

Alternative energy sources as an integral part of the green economy concept

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Abstract. In Russia, the issue of renewable energy sources is far from unambiguous. On the one hand, Russian government has demonstrated strong political will to support the development of renewable energy by setting a target of 4.5 percent of total renewable electricity production and consumption by 2020. The national energy legislation was amended to achieve this goal. These steps sent positive signals to potential investors and the international community. On the other hand, support measures have been slowly implemented. There are still no federal laws that would make renewable energy investments profitable. Energy decarbonization and the desire to meet the criteria of the Paris climate agreement are dominant motives for this development. Climate and energy policies, new technologies, changing prices for gas, coal and carbon, and the growing consumption of renewable energy continue to challenge operators, developers and utilities in the energy system. The article examines opportunities for green energy that can boost the national economic growth, contribute to the development of the green economy and the implementation of environmental policies. The prerequisites for the development of a renewable energy market in Russia were identified; conditions and factors that affect the development of the environmentally friendly goods and services market were described. Legislative initiatives for the development of the alternative energy market, taking into account Russia's participation in the Paris Climate Agreement, were analyzed. Examples of regional experience in implementing projects aimed to install wind and solar generators were provided. Trends in the development of the green economy in Russia were described. Conclusions about the need to expand the energy strategy of Russia were drawn. The need for the digitalization of the industry was emphasized.

1 Introduction

The study is relevant due to the fact that the use of renewable energy sources in the Russian Federation has been discussed by the government since the 1990s. Despite significant progress in the renewable energy development, some issues remain controversial. In 2014,

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Russia did not have an active support scheme that could stimulate the large-scale deployment of clean energy sources. However, a number of laws were enacted and renewable energy support measures were developed.

In practice, investors in the renewable energy sector face a variety of hurdles such as persistent regulatory gaps, high protectionist barriers, and insufficient financial incentives to level the playing field with conventional power and heat generation. Without an efficient scheme to support renewable energy sources, Russia runs the risk of not keeping up with the “green revolution” and falling far behind developed countries and other BRICS economies [1] in the clean technology sector. Moreover, the failure to develop significant renewable energy potential will expose consumers to the price risks inherent in the Russian isolated energy systems.

The purpose of the present study is to assess the feasibility of the large-scale state policy aimed to develop alternative energy sources taking into account Russian trends.

2 Materials and methods

To achieve this goal, theoretical research methods were used: the method of analysis helped reveal theoretical provisions of the concept and identify controversial issues; the method of synthesis was used to determine key points and a sequence of changes and additions; and the method of generalization assisted in drawing conclusions. Research articles derived from Web of Science and Scopus, RSCI, Russian and foreign publishers, as well as official documents of international organizations (1987-2020) were reviewed.

3 Results

In the literature, there are a number of definitions of green economy. The authors analyzed and systematized these definitions in Table 1.

Table 1. The concept of green economy.

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|-------------|--|
| Zomonova | "green" economy is an economic development model based on sustainable development, internalization of externalities, an integrated approach to the decision-making process, improving the quality of life in terms of resource conservation and resource efficiency using new technologies and innovations [1] |
| Khramkov | green economy is part of nature, and it is necessary to manage the economy of nature rather than environmental protection for the purposes of production[3] |
| Fuks | green economy is marked by a productive synthesis of biological evolution and technology [8]. Environmental innovation, biotechnological innovation, renewable energy and efficient technology will underpin the next long wave of growth and contribute to the gradual transition to bioeconomics [4] |
| Yashchalova | green economy is a low carbon economy that uses resources efficiently and serves social interests. This model helps preserve, increase and restore natural capital, which is the most important source of public goods [5] |
| Porfiryev | green economy is an economic activity, which, along with modernization and increasing production efficiency, contributes to improving the quality of life and the environment [2] |

*compiled by the authors

The definitions of green economy presented in Table 1 indicate that this issue is debatable. The authors define green economy as an activity aimed to minimize environmental risks, contributing to effective investment in "green" technologies, which will help balance the interests of the Government, the efficient use of resources and the environment.

Green technology is defined as alternative energy sources.

The main goal of energy development is to make energy affordable. Traditional energy sources cannot achieve this goal. In this regard, the role of alternative energy is increasing. Alternative energy is a set of promising methods for generating energy from renewable sources, which are not as widespread as traditional ones, but are of interest due to the low level of damage to the environment.

In Russia, several alternative energy sources are used: wind energy, solar energy, alternative hydropower, geothermal energy, space energy, tidal energy, hydrogen and hydrogen sulfide-containing energy, biofuels, distributed power generation [13]. Figure 1 shows the dynamics of commissioning of power plants based on alternative energy sources (CSA RES), MW.

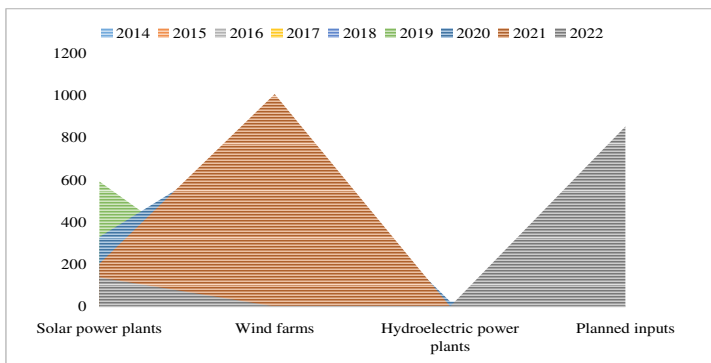


Fig. 1. Dynamics of commissioning of power plants based on alternative energy sources (CDA RES), MW in the Russian Federation.

At the end of 2021, the alternative energy market demonstrated improved competencies in the construction of facilities, overcoming most of the existing penalty delays and completing the commissioning plan by more than 90%. Electricity generation by renewable energy generation facilities built under CSA RES amounted to 5,213 million kWh, which corresponds to 0.47% of the total electricity generation in the UES of Russia. According to the ARVE, as of July 2022, the share of solar, wind and small hydro generation facilities in the electricity consumption was 0.7%. The average installed capacity utilization factor (hereinafter referred to as KIUM) of power plants was: for SPPs - 14.3%, WPPs - 29.9%, SHPPs - 24.8%.

By the end of 2024, based on the results of the first stage of the CSA RES 1.0 support program, Russia will generate 5.43 GW of RE. Over the past eight years, market participants have paid off their investments. As part of the quarterly reports, ARVE monitors the generation of all power plants operating under the CSA RES. The force majeure event was the flooding of the automobile bridge in the summer of 2020, the only road from the port to the site of the Kola WPP.

In terms of renewable energy facilities, the key regions are the Republic of Crimea (18%), Orenburg (16%) and Astrakhan (14%) regions (Figure 2).

Considering that in accordance with the decision of the European Commission, new investments in gas projects will be considered sustainable within the EU taxonomy only until 2030, the development of domestic innovations in the field of renewable energy is of strategic importance. In addition to the development of renewable energy sources, it is proposed to conduct R&D with the aim to develop technologies for the chemical utilization of carbon dioxide, which will create popular products, including motor fuels, help find innovative approaches to the use of CO₂, create new jobs and help occupy a stable position in international markets.

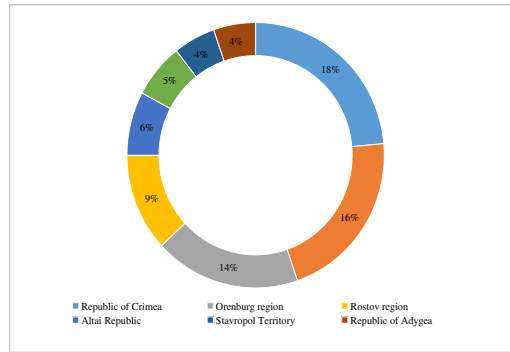


Fig. 2. Distribution of operating RES plants in the Russian Federation.

The renewable energy capacity in Russia has increased by 45% over the past decade and amounted to 4 GW by January 1, 2022 (Figure 3).

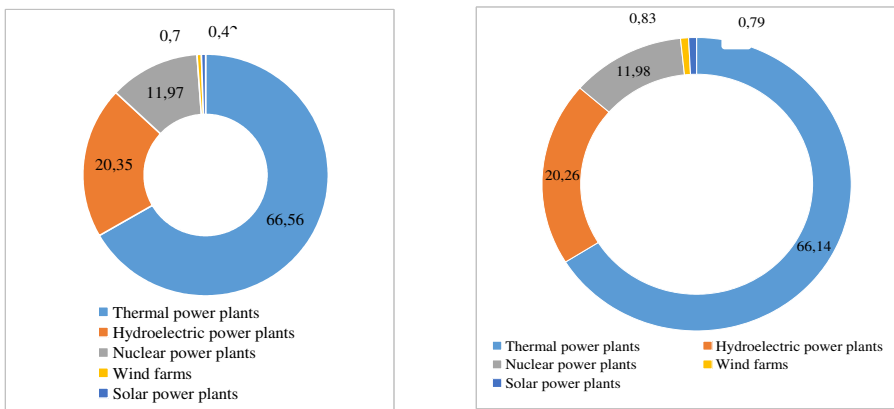


Fig. 3. The structure of the installed capacity of power plants in Russia, 2021-2022, % [6].

In 2021, 232.9 MW of solar power plants were put into operation, the total capacity of these power plants reached 1960.6 MW. The capacity of wind power plants (WPPs) increased from 1,008.89 MW to 2,035.4 MW. At the end of 2021, the share of RES was only 0.5%. The total output of green energy in the UES increased by 74.8% and reached 5,873 million kWh. In December, the value was 530.2 million kWh, which is 93% more than in December 2020 [6].

The annual output of wind farms increased by 162.4% to 3619.8 million kWh; in December, it was 123.6% higher than in 2020, increasing to 481.3 million kWh. The generation of solar power plants in 2021 amounted to 2254.5 million kWh, which is 13.7% more than in 2020. An increase in the volume of production corresponds to an increase in the capacity of power plants (13.5%) [6].

4 Discussion

Against the backdrop of the current financial and economic crisis, energy production is the key global problem whose roots go back to limited reserves of hydrocarbon fuels and increasing demand for them.

According to Kontorovich, in the twentieth century humanity has used almost ten times more traditional energy sources than in the previous 60 thousand years. Energy saving is

impossible due to new large-scale energy consumers - "catch-up" developing countries - whose share will have accounted for 80% of oil demand and two thirds of oil consumption by 2030. Exploration of hydrocarbon reserves lags behind their production, and there are no new fossil energy sources that can replace oil and gas. Technological progress, that has significantly leveled the factor of limited energy resources, is unable to play this role.

As a result, the energy crisis is no longer transient and opportunistic; it is systemic, structural, determined by the resource rarity factor, with a trend towards an increase in equilibrium prices of fossil fuels. It is no coincidence that the way out from the last crisis began with a return to the previous oil price.

Finally, 80% of the harmful gases emitted into the atmosphere are produced by traditional energy sources; the "greenhouse" effect has caused negative changes in the planet climate [12].

Renewable energy sources have been recognized in a number of national energy laws. The Energy Strategy of Russia for the period up to 2030 aims to expand their role in the energy sector. However, these laws do not feature an internationally recognized "triad" approach to the development of renewable energy sources in conjunction with energy saving and ecology. There are no regulatory framework and effective economic mechanism for the development of renewable energy sources comparable with those in developed countries.

5 Conclusion

In the current economic conditions, the government of the Russian Federation has developed a program aimed to support renewable energy sources based on the localization of production of required equipment.

Due to the government policy of import substitution, we can use cheaper alternative energy sources, since the development of domestic technologies for the production of components for renewable energy facilities will allow for significant savings. Taking into account reduced construction and production costs, by 2035 Russia will produce about 25 billion kWh of green energy.

Government programs intended to support renewable energy sources made it possible to create new capacities for generating electricity without damage to the environment. The next step is to make the segment independent of government support, which is necessary to increase the volume of green generation and create an additional incentive to increase profits in related industries: microgeneration, production of autonomous energy systems, IT technologies and production of components.

For example, through the implementation of microgeneration projects, it is possible to increase the demand for the production of renewable energy sources by 10 GW. Therefore, at the second stage of government program implementation, the main emphasis should be on RES station equipment localization and import substitution. This approach will contribute to the creation of new industries: production of photovoltaic modules and electrical products for solar power plants and components for wind farm equipment.

To increase the volume of green generation in Russia, it is also important to choose proper regions for the construction of renewable energy facilities: to construct wind power plants near the Volga river as it provides the possibility of transporting dimensional parts for wind power plants, or to construct solar power plants in Altai, Primorye and in the southern regions of the Russian Federation. Ulyanovsk region declares ambitious plans aimed to expand the share of alternative energy production.

The transition to renewable energy is a slow process. In the energy balance of Russia, alternative energy generation takes about 1.5%. To increase the share, government financial

support is needed. In addition, both the volume of investment and targeted spending are fundamental.

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