Transition to a Green Economy through the Development of Renewable Energy in the European Union

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Abstract: - The European Union is a leader in renewable energy development. In the first six months of 2024, the share of renewable energy in the EU's total generation reached a record high of 50%. The dynamics of the EU energy sector demonstrate a rapid transition to low-carbon technologies. Data for the first half of 2024 highlight significant progress in this direction: the share of solar and wind power plants has increased significantly, securing the achievement of 50%. This confirms the effectiveness of the EU's efforts to increase infrastructure capacity and implement innovative technologies in this area. For the first time in history, the total electricity generation from solar and wind installations reached 30% (386 TW·h), which exceeded the 27% of fossil fuel-based energy production (343 TW·h) over the same period. This article aims to examine the progress in the field of "green" energy, and assess the current situation and prospects for the development of the European Union economy. The analysis covers the period from the publication of the European Commission's Green Paper on the Future of Renewable Energy in 1996 to the present day. The main focus is on the strategy for the transition to a sustainable green economy, including key quantitative indicators characterizing the level of implementation of environmentally friendly technologies. The study concludes that renewable energy in the EU continues to actively develop and gain popularity among member states, creating prospects for further strengthening of a sustainable energy system.

Key-Words: - renewable energy, fossil fuels, electricity generation, European Union, green economy, energy transition.

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1 Introduction

As the world's climate and environment deteriorate, the transition from traditional energy sources (oil, coal, natural gas) to renewable energy sources (RES) is becoming increasingly important. According to many experts, oil and gas reserves will be significantly depleted this century, and as the world's population grows, energy consumption will only increase, [1], [2], [3]. Therefore, the problem is how to provide people with energy-saving, environmentally friendly, and no less important inexhaustible energy.

The growth of energy consumption is inevitable and inseparable from economic development. Given the average rate of population growth and energy demand, hydrocarbons (currently accounting for 86% of primary energy consumption) and other traditional energy sources are likely to be exhausted within a few decades. The finite and consumable nature of energy creates a need for alternative solutions. One of them is "green" energy

"Green" energy is that part of an energy production system based on humanity's inexhaustible, inexhaustible, or renewable natural resources. "Green" energy sources include wind, sunlight, water flow, geysers, and biofuels. The beauty of such energy sources is not only that they are inexhaustible, but also that they are environmentally friendly. It is believed that green energy will help offset the negative impacts of urbanization and climate change.

The concept of a green economy was proposed in 1991 [4], suggesting a gradual shift to renewable energy to achieve sustainable development. The authors outline its main provisions in the book Green Economy: Environment, Sustainability and the Politics of the Future, [4]. However, these ideas did not begin to spread widely until after the 2008 economic crisis, and the “green” economy began to

be regarded as an operational strategy to restore the global economy and prevent future major shocks.

The renewable (alternative, "green") energy sector is becoming increasingly important in the global energy balance. The high importance of renewable energy for the global economy is due to several factors:

- The use of renewable energy sources allows countries to become more independent from the import of energy raw materials, which, in turn, increases their energy security;
- Unlike traditional energy, renewable energy has stable prices and has a positive impact on the global economic process;
- Renewable energy has advantages over fossil fuels in terms of energy efficiency and low cost of economic resources due to innovation, energy-saving technologies, and large investments.

Many countries around the world have developed plans for the development of renewable energy. In addition, many private companies and even traditional energy market players are actively involved in the development and implementation of renewable energy technologies, [5].

The European Union is one of the leaders in the development of renewable energy. Therefore, in the first half of 2024, the EU's renewable energy power generation reached 50%.

Trends in the EU power industry do show a rapid transition to carbon-free energy, and European power data for the first half of 2024 highlight several important aspects of this transition. The share of renewable energy sources such as solar and wind energy in the energy mix has increased significantly, reaching 50%, indicating the success of the EU's efforts to increase infrastructure and technology in this field. This growth is linked to many EU initiatives, including the Green Deal and decarbonization targets by 2050. Nuclear energy provides 24% of electricity and is a reliable, carbon-free energy source. This is critical to stabilizing the energy system during periods of low renewable energy generation. The EU is still debating expanding or phasing out nuclear energy in the longer term. Some countries, such as France, support nuclear energy as a key pillar of decarbonization, while others favor phasing it out. The shares of fossil fuels and natural gas reached record lows of 13% and 9% respectively. This shift is due to tight limits on carbon emissions in the European Union, as well as tax and market measures that increase the cost of using carbon sources. Reducing reliance on coal and gas is also linked to the EU's long-term strategy to reduce energy dependence on imported fossil fuels, especially given geopolitical considerations.

The most important task of the EU in the field of energy policy is to improve energy efficiency and ensure regional energy security by reducing dependence on imported energy, improving energy efficiency, and reducing harmful effects on the environment, [6], [7]. In many ways, these goals are achieved thanks to the use of renewable energy sources, which have sufficient potential to secure energy consumption in European countries. Therefore, the EU is very interested in developing renewable energy and introducing various types of renewable energy.

The purpose of this article is to identify the EU's main tasks, support mechanisms, and opportunities for further development in the field of renewable energy utilization. The methodological basis of this work is a systematic approach to scientific knowledge and a historical, analytical, and comparative approach. The original database includes official EU documents, and statistics from the International Energy Agency, Eurostat, and the International Renewable Energy Agency.

2 Methods

To prepare this article we conducted a review of the published literature in order to provide readers with the most relevant and up-to-date data and information on the EU energy transition i e from a society that burns fossil fuels for electricity generation to a Green economic transformation, to one that uses a variety of renewable energy sources, generate electricity. The method used in preparing the manuscript was the historical logical method. This method allows the author to describe facts through logical development.

3 The Paris Agreement and the European Green Deal

The dialogue between EU member states on the prospects for the development of renewable energy began with the release of the European Commission's Green Paper "Future Energy: Renewable Energy" in 1996, which set a goal of reaching 12% of renewable energy by 2010, an official document containing a series of actions required to develop renewable energy was developed, [8].

In September 2001, the first directive 2001/77/EC "On the promotion of renewable

energy sources in the internal electricity market" was promulgated, which set the goal of increasing the share of renewable energy production in the EU by 2010, to 22%.

In October 2005, EU leaders discussed a series of so-called measures at an informal meeting at Hampton Court Palace. The new energy policy clarifies the tasks of EU countries in the fields of energy conservation and the introduction of renewable energy. For the first time, the importance of "green" energy in solving climate problems was emphasized, [9].

In 2009, the European Council and the European Parliament adopted a new directive on the use of renewable energy (the so-called 20/20/20 plan). The document outlines the EU's key target of improving energy efficiency by 20% by 2020 and outlines individual targets for renewable energy production for each EU member state, which are expected to be achieved by 2020.

In order to achieve the set goals, one of the first tasks that needs to be addressed is optimizing energy efficiency at the building level, since they account for approximately 40% of electricity consumption. In other words, each building should generate its own electricity and rely on renewable energy to meet its energy consumption. According to calculations by the European Commission, in order to achieve this target, the energy efficiency of buildings must increase by 3% per year. In the summer of 2018, the document was modified to stipulate that by 2050, through renovation, the entire building complex in the EU must comply with the above standards, [10].

The tasks identified in the above-mentioned documents are implemented with direct subsidies from the state budget. Only research activities and some infrastructure projects are funded by the EU budget. However, the global economic crisis of 2008-2009 led to a significant reduction in state support, [11]. Therefore, Germany significantly reduced its financial investment in solar energy projects in 2009. Spain has followed suit, deeming solar power plants unprofitable, [12]. If the total renewable energy production of EU countries is taken into account, it will decrease by 2.7% by 2011. While the European Commission initially advocated increased investment in renewable energy development, in early 2013 it proposed modifying existing support mechanisms to make them “cost-effective and market-oriented”, [13].

At the next European Council Summit in October 2014, the main directions of climate and energy policy before 2030 (the so-called 2030 Strategy) were approved [14], which include reducing greenhouse gas emissions, reforming the carbon emissions trading system, etc. Mandatory target to increase the share of renewable energy in the EU's final energy consumption to 27% by 2030.

In November 2016, the European Commission proposed the “Clean energy for all Europeans” package, which contains regulatory prerequisites for the EU’s transition to green energy. One of the provisions of the document is to increase the energy efficiency target to 30% by 2030 using renewable energy sources with the intention of ensuring compliance with this standard throughout the EU. However, some experts have stressed that the Commission’s calculations may be overly optimistic since job growth depends on national renewable energy incentives and favorable features of national renewable energy policies, otherwise, the introduction of such high standards could lead to job losses, [15], [16]. Moreover, raising the above-mentioned figure to 30% would require strict monitoring and regulation in the areas of renewable energy and energy efficiency, areas where Member States are not yet ready to fully transfer competencies to the EU. As a result, the Clean Energy for the Whole of Europe package was only partially adopted, and the rest was sent back for revision.

On 18 December 2017, within the framework of the 2009 Renewable Energy Directive, the European Council adopted a number of new measures aimed at increasing subsidies in the renewable energy sector, accelerating the development of renewable energy sources in cooling/heating, transport, and energy saving. The EU's intention to achieve 27% renewable energy in final energy consumption within the 2030 strategy was confirmed, which requires annual investments of 380 billion euros. However, back in November 2018, in order to maintain its leadership in the development and implementation of RES, the EU decided to increase the share of renewable energy in final energy consumption from 27% to 32% by 2030, [16].

To ensure that the necessary targets are met by 2030, the European Parliament has defined a number of measures aimed at strengthening renewable energy:

1. Improve the support system for renewable energy: it should be cost-effective and facilitate the integration of renewable energy into the energy market. National support systems for renewable energy in EU Member States should be coordinated with each other.
2. Create a clear and stable regulatory framework for the use of renewable energy by consumers.

3. Expand the use of renewable energy in transport. By 2030, electric vehicles are expected to account for a significant share of all transport in Europe, and 14% of all fuel will be biofuels.
4. Increasing the sustainability of bioenergy use. It is planned to create an efficient waste recycling system to prevent its excessive accumulation and to set clear quality standards for the sustainable production of biofuels, [17].

In 2019, the second part of the Clean Energy for All Europeans package was adopted. It contains provisions on risk preparedness in the energy sector to ensure an uninterrupted and secure energy supply in crisis situations. Thus, the second part of the package aims to strengthen the EU's energy security, and renewable energy sources are a key tool to achieve this goal.

In the same year, the European Commission proposed the European Green Deal with the aim of turning Europe into a "climate-neutral continent" by 2050. This should be achieved through decarbonization (reduction and then complete elimination of CO_2 emissions) and the widespread introduction of renewable energy sources. However, not all EU member states are optimistic about this proposal: countries in Eastern and Central Europe, where coal accounts for a higher share of their national energy mix, say they are not ready to take such radical measures. Poland, for example, refuses to decarbonize, as coal produces almost 80% of its energy. The Polish Energy Policy 2040, developed in 2018, confirms that coal will remain the single most important source of electricity production by 2040, although its role will decrease, [18]. However, the EU is doing its best to convince the “skeptics” by pouring funds into those regions that must do everything possible to achieve the goals of the European Green Deal. These regions will be allocated 100 billion euros between 2021 and 2027, [19]. The goal is ambitious but entirely achievable. Many EU member states have set deadlines for the closure of coal-fired power plants, with France planning to close its last coal-fired power plant in 2022 and Germany planning to close its last coal-fired power plant in 2038, [20]. In September 2020, the European Electricity Association, which represents the interests of over 3,500 energy companies in 32 European countries, published the Energy Barometer, a set of key indicators reflecting the development of the energy industry. As noted in the study, the decarbonization of the electricity sector is proceeding rapidly. Two-thirds of the electricity generated in Europe in the first half of 2020 was carbon-free.

In addition to implementing the tasks set by the European Commission, EU member states are developing their own national strategies aimed at developing renewable energy. For example, as part of Germany's energy transition by 2050, it is planned to reduce the consumption of traditional energy sources, increase the share of renewable energy sources in electricity production to 60%, and reform the national market to increase its efficiency, taking into account the growing role of renewable energy sources, [21].

EU countries independently determine national measures to stimulate and support the development of renewable energy: preferential prices for electricity generated from renewable energy sources; transactions with "green" certificates based on tax breaks for electricity consumption and "green" tariffs for companies using renewable energy sources, etc., [22]. In addition to providing funds for R&D, Denmark is also the first country among the Nordic countries to introduce tariff subsidies, [23]. In 2016, the energy ministers of Germany, Luxembourg, Sweden, Norway, the Netherlands, Ireland, Belgium, France, Denmark, and the United Kingdom signed a memorandum of understanding and a work plan to strengthen and develop cooperation in the field of renewable energy. The agreements provide for measures aimed at reducing overall financial costs, cooperating in the planning of energy networks (to ensure rational energy distribution and uninterrupted power supply between countries), developing common standards and rules in the field of renewable energy, and emphasizing the need to create common "Green" projects and joint cross-border plans. In addition to financial support, European countries share experiences and best practices in the renewable energy sector and sell surplus energy generated from renewable sources to each other. In addition, private companies from some EU member states are also building renewable energy projects in other EU countries. An onshore wind farm in Poland at Nawrocco, built by German energy company RWE, was completed in early 2020, while Italy's Enel Green Power is building a similar plant in Greece.

4 Renewable Energy Development: Impact of the Pandemic

The COVID-19 coronavirus pandemic has reduced electricity demand worldwide, especially in the

European Union, where energy consumption fell by 4%. However, the epidemic has not had a negative impact on the development of renewable energy. Instead, in 2020, record-breaking solar and wind installations with a total capacity of more than 250 GW were commissioned, with an installed capacity equivalent to the power grid of the Russian Federation.

In January 2021, the German Agora Institute for Energy Transformation and the British think tank Ember jointly published a report stating that the EU is phasing out coal faster than expected, while renewable energy production has reached a record level. Thus, the report states that in 2020, the share of electricity generation from renewable sources exceeded the share of coal-fired power plants for the first time, reaching 38%, while fossil fuel generation was only 37%. The output of renewable energy plants increased by 11%, while that of oil, natural gas, and coal-fired power plants decreased by 18% and coal-fired power generation decreased by 32%, [24]. Regarding the implementation of the 20/20/20 plan, the total final energy consumption of EU countries in 2020 was 22.1%, which is about 2% higher than the target. All countries except France achieved the national target (19.1% instead of 23%). The top three are Sweden (60.1%), Finland (43.8%) and Latvia (42.1%), while the lowest are Belgium (13%), Luxembourg (12%) and Malta (11%). In 2020, the European Commission proposed a "Next Generation EU" plan to overcome the recession following the coronavirus crisis and to restore the economy. The plan will cost around €750 billion, which will be made available through other targeted programs, one of which is the European Green Deal.

The European Commission proposed an ambitious new package of measures to reduce greenhouse gas emissions in July 2021, called Fit 55. Under the proposed plan, CO_2 emissions are expected to fall by 55% by 2030 compared to 1990 levels, which will require renewable energy to take a higher share of the EU energy mix. Since the energy sector accounts for more than 75% of CO_2 emissions, the European Commission has set a target of increasing the share of energy produced from renewable sources from 32% to 40% by 2035.

Renewables continued to steadily outperform fossil fuels in the first half of 2021 (coal-fired power generation, as usual, declined). Electricity demand increased by 6% compared to the first half of 2020, almost reaching pre-pandemic levels. However, fossil fuel electricity generation decreased by 10% compared to pre-pandemic levels, while renewable electricity generation increased by 11% in the first half of 2021 compared to pre-pandemic levels, driven by structural growth in wind and solar power, as well as high hydropower. In addition, rising gas and coal prices have made fossil fuel electricity generation costs higher than wind and solar power generation costs, [25].

5 Current state of renewable Energy in the European Union

On 11 December 2019, the European Commission approved the European Green New Deal, a comprehensive strategy aimed at achieving net-zero greenhouse gas emissions and reducing pollution to a minimum. The initiative sets a goal to phase out fossil fuels entirely by 2050, transitioning to a renewable energy-based economy.

The Green Deal enforces climate laws that legally bind EU member states to meet these ambitious objectives. Participating nations are required to submit progress reports biennially, [26].

As reported by EEA, the proportion of renewable energy in the total final consumption across the EU-27 is projected to reach 24.5% by 2023. This marks a 1-percentage point rise from 2022, setting a new record. This milestone is largely attributed to pivotal EU legislative efforts, including the Fit-for-55 package and the RepowerEU program, [27].

After a dip in the share of renewable energy in 2021, 2023 signals a return to consistent growth. Overall renewable energy consumption increased by the equivalent of 6 million tonnes of oil, driven predominantly by robust expansions in solar energy (+18.6%) and wind power (+8.5%), [27].

The progress in renewable energy adoption is significantly supported by the reduced reliance on non-renewable resources. The newly adopted EU Directive 2023/2413 sets an ambitious goal, raising the renewable energy target from the current 32% to 42.5% by 2030, with a potential increase to 45%. However, meeting these high expectations necessitates a doubling of renewable energy growth rates and a comprehensive overhaul of Europe's energy infrastructure, as shown in Figure 1 (Appendix).

To achieve the elevated benchmarks, EU member states must accelerate their efforts, striving to boost the share of renewable energy by almost 20 percentage points.

Sweden remains the frontrunner within the EU, achieving a remarkable 66% of its final energy

consumption from renewables in 2023, largely powered by hydropower, wind energy, biofuels, and heat pumps, [28].

Finland secures second place, with renewables contributing 50.8% of its energy mix, dominated by hydropower, wind resources, and biofuels. Denmark (44.9%), Estonia (40.9%), and Austria (40.8%) follow suit, utilizing a blend of wind energy, biomass, hydropower, and thermal pumps. At the other end of the spectrum, Ireland (15.2%), Malta (15.1%), Belgium (14.7%), and Luxembourg (11.6%) report the lowest renewable energy shares, as shown in Appendix in Figure 2 and Figure 3.

In 2023, renewable energy adoption progressed most rapidly in the power sector, where it accounted for 44.3% of electricity generation. This was followed by heating, cooling applications (25.4%), and transportation (10.1%), [27], [28], [29].

Biomass remains the dominant renewable energy source, encompassing solid, liquid, and gaseous forms, and represents 50% of total renewable energy consumption. This dominance, however, raises environmental concerns regarding carbon sink preservation, biodiversity impacts, and air quality. Other notable contributors include wind energy (17%), hydropower (13%), and solar energy (9%), with heat pumps and biofuels each contributing 8%, [27], [28], [29].

Over the decade from 2012 to 2022, the European Union witnessed a remarkable surge in renewable electricity production, driven by the rapid expansion of wind and solar power. By 2022, renewable energy accounted for 41.2% of the EU's total electricity consumption, as shown in Figure 4 (Appendix), marking a 3.7 percentage point increase from the prior year [28], [29].

Leading this green energy transition, wind power contributed 37.5%, while hydropower added 29.9%, together forming two-thirds of the EU's renewable electricity output, as shown in Figure 5 (Appendix). Solar power, meanwhile, has emerged as a standout performer, achieving an impressive annual growth rate of 18.2%, outpacing other renewable sources, [28], [29].

In a historic first, wind and solar energy combined to generate 30% of the EU's electricity (386 TW·h) in the first half of 2024, surpassing fossil fuels, which accounted for 27% (343 TW·h), as shown in Figure 6 (Appendix). This landmark shift was achieved by countries like Germany, Belgium, Hungary, and the Netherlands, further solidifying renewable energy's dominance in the region [28], [29].

Today, wind and solar power generation outpaces fossil fuel production in 13 EU member states. Remarkably, this progress has been exponential: just five years ago, only five nations reached this milestone, with renewables meeting 25% of their electricity demands. Now, that share has soared to an impressive 70%, showcasing the EU's commitment to a sustainable energy future [28], [29].

The energy breakthroughs are driven by the rapid development of solar technology, the high efficiency of wind turbines, and a reduction in electricity consumption. Solar power production reached a record high in May, accounting for 14% of total EU electricity production and reaching a new high of 27 TW·h. This exceeds the solar achievement set in July last year. Solar power has surpassed coal power generation for the first time, with coal accounting for just 10% of the EU's electricity in May, [30], [31], [32].

Wind power has increased year on year, accounting for 17% (32 TW·h) of electricity in May. However, this figure is still below the record set in January, when wind power accounted for 23% (54 TW·h) of total energy consumption, [30], [31], [32].

Strong performance from wind and solar power plants has led to coal power generation in the EU falling to a historic low. Coal accounted for just 10% (20 TWh) in May, the lowest month on record. This is even lower than during the 2020 lockdown when coal provided more than 10% of the EU's electricity. In addition, the share of electricity generated from fossil natural gas reached its lowest level since 2018 in May – just 15%, [30], [31], [32].

The global shift away from fossil fuels is gaining momentum. The accelerated adoption of renewable energy, particularly solar power, coupled with a decrease in electricity demand, has bolstered the dominance of wind and solar energy. This transition has significantly eroded the market shares of coal and natural gas since late 2022. Between January and May this year, electricity production from coal and natural gas plummeted by 20% and 15%, respectively, compared to the same timeframe last year. Conversely, solar power generation rose by 10%, while wind energy saw a 5% increase. Insights from Ember's analysis of European energy trends reveal that in 2022, the combined share of wind and solar power surpassed natural gas for the first time. Within just a few months of this year, renewable energy sources collectively outproduced all fossil fuel categories combined, [30], [31], [32].

The decline in fossil fuel reliance is evident across numerous EU nations. In Germany, coal power generation dropped to 7 terawatt hours - the lowest figure since early 2020 - despite the decommissioning of the country's final nuclear power plants earlier this year. This was driven by diminished demand, robust renewable energy output, and an increase in electricity imports. Similarly, Poland, the EU's largest coal power producer, recorded a historic low in coal's share, which fell to 62% (7 TW·h). A representative from Ember, an independent global energy think tank that uses data and policy to accelerate the transition to clean energy, said: "Wind and solar energy continue to displace fossil fuels. Not only has coal generation reached unprecedented lows, but gas-powered generation is also steadily declining. This year marks a pivotal phase for the EU as it advances toward a profound energy transformation with renewables at the forefront", [30], [31], [32].

6 Conclusion

Renewable energy has great potential in the EU. It is not only that the EU is actively developing the industry and creating mechanisms to stimulate the introduction of renewable energy. Due to the awareness of growing environmental and climate problems, European society is ready to switch from traditional energy sources to "green" energy sources, [6], [7]. Various analytical institutes have given optimistic forecasts for the development of renewable energy in Europe. For example, scientists from the Lappeenranta University of Technology have concluded that by 2050 it will be possible to completely switch to electricity from renewable sources in all sectors: energy, heating, and transport. The authors of the study note that as the population increases, the demand for energy will grow, which makes renewable energy an ideal energy-saving technology.

There is no doubt that renewable energy continues to develop actively. According to expert forecasts, renewable energy will show the highest growth rates among all energy sources by 2040, with an annual growth rate of 6.3-8.3%. With its further development, the energy structure will undergo the most serious transformation. By 2040, the consumption of all renewable energy will increase by 76-115%, and the amount of renewable energy used to generate electricity will increase by 2.5-3.7 times, mainly due to a doubling of the capacity of solar and wind power plants, [33], [34]. The International Energy Agency noted in its annual report for 2024 that "the sun is becoming the new king of electricity." Solar energy is cheaper than electricity production from new coal or gas-fired power plants, making it the most cost-effective new energy source. Electricity in many countries. The cost and value of electricity generated from renewable sources (primarily solar) will continue to decline, while the complexity and cost of producing fossil fuels will increase. Therefore, in the near future, electricity produced using renewable energy sources will always be cheaper than hydrocarbon generation, [35], [36].

However, there are certain barriers to the faster development of renewable energy. There are still large reserves of fossil fuels, which reduces the desire to switch to renewable energy sources as quickly as possible. Similar situations exist not only in the EU but also worldwide. The growth of shale and liquefied natural gas production, as well as advances in nuclear energy technology, have also slowed down the adoption of renewable energy sources. The development of renewable energy technologies is complicated by the need for large investments, which are essentially initial investments that only begin to pay off after the renewable energy facility has been built. There are also unresolved technical issues: the operation of wind turbines in extreme cold (which now must be switched off), noise pollution, infrasound sources, etc. However, as technology develops, the share of renewable energy sources will grow rapidly. However, world experience shows that development is almost impossible to achieve without a sustainable government policy on the development and implementation of low-carbon energy technologies, the promotion of energy-saving technologies, and renewable energy technologies.

7 Proposals

Based on an analysis of the current situation and the prospects for a significant contribution of renewable energy sources to the EU energy mix for electricity generation, a number of recommendations have been developed for consideration by the EU competent authorities. The proposals are:

1) Accelerate the transition from a society producing traditional energy to one producing energy from renewable sources. But this process should be based on a well-prepared technical and economic plan, providing for the replacement of thermal power plants with renewable energy sources, ensuring reasonable prices and stable energy supplies throughout the process, and

ensuring its shared use by all people. Reliable and modern electricity services without any undue political interference.
2) Create a dedicated EU fund to support vulnerable households and small businesses during the energy transition.
3) The choice of the type of renewable energy to be installed should take into account factors such as the advantages and disadvantages of each energy source, the geographical characteristics of the chosen site, levels of electricity demand, construction time, energy efficiency, public opinion, and the investments required.
4) The decarbonization process requires multiple baseload power plants that are minimally polluting but can stabilize the system in the event of disruptions to renewable energy due to weather conditions, drought, cloudy days, etc.
5) Promote and support the interconnection of energy infrastructure between EU countries to diversify supplies and address potential energy supply disruptions.
6) Promote the use of hydrogen as an important source of energy production as it does not emit greenhouse gases.
7) Increase the participation of offshore renewables in the EU energy mix of the future.
8) Expand cooperation in new research and development of technologies in the field of renewable energy and clean fossil fuel technologies.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author used ChatGPT in order to use this technology to improve readability and language. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The author contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

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Conflict of Interest

The author has no conflicts of interest to declare.

APPENDIX

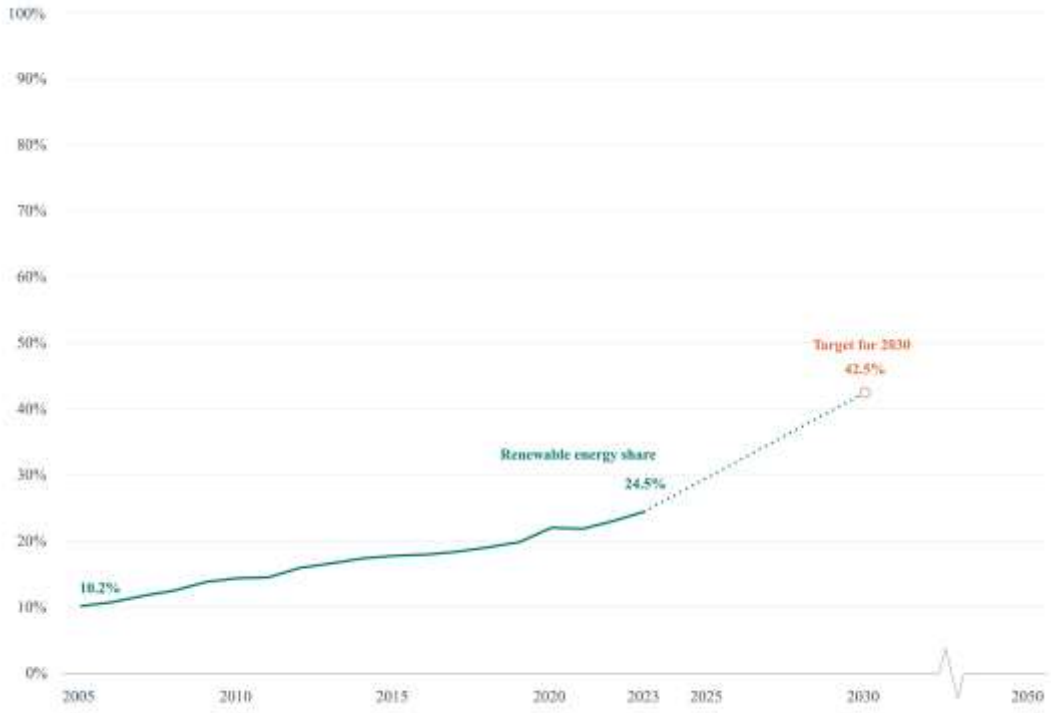

Fig. 1: Progress towards renewable energy source targets for EU-27, [27]

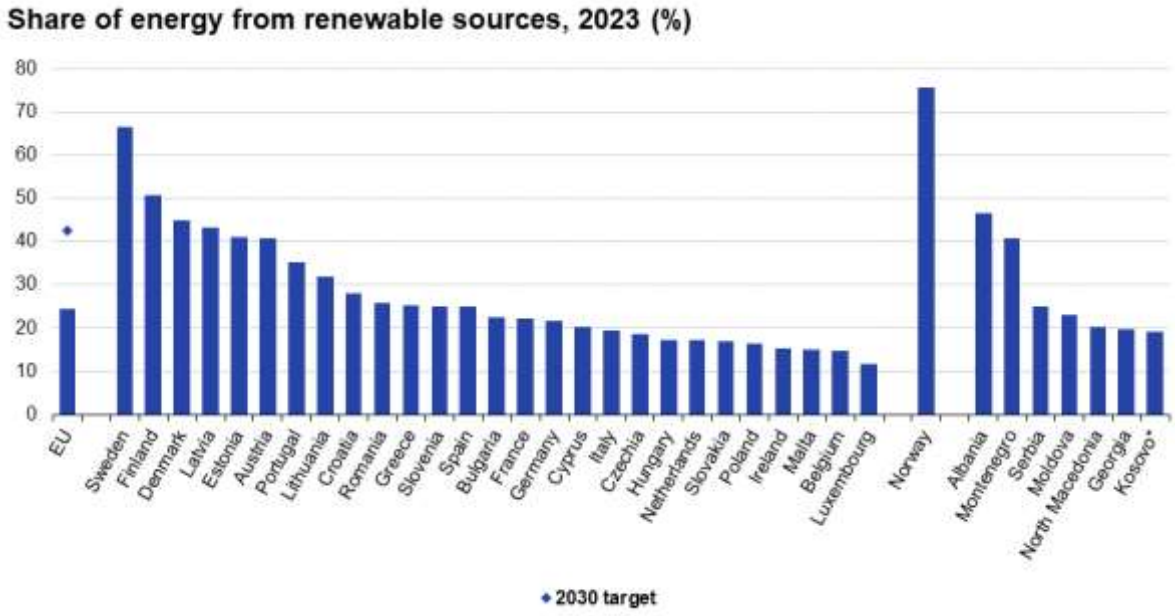

Fig. 2: Share of energy from renewable sources, 2023, (% of gross final energy consumption), [28]

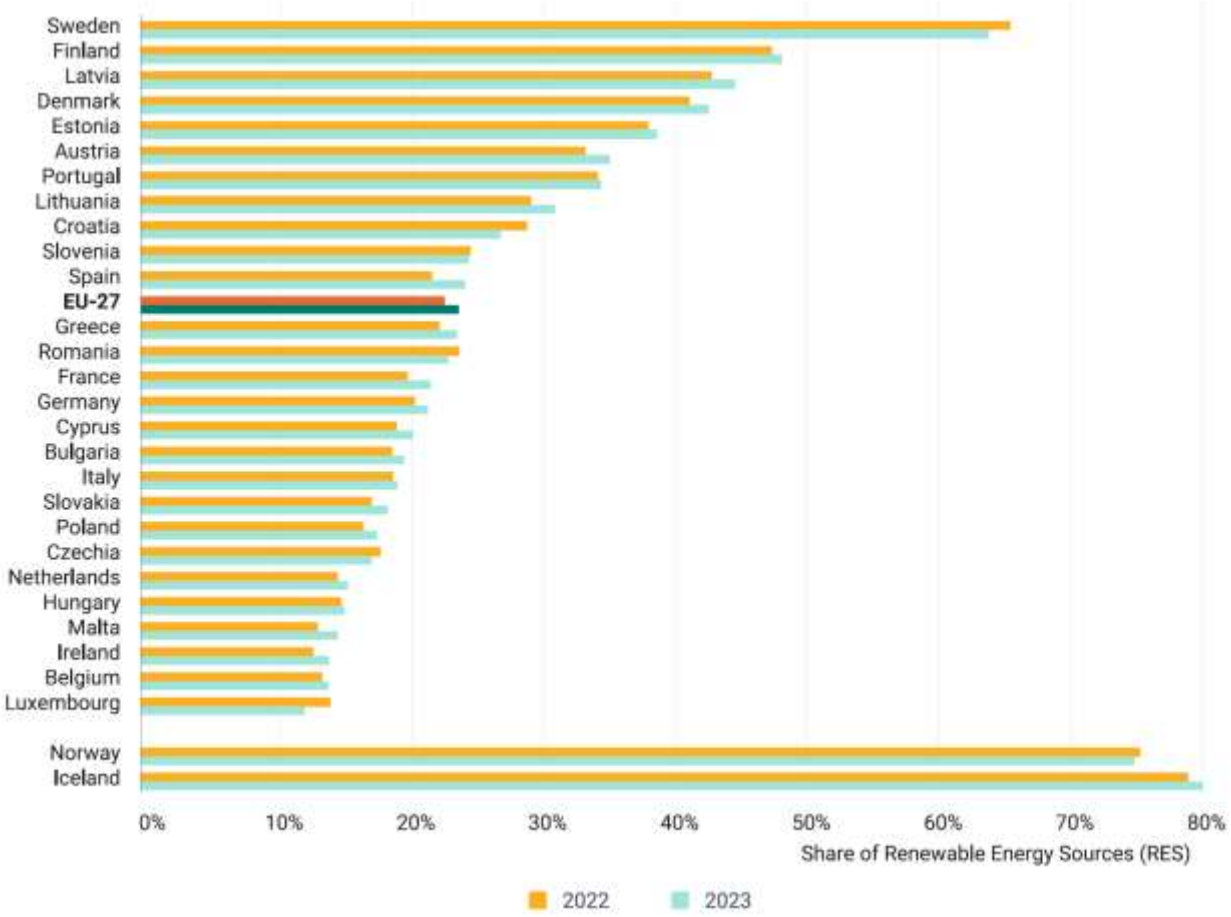

Fig. 3: Share of energy from renewable sources, by country, [27]

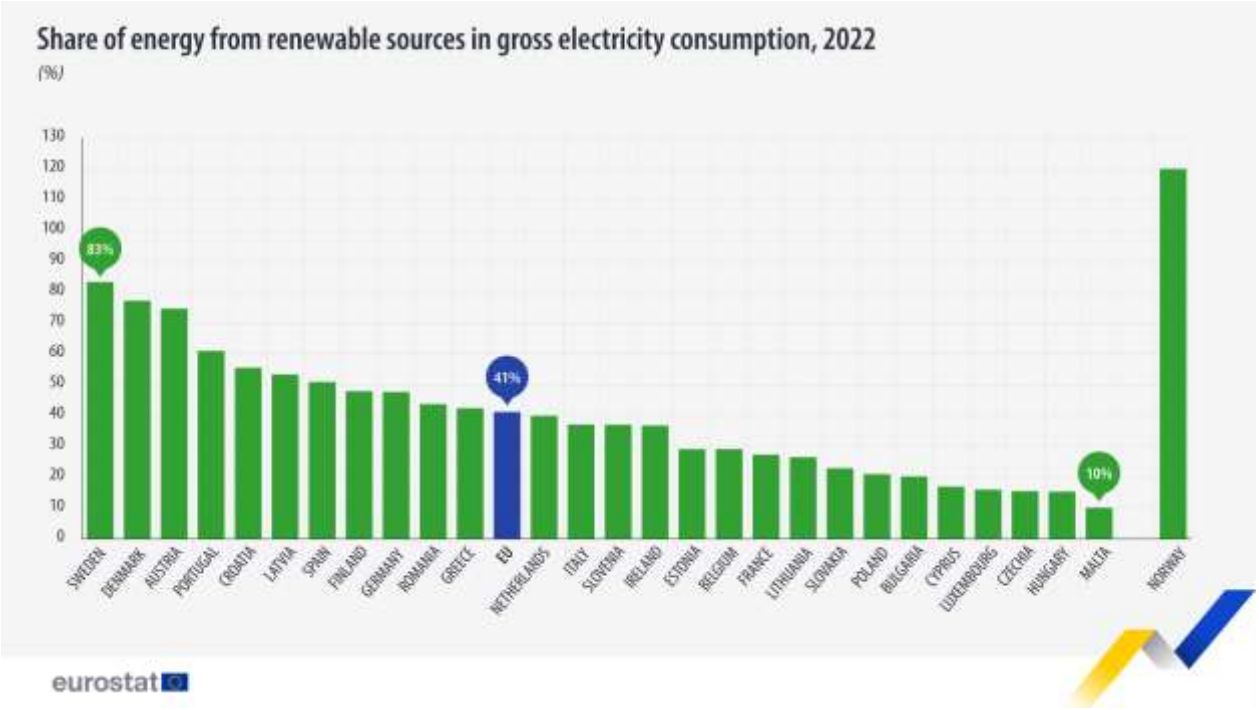

Fig. 4: Share of energy from renewable sources in gross electricity consumption, 2022, [29]

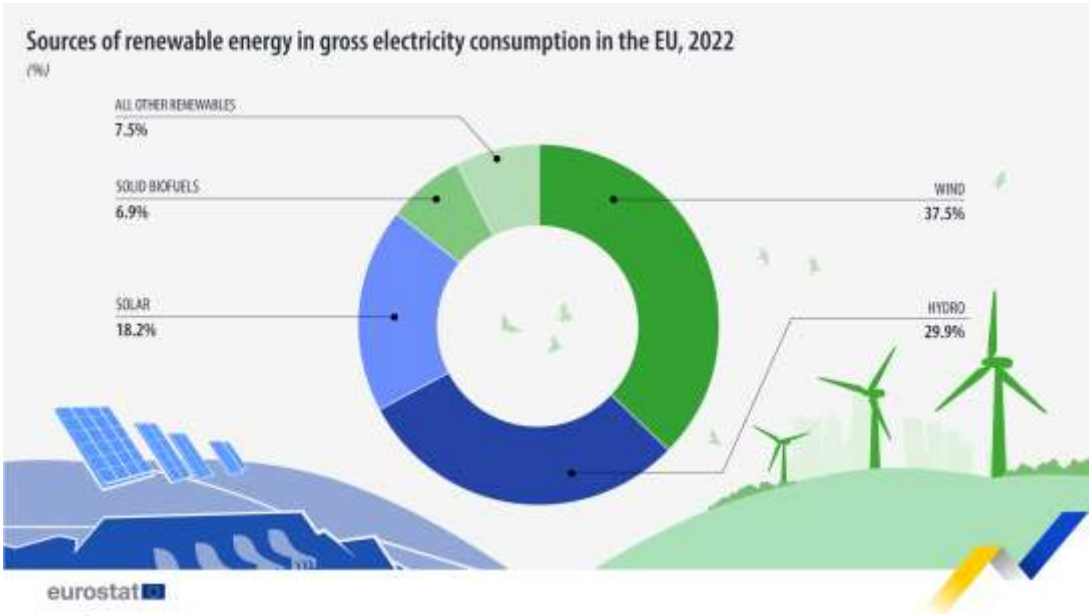

Fig. 5: Sources of renewable energy in gross electricity consumption in the EU, 2022, [29]

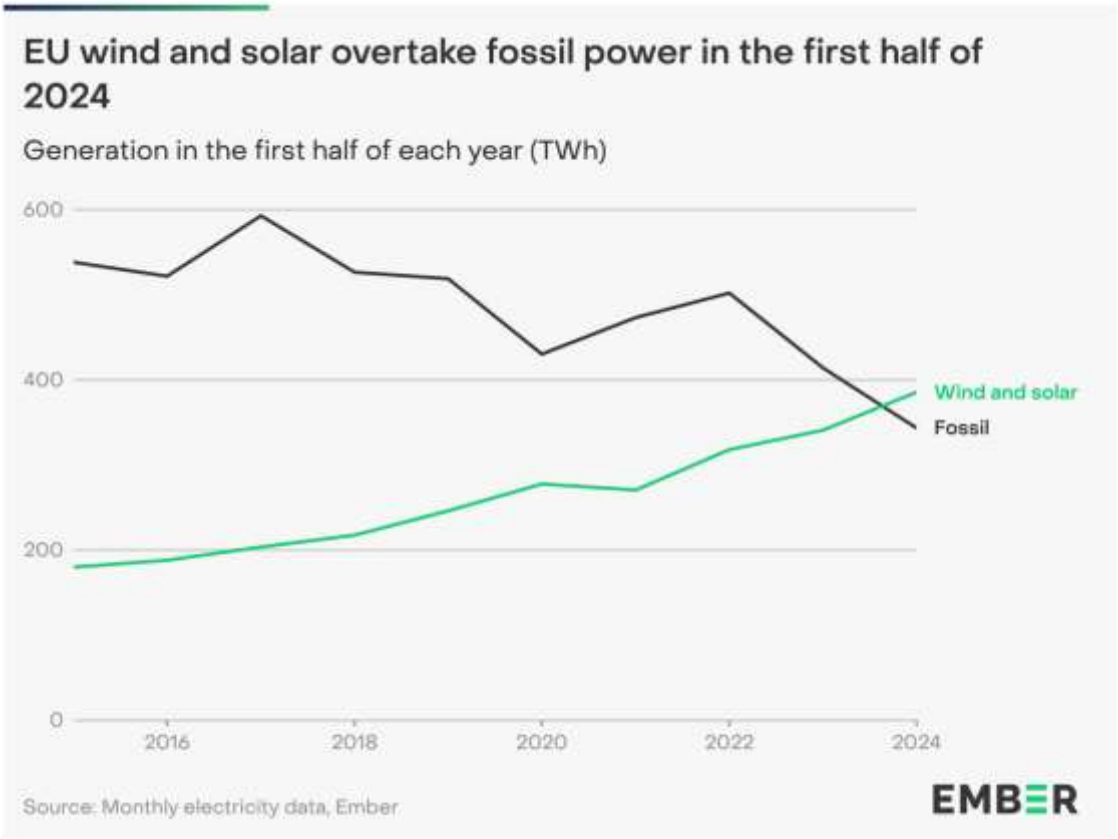

Fig. 6: EU wind and solar overtake fossil power in the first half of 2024, [32]