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Energy: Renewable Energy Sources

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The preliminary report from Eurostat indicates that in 2022, renewable energy sources accounted for 23 percent of the European Union's gross final energy consumption, which is approximately 1.1 percentage points higher compared to the previous year.

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In 2022, 2,451.68 GWh of electricity from renewable energy was produced in 1,304 plants in the incentive system, with a total installed capacity of 619.85 MW. The installed capacity of plants in the incentive system decreased by 37 percent compared to 2021.

_26 Leading companies

In relation to the year 2021, the revenue of the company INA d.d. increased by 56.9 percent, while the profit almost doubled. The total revenues of the ten leading companies in the supply of electricity, gas, steam, and air conditioning in 2022 were 90.5 percent higher than in 2021.

As of 2024 (starting from no. 110), the Sector Analyses publication will be published in English as well.



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Main sectoral indicators in the European Union

“Greenhouse gas emissions in the European Union decreased by 21 percent in the period from 2011 to 2022, that is, -0.858 million tons of CO₂ equivalent.

Although in 2020 the pandemic of COVID-19 slowed down the world economy and, consequently, reduced greenhouse gas emissions, the world continued on its path to reach a temperature rise of more than 3°C by the end of the century. According to the report from the United Nations Environment Programme¹, without significant behavioral changes at all levels, from governmental and institutional to personal and local, the goal of the Paris Agreement to limit the temperature increase to below 2°C, with a target of 1.5°C by 2100, remains unattainable, with catastrophic consequences for humanity and the world as we know it. The accumulation of anthropogenic emissions of greenhouse gases is the main reason for the climatic extremes we have witnessed in recent years. The burning of fossil fuels is responsible for about three quarters of anthropogenic greenhouse gas emissions. International Energy Agency² points out that in 2021, greenhouse gas emissions from the energy sector increased by almost 2.1 Gt compared to emissions from 2020. An annual increase in greenhouse gas emissions of this magnitude has not been observed since 2010, effectively bringing emissions from 2021 back to the levels seen before the pandemic in 2019. Despite energy efficiency measures and an increasing share of energy from renewable sources, the geopolitical situation and unfavorable weather conditions led to the burning of larger quantities of coal. In the European Union (EU), overall greenhouse gas emissions rose in 2021 compared to the pandemic year of 2020, but they did not surpass the levels observed in 2019, as seen in global emissions³. Greenhouse gas emissions from 2021 stopped at 3,311.47 million tons of CO₂ equivalent (CO₂eq). In the period from 1990 to 2021, the net emissions of greenhouse gases in the EU were reduced by 30 percent.

Due to the need to speed up the transition to clean energy in the EU, motivated not only by measures to prevent climate change but also to reduce dependence on energy imports, the Renewable Energy Directive was

1 Emissions Gap Report 2020, available at: <https://www.unep.org/emissions-gap-report-2020>

2 IEA (2022), Global Energy Review: CO₂ Emissions in 2021, IEA, Paris, <https://www.iea.org/reports/global-energy-review-co2-emissions-in-2021-2>

3 Eurostat: Greenhouse gas emission statistics – emission inventories (June 2022), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Greenhouse_gas_emission_statistics_-_emission_inventories#Trends_in_greenhouse_gas_emissions

revised in 2023⁴ [the so-called RED II]. Revised Directive EU/2023/2413 [so-called RED III] entered into force on October 20, 2023. The transposition period into the national legislative framework is 18 months, but some parts related to issuing permits for renewable energy production facilities come into effect as early as July 2024.

The whole purpose of the RED III Directive is to accelerate the transition to clean energy and increase the ambition to a binding minimum share of 42.5 percent of energy from renewable sources by 2030 but aiming for 45 percent. The European Commission proposed a revision of the RED II Directive as early as July 2021, with an increase in the binding target of the share of energy from renewable sources from 32 percent to 40 percent, as part of the "Fit for 55" package, together with other measures to increase the production and use of renewable energy throughout the economy. Following Russia's invasion of Ukraine, the Commission proposed further increasing the target to 45 percent by 2030, along with measures to speed up the licensing of renewable energy plants⁵. The direction of the EU is clear: a climate-neutral Europe by 2050, decoupling economic growth from greenhouse gas emissions and resources, and a fair and inclusive transition, while increasing the resilience and independence of the energy system.

In the Report on the State of the Energy Union 2023⁶, the European Commission analyzes the EU's response to the unprecedented two-year energy crisis, assesses the current state of the green transition at national, European, and global levels, and identifies future challenges and opportunities that await Europe on its way to achieving the ambitious climate and energy targets for 2030 and 2050.

The report shows how the EU collectively responded to Russian aggression in Ukraine and to Russia's use of energy supplies as a weapon by accelerating the transition to clean energy, diversifying supplies, and reducing energy consumption. The implementation of the REPowerEU plan and a series of urgent legislative measures made it possible for Europe to avoid disruptions in energy supply and to reduce the pressure on energy markets, prices, and consumers and to continue with the structural reform of the energy system. This was achieved through the implementation of legislative acts related to the European Green Deal, the wider introduction of energy from renewable sources and the increase of energy efficiency. The EU is well on its way to achieving the targets of the REPowerEU plan. It is better prepared

⁴ Directive (EU) 2018/2001.

⁵ See more details at: Renewable energy directive, https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en?prefLang=hr

⁶ COM/2023/650, State of the Energy Union 2023, https://ec.europa.eu/commission/presscorner/detail/hr/ip_23_5188

to ensure energy supply during the winter of 2023–2024, thanks to well-coordinated measures for filling gas storages, diversification of routes, and infrastructure for energy import, investments in energy from renewable sources and energy efficiency, and joint efforts to reduce energy demand.

State of the Energy Union – main figures:

- In 2022, the net emissions of greenhouse gases in the EU were reduced by about 3 percent, thus achieving a reduction of 32.5 percent compared to 1990 levels.
- The EU has significantly decreased its reliance on Russian fossil fuels: it is gradually discontinuing coal imports, reducing oil imports by 90 percent, and decreasing gas imports from 155 billion cubic meters in 2021 to approximately 80 billion cubic meters in 2022, with estimates projecting a further reduction to 40–45 billion cubic meters in 2023.
- The EU reduced gas demand by more than 18 percent compared to the previous five years, saving about 53 billion cubic meters of gas.
- Before the winter of 2022–2023, the gas storages were 95 percent full, and today, in preparation for the coming winter, they are 98 percent full.
- Three rounds of joint gas purchases were organized on the EU's energy purchase platform, where the total demand was 44.75 billion cubic meters, for which offers for the supply of 52 billion cubic meters were received.
- The year 2022 was a record year for new solar photovoltaic capacities [+41 GW], which is 60 percent more than in 2021 [+26 GW]. New capacities for onshore and offshore wind energy were 45 percent higher than in 2021.
- In 2022, 39 percent of electricity was produced from renewable sources, and in May, the production of electricity from wind and solar energy exceeded the production of electricity from fossil fuels for the first time.
- Legislative targets have been agreed upon for a minimum share of energy from renewable sources in the EU, set at 42.5 percent by 2030, with the ambition to reach a share of 45 percent. Energy efficiency targets have also been increased: final energy consumption must be reduced by 11.7 percent by 2030.

Eurostat data⁷ (2023) indicate that in 2022 the total share of energy from renewable sources (RS) in gross final energy consumption reached

⁷ Renewable energy statistics – Statistics Explained (europa.eu), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics#Share_of_renewable_energy_more_than_doubled_between_2004_and_2022

23 percent at the EU level, which is about 1.1 percentage points more compared to the previous year.

The achieved share of energy from renewable sources needs to be doubled by 2030, in order to achieve the ambitious target of a minimum of 42.5 percent of energy from renewable sources, which simultaneously reduces greenhouse gas emissions and the EU's dependence on imported energy sources. Achieving this target depends significantly on the successful implementation of the Energy Efficiency Directive⁸, which was also revised in 2023. This Directive establishes the principle of "energy efficiency first" as a basic principle of the Union's energy policy. Energy efficiency helps to reduce the overall energy consumption, which significantly contributes to the reduction of greenhouse gas emissions by avoiding the unnecessary use of energy and, thus, the burning of fossil fuels. Together with other rules related to energy and climate, the Directive aims to reduce greenhouse gas emissions by at least 55 percent compared to 1990, or an additional reduction of 11 percent in total energy consumption by 2030.

As a member state of the European Union, Croatia participates in the fulfillment of the common goal. In 2022, the total share of energy from renewable sources broke the streak of annual growth, going on since 2016 and recorded a share of 29.35 percent, which is lower than the share in 2020. In 2022, Croatia had a 55.52 percent share of renewable energy in electricity production, 2.4 percent of renewable energy in transport, and 37.21 percent in heating and cooling, making the total share of renewable energy in gross final energy consumption 29.35 percent, or an annual decrease of 1.93 percentage points.

For the period up to 2030, the target of the share of energy from renewable sources in gross final energy consumption has been increased to at least 42.5 percent, with a target of 45 percent (RED III). Member states can choose between a) a binding target of 14.5 percent reduction in the intensity of greenhouse gas emissions in transport through the use of energy from renewable sources by 2030 or b) a binding target of at least 29 percent of energy from renewable sources in the final energy consumption in transport by 2030. The new rules establish a binding sub-target of 5.5 percent of advanced biofuels (mainly produced from biomass that is not suitable for human and animal consumption) and renewable fuels of non-biological origin (RFNBO) in the share of energy from RS in transport. Hydrogen and synthetic fuels derived from hydrogen are mostly considered under RFNBO. Within this target, a minimum requirement of

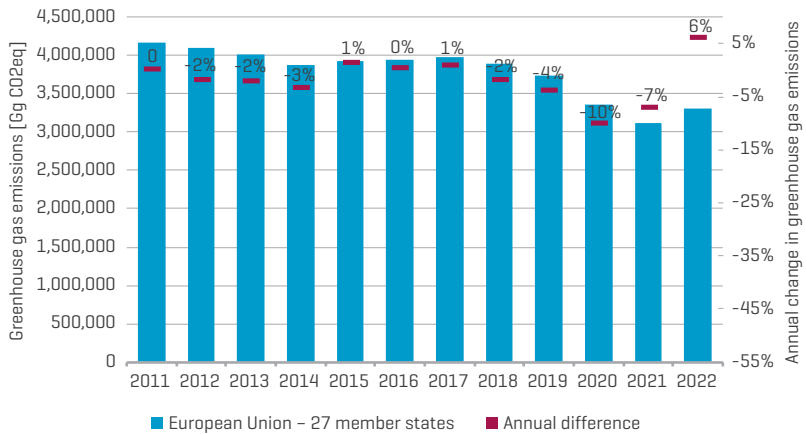
⁸ Energy Efficiency Directive (EU/2023/1791), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766

1 percent of RFNBO's share in the total share of energy from renewable sources in transport is prescribed.

Figure 1 shows the trend of reducing greenhouse gas emissions in the European Union, which, in the period from 2011 to 2022, amounted to -21 percent or -0.858 million tons of CO₂ equivalent.

Figure 1
Trend of greenhouse gas emissions for the European Union for the year 2022

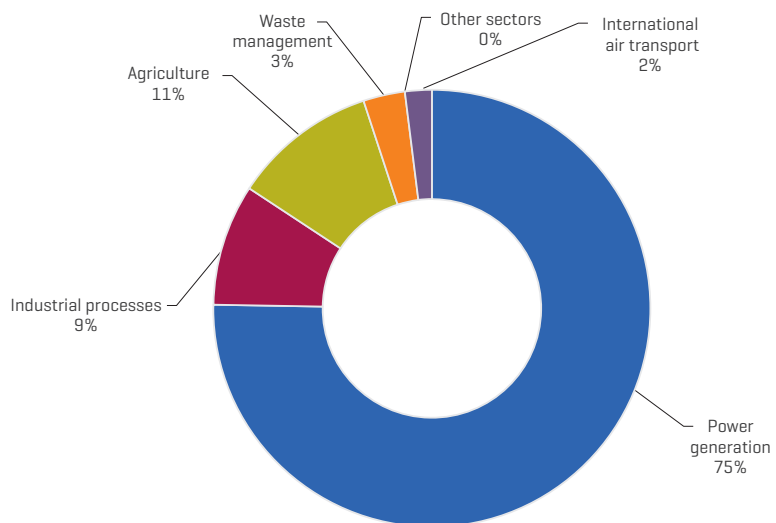
Source: EEA (2023).



Anthropogenic emissions of greenhouse gases are for the most part related to the consumption of energy sources in the daily activities of society and are created as a by-product of fuel combustion in power plants, cars, industrial processes or homes. Agriculture, industry, and the waste sector are also sources of greenhouse gas emissions. Agriculture is the largest emitter of the greenhouse gas methane (28 times CO₂ equivalent) and nitrogen oxides (265 times CO₂ equivalent).

Figure 2
Shares of greenhouse gas emissions by sector in the European Union for 2022

Source: EEA (2023).



“ The Eurostat report states that in 2022, energy from renewable energy had a share of 23 percent in gross final consumption of energy in the European Union, which represents an increase of 1.1 percentage points compared to last year.

After the reduction achieved in 2020, whereby greenhouse gas emissions in the European Union decreased by 31 percent compared to 1990 levels, amounting to about 4 million tons of CO₂ equivalent emissions, the trend of reducing emissions was interrupted. The next challenge for the member states of the European Union is to reduce greenhouse gas emissions by at least 55 percent by 2030 compared to 1990 at the EU level and to achieve climate neutrality in Europe by 2050.

In 2021, greenhouse gas emissions in the European Union increased by 2 percentage points compared to 2020 and amounted to a net of 3.31 million tons of CO₂ equivalent emissions. The achieved reduction of CO₂ equivalent emissions in the sector of land use, changes in the use of the land and in forestry [so-called LULUCF sector] amounted to -0.230 million tons. Emissions related to fuel combustion accounted for 76.7 percent of the total greenhouse gas emissions of the European Union.

Eurostat report⁹ records a share of 23 percent of energy consumed in the European Union for the year 2022, which is an increase in the share of energy from RS by 1.1 percentage points compared to the previous year. The new political period is defined by the Directive [EU] 2018/2001¹⁰ [the so-called RED II] which increases the binding common target of the EU to 32 percent of the share of energy from renewable sources in the total gross final energy consumption, i.e. to 40 [Fit for 55] or 45 percent [REPowerEU]. In contrast to the previous political period, no individual targets were assigned per country, but the member states commit themselves through the implementation of the National Energy and Climate Plans that the cumulative share of energy from RS is equal to the common target for 2030, and individually at least equal to the target from 2020.

“ The new binding target for 2030 is set at 42.5 percent of the share of energy from renewable sources, aiming for 45 percent.

European climate law¹¹ set the reduction of greenhouse gas emissions of the European Union by a minimum of 55 percent by 2030, compared to the emission levels of 1990, as a legal obligation. Thus, the year 2030, will certainly be a significant milestone towards achieving the EU's target of net climate neutrality by 2050 and the European Green Deal. In 2021, the European Commission published a package of legislative proposals "Fit for 55"¹² which proposes to increase the share of energy from RS to a minimum of 40 percent by 2030 through the joint efforts of all member states. REPowerEU increases that share to 45 percent.

9 See more details at: <https://ec.europa.eu/eurostat/web/energy/data/shares>

10 See more details at: <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018L2001&from=EN#d1e32-141-1>

11 EUR-Lex - 32021R1119 - EN - EUR-Lex [europa.eu], <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1119>

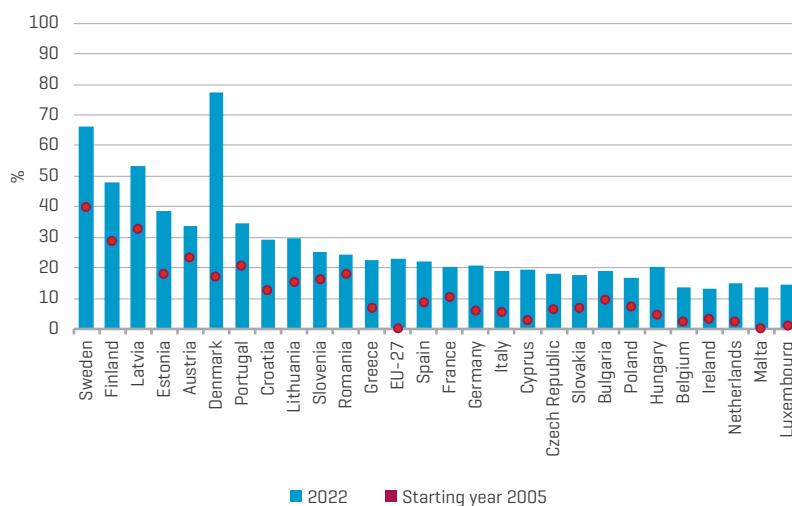
12 Transformation of the economy and society to achieve climate targets [europa.eu], https://ec.europa.eu/commission/presscorner/detail/hr/ip_21_3541

In total, 23 member states of the European Union achieved an increase in the share of RS in gross final energy consumption in 2022, and 4 member states recorded a decrease in the share of RS compared to 2021. The largest shares of energy from RS are recorded in [Figure 3]: Sweden (66 percent), Finland (47.1 percent), Latvia (43.3 percent), Denmark (41.6 percent), Estonia (38.5 percent), Portugal (34 percent) and Austria (33.4 percent). Other member states have less than a third of the share of energy from RS, while Ireland (13.1 percent), Malta (13.4 percent) and Bulgaria (13.8 percent) have the smallest share of energy from RS.

The largest relative increase in the share of energy from RS was achieved by Finland (5 percentage points), Sweden (3.3 percentage points) and Luxembourg (2.6 percentage points).

Figure 3
The share of energy from RS in the total gross final energy consumption compared to the initial year and the realized share in 2022, in percentages by member states of the European Union

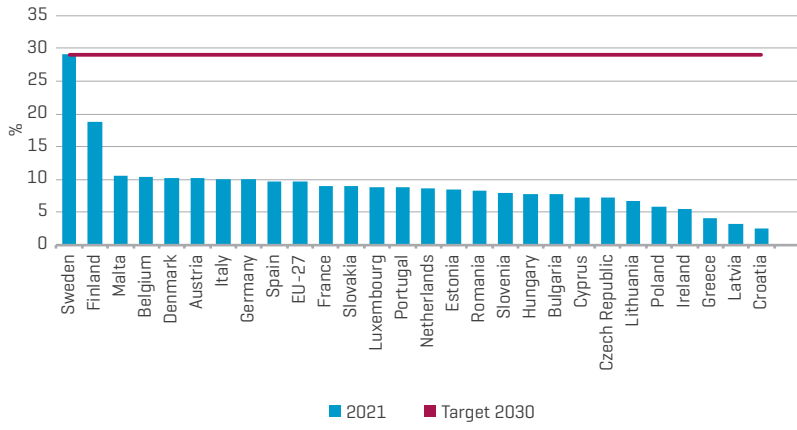
Source: Eurostat, SHARES 2022 summary results (February 11, 2024).



The share of energy from RS in transport accounted for 9.6 percent of gross final energy consumption at the level of the European Union in 2022 (Figure 4), which represents an increase of 0.5 percentage points compared to the previous year. All renewable energy used in transport had been taken into account: liquid biofuels, hydrogen, biomethane, "green" electricity, etc. Sweden already achieves a 29 percent share of energy from renewable energy sources in transport, but most member states are far from the new target for 2030. The closest to Sweden is Finland (18.8 percent), followed by the Netherlands (10.8 percent), Malta (10.5 percent), Belgium (10.4 percent), Denmark (10.2 percent), and Austria and Italy with 10.1 percent as member states that record more than 10 percent share of RS in transport in 2022.

Figure 4
Share of energy from RS
in the transport sector
by member states of the
European Union in 2022

Source: Eurostat, SHARES 2022
summary results (February 11,
2024).



The market of renewable energy sources in Croatia

In accordance with Article 12 of the Law on the System Strategic Planning and Development Management of the Republic of Croatia (OG 123/17, OG 151/22), the Integrated National Energy and Climate Plan (NECP) for the period from 2021 to 2030 is adopted by the Government of the Republic of Croatia at the proposal of the Ministry of Economy and Sustainable Development. The draft of the updated National Energy and Climate Plan from 2023 highlights the main targets, shares, and contributions of the Republic of Croatia to the common targets of the European Union (Table 1).

Table 1
The most important targets of NECP for the year 2030 for the Republic of Croatia

Source: Integrated National Energy and Climate Plan for the Republic of Croatia for the period from 2021 to 2030 – draft (June 2023)¹³.

Indicator	Target 2030
Reduction in greenhouse gas emissions for the ETS sector, compared to 2005	-50.2%
Reduction in greenhouse gas emissions for non-ETS sectors, compared to 2005	-16.7%
Share of RES in gross final energy consumption	42.5%
Share of RES in final energy consumption in transport	21.6%
Primary energy consumption (total energy consumption without non-energy consumption)	340.9 PJ
Final energy consumption	274.2 PJ

Indicative national targets for the share of energy from RS for the Republic of Croatia published in the draft of the updated NECP from 2023 (Table 2) are subject to revisions every other year, in order to respond in a timely manner to the dynamics of the environment. For example, disruptions in the security of natural gas supply since February 2021 have influenced the increase in fossil fuel prices, which has made some technologies for the production of energy from RS become market competitive (for example, the production of electricity from some solar power plants or wind power plants) or are being considered through production with a support system as a necessity for increasing energy independence (for example, production

¹³ Available at: Croatia – Draft Updated NECP 2021–2030 – European Commission (europa.eu), https://commission.europa.eu/publications/croatia-draft-updated-necp-2021-2030_en

IN 2022, THE REPUBLIC OF CROATIA HAD 29.35 PERCENT OF ENERGY FROM RENEWABLE SOURCES IN GROSS FINAL CONSUMPTION, OF WHICH THE SHARE OF ELECTRICITY WAS 55.52 PERCENT, HEATING AND COOLING 37.21 PERCENT, AND RESOURCES IN TRANSPORT 2.40 PERCENT.

of biomethane and hydrogen). The draft NECP from June 2023 is based on the common target of a 42.5 percent share of energy from renewable sources in total gross consumption, targeting 45 percent.

Table 2
The main national targets of the share of energy from RS for the Republic of Croatia within the EU

Notes: * According to the Effort Sharing Regulation (ESR).

** According to the Regulation on Land Use, Land Use Change and Forestry (LULUCF).

*** According to the formula specified in Appendix I of Directive (EU) 2023/1791 on energy efficiency and supplemented by Regulation (EU) 2023/955 ("EED recast").

**** According to the formula specified in Appendix II of Regulation (EU) 2018/1999 on the management of the energy union and action in the area of climate.

Source: Summary of the European Commission's assessment of the draft of the updated National Energy and Climate Plan for the Republic of Croatia¹⁴.

Indicator	Value in 2030 according to the draft of the updated NECP	2030 national target and contribution	Assessment of 2030 ambition level
Binding target for greenhouse gas emissions (GHG) compared to 2005 under the Effort Sharing Regulation (ESR) (%)	-17.1%	-16.7%*	Croatia is achieving its targets according to projections.
Removal of greenhouse gas emissions from LULUCF (Mt equivalent of CO₂ of net greenhouse gases removed)	-4.24	-0.593 (additional removal target) -5.527 (total net removals)**	According to these projections, Croatia's targets are not being achieved.
Energy efficiency (final energy consumption)	6.6 Mtoe	5.9***	Final energy consumption in Croatia is above the indicative level targets according to EU legislation.
Renewable energy (share of renewable energy in gross final consumption)	42.5%	44%****	According to these projections, Croatia's targets are slightly lower than those stated in the EU legislation.

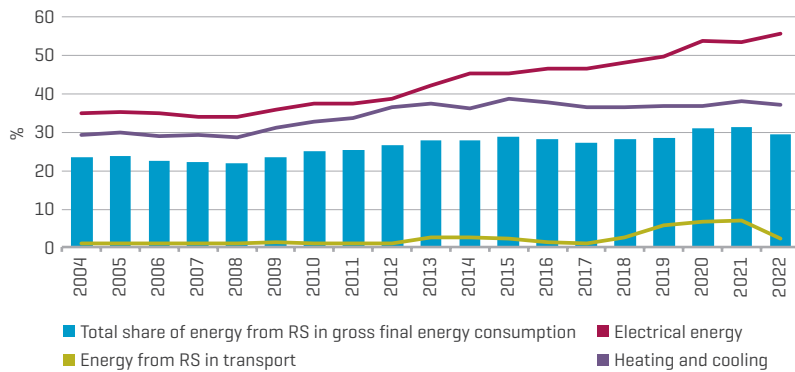
In 2022, the Republic of Croatia had 29.35 percent of energy from RS in gross final consumption, of which the share of electricity was 55.52 percent, and heating and cooling accounted for 37.21 percent. In 2022,

¹⁴ European Commission, Croatia's Draft Updated National Energy and Climate Plan, An important step towards the more ambitious 2030 energy and climate objectives under the European Green Deal and REPowerEU Plan, available at: https://commission.europa.eu/publications/commission-recommendation-assessment-swd-and-factsheet-draft-updated-national-energy-and-climate-19_en

there was a decrease in the share by -1.93 percentage points compared to 2021, which can be attributed to a significant decrease in the share of RS in transport [-4.59 percentage points] and a decrease in the share of RS in heating and cooling [-0.79 percentage points] which the increase of 2.05 percentage points in electricity production from RS could not compensate. The share of energy from RS in transport in gross final energy consumption was 2.40 percent in 2022.

Figure 5
Shares of energy from RS in gross final consumption in Croatia (2004-2022) and subsectoral shares

Source: Eurostat, SHARES summary results (February 13, 2024).

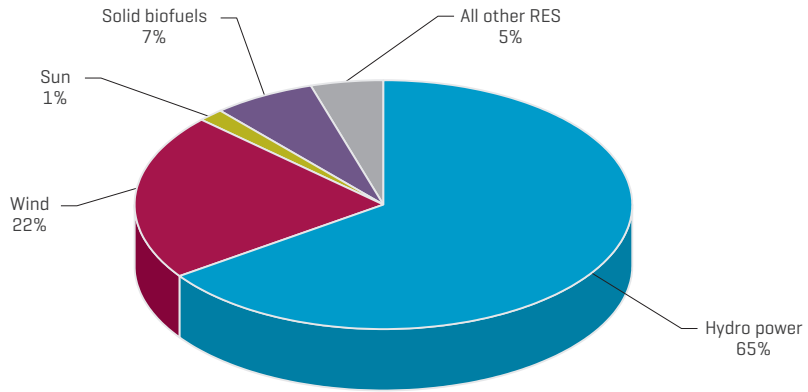


“According to the data available for 2022, in the structure of electricity production from RS in Croatia, the largest share of 65.35 percent was held by water power, which includes also the electricity production from large hydropower plants, followed by wind energy with a 21.69 percent share and energy from solid biomass with a 6.90 percent share.

According to the data for the year 2022, in the structure of electricity production from RS, the largest share of 65.35 percent was hydropower, which also includes the production of electricity from large hydropower plants. It is followed by wind energy with a 21.69 percent share and electricity from solid biomass with 6.90 percent as the third single most important source of electricity from RS. Biomass is viewed as a renewable fuel that can be solid (firewood, wood chips, pellets, briquettes...), gaseous (gases from anaerobic fermentation – biogas, biomethane, and gases from thermal processes) or liquid (biodiesel, bioethanol, and other liquid biofuels that are used in transport). Electric energy from biogas is presented collectively with other RS energy that participated with 4.61 percent. In relation to 2021, all sources of electricity from RS recorded an increase in 2022, with the exception of other RES power plants, which recorded a significant decrease of -9.2 percent. Water energy has a stable production, which breaks the continuity of decline since 2018 and the indicator that had shown a decrease in the productivity of hydropower plants due to climate change. New plants for the production of electricity from solar energy increased production by 1.46 percent compared to the previous year.

Figure 6
Structure of electricity produced from renewable sources in Croatia, 2022 (in %)

Source: Eurostat, SHARES summary results (February 13, 2024).



Despite the decline in production from other renewable energy sources, especially biogas, the increase in all electricity generation technologies from renewable energy sources in 2022 saw an increase in production amounting to 2.4 percent compared to 2021.

Figure 7
Trends in electricity production from renewable sources in Croatia in the period from 2004 to 2022 and the corresponding shares

Source: Eurostat, SHARES summary results (February 13, 2024).

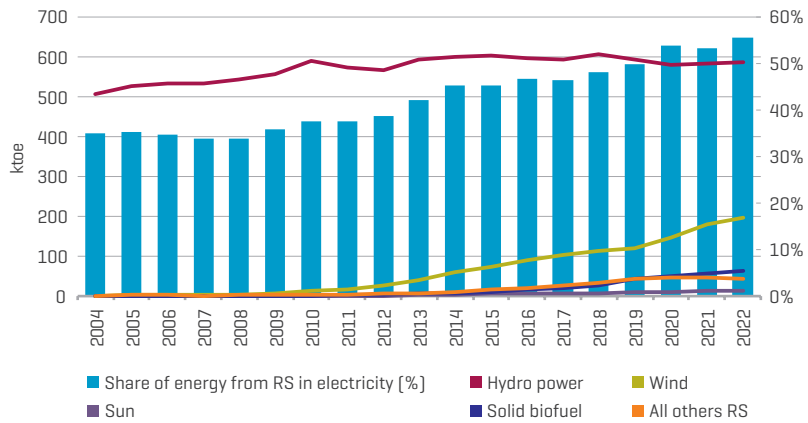
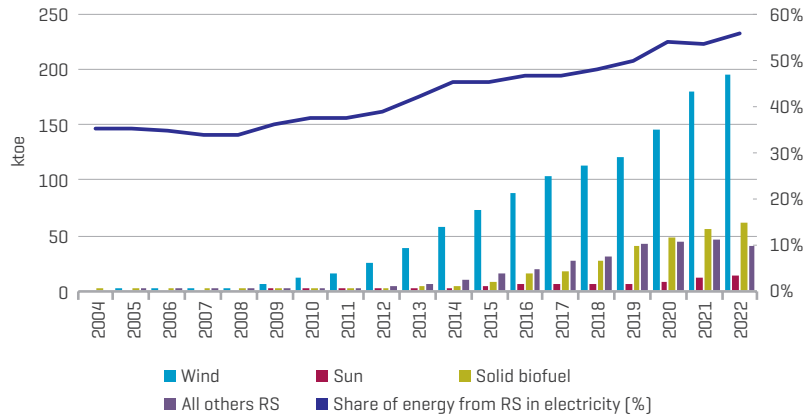


Figure 8
Trends in electricity production from renewable sources, with the exception of hydroelectric power plants, in Croatia from 2004 to 2022 and the corresponding shares

Source: Eurostat, SHARES summary results (February 13, 2024).



Transport sector and renewable energy sources

In the transport sector, the largest share of energy from renewable sources refers to compliant biofuels (61.05 percent), while electrical energy records a share of 38.95 percent in 2022. In 2022, the total amount of used compliant fuel as RS energy in transport decreased by 77 percent [from 91.19 to 21 ktoe]. All biofuels were compliant with Directive [EU] 2018/2001 (RED II) and thus there were no non-compliant biofuels on the Croatian market. In the year 2022, the share of electricity in the energy from RS in transport recorded a total year-on-year increase of 38.95 percent, which is mostly attributed to the growth of 32.56 percent in the electricity consumption in railway transport. The share of electricity from RS in road transport is still negligible and amounts to 0.6 ktoe or 1.74 percent. Biofuels from food and feed (33.72 percent) account for the largest share of RS in circulation. Due to the methodology for calculating the share of energy from RS in transport, described in RED II, which assigns stimulating multipliers for liquid biofuels from waste and by-products [advanced biofuels from Annex IX], and electricity, the energy share of RS in transport (Figure 9) is different from the administrative share related to the achievement of the set target of 29 percent by 2030, that is, the achieved share in 2022. In 2022, it amounted to 2.40 percent with an administrative value of 51.1 ktoe, which is 4.59 percentage points lower compared to the previous year.

Figure 9
Individual shares of renewable energy sources in transport in Croatia in 2022 (in ktoe)

Source: Eurostat, SHARES summary results (February 13, 2024).

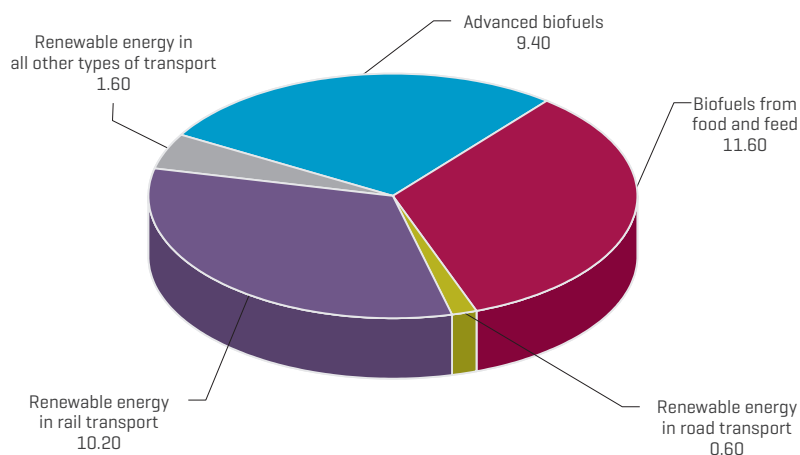
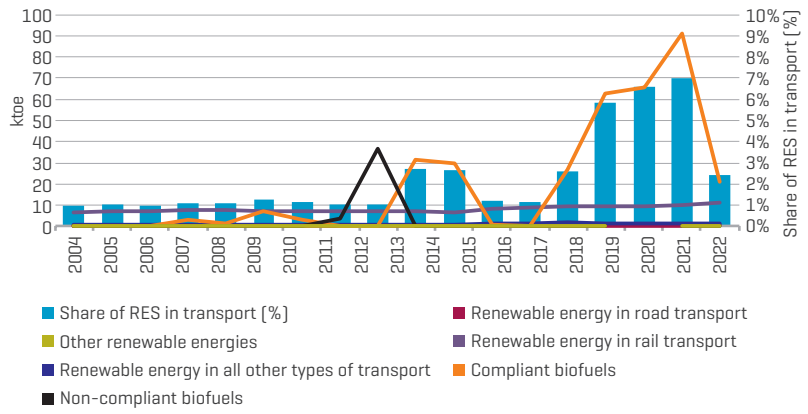


Figure 10
Trends in energy from RS
in transport in Croatia
from 2004 to 2022
and the corresponding
shares

Notes: Until 2014, no biofuels were compliant, and their compliance was regulated by Articles 17 and 18 of the Directive RED I and Article 2 of the Directive RED II. Data for 2015 have been omitted.

Source: Eurostat, SHARES summary results [February 13, 2024].



Heating and cooling sector and renewable energy sources

If we look at the shares of individual sources of renewable energy in the heating and cooling sector in 2022, it can be seen that the largest share, 89.90 percent, is recorded by the final energy consumption from renewable energy, which mostly refers to firewood for space heating, the preparation of hot water, and the use of solid biomass for the production of water vapor and thermal energy in industrial processes. This is followed by derived heat, with a share of 8.91 percent, and energy from heat pumps, which accounts for only 1.19 percent of all RS in the heating and cooling sector. In relation to 2021, the share of final energy consumption from RS decreased by 9.05 percent, which is a consequence of the decrease in thermal energy consumption from RS in all categories. The share of derived heat consumption recorded a decrease of 6.25 percent, and energy consumption from heat pumps recorded a decrease of 11.51 percent in 2022.

Figure 11
Individual shares of RS
in heating and cooling,
2022 (in ktoe)

Source: Eurostat, SHARES summary results (February 13, 2024).

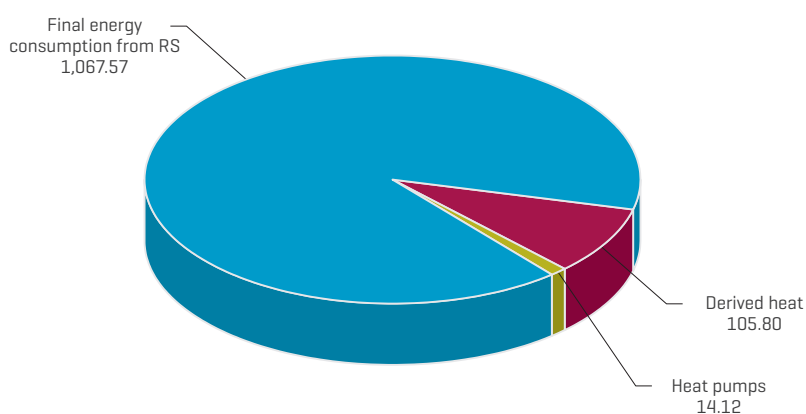
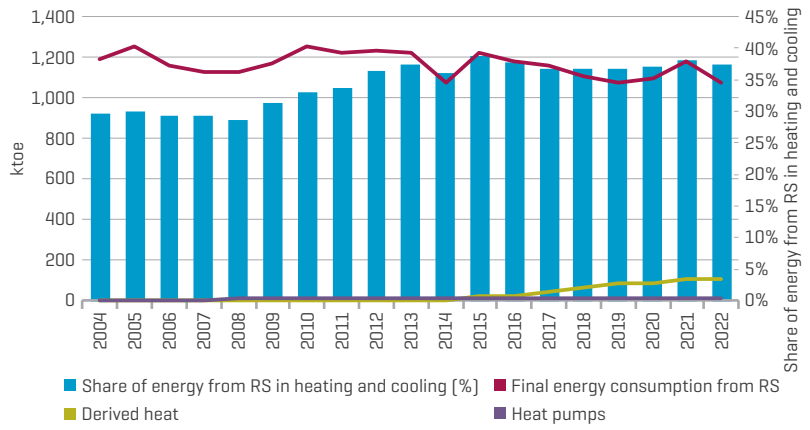


Figure 12
Trends in energy from RS in the heating and cooling sector from 2004 to 2022 and the corresponding shares

Source: Eurostat, SHARES summary results (February 13, 2024).



Development of the electricity market from renewable sources

“In 2021, 3,515 GWh of electricity was produced from RS in 1,360 plants in the incentive system, with a total installed capacity of 942,215 MW. The installed capacity of the plant increased compared to 2020 by 20.49 MW, or 1 percent.

From the beginning of the establishment of the system for encouraging the production of electricity from renewable energy sources (RES) and cogeneration in the Republic of Croatia (July 2007) until the end of 2021, 1,360 contracts for the purchase of electricity from RES plants with a total installed capacity of 942,215 MW were in force. In 2022, a multi-year and continuous streak of growth was interrupted, with the incentive system recording a 37 percent drop in installed capacity, or 22 percent in production.

The year 2022 was the year of the energy crisis in Europe caused by the Russian aggression against Ukraine and the consequent interruptions in the supply of energy sources from Russia. Increased energy prices made the production of energy from non-renewable sources of energy, such as wind and solar, more competitive, but also reduced the state's ability to provide greater support to plants that still depended on fossil fuels, such as biomass and biogas, for their supply. The Government of the Republic of Croatia has also implemented numerous price stabilization measures on the energy market. The Croatian Energy Market Operator (HROTE) states in its Annual Report that "the EKO balance group has significantly contributed to the stabilization of electricity prices in 2022, since 60 percent of the production of privileged producers was sold to suppliers in the Republic of Croatia at a regulated price of EUR 55.743/ MWh (HRK 0.42/kWh). However, it should be pointed out that the year 2022, due to extreme energy prices on the energy markets, was marked by the exit from the incentive system of a part of privileged producers who will seek their further economic sustainability on market grounds no longer burdening the incentive system."

In 2022, production was contracted from 12 new plants for the production of electricity from RS, with a total connected power of 5,259 MW (Figure 14).

Figure 13
RES power plants in total and as part of the electricity purchase system until 2022

Sources: HROTE (2023a) and the Ministry of Environmental Protection and Energy (2023).

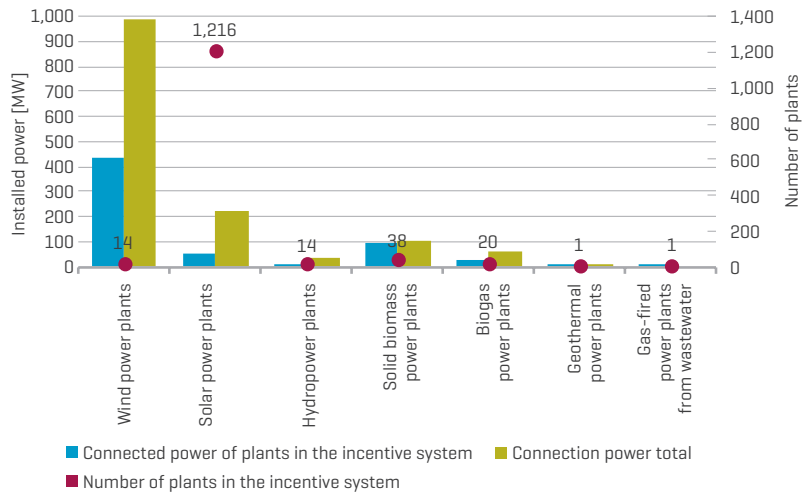
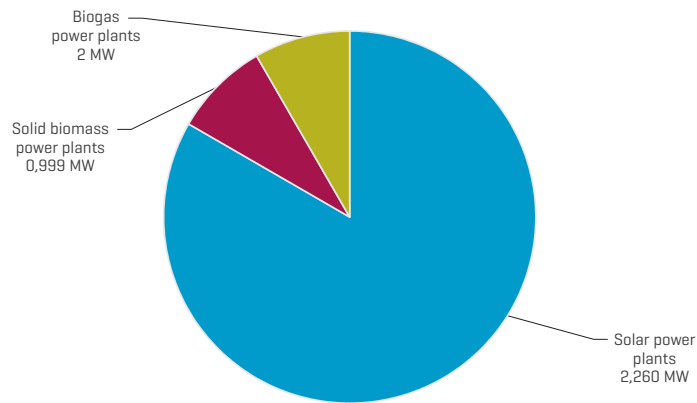


Figure 14
Number of new contracts concluded in 2022

Source: HROTE (2023a).



In 2022, HROTE terminated 64 contracts, with a total connected power of 273,311 MW. The largest share of connected power was related to 11 wind farms, or 86 percent. The connected power for the production of electricity from biogas was halved compared to last year and fell by 26.64 MW, while the number of plants fell from 42 to 20.

In 2022, 2,451.68 GWh of electricity was produced from RS in 1,304 plants in the incentive system, with a total installed capacity of 619.85 MW. The installed capacity of plants in the incentive system decreased by 37 percent compared to 2021. The total electricity produced from RS amounted to 3,610.8 GW, of which 67.7 percent was produced in the incentive system.

Figure 15
The number and total capacity of all (at their request) terminated contracts with the privileged producers who stopped supplying energy within the incentive system during 2022, according to technologies

Source: HROTE (2023a).

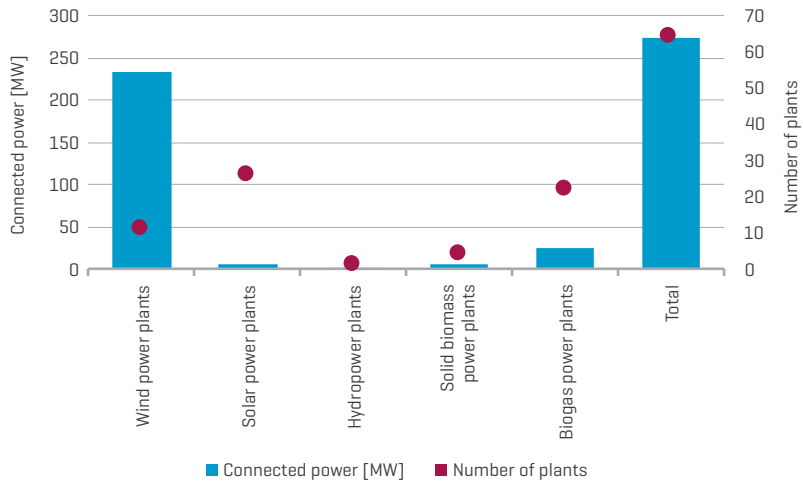


Figure 16
The relationship between the number of plants and the installed power in plants for the production of electricity from RS in the incentive system during the period from 2007 to 2022

Source: HROTE (2023a).

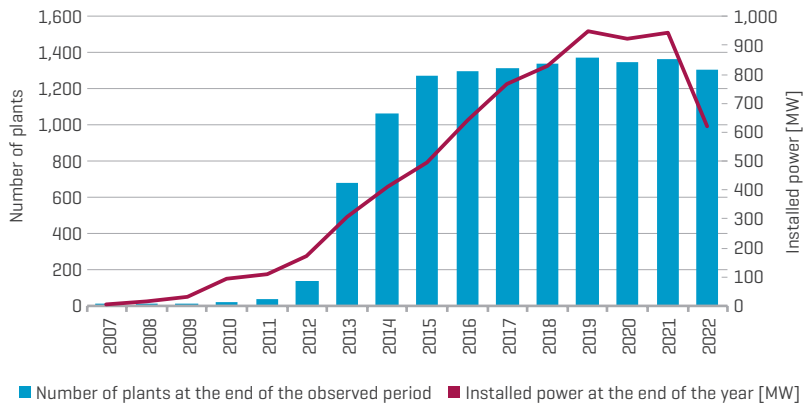
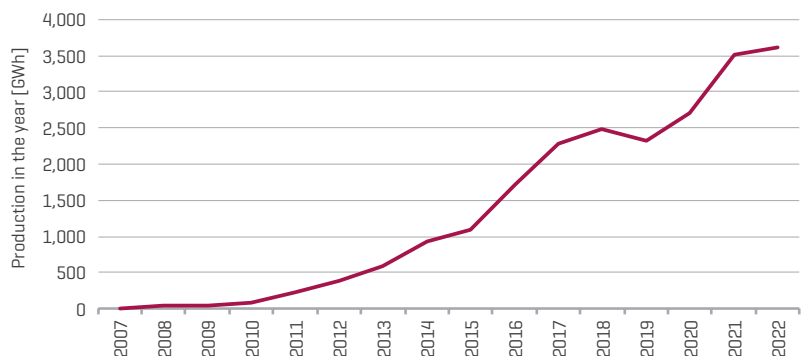


Figure 17
Production of electricity from RS in total, during the period from 2007 to 2022

Source: Energy in Croatia (2023).



In the structure of renewable energy power plants in the incentive system in 2022, the largest installed power for the production of electricity from renewable energy was achieved by wind power plants with 70.5 percent, followed by solid biomass power plants with 14.6 percent, and solar power

FOR THE ACHIEVED PRODUCTION OF ELECTRICAL ENERGY FROM RS IN THE INCENTIVE SYSTEM IN 2022, SHARES WERE AS FOLLOWS: WIND POWER PLANTS 58 PERCENT, BIOMASS POWER PLANTS 26 PERCENT, BIOGAS POWER PLANTS 10 PERCENT, AND SOLAR AND GEOTHERMAL POWER PLANTS 3 AND 2 PERCENT, RESPECTIVELY.

plants with 8.3 percent. In the case of electricity production from RS in 2022, the shares were as follows: wind power plants 57.5 percent, solid biomass power plants 25.6 percent, biogas power plants 10.3 percent, geothermal power plants 2.5 percent, and solar power plants 3 percent.

Figure 18
Structure of electricity production from RS in the incentive system in 2022 (in GWh)

Source: HROTE (2023a).

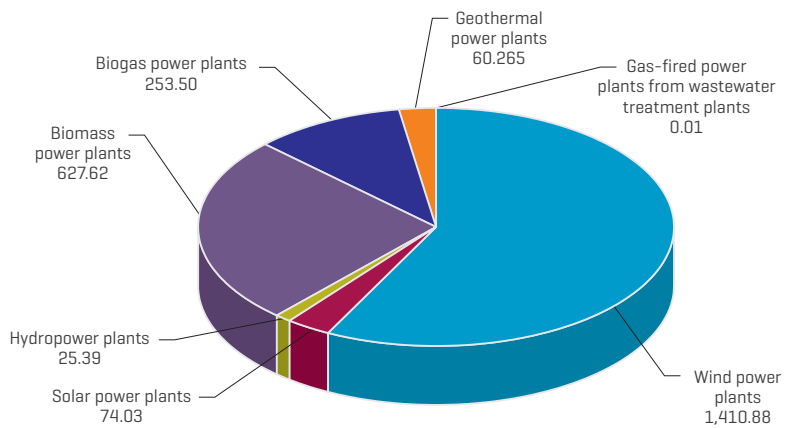
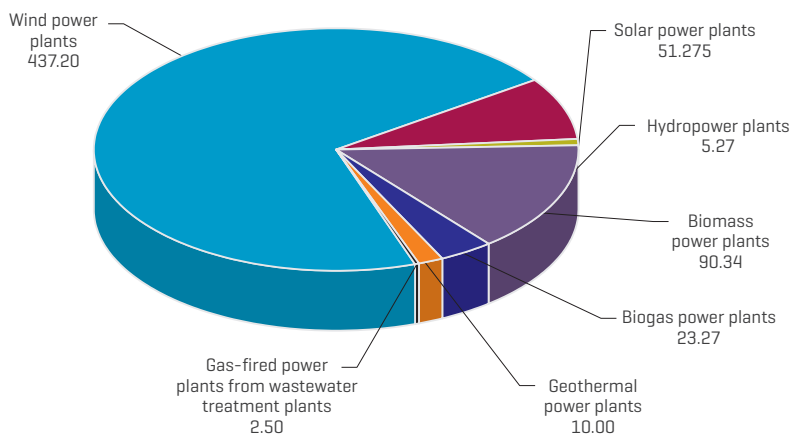


Figure 19
Structure of RS power plants in the incentive system in 2022 (in MW)

Source: HROTE (2023a).

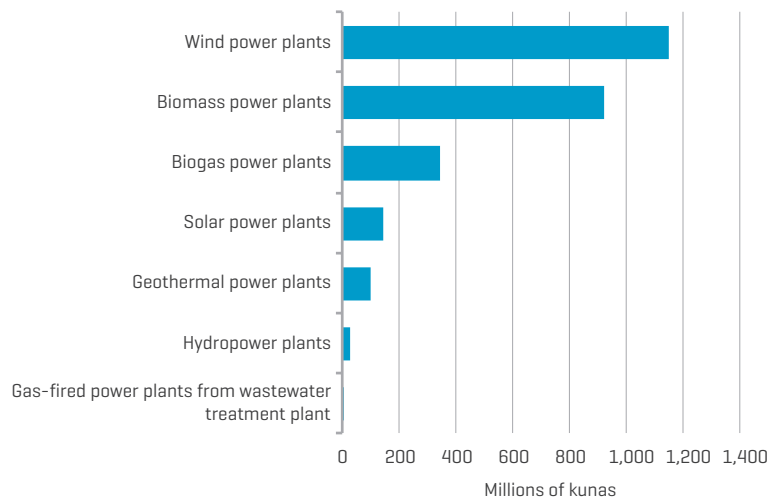


“The most incentives in 2022 were paid for electricity from wind power plants (42.82 percent), followed by solid biomass power plants (34.38 percent), and biogas power plants (12.77 percent).

The most incentives in 2022 were paid for electricity from wind power plants (42.82 percent), followed by solid biomass power plants (34.38 percent), and biogas power plants (12.77 percent). In 2022, in the payment of incentives for electricity produced from RS according to technology, the largest year-on-year increase of 92.59 percent was for solar power plants, followed by a 55.23 percent increase for solid biomass power plants and a 30.94 percent increase for geothermal power plants. All other categories of power plants in the incentive system recorded a drop in incentives paid compared to 2021, with the biggest drop in the category of wind power plants, whose incentives paid in 2022 were at the level of 62.93 percent from 2021. In total, the disbursed incentive funds for produced electricity from RS decreased by 9.45 percent compared to 2021 and amounted to HRK 2.674 billion without VAT.

Figure 20
Disbursed incentives (without VAT) for individual RS power plant technologies in 2022

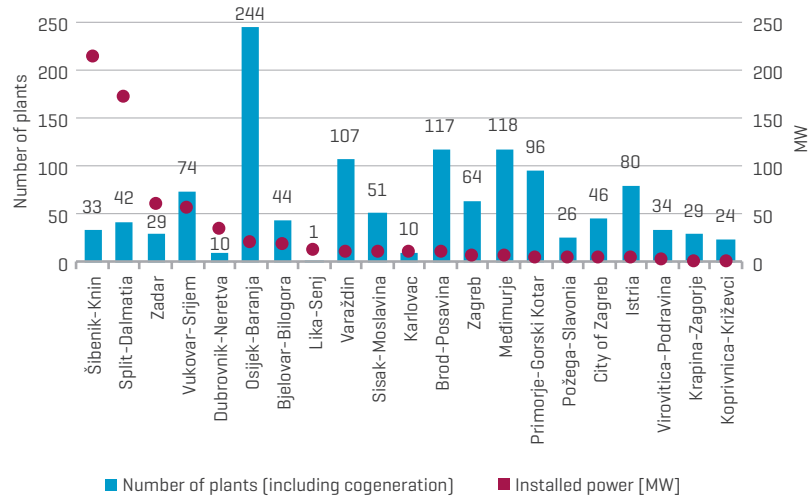
Source: HROTE (2023a).



It is interesting to observe the spatial distribution of RS power plants. The largest number of renewable energy power plants in the incentive system is located in Osijek-Baranja County (244 plants), followed by Međimurje County (118 plants), Brod-Posavina County (117 plants), and Varaždin County (107 plants). The installed power in these counties is small [Osijek-Baranja County 21.3 MW, Međimurje County 6.4 MW, Brod-Posavina County 9.95 MW, and Varaždin County 11.69 MW], which indicates that these are predominantly small solar power plants and some small hydroelectric power plants and biogas and biomass power plants. The southern counties with wind power plants have the largest installed capacity: Šibenik-Knin County (213 MW in 33 plants), Split-Dalmatia County (172.25 MW in 42 plants), and Zadar County (59.62 MW in 29 plants).

Figure 21
Installed power and number of plants in the incentive system by county, year 2023

Source: HROTE (2023b).

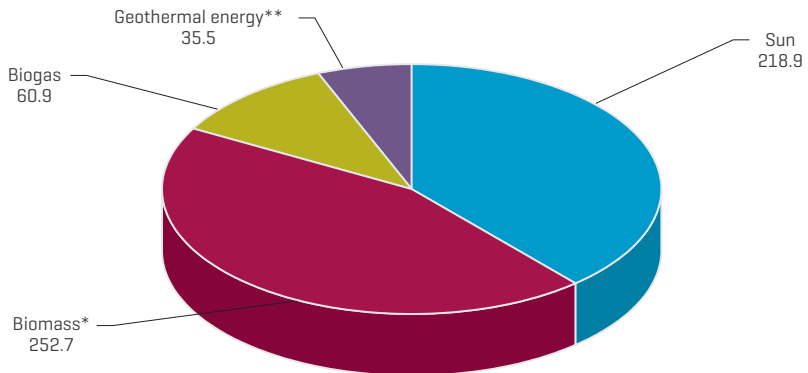


In the production of heat energy from renewable sources, biomass is dominant with 45 percent of the installed capacity, excluding the use of firewood in households.

Figure 22
Installed capacities for the production of thermal energy from RS in Croatia in 2022 (in MW)

Notes: * Applies only to biomass cogeneration.
 ** Geothermal thermal energy for space heating.

Source: Ministry of Environmental Protection and Energy (2023).



When interpreting the above data on the installed capacities for the production of thermal energy from RES, the fact that there are no reliable statistical data on the installed power for the sun and biomass must be taken into account, while there are two methods of data monitoring for geothermal thermal energy. The installed thermal power of solar collectors was estimated based on data on their surface area obtained through a survey of the Hrvoje Požar Energy Institute, while the thermal power, i.e., the final usable heat of solar systems, was calculated according to the guidelines of the European Solar Thermal Industry Federation (ESTIF) and takes into account spatial distribution of solar thermal systems.

“ Although the largest number of RE power plants is located in Osijek-Baranja (244), Međimurje (118), Brod-Posavina (117), and Varaždin (107) Counties [predominantly small solar power plants and a smaller number of hydroelectric power plants and power plants powered by biogas and biomass], the southern counties with wind power plants have the largest installed capacity, more precisely, Šibenik-Knin (213 MW), Split-Dalmatia (172.25 MW), and Zadar (59.62 MW) County.

The data on the estimated installed thermal power of biomass boilers refers to industrial biomass boilers and does not include the thermal power of small stoves for heating and hot water preparation in households. In the professional literature, there are two methodologies for displaying the used geothermal energy: either only the energy used for space heating can be observed, or the energy for space heating and bathing can be observed. The total installed capacity of geothermal sources in Croatia is 36.1 MW if only space heating is considered, or 60.5 MW if geothermal energy for space heating and bathing is considered.

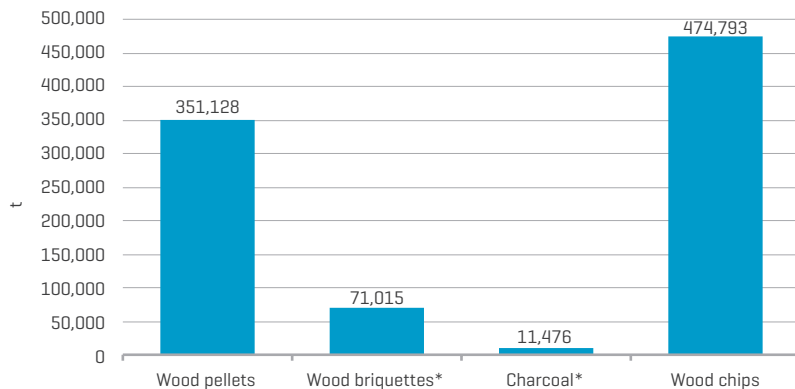
When producing fuel from renewable energy for the production of renewable energy, different forms of solid biomass are present in the Republic of Croatia. Compared to 2022, statistical indicators for the production of solid biofuels from biomass indicate an increase in the production of wood briquettes by 26 percent and wood chips by 12 percent. The production of charcoal recorded a decrease of 19 percent. The production of wood pellets stabilized and grew by only 2 percent in 2022 compared to the previous year. Firewood is still the most common renewable fuel used in Croatia, amounting to 4,883,600 cubic meters in 2022.

Of the total amount of pellets produced in 2022, about 57.7 percent was placed on foreign markets, while of the total amount of briquettes produced in 2022, about 78.5 percent was placed on foreign markets.

Figure 23
Production of solid biofuels in 2022 (in tons), without firewood

Note: * indicates that it is an estimate.

Source: Ministry of Environmental Protection and Energy (2023).



Leading companies

According to data from Poslovna Hrvatska, in 2022, 12 business entities were active in the field of "Manufacture of refined petroleum products", while 1,053 were active in the field of "Electricity, gas, steam and air conditioning supply". Within the activity of the production of refined petroleum products in 2022, the largest trading company was INA d.d., which with total revenues of 4,653,332,200 euros achieved 99.1 percent of the total revenues of this activity. A significant part of its business is related to business with the Government of the Republic of Croatia, its ministries and agencies. INA d.d. thus has a dominant position in Croatia in the exploration and production of oil and gas, oil processing, and sales of gas and oil products. According to data from Poslovna Hrvatska, INA d.d. achieved a gross profit of 397,903,917 euros in 2022 (Table 3). Compared to 2021, total revenues increased by 56.9 percent, while profits almost doubled (96.9 percent growth). In 2022, INA d.d. operated with a net profit of 243,759,554 euros, and in 2021 it achieved a net profit of 168,997,413 euros. In 2022, the company increased investments in all activities compared to 2021, to the level of EUR 358.3 million, with the largest part of the investment directed to the Rijeka Oil Refinery upgrade project and the drilling campaign in the northern Adriatic. The main strategic project of the Rijeka Oil Refinery continued in 2022 and reached 70 percent completion.¹⁵ In 2022, the company was also very successful in the exploration and production of oil and gas. As a result of the natural decline in production in mature fields, a new investment cycle was launched in both continental Croatia and the Adriatic. An extensive Northern Adriatic Development Program was started, in which positive results were achieved from the Ilena-2, Ida D-1, and Ida D-2 wells. The already drilled wells, Ika B and Marica D, were put into production in March and May 2022, respectively. INA d.d. also has concessions on three exploration areas in Panon: Drava-02 (DR-02), Drava-03 (DR-03), and Northwest Croatia-01 (SZH-01), as well as on one investigation area in the Dinarides, Dinarides-14. INA d.d. is the concessionaire of three hydrocarbon exploitation fields with a total of 11 gas fields in the Adriatic. INA d.d. is the operator of ten fields, and the operator of one field is the company ED-INA d.o.o. – joint company of INA and Energean.

¹⁵ Annual report 2022, <https://www.ina.hr/press-centar/publikacije/izvjescianje/>

INA D.D. WAS THE LARGEST BUSINESS SUBJECT IN 2022 IN THE PRODUCTION OF REFINED PETROLEUM PRODUCTS, WITH A TOTAL REVENUE OF 4.65 BILLION EUROS, ACHIEVING 99.1 PERCENT OF THE TOTAL REVENUE OF THAT ACTIVITY.

The number of employees was reduced from 3,214 employees in 2021 to 3,005 employees in 2022 [a decrease of 6.5 percent]. It is interesting to note that the company has been recording a decreasing trend in the number of employees since 2015. In 2015, INA d.d. employed 7,605 workers, while in 2022 it employed less than half of that number, more precisely, 3,005. Table 3 shows some of the selected financial indicators of the company INA d.d. for the year 2022 and 2021.

Table 3
Selected business indicators of the company INA d.d., 2021 and 2022

Note: p.p. indicates a percentage point.

Source: Poslovna Hrvatska.

	2021	2022	2022/2021
Total revenue (in millions of euros)	2,966.2	4,653.3	156.9
Profit before tax (in millions of euros)	202.1	397.9	196.9
Number of employees	3,214	3,005	93.5
Gross margin (in %)	6.8	8.6	1.7 p.p.
Return on asset (in %)	5.6	7.5	1.9 p.p.
Labor productivity (income in thousands of euros per employee)	922.9	1,548.5	167.8
Asset turnover ratio	1.0	1.4	144.7
Current ratio	1.5	1.4	93.6
Debt ratio	0.3	0.3	106.1

A more detailed insight into the state and dynamics of the "Supply of electricity, gas, steam, and air conditioning" activity is provided by the analysis of the financial indicators of ten leading companies [Table 4]. The main characteristics of the operations of the leading companies in the supply of electricity, gas, steam, and air conditioning in 2022 are an increase in income, a slight decrease in employment and loss-making operations [Table 4]. In 2022, the total revenues of the ten leading companies in this industry amounted to 11.5 billion euros and were 90.5 percent higher than in 2021 [Table 4]. The number of employees at the level of the ten leading companies in this industry decreased by 0.6 percent, from 10,200 employees in 2021 to 10,142 employees in 2022. In 2022, ten leading

TOTAL REVENUES OF THE TEN LEADING COMPANIES IN THE ELECTRICITY, GAS, STEAM, AND AIR CONDITIONING SUPPLY ACTIVITIES IN 2022 WERE 90.5 PERCENT HIGHER THAN IN 2021.

trading companies made a cumulative negative business result [EUR 6.3 million loss], whereby both profit and gross margin decreased compared to the previous year. The company HEP ELEKTRA d.o.o. contributed the most to the negative business result. This company ended 2022 with a loss of 77.7 million euros, followed by Gradska plinara Zagreb – Opskrba d.o.o. with a loss of 12.8 million euros. It is interesting to note that the company Gradska plinara Zagreb – Opskrba d.o.o. ended 2021 with a loss of 47.6 million euros. The company HOPS d.d. also recorded a negative business result in 2022. The remaining seven leading companies in the "Supply of electricity, gas, steam, and air conditioning" business ended 2022 with a positive business result.

Table 4
Average values of selected performance indicators of the leading ten companies in the business activity described as "Electricity, gas, steam, and air conditioning supply", 2021 and 2022

Note: p.p. indicates a percentage point.

Source: Poslovna Hrvatska.

	2021	2022	2022/2021
Total revenue (in millions of euros)	6,039.9	11,503.5	190.5
Profit before tax (in millions of euros)	102.6	-6.3	-6.1
Number of employees	10,200	10,142	99.4
Gross margin (in %)	1.7	-0.1	-1.8 p.p.
Return on asset (in %)	1.2	-0.2	-1.4 p.p.
Labor productivity (income in millions of euros per employee)	0.6	1.1	191.5
Asset turnover ratio	1.0	1.7	173.4
Current ratio	1.1	1.1	95.0
Debt ratio	0.6	0.7	105.4

A strong growth in total income followed by a slight decrease in the number of employees resulted in an increase in labor productivity of 91.5 percent. The value of the coefficient of current liquidity for ten leading companies in the supply of electricity, gas, steam, and air conditioning of 1.1 indicates that they had certain difficulties in maintaining liquidity in 2022. Compared to the previous year, liquidity decreased by 5 percent. The debt ratio of the leading ten companies in the supply of electricity, gas,

steam, and air conditioning amounting to 0.70 in 2022 indicates relatively higher indebtedness of companies. Also, its value was 5.4 percent higher than a year earlier.

Table 5 shows the key indicators of ten leading companies in the supply of electricity, gas, steam, and air conditioning. Measured by total revenues, among the ten leading companies in this sector in 2022 are the following companies: Prvo plinarsko društvo d.o.o., MVM CEEnergy Croatia d.o.o., HEP-Proizvodnja d.o.o., MET Croatia Energy Trade d.o.o., HEP ELEKTRA d.o.o., HEP-Operator distribucijskog sustava d.o.o., GEN-I Hrvatska d.o.o., HOPS d.d., Gradska plinara Zagreb – Opskrba d.o.o. and E.ON Energija d.o.o.

Compared to the previous year, increase in income in 2022 was achieved by all ten companies, among which the leading companies are MET Croatia Energy Trade d.o.o. with revenue growth of 286.1 percent and MVM CEEnergy Croatia d.o.o. with a growth of 260.7 percent. These are the Croatian branches of the Hungarian energy companies MET Group and MVM Group. Both companies are tenants of the LNG terminal on Krk¹⁶ [there are also Prvo plinarsko društvo d.o.o., HEP d.d., INA d.d., and Slovenian Geoplin]. Only one company, HEP-Proizvodnja d.o.o., records favorable values of the current ratio in 2022, while the remaining eight companies have had certain difficulties in maintaining liquidity.

Of the ten largest companies in the supply of electricity, gas, steam, and air conditioning, five companies are 100% privately owned, i.e. Prvo plinarsko društvo d.o.o., MVM CEEnergy Croatia d.o.o., MET Croatia Energy Trade d.o.o., GEN-I Hrvatska d.o.o., and E.ON Energija d.o.o. Prvo plinarsko društvo d.o.o. is in domestic ownership, while the remaining four companies are foreign-owned. The remaining five companies are 100% state-owned.

¹⁶ The company MET Croatia Energy Trade d.o.o. leased a total of 4.7 billion cubic meters of gasification capacity at the LNG terminal on the island of Krk, for a period of twelve years.

Table 5
Ten leading companies in the "Supply of electricity, gas, steam, and air conditioning" – selected financial indicators, 2022

Source: Poslovna Hrvatska.

	Total revenue (in millions of euros)	Debt ratio	Current ratio	Gross margin
Prvo plinarsko društvo d.o.o.	4,368.1	0.9	1.1	1.2
MVM CEEnergy Croatia d.o.o.	1,721.0	1.0	1.0	0.3
HEP-Proizvodnja d.o.o.	1,510.6	0.8	2.0	0.1
MET Croatia Energy Trade d.o.o.	1,280.6	1.0	1.0	0.4
HEP ELEKTRA d.o.o.	717.3	1.2	0.8	-10.8
HEP-Operator distribucijskog sustava d.o.o.	567.6	0.6	0.8	1.4
GEN-I Hrvatska d.o.o.	500.5	0.8	1.2	0.2
HOPS d.d.	418.2	0.2	0.8	-0.3
Gradska plinara Zagreb – Opskrba d.o.o.	225.7	1.6	0.6	-5.7
E.ON Energija d.o.o.	193.8	0.6	0.9	5.6

References:

Croatian Energy Market Operator (HROTE). [2023a]. *Annual report for 2022*. Downloaded from: <https://files.hrote.hr/files/PDF/RSEIK/GIRSEIK2022.pdf>

Croatian Energy Market Operator (HROTE). [2023b]. *Installed capacity and number of plants in the incentive system by county for December 2023*. Downloaded from: https://files.hrote.hr/files/PDF/RSEIK/2023/Reports/Installed_power_and_number_of_plants_in_the_promotion_system_by_counties_HR-December-2023.pdf

Directive [EU] 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive [EU] 2018/2001, Regulation [EU] 2018/1999 and Directive 98/70/EC with regard to the promotion of energy from renewable sources and repealing Council Directive [EU] 2015/652.

Energy development strategy of the Republic of Croatia until 2030 with a view to 2050. "Official Gazette", no. 25/20.

European Commission. [2019]. *Clean energy for all Europeans*. Downloaded from: <https://doi.org/10.2833/9937>

European Commission. [2020]. *European Green Deal*. Downloaded from: <https://eur-lex.europa.eu/legalcontent/HR/TXT/HTML/?uri=CELEX:52019DC0640&from=EN>

European Environmental Agency (EEA). [2023]. *Annual European Union greenhouse gas inventory 1990-2021 and inventory report 2023*. Submission to the UNFCCC Secretariat 15 April 2023. Downloaded from: <https://www.eea.europa.eu/publications/annual-european-union-greenhouse-gas-2>

Eurostat. [2023]. *SHARES 2022 summary results 2022: Short assessment of renewable energy sources* [24.1.2024.]. Downloaded from: https://ec.europa.eu/eurostat/documents/38154/4956088/SUMMARY-results-SHARES_2021.xlsx/a3ec29ed-95d3-8dfd-6f2f-4acd1eafdc91?t=1673009663750

Law on renewable energy sources and high-efficiency cogeneration. "Official Gazette", no. 138/21.

Ministry of Economy and Sustainable Development (MINGOR). [2023]. *Integrated National Energy and Climate Plan for the Republic of Croatia for the period from 2021 to 2030 - draft 2023*. Downloaded from: https://commission.europa.eu/publications/croatia-draft-updated-necp-2021-2030_en

Ministry of Environmental Protection and Energy. [2023]. *Energy in Croatia in 2022: Annual energy audit*. Zagreb: Ministry of Environmental Protection and Energy of the Republic of Croatia. Downloaded from: https://mingor.gov.hr/UserDocImages/slike/Vijesti/2022/EnergijauHR22_WEB_Velika.pdf

Regulation [EU] 2021/1119 of the European Parliament and of the Council of June 30, 2021 on the establishment of a framework for achieving climate neutrality and on the amendment of Regulation [EC] no. 401/2009 and [EU] 2018/1999 ["European Climate Law"]. [2021]. *Official Journal of the European Union*, L243/2.

The European Parliament and the Council of the European Union. [2018]. Directive [EU] 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources [Text with EEA relevance]. Downloaded from: <https://eur-lex.europa.eu/legal-content/HR/TXT/PDF/?uri=CELEX:32018L2001&from=LV>

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