

Implementation of bioenergy in Croatia - 2021 update

Country Reports

IEA Bioenergy: 10 2021



This report was prepared from the 2021 IEA World Energy Balances and Renewables Information, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members¹. Reference is also made to FAOstat and Eurostat data as well as data from national statistics. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report for all country reports.

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HIGHLIGHTS

- Renewables made up 25% of total energy supply in Croatia in 2019, of which two thirds is from biomass.
- Most biomass demand is for residential heating, where it represents 60% of fuel/heat demand.
- Hydropower is dominant in electricity production and there is an important share of electricity imports from neighbour countries (typically 30% of electricity consumption). Bioelectricity has a modest, but increasing share (next to wind power).
- The share of diesel in transport fuels still increases. So far, the role of biofuels in transport was modest. In 2019 there was an important increase of biodiesel, reaching an average share of 3.8% by energy in diesel fuel.
- Bioenergy related research is placed in a broader context of bioeconomy and climate actions by setting the scene for sustainable biomass supply solutions – bio hubs, supplying biomass from dedicated crops (Miscanthus, SRC) for 2nd generation biofuels and anaerobic digestion for curbing the GHG emissions from agriculture.

¹ While data for 2020 are starting to become available at national level, it was decided to consider trends up to 2019 for good comparability and benchmarking between the different IEA Bioenergy member countries. Care should also be taken when using 2020 data for analysing trends as these data are distorted by the COVID19 Pandemic.

COUNTRY PROFILE

Population and land use

Croatia is a country at the crossroads of Central and Southeast Europe and is member of the European Union. It has a total land area of 56.6 thousand km² and a small population of 4.1 million people. This represents a relatively modest population density of 73 persons per km².

Around one third of the land area is forest land. 25% is agricultural land, split between arable land and permanent meadows/pastures.

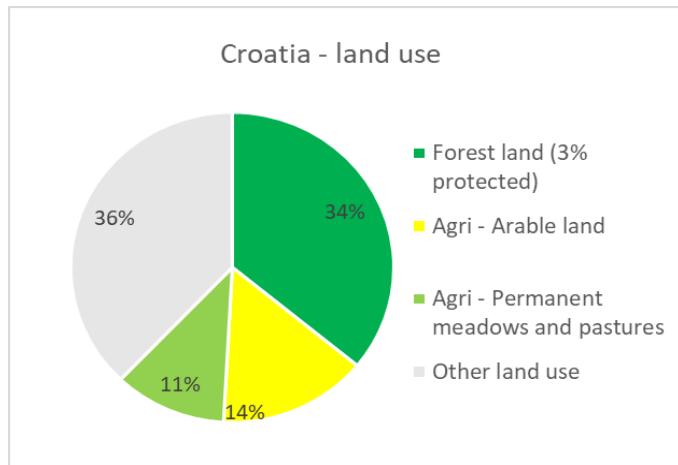


Figure 1: Land use in Croatia (2018 figures - Source: FAOstat)

Final energy consumption

Overall final energy consumption in Croatia (*also including non-energy use of oil, natural gas, and coal in industry*) comes down to 1.8 tonnes of oil equivalent (toe) per capita, which is lower than the average of IEA Bioenergy countries. Particularly industry has a very low share compared to other countries.

Table 1: Distribution of the final consumption of energy carriers by sector in Croatia (2019 figures - Source: IEA (2021) World Energy Balances and Renewables Information)

Final consumption energy carriers	Toe/capita (2019)	% of total	Median* (toe/capita)
Industry (energy use)	0.28	16%	0.67
Industry (non-energy use)	0.14	8%	0.21
Transport	0.54	31%	0.69
Residential	0.54	31%	0.57
Commercial & public services	0.20	11%	0.34
other	0.06	3%	
Total	1.76		2.34

* Median of the 25 member countries of IEA Bioenergy²

² Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

NATIONAL POLICY FRAMEWORK IN CROATIA

TARGETS AND STRATEGIES

Croatia has adopted a new Strategy for development of the energy sector by 2030 with a view to 2050. Based on this document and EU methodology, a National Energy and Climate Plan (NECP) was drafted in 2019, with revision in late 2020; in the near future a revision can be expected on share of heating and cooling in the near future. Also, in 2021, Croatia adopted a Strategy for low-carbon development by 2030 with a view to 2050. Targets for renewable energy and GHG reduction are presented in the table below.

*Table 2: renewable energy and climate targets in Croatia**

Sector	Share renewables in gross final consumption per sector	GHG reduction target compared to base year 2005
Overall target	36.6 % by 2030	at least 43 % in ETS sector, at least 7% by 2030 from other (non-ETS) sectors
Heating and cooling	36.6 % by 2030	Not specified
Electricity	63.8 % by 2030	Not specified
Transport	14.0 % by 2030	Not specified

* 2030 targets mentioned in the 2019 NECP are likely to be reviewed in the frame of the European Fit for 55 package

The NECP does not give specific GHG reduction targets per sector, but only overall an target for ETS and non-ETS sector.

An increase of the RES share in heating and cooling to 47.8 % is planned with the new revision of the NECP, in order to satisfy requirements set by the European Renewable Energy Directive. However, at the moment this document is in draft phase.

Bioenergy is included in the Zero emission scenario by 2050, with the following anticipated trends:

- The bioenergy share in the national energy mix is expected to remain stable by 2030 and decrease by 2050, given the expected raise in energy efficiency in buildings and phasing out traditional biomass for heating.
- The bioelectricity share is expected to remain constant, with more dynamic development from the stakeholders' side with small scale biogas plants that will not be much visible in the energy balances.
- Bioheat mostly consists of traditional biomass that will be phased out by 2050.
- The current wood pellets exports are to be used in the national system.
- The role of transport biofuels is aimed towards using renewable gases (biomethane) and 2nd generation biofuels.

The Ministry of Agriculture considers the establishment of bio-hubs to secure stable and quality supply of biomass to the bioeconomy, supporting cascading use of biomass.

A description of renewable energy and climate policies and measures in Croatia is available at the IEA's Policies and Measures Database: <https://www.iea.org/policies?country=Croatia>

Specific policies related to renewable electricity, renewable heat and transport biofuels will be highlighted in the chapters about the role of bioenergy in different sectors.

THE CONTRIBUTION OF BIOENERGY IN NATIONAL ENERGY SUPPLY

TOTAL ENERGY SUPPLY

The total energy supply (TES) of Croatia in 2019 amounted to 359 petajoules (PJ) and is dominated by fossil fuels (69%). Oil products account for 36% of the energy supply (129 PJ) and natural gas is contributing another 28% (101 PJ). The role of coal is limited to less than 5% (18 PJ). Electricity imports represent 6% of total energy supply.

Renewable energy sources have a share of merely 25% or 89 PJ. Around 67% of renewable energy supply in 2019 comes from biomass (60 PJ), followed by hydropower (21 PJ) and wind power (5 PJ).

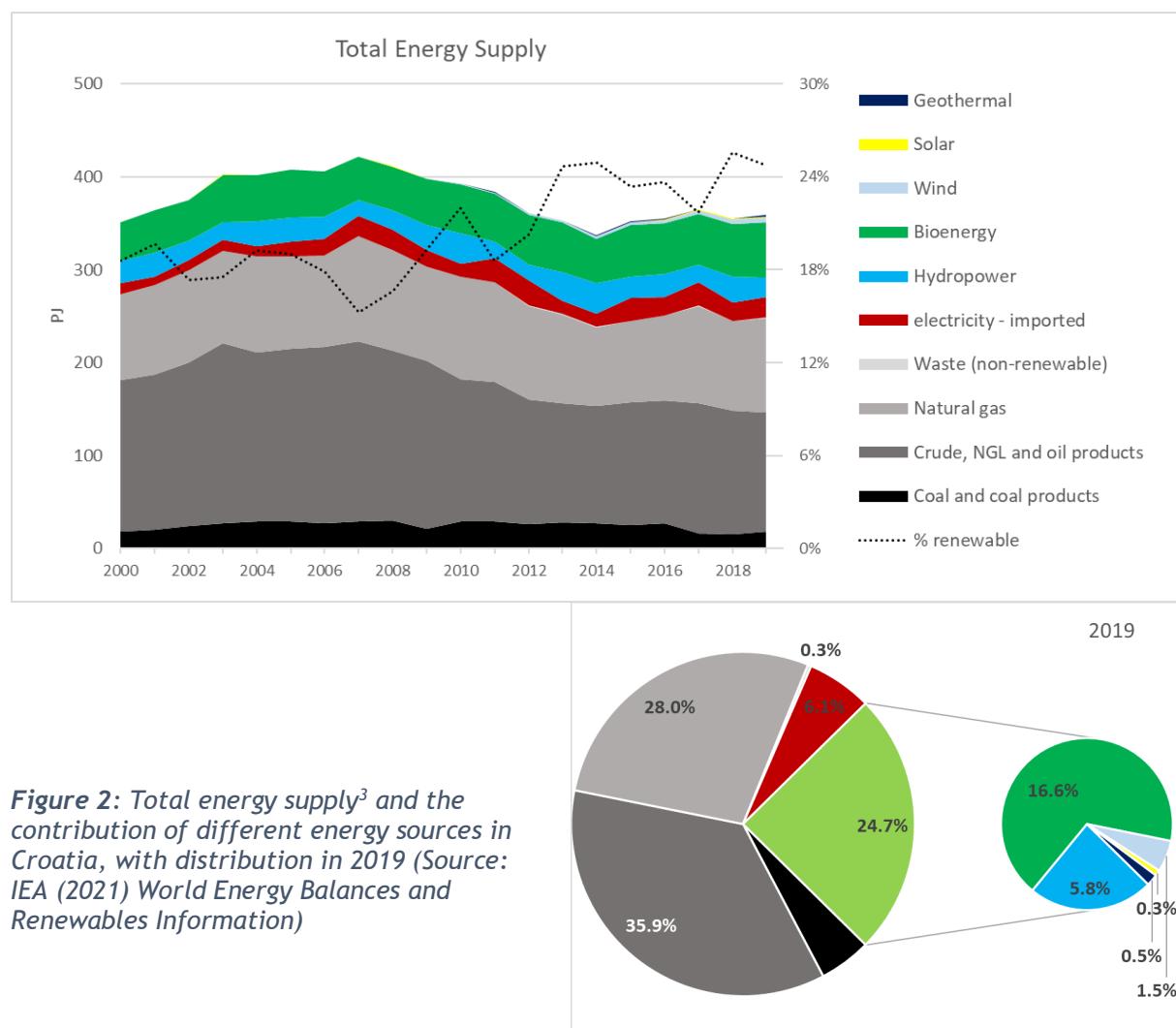


Figure 2: Total energy supply³ and the contribution of different energy sources in Croatia, with distribution in 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

³ Total energy supply refers to the use of resources. In terms of the role in the energy system this distribution overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear plants).

Since 2012 the amount of oil products has been fairly stable around 130 PJ, while coal went down from 30 to 18 PJ. Natural gas decreased from 100 to 85 PJ between 2012 and 2014 but has again recovered to 100 PJ in recent years.

Renewable energy saw some fluctuations (mainly related to hydropower fluctuations) but the long-term trend is slightly increasing from 20% of TES in 2012 to 25% in 2019. The overall share of bioenergy in total energy supply increased from 13% to 16% in the past 10 years, while hydropower fluctuated between 5 and 8%. Wind and solar combined increased from 0 to 1.5% in 10 years' time.

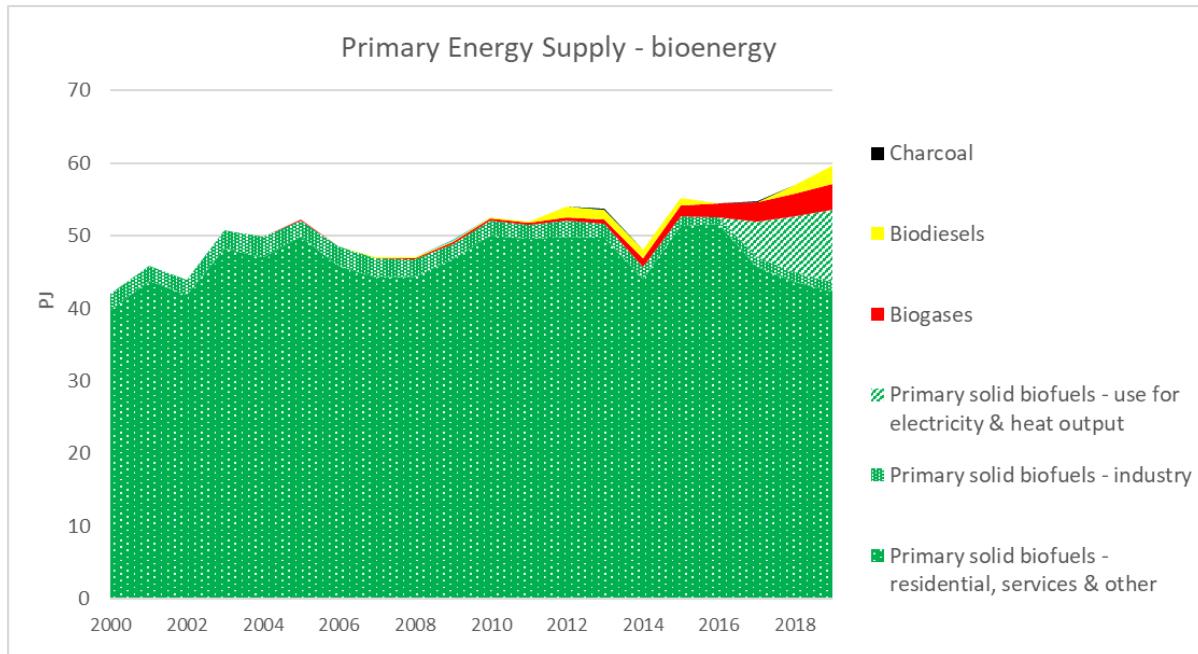


Figure 3: Development of total energy supply from bioenergy in Croatia 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

As shown in Figure 3, most of the bioenergy consumed in Croatia comes from solid biofuels, used in residential applications, with an increasing, but still modest, role of biogas and biofuels.

Evolution of the bioenergy carriers:

- The use of solid biofuels in residential applications was fairly stable around 50 PJ until 2016. In the past few years this is going down. On the other hand, this decrease is compensated by an increased use of solid biofuels for electricity and heat production in bio-CHPs (already reaching 10 PJ in 2019). There is also some use of solid biofuels in industry, but at much lower levels (1-2PJ).
- Biogas saw a steady increase after 2010, reaching 3.4 PJ currently.
- Transport biofuels (mostly biodiesel) are still at very modest levels, reaching 2.6 PJ in 2019, with some fluctuations in the past years.

Table 3 displays the 2019 total bioenergy supply values on a per capita basis. Compared to the other 24 member countries of IEA Bioenergy (expressed per capita), Croatia ranks at the higher end for solid biofuels, in the middle for biogas and at the lower end for biofuels and renewable MSW.

Table 3: Total energy supply per capita in 2019 for different bioenergy carriers

Supply per capita		Median IEA Bioenergy members
Bioenergy	14.5 GJ/cap	10.6
Solid biofuels	13.0 GJ/cap	7.0
Renewable MSW	0.0 GJ/cap	0.8
Biogas	0.8 GJ/cap	0.7
Liquid biofuels	0.6 GJ/cap	1.5

Source: IEA (2021) *World Energy Balances and Renewables Information*

Table 4 indicates the amounts of the different bioenergy carriers compared to some relevant reference points, namely the amount of forest in the country (for solid biomass), the amount of generated MSW (for renewable MSW used for energy), the amount of natural gas consumed in the country (for biogas) and the amount of fossil oil products consumed (for liquid biofuels).

Table 4: Comparison of the supply of different bioenergy carriers in 2019 to specific reference points

Compared to reference points			Median*
Bioenergy	16.6 %	of total energy supply	7.2 %
Solid biofuels	28.5 GJ/ha_forest	compared to the domestic hectares of forest land (excl. protected)	21.3 GJ/ha_forest
Renewable MSW	0.00 GJ/ton_MSW	compared to the total generated MSW in the country	1.4 GJ/ton_MSW
Biogas	0.034 GJ/GJ_NG	compared to natural gas supply	0.023 GJ/GJ_NG
Liquid biofuels	0.020 GJ/GJ_oil	compared to oil products supply	0.028 GJ/GJ_oil

Source: energy data from IEA (2021) *World Energy Balances and Renewables Information*; forest figures from FAOStat; waste figures from World Bank

* Median of the 25 member countries of IEA Bioenergy⁴

Specific comments in relation to the reference points:

- The use of solid biofuels compared to the domestic forest area is modest (~1.5 tons_dry mass of wood per hectare⁵) and there is room for increased mobilization.
- Energy production from (the renewable share of) MSW has not developed yet, so major steps can be taken there.
- Transport biofuels are still at relatively low level, so this also has substantial growth potential.

⁴ Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

⁵ Counted with a typical calorific value of wood (dry mass) of 19 GJ/ton_dry mass

ROLE OF BIOENERGY IN DIFFERENT SECTORS

OVERVIEW

The overall share of renewables in **final energy consumption** among electricity, transportation and heat sectors is 28%, with bioenergy making up 18% of the energy share (Table 5). Mind that these figures are slightly higher than the shares in total energy supply (where unused waste heat, e.g., in fossil power production, is also included).

Table 5: Role of bioenergy and renewable energy in electricity, transport energy and fuel/heat consumption in 2019

Sector	Share of bioenergy	Share of renewable energy	Overall consumption
Electricity ⁶	4.7%	44.4% (31% hydro)	18.8 TWh (68 PJ)
Transport energy (final consumption)	2.8%	3.5%	93 PJ
Overall fuel and heat consumption ⁷	Direct biomass: 33.1% Biobased heat: 2.7%	36.3%	133 PJ
TOTAL FINAL ENERGY CONSUMPTION*	18.2%	27.6%	293 PJ

Source: IEA (2021) *World Energy Balances and Renewables Information*

The following paragraphs will consider the evolutions in the different sectors.

ELECTRICITY

The Croatian power generation is dominated by hydropower, which fluctuated between 5 and 9 TWh, representing between 25 and 50% of electricity *consumption* in the past decades. The share of fossil fuels-based power decreased in the past decade from 30% to 23%; currently still 14% (2.6 TWh) comes from natural gas and 9% (1.6 TWh) from coal. Renewable electricity from non-hydro sources increased from negligible levels in 2009 to 13% (2.5 TWh) in 2019. There was growth in bioelectricity (split between biogas and solid biomass), but also important growth in wind energy. In the past 10 years typically 30% of electricity consumption in Croatia was imported from neighbour countries (with fluctuations between 20 and 40%, depending on fluctuations in hydropower).

⁶ Renewable electricity production compared to final consumption. Potential renewable shares of imported electricity are not included.

⁷ This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.

Electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported.

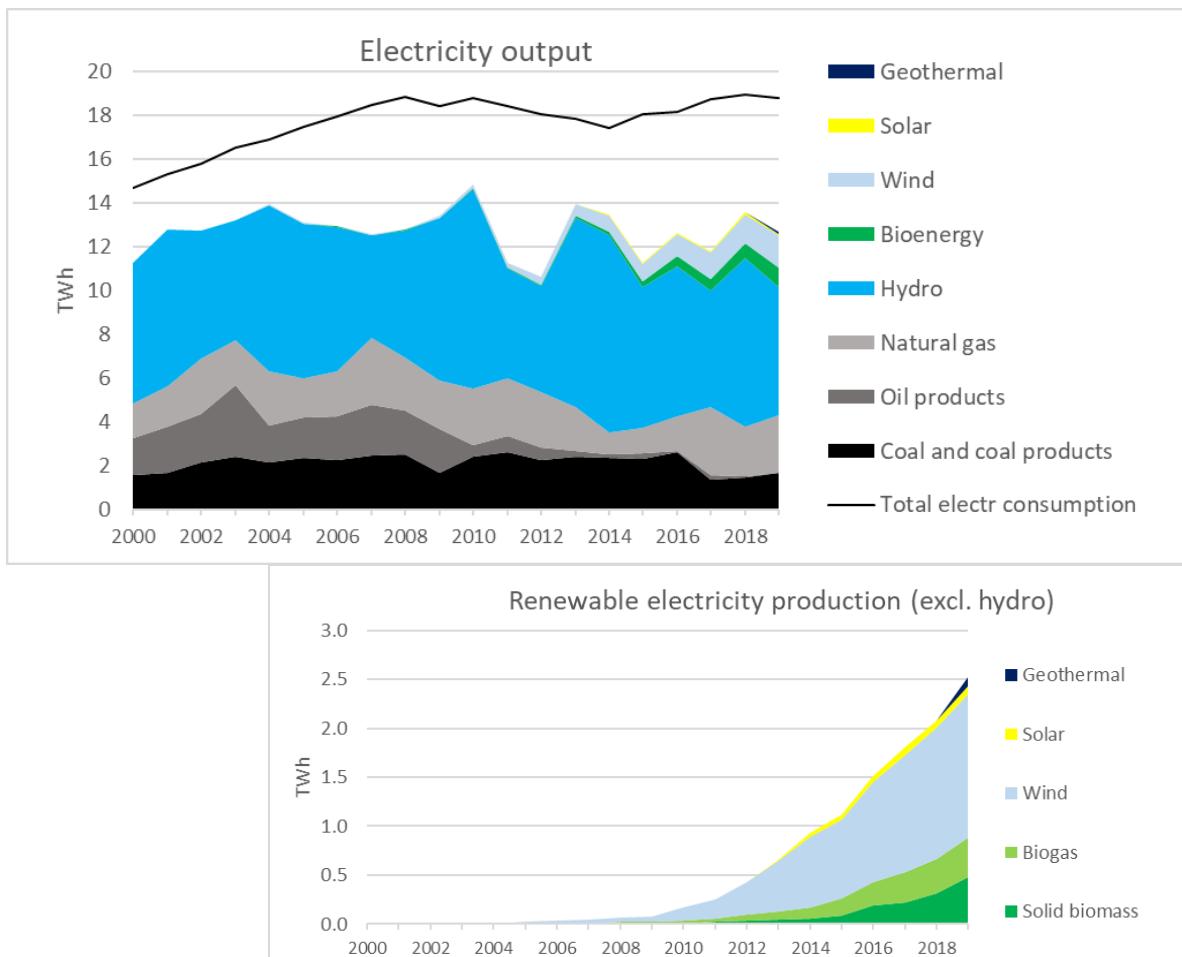


Figure 4: Evolution of the electricity mix in Croatia 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Policy framework

The main relevant policy instruments behind these evolutions are:

- *Energy Act (NN 120/12, 14/14, 102/15, 68/18)*, in force since 13 July 2018.
The Energy Act regulates measures for secure and reliable energy supply and its efficient production and use, acts on the basis of which energy policy and energy development planning are implemented, performing energy activities, on the market or as public services, and basic issues of performing energy activities.
- *Electricity market Act (NN 22/13, 102/15, 68/18, 52/19)*, in force since 10 May 2019.
The Electricity market Act regulate the rules and measures for the safe and reliable generation, transmission, distribution and supply of electricity and for the trade in electricity and the organization of the electricity market as part of the electricity market of the European Union. Furthermore, it establishes rules relating to the protection of final customers, organization and functioning of the electricity sector, open market access, determination of general service obligations and rights of electricity customers, which include the rights of end customers,

separate bookkeeping, financial statements, network access rules, principles of reciprocity and cross - border transmission of electricity.

Renewable energy sources and high efficiency cogeneration Act (NN 100/15, 111/18), in force since 12 December 2018.

This Act regulates the planning and stimulation of production and consumption of electricity produced in generating plants using renewable energy sources and high-efficiency cogeneration, determines incentive measures for electricity production using renewable energy sources and high-efficiency cogeneration, regulates the implementation of systems to stimulate electricity production from renewable energy sources and high-efficiency cogeneration, regulates issues of construction of plants for production of electricity from renewable energy sources and high-efficiency cogeneration on state land, regulates keeping the register of renewable energy sources and high-efficiency cogeneration for projects, project holders and eligible producers of electricity from renewable energy sources and high-efficiency cogeneration, regulates international cooperation in the field of renewable energy sources and regulates other issues of importance for the use of renewable energy sources and high efficient cogeneration.

- *General conditions for network use and electricity supply (NN 85/15, 49/20, 104/20), in force since 18 September 2020.*
These general conditions regulate mutual contractual relations between energy entities and network users, mutual relations of transmission system operators and distribution system operators, rules and conditions governing the relationship between suppliers and transmission system operators or distribution system operators, collection and processing of metering data from metering points of network user, conditions for metering, calculation of electricity consumption and billing of delivered electricity and power, and standard calculation methods.
- *Regulation on quotas to encourage the production of electricity from renewable energy sources and high-efficiency cogeneration (NN 57/20), in force since 14 May 2020.*
This Regulation establishes quotas to encourage the production of electricity from renewable energy sources and high-efficiency cogeneration, for the purpose of conducting tenders on allocation of market premiums and tenders on guaranteed purchase price.
- Recently, on October 1, 2021, the Croatian Parliament voted for the *new Electricity market act*. The new Electricity Market Act transposes all the provisions of European Directive (EU) 2019/944 on common rules for the internal market in electricity and amending Directive 2012/27 / EU (OJ L 158, 14.6.2019). After the vote in the Croatian Parliament and the adoption of the draft law and its entry into force by the middle of October, the adoption of bylaws will follow.

HEAT/FUEL

Figure 5 shows the role of different fuels/energy carriers for providing heat in different sectors (industry, residential sector, commercial and public services and other). It also includes heat sold to customers, e.g., through district heating. Fuel use by energy producing industries for transformation and for own use is excluded. Mind that electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported in the IEA database.

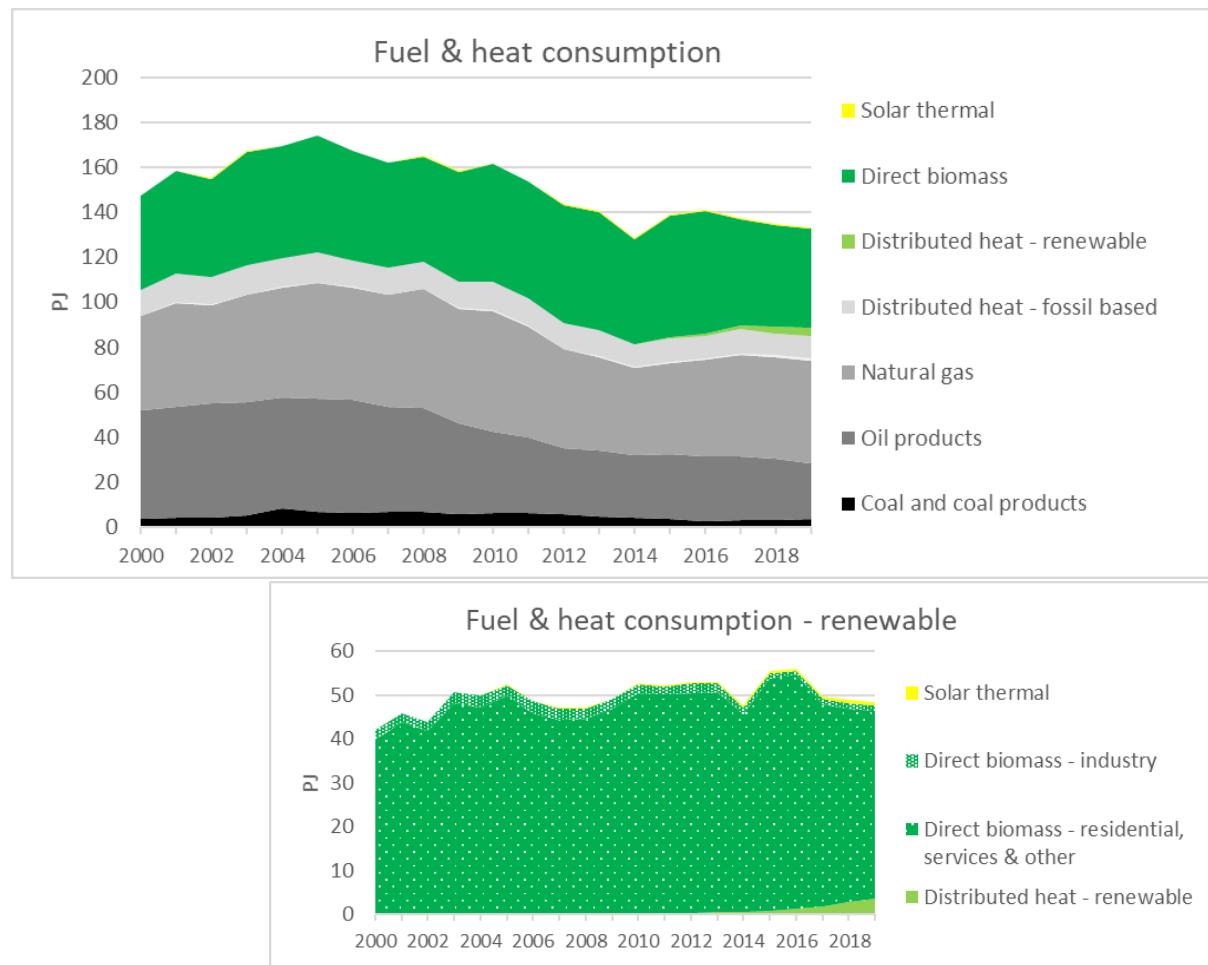


Figure 5: Evolution of fuel and heat consumption in Croatia 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Biomass provides around one third of heat provision. Levels have been quite stable in the past decades between 45 and 55 PJ. The rest of heat production is still mostly based on natural gas and oil, with a slightly increasing trend in gas and slightly decreasing trend in oil. Biomass represents 60% of residential fuel consumption. Energy use in industry is quite low in Croatia, and the use of biomass for industry heat is marginal.

Heat sales – e.g., through district heating – is also relevant in Croatia. Heat output generated and sold by CHP plants and heat plants represented around 10% of fuel/heat provided in 2019. Up to 2014 this was mostly based on fossil fuels, particularly natural gas. However, growth in past years has been covered by biomass up to a level of 4 PJ, while natural gas remained stable around 10 PJ and oil products were phased out in this sector.

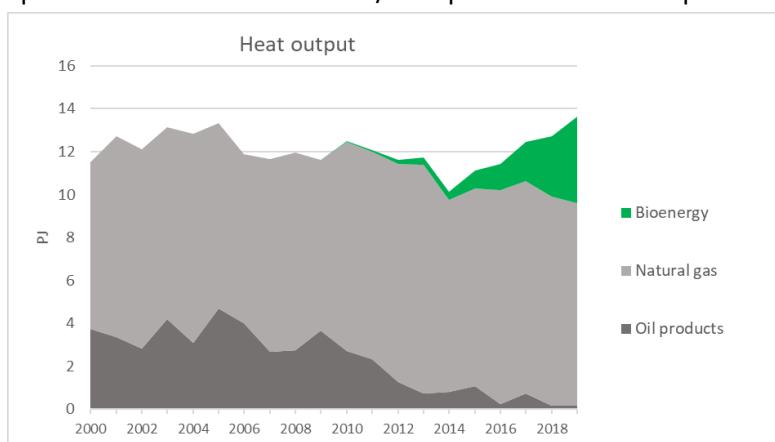


Figure 6: Evolution of fuels for heat output in Croatia 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Policy framework

The main relevant policy instruments behind these evolutions are:

- Law on Renewable Sources of Energy and High-Efficiency Cogeneration, in force since 20.12.2018
- Law on Heat Market, in force since 13.09.2019
- Law on Energy Efficiency, in force since 24.04.2021

Under to the Act on Heat Market, a series of by-laws was enacted that detail the rights, duties, obligations, responsibilities, and relationships between individual participants in the heat market: heat producers, heat distributors, suppliers of heat, heat customers and final customers.

Increase in heat produced from biomass since the previous country report (of 2018) is most visible in the district heating sector where the share of heat produced from renewable sources increased from 0.5% to 4.9% exclusively due to two new biomass fired cogeneration plants, each of 10 MW of thermal power. The previously mentioned reduction in heating oil consumption is partly due to occasional co-financing programs for the replacement of heating oil boilers with those on biomass (mainly wood pellets) implemented by the Environmental Protection and Energy Efficiency Fund. Compared with heat produced from solar thermal collectors, since 2013 there is continuous increase in production of around 14 GWh each year up to 2019, without any significant subsidy and obligations.

In relation to CHP system on biomass, the condition for a minimum annual efficiency of 50% is still in force, which is why the use of green heat is still minimal, and the expected legal framework that would lead to co-financing of green heat from that and any other ways of production, is still pending. Although, in the NECP for the period 2021-2030 for the heating and cooling sector, it is crucial to point out that the target share of RES in the gross direct energy consumption for heating and cooling is set at 47.8% in 2030 compared to the share of 36.8% in 2020. Also, it is planned to stimulate the production of biomethane and hydrogen with the aim of decarbonization of the gas system, as well as greater integration of RES, which would then consequently lead to increasing in the share of green heat.

TRANSPORT

Figure 7 shows an overview of the energy used in transport in Croatia, split up by different fuels/energy carriers.

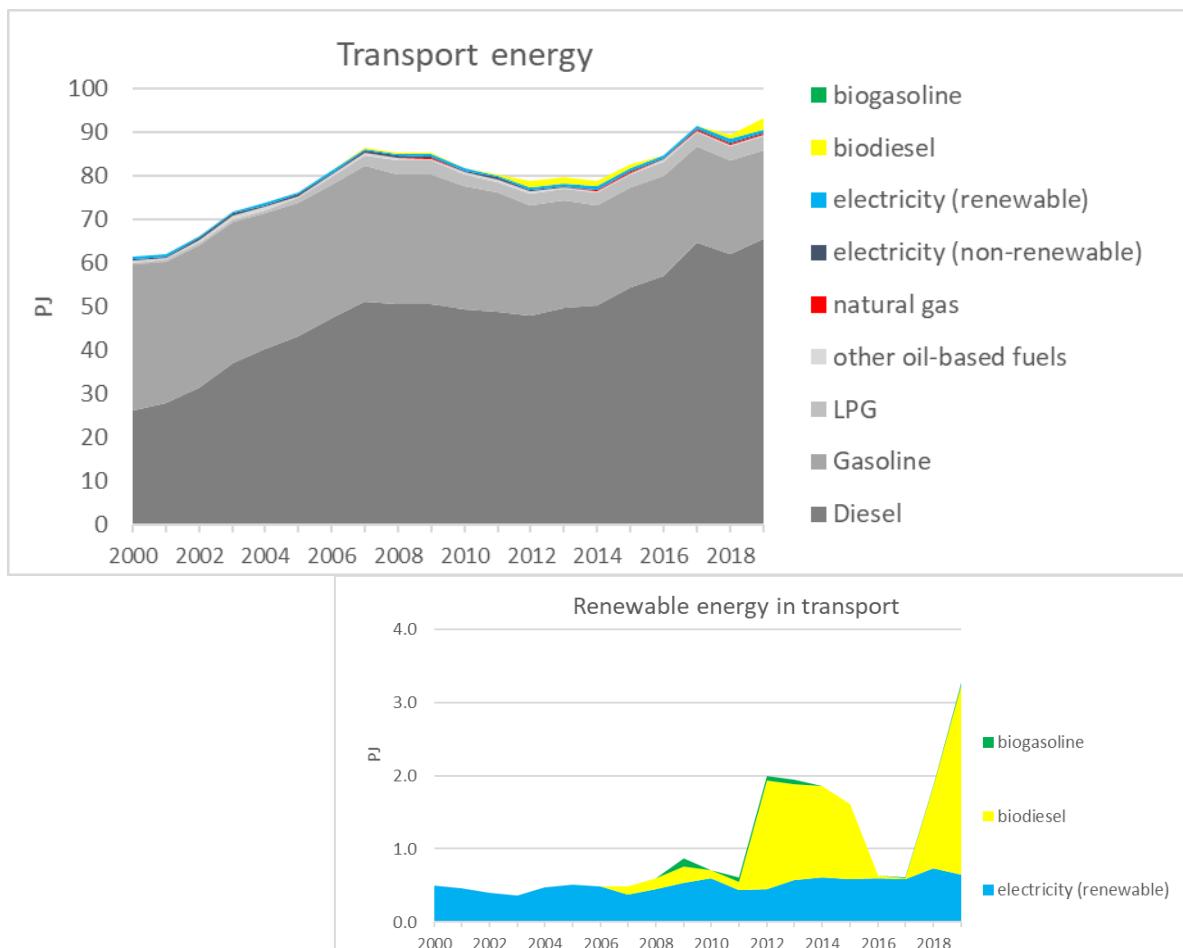


Figure 7: Evolution of transport fuels in Croatia 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

The share of fossil diesel still increases and currently represents 70% of transport fuel consumption in Croatia. The role of gasoline has been steadily declining. Biodiesel was introduced after 2010 up to 1.5% of transport fuel consumption. In 2016 and 2017 there was a temporary interruption of biodiesel blending, which was resumed in 2018. In 2019 the average share of biodiesel in diesel fuel was 3.8% by energy. There was no reporting of biogasoline/bioethanol use.

Electricity represents a share of 1.1% of total transport energy use. This is mostly in rail - the use of electricity in road vehicles is still marginal in 2019 (0.006% of total transport energy use).

Policy framework

The main relevant policy instruments behind these evolutions are:

- Law on biofuels for transport (NN 65/2009, NN 145/2010, NN 26/2011, NN 144/2012, NN 14/2014, NN 94/2018, NN 52/2021), in force since June 2009, last major amendments since May 2021

- Ordinance on measures to encourage the use of biofuels in transport (NN 88/2021) in force since August 2021
- Ordinance on the manner and conditions of application of sustainability requirements in the production and use of biofuels (NN 88/2021) in force since August 2021

In general, the biofuels policy framework is oriented towards an obligation for suppliers to satisfy a minimum share of biofuels on market. Suppliers can meet the minimum share also with other measures, such as installation of chargers for electrical vehicles or use of hydrogen. Within this law, fees for suppliers are prescribed, in case of non-fulfilling obligations.

COMPARISON WITH RENEWABLE ENERGY TARGETS

According to Eurostat⁸, the following renewable energy shares in *gross final energy consumption* were reached.

Table 6: Share of renewables in different sectors in Croatia, according to Eurostat, and compared to the 2020 target

	2005	2010	2015	2019	2020 target
Overall share	23.8%	23.6%	29.0%	28.5%	20.1%
In heating & cooling	30.0%	32.8%	38.5%	36.8%	19.6%
In electricity	35.6%	37.6%	45.4%	49.8%	39%
In transport	1.0%	1.1%	3.6%	5.9%	10%

Mind that some of these figures can differ from the IEA derived data because of different accounting rules. Particularly in transport the Eurostat shares are higher, which is due to the multiple counting of advanced biofuels and renewable electricity towards the transport target. The heating & cooling figure in Eurostat also includes heat pumps.

⁸ http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en

RESEARCH FOCUS RELATED TO BIOENERGY

Research related to bioenergy is mostly funded by the international funds such as Horizon Europe, Interreg programmes and IEA Bioenergy.

Bioenergy related research is placed in a broader context of bioeconomy and climate actions (National Energy Climate Action Plan). Research is branching out to setting the scene for biomass supply solutions such as:

- A. bio hubs as an intermediary between the disperse and variable biomass supply and stable industry demand, securing stability and sustainability of biomass supply as well as price maximisation via cascading use of biomass and
- B. supplying biomass from dedicated crops (Miscanthus, SRC) for 2nd generation biofuels and novel value chains in biorefineries.

The other research branch is focusing on the role of biomass and bioenergy in climate actions such as combining small scale biogas plants with PVs for curbing the GHG emissions from agriculture and a source of green hydrogen.

Leading bioenergy research institutions in Croatia are Energy Institute Hrvoje Pozar (EIHP), Croatian Forestry Institute, Agronomic Faculty University of Zagreb and Faculty of Life Sciences in Osijek, University of J.J. Strossmayer.

RECENT MAJOR BIOENERGY DEVELOPMENTS

One of the measures of NECP is new plant for bioethanol production, planned in city of Sisak, with capacity of 55000 t of advanced ethanol annually. It is expected this plant will use a combination of agricultural residues, mainly cereal and maize straw, and the energy plant Miscanthus x giganteus.

LINKS TO SOURCES OF INFORMATION

Strategy for development of energy sector by 2030 with a view to 2050 -

<https://mingor.gov.hr/UserDocs/Images/UPRAVA%20ZA%20ENERGETIKU/Strategije,%20planovi%20%20programi/Strategija%20energetskog%20razvoja%20RH%202030%20s%20pogledom%20na%202050.pdf>

National energy and climate plan -

http://ec.europa.eu/energy/sites/default/files/documents/hr_final_necp_main_en.pdf

Low-carbon development strategy of the Republic of Croatia until 2030 with a view to 2050 -

https://mingor.gov.hr/UserDocs/Images/klimatske_aktivnosti/odrzivi_razvoj/NUS/lts_nus_eng.pdf