

Overview of the Prospects for Developing a Renewable Energy in Russia

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Abstract—Russian Federation is one of the world's largest importers of energy raw materials. However, within the country, there are many problems associated with the efficiency of power plants and power supply in remote regions, particularly in the Arctic zone. Solving these problems is possible through the development of renewable energy. This paper represents the analysis of the resource base of renewable energy in Russia. The main barriers to the development of the renewable energy and measures of state support were determined. We also summarize large amount of information about the prospects for renewable energy development in the Russian regions, considering current and possible problems of the Russian energy industry.

Keywords—renewables; Russia; state regulation; reserves; prospects

I. INTRODUCTION

Russia is one of the emerging countries with large reserves of almost all types of fossil energy resources. In this regard, approximately 95% of energy production in the country accounted for crude oil, natural gas and coal. A similar pattern is observed in many other countries, for example in OPEC (Table 1).

TABLE I. THE STRUCTURE OF COUNTRIES ENERGY PRODUCTION [1]

Country	Share in production, %						
	Coal	Crude Oil	Natural gas	Nuclear	Hydro	Renewables	Biofuels and waste
Russia	14,5	40,5	39,6	3,6	1,15	0,01	0,54
Iran	0,2	52,2	46,7	0,4	0,38	0,01	0,16
Iraq	0,0	96,4	3,4	0,0	0,15	0,00	0,03
Venezuela	0,5	84,5	10,6	0,0	4,04	0,00	0,40
Saudi Arabia	0,0	88,8	11,2	0,0	0,00	0,00	0,00
Qatar	0,0	35,3	64,7	0,0	0,00	0,00	0,00
Kuwait	0,0	92,6	7,4	0,0	0,00	0,00	0,00

The absence of necessity for alternative energy development in these countries is a fairly well-established stereotype, however, it is becoming outdated. The reason for

its occurrence was low competitiveness of renewable energy compared to the traditional in the beginning of the century.

The data of IRENA agency of the recent years show that increasing of renewable energy share in these countries' balance may be justified not only from environmental [2], but also from the economic point of view (Fig. 1). In Fig. 1, the size of the diameter of the circle represents the size of the project. The center of each circle is the value for the cost of each project on the Y axis.

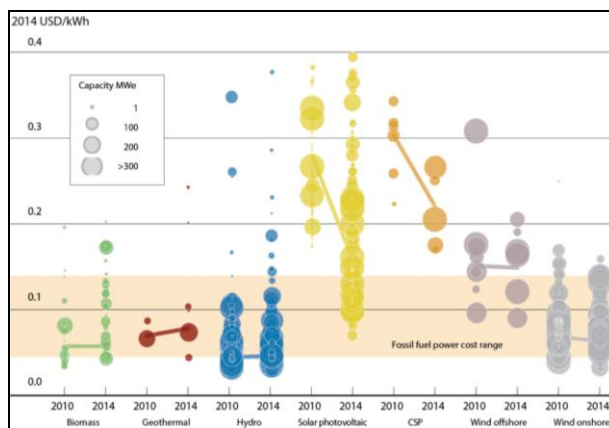


Figure 1. The comparison of the renewables costs [3].

It would be fair to note that the complete substitution of fossil energy is not possible in the coming decades in emerging countries with significant share of raw materials export in the national economy. Firstly, it is connected with a significant political influence of oil, gas and coal companies. Secondly, with the absence of significant state support for the alternative energy sector. Thirdly, even the projected prices for energy generation (not taking into account the ability to reduce the cost of fossil fuels) do not allow to say about indisputable advantages of renewable energy (Fig. 2).

Despite these features, Russian economic and geographic conditions have a number of features that make renewable energy projects more attractive in comparison with other countries. It is especially fair in the regions of the Arctic zone [4].

Russia has a huge potential for development of almost all renewable energy resources. Even with significant monopoly influence of gas, oil and coal enterprises in the country there are already beginning the implementation of large-scale projects based on renewables use. In this regard, the aim of

this paper is to analyze the trends and prospects for development of the various sectors of renewable energy in Russia.

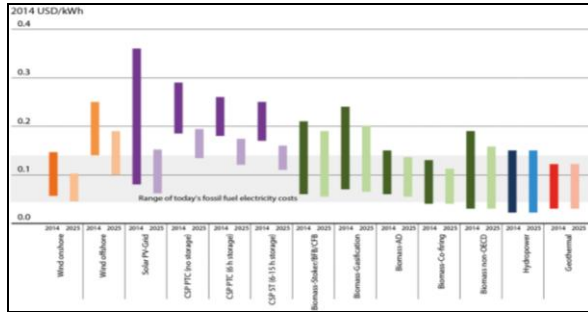


Figure 2. The forecast of the electricity generation costs [3].

II. MATERIALS, METHODS AND ASSUMPTIONS

The prospects for renewable energy development in Russia are defined by four key factors:

1. Availability of necessary resources. In the case of renewables, it is climatic conditions, which determine the feasibility and effectiveness of the use of certain energy facilities in the region.

2. State regulation. As a rule, any state policy in the field of renewable energy development could be supporting or neutral. In both cases, the implementation of the renewable projects is possible; however, the neutral policy could create a lag of country's technical and technological base development.

3. The region's energy supply scheme. There are two main directions for renewable energy development. Firstly, to replace existing energy facilities operating on fossil fuel. Secondly, for providing energy for remote regions with lack of infrastructure.

4. The presence of already implemented projects. This factor is of particular importance for Russia in connection with the current import substitution strategy aimed at the development of national technology innovations. In other words, Russia's regions do not have access to the best international technologies and are forced to rely on the most successful projects implemented in the country.

Today in Russia, major part of operating power plants using renewable energy sources are small. Several major projects are underway.

The materials for this research were scientific publications, statistical reports of national and international agencies, the results of natural and climatic conditions observations of the regions of Russia.

A. Renewable Energy Resources of Russia

Russia has significant resource potential for the development of renewable energy (Table 2). However, this potential is relatively evenly distributed across the country's area, which total square is 17.1 mln km².

The most promising areas for the development of solar energy are located in the Caucasus Mountains, on the border with Mongolia and near the Vladivostok city. In these areas,

the average annual daily amount of solar radiation falling on the surface with the angle equal to the latitude ranges is from 4 to 5,5 KWh / m² per day (Fig. 3).

TABLE II. RESOURCE POTENTIAL OF RENEWABLES IN RUSSIA

Type of power plant	Potential resources, bil. KWh/year
Solar (Fig. 3)	3
Wind (Fig. 4)	32,6
Geothermal (Fig. 5)	335
Bio (Fig. 6, 7)	69
Small Hydro (Fig. 8)	205
Large Hydro (Fig. 8)	61,6

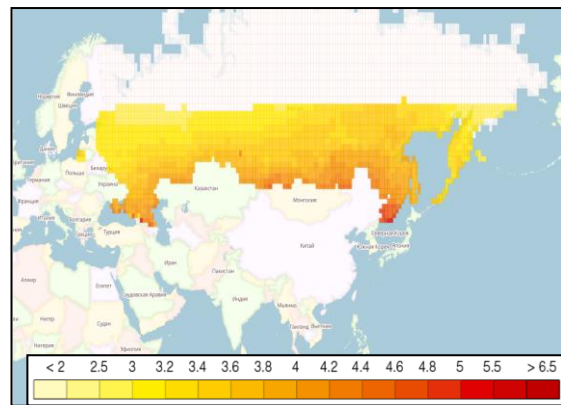


Figure 3. Solar power in Russia, KWh/m² per day [5].

According to some estimates the duration of sunshine in areas near the southern border of Russia is more than 2 thousand hours per year. In central Russia from 1700 to 2000 per year, in the northern regions is less than 1700.

Also, near the southern border of Russia has a certain resource potential of wind energy. Fig. 4 shows the annual specific technical potential of wind energy at a height of 30 meters defined in MWh / year.

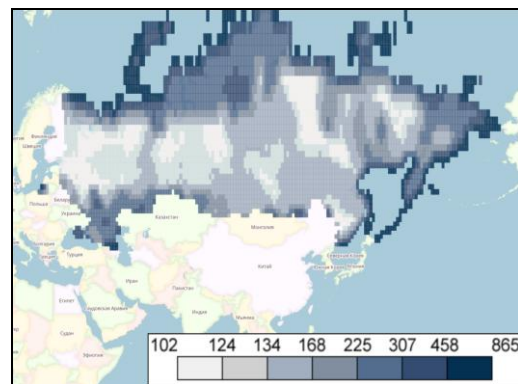


Figure 4. Wind power in Russia, MWh per year [5].

The greatest resource potential for the development of wind energy has the Arctic zone, in particular coastal areas where is no developed energy infrastructure. Maximum

annual average wind speed is observed along the shores of the Barents, Kara, Bering and Okhotsk seas (over 6 m / s).

Exploration of geothermal resources began in the USSR on the territory of Kamchatka. To date, almost all geothermal potential of Russia is explored (Fig. 5 - according to information of the "Geothermal energy society"). The greatest resources found on the territory of Kamchatka (127 volcanoes, 150 groups of thermal springs) and the Kurile Islands.

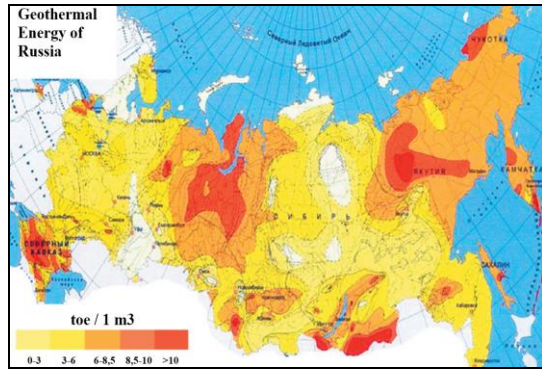


Figure 5. Geothermal power in Russia.

Also in the central part of Russia, forest resources are common. Forest is the main raw material for bioenergy industry (Fig. 6).

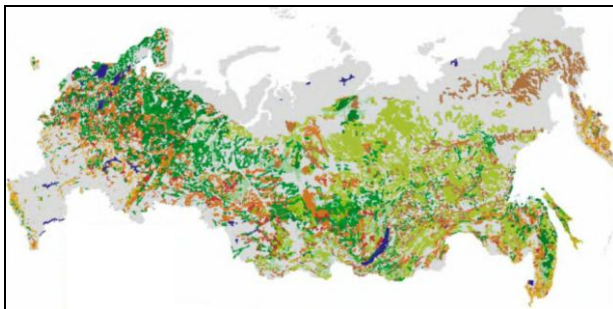


Figure 6. Forests in Russia.

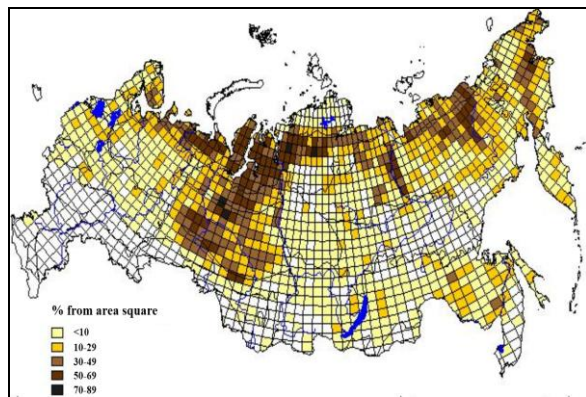


Figure 7. Peatlands of Russia, % from area square [7].

In addition to wood bio-resources include peat, which is a low-calorie fossil fuel. Russia possesses 30% of total world

peat reserves, which are spread across the country relatively evenly (Fig. 7).

The resource potential of the peat industry in Russia, to date, is inexhaustible. The annual replenishment of its reserves is more than 250 mln.t., while the production volumes do not exceed 1.5 million tons in last ten years (maximum production volumes were reached in the middle of the last century - 180 million tons per year) [6].

Most of the hydropower potential resources are located in remote regions of Russia, Central and Eastern Siberia and the Far East, as well as in the North Caucasus and in the west of the Urals (Fig. 8).

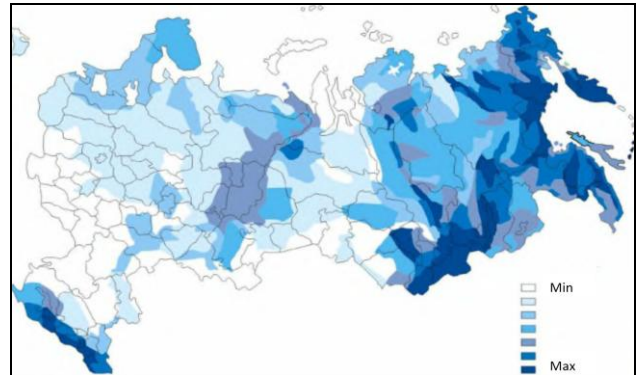


Figure 8. Hydropower of Russia, relative assessment.

The Far East and Eastern Siberia together have over 80% of the country's hydropower potential.

B. State Regulation

Russia is actively developing the legislative framework in the field of increasing the availability of renewable energy, as well as to improve their competitiveness in comparison with fossil fuels. There were three Federal law and more than seven orders of various government bodies in this area.

These documents determined the list of renewable energy sources, their status in the Russian energy sector, measures to support energy companies operating in the renewable energy, described the forward-looking indicators of this energy sector development (Table 3) and a list of the regions for the implementation of promising projects.

TABLE III. FORECAST OF NEW CAPACITIES COMMISSIONING, MW

Year	Solar	Wind	Mini Hydro
2014	120	-	18
2015	140	51	26
2016	200	50	124
2017	250	200	124
2018	270	400	141
2019	270	500	159
2020	270	500	159
2021	-	500	
2022	-	500	
2023	-	500	
2024	-	399	

The main measures to support alternative energy in Russia are:

1. Grants for the implementation of regional development programs of electric generation based on renewables.
2. Grants to organizations for the construction of generating facilities with using renewables.
3. Tariff regulation mechanism of energy purchase and sale produced with using renewables.
4. Exempt of organizations from paying taxes on the property (for 5 years) in relation to facilities, functioning based on renewables.
5. Provision of credit for companies investing in the construction of generating facilities operating on renewables.

To support the import substitution strategy in the renewable energy sector Russian government has set the target value of the "localization" indicator. This indicator shows the extent of the Russian equipment use for project implementation. The most stringent requirements are set on the localization of the solar plants: 50% in 2014-2015, 70% in the 2016-2024. For wind and hydroelectric power plants in 2019 (2018) - 2024 it is expected to achieve 65% of the localization.

Thus, Russia has developed a specific regulatory framework supporting renewable energy development. However, there are no strict requirements for the use of environmental technologies in Russian energy. Also, no significant taxes on pollutants emission. Environmental legislation - a key driver for development of alternative energy is in the process of formation in Russia [8].

C. Energy Supply in Russia

Fig. 9 shows Russian regions with the centralized (red), decentralized (yellow) power supply and areas with independent energy infrastructure (green).

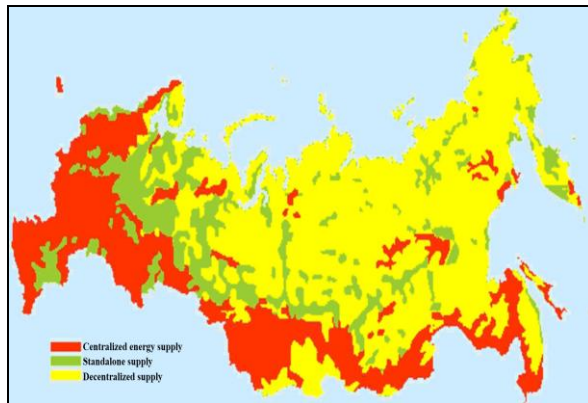


Figure 9. Energy supply in Russia.

“Centralized energy supply” means the presence of the gas infrastructure. The green area is supplied by local power plants, which, in some cases, built in Soviet times. At the same time, many regions of green area do not have access to the energy (more than 80% of the territory). In other words, the development of renewable energy is essential for more than 70% of the Russian territory [9]. This applies particularly to the Arctic regions [10].

The development of the centralized power supply in the direction of Yakutia and beyond is not foreseen in the coming years.

III. RESULTS AND DISCUSSION

Russia has significant resource potential for the development of all types of alternative energy sources. Despite the fact that the share of renewable energy production in the energy balance of the country less than 1%, it occupies an important place in public policy documents in recent years [11]. In accordance with these documents the share of renewable energy in Russia's balance may be about 20% in 2024.

Despite the ambitious plans for the development of alternative energy, the analysis of the real trend of recent years does not allow to speak about the achieving most of planned indicators [12]. For example, the total capacity of power plants on renewable energy projects, which receive state support, is two times lower than planned (see Fig. 10).

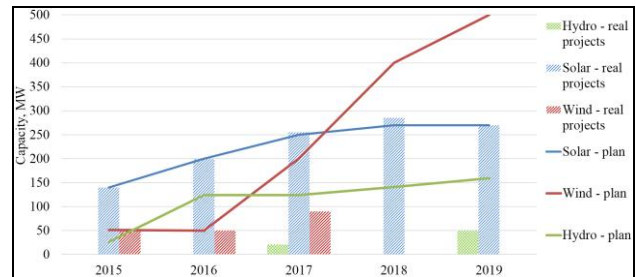


Figure 10. Selected for state support projects 2013-2015.

The most intensive growth is observed in the solar energy sector, despite some shortage of materials and components. Failure of wind and hydro energy projects associated with the limitation of critical CAPEX for the construction of 1 kW capacity (Table 4), as well as the requirements for the rate of projects' localization.

TABLE IV. CRITICAL CAPEX, RUR

Year	Solar	Wind	Mini Hydro
2014	116451	65762	146000
2015	114122	110000	146000
2016	111839	109890	146000
2017	109602	109780	146000
2018	107410	109670	146000
2019	105262	109561	146000

The main factor determining the lag between real and planned indicators of alternative energy is the low development of the country's technological base. In other words, the development of the necessary materials production capacity occurs with a lag [13]. In connection with this, the plan of wind and hydro power plants capacity commissioning in the 2017-2019 is unfeasible. The most probable is the scenario where the share of renewables in the

energy balance of the country will not exceed 4-6%, which is 3.5-5 times lower than state targets.

IV. CONCLUSION

Intensive development of renewable energy in Russia is constrained by a number of adverse factors: significant political weight of the largest oil, gas and coal companies; ineffective mechanism of state programs realization; the lack of access to the foreign technologies; migration of the population from eastern to the European part of the country, which reduces the relevance of large energy projects in regions with decentralized power supply.

Moreover, there is excess of heat and power generation. In Soviet period there was a developed system of regional energy supply. However, in modern conditions, these enterprises are not competitive due to the wear-out of the facilities. Increasing the number of low-performing power plants led to a surplus of generating capacity from 15 to 25 GW. However, this energy network is unevenly distributed throughout the country's territory, so that some regions have a lack of heat and electricity.

Major part of the Russian economy sectors are dependent on foreign technologies. For example, there are no companies, which can carry out a full cycle of solar panels production. It is possible to ensure the production of necessary components for alternative energy plants, but they will be much less effective than abroad.

There are no tangible taxes on pollutants emission in Russia [14]. In addition, it is frequently when the environmental protection legislation requirements carried out by enterprises only on paper. This hinders the development of environmental friendly technologies and reduces the competitiveness of renewable energy compared with fossil fuels.

Another factor slowing alternative energy development is the substantial debt of taxpayers to the budget. In the end of 2016 the amount of debt expected to reach \$ 1 trillion. RUR. About half of these payments are for heat and electricity.

Energy is one of the most state regulated sectors of the Russian economy. It does not allow realizing competitive advantage of the renewables. Including bio and geothermal energy, which in principle are not observed in the program of renewable energy development in Russia.

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