BSR Policy Briefing series 3/2022

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CENTRUM BALTICUM

ISSN: 2342-3153

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Abstract

The policy paper analyzes the state of renewable energy industry in Russia in 2021 with an outlook to 2030. Several development paths are outlined, including business-as-usual, shock scenarios, and the visionary future. Clean energy, including renewables, will see faster growth under shock scenarios and the visionary future (negative and positive externalities) following different reasons. The main barriers for the industry's development include surplus of installed electricity capacity, old approaches to power grid management, and limited domestic R&D. The main policy recommendations cover decommissioning of old power plants, radical reduction of coal-fired generation, and fostering market competition in the industry, while plans for localization of equipment manufacturing may be revisited. The Russian renewable energy sector should rely on solid domestic R&D base and manufacturing facilities.

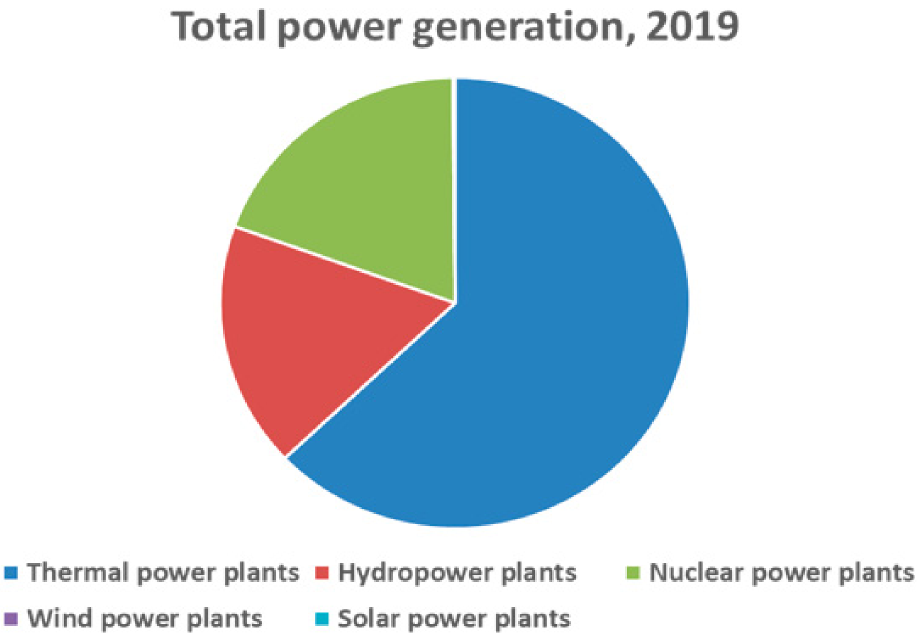
Key words: Russia, renewable energy, energy policy, green energy, electric power sector, power purchase agreements

1. Introduction: State of affairs in the Russian renewable energy industry

Russia has been for decades oriented towards extraction and exploitation of hydrocarbon reserves with a focus on low-cost natural gas power generation. The wider use of renewable energy sources (RES) has not been considered as an important development path, until 2013 when the first regulatory acts to promote RES were adopted. The main rationale for RES advancement were climate change obligations, the need to improve environmental situation in certain regions, and the need to provide affordable energy in off-grid areas. After the government support scheme was put in place, the new energy segment has become attractive to many large players, including international leaders (i.e. Fortum, Vestas) and Russian state corporations Rusnano, Rosatom, and Rostec.

In Russia, the Government aims to increase the share of RES 10 times over 20 years, raising their share in the total installed capacity to 10% by 2040. The investments in renewables will amount to one trillion Russian Rubles by 2035. In 2020 alone around 1 GW of solar and wind energy facilities were installed (ADRE, 2020), which made up 60% of new installed capacities (Figure 1). While solar and wind power plants have seen exponential growth, other RES-based power plants form a minor share (Figure 2). The target share of renewable energy in the country's electricity generation, set earlier by the Russian Government as 4.5% by 2024, will not be achieved due to the delays caused by the country's economic problems in 2014-2016 and time required for local equipment manufacturing. These targets are ambitious but are well below the world average. In the course of the 2021 power purchase agreement (PPA) competition, the solar and wind prices fell significantly, making the grid parity in Russia achievable within 5-7 years. Meanwhile natural gas remains the main RES competitor and is considered the main source of energy in the long term due to existing infrastructure and the need for heat supply (Figure 3).

Figure 1. Total power generation in Russia, by type of power plant, 2019

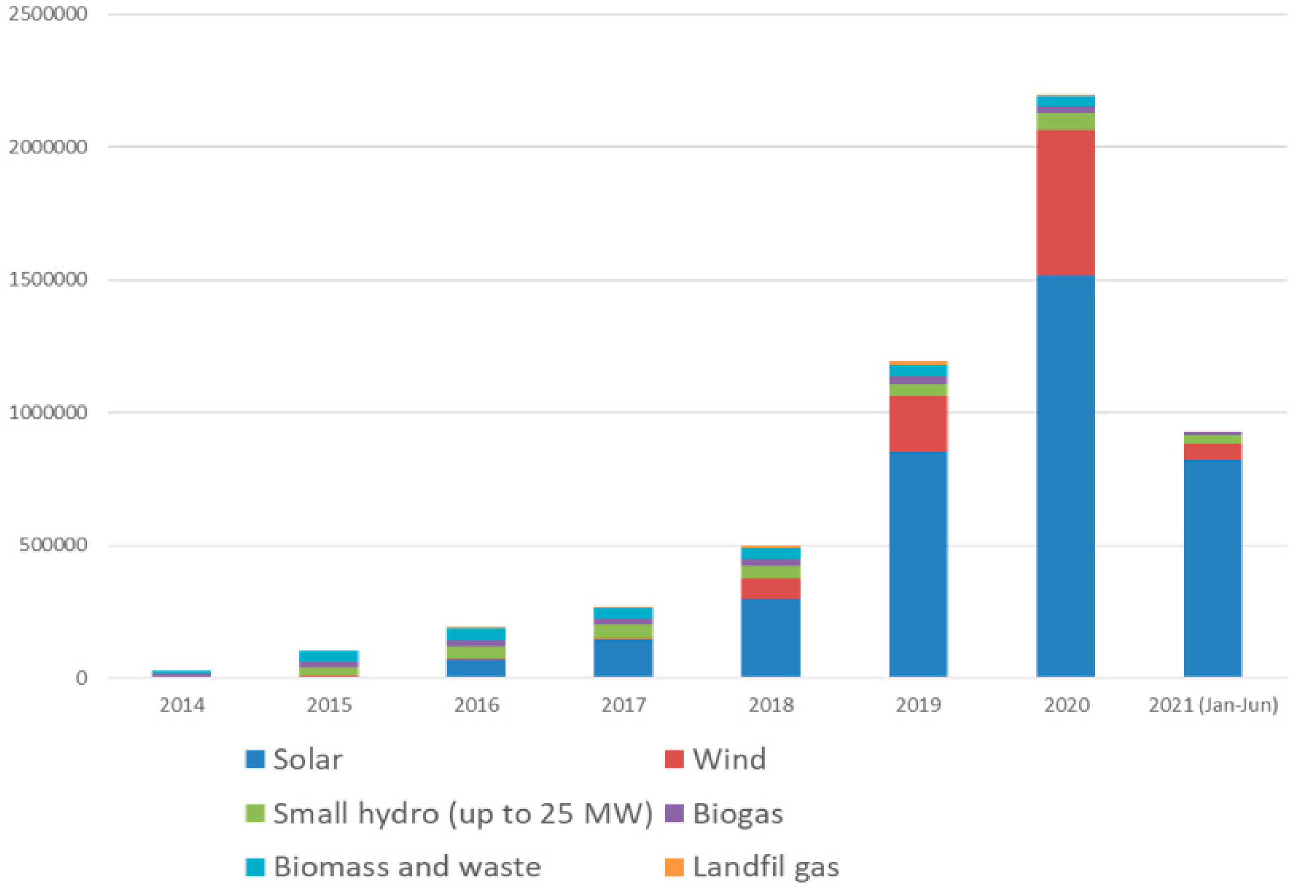


Generation type	bn kW/h	%
Thermal power plants	679.9	62.92%
Hydropower plants	190.3	17.61%
Nuclear power plants	208.8	19.32%
Wind power plants	0.32	0.03%
Solar power plants	1.3	0.12%
Total	**1080.62**	**100%**

Nearly 80% of thermal power plants are steam turbine plants

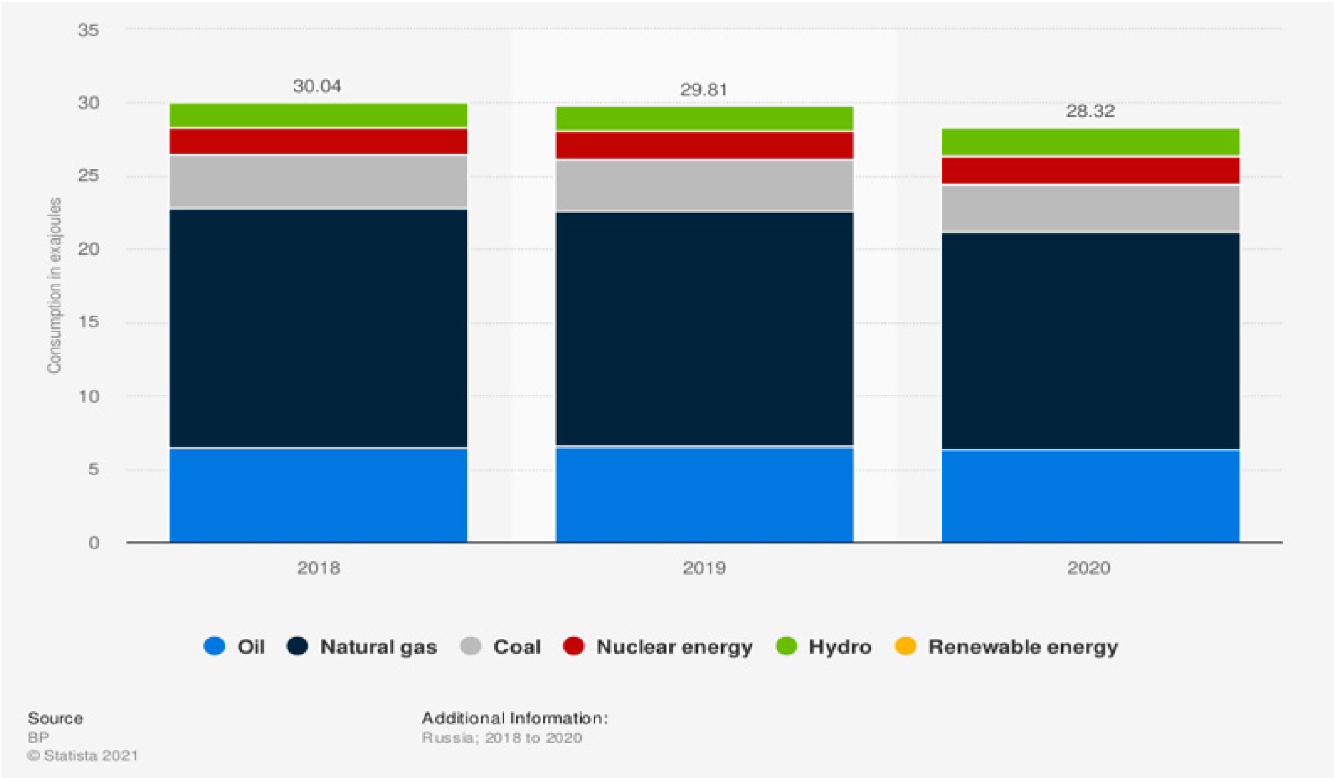
Source: Russian Ministry of Energy, 2021.

Figure 2. Power generated at qualified renewable power plants at wholesale and retail markets, with certificates, thousand kW/h



Source: Russian Energy Market Council, 2021.

Figure 3. Primary energy consumption in Russia, 2018-2020, by fuel (in exajoules[1])

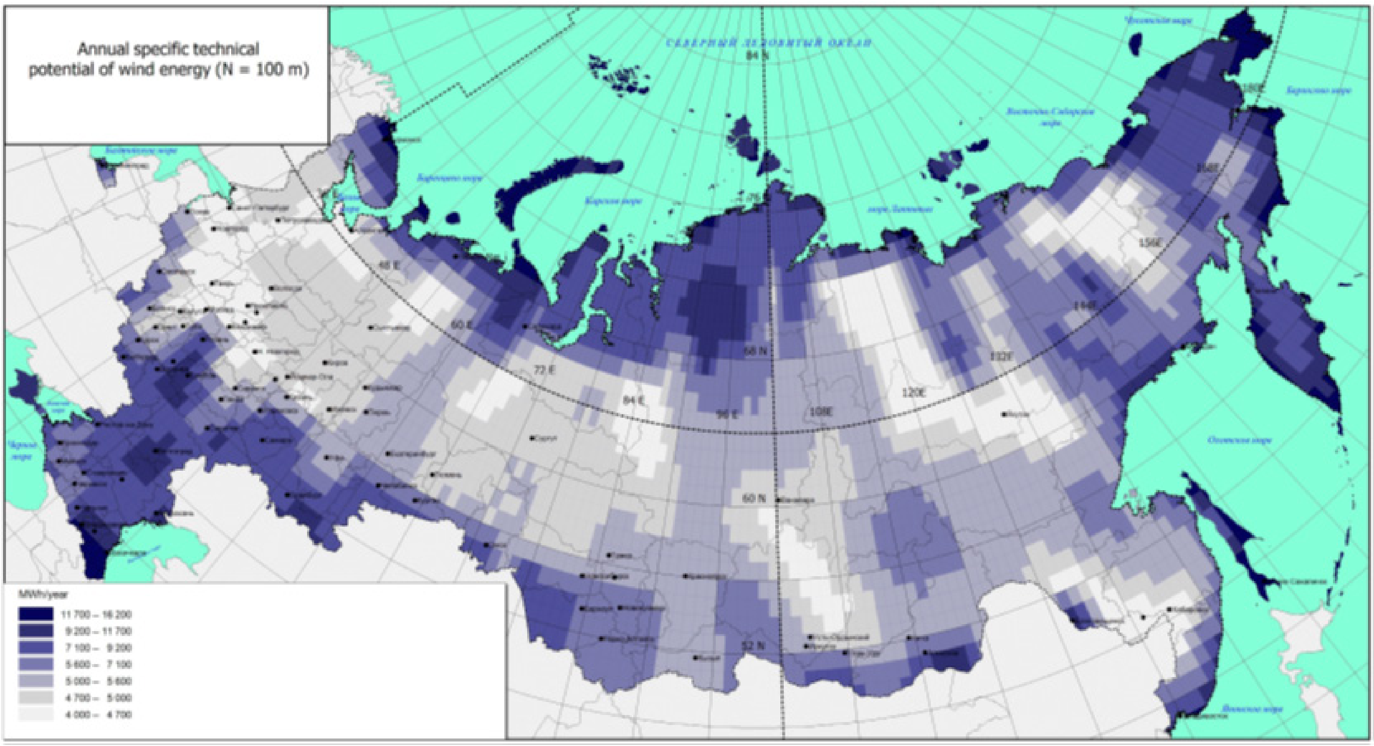


Source: BP, 2020.

1 The joule is the SI unit of energy and work. One exajoule is equal to 10^{18} joules.

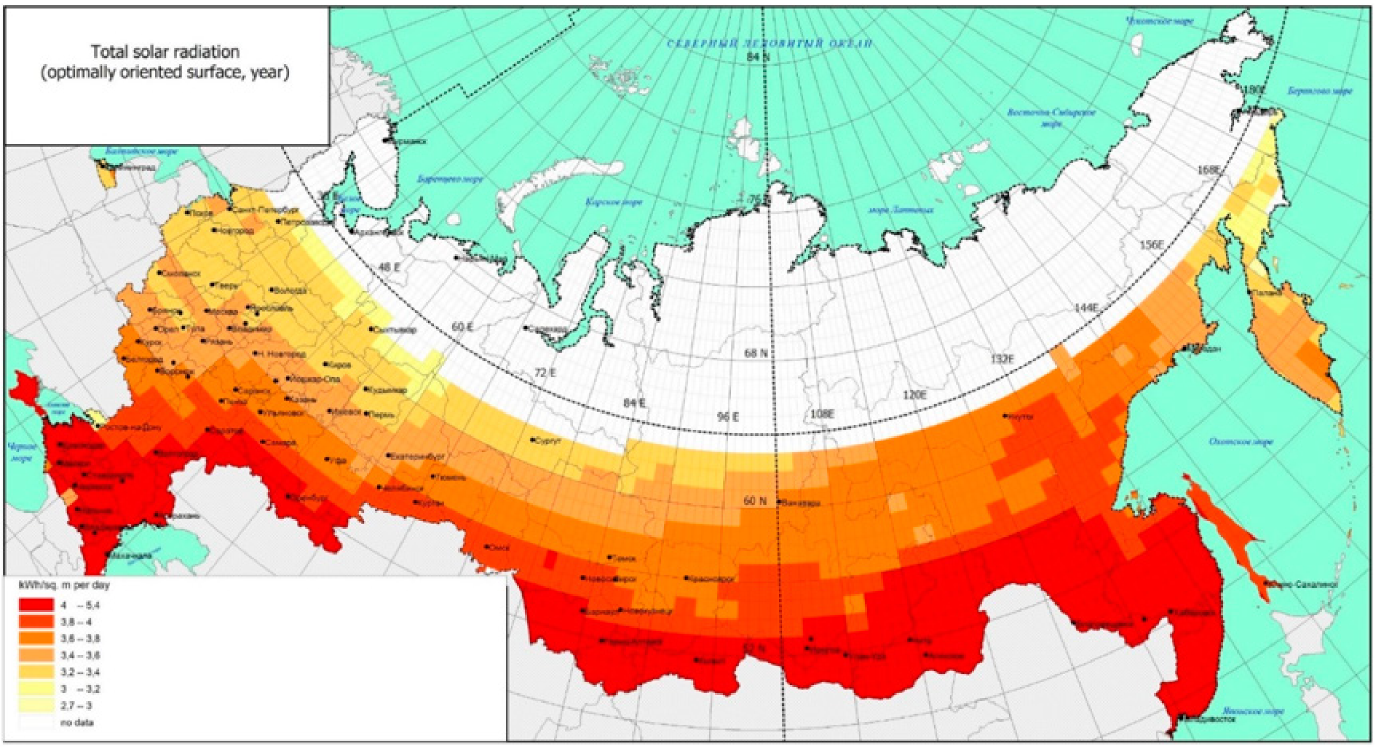
Despite initial policy discourse, estimations prove high wind and solar energy exploitable technical potential in many Russia's regions. Wind energy projects have good prospects in Southern and North Caucasus federal districts, the Arctic territories of the North-West, Urals, Siberian and Far Eastern federal districts. Solar potential is particularly high in Altay, Astrakhan, Stavropol, and Volgograd regions, Buryatia Republic, Promorsky Krai, and in the coastal regions of the North-East (Sakhalin and Kamchatka) (Figure 4 and Figure 5).

Figure 4. Annual specific technical potential of wind energy (N=100 m; MWh/year)



Source: Ermolenko et al., 2017.

Figure 5. Total annual solar radiation in Russia (optimally oriented surface, kWh/sq. m per day)



Source: Ermolenko et al., 2017.

The recently adopted Russia's 2035 Energy Strategy in addition to centralized energy supply previews the development of decentralized power generation (Russian Ministry of Energy, 2020). In 2019, the Law on Microgeneration provided additional mechanisms for the support of RES retail market players, such as households and small companies. They obtained an opportunity to connect their RES generation units with capacity up to 15 kW to the grid and sell the surplus power at the wholesale market price. A full list of policy acts in place are given in Table 1.

Table 1. Policy mix in support of renewables in Russia

2008	the Russian Government decree setting the rules for power generation unit to qualify as RES-based
2013	Government decree to supporting the use of renewables at the wholesale power and capacity market: RES support scheme (PPA) (2014-2024, 6 GW target)
2013	the Russian Government Decree that aims at increasing the energy efficiency of the electric power industry through renewables until 2020
2014	the Russian Government decree setting the rules for registry of renewable certificates
2015	the Russian Government decree introduced tools to support biogas, energy biomass, landfill gas, and other renewables on retail electricity markets, including the definition of regulated long-term prices (tariffs)
2016	a roadmap to promote the development of 7 smart grid and Internet of Energy markets (Energy.Net) in the scope of the National Technology Initiative
2019	Federal Law amending the "Law on Electric Power Industry" with regard to microgeneration (allowing to sell excessive power below 15 kW to the grid)
2021	extended RES support program (PPA) (2025-2035, 6 GW target)

The share of large prosumers[2] has also been growing. Manufacturing and other companies' off-grid generation has been growing by 5% annually and made up over 6% of the total electricity produced in 2020. The share of large prosumers installed capacity may account for 5-10% of the total capacity in Russian power system. Experts estimate that in the majority of Russia's regions that are part of wholesale electricity market it is more economically beneficial to become prosumers than to pay for electricity from the grid (Vedomosti, 2020).

Given cold and moderate climate in most regions, there is high demand for centralized heat supply systems, which are the world largest in Russia. Although there are some pilot cases of using heat pumps by households, these renewable heat sources in most locations have to be complimented by centralized heat supply or by electricity-based heating solutions. Heat pumps could also rely on residual waste heat from wastewater or return heating water (Lund, 2018). However, there are no policy tools in place to stimulate house owners or constructing companies to install heat pumps.

2. The impact of the pandemic and future development trajectories

The impact of the pandemic on the Russian energy industry has been moderate. The main noticeable effects are the decrease of energy generation and consumption that led to lower energy prices. This, in turn, has led to lower energy companies' revenues. Power companies, for example, had to cover their cash shortages by credits, thus increasing their debt burden. As the Russian energy industry (including many of the renewable energy segments) are dependent on imported equipment, currency fluctuations have aggravated associated technological and security risks. Consumers have also suffered, which led to non-payments and deferrals due to company bankruptcies and higher poverty. Additionally, the government support measures (such as temporary prohibition to disconnect consumers for non-payments) have worsened the situation of energy companies. Some of them were able to turn this challenge into an opportunity by increasing efficiency and faster digital transformation (Proskuryakova et al., 2021).

2 Producers + consumers: consumers that produce energy to satisfy own demand.

The COVID-19 pandemic had a dubious twofold on green energy and power generation. On the one hand, low oil prices and lowering corporate and public budget revenues made renewables less competitive compared with fossil fuels. On the other hand, the climate and environmental policy goals have already paved the way for long-term green investment trends that proved to be stress resistant. Renewables have already shown good performance during the first pandemic years as their share in electricity generation increased to 7% (IEA, 2020) in 2020. By 2025, they are expected to become the largest source of electricity generation worldwide, overtaking coal. Although RES development in Russia will be moderate, small RES-based power plants have the potential to cover over a half of Russia's capacity deficit by 2035 that may occur due to equipment depreciation and replacement (Proskuryakova and Ermolenko, 2019).

Existing forecasts paint a contradictory future for Russia's renewables. The Russian researchers from the Energy Research Institute of the Russian Academy of Sciences (ERI RAS) and Analytical Center of the Russian Government are less optimistic about the country's ability to meet the climate targets and executing energy transition than BP experts (Table 2). Official Russian document also point to different targets that become less ambitious with time (Table 3).

Table 2. Energy scenarios for Russia

	ERI RAS & Analytical Center scenarios (2018-2040)	BP scenarios (2050)
Total primary energy consumption	increase by 12–13 %	decrease by 1-11%
Natural gas	will remain to be the dominant fuel: its share will raise from 54 to 57% of the total primary energy consumption	will remain the dominant energy source constituting 23-57%
Liquid fossil fuel	decrease from 21 to 15-17%	oil (and gas) demand will not change in *Business-as-Usual (BaU)* scenario, decrease by 39% in *Rapid* scenario and by 64% in *Net Zero* scenario
Solid fuel	decrease from 17% to 9-13%	decrease in all scenarios up to zero
Low-carbon energy sources (RES, hydro, nuclear)	grow from 10% to 19%	Renewables will grow to 4-48% Nuclear power will grow by 17-94% (up to 13% in energy balance)
Net CO2 emissions		decrease by 24-92%

Sources: ERI RAS, Moscow School of Management SKOLKOVO, 2019; BP, 2020.

Table 3. The evolution of green energy targets in Russian strategy documents

Russian strategy documents (name and date of adoption)		Renewable targets
November 2009	Energy Strategy until 2030	Up to 25 GW
July 2015	The basic provisions of the energy policy by the Russian Government	4.5% until 2024 (wind up to 25 GW, solar up to 50 GW)
June 2017	General Development Plan of the Russian Power Sector until 2035	11.6 GW
February 2018	Energy Strategy until 2035 (draft)	Increase the volume of renewable power 20 times to 46 billion kW/h
June 2020	Energy Strategy until 2035	Lower the costs of 1 kW/h in off-grid areas by 6% (2024), by 17% (2035) compared with 2018

Source: compiled by the author based on mentioned documents.

Based on varied forecasts and the official targets the future of Russian renewables looks uncertain. However, the pandemic and other wild cards may completely change the picture, creating an impetus for a rapid and profitable RES advancement. Importantly, renewables and decentralized energy systems may benefit households and small and medium-sized enterprises (SMEs), particularly in certain (off-grid and energy poor) regions under the different stress scenarios (Table 4).

Table 4. Post-COVID scenarios for the Russian electric power industry

Indicators / Scenarios	Conservative scenario	Smart Energy scenario	Recurrent COVID-19 scenario	One More Wild Card scenario
Economic growth (% per year – on average until 2030)	2.5-3.0	3.0-3.5	1.0-1.5	0-0.5
Inflation (%, on average - per year until 2030)	4	4	6	7
Domestic demand for electricity (TWh by 2030)	1.207	1.241	1.146	1.032
Installed capacity of power stations, centralized power systems (GW by 2030)	254	274	234	224
The share of electric energy produced by the consumers (companies) (%)	7	12	11	14
Installed capacity of renewable power plants (GW by 2030)	6.3	14.5	5.5	5.5
Poverty level (%)	6.45	5.5	10	13

Source: Proskuryakova et al., 2021.

The *Conservative* scenario that is similar to BPs' *BaU scenario* in Table 2 previews that the current energy policy will be maintained. The visionary *Smart Energy* scenario suggests structural changes in the industry that imply transition to clean energy, a larger decentralization, and new water-food-energy nexus solutions. The *Recurrent COVID-19* scenario previews ongoing pandemic outbreaks until 2025 that will preserve the current challenges for the next five years. The *One More Wild Card* scenario assumes the appearance of yet another unexpected event (wild card) that, together to the COVID-19 pandemic, will have a game-changing effect for the existing power systems (Proskuryakova et al., 2021).

3. Barriers to RES advancement in Russia

There are certain barriers to a wider RES application in Russia. Assessing and addressing these barriers could facilitate the development of renewable energy industry in Russia. First, there is a surplus of installed capacity in the country. Therefore, simply adding new renewable capacities is not a solution. Some old and outdated power plants, first of all, coal-based ones, have to be decommissioned.

Second, managers of energy companies often consider a 100% back-up facilities for RES-based power plants, to be the only solution. At the same time, Russia's national grid faces a problem of unloading power plants at night-time and summer time, as well as low average capacity factor of thermal power plants (less than 49% of calendar time). Clearly, the approach to power system management has to be revisited in order to integrate new green power in an efficient and cost-effective manner and will not entail rising power tariffs.

Third, the variable nature of renewables and their low predictability, as well as lower energy density (IPCC, 2018). This limits their integration in the grid, especially in larger volumes, and requires additional costs and smart solutions. Alternatively, the solution could be to extend decentralized power systems and construction of power plants close to the main consumers.

Fourth, the renewable energy market is monopolistic with two large players in solar and two main players in wind energy. Even with the limited number of players, renewables have achieved significant success in terms of installed capacity, share of localized equipment manufacturing, and economic characteristics (levelized cost of energy capital costs, and power tariffs). Undoubtedly, with a more competitive market, these achievements could be extended.

Fifth, there is little domestic R&D and intellectual property related to renewable energy technologies and equipment, most of which are licenced or purchased abroad. This means that the national knowledge base is very limited, and most royalties drain abroad. The situation cannot be sustainable in the long term and has to be addressed. The condition for PPAs set by the government is rapid localization of equipment manufacturing. However, the rapid advancement of national R&D base is not taking place. Moreover, fast localization requirement may distort the market and reinforce other barriers.

Similar to the lack of R&D centers, there is a lack of plants that are capable of renewable equipment manufacturing and comply with the international standards. Addressing these two issues takes time and relies on educating a sufficient number of high-quality specialists. Additionally, construction of new plants or re-profiling some of the existing ones imply high capital costs that could be paid back only with market growth.

4. Policy recommendations

There are several possible development paths that the Russian renewable energy industry may follow. They depend on a wide range of external (social, economic, etc.) and internal (industry-specific) factors. Various stress scenarios may exacerbate the problems in electric power industry. A scientifically grounded energy foresight and monitoring system will allow for timely identification of unexpected events and stress factors, as well as planning for mitigation measures. Science and technology foresight has become part of the national strategic planning system and tested in the part at national and sectoral level (Proskuryakova, 2017; Kindras et al., 2019; Proskuryakova, 2019).

External shocks will increase the demand for higher efficiency, resource saving, off-grid, and flexible energy supply solutions. As government budgets will shrink, decentralized electricity generation should be treated as a measure to lower load of centralized power supply systems and capital expenditures for equipment maintenance and upgrade. Home owners will explore greener and smarter power and heat supply options, such as mixed heat supply systems that combine heat pumps and centralized heat supply (Fragkos et al., 2021).

In case business-as-usual policies and practices will be extended, problem conservation in the industry will occur. No challenges faced by the Russian energy industry will be properly addressed. Moreover, it will be difficult to achieve climate, environmental, and energy efficiency targets. Under current policies, it may be difficult to change industry-level planning in order to implement efficient cross-sectoral solutions and achieve resource saving. Limited international R&D cooperation and technology transfer due to tense foreign economic and political relations will only contribute to structural problems in the industry or become the first trigger for changes (Vatansever, 2020). Therefore, business-as-usual is not an optimal policy course and has to be averted.

The required changes should be planned and implemented by policymakers together with stakeholders. The development of renewable energy sector is not an artificial exercise in a fossil-fuel rich country, but the first necessary step to respond to global mainstream trends and the changing global economic and policy priorities. A solid R&D and manufacturing base has to be created within the country in order to achieve a good level of technological maturity and avoid import dependence (Smeets, 2018). Qualitative (structural) changes in the energy industry seem inevitable and somewhat overdue. These include full decommissioning of old power plants, radical reduction of coal extraction and coal-fired generation, and launching an ambitious modernization program. The side effects (unemployment, etc.) in those segments that will have to be closed or significantly limited should be properly addressed.

Market competition in the economy, energy industry, and renewable energy sector should be reinforced. This should bring additional gains in terms of technology efficiency and cost reduction. Plans for localization of equipment manufacturing, however, may be revisited (slowed down). This will allow more actors to enter the market, including traditional energy companies (including extractive industry companies) that may diversify their business. Grid companies should improve relay protection, automation, and accident prevention systems, given the growing share of distributed power plants.

In future clean energy technologies have to fully provide for domestic power and heat consumption at affordable price without compromising energy security. This is not an easy task and requires long-term planning, diversified energy mix and mass implementation of new efficient water-food-energy solutions, better energy transmission and distribution, and cheaper energy storage systems. A clear and scientifically grounded list of green energy priorities should guide government and private sector expenditure on R&D (gross domestic expenditure on R&D) aimed at achieving technology independence and gaining required competences. Better international R&D cooperation and technology transfer would contribute to reaching the global environmental and climate goals.

For instance, Russia's green energy technology cooperation with the EU is a good example of a mutually beneficial partnership in green energy (Boute and Willems, 2012). European companies are important partners of their Russian counterparts in renewable equipment manufacturing following policy requirements to localize it. The European Green Deal, however, will have a dubious effect on the Russian energy industry and renewables, in particular. On the one hand, all industries that have trade relations with the EU will apply efforts to lower their greenhouse gas emissions in order to minimize the 'penalties' (carbon tax). On the other hand, some companies will try to re-orient towards other world regions, where trade partners are more prone to cooperation. In its present form the Green Deal reads like a green ultimatum. Although it will make a significant contribution to climate change mitigation, economic and social consequences for some trade partners will be tough. Therefore, additional efforts should be applied to help neighboring fossil fuel exporters manage the repercussions of this policy act (Leonard et al., 2021), i.e. extend the grace period beyond 2025.

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