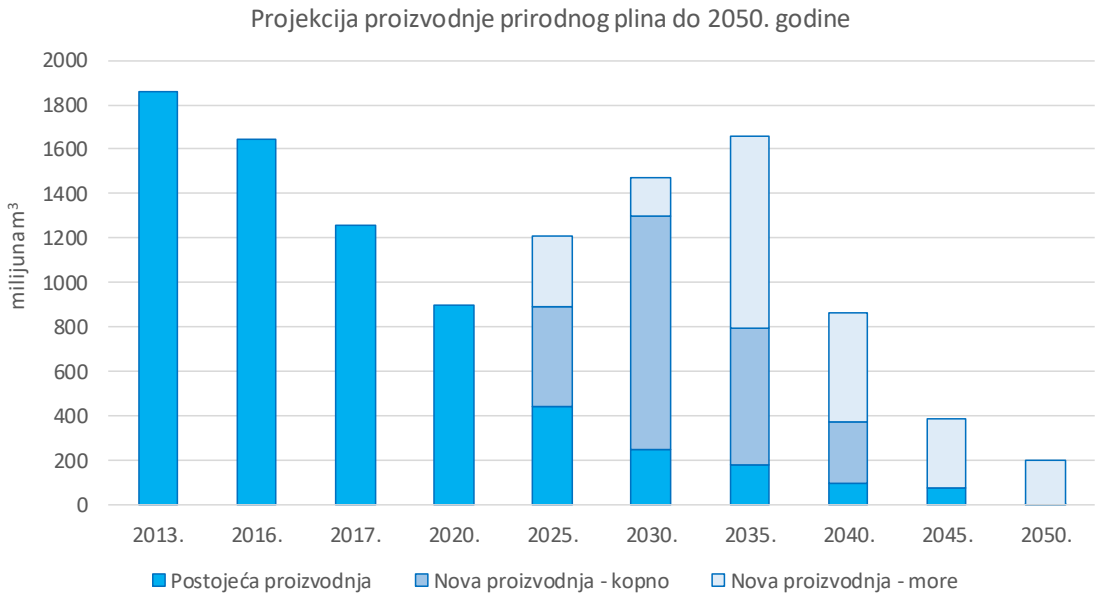

Figure 3-8. Natural gas production estimate by 2050

Power sector

In accordance with Article 32 of the Electricity Market Act, the transmission system operator is obliged to publish the annual report on security of supply in the transmission system for the previous year on the basis of which the Ministry prepares its own annual report on the security of electricity supply and expected electricity demand in the Republic of Croatia. Pursuant to Article 29, paragraph 22 of the Electricity Market Act, the transmission system operator is particularly responsible for submitting a reasoned proposal to the competent ministry on the

need for construction of new facilities for electricity production for the purpose of ensuring security of supply. In addition to intensive construction of renewable energy sources, specific electricity market conditions of a relatively low average wholesale price, and the termination of operation of a number of conventional power plants in the Republic of Croatia due to high production costs, failures and ecological constraints, the aspect of self-sufficiency of production facilities in Croatia changed significantly in a very short period of time, in the last few years.

As the power sector in Europe is organized in a market-driven way, the issue of self-sufficiency of production capacity boils down to the self-sufficiency of the system as a whole (can the power system receive sufficient quantities of electricity corresponding to the quantities that exit the system). In the market environment, power plants in the territory of the Republic of Croatia also operate on market principles, which is the most important cause of reduced availability of thermal power plants owned by HEP-Proizvodnja. Of around 1,900 MW of installed power in thermal power plants in the territory of the Republic of Croatia, around half of this power was inoperational at the end of 2017, which is likely to continue in the years to come.

In addition to the high unavailability of TPP that will likely not decrease significantly in the next five years, the production capacity of domestic power plants is traditionally greatly affected by the hydrological situation in the observed year when domestic hydro power plants are able to produce between approx. 4.6 TWh and 8.1 TWh of electricity, and the lack of construction of new conventional power plants. Power plants using RES are the only types of new generation plants that have been built in Croatia for the last few years, showing that their total production of around 1.5 TWh per year (without large HEPP) cannot and will not in the near future be able to significantly reduce the dependence of the Croatian power system on the import of electricity.

The actual responsibility for supplying the power system of the Republic of Croatia, that is, securing sufficient quantities of electricity, lies with several entities, namely:

- Suppliers who are obliged to settle their contractual obligations to customers, in particular HEP-Supply as the largest commercial supplier and HEP Elektra as the universal and guaranteed supplier,
- HEP-ODS for the procurement of electricity needed to cover losses in the distribution network,
- HOPS for the procurement of electricity needed to cover losses in the transmission network 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 network availability, i.e. particularly the interconnection lines, and to maintain/increase the NTC 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 NTC can be used by all market participants, not just those who import energy into the Croatian power 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 power 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 €/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.).

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

- creating a favorable 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 and increase the competitiveness of power stations located in the country,
- construction of different types of power plants with respect to the characteristics of the system as a whole (basic, regulation-peak, other), for the purpose 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 type of primary energy source used, in order to avoid major disruptions in customer supply during periods of unavailability of particular primary energy sources,
- maintaining high availability of the transmission network and cross-border lines in order to secure electricity imports from the market for economic or security reasons,
- maintaining high possibility of cross-border exchanges (further increase of NTC value at all borders) for the reason mentioned above,
- timely implementation of investment plans of the transmission and distribution system operators with regulatory supervision, in order to avoid disruptions in customer supply during network failures,
- implementation of energy efficiency measures to reduce electricity consumption, in order to reduce electricity demand, and
- construction of distributed power sources with a low-voltage connection near the point of consumption in order to further increase the power generation capacity in the territory of the state and relieve stress on grids.

3.4. Dimension: the internal energy market

3.4.1. Electricity interconnection

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 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.

With regard to further increase of cross-border capacity by 2030, no specific requirements are set.

With regard to further enhancement of the possibilities of existing cross-border exchanges, the aim is to continuously increase the NTC value at the borders by eliminating congestion/ limitations primarily in the internal network.

3.4.2. Energy transmission infrastructure

Key national targets for the power transmission infrastructure

In the process of preparation of backgrounds for the new energy strategy of the Republic of Croatia, a preliminary assessment of the necessary investments in the transmission network (including the connections of new conventional power plants, wind farms and solar power plants, and various other costs identified in the ten-year transmission network development plan 2018-2027) has been performed in the amount of HRK 7.9 to 8.2 billion (with equal annual investments, this would mean an investment cost of HRK 666 to 686 million per year). The

funds needed for the development/revitalization of the transmission network would be secured by investors in the construction of new power plants and through the electricity transmission fee.

In addition to the financial resources necessary to cover the costs of the construction of the transmission network, 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 - 425 million per year, and the funds needed for redispatching production facilities to eliminate periodic restrictions in the transmission network.

The main objectives for the electricity transmission infrastructure are as follows:

- 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 network units,
- increasing the transmission capacity of individual lines planned for revitalization by using HTLS conductors, and reducing losses in the transmission of electricity,
- application of new technologies in transmission, if they are technically and economically justified.

Key national 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, and pursuant to the Energy Development Strategy.

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 as follows:

- gas pipelines for the transport of natural gas and biogas 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 liquefied natural gas (LNG) and compressed natural gas (CNG);
- all equipment important for protected, secure and efficient operation of the system or enabling a two-way interconnection, including compressor stations.

In accordance with Regulation (EU) No. 347/2013, a list of projects of common interest of the Union is defined every two years. A new list of projects of common interest, as set out in Annex VII to Regulation (EU) No. 347/2013 of 23rd November 2017, includes the following groups of projects of common interest in the territory of the Republic of Croatia (Table 3-10).

Table 3-10 Projects of common interest in the territory of the Republic of Croatia

6.5.	Cluster Krk: LNG terminal with connecting and evacuation gas pipelines to Hungary and beyond, including the following projects of common interest: 6.5.1. Development of the LNG terminal on Krk (HR) up to 2.6 bcm/a – Phase I and the connecting gas pipeline Omišalj-Zlobin (HR) 6.5.5. Compressor station 1 in the Croatian gas transmission system 6.5.6. Expansion of the LNG terminal on Krk above 2.6 bcm/a – Phase II and the evacuation gas pipelines Zlobin - Bosiljevo - Sisak - Kozarac - Slobodnica (HR)
6.26.	6.26.1. Cluster Croatia - Slovenia - Austria in Rogatec, including: - interconnection Croatia - Slovenia (Lučko - Zabok - Rogatec) - compressor stations 2 and 3 in the Croatian gas transmission system - upgrade of Rogatec interconnection

3.4.3. Market integration

- If applicable, the national goals associated with other aspects of the internal energy market, such as market integration and coupling, including the time frame for achieving the goals

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 Southeast 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. In 2019, the second phase of the expansion of the XBID intraday market 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. The borders that will take part in the second phase will be confirmed in the spring of 2019. Croatian institutions participate and support processes within the Energy Community related to the connection of markets in the WB6 countries. The project of connecting day-ahead markets in the WB6 countries is expected to result in complete integration of markets in the region by 2025.

- If applicable, the national goals with regard to ensuring the adequacy of the power system, as well as the flexibility of the power system with respect to production of renewable energy, including the time frame for achieving the goals

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 renewable energy sources 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. The goals have been specified in Chapter 3.3.

Active participation of end customers in providing services to system operators will also contribute to the flexibility of the power system.

By establishing the ECO balance group, HROTE will be obliged to cover the balancing energy costs to the transmission system operator due to the divergences of the hourly EE production plans from the realized hourly deliveries of the EE ECO balance group. According to the provisions of the Act on RES and HEC, HROTE 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 renewable energy sources 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 Croatian Energy Regulatory Agency.

The full establishment of the ECO balance group planned for 1st January 2017 was postponed by the Regulation on amendments to the Act on Renewable Energy Sources and Highly Efficient Cogeneration (OG 123/2016) and Regulation on amendments to the Act on Renewable Energy Sources and Highly Efficient Cogeneration (OG 131/2017) until 1st January 2019 at the latest. From this date onward, HROTE will plan the production of electricity for the ECO balance group and sell electricity from the ECO balance group on the market. When the ECO balance group starts operating, electricity suppliers will no longer be required to off-take a share of electricity, which HROTE purchases from eligible producers. Electricity will be sold in a transparent and impartial manner in accordance with the Sale of Electricity Rules issued by HROTE with the prior opinion of the Croatian Energy Regulatory Agency and prior consent of the Ministry of the Environment and Energy.

- If applicable, the national goals for the protection of energy consumers and improvement of competitiveness on the retail market of the power 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 favorable electricity supplier.

The Croatian goals with regard to improving competitiveness in the retail electricity market are as follows:

- activating and aggregating end customers,
- offering a wider selection of suppliers (increasing the HHI for measuring points from the household and entrepreneurship categories),
- a simplified supplier switch procedure.

3.4.4. Energy poverty

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

Before the start of the implementation of the Integrated Energy and Climate Plan, the Programme for Elimination of Energy Poverty will be prepared and capacity building to eliminate energy poverty will start, in accordance with the 4th National Energy Efficiency Action Plan for the period from 2017 to 2019.

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,
- 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 the above mentioned 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 envisaged in the Draft of the 4th National Energy Efficiency Action Plan for the period 2017 - 2019.

3.5. Dimension: research, innovation and competitiveness

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

In order to achieve the goals set in the Energy and Low-Carbon Strategy, it is necessary to support innovation and patents in the field of clean energy and low-carbon technologies in order to reduce production costs, increase added value, and make production as competitive as possible in terms of achieved level of technology. Therefore, the fundamental national goal is to adapt the existing infrastructure and legislative framework to additional needs for research and development in the area of energy and climate, in accordance with the goals set out in the Draft of the Low-Carbon Strategy and the Green Paper. Research and development should focus on the following areas:

- 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 CO_2,
- 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 aimed at improving the education system, smart specialization and lifelong education as part of the response to the challenge of mitigating climate change,
- research of financing models, in particular the possibilities of models of public-private partnerships,

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.

As in the previous period, the main source of funding will continue to be ESI funds and funds collected through the auction of CO_2 emission allowances managed by the Environmental Protection and Energy Efficiency Fund (EPEEF). In addition, ETS funds intended for modernization will be available.

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. Also, the revised EU ETS Directive establishes a financial mechanism of support to innovation for the period 2021-2030, in the ten EU Member States whose GDP per capita at market prices was below 60% of the EU average, including the Republic of Croatia.

3.5.2. National goals by 2050 relating to the promotion of clean energy technologies and development of low carbon technologies, including targets for the decarbonization of energy and carbon intensive industrial sectors and industrial sectors with a high carbon share and, where applicable, for carbon storage and transport infrastructure

In November 2018, the Analyses and Basis for the Preparation of the Energy Strategy of the Republic of Croatia until 2030 with an outlook to 2050 were presented. The following trends have been recognized as key determinants of changes in the energy sector:

- increasing energy efficiency in all parts of the energy chain (generation, transport/ transmission, distribution and consumption of all forms of energy);
- switching as many activities as possible to the use of electricity (where technologically feasible and long-term cost-effective);
- production of electricity with reduced greenhouse gas emissions (renewable energy sources, nuclear option, fossil fuels with lower specific emission and fossil technologies with CO_2 capture and storage).

Increasing energy efficiency is strongly present. The strongest impact is expected in construction of buildings and transport.

In the construction of buildings, a continuation of good practices of energy efficient residential and non-residential buildings is expected, targeting renovation according to the nZEB

standard, which also implies a greater utilization of renewable energy sources (photovoltaic systems, solar thermal collectors, biomass boilers, heat pumps). To achieve the goals in the construction of buildings, extensive use of financial mechanisms is envisaged, which includes both grants and financial instruments that will enable private capital mobilization (ESCO model, commercial banks). Thus, it is necessary to timely plan these funds for the next financial period of use of the ESI funds in the period 2021-2027, as well as to plan the use of available funds of the EPEEF, in order to optimize the allocation of available financial resources from this two sources. The use of both financial and fiscal mechanisms is also envisaged for achieving the goals in transport and industry, where it is necessary to determine the possibilities of using the tax (fiscal) system to encourage systematic energy management.

The greatest opportunities for the Croatian industry lie in:

- energy renovation of buildings,
- production of equipment for the use of renewable energy sources,
- production of biomass and biogas,
- construction of facilities using renewable energy sources,
- manufacturing of components for advanced energy systems and energy storage,
- development of production capacity for electric vehicles,
- development of sustainable transport infrastructure,
- manufacturing of vessels and non-road vehicles,
- development of infrastructure for transport and storage of CO_2 and
- digital transformation of the said industries and processes.

3.5.3. National goals regarding competitiveness

Goals with regard to competitiveness in the area of energy and climate relate to the increase in clean energy and low-carbon technological innovations that would lead to economic growth, increased exports and employment, and ultimately productivity gains.

4. POLICIES AND MEASURES

4.1. Dimension: decarbonization

4.1.1. Emissions and elimination of greenhouse gases

- Policies and measures to achieve the target defined in Regulation [ESR] as specified in section 2.1.1. and policies and measures in line with Regulation [LULUCF], covering all key sectors generating high emissions and sectors for strengthening elimination of emission, for the purpose of achieving a low-emissions economy within the framework of a long-term vision and a long-term target with a 50-year perspective and achieving a balance between emissions and their elimination in accordance with the Paris Agreement.

Measures are specified for the following sectors significant for GHG 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

Pursuant to the Air Protection Act (OG 130/11, 47/14, 61/17), 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 114/14). 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. Representatives of competent state administration bodies and other relevant institutions, agencies and non-governmental organizations 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. The Committee consists of the Coordination Group and the Technical Working Group.

MS-2: Promoting the use of innovative information and communication technologies (ICTs) to reduce GHG emissions

Innovative information and communication technologies play an increasingly important role in reducing GHG 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 GHG 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 GHG emissions.

MS-3: The EU emissions trading system

The EU emissions trading system (EU ETS) includes all the activities listed in Annex I to the Regulation on trading with GHG emission allowances (OG 69/12, 154/14), and operators of

facilities included in the system are responsible for reducing GHG emissions. Through an allocation of emission allowances, 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 in the Republic of Croatia, in accordance with the EU ETS rules, have received GHG emissions permits and established a regime for monitoring emissions and reporting to the competent authority. The GHGs covered by the EU ETS are: carbon dioxide (CO_2) for all activities and additionally for specific activities, nitrous oxide (N_2O) 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 GHG emissions have the option of purchasing emission allowances through auctions or on the secondary ETS market.

MS-4: Use of funds acquired from the sale of emission allowances through auctioning within the EU ETS for measures to reduce GHG emissions

Of the total number of allowances allocated for distribution to operators and aircraft operators, for each year of the trading period, a share of them is distributed free of charge. The remainder is distributed to EU Member States and is subject to public auctions. The Air Protection Act (OG 130/11, 47/14, 61/17) stipulates that the Republic of Croatia uses for climate-related purposes 95% of the received funds paid to a special account to the Environmental Protection and Energy Efficiency Fund and 5 % of the funds is directed to the state budget of the Republic of Croatia. Funds to be paid to a special account of the Environmental Protection and Energy Efficiency Fund should be dedicated for the implementation of measures of mitigation of and adaptation to climate change. Funds to be paid into the state budget should be used to cover the costs of managing the emissions trading system, for administrative tasks, for the functioning of the Registry of the Union, for auctioneers, for the National GHG Emissions Monitoring System and other issues related to climate change. The plan for the use of funds acquired through the sale of emission allowances through auctions in the Republic of Croatia for the period 2014-2016 was adopted by the Government of the Republic of Croatia (OG 140/14, OG 12/17). The total realized revenues for the period from 2014 to 2016 amount to HRK 733,984,921.23 and were used for renewable energy sources, energy efficiency, transport, waste management and research, development and professional support. The plan for using the funds from auctions for the period until 2020 was adopted in February 2018 and it is expected that HRK 825,000,000.00 will be raised. These funds will be used for measures to mitigate and adapt to climate change.

MS-5: The CO_2 emission tax for the non-ETS stationary sources

The Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks for determining the charge for emissions of carbon dioxide into the environment (OG 73/07, 48/09, 2/18) stipulates the obligation to pay the CO_2 emission tax for all stationary sources

emitting more than 30 tons of CO_2 per year for the period 2007-2016 and more than 450 tons of CO_2 per year until 1st January 2017. The obligated parties investing in energy efficiency, renewable energy and other measures to reduce GHG emissions pay a lower tax. The Environmental Protection and Energy Efficiency Fund is authorized for accounting and collecting charges. The Law on Amendments to the Law on Environmental Protection and Energy Efficiency Fund (OG 142/12) stipulates that from 1 January 2013, legal or natural persons who own or use a single source of CO_2 emissions, for which permits for GHG emissions have been obtained, do not have to pay fee. This means that from 2013 onwards measures apply only to sources that are not covered by the ETS.

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

The European Covenant of Mayors for Climate and Energy brings together thousands of local authorities who have voluntarily committed themselves to the implementation of the European Union's climate and energy goals. The Covenant of Mayors brings together more than 7,000 local and regional authorities in 57 countries and 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 GHG 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 70 cities and municipalities in the Republic of Croatia, and 62 Action Plans were submitted. The Covenant of Mayors thus encompasses over 2 million people in the Republic of Croatia.

MS-7: Implementation of an interdisciplinary research on the potential for CO_2 geological storage in the Republic of Croatia

The carbon capture and storage technology for large emission sources is not yet commercially available. The possibility of commercial application is expected in the period after 2020. 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 obtained a construction permit after the entry into force of Directive 2009/31/EC, it is necessary to evaluate whether the following conditions are met: a) available suitable locations for storage, b) transport facilities are technically and economically feasible and c) upgrade of the plant for CO_2 capture is technically and economically feasible. If these conditions are satisfied, the competent authority should provide adequate reserve area on the plant's location for equipment for capturing and compressing extracted CO_2. Due to described commitments for new thermal power plants, with this measure the preparation of National Feasibility Study with the action plan of the preparatory activities for CCS projects is planned. This Study will include stages of capturing on the sources of emissions, transport, injection and storage.

MS-8: Improving sustainability of urban areas

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 the preparation of urban development plans, which will, based on the evaluation of sustainability indicators, define development projects to improve the defined indicators. For these projects, co-financing will be provided from ESI funds 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 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.

The measures related to **industrial processes** are presented below.

IP-1: Reducing emissions of volatile organic compounds in solvent utilization sector

The 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) 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.

IP-2: Handling of substances that deplete the ozone layer and fluorinated greenhouse gases

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.

IP-3: Technical and organizational measures for collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases

This set of measures defines how the used controlled substances and fluorinated greenhouse gases contained in products and equipment must be collected, reused, recovered or destroyed.

IP-4: Capacity building and strengthening the knowledge of authorized repairers

Education of authorized repairers on collection and handling of controlled substances and fluorinated greenhouse gases during device and equipment servicing.

IP-5: Leakage detection of controlled substances and fluorinated greenhouse gases

Technical measures to prevent or eliminate leakage of controlled substances and fluorinated greenhouse gases.

IP-6: A fee to cover the costs of collection, reuse, recovery and destruction of controlled substances and fluorinated greenhouse gases

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

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

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 of at non-compliant landfills are defined. By the end of 2017, the maximum allowable mass of waste that can be disposed of at non-compliant landfills is 800,000 tons. Disposal of waste at non-compliant landfills in Croatia is prohibited after 31st December 2017.

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

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 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.

GO-3: Methane flaring

The Ordinance on the methods and conditions for waste disposal, categories and operational requirements for landfills (OG 114/15) and Ordinance on waste management (OG 23/14, 51/14, 121/15, 132/15) 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.

GO-4: Reducing the amount of disposed biodegradable municipal waste

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.

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

The measure is linked to the measure OIE-3: Promoting the use of renewable energy sources for production of electricity and thermal energy, within renewable energy sources and TR-5: Obligation to use renewable energy sources in transport. 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.

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

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

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.

POLJ-2: Anaerobic decomposition of manure and biogas production

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 litter 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_2O emissions in the nitrification process.

POLJ-3: Improving cattle facilities and systems of animal waste management

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.

POLJ-4: Improvement of mineral fertilizer application methods

Application of new slow-release fertilizers suitable for growing corn and wheat (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.

POLJ-5: Hydromeliorative interventions and systems of protection against natural disasters

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.

POLJ-6: Introduction of new cultivars, varieties and cultures

Encouraging development, education and implementation of technologies at a national and regional level, encouraging the transition and adaptation of the entire production chain to produce new crops or enabling and encouraging the implementation of cultivars and varieties that are more resistant to drought and disease and have a lower overall carbon footprint. This, among other benefits, is aimed at reducing the need for the introduction of nitrogen into the soil through fertilizers.

POLJ-7: Implementation of the rural development programme

One of the most significant areas of activity of EU institutions, both in terms of the scope of the acquis communautaire and in terms of share in the EU budget, is the Common Agricultural Policy (CAP). Rural development, as the second pillar of the CAP, is financed by the funds of the European Agricultural Fund for Rural Development (EAFRD). Upon completion of the implementation of the Rural Development Programme of the Republic of Croatia 2014-2020, it is expected that the programme will be concluded for the next period, within which priorities and measures of rural development will be elaborated.

POLJ-8: Capacity building of farmers

To encourage projects that contribute to the decarbonisation of agriculture, it is proposed to create several simple, easy-to-apply and highly reproducible business models for different types of agricultural production (animal husbandry, perennial crops, crop farming, vegetable farming, etc.), which at the same time allow for the creation of added value on the farm and reduction in greenhouse gas emissions. The business models will help farmers to recognize business opportunities and to comply with stipulated procedures and maximize the effect of decarbonisation. The business models will integrate energy efficiency measures, use of renewable energy sources, and creation of new biomass products for the needs of bioeconomy.

POLJ-9: Improvement of the regulatory framework for digestate

It is necessary to adjust the regulatory framework to improve management (covered digestate containers, pasteurization of digestate from biowaste, etc.) and use of digestates as fertilizers (taking into account the macro and micronutrients content), which contributes to the decarbonization of agriculture through greater use of organic fertilizers, increase of organic matter in the soil and reducing the costs of agro-input.

POLJ-10: Establishment of biomass collection and logistic centers

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 centers will be established using the existing infrastructure (utility companies, competence centers, 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 bioeconomy. Collection and logistic centers will link farmers who posses 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: Improving reporting in LULUCF sector

The countries of Annex I to the UNFCCC, including Croatia, are required, pursuant to Annex I to Decision 15/CP.17, to continuously review the quality of relevant technical elements of inventories of greenhouse gas emissions. Due to this obligation and provisions of Decision 529/2013/EU, which obliges countries to also prepare reports on emissions/sinks from activities Pasture Management and Agricultural Land Management, and to submit their final annual estimates for calculation by 15th March 2022, the implementation of this measure is still considered to be necessary. For the implementation of this measure, the Ministry of the Environment and Energy has defined specific projects whose implementation is envisaged in the period until 2020. The defined projects aim at 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 for 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. For each of the defined projects, the Ministry will determine funding methods and mechanisms depending on the funds available in each financial instrument in the period until 2020.

LUF-2: Preparation of cost-benefit analysis of afforestation on new areas and natural regeneration of forests as a measure of increasing the sinks in LULUCF sector

Changes in greenhouse gas sinks as a result of direct change in land use caused by human activity and forestry, since 1990 limited to afforestation, reforestation and deforestation, may be calculated within the national balance of greenhouse gas emissions and sinks and used to meet the obligations of Kyoto Protocol. This is stipulated by Article 3, paragraph 3 of the Kyoto Protocol for the parties included in Annex I to the Kyoto Protocol. 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 would 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. The implementation of this activity is set out in the Plan for the Protection of Air, the Ozone Layer and the Mitigation of Climate Change in the Republic of Croatia for the period 2013 - 2017 (OG 139/13) and its implementation, originally planned for 2015, is postponed and anticipated in 2017.

LUF-3: Implementation of the Action plan for LULUCF sector

Pursuant to Decision 529/2013/EU15, the Republic of Croatia was obliged, as an EU member state, to prepare and submit to the European Commission information in the LULUCF sector in accordance with Article 10 of Decision 529/2013/EU. The plan was prepared and submitted to the European Commission on 9th January 2015, and will form an integral part of the national low carbon development strategy. In the preparation of this plan, measures in the LULUCF sector of the Republic of Croatia were recognized and taken from relevant strategies, programmes and laws such as the Plan for the Protection of Air, the Ozone Layer and Mitigation of Climate Change in the Republic of Croatia for the period from 2013 to 2017 (OG 139/13), the Rural Development Programme of the Republic of Croatia for the period from 2014 to 2020, the Ordinance on cross-compliance (OG 32/15) and the Forest Management Plan of the Republic of Croatia for the period from 2006 to 2015. The first report on the implementation of measures has been submitted to the Commission in accordance with Article 10, paragraph 4.

- Regional cooperation in this area.

Not applicable.

- Without prejudice to the applicability of the rules on state aid, financial measures in this area at the national level, including EU support and use of EU funds, if applicable.

In preparation.

4.1.2. Renewable energy

- Policies and measures for achieving a national contribution to the binding target at the EU level by 2030 for renewable energy and trajectories referred to in Article 4, item (a), subitem 2 and, if applicable and available, elements from section 2.1.2, including sector-specific measures and technology-specific measures

OIE-1: Informational and educational measures

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. The measure will be implemented in order to build the capacity of consumers who produce energy for their own needs and energy communities.

OIE-2: Spatial planning prerequisites for use of renewable energy sources

According to the Strategy and Action Plan for Biological and Landscape Diversity (OG 143/08), the preparation and implementation of the Landscape Plan of the Republic of Croatia is planned through cooperation of relevant sectors (spatial planning, nature protection, environmental protection, cultural heritage protection, transport, agriculture, forestry, water management, mining, energy sector, education and science, etc.) in order to identify the condition of landscape features, take inventory and categorize. Based on the prepared spatial inventory, the Ministry of the Environment and Energy shall, if needed, in cooperation with the Ministry of Construction and Physical Planning prepare the spatial planning documentation for identified locations.

OIE-3: Promoting the use of renewable energy sources for production of electricity and thermal energy

It is expected that the premium system will be established and fully operational by 2020. In line with the goals for using renewable energy sources and the planned increase in installed power in all technologies, the Ministry of the Environment and Energy will each year prepare a three-year plan for the increase in RES power by type and technology, with detailed elaboration for the next year, by 30th September of the year preceding the plan. The Ministry shall at least once a year issue a tender for the construction of facilities using RES.

OIE-4: Development of the regulatory framework

Development of the regulatory framework for aggregators, energy communities (participation in local energy production, distribution, storage and supply, and provision of energy services and aggregation services) and energy production for own needs, in accordance with the provisions of the Electricity Directive and the Regulation on the Internal Electricity Market).

OIE-5: Promoting the use of RES at the point of consumption

Subsidizing investment in RES technologies for customers with own production.

OIE-6: Encouraging farmers and land owners to grow biomass for energy needs

Favoring lease of unused agricultural land and degraded agricultural land owned by the state /local self-government units for the dedicated production of biomass resulting in carbon sequestration, for advanced biofuels (biorefineries), while complying with sustainability requirements. For the purpose of absorption of atmospheric carbon, and according to the development needs of the food sector and bioeconomy (biorefineries and anaerobic

digestion), to create models for agricultural land owners aimed at motivating them to put this land into operation, either through lease or other means of compensation for carbon sequestration and biomass production.

OIE-7: Promotion of biorefineries

For the purposes of decarbonization and development of the food sector and bioeconomy, to promote the development of biorefineries which will, in addition to advanced biofuels, also produce biopolymers and biochemicals necessary to reduce the carbon footprint of food and pharmaceutical products (bioplastic packaging, dietary supplements and pharmaceuticals).

OIE-8: Capacity building for bioeconomy

To encourage inclusion in bioeconomy and increase the competitiveness of the biomass-based industry, it is proposed to create several highly reproducible business models for different biomass sources, types and pathways, which will encourage the use of innovative business chains valuing by-products and biowaste created during the production process.

- Financing of measures

In preparation.

- Specific measures for regional cooperation as well as, optionally, an estimated renewable energy production surplus that could be transferred to other Member States in order to achieve the national contribution and trajectories from section 2.1.2.

Not applicable.

- Specific measures for financial support, if applicable, including EU support and use of EU funds, to promote the production and use of renewable energy in electricity generation, heating, cooling and transport

In preparation.

- Specific measures for the introduction of one or more contact points, rationalization of administrative procedures, dissemination of information and training and strengthening of consumers producing and consuming their own renewable energy and energy communities

Planned within OIE-1 "Informational and educational measures".

- If applicable, assessment of the need for the construction of new infrastructure for centralized heating and cooling produced from renewable energy sources

Not applicable.

- If applicable, specific measures to encourage the use of energy from biomass, particularly for the generation of new biomass, taking into account:
    - availability of biomass: domestic potential and imports from third countries

- other uses of biomass in other sectors (agriculture and forestry); as well as measures for the sustainability of biomass production and use

Not applicable.

4.1.3. Other elements

- National policies and measures affecting the emission trading system (ETS) sector and assessment of its complementarity with and impact on the EU Emissions Trading System (EU ETS), if applicable

Not applicable.

- Strategies, plans and measures for adaptation to climate change

According to the Draft of the Climate Change Adaptation Strategy.

- Policies and measures for achieving other national goals, if applicable

Not applicable.

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

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

TR-1: Providing information to consumers on fuel cost-effectiveness and CO_2 emission of new passenger cars

According to the Ordinance on availability of information on fuel cost-effectiveness and CO_2 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 CO_2 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 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.

TR-2: Special environmental fee for motor vehicles

The existing system of payment of a special environmental fee for motor vehicles is regulated by the Act on the Environmental Protection and Energy Efficiency Fund (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, CO_2emissions and vehicle's age.

TR-3: Special tax on motor vehicles

Based on the polluter pays principle, the model is calculated with regard to 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 kilometer, engine volume in cubic centimeters 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).

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

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 compile a certified report to be submitted to the Croatian Agency for the Environment and Nature.

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) of the Government of the Republic of Croatia stipulates the limit values of components and/or quality characteristics of liquid petroleum fuels, method for determining and monitoring the quality of liquid petroleum fuels, conditions for operation of laboratories for sampling and laboratory analysis of the quality of liquid petroleum fuels, method of demonstrating conformity of products, name and labelling of products, 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 Croatian Agency for the Environment and Nature, 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.

TR-5: Obligation for the use of renewable energy sources in transport

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 needs to transpose obligations from the final draft of the revision of the Renewable Energy Directive adopted in June 2018 (the target is 14% of renewable energy sources in the transport sector in 2030).

TR-6: Promotion of clean and energy efficient vehicles in road transport

The measure is regulated by the Act on the Promotion of Clean and Energy-Efficient Vehicles in Road Transport (OG 127/13), 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.

TR-7: Promotion of intermodal transport

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.

TR-8: Legislative adaptation of provisions on the establishment of infrastructure for alternative fuels

At the national level, it is necessary to enact laws and by-laws that will regulate the conditions for filling stations for electric vehicles, conditions of distribution, charging and unit cost of alternative energy used in transport, and define conditions for filling stations for liquefied natural gas and compressed natural gas. It is necessary to anticipate amendments to the laws regulating transport 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.

TR-9: Financial incentives for energy-efficient vehicles

In the context of co-financing cleaner transport projects, it is necessary to define special co-financing lines for specific purposes, namely, for the purchase of electric vehicles, compressed and liquefied natural gas and hydrogen. Incentives for co-financing the purchase of vehicles will be primarily 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% of alternative fuel vehicles in the total number of vehicles registered in the country.

TR-10: Development of alternative fuels infrastructure

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. The measure is in line with the Directive on the deployment of alternative fuels infrastructure (2014/94), the Act on the Deployment of Alternative Fuels Infrastructure (OG 120/16) and the National Policy Framework for the Deployment of Alternative Fuels Infrastructure and the Development of Alternative Fuels Market in Transport (NPF, OG 34/17) and encourages the construction of filling stations according to the said documents.

This infrastructure measure will not directly affect the reduction in fuel consumption in transport, but the development of infrastructure is a precondition for the development of the market of vehicles using electricity, compressed and liquefied natural gas 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.

TR-11: Promoting integrated and intelligent transport and development of alternative fuels infrastructure at the local and regional level

It is necessary to promote sustainable development of urban transport systems through the optimization of logistics of transport of goods and intelligent management of public parking spaces (ICT technologies), introduction of integrated passenger transport, introduction of car-sharing schemes in cities, introduction of public city bicycles system 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 centers for monitoring and management of intersections with installed traffic lights). At the local level, it is necessary to continuously prepare and implement Sustainable Mobility Plans in cities, as well as strategic plans that build on the existing planning practices, and take into account integration,

participation and evaluation principles to meet the citizens' mobility needs now and in the future, and ensure better quality of life in cities and their surroundings.

TR-12: Training for drivers of road vehicles for eco-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), 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.

TR-13: Promoting the development of intermodal and integrated transport

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/intermodality 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.)

4.2. Dimension: energy efficiency

Planned policies, measures and programmes for the achievement of the national indicative energy efficiency target 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 required by the Draft of the Regulation on the Governance of the Energy Union.

i. Energy efficiency obligation schemes and alternative policy measures under Articles 7a and 7b of Directive 2012/27/EU [as amended in accordance with COM (2016) 761)

ENU-1: Energy Efficiency Obligation Scheme for Suppliers[2]

Obligated parties of the energy efficiency obligation scheme are energy suppliers. The start of the scheme operation is foreseen for 2019, when the suppliers who delivered more than 300 GWh of energy to the market in 2017 enter the obligation scheme. In 2020, the suppliers who

[2] The general description of the energy efficiency obligation system is based on the final draft of amendments to the Energy Efficiency Act, which was, at the time of drafting this Plan, in parliamentary procedure. Therefore, the description is covered and subject to change, depending on the final adopted text of the Act.

delivered more than 100 GWh of energy to the market in 2018 enter the scheme, and from 2021 onwards the scheme is entered by all those suppliers who supplied more than 50 GWh of energy to the market during the previous year. The Ministry of Environment and Energy determines the exact annual amount of energy savings obligation in kWh for the following year for each obligated party until 30th June of the current year, allocating to all obligated parties a part of the national indicative energy savings target for the next year realised through the obligation scheme as well as the cumulative energy savings target 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 final 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 proven by methods from the Ordinance on the system for monitoring, measurement and verification of energy savings. **In that sense, it is necessary to amend and update the above-mentioned Ordinance regularly.** Investments should not relate to activities previously covered by alternative measures. Revenues from fees collected on the basis of the obligation scheme shall be used by the Fund purposefully. That is why it is necessary to create a **Plan for the use of funds collected from the obligation scheme fees**, the implementation of which must start from 2021. Creating such a Plan 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.

The Republic of Croatia also envisages the implementation of alternative measures, which are described hereafter: ENU-3, ENU-4, ENU-5, ENU-6 and ENU-7. In addition, alternative measures include the following measures in transport: TR-9: Financial incentives for energy efficient vehicles, TR-11: Promoting integrated and intelligent transport and development of alternative fuel infrastructure at the local and regional level and TR-12: Eco-driving trainings, as well as the implementation of the Programme for the Elimination of Energy Poverty (UET-5).

ii. Long-term strategy for the renovation of the national stock of residential and non-residential buildings, both public and private

To achieve the strategic goals of reducing energy consumption in buildings, three key energy renovation programmes for the period between 2021 and 2030 are expected to be adopted: programme for multi-apartment buildings, single family houses and public sector 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 suppliers within the energy efficiency obligation scheme 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: Programme for increasing the number of buildings with nearly-zero energy consumption (B.2: MEN-1)

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 legal 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. These activities include:

- 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 IEC system, 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.

ENU-3: Energy renovation programme for multi-apartment buildings (B.3; MEN-2)

The Programme should be structured as a continuation of the implementation of the Energy renovation programme for multi-apartment buildings for the period 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. Allocation for this Programme needs to be planned to provide grants amounting to 60% of eligible costs as in the previous Programme, with the maximum co-financing of energy audits, energy certificates, project documentation and technical assistance in the preparation and implementation of the project. Technical conditions should also be the same as in the existing Program, so it is necessary to achieve a reduction of at least 50% of the heating demand of the building. 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. Implementation of the Program must be accompanied by strong promotional activities, technical assistance to applicants and it is necessary to ensure energy consumption monitoring before and after the energy renovation.

ENU-4: Energy renovation programme for single family houses (B.5; MEN-4)

The Programme should be structured as a continuation of the implementation of the Energy renovation programme for single family houses for the period 2014 to 2020, especially in the period from 2014 to 2016, when the Program was co-financed by the Environmental Protection and Energy Efficiency Fund. Namely, due to the complexity of administrative procedures for utilizing ESI funds, funds for this programme need to be provided from national sources. The primary source of co-financing should be revenues from the sales of greenhouse gas emission allowances at auctions. Allocation for this Programme needs to be planned to provide grants amounting to 60% of eligible costs as in the previous Programme, with the maximum co-financing of energy audits, energy certificates, project documentation and technical assistance in the preparation and implementation of the project. Technical conditions should also be the same as in the existing Programme, so it is necessary to achieve a reduction of at least 50% of the heating demand of the building. Additionally, it is necessary to 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 one 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. Energy poor households should be covered by a special programme (H.5; MEN-11), described in Chapter 3.4.4. of this Plan. Implementation of the Programme must be accompanied by strong promotional activities, technical assistance to applicants and it is necessary to ensure energy consumption monitoring before and after the energy renovation.

ENU-5: Energy renovation programme for public sector buildings (P.2; MEN-5)

The measure represents the continuation of the implementation of the Energy renovation programme for public sector buildings for the period 2016 to 2020. For this purpose, co-financing 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. For buildings that are not suitable for market models, it is necessary to provide grants under the same conditions as in the current program. The renovation of the public sector building must be directed to the nZEB standard wherever technically feasible.

iii. Description of policies and measures to promote energy services in the public sector and measures to remove regulatory and non-regulatory barriers that impede the uptake of energy performance contracting and other energy efficiency service models

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 baseline conditions it leads to a

verifiable and measurable or assessable improvement of energy efficiency and/or energy and/or water savings. According to the final proposal of the Act on Amendments to the Energy Efficiency Act, the definition is broadened to include the cases where the energy service provider provides expert knowledge of energy management without direct investment and includes the possibility of reducing energy-related costs without reducing energy consumption.

According to the final proposal of the Act on Amendments to the Energy Efficiency Act, the contents of the energy performance contract is defined only for public buildings, thus liberalizing the approach to this issue in the private sector, and a positive impact on the market may 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 final proposal of 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 as examples of good practice 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 to achieve the indicative national energy efficiency contributions for 2030, as well as other objectives under section 2.2. (for example, measures to promote the exemplary role of public buildings and energy-efficient public procurement, measures to promote energy audits and energy management systems, consumer information 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-6: Systematic energy management in the public sector (P.3; MEN-6)

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 (OG No. 18/15, 06/16). The measure is based on the information system for energy management (ISEM).

In the period until 2020, the focus will be on the automation of data collection for energy products and water consumption (remote reading), connecting EMIS with systems of suppliers of energy and water, reporting and verification of energy saving measures, and education of energy experts and advisors responsible for energy management in their buildings. By 2020 remote metering should cover all public sector locations whose energy and water consumption exceeds HRK 400,000.00/year. In addition, by 2020, the implementation of the following measures is planned: optimization of peak power contracting, reduction of excess reactive power, optimization of thermal power contracting, analysis of potential for replacement and optimization of boiler performance, and analysis of the potential for accumulation of cooling energy in the public sector buildings.

In the period from 2021 to 2030, it is planned to introduce the energy management system and apply EMIS 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 EMIS;
2. Integrate EMIS with other bases: DGU (Geoportal of the State Geodetic Administration), Cadastre, Register of protected facilities, IEC, SMIV, etc.);
3. Stipulate EMIS as a system for verifying real savings after renovation of the building (define which data the sensors in rooms send to the system, EMIS is ready to receive data);
4. Extend the use of EMIS 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. Upgrade the EMIS so that it can carry out a financial analysis of cost-effectiveness of renovation measures on the basis of actual data;
6. Develop the EMIS in the direction of so-called artificial intelligence, whereby the system would propose measures to increase energy efficiency according to input parameters.

Apart from upgrading the EMIS, 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.

ENU-7: Energy renovation programme of public lighting (P.4; MEN-13)

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 soft loan offered by the Croatian Bank for Reconstruction and Development[3] to local and regional self-governments. 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

[3] The programme information can be found at: https://www.hbor.hr/152-milijuna-kuna-povoljnih-kredita-za-javnu-rasvjetu/ (access: 1st October 2018)

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 the 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 estimated at 225 GWh could be utilized by the end of 2030. 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 provider and guarantees. For projects requiring investment in new public lighting infrastructure (poles, additional lamps and the like), in order to meet the standardized technical requirements, it is necessary to secure grants.

ENU-8: Green public procurement (P.5; MEN-14)

The Government of the Republic of Croatia adopted the first National Action Plan for green public procurement for the period from 2015 to 2017 with an outlook to 2020, therefore green public procurement was also accepted as a measure in the Draft of 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.

Initiated activities will continue in the period until 2030, through: 1) training of public procurement participants and promotion of green public procurement criteria; 2) improving monitoring of green public procurement implementation with the aim of quantifying the effects; and 3) continued development of new criteria and benchmarks for green public procurement, including energy efficiency. In 2030, the objective is to have 75% of all implemented public procurement procedures that apply green public procurement criteria. It is necessary to improve the monitoring of the effects of this measure.

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 with an energy audit obligation (ISO 50001) has been set up);
- 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 heating/cooling 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-9: Energy management system in the business (service & production) sector (new fiscal 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. These tax incentives should be introduced from 2021.

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-10: Informative bills (H.1; MEN-7)

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 bills containing the information about the previous consumption of the final customer for measuring points that are the subject of a contractual relationship, including a comparison with the average usual 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 (HERA) 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 Energy Efficiency Authority.

ENU-11: Providing information on energy efficiency (H.2; MEN-10)

Providing information to the general public and target groups shall be conducted through the organization of targeted information campaigns related to specific programmes of promoting energy efficiency, particularly energy renovation of buildings. The National Energy Efficiency

Authority 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 about the obligations of the supplier within the obligation system.

ENU-12: Energy efficiency education (H.4; MEN-12)

Education will be achieved through the continuation of the implementation of the said measure and adjusting 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 stated energy-climate targets.

ENU-13: Integrated information system for monitoring energy efficiency (H.5; MCC-2)

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 (OG 71/15). 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 (EMIS), and inform and educate obligated parties about the correct data entry required to calculate and verify energy savings.

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 CO_2 emission fees (MS-5: CO_2 emission tax for the non-ETS stationary sources) shall remain, according to the Regulation on unit charges, corrective coefficients and detailed criteria and benchmarks to determine the carbon dioxide emissions to the environment (OG73/07, 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 energy efficiency obligation scheme to the energy suppliers 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 performance contracting. Therefore, in the period from 2021 to 2030, new financial incentives from public sources are not foreseen.

v. If applicable, a description of the measures to utilise energy efficiency potentials of the gas and electricity infrastructure

Measures for increasing the energy efficiency of the electricity infrastructure (transmission and distribution networks) are based on ten-year development plans of the transmission and

distribution grid for 2016-2025 and the HERA Decision on implementation of energy efficiency measures (more details in Chapter 1.2 .2).

ENU-14: Management of power system and development of transmission network (E.8; MEN-25)

In the period up to 2030, the HOPS will continue to carry out activities to improve the management of the power system (topological changes in the network depending on the current state of operation, change of the switching state of the transformer and optimization of the operation of the transformer with phase shifting, voltage management and optimization of power flows in the network, optimization of operation of generators) and replacement of existing equipment (energy transformers and conductors with smaller losses, construction of new lines), all with the aim of further reducing technical losses in the network. 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.

ENU-15: Reduction of losses in the distribution network and introduction of smart grids (E.9; MEN-25)

In the period of up to 2030, HEP-ODS will continue to conduct activities to reduce technical and non-technical losses in the distribution network. Activities to reduce technical losses include optimizing the network operating condition, reconstructing parts of the network with a small cross-section of conductors and long sections, switching parts of the 10 kV network to a 20 kV voltage level, replacement of old transformers with large losses, installing energy transformers with reduced losses and reducing own consumption. On the side of non-technical losses, activities will include the 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. Based on the experience gained from the implementation of a pilot project for the deployment of smart 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 smart grids.

For gas infrastructure, there are not specific measures prescribed.

For Croatia, it is essential to improve the infrastructure for production, transmission and distribution of energy for heating and cooling. Therefore, for the following period the implementation of the following measure is also forseen:

ENU-16: Increasing the efficiency of the district heating systems (E.7; MEN-24)

In the existing large centralized heating systems, a large source of losses is the deteriorated steam and hot water network, and this measure foresees the continuation of the replacement of deteriorated steel hot water pipes and steam lines with new pre-insulated pipes. 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. The use of ESI funds in the next programming period from 2021 to 2027 must be programmed for the implementation of this measure.

vi. Regional cooperation in this area, if applicable

Not applicable.

vii. 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 sales 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 (OG 19/18) and
- ESI Funds, in particular the European Regional Development Fund (EFRR) in accordance with the Operational Programme Competitiveness and Cohesion 2014-2020.

The funds and financial measures for which they are used are shown in Table 4-1 and Table 4-2, and it should be noted that the funds from the EFRR and related measures are being implemented by the end of 2023. The tables also provide a proposal for the use of these sources for the period 2021-2030 for the continuation of the implementation of existing measures or the introduction of new measures. **It should be clearly noted that the tables do not give an estimate of the necessary funds for the implementation of these measures for 2021-2030.**

Table 4-1: Estimated disposable financial assets from the sale of greenhouse gas emission allowances for energy efficiency investments by 2020 with proposed measures up to 2030

Source of funds	Investment priority	Available allocation	Existing financial measure	Measure for period 2021 - 2030
EU-ETS	HRK 165,000,000	HRK 70,000,000	Energy renovation programme for public sector buildings for 2014 - 2015 (P.1)	/
		HRK 23,000,000	Energy renovation programme for public sector buildings 2016 - 2020 (P.2; MEN-5)	/
		HRK 44,108,000	Energy renovation programmes for multi-apartment buildings and single family houses (B.3; MEN-2 and B.5; MEN-4)	Energy renovation programme for single family houses (ENU-4)

		HRK 1,050,000	Integrated information system for monitoring energy efficiency (H.6; MCC-2)	Informative and educational measures (ENU-10 to ENU-13)
		HRK 90,000	Industrial Energy Efficiency Network (I.1; MEN-16)	/
		HRK 4,000,000	Increasing energy efficiency and use of RES in manufacturing industries (I.2; MEN-17) - introduction of energy management system and energy audits	/

Table 4-2: Available funding from ESI funds and energy efficiency measures by 2020 (2023) with a proposed measure until 2030

Source of funds	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	Increasing 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 infrastructure, including public buildings and the housing sector	EUR 211,810,805	Energy renovation programme for public sector buildings 2016-2020 (P.2; MEN-5)	Energy renovation programme for public sector buildings 2016-2020 (ENU-5)
		EUR 70,000,000	Promotion of integral renovation of apartment buildings (B.3; MEN-2)	Energy renovation programme for multi-apartment buildings (ENU-3)
		EUR 30,000,000	Energy renovation programme for single family houses 2014-2020 (B.5; MEN-4)	/
		EUR 80,000,000	Increasing the efficiency of the district heating system (E.7; MEN-24)	Increasing the efficiency of the heating system (ENU-16)
		EUR 20,000,000	"Energy efficient public lighting" programme (P.4; MEN-13)	Energy renovation programme for public lighting (ENU-7)
ERDF	4d - Development and implementation of smart distribution systems at low	EUR 80,000,000	Pilot project of introduction of smart grids in pilot areas (E.9; MEN-25)	Introduction of smart grids (ENU-15)

	and medium voltage levels			
				Development of transmission network (ENU-14)

In the period 2021-2030, for the financial measures envisaged by this Plan, national funds from sales 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 to 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 to plan sufficient funds for their implementation**.

4.3. Dimension: energy security

- Policies and measures related to the elements set out in 2.3.

ES-1: Integrated planning of security of energy and energy products supply

The overarching measure to increase energy security is the integrated planning of security of supply in the context of all energy products and all energy systems. This planning will be carried out within the framework of the audit of the Integrated Energy and Climate Plan, which should be prepared by 23 June 2023, and within the framework of the preparation and audit of subsequent plans. For this purpose, it is necessary to supplement the existing regulatory framework.

ES-2: LNG terminal construction

The size of the liquefied natural gas terminal depends on the interest of market. In the first phase, the construction of the FSRU vessel (Floating Storage Regasification Unit) is planned, whose maximum annual natural gas supply will amount up to 2.6 billion cubic meters. The planned maximum capacity of natural gas supply from the terminal, and indirectly its size and capacity, is conditioned by the maximum capacity of the gas pipeline system 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/d. By building an extension of the Zlobin-Kozarac evacuation gas pipeline, the total capacity of the liquefied natural gas 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 the beginning of 2021.

ES-3: Inclusion in the Ionian-Adriatic gas pipeline

The Ionian-Adriatic gas pipeline would enable the supply of gas from TAP for Croatia and the countries in the region, and possible transport towards Hungary, Slovenia and Austria. The gas pipeline would be built in a total length of 511 km, of which the longest part of about 250 km would be in Croatia. The construction of gas pipeline of a diameter of DN800 with a single compressor station in Split is foreseen. The planned investment in the Republic of Croatia is around HRK 2.2 billion.

ES-4: Pumped-storage hydroelectric power plants construction

The construction of additional 150 MW pumped-storage hydroelectric power plants before 2030 is foreseen, primarily due to regulatory requirements in the system.

ES-5: Expansion of the gas storage facility in Grubišno Polje

The planned capacity of gas withdrawal from the underground gas storage facility in Grubišno Polje is up to 2.4 million m3/d and the injection capacity is up to 1.68 million m3/d, with the possibility of repeated charging and discharging during the heating season. The main task of this underground gas storage would be to cover peak gas demand in the gas system of the Republic of Croatia during the heating season, i.e. it would be support during gas withdrawal from the seasonal underground gas storage facility in Okoli. It is estimated that the total investment in construction would be around HRK 380 million and the start of work can be expected approximately in 2025.

ES-6: Introduction of smart metering

In order to enable further development of energy markets and the active role of customers of energy in energy markets, the introduction of advanced consumption meters is planned.

ES-7: Launching pilot projects to provide ancillary services

With pilot projects, services that users can provide to an operator of distribution or transmission power system will be analyzed in detail. Possible type, scope, method and period of providing ancillary services will be analyzed. Obstacles to the usage of ancillary services will be identified and ways of removing them will be proposed.

ES-8: Research of potential hydrocarbon deposits in Slavonia, Dinarides and Southern Adriatic

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.

ES-9: Development and management of the power system

Further development of techniques and procedures for managing the power 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 centers and communication with other participants of the electricity market. 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 power system and power supply.

- Regional cooperation in this area

Not applicable.

- Financial measures in this area at national level, including EU support and the use of EU funds, if applicable.

In preparation.

4.4. Dimension: the internal energy market

4.4.1. Electricity infrastructure

- Policies and measures for the achievement of the targeted level of interconnectivity set out in Article 4, item d)

As stated in chapter 2.3, regarding further increase of cross-border capacities by 2030, there are no specific requirements.

- Regional cooperation in this area

Not applicable.

- Financial measures in this area at national level, including EU support and the use of EU funds, if applicable.

Not applicable.

4.4.2. Energy transmission infrastructure

- Policies and measures related to the elements set out in 2.4.2, including, if applicable, special measures to enable the implementation of projects of common interest (PCI) and other key infrastructure projects.

UET-1: Implementation of the ten-year development plan for electricity transmission network

The ten-year development plan defined the need for the following reinforcements/revitalizations of the transmission network that are demanding in terms of investment:

- reinforcement of 400 kV network in the Zagreb area by building a new 2x400 kV Tumbri - Veleševec transmission line, which connects to the existing 2x400 Žerjavinec - Veleševec transmission line, and new connections are formed: 2x400 kV Tumbri - Žerjavinec and 400 kV Ernestinovo - Tumbri,
- construction of 220/110 kV Vodnjan substation,
- replacement of submarine cables on the following sections: Crikvenica - Krk, Dugi Rat - Nerežišća, Nerežišća - Starigrad, Krk - Lošinj and Starigrad - Blato,
- installation of two variable shunt reactors of 200 MVAr and 100 MVAr and static var compensator of 250 MVAr within the SINCRO.GRID project, which are connected to 220 kV network,
- replacement of conductors and increase of the transmission power of 220 kV Zakučac - Konjsko and Senj - Melina lines,
- replacement of conductors and increase of the transmission power on a certain number of 110 kV lines, and replacement of conductors without increasing the transmission power on the oldest lines in 110 kV network,
- replacement of a larger number of 220/110 kV and 110/x kV power transformers.

UET-2: Implementation of the ten-year development plan for gas transmission system

Planned projects for the improvement of gas transmission system:

- **Transmission system that serves as new supply**: The gas transmission system for the evacuation of gas from the liquefied natural gas terminal consists of three groups of gas pipelines: Omišalj - Zlobin (DN 1000, 18 km), Zlobin - Kozarac (DN 800, 180 km) and Kozarac - Slobodnica (DN 800, 128 km). Gradual development enables the gradual increase of the liquefied natural gas terminal capacity from the initial 7.2 million m^3/d to a maximum of 19 million m^3/d. In the first phase, the construction of the Omišalj - Zlobin gas pipeline is foreseen, which will be operational at the time of the construction of the terminal at the beginning of 2020; IAP - the Ionian-Adriatic pipeline would enable to supply gas from TAP to Croatia and the countries in the region and possible transmission towards Hungary, Slovenia and Austria. The gas pipeline would be built in a total length of 511 km, of which the longest part of about 250 km would be in Croatia (estimated investment in the Republic of Croatia is around HRK 2.2 billion); by increasing the capacity of the interconnection with Slovenia and by building Lučko - Zabok, Zabok - Jezerišće and Jezerišće - Sotla gas pipeline systems (DN 700, 69 km, operating pressure 75 bar), an additional supply from the direction of Slovenia and LNG or gas export from IAP towards Slovenia would be enabled. The construction of Bosiljevo - Karlovac (DN 700) and Karlovac - Lučko (DN 500) gas pipelines of a total length of 71 km would further increase the export capacity towards Slovenia and this system is particularly important in the case of IAP system construction; Slobodnica - Sotin gas pipeline (DN 800, 102 km) would allow the interconnection with Serbia and direct gas export from the liquefied natural gas terminal towards Serbia, or direct gas import from TurkStream section after its construction.

- **Transport system that serves as internal operational security of supply**: The transmission system that serves as internal security of supply will enable a more stable and secure supply for areas that are powered by gas and have only one power source, and it will enable the creation of internal loops increasing the security of gas supply.

- **Transport system that serves as export**: Lička Jesenica - Bihać (DN 400/500, 30 km), Zagvozd - Posušje (DN 500, 22 km) and Slobodnica - B. Brod (DN 700, 5 km) gas pipeline systems would enable to supply gas to the neighboring Bosnia and Herzegovina, while Umag - Koper (DN 300, 8 km) gas pipeline would enable to connect Istria and southern Slovenia. The construction of these gas pipelines primarily depends on the interest of neighboring countries and the economic justification for the construction. Total investments necessary to develop gas transmission system by 2030 are around HRK 8 billion.

- Regional cooperation in this field

Due to the fact that the energy transmission infrastructure of the Republic of Croatia is connected to the systems of neighboring countries, full technical and operational compliance with the operators of these systems is necessary, which is regulated by appropriate documents.

The overall connection of the Croatian gas transmission system with the gas transmission systems of all neighboring countries is planned, so the gas transmission system operator already in the preparatory phase of interconnection projects cooperates closely with the operators of transmission systems of these countries.

- Financial measures in this area at a national level, including EU support and the use of EU funds, if applicable.

In preparation.

4.4.3. Market integration

- Policies and measures related to the elements set out in 2.4.3.

The following measures will contribute to the achievement of objectives set out in 2.4.3.: ES-6: Introducing advanced consumption meters, ES-7: Launching pilot projects to provide ancillary services, and ES-9: Development and management of the power system.

- If applicable, measures to increase the flexibility of the energy system with regard to renewable energy production, including the roll-out of intraday market coupling and cross-border balancing markets

Measure ES-4 - Pumped-storage hydroelectric power plants construction will contribute to the achievement of this objective.

In addition, the following measure should be carried out:

<u>UET-3: Ensuring balance of the power system</u>

It is necessary to ensure the implementation of an appropriate balancing mechanism that involves all the entities responsible for imbalances and to ensure an appropriate remuneration or pricing mechanism for these services. It is necessary to ensure an adequate secondary and tertiary P/f reserve for balancing, including the intraday market and the organization of balancing energy market.

- 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

The following measures will contribute to the achievement of this objective: OIE-3 - Encouraging the use of renewable energy sources to produce electricity and heat, and ENU-16: Increasing the efficiency of heating systems.

- 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

Elaborated in 3.4.4.

- Description of measures to enable and develop demand response including those addressing tariffs to support dynamic pricing

UET-4: Elaboration of the regulatory framework for the active participation of customers on the electricity market

The analysis of the potential to provide ancillary services and flexibility services by consumption response of network users will be conducted. The method of providing services from final customers will be defined and the regulatory framework will be appropriately modified, primarily through the introduction of an aggregator as a market participant.

4.4.4. Energy poverty

- 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: Implementation of the Programme for the reduction of energy poverty

Within the Programme for the reduction of energy poverty, capacity building will be continued through local info centers, 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. This will contribute to the reduction of energy poverty and vulnerability level and encourage the use of available resources, from ESI and national sources. 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 analyzed. 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 products (in particular electricity and fuel oil)) with systems that are environmentally and economically more favorable 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.

4.5. Dimension: research, innovation and competitiveness

4.5.1. Policies and measures related to the elements set out in 2.5.

The preparation of the National Development Strategy for the period until 2030 is ongoing, which will set the overall strategic objectives and key areas of intervention for the energy and sustainable environment by 2030. All development strategies and plans will have to comply with the national development strategy.

In the context of research, innovation and competitiveness, it is expected that the most important measure will be

IIK-1: Fostering research and development of clean energy technologies and low-carbon technologies

4.5.2. Collaboration with other Member States in this area, including information on how the objectives and policies of the Strategic Energy Technology Plan (SET) are transferred to the national context

The Republic of Croatia has been included in the SET-Plan Steering Group since 2015 and covers all ten key activities. The connection between SET Plan activities at the European and national level will be ensured by launching thematic working groups composed of representatives of state administration bodies, scientific-research and commercial sectors.

IIK-2: Thematic working groups for SET-Plan key activities

4.5.3. Financial measures in this area at national level, including EU support and the use of EU funds

In preparation.

SECTION B: ANALYTICAL BASIS

5. CURRENT SITUATION AND PROJECTIONS WITH EXISTING POLICIES AND MEASURES

5.1. Projected evolution of main exogenous factors influencing energy system and GHG emission developments

The most important factors influencing energy system and GHG emission developments are demographic and economic movements.

The number and composition of population according to different demographic and socio-economic characteristics are the basic determinant of the present and predictable social and economic growth and development. In order to guide the overall development, it is necessary to know the number, dynamics and spatial distribution of population according to different demographic and economic characteristics. In addition, it should be pointed out that the population is the basic factor that through its activity changes societal, economic, social, cultural, psychological and other conditions of development. It is particularly important to bear in mind the fact that demographic processes are by their nature long-term as regards their formation and future effects. Projections related to the size of the population used for the purpose of preparing the basis of the Energy Strategy are presented here [17]. Projections were made in three variants (low, medium and high), and forecasts of demographic trends for all three variants are presented in **Figure 4-1**.

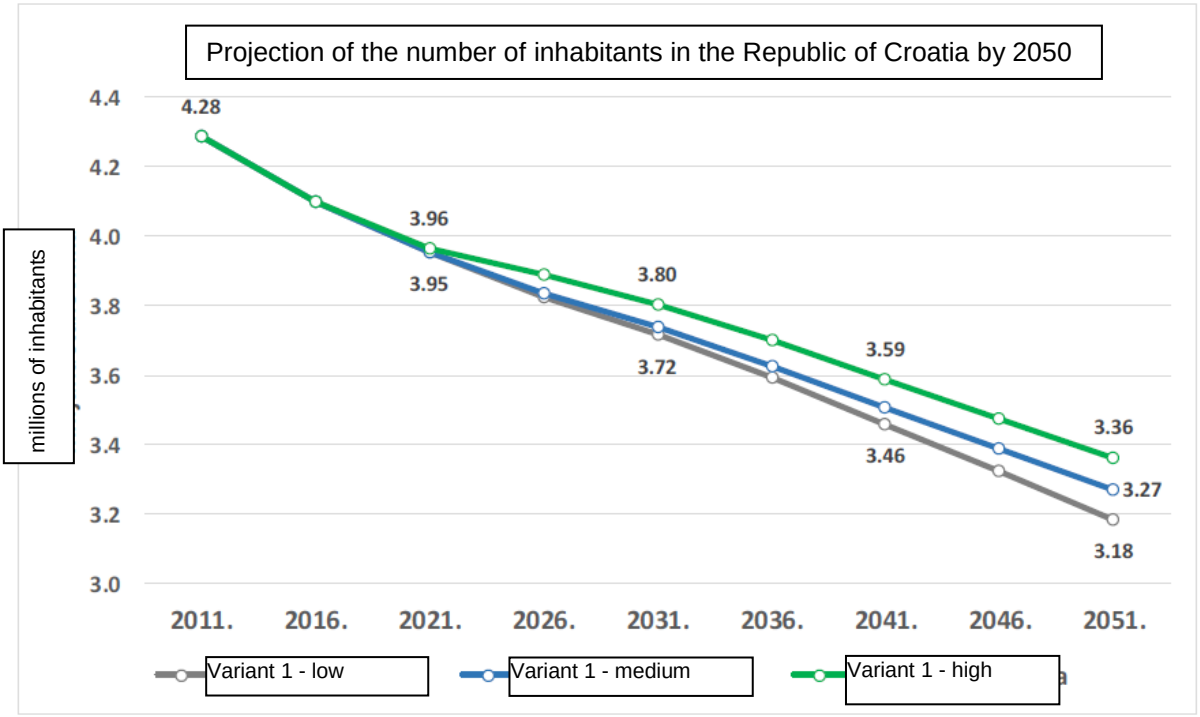

Figure 4-1: The projection of the number of inhabitants in the Republic of Croatia by 2050 in three variants

In addition, for the purpose of preparing the basis of the Energy Strategy, projections of economic trends were made for the period by 2050. The activities foreseen by the project task cover the preparation of the projection of 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 demographic projections covering the medium dynamics of population movements, the projections of GDP growth for the basic and increasing productivity are made (Figure 4-2).

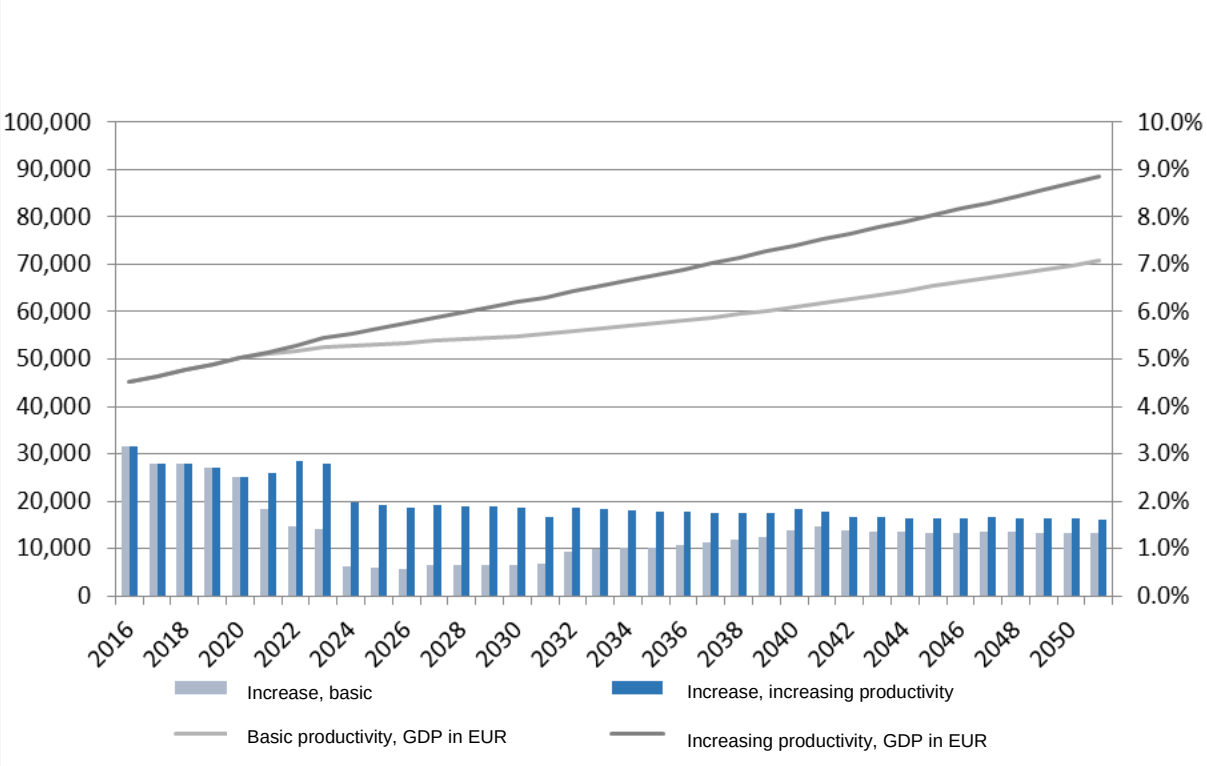

Figure 4-2: The GDP projection based on medium demographic projections (for the basic and increasing productivity)

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, TFP convergence 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 4-3: Projections of economic parameters on the basis of medium demographic projections

	2016	2020	2030	2040	2050
	Basic productivity				
GDP, constant prices in 2010, million HRK	335.902	373.595	408.987	454.649	520.277
GDP, index, 2016 = 100	100.0	111.2	121.8	135.4	154.9
GDP per capita, constant prices in 2010, thousand HRK	82	94	109	129	158
GDP per capita, index, 2016 = 100	100.0	114.4	132.9	157.1	192.7
Number of inhabitants, in millions	4.099	3.984	3.755	3.532	3.295
Number of persons employed, constant activity, in millions	1.550	1.559	1.434	1.315	1.191
	Convergence of productivity				
GDP, constant prices in 2010, million HRK	335.902	373.595	462.111	551.311	649.695
GDP, index, 2016 = 100	100.0	111.2	137.6	164.1	193.4
GDP per capita, constant prices in 2010	82	94	123	156	197
GDP per capita, index, 2016 = 100	100.0	114.4	150.2	190.5	240.6
Number of inhabitants, in millions	4.099	3.984	3.755	3.532	3.295
Number of persons employed, increasing 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.

The key contribution to the achievement of objectives is expected from the sector of renewable energy sources (especially in electricity generation), the construction sector and the transport sector. Detailed descriptions of the expected changes are given in the corresponding chapters.

The expected development of specific costs of investment in certain technologies for the period from 2015 to 2050 is taken from IEA WEM data (World Energy Model used for the World Energy Outlook publication), on the basis of the Fraunhofer ISE study (for solar photovoltaic power plants) and internal estimates, particularly as regards wind farms (Figure 4-3 and Figure 4-4).

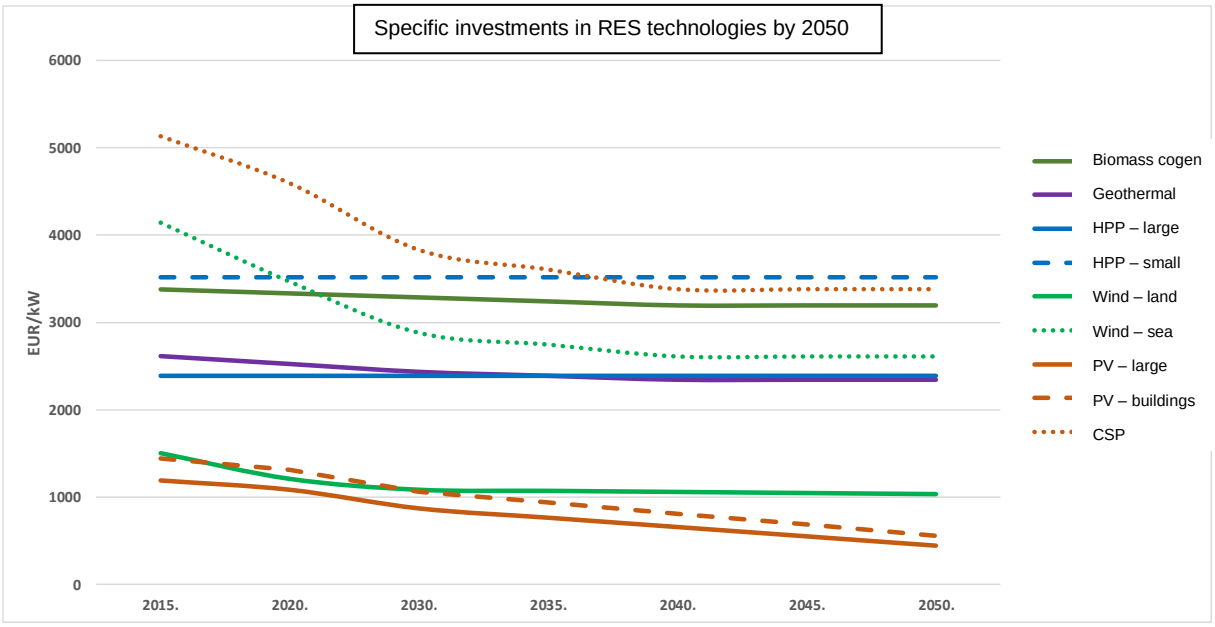

Figure 4-3: Specific investments in RES technologies

As regards renewable energy sources, further reduction of the specific cost is expected, especially for solar power plants and offshore wind farms. Some of wind farm and PV projects are already showing lower cost than the one presented here. For large and small hydroelectric power plants and biomass power plants, no technological/cost improvement is expected.

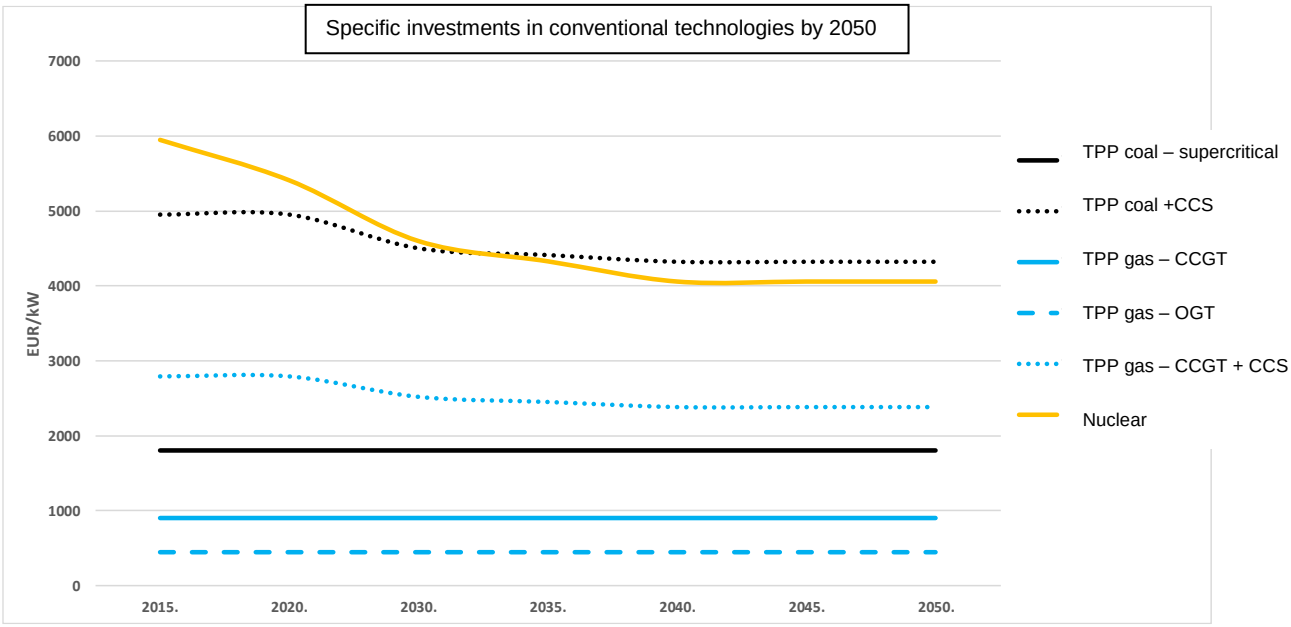

Figure 4-4: Specific investments in fossil fuel and nuclear power plants

For coal and natural gas thermal power plants, no technological progresses are expected, except in the case of CCS option. As regards nuclear power plants, there is a possibility of progress in the case of greater use of this option for the achievement of objectives of emission

reductions at global level (the presented estimate refers to projects that would be implemented in Europe).

Fossil fuel prices by 2050 are estimated in accordance with the International Energy Agency forecasts (IEA, World Energy Outlook 2017). The so-called *New Policies Scenario* is observed.

Table 4-4: 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/tona	Coal (EU)	46	101	63	77	80	81	82

Source: IEA WEO 2016/2017

Prices for the period after 2040 have been extrapolated and for the purpose of the analysis are presented in EUR from 2015. In **Figure 4-5** the level of estimated fossil fuel prices in EUR/GJ is presented.

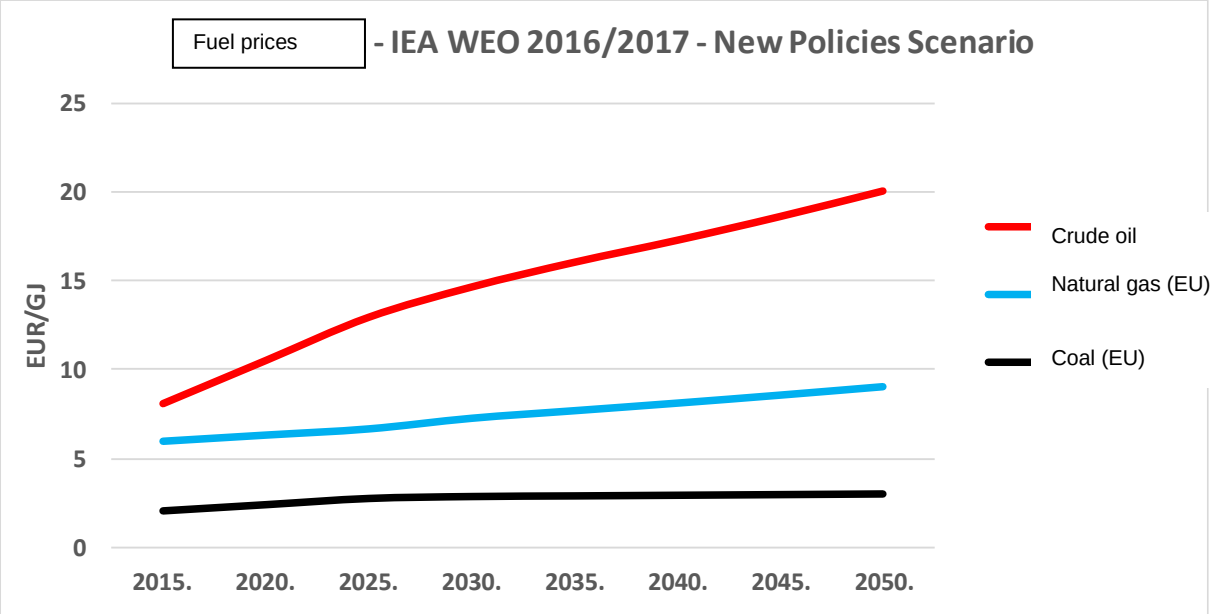

Figure 4-5: Fossil fuel prices by 2050

Source: IEA WEO 2016/2017 and EIHP elaboration

For natural gas and coal, prices relevant to the EU are 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 4-5. Basic prices are expressed in EUR from 2013, amounts are converted to the level of 2015 (values used in the analyzes) and in EUR from 2016 (values also stated in documents of the European Commission).

Table 4-5: Prices of emission allowances

Prices of emission allowances	2015.	2020.	2025.	2030.	2035.	2040.	2050.
NEKP – EK recommendation EUR'13/t CO_2	7,5	15,0	22,5	33,5	42,0	50,0	90,0
NEKP – EK recommendation EUR'16/t CO_2	7,8	15,5	23,3	34,7	43,5	51,7	93,1
NEKP and historical prices correction, EUR'16/t CO_2	7,8	25,9	30,3	34,7	43,5	51,7	93,1
NEKP and historical prices correction, EUR'16/t CO_2	7,7	25,6	29,9	34,3	43,0	51,1	92,1

Source: EU Reference Scenario 2016 i EIHP analysis

Current market prices show even higher values than those recommended by the EC. On the basis of such movements, the alternative price trend was estimated by 2030, and presented in EUR from 2015. These values are used to optimize the electricity generation system (Figure 4-6).

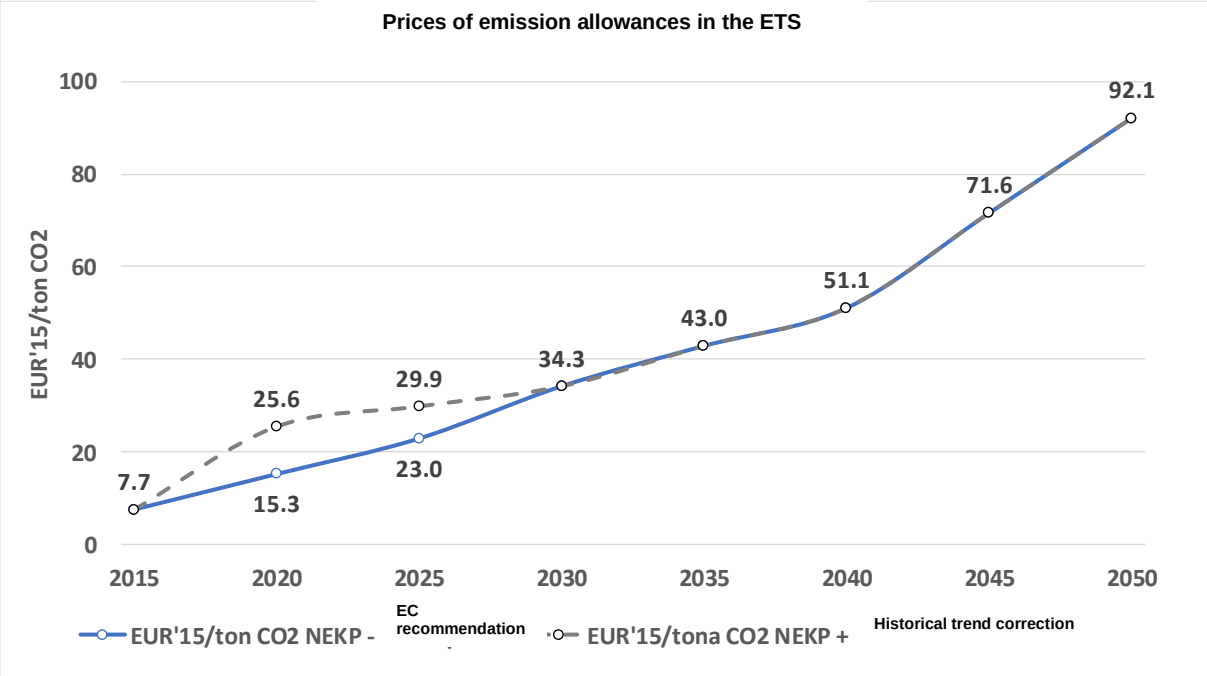

Figure 4-6: The expected price of emission allowances by 2050

Source: EU Reference Scenario in 2016 and EIHP analysis

5.2. Dimension: decarbonization

5.2.1. GHG emissions and removals

- Trend of 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 4-7.

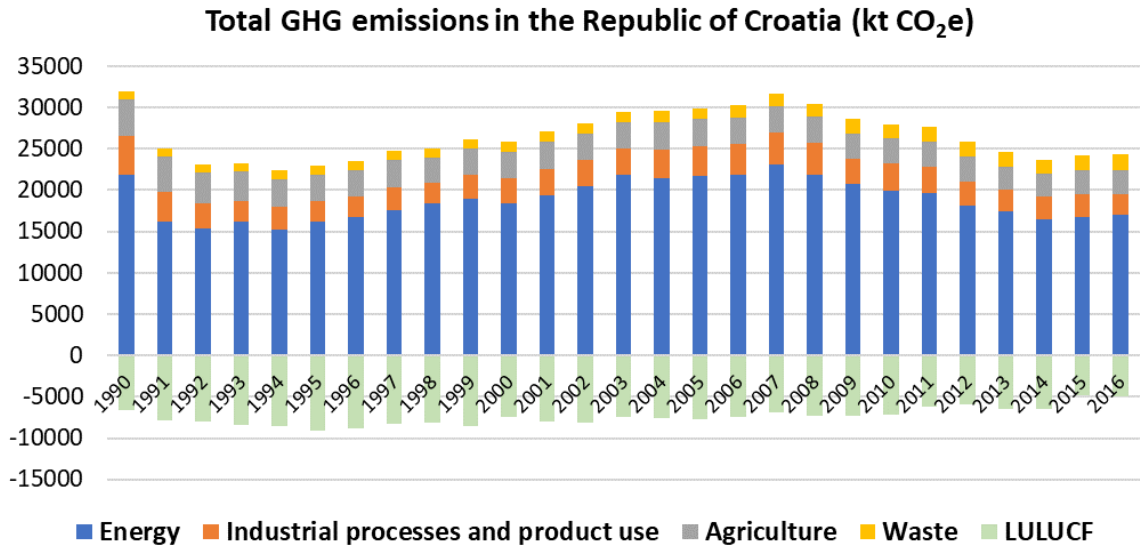

Figure 4-7: Trend of GHG emissions in the Republic of Croatia

Since 1 January 2013, plants in the Republic of Croatia participate in the EU Emissions Trading System (EU ETS). The emissions from ETS sector and non-ETS sectors are available for 2005 and for the period from 2013 to 2016 (Table 4-6).

Table 4-6: Trend of GHG emissions from ETS sector and non-ETS sectors in the Republic of Croatia

Emission (kt CO_2e)	**1990**	**2005**	**2013**	**2014**	**2015**	**2016**
Non ETS sectors		19307	15778	15311	15802	16038
ETS sector		10627	8786	8387	8386	8267
Total GHG emissions	**31894**	**29934**	**24563**	**23698**	**24189**	**24305**

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.

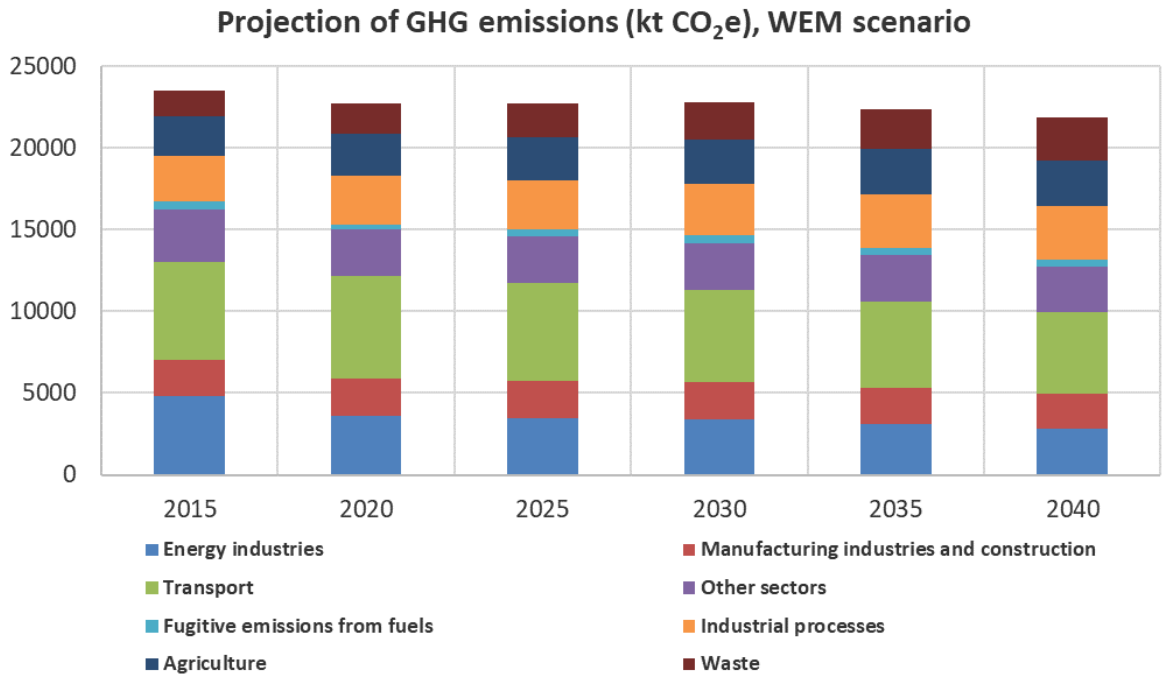

Figure 4-8: Projection of GHG emissions, with existing measures, in the Republic of Croatia

5.2.2. Energy from renewable sources

In the case of the scenario with existing measures (Scenario S0 or Scenario 0), RES shares and forecasts with existing measures are presented below.

Table 4-7: Indicative trajectories of RES shares by 2030 in the scenario with existing measures

RES share, %	2020.	S0 2030.	S0 2040.
In gross final consumption	28,3	35,8	40,0
U electricity consumption	46,7	62,2	74,3
U heating and cooling	37,6	35,2	33,4
U transport	1,3	13,2	19,9

The following figure shows the expected trajectories (shares) for the observed categories (total RES, RES in electricity, RES in heating and cooling and RES in transport) for the scenario with existing measures.

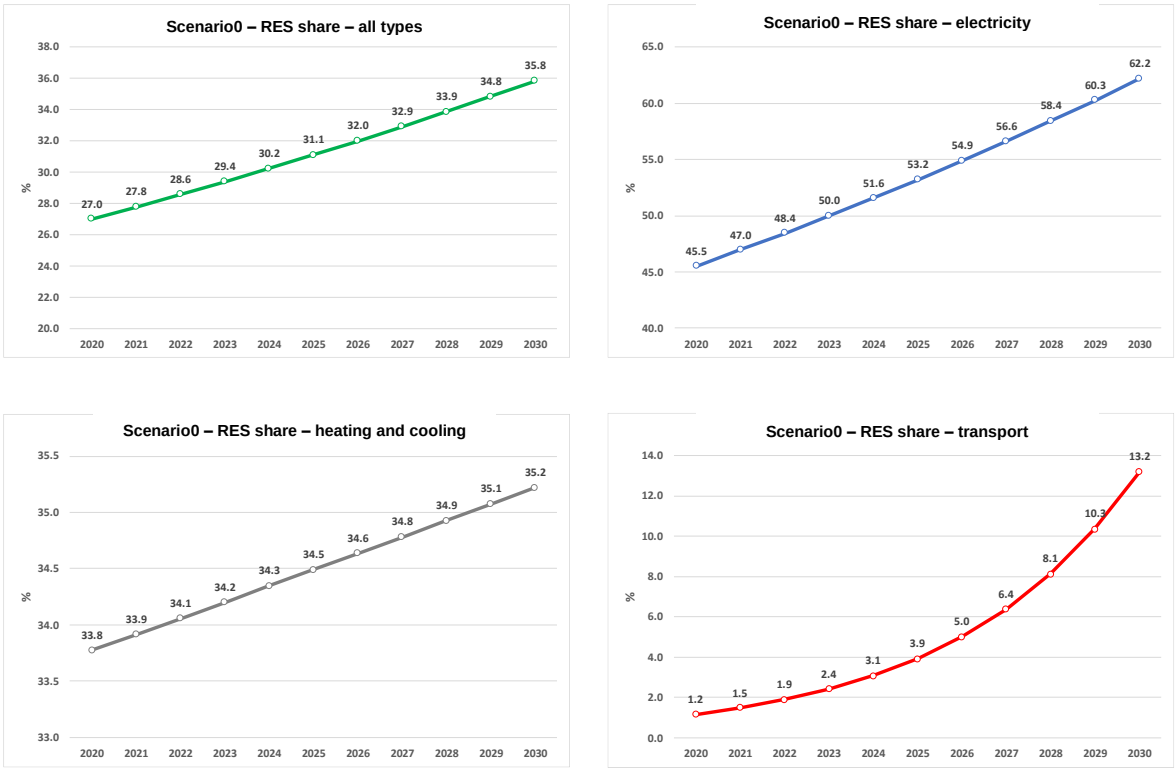

Figure 4-9: Expected trajectories of RES shares in the scenario with existing measures

Estimated contributions of technologies for obtaining energy from RES in the scenario with existing measures are presented in Figure 4-10, and in Tables 4-8 to 4-11.

Table 4-8: Estimated contribution of technologies for RES - Scenario with existing measures

ktoe	**2020**	2021	2022	2023	2024	2025	2026	2027	2028	2029	**2030**	**2040**
Gross final RES energy	**1950,0**	**2025,2**	**2100,4**	**2175,6**	**2250,8**	**2326,0**	**2401,2**	**2476,4**	**2551,6**	**2626,8**	**2702,04**	**2883,91**
Solar	**20,3**	20,9	21,6	22,2	22,9	23,5	24,1	24,8	25,4	26,1	**26,71**	**42,94**
Solid biomass	**1155,0**	1156,9	1158,7	1160,5	1162,3	1164,2	1166,0	1167,8	1169,6	1171,4	**1173,26**	**957,24**
Gaseous biofuels	**0,0**	0,1	0,2	0,4	0,5	0,6	0,7	0,8	1,0	1,1	**1,19**	**5,03**
Liquid biofuels	**2,0**	28,5	55,1	81,7	108,3	134,9	161,5	188,1	214,7	241,3	**267,90**	**304,50**
Geothermal	**9,8**	12,5	15,1	17,7	20,4	23,0	25,6	28,3	30,9	33,5	**36,18**	**54,19**
RES Heat	**30,5**	38,9	47,3	55,6	64,0	72,3	80,7	89,1	97,4	105,8	**114,15**	**139,92**
RES Electricity	**732,3**	767,4	802,4	837,4	872,5	907,5	942,5	977,6	1012,6	1047,6	**1082,65**	**1380,10**

Table 4-9: Estimated contribution of technologies for RES in electricity - Scenario with existing measures

ktoe	**2020**	2021	2022	2023	2024	2025	2026	2027	2028	2029	**2030**	**2040**
Gross final RES electricity	**755,9**	**788,5**	**821,2**	**853,9**	**886,6**	**919,3**	**951,9**	**984,6**	**1017,3**	**1050,0**	**1082,65**	**1380,10**
Hydro	**566,2**	570,0	573,8	577,6	581,4	585,2	589,0	592,8	596,6	600,4	**604,19**	**645,72**
Wind	**148,1**	159,3	170,5	181,7	193,0	204,2	215,4	226,6	237,8	249,0	**260,26**	**382,84**
Solar PV	**11,5**	16,1	20,7	25,4	30,0	34,6	39,2	43,8	48,4	53,1	**57,68**	**141,30**
Geothermal	**6,5**	7,6	8,6	9,6	10,7	11,7	12,8	13,8	14,8	15,9	**16,93**	**31,45**
Thermal - solid and gaseous biomass	**23,5**	35,5	47,5	59,5	71,5	83,5	95,6	107,6	119,6	131,6	**143,58**	**178,79**

Table 4-10: 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	2040
Gross final RES for heating and cooling	**1215,7**	**1229,2**	**1242,6**	**1256,1**	**1269,5**	**1283,0**	**1296,5**	**1309,9**	**1323,4**	**1336,8**	**1350,30**	**1194,28**
Solar	**20,3**	20,9	21,6	22,2	22,9	23,5	24,1	24,8	25,4	26,1	**26,71**	**42,94**
Solid biomass	**1155,0**	1156,9	1158,7	1160,5	1162,3	1164,2	1166,0	1167,8	1169,6	1171,4	**1173,26**	**957,24**
Geothermal	**9,8**	12,5	15,1	17,7	20,4	23,0	25,6	28,3	30,9	33,5	**36,18**	**54,19**
Heat RES	**30,5**	38,9	47,3	55,6	64,0	72,3	80,7	89,1	97,4	105,8	**114,15**	**139,92**

Table 4-11: Estimated contribution of technologies for RES in transport - Scenario with existing measures

kten	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2040
Gross final RES in transport	**17,6**	**44,9**	**72,2**	**99,5**	**126,8**	**154,0**	**181,3**	**208,6**	**235,9**	**263,2**	**290,43**	**364,49**
Biofuels	**2,0**	28,7	55,4	82,1	108,8	135,5	162,2	188,9	215,7	242,4	**269,09**	**309,53**
RES Electricity	**15,7**	16,3	16,8	17,4	18,0	18,5	19,1	19,6	20,2	20,8	**21,34**	**54,97**

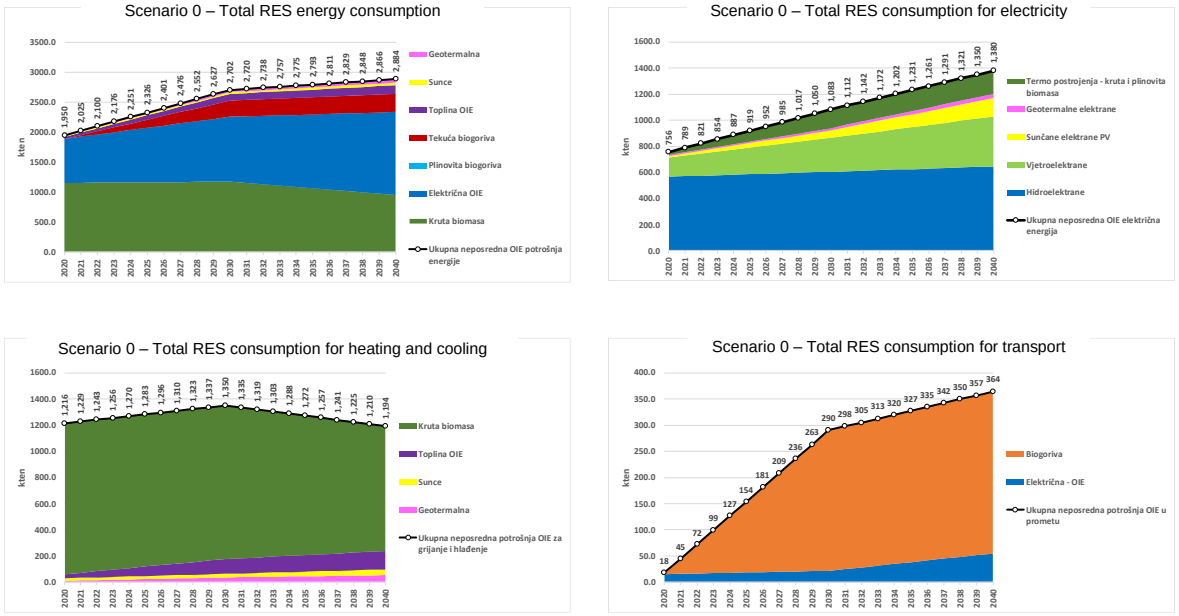

Figure 4-10: Estimated contributions of RES technologies by sector - Scenario with existing measures

The expected structure of power plant capacity for the production of electricity in the scenario with existing measures is presented in Table 4-12 and Figure 4-11.

Table 4-12: Expected power plant capacity in the scenario with existing measures

MW	Hydro	Gas	Oil	Coal	Nuclear*	Biomass	Geotherm.	Wind	Solar	Total
2020.	2125	799	501	192	348	154	10	734	72	4934
2021.	2125	799	501	192	348	171	10	759	95	4999
2022.	2125	799	501	192	348	170	10	784	117	5045
2023.	2125	1099	501	192	348	166	10	809	140	5389
2024.	2158	1099	501	192	348	161	10	834	162	5465
2025.	2158	1099	501	192	348	156	17	859	185	5514
2026.	2536	1049	303	192	348	156	17	897	222	5719

2027.	2536	1049	303	192	348	155	17	934	260	5793
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
NB: Nuclear power plant Krško located in Slovenia, 50% owned by Croatia, 50% of produced electricity used in Croatia										

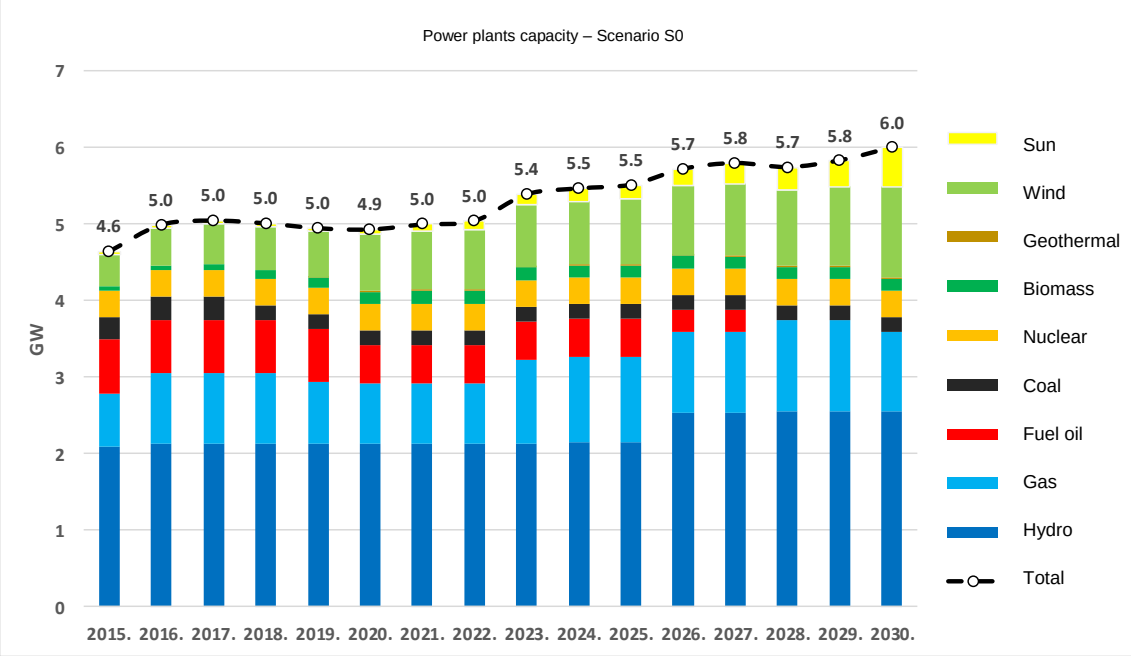

Figure 4-11: Expected power plant capacity in the scenario with existing measures

5.3. 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 2016 and they are presented in Table 4-13 and Table 4-14.

Table 4-13: The structure of primary and final energy consumption by sector in 2016

2016	PJ	ktoe
PRIMARY ENERGY CONSUMPTION	**405.34**	**9,681.38**
Transformation losses	74.56	1,780.84
Operational consumption	22.88	546.48
Transport and distribution losses	9.20	219.74
Non-energy consumption	21.58	515.43
FINAL ENERGY CONSUMPTION	**277.12**	**6,618.90**
Industry	40.30	962.55

Transport	90.71	2,166.57
Residential	100.70	2,405.18
Service	31.59	754.51
Agriculture	9.78	233.59
Construction	4.05	96.73

Table 4-14: The structure of primary and final energy consumption by energy product

2016	PJ	Ktoe
PRIMARY ENERGY CONSUMPTION	**405.34**	**9,681.38**
Coal and coke	32.14	767.65
Wood and biomass	52.47	1,253.22
Liquid fuels	130.78	3,123.63
Natural gas	91.08	2,175.41
Water power	65.63	1,567.55
Electricity	19.91	475.54
Thermal energy	0.66	15.76
Renewable sources	12.68	302.86
FINAL ENERGY CONSUMPTION	**277.12**	**6,618.90**
Coal and coke	7.71	184.15
Wood and biomass	48.52	1,158.88
Liquid fuels	111.95	2,673.88
Natural gas	35.06	837.39
Electricity	55.04	1,314.61
Thermal energy	18.20	434.70
Renewable sources	0.64	15.29

Source: Annual Energy Report - Energy in Croatia 2016, Ministry of Environment and Energy, December 2017

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 of 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 district heating systems 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 4-15.

Table 4-15: Potentials for use of high-efficiency cogeneration and efficient district heating and cooling

Indicator	Unit	Conservative scenario for 2030	Optimistic scenario for 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 consumers of district heating system	%	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
Potentially produced electricity	GJ	8,653,115	26,125,941
	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 considering existing policies, measures and programmes, as described in 1.2. (ii), for primary and final energy consumption for each sector at least until 2040 (including for the year 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 4-12.

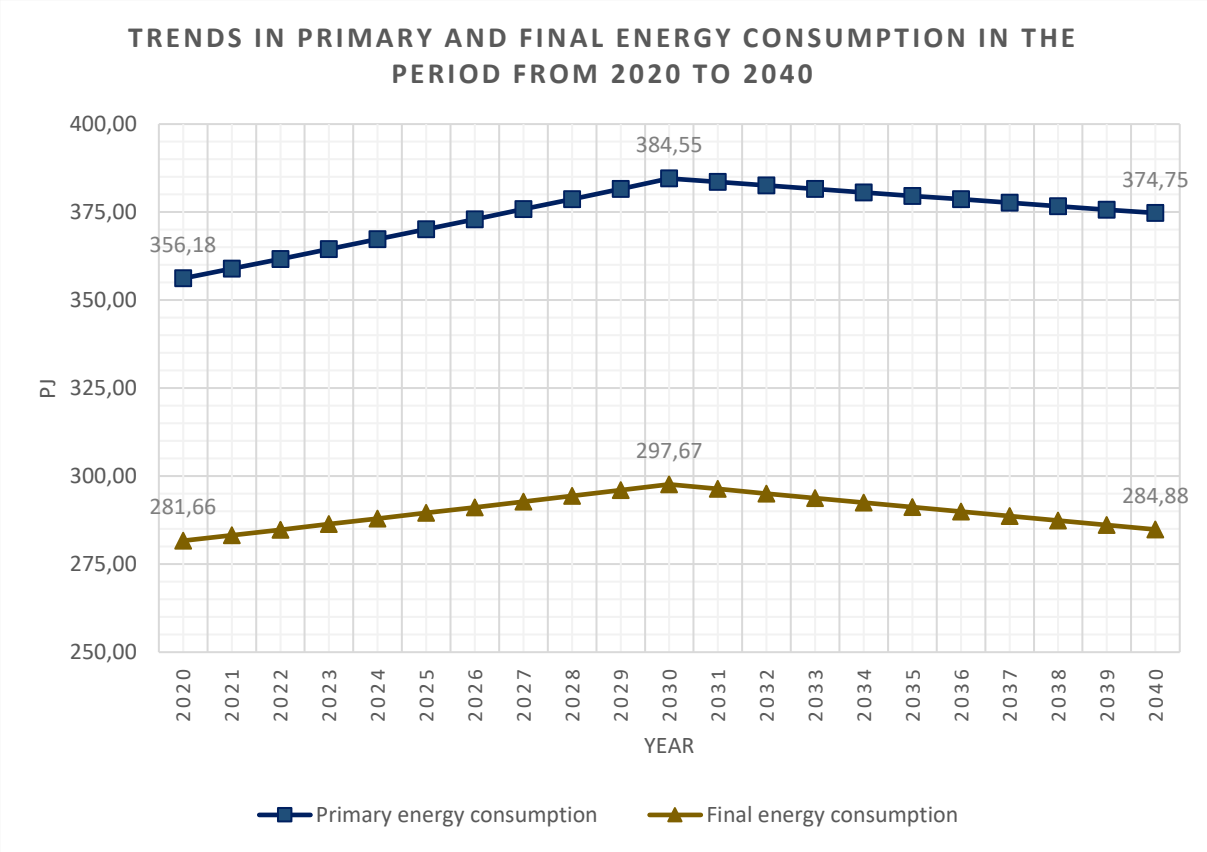

Figure 4-12: Projection of energy consumption by 2040 with existing policies, measures and energy efficiency programmes

iv. Cost-optimal levels of minimum energy performance requirements resulting from national calculations, according to 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-apartment) and non-residential buildings (offices, educational buildings, wholesale and retail trade buildings, hospitals, hotels, restaurants and sport halls)[4]. The energy performance is determined through maximum permissible primary energy for buildings, using a number of additional parameters that define more precisely the behavior of a building (required energy, thermal transmittance of the external envelope, share of RES, efficiency 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 upgrade the calculation method for determination of the energy performance of buildings. The results of this cycle of optimization 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.

5.4. Dimension: energy security

The current structure (2016) and expected primary energy production for the Scenario with existing measures is presented in the following table and figure.

Table 4-16: Expected primary energy production - Scenario with existing measures

PJ	Liquid fuels	Natural gas	Renewable sources	Non-renewable waste	Total
2016	31.72	57.32	96.04	0.41	**185.49**
2030	35.85	49.52	122.94	0.45	**208.75**
2040	29.27	43.84	136.89	0.42	**210.42**

[4] All reports according to Article 5 (2) of Directive 2010/31/EU and Article 6 of Regulation (EU) 244/2012 of 16 January 2012 on minimum requirements for the energy performance of the above-mentioned types of buildings are available on the website of MoCPP: http://mgipu.hr/default.aspx?id=12841 (date of access: 27 November 2018)

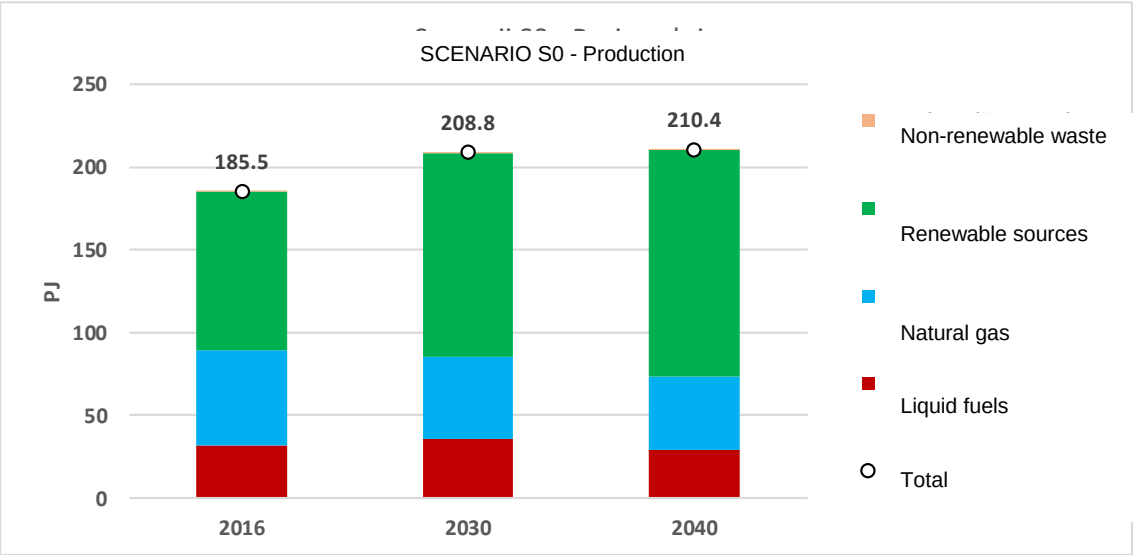

Figure 4-13: Expected primary energy production - Scenario with existing measures

Future domestic production of fossil energy (crude oil and natural gas) will depend on the opening and development of new fields. Without additional production, all the fields existing today will stop working by 2030/2035.

The current structure (2016) and expected total energy consumption (production + import - export) for the Scenario with existing measures is presented in the following table and figure.

Table 4-17: Expected total energy consumption - Scenario with existing measures

PJ	Coal	Liquid fuels	Natural gas	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**

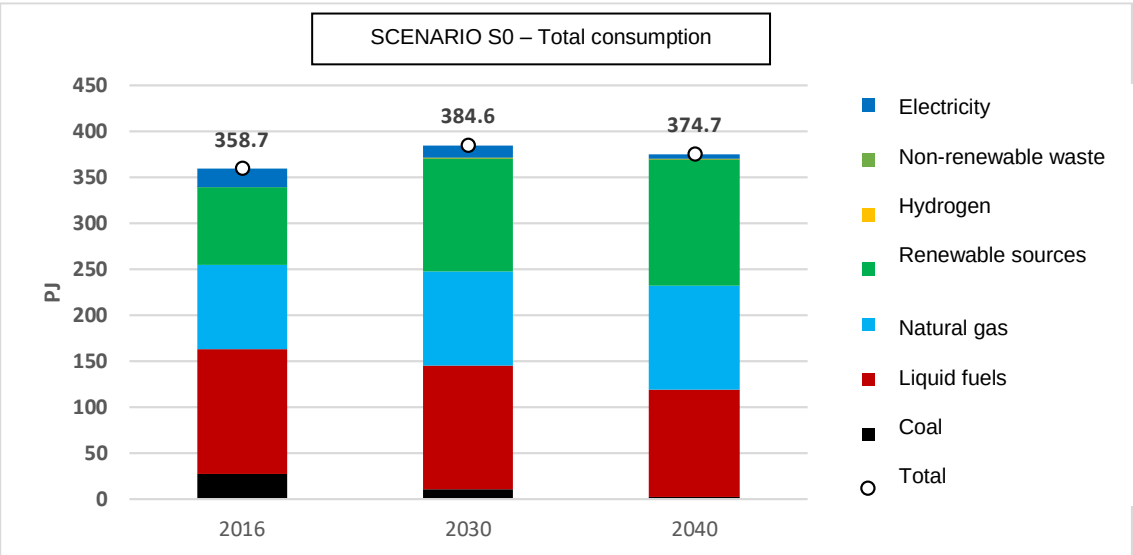

Figure 4-14: Expected total energy consumption - Scenario with existing measures

Self-supply according to the Scenario with existing measures increases, but this increase depends mostly on opening new production fields for crude oil and natural gas.

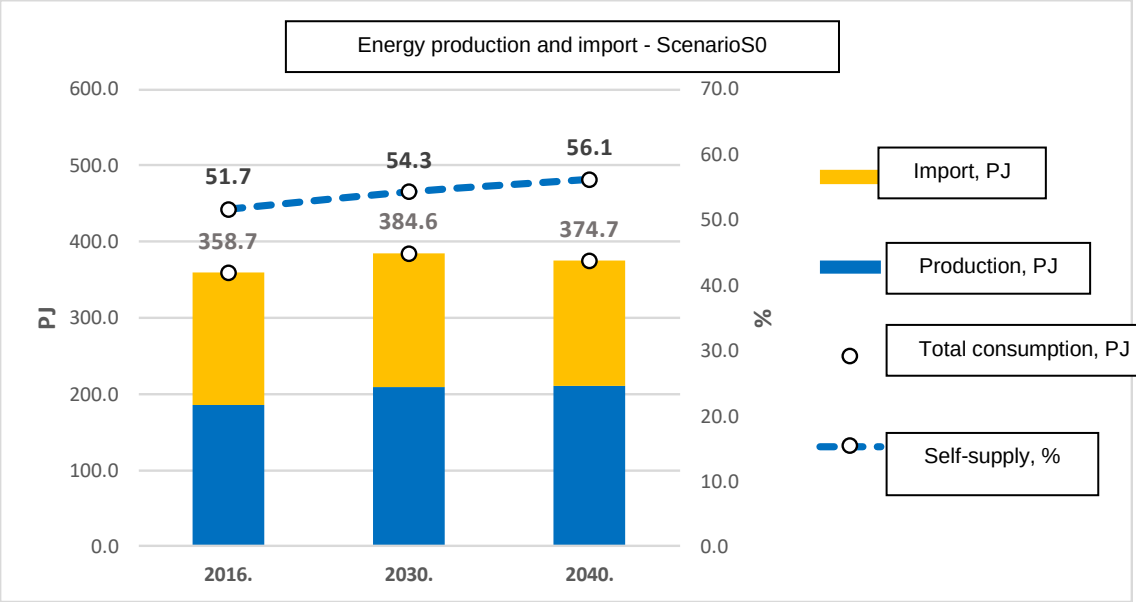

Figure 4-15: Expected energy production, energy import and self-supply with all forms of energy - Scenario with existing measures

5.5. Dimension: internal energy market

5.5.1. Power interconnectivity

- Current interconnection level and main interconnectors

The Croatian power system is connected with 400 kV, 220 kV and 110 kV voltage levels to the systems of neighboring countries. With 400 kV transmission lines (a total of seven transmission lines of which three are double and four are single), the Croatian power 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 neighboring 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). Good connection with neighboring systems enables more significant export, import and transmission of electricity through the transmission network, and makes the Republic of Croatia an important link between the power systems of Central and South East Europe.

- Projections of the requirement to increase the number of interconnectors by at least 2040 (including projections for 2030)

By 2030, the construction of a new 400 kV interconnector Lika - Banja Luka is possible, that would further connect the power systems of Croatia and Bosnia and Herzegovina. At the moment, technical and economic evaluations of profitability of its construction are in the preparation.

Regarding additional new interconnectors, at the level of ENTSO-E, the possibility and justification of the construction of the following lines are currently analyzed:

- 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 the following new interconnectors is possible:

- HVDC Croatia (Konjsko) – Italy;
- 400 kV transmission line Konjsko (Republic of Croatia) – Mostar 2 (Bosnia and Herzegovina);
- 400 kV transmission line Melina (Republic of Croatia) – Divača 2 (Slovenia);

5.5.2. Energy transmission infrastructure

- Key characteristics of the existing transmission infrastructure for electricity and gas

The electricity transmission network 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 network connects power plants and larger consumer centers, or distribution network, 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 network contains around 200 substations of 400/220/110 kV, 400/110 kV, 220/110 kV and 110/x kV. The backbone of the transmission

network is 400 kV network that connects the wider Osijek, Zagreb, Rijeka and Split areas, a significant number of large production facilities is connected to 220 kV network that connects certain regions within the country, while 110 kV network connects local areas and serves to supply the distribution network or large customers directly connected to this voltage level, where part of power plants/generators is connected also to 110 kV network.

The transmission network is managed by HOPS d.o.o. that is also responsible for developing the transmission network, as well as for guiding and managing the entire power system. All this is conducted from the National Dispatch Center (NDC) and four regional management centers. 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 network, 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.

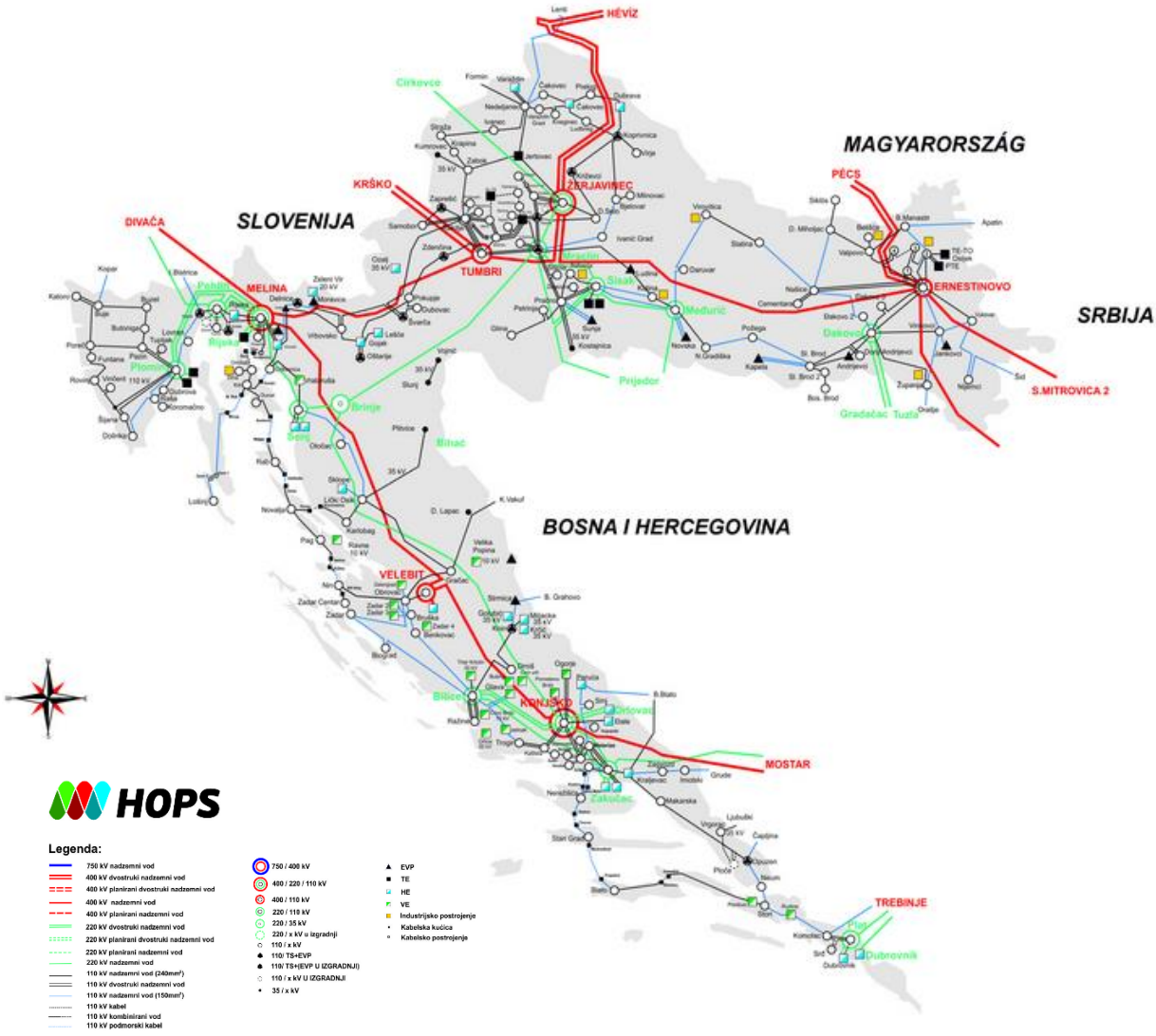

Figure 4-16. Croatian power system transmission network

Source: HOPS /Croatian Transmission System Operator/

The transmission network 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 network planning and operational management of the system. The transmission network 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 network 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 network of power plants of a total power of around 4 600 MW, the construction of the transmission network 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 network (order of magnitude up to 1 GWh). The electricity quality from the transmission network 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.

Inadequate characteristic of the transmission network is the relatively high share of old plants and network units, especially with voltage levels of 110 kV and 220 kV, which HOPS plans to systematically renovate and revitalize in the next period. Despite this, existing reliability indicators are at a very high level with relatively low annual electricity losses (below 500 GWh), having regard to high transmissions to which the network 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 neighboring 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.

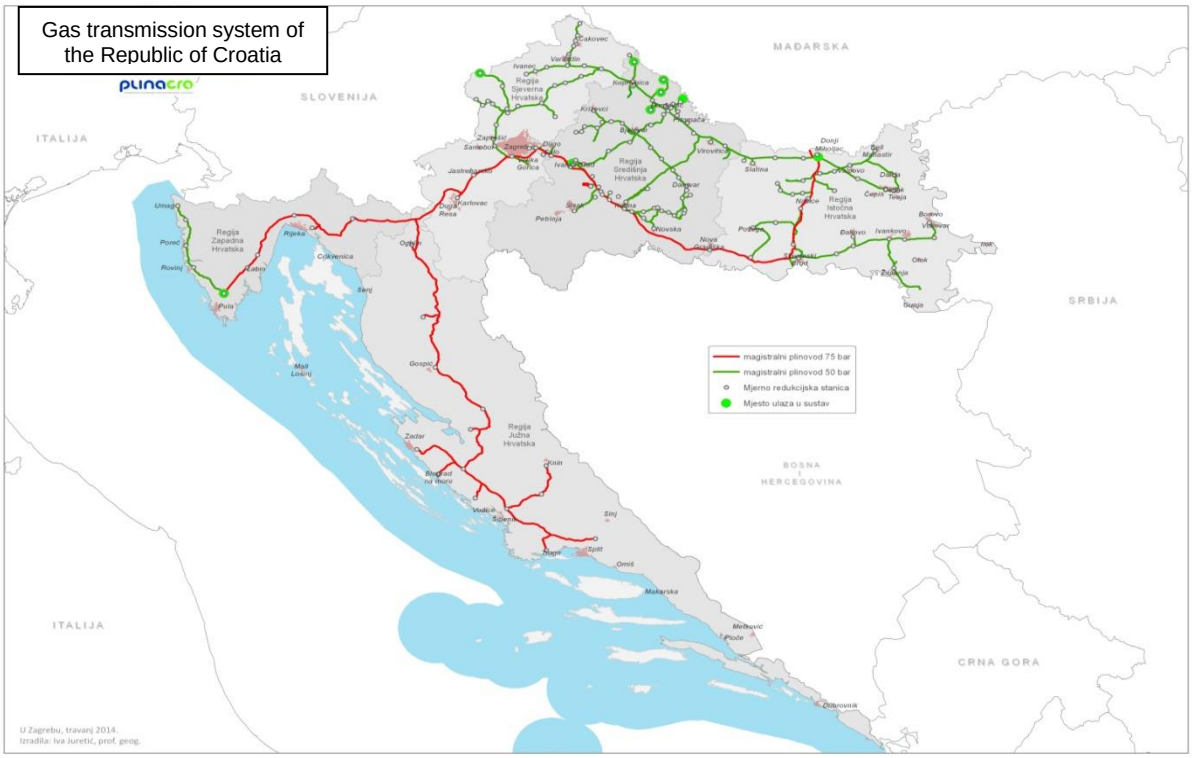

Figure 4-17: Gas transmission system in the Republic of Croatia

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.

- Projections regarding the requirements for expansion of the network at least by 2040 (including projections for 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 network development** should be determined taking into account the following:

- peak load at the level of transmission network 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 network of a new hydropower plant (power of around 36 MW) is planned in 2024, connector to 220 kV network (400 kV) of another hydropower plant (power of around 380 MW) is planned in 2026, and the construction and connector to 110 kV network of a new pumped-storage hydroelectric power plant (power of around 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 network,
- 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 network (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 network 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.

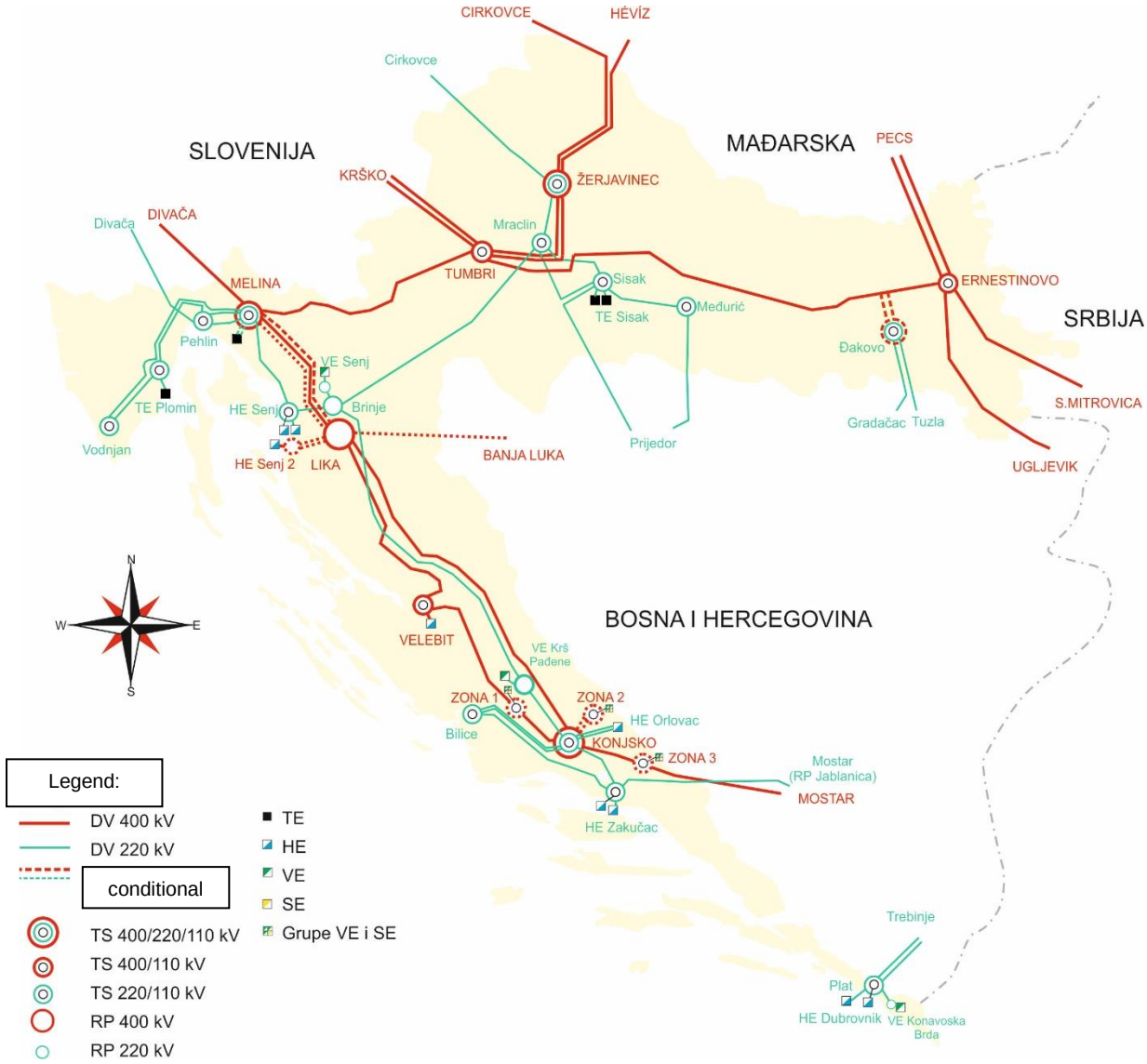

Figure 4-18: Predictable topology of 400 kV and 220 kV network on the territory of the Republic of Croatia in 2030

Besides a large part of investments already contained in the official ten-year development plan of the transmission network for the period 2018-2027, additional network reinforcements requiring larger investments are the following:

- increase of transmission power of 220 kV transmission line Konjsko - Krš Pađene - 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 hydropower plant network 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 network, through which the energy produced by wind and solar power plants would be transmitted through 400 kV network in remote areas, in the case where 110 kV network 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 network)
- 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 power system in a way to ensure the security of electricity supply, in the future, it will have to follow the functioning of the power 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.

The need to implement development projects for the expansion of the gas pipeline network is related to the implementation of projects for new gas supply routes, primarily to the implementation of the project of the liquefied natural gas terminal on the island of Krk. The implementation of projects for new gas supply routes requires significant investments in the gas pipeline infrastructure. The purpose of these projects is to provide sufficient capacity on the main transport-transit routes of the gas transmission system, ensure two-way flow on interconnections with Slovenian and Hungarian transmission systems and ensure sufficient capacity on these interconnections in order to enable the gas transmission/supply from new supply projects to the markets of neighboring countries and to the domestic market. Consideration of the need for new transmission system capacities and the hydraulic simulation of gas transmission for specific years of the planning period was conducted for three scenarios:

1 - without the implementation of new supply projects for the liquefied natural gas terminal and Ionian-Adriatic Pipeline (IAP),

2 - with the implementation of the liquefied natural gas terminal project on the island of Krk,

3 - with the implementation of the liquefied natural gas terminal project and Ionian-Adriatic Pipeline (IAP).

Below is a table showing the required implementation and entry into service of the planned projects.

Table 4-18: Required implementation and year of entry into service of the planned projects

	Required construction and entry into service of new gas transmission system capacities			
	2020	**2021**	**2023**	**2027**
Scenario 1	CS1 Velika Ludina	No new capacity is needed	No new capacity is needed	No new capacity is needed
Scenario 2	Zlobin - Omišalj; CS1 Velika Ludina	Zlobin - Bosiljevo; Bosiljevo - Sisak; Kozarac - Sisak	Kozarac - Slobodnica	No new capacity is needed
Scenario 3	As Scenario 2	As Scenario 2	Lučko - Zabok Zabok - Jezerišće Jezerišće - Sotla	No new capacity is needed

Development projects of the transmission gas system operator are divided into the following groups: gas pipelines, measuring-reduction stations, gas nodes, abandoning non-functional facilities, compressor stations, control and management system, technical protection system, production facilities and development of new technologies.

5.5.3. Electricity and gas markets, energy prices

- Current situation of electricity and gas markets, including energy prices

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 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.

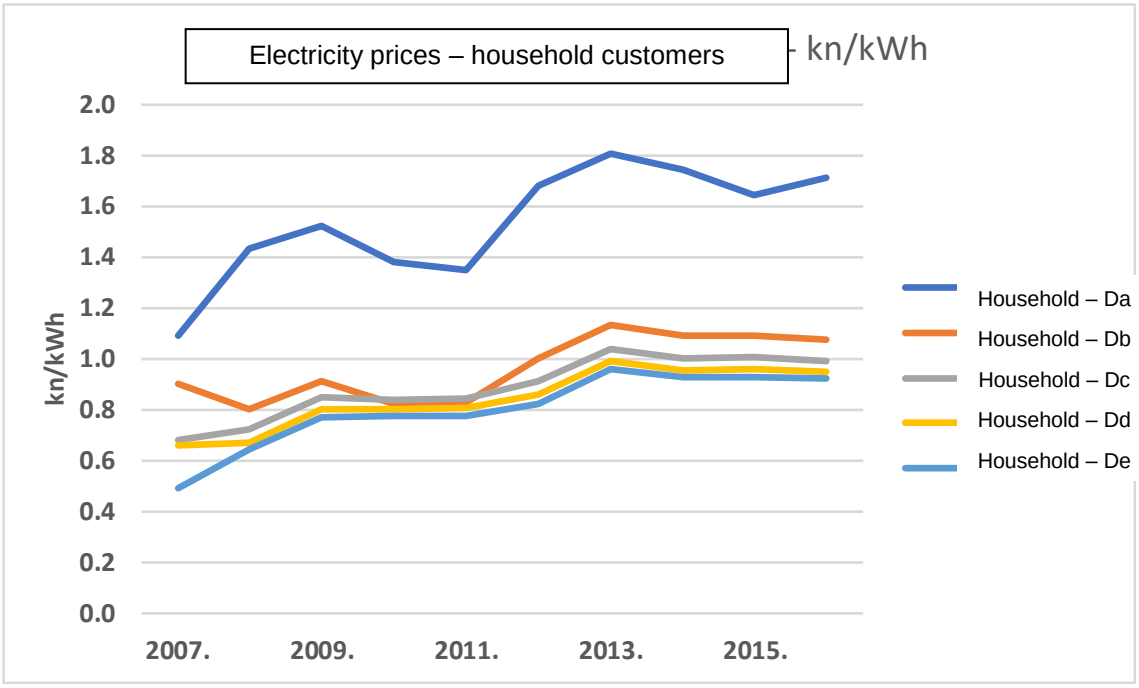

Figure 4-19: Electricity prices for household customers in Croatia

Source: Eurostat

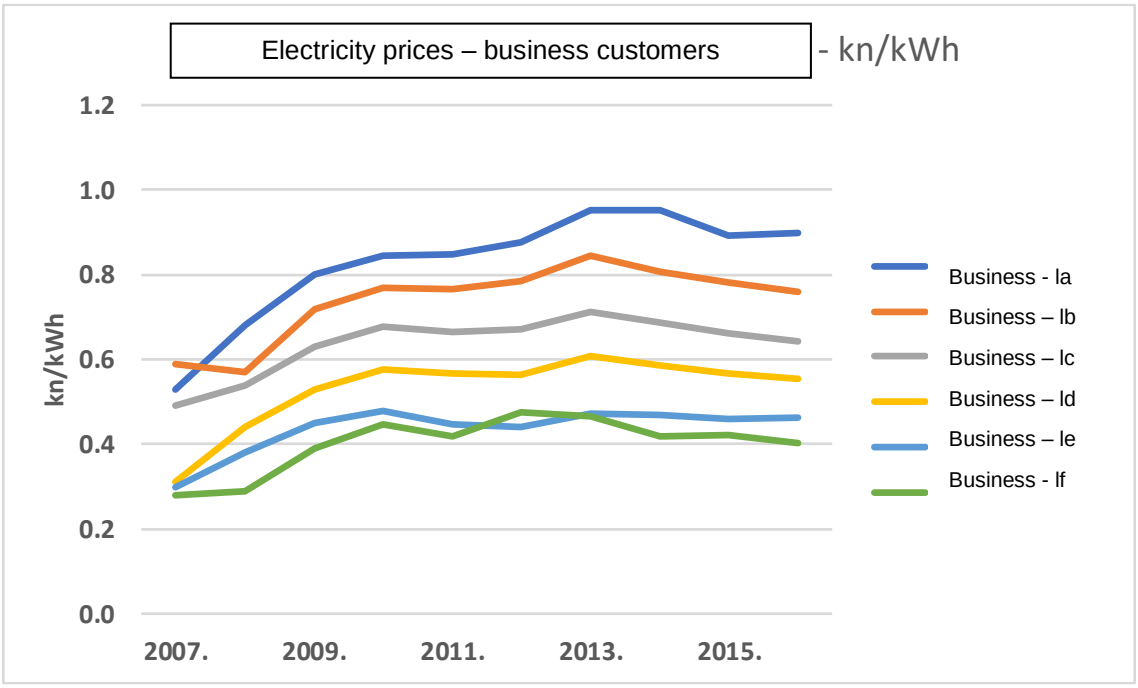

Figure 4-20: Electricity prices for business customers in Croatia

Source: Eurostat

Historical prices of natural gas for household and business final customers are presented below, according to Eurostat data. Natural gas prices for household customers include value added tax, while natural gas prices for industrial customers are expressed without VAT.

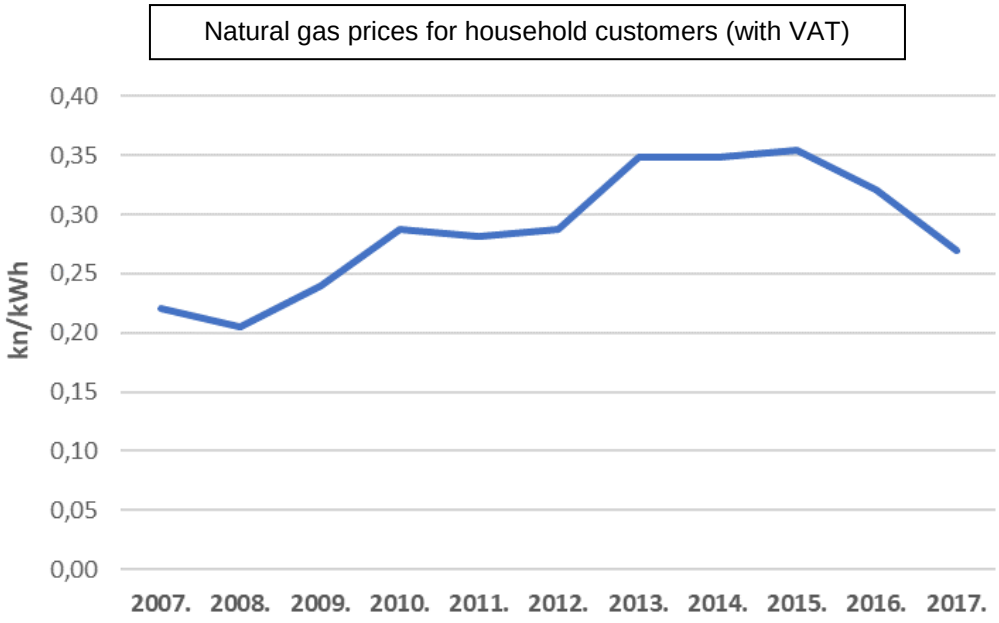

Figure 4-21: Natural gas prices for household customers in Croatia

Source: Eurostat

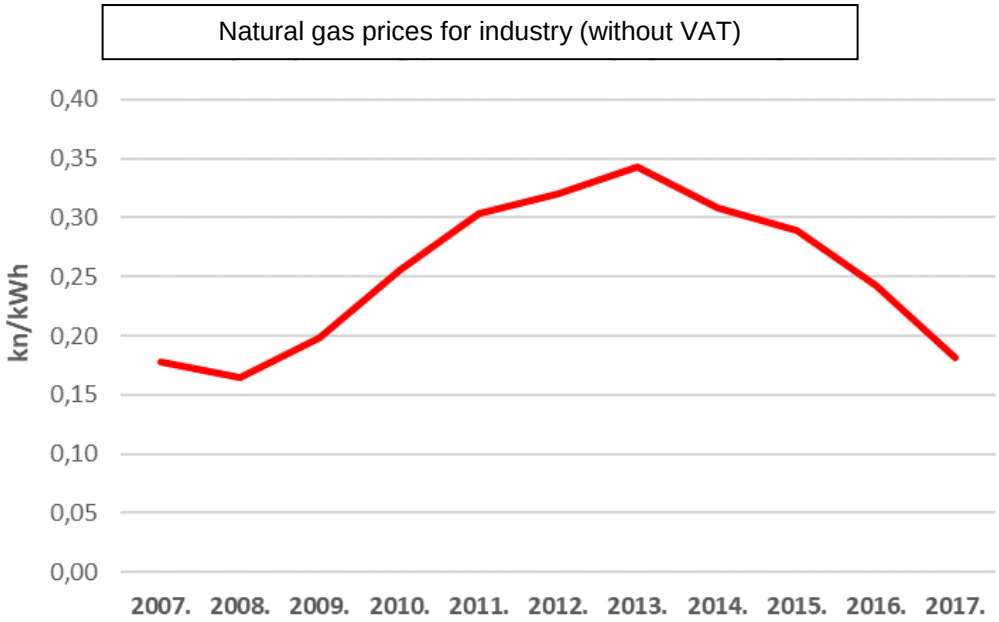

Figure 4-22: Natural gas prices for business customers in Croatia

Source: Eurostat

- Projections of trends with existing policies and measures at least by 2040 (including projections for 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 analyzed 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. It does not include the annuities of plants that are already in operation. By 2030, a gradual decrease in electricity import is assumed.

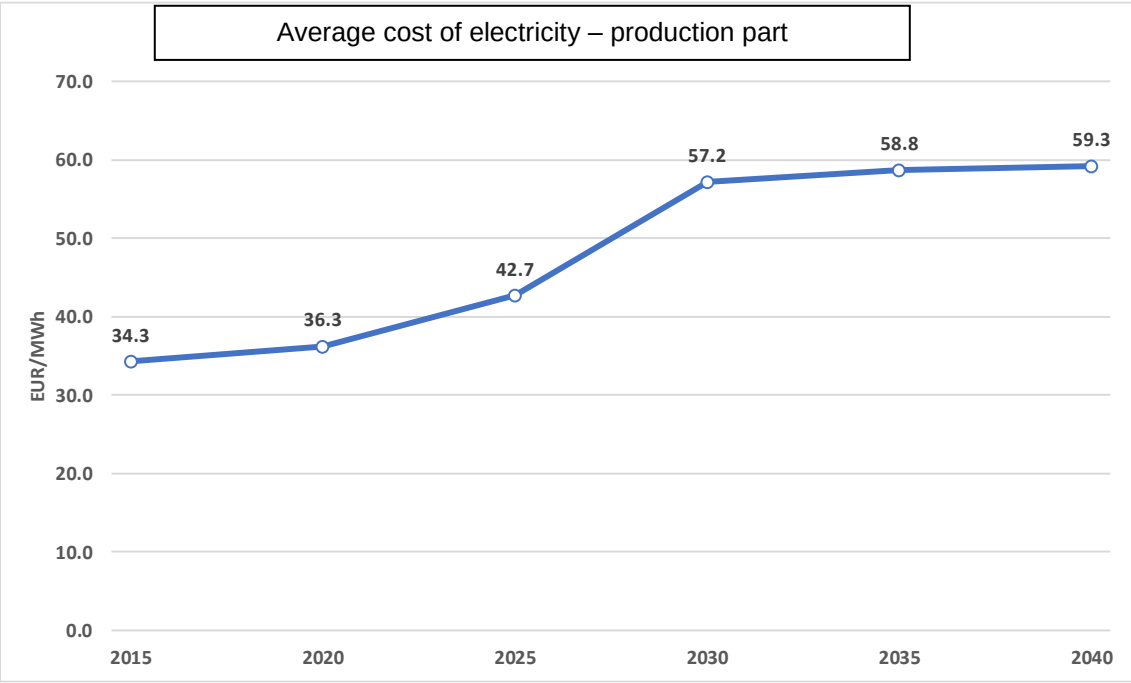

Figure 4-23: Electricity prices for business customers in Croatia

Below is the estimation of natural gas price trends by 2040 [18].

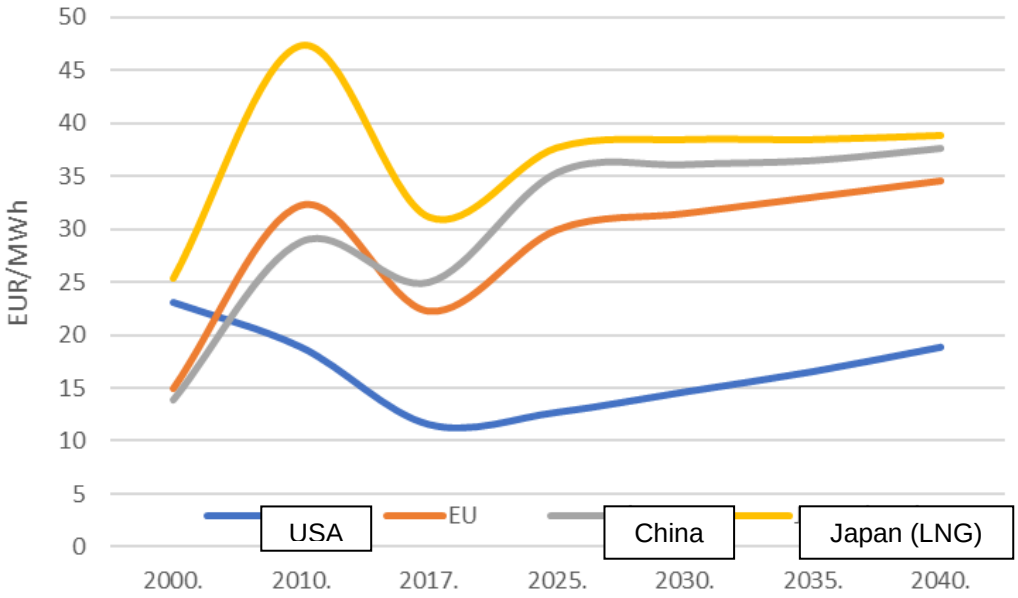

Figure 4-24: Projections of natural gas prices according to the World Energy Outlook 2018

5.6. Dimension: research, innovation and competitiveness

5.6.1. Current situation of low-carbon technologies and their position on the EU market

The area of low-carbon technologies is related, by thematic priority, to the area of energy and environment of the Smart Specialization Strategy. 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 systems (eg. 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:

- Energy technologies, systems and equipment,
- Ecologically acceptable technologies, equipment and advanced materials.

5.6.2. 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%.

In 2017, according to the data of the National Bureau of Statistics, 8,200 patents were valid in the Republic of Croatia. In 2017, 159 patent applications were presented to the State Intellectual Property Office. However, with regard to the number of applications in the period from 2013 to 2017, there was a noticeable decrease in patent applications (253, 200, 186, 188, 159), which indicates the reduction of patent activity in the Republic of Croatia.

A total number of employees in research and development in 2016 was 18,133, out of which 9,300 women (51.29%). 12,618 of them are researchers, while the rest are professional, technical and other employees. Out of the total number of employees in research and development, 18.86% were employed in the business sector, 22.76% in the state and private non-profit sector, and 58.38% in higher education institutions.

6. ASSESSMENT OF IMPACTS OF PLANNED POLICIES AND MEASURES

6.1. Impacts of planned policies and measures described in section 3 on energy system and greenhouse gas emissions and removals

- The projections of trends in view of the energy system, emissions and greenhouse gas elimination as well as, if relevant, air pollutants emission in accordance with the Directive (as proposed in the document COM72013/0920) within the framework of planned policies and measures, including relevant EU policies and measures, at least until 10 years after the period covered by the plan (including the projections for the last year of the period covered by the plan).
- The assessment of policies interaction (interaction between existing and planned policies and measures within the framework of a single dimension, and interaction between existing and planned policies and measures of various dimensions) at least until the least year of the period covered by the plan.

Projections of GHG emissions from stationary and mobile energy sources in the Republic of Croatia are given in Figure 6-1. A 'with existing measure' scenario and a 'with additional measures' scenarios are presented.

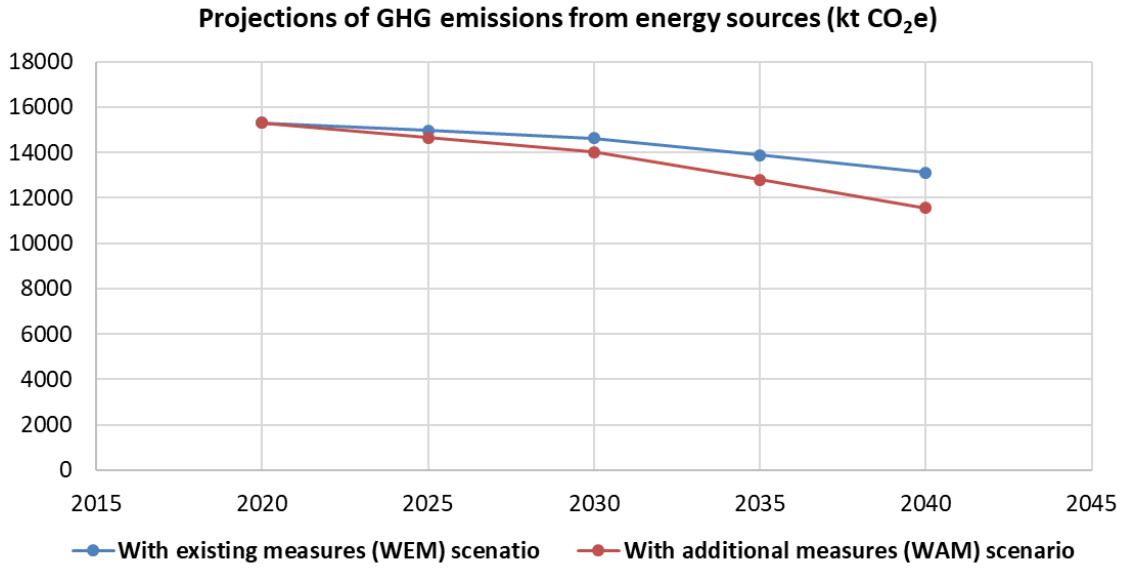

Figure 6-1. Projections of GHG emissions for the 'with existing measure' scenario and the 'with additional measures' scenario - energy sources

The potential of additional measures in regard to emission reduction by energy sector is depicted in Table Table 6-1, and it represents the difference in emissions between the 'with existing measure' scenario and the 'with additional measure' scenario.

Table 6-1: The potential for GHG emissions reduction using additional measures for energy sources

CO_2e (kt) emission reduction	2025	2030	2035	2040
Energy industries	129	258	366	474
Manufacturing industries and construction	32	64	119	174
Transport	42	85	166	247
Other sectors	107	213	388	562
Fugitive emissions from fuels	-3	-6	44	95
Emission reduction potential - energy sources	**307**	**614**	**1083**	**1552**

The projections of GHG 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, are presented in Figure Figure 6-2. For the 'with existing measures' scenario, the reference scenario (NUR) was selected, and for the 'with additional measures' scenario, the gradual transition scenario (NU1) was selected.

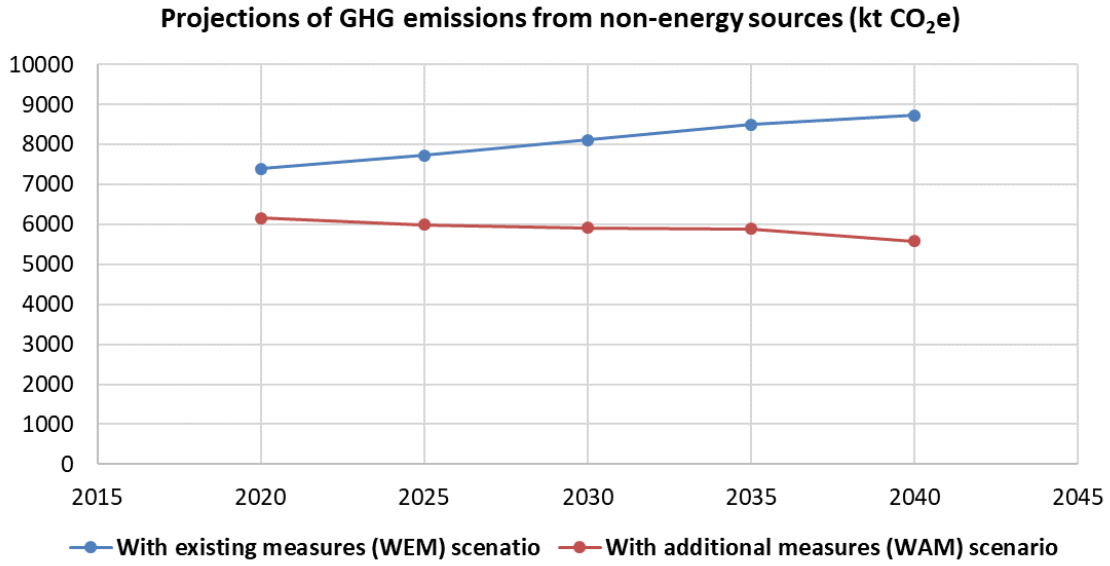

Figure 6-2. Projections of GHG emissions for the 'with existing measures' scenario and the 'with additional measures' scenario - non-energy sources

The potential of additional measures in regard to reduction of emissions for non-energy sectors is presented in Table 6-2, and it represents the difference in GHG emissions between NUR and NU1 scenarios.

Table 6-2: The potential for GHG emissions reduction using additional measures for non-energy sources

CO_2e (kt) emission reduction	2025	2030	2035	2040
Industrial processes	577	600	643	688
Agriculture	274	317	360	576
Waste	888	1283	1599	1873
Emission reduction potential - non-energy sources	**1738**	**2200**	**2602**	**3137**

The total GHG emissions in the Republic of Croatia, for the two analysed scenarios, are depicted in Figure 6-3. The figure shows the trend of historical emissions and of the expected emission reduction for the 'with existing measures' scenario and the 'with additional measures' scenario. The GHG emission would be 28.7 % to 37.5 % lower than the 1990 emission level, depending on the scenario. Greater emission reduction would be achieved with the accomplishment of the 'with additional measures' scenario.

During 2019, projections of GHG emissions from energy and non-energy sources will be mutually reconciled, so corrections are possible in view of emission projections.

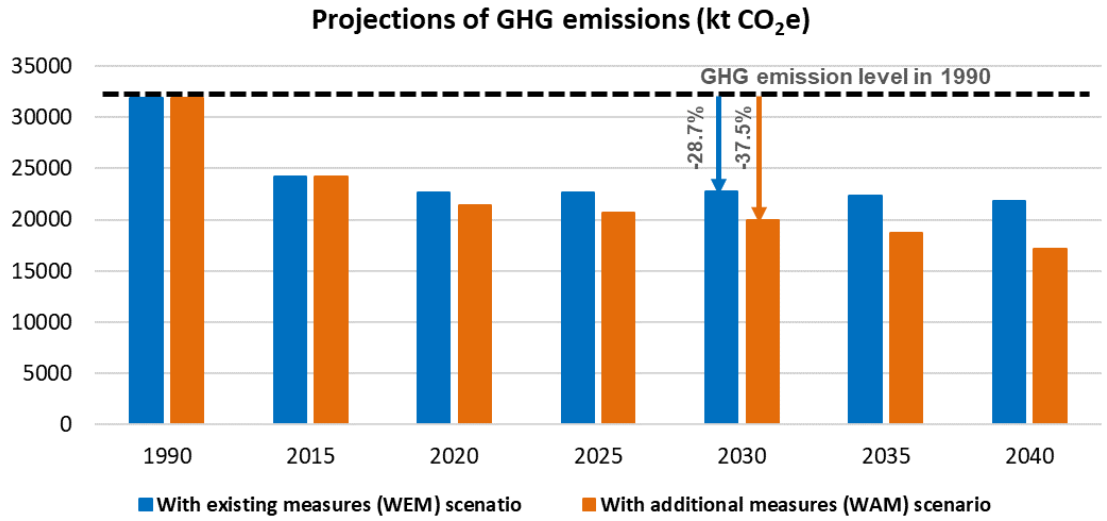

Figure 6-3. Projections of total greenhouse gas emissions for the 'with existing measures' scenario and the 'additional measures scenario'

With these scenarios, Croatia fulfils the obligation of non-ETS sectors GHG emission reduction for 2030 (-7 %). The non-ETS sector emission reduction would amount to 20.6-32.0 % by 2030 in relation to the 2015 emissions (Figure 6-4).

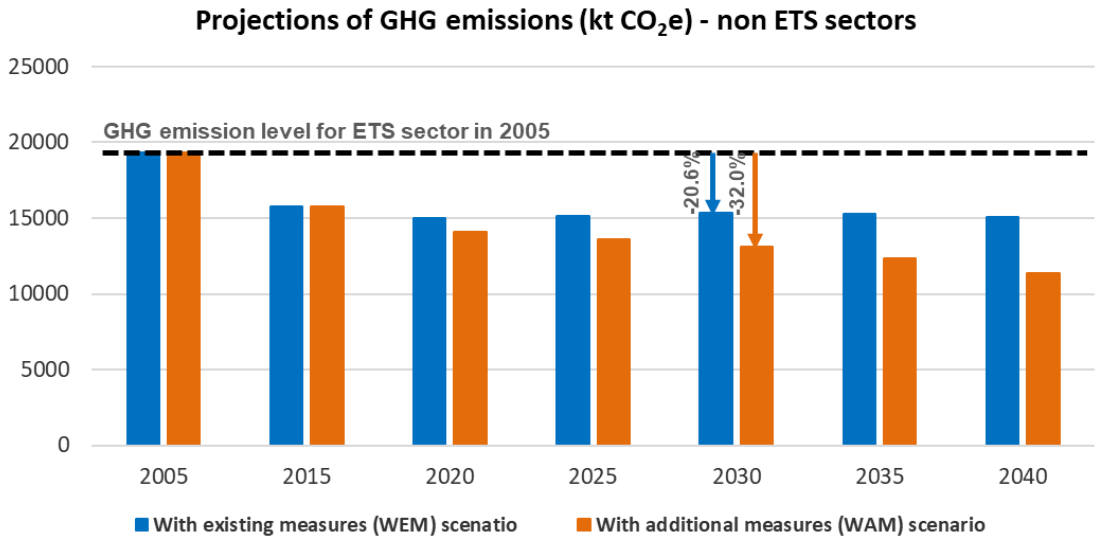

Figure 6-4. Projection of non-ETS sectors GHG emissions, for the 'with existing measures' scenario and the 'with additional measures' scenarios

The ETS sector GHG emission reduction in 2030 would be 30.1-35.8 %. The ETS sector GHG emission projection is depicted in Figure 6-5.

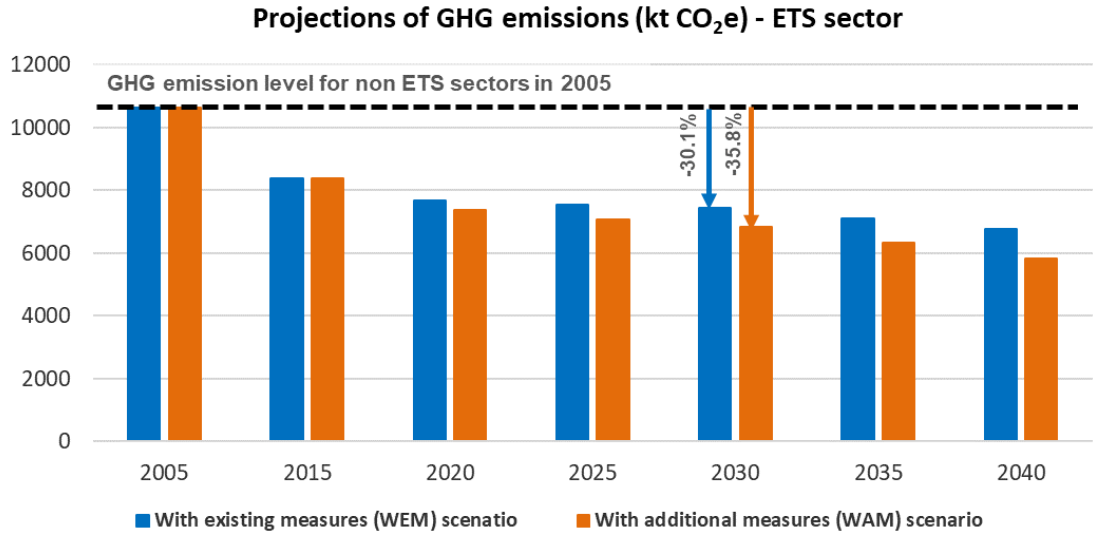

Figure 6-5. Projection of ETS sector GHG emissions, for the 'with existing measures' scenario and the 'with additional measures' scenario

The above figures show preliminary results of the consolidation of the projections for GHG emissions from energy sources according to the analyses conducted for the purpose of drafting the Energy Strategy and from non-energy sources in accordance with the proposal of the Low-Carbon Strategy. During 2019, those sources will be mutually reconciled, so corrections are possible in view of emission projections.

6.2. Macroeconomic and, to the extent feasible, the health, environmental, employment and education, skills and social impacts including the just transition aspects (in terms of costs and benefits as well as cost-effectiveness) of the planned policies and measures described in section 3

In preparation.

6.3. Impacts of planned policies and measures described in section 3 on other Member States and regional cooperation

In preparation.

7. REFERENCES

1. Analyses and basis for preparation of the Energy Strategy of the Republic of Croatia, Ministry of Environmental Protection and Energy, 2018.
2. State of the Environment Report in Croatia, Agency for Environment, 2014.
3. Proposal of a Low Carbon Development Strategy of the Republic of Croatia – for public consultations, Ministry of Environmental Protection and Energy, 2018.
4. Proposal of a Climate Adaptation Strategy for the period until 2040 with a view to 2070, Ministry of Environmental Protection and Energy, 2017.
5. Strategy of Education, Science and Technology, Ministry of Education, Science and Sports, 2014
6. Smart Specialization Strategy of the Republic of Croatia for the period 2016 . 2020, Ministry of Economy, 2016
7. Strategy for Stimulating Innovations of the Republic of Croatia 2014. -2020., Ministry of Economy, 2014.
8. Energy in Croatia 2016, Ministry of Environmental Protection and Energy, 2017.
9. Seventh National Communication and Third Biennial Report of the Republic of Croatia Under the United Nations Framework Convention on Climate Change, Ministry of Environmental Protection and Energy, 2018.
10. Croatian Greenhouse Gas Inventory for the Period 1990. - 2016. (NIR 2018), MZOE, 2018.
11. Rural Development Program of the Republic of Croatia from 2014 until 2020, Ministry of Agriculture, 2015.
12. National Action Plan for Renewable Energy Sources until 2020, Ministry of Environmental Protection and Energy, 2013.
13. 3rd National Energy Efficiency Action Plan from 2014 to 2016, Ministry of Environmental Protection and Energy, 2014
14. Draft of the 4th National Energy Efficiency Action Plan from 2017 to 2019, Ministry of Environmental Protection and Energy, 2017
15. Assessment of Potential for Increasing Energy Efficiency of the Electricity Infrastructure, EIHP, 2016
16. Long-term strategy for promotion of investments in the renovation of the national building stock, Ministry of Construction and Spatial Planning, 2017.
17. Akrap, A.; Ivanda, K.: Demoghraphic Projections in the Republic of Croatia, 2018.
18. World Energy Outlook 2018, International Energy Agency, 2018.

8. LIST OF ANNEXES

1. Annex 1: Reporting of used parameters and variables included in Annex 1, part 2, of the Energy Union Governance as agreed in trilogue (xls)
2. Annex 2: Measures and methods for implementing article 7 (doc)
3. Annex 3: Policies and measures (xls)
4. Annex 4: Reporting on GHG projections per IPCC sector and gas (xls),