

Review and Comparative Analysis of Renewable Energy Policies in the European Union, Russia and the United States



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ABSTRACT

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The activity of the world community in the field of climate and environmental conservation is increasing every year. The Paris Agreement, signed in 2015 by the majority of governments, and the additional goals set on COP26 in 2021 set the objectives of maximum reduction of greenhouse gas emissions into the atmosphere and the transition to renewable energy sources (RES). Consequently, the energy sector, as the largest sector of the world economy and the largest environmental polluter, is undergoing the greatest change. The development and implementation of an effective policy in the field of RES, which is part of the energy development strategy, is one of the factors of renewable energy market's rapid development and stimulating the transition to clean energy. However, despite the measures taken by the world community to reduce the environmental impact of the energy sector and the development of renewable energy, the volume of greenhouse gas emissions continues to show an upward trend: from 2000 to 2021, the volume of CO₂ emissions produced by the power sector increased by 74.7%. This trend might be associated with a low level of elaboration of the current renewable energy policy, with barriers to the development of the renewable energy market or with the specifics of the energy sector. The purpose of this study is to review and analyze renewable energy policies in the European Union, Russia, and the United States in order to identify specific approaches to the development of renewable energy, key tools, and barriers. The current state of the energy sectors of the considered countries was analyzed, their features were identified, and a review as well as a comparative analysis of their renewable energy policies were conducted.

1. INTRODUCTION

The energy sector is one of the most significant sectors of the world economy. The growth of energy consumption, scientific and technological progress, and the environmental agenda pose new challenges to the industry, namely the need to reduce the negative impact of the sector on the environment while simultaneously meeting the growing demand for energy in the world [1-3].

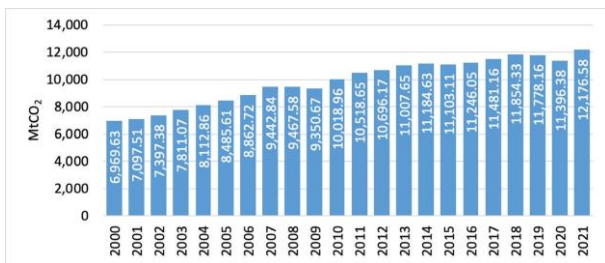


Figure 1. Global CO₂ emissions by electricity and heat production sector from 2000 to 2021, MtCO₂. (Chart produced by the authors using data from [4])

In 2021, the volume of CO₂ emissions from energy

combustion and industrial processes amounted to 36.3 GtCO₂. It is the highest indicator in the entire history of observations [5]. In comparison with 2010, the volume of emissions increased by 12.04%, despite all the measures taken by the world community in the field of climate conservation and environmental protection. The largest contribution to emissions was made by the power sector: electricity and heat production accounted for 40.2% of all CO₂ emissions in 2021 [6]. Figures 1 and 2 show, respectively, the global dynamics and structure of CO₂ emissions by the power sector by fuel type.

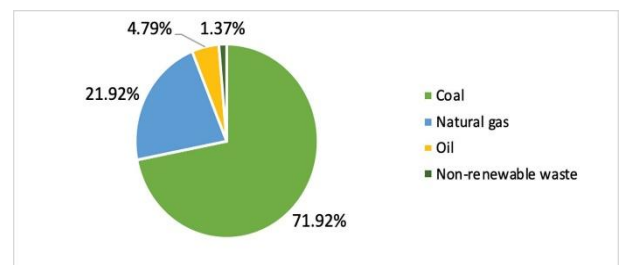


Figure 2. The structure of CO₂ emissions from electricity and heat production sector by fuel, 2021, % (made by authors using data from [7])

The impact of the energy sector on the environment shows an upward trend: CO₂ emissions increased by 74.7% from 2000 to 2021. Most of the CO₂ emissions from energy production (71.92%) are accounted for by energy facilities using coal as the main fuel. These trends indicate the need for large-scale eco-modernization of the energy sector in most countries of the world: if the current trend continues, the level of the sector's impact on the environment will only increase, since the total global energy consumption will increase with the growth of the world economy [6].

In 2015, the Sustainable Development Goals (SDGs) were formulated, some of which are aimed at developing renewable energy (SDG 7: Affordable and clean energy), reducing anthropogenic impact (SDG 13: Climate action), and efficient resource consumption (SDG 12: Responsible consumption and production) [8]. In the same year, the Paris Agreement was reached and signed at the UN Climate Change Conference (COP21); it presents regulatory measures to reduce CO₂ emissions starting from 2021 [9]. In 2021, at COP26, many governments made decisions to abandon the use of coal in the energy sector, as the main cause of climate change, and limit methane emissions by 30% by 2030 [10].

To achieve the stated goals, a full-scale eco-modernization of the global energy sector is required. Decarbonization of the economy and the development of green energy are the major ways to develop the global energy sector until 2050; these measures contribute to a significant reduction of its negative impact on the environment and will allow achieving the set goals provided the effective implementation of the announced activities and programs [11, 12]. The most promising direction is the development of renewable energy sources (RES) – energy sources whose reserves are replenished naturally [12-16]. RES includes wind energy, solar energy, bioenergy, geothermal energy, hydropower, among others.

Currently, many countries of the world, including the main contributors in environmental pollution, are elaborating and implementing large-scale programs for the development of RES. But, despite the set goals and implemented programs, only 29% of all electricity produced in the world is accounted for by RES that might be due to the low efficiency of implemented energy policies or the presence of administrative, technological, and/or economic barriers [17, 18].

The purpose of this study is to review and analyze renewable energy policies in the European Union (EU), Russia, and the United States (USA) in order to identify specific approaches to the development of renewable energy, key tools, and barriers. The current state of the energy sectors of the considered countries was analyzed, their features were identified, and the review and comparative analysis of their renewable energy policies was conducted.

2. METHODOLOGY

The research was divided into main three stages:

1. Review of the current condition of the energy sector in the European Union, Russia, and the United States.
2. Review and critical analysis of the national renewable energy policies in the European Union, Russia, and the United States.
3. Comparative analysis of the renewable energy policies.

At the first stage, emphasis was placed on the analysis of the renewable energy development in each of considered countries and the overall state of the energy sectors based on

literature review and official statistical data. The key characteristics of the energetics also were taken into consideration and provided as they might affect the RES implementation.

At the second stage, the review and critical analysis of current national policies in the field of renewable energy was conducted based on official government documents and programs. As a result of the analysis, the key targets, support tools, benefits, and barriers of RES development were identified.

The comparative analysis of the renewable energy national policies was conducted using the given results of the first two stages. It includes the list of key documents of the renewable energy policy and considers the following factors:

- key targets of the renewable energy policy;
- key directions of the renewable energy policy;
- main government support tools; and
- barriers for implementation.

3. BRIEF OVERVIEW OF ENERGY SECTORS

3.1 European union

The EU energy sector is characterized by a high share of green energy in the overall structure of energy production. According to data for 2020, 40.8% of all energy produced in the EU was accounted for by RES [19]. Currently, large-scale programs are being implemented in the participating countries to decarbonize the economy, achieve SDGs in the power sector, and reduce the EU's dependence on fossil fuels exports. Dependency rate on energy imports was 57.5% in 2020 [20]. Dependence on imports is due to relatively small volumes of oil and gas reserves and production in the EU countries: according to [21] in 2021, only 17.8 million tons of oil and 44 billion m³ of natural gas were produced in the European Union, while the volume of oil and natural gas production in the United States and Russia amounted to 711.1 and 536.5 million tons of oil and 934.2 and 701.7 billion m³, respectively.

Despite the high level of RES development, its main consumers in the European Union are the residential sector and other smaller sectors of the economy [22, 23]. The industry and transportation sector consume more energy derived from traditional energy sources. EU Member States such as Germany, France, and Italy are among the largest economies in the world, and the total GDP of the EU countries according to the World Bank in 2020 amounted to 15,193 billion US dollars, which is 17.9% of global GDP [24]. The consumption of fossil fuels by the industrial sectors of the economy of the participating countries significantly affects the structure of primary energy consumption (Figure 3).

More than 70% of all energy consumed is accounted for by non-RES, namely oil, natural gas, and coal. At the same time, the share of renewable energy in primary energy consumption (including hydropower) is 18.56%. Despite the fact that hydropower is considered as RES along with wind energy, solar energy, geothermal energy, etc., in most statistical reports, it is presented as a separate type of energy.

Thus, the main characteristics of the EU energy sector include:

- developed renewable energy market;
- predominance of natural energy carriers in the structure of primary energy consumption;

- high dependence on natural energy exports;
- the main direction of its development until 2050 is the decarbonization of the economy and the rejection of the use of traditional fuels [25]; and
- implementation of a wide range of programs to support projects in the field of green energy [26].

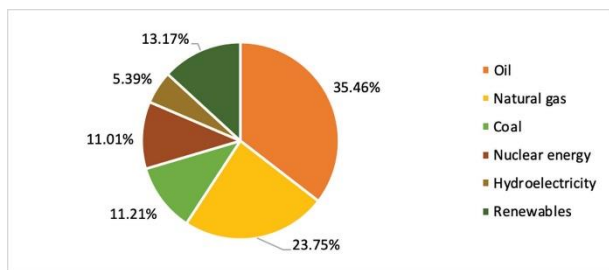


Figure 3. Primary energy consumption by fuel in European Union in 2021, % (chart produced by the authors using data from [27])

3.2 Russia

The energy sector of Russia, based entirely on its own energy resources, is a system-forming branch of the economy that employs more than 2 million people [28]. Russia is one of the largest exporters of natural energy resources: in 2021, the share of energy exports in the total volume of Russian exports of goods amounted to 49% [29].

According to data for 2021, there are 880 power plants with a capacity of over 5 MW in Russia, the total installed capacity of all power plants is 246,590.90 MW [28]. The predominant type of power plants are thermal power plants (66.56%), where natural energy carriers (gas, oil, or coal) are used as fuel, followed by hydroelectric power plants (2.35%), nuclear power plants (11.97%), wind power plants (0.42%), and solar power plants (0.7%). Thus, the structure of primary consumption of fuel resources is largely dominated by oil, natural gas, and coal (Figure 4).

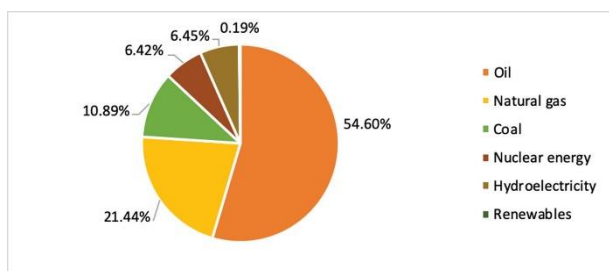


Figure 4. Primary energy consumption by fuel in Russia in 2021, % (chart produced by the authors using data from [30])

The share of RES (including hydropower) accounts for less than 7% of the total energy production in the territory of the Russian Federation. The main reason for the low level of its development is the availability of other energy resources and, consequently, the low cost of electricity production [31]. In this regard, the energy industry in Russia is one of the largest environmental pollutants: the production of energy from fossil sources leads to the formation of significant emissions of greenhouse gases and toxic substances into the atmosphere and pollution of water bodies and land resources [32].

One of the key priorities for the development of the Russian energy industry are (i) ensuring full energy security of the

country and stable functioning of electricity and heat supply systems; (ii) reducing the technological dependence of the Russian Federation in the energy sector – currently, most of the technologies used in this area are produced abroad; (iii) reducing the anthropogenic load of the sector environmental impact; and (iv) support and stimulation of innovative activities of the fuel and energy complex of the Russian Federation [33]. The development of renewable energy in the territory of the Russian Federation is considered as one of the directions of providing remote regions of the country with stable access to electricity.

Thus, the main characteristics of the Russian energy sector include:

- availability and low cost of extraction of natural energy resources;
- more than 49% of exports are accounted for by exports of energy products (coal, gas, and natural gas);
- the traditional nature of energy and the predominance of natural energy carriers (more than 85%) in the structure of primary energy consumption;
- high technological dependence: most of the modern power equipment is supplied from foreign countries; and
- low level of renewable energy development.

3.3 United States

In 2021, 16.8% and 23.1% of the total volume of oil and natural gas produced in the world were produced in the United States; this makes its energy sector independent of external supplies of minerals necessary for energy production [31]. In addition, the United States, like Russia, is the largest exporter of natural gas: 15% of global exports come from the United States and 26% come from Russia [34].

The structure of primary energy consumption in the United States by fuel type is shown in Figure 5.

More than 81.37% of energy consumption is accounted for by minerals (coal, natural gas, and oil), more than 10% by RES, and 7.96% by nuclear power.

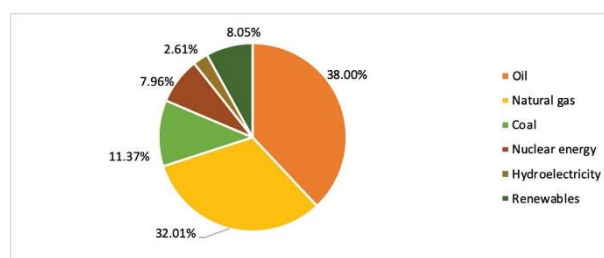


Figure 5. Primary energy consumption by fuel in the United States in 2021, % (made by authors using data from [35])

According to data for 2021, the total utility-scale electricity generating capacity was 1,143,757 MW, which indicates a high level of production energy capacity and, consequently, a high level of energy consumption in the United States [36]. Forty-three percent of all electricity was produced at facilities where natural gas is used as fuel, 18% was obtained from the use of coal, and 27% from RES (9% of which is from hydropower).

Despite the availability and relative cheapness of energy resources, by 2050, the United States, like the EU countries, plan to achieve zero greenhouse gas emissions in order to achieve the stated goals for climate conservation and sustainable development. Achieving the stated goal means a

complete rejection of the use of coal as fuel for energy production, large-scale eco-modernization of energy, and the rapid development of RES [37]. The US energy policy and its priorities are outlined in The Energy Policy Act (EPA): one of the key vectors of energy development in the long term is almost all types of renewable energy and the development and use of advanced environmental technologies [38].

Thus, the main characteristics of the US energy sector include:

- availability and low cost of extraction of natural energy resources;
- high share of oil and natural gas exports;
- the predominance of natural energy carriers (more than 81%) in the structure of primary energy consumption;
- 10% of primary energy consumption is accounted for by RES; and
- the current energy policy is focused on reducing the impact of the energy sector on the environment and the development of green energy until 2050.

4. POLICIES AND DISCUSSION

4.1 Renewable energy policy in the European Union

The main documents on the development of renewable energy in the European Union are the Renewable Energy Directive 2018/2001/EU updated in 2018 [39] and the REPowerEU Plan adopted in May 2022 [40].

For the first time, the directive on the development of renewable energy was adopted by the European Commission (EC) in 2008. The main goal of the directive was to increase the share of RES in total energy production to 20% by 2020. In 2018, the EC revised the directive and set a new goal: 32% of energy should be obtained from RES by 2030 [39]. In 2021, the EC increased its share to 40%. In May 2022, the Recovery Plan came into force, according to which by 2030, 45% of all energy consumed in the European Union should be obtained from RES [40]. According to the results for 2020, about 40% of the energy consumed in the European Union was produced from RES [41]; this indicates the achievement of the goal set in 2009 and the effectiveness of the energy policy.

The key directions of the European energy policy in the field of renewable energy include: offshore renewable energy, onshore wind energy; hydropower, solar energy, and bioenergy [39, 40]. The existing energy policy in the field of renewable energy covers almost all possible directions of renewable energy development in the European Union. A significant amount of state support and emphasis on the implementation of investment projects stimulate the development of renewable technologies and the expansion of the geography of their use. The most important financial instruments used to support renewable energy include tax incentives, quota obligations with green certificates, feed-in tariffs, feed-in premiums, tendering schemes, grants and investment subsidies, loan guarantees, and soft loans [42]. EC tightens the requirements for the evaluation and selection of investment projects in the energy sector: environmental indicators of projects come to the fore; therefore, preference is given to green energy projects [43]. In addition, the governments of the EU Member States stimulate both energy producers and their end users, which gives a double impetus to the development of the industry: in addition to the growth of supply, the demand for green energy is also increasing.

Despite the fact that the renewable energy market in Europe is the fastest growing in the world, scientists and specialized agencies identify a number of barriers to its development. Bureaucracy and low level of digitalization of project approval procedures in the energy sector increase the time required for companies to pass standard administrative procedures; this negatively affects the financial and time costs of project implementation [44–46]. In addition, the difference in tax regimes for renewable energy enterprises and the lack of specialists in some Member States leads to heterogeneous rates of renewable energy development: some EU countries, despite all the support measures being implemented, cannot independently implement major projects on decarbonization of the economy and development of renewable energy due to the lack of technologies, materials, and specialists [46]. To solve this problem, it is necessary to attract funds and specialists from other Member States, which is not always possible due to the general shortage of personnel in the European Union.

4.2 Renewable energy policy in Russia

The main document regulating the development of the energy industry in Russia is valid until 2035 [33]. The strategy pays great attention to the spatial and regional development of energy in Russia, the achievement of technological independence in the field of energy technologies, the development and maintenance of relations in the international energy market. The development of RES is not the central goal of the energy policy for the development of the Russian energy complex, but the transition to green and resource-saving energy has been designated one of the priorities of the development of the energy sector of the Russian Federation until 2035. A more detailed strategy for the development of renewable energy is presented in the Order of the Government of the Russian Federation of 08.01.2009 N 1-p (ed. of 03.04.2022) ‘On the main directions of state policy in the field of improving the energy efficiency of the electric power industry based on the use of RES for the period up to 2035’, according to which the share of RES in the structure of energy production and consumption should be at least 6% [47].

The key areas of renewable energy development in the Russian Federation are:

- improving the resource and energy efficiency of hydropower;
- providing stable access to electricity in remote and isolated territories of the Russian Federation with the help of non-traditional energy facilities and local fuels (advantage due to SES and wind farms);
- increasing the share of RES in the structure of energy production and consumption to 6% by 2035; and
- achievement of technological independence and development of the renewable energy market.

In 2013, the Renewable Energy Development Program (DMP RES) for 2014–2024 was launched [48]. The renewable energy DMP is a program for the development of renewable energy generation in Russia due to the payment of power guaranteed for a certain time under a contract for the provision of power to the wholesale market concluded with the owner of the power plant [49].

The main goal of the program was to stimulate the development of renewable energy and increase the share of renewable energy generation to 4.5%, but the goal of the program was not achieved: by 2025%, the expected share of

renewable energy generation in Russia will be only 1%. From 2024, an updated renewable energy support program for the period up to 2035 will be in effect – VMP RES 2.0. According to the VPM RES 2.0, the achievement of 4% as the level of renewable energy generation is expected by 2035, the main contribution to the development of the industry should come from solar and wind energy. In addition, the development of the bioenergy and hydropower industry is being considered [49].

The main instruments of state support for the development of renewable energy in Russia are: subsidizing interest rates on loans attracted for the development of production to enterprises producing energy from RES [33, 47]; state financing of research and pilot projects in the field of renewable energy [33]; support for the implementation of investment projects in the field of renewable energy with a capacity; introduction of obligations for grid companies to purchase electricity from qualified renewable energy facilities at regulated tariffs for the purpose of compensation of losses [50]; compensation of technological connection to the electric networks of qualified renewable energy facilities from their federal budget [33, 50]; and improvement of approaches to the evaluation and selection of investment projects in the field of renewable energy [43].

The development of the green energy market, despite the state support measures taken, faces a number of significant barriers. One of such barriers is the low competitiveness of the energy received: the cost of 1 kW of electricity received from traditional sources is much lower. The high level of capital expenditures for the creation of RES in comparison with traditional energy facilities is the reason for the low pace of development of the renewable energy market in Russia, even despite all the support measures taken [51, 52].

4.3 Renewable energy policy in the United States

The key document on energy development in the United States is the EPA, which contains the goals, objectives, and priorities of energy development. The law contains a detailed description of the development of various energy sectors, including energy efficiency, RES, oil and gas, coal, tribal energy, nuclear issues and safety, vehicles and motor fuels, including ethanol, hydrogen, electricity, energy tax incentives, hydropower and geothermal energy and climate change technologies [38].

The current energy policy attaches great importance to the rejection of the use of coal as a fuel for energy production, the development of green energy, and the reduction of negative environmental impacts. By 2035, the presidential administration has set a goal to achieve 100% carbon pollution-free electricity, which indicates big plans for the development of the renewable energy market [53].

Most of the renewable energy development strategies are presented in The State and Local Energy and Environment Program's Guide to Action, which was updated in 2022. The document contains information about the implemented funding and financial incentive policies, energy efficiency policies, renewable portfolio standards, policy considerations for combined heat and power and electric utility policies [54]. In total, the document contains 16 green energy policies. In addition, the following programs are being implemented to stimulate the development of renewable energy:

- Green Power Partnership – expert assistance program on the organizational procurement of green power;

- AgSTAR is a program aimed at reducing methane emissions from livestock waste and stimulating the development of bioenergy;
- RE–Power America's Lands – stimulating and supporting the implementation of RES projects on current and formerly contaminated land and mining sites;
- Landfill Methane Outreach Program (LMOP) – stimulating the development of bioenergy in the use of landfill gas as a renewable, green energy source [55].

To stimulate the renewable energy market at various levels, the US government has developed and implemented a wide range of tools. In addition to Feed-In Tariffs and financial incentives used in the European Union, financial support for green energy projects, subsidies and compensations, such tools as Renewable Portfolio Standards, Output-Based Environmental Regulations and Interconnection Standards are used in the United States [56]. These tools are aimed at increasing the share of energy use received from RES in enterprises and at limiting the volume of emissions of harmful substances and greenhouse gases into the atmosphere. The use of emission limits encourages enterprises to buy 'green' energy for the implementation of their activities.

In general, the policy on the development of renewable energy in the United States can be described as full scale and covering almost all areas of possible development. It should be noted that there is a wide list of initiatives and tools to support enterprises and organizations engaged in renewable energy, as well as mechanisms to encourage consumers and industrial enterprises to use energy obtained from renewable sources.

Despite all the measures taken and ambitious tasks, the renewable energy market faces a number of significant barriers, one of which is the low competitiveness of energy obtained from RES in the national market. In addition, it is possible to distinguish unfavorable utility rate structures, administrative barriers in environmental permitting, and lack of transmission [57, 58].

4.4 Comparative analysis of the renewable energy policies

The policy in the field of renewable energy in the countries under consideration is complex and covers almost all possible areas of renewable energy development. The review showed that despite the measures taken and rather ambitious goals for the transition to a new 'green' vector of energy development, especially in the United States and the European Union, there is still a number of barriers preventing the dynamic development of this energy sector. Table 1 presents a comparative analysis of renewable energy policies.

The renewable energy policies of the countries under consideration generally have a similar structure and priorities, namely: increasing the share of renewable energy in the structure of energy production and consumption, improving energy efficiency, and reducing the impact of the energy industry on the environment. Significant differences are observed in the stated goals and barriers to development.

The current EU policy demonstrates the highest results among the countries under consideration: by 2020, the previously set goals for renewable energy have been achieved, various projects are currently being implemented on the territory of EU countries aimed at reducing the dependence of EU energy on fossil fuels. A distinctive feature of the EU policy is the presence of a document common to all Member States on the development of renewable energy, which sets out

the main goals, objectives, priorities, development directions, and support tools. However, despite the high effectiveness of the policy, barriers, in particular administrative ones, significantly slow down the pace of development of this industry.

In Russia, the development of RES is only one of the priorities of the state energy policy. The review showed that the Russian government does not set global goals for the development of this industry: by 2030, it is expected that only 6% of all energy will be produced from RES (in Europe, the target figure is 45%). This trend may be related to the specifics of the energy sector, the availability of other natural energy resources, in particular natural gas, and technological dependence. One of the key areas of renewable energy development is the development of projects to ensure stable access to electricity in regions remote from the central energy infrastructure.

The most ambitious goals for the development of renewable

energy are set by the US government: by 2030, 80% of all generated energy should be produced from clean energy sources, by 2050, the US plans to achieve net-zero emissions. Despite the deep elaboration of programs and support measures, many experts say that the probability of achieving the stated goals by 2030 and 2050 is low due to the presence of a number of serious barriers [59]. Among them, it is possible to distinguish different rates of renewable energy development by different states, differences in regional policy in the field of green energy and administrative barriers.

In addition, in the United States, as in Russia, the competitiveness of RES is low; due to the cheapness and availability of other natural resources such as natural gas, oil and coal, the cost of energy obtained from renewable energy facilities is much higher. High capital costs and long payback periods of projects can also be called key barriers to the development of renewable energy in both the United States and Russia.

Table 1. Comparative analysis of renewable energy policies

Factor	The European Union	Russia	The United States
Key documents of renewable energy policy	<ul style="list-style-type: none"> – The Renewable Energy Directive 2018/2001/EU – REPowerEU Plan 	<ul style="list-style-type: none"> – The Energy Strategy of the Russian Federation till 2035 – The State policy in the field of improving the energy efficiency of the electric power industry based on the use of RES for the period up to 2035 	<ul style="list-style-type: none"> – The EPA – The State and Local Energy and Environment Program’s Guide to Action
Key targets of renewable energy policy	<p>The share of RES will increase to 45% by 2030.</p>	<p>The share of RES will increase to 6% by 2035</p>	<p>The share of RES in electricity generation will be 80% by 2030</p>
Key directions of renewable energy policy	<ul style="list-style-type: none"> – offshore wind and wave energy; – onshore wind energy; – ocean and hydropower; – solar energy (photovoltaic and solar thermal); – bioenergy; – geothermal energy; – energy efficiency; – reduce the dependence on fossil fuel imports. 	<ul style="list-style-type: none"> – wind energy; – solar energy (photovoltaic and solar thermal); – bioenergy; – hydro energy; – geothermal energy – offshore wind energy; – energy efficiency; – reduce the technological dependence in the field of renewable energy. 	<ul style="list-style-type: none"> – solar energy (photovoltaic and solar thermal); – wind energy; – geothermal energy; – bioenergy; – low-impact hydroelectricity; – energy efficiency.
Main government support tools	<ul style="list-style-type: none"> – tax incentives; – quota obligations with green certificates; – feed-in tariffs; – feed-in premiums; – tendering schemes; – grants and investment subsidies; – loan guarantees; – soft loans 	<ul style="list-style-type: none"> – tax incentives; – state financing of research and pilot projects; – grants and investment subsidies; – contracts for the provision of power (PDM) to the wholesale market concluded with the owner of the power plant. – introduction of obligations for grid companies to purchase electricity from qualified renewable energy facilities at regulated tariffs for the purpose of compensation of losses. 	<ul style="list-style-type: none"> – renewable portfolio standards (RPS); – public benefits funds for renewable energy – output-based environmental regulations – feed-in-tariffs; – property assessed clean energy; – net metering; – grants and investment subsidies;
Barriers	<ul style="list-style-type: none"> – the high level of bureaucracy and the low level of digitalization of administrative procedures for renewable energy projects; – long production chains – lack of installers, staff capacities, and materials; – diversity of tax system among Member States of the EU. 	<ul style="list-style-type: none"> – high cost of energy production from RES – in comparison with traditional energy sources; – high level of capital expenditures for the implementation of projects in the field of renewable energy; – the need for large-scale modernization of energy infrastructure; – administrative barriers for renewable energy project evaluation and implementation. 	<ul style="list-style-type: none"> – high cost of energy production from RES in comparison with traditional energy sources; – unfavorable utility rate structures, – administrative barriers in environmental permitting; – lack of transmission

In order to increase the effectiveness of national energy policies in all considered countries, it is needed to minimize the administrative barriers that significantly slow the embrace of RES. For instance, this might involve simplified procedures for processing documents and obtaining the necessary permits for renewable energy projects and its full digitalization. Moreover, it is significant to provide additional financial support to RES development in countries with cheap and readily available fossil fuels otherwise the current pace of renewable energy development will not remain fast enough.

The set of support measures used is generally similar in all the countries under consideration: financing of research, pilot projects, tax incentives, obligations to purchase electricity obtained from RES, etc. However, feed-in tariffs and green certificates that are used on the territory of the European Union and the United States proved to be among the most effective tools to stimulate the development of the renewable energy market. In this regard, these tools could be used by other countries in order to stimulate consumers and producers to use sustainable energy sources.

The scale and depth of the elaboration of a policy directly depends on the goals set in the field of renewable energy development. Currently, the EU policy can be described as the most effective due to the wide range of diverse initiatives, support measures, and the pace of successful implementation. The US policy in the field of renewable energy is twofold: on the one hand, the renewable energy development program covers all possible areas and sets ambitious goals, on the other hand, due to a number of serious barriers, the stated goals may not be achieved. In Russia, the development of renewable energy is proceeding at a slower pace in comparison with the European Union and the United States, which may be due to the territorial specifics and availability of natural energy carriers.

5. CONCLUSIONS

Based on the results of the review and analysis of renewable energy policies, the structure, goals, objectives and priorities of development, as well as a number of barriers, largely coincide among the considered countries. A significant difference is observed in the key targets of current renewable energy policy: the United States and the European Union plan to increase the share of renewable energy in the structure of energy production to 80% and 45%, respectively, by 2030, while in Russia, this figure is only 6%. This difference may be related to the peculiarities of the national economy and the structure of the energy sector.

All policies contain a wide list of measures to support the development of the industry. These include financing of research, pilot projects, tax incentives, obligations to purchase electricity obtained from RES. On the territory of the European Union and the United States, the list of tools is a little wider: in addition to the tools listed earlier, feed-in tariffs and green certificates are used, which have proven to be effective tools to stimulate the development of the renewable energy market and can be used in Russia.

Administrative barriers to the development of renewable energy are found in the European Union, Russia, and the United States. At the same time, in the United States and Russia, the key barrier is the availability and cheapness of minerals, high capital costs for the implementation of

renewable energy projects, while in the European Union – lack of installers, staff capacities, and materials.

For enhancing the current renewable energy policies, it is essential to minimize administrative barriers and provide additional financial support to renewable energy enterprises and projects.

DATA AVAILABILITY STATEMENT

Data available in a publicly accessible repository. The data presented in this study are openly available in studies [4-6, 19-21, 27, 30, 35, 38-40, 42, 47, 48, 53-56].

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