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Wind energy market in Russia and abroad: Problems and prospects development

M.Y. Mokshin[1]
A.V. Putilov[1]
O.N. Rimskaya[2]
[1] National Research Nuclear University MEPhI (Moscow, Russia)
[2] Federal Register of the Scientific and Technical Sphere of the Russian Federation (Moscow, Russia)

Abstract
Wind energy is a renewable energy source, and wind power is a dynamically developing new branch of non-traditional green energy in Russia and in the world. Despite the sanctions and the unfavourable economic situation in the country, Russian energy specialists are pursuing a course for the wind energy development, supported by government programmes. The difficult situation for the implementation of the green energy programme is linked to objective difficulties: Russia has accumulated a surplus of oil and gas that is not needed in Europe, and Western manufacturers have left the Russian market, without which it is difficult to build new wind turbines. The industry has also accumulated methodological problems - on the choice of a methodology for calculating the efficiency of wind farms and tools for internal and strategic planning. This article is an overview of the amount of energy production from wind farms in Russia and countries around the world.
Keywords: green energy, wind energy, efficiency calculation methodology, planning, wind farms in the world, wind farms in Russia.

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俄罗斯和国外的风力发电市场：风力发电发展的问题和前景

M.Y. Mokshin[1]
A.V. Putilov[1]
O.N. Rimskaya[2]
[1] 国立核能研究大学莫斯科工程物理学院(俄罗斯，莫斯科)
[2] 俄罗斯联邦科技领域联邦登记册(俄罗斯，莫斯科)

简介
风能属于可再生能源，在俄罗斯和世界上，风能是非常规绿色能源中一个蓬勃发展的新部门。尽管俄罗斯面临制裁和不利的经济形势，但国内能源部门仍在政府计划的支持下发展风力发电。由于客观困难，绿色能源计划的实施面临困难：俄罗斯积累了欧洲不需要的过剩石油和天然气，西方制造商离开了俄罗斯市场，没有这些资源，建设新的风力发电厂就成了问题。该行业还积累了一些方法论问题，如风电场效率计算方法的选择以及内部和战略规划工具的选择。文章概述了俄罗斯和世界风电场的发电量。
关键词：绿色能源、风力发电、效率计算方法、规划、世界风电场、俄罗斯风电场。

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Introduction

Wind energy is a non-traditional branch of the power industry and an important branch of the national economy of any country, creating the necessary conditions for efficient production, economic growth and improvement of the conditions for social development of society. In the last two decades of the 20th century, renewable energy sources (hereafter referred to as RES) have been increasingly used worldwide: sun, water, wind, tides, underground currents, geothermal sources, biomass, instead of traditional hydrocarbons. Unlike water, the sun and wind are clean, renewable and ubiquitous sources of energy. The kinetic energy of air masses moving under the force of wind is caused by the uneven heating of the atmosphere by the sun and the rotation of the Earth. Wind energy is estimated at 175-219 thousand TWh per year, while the power it develops is approximately 2.7 times greater than the total energy consumption on the planet [Gvozdev, 2019]. The potential of renewable energy sources, including wind, is great and offers innovative solutions to the problem of energy supply, while at the same time solving environmental problems.

Today, wind power is a part of the green energy programme and a dynamically developing sector of the global and Russian energy sector. In 2023, the installed capacity of wind power plants in the world will reach 1TW, and by 2030, subject to strengthening of supply chains and solving other problems, it will reach 2TW[1].

According to experts, renewable energy sources will be the fastest growing segment of the global energy market over the next 20 years, and their share of global electricity generation will increase significantly by 2035 - about one and a half times the current 21%. Currently, 65% of Russia's electricity is generated by thermal power plants, 18.3% by the ten nuclear power plants in operation, and 15.9% by hydroelectric power plants. However, alternative energy, including wind power, is still underdeveloped in Russia, accounting for less than 1% of electricity[2].

In 2009, the Russian energy industry for the first time set a course for the development of renewable energy sources, setting a target of 4.5% of total production by 2024. Wind power is therefore a very young part of green energy, both in Russia and in other countries around the world.

In 2021, the Government of the Russian Federation decided to extend the validity of the basic document in the field of alternative energy 'Main directions of state policy in the field of increasing the energy efficiency of the electric power industry based on the use of renewable energy sources' from 2025 to 2035[3]. By the end of the programme, the systematic development of the Russian energy sector is expected to result in the introduction of more than 12 GW of renewable generation capacity. The estimated volume of investment in green energy is 360 billion roubles[4]. The expected effect of extending the renewables programme to 2035 is to make green electricity cheaper than electricity from conventional sources.

Energy-efficient wind zones in Russia are mainly located on the coasts of seas and oceans. According to the Russian Wind Energy Association[5], the most promising areas for wind energy development are Kalmykia, Krasnodar and Stavropol Krai, Astrakhan, Volgograd and Rostov oblasts, the Far Eastern, North-Western, North Caucasian, Siberian and Ural Federal Districts, territories beyond the Arctic Circle and coastal areas in the north-east of the country.

1. Basic concepts and terms of wind energy, a brief history of its origins

Wind energy is a branch of science and technology that develops the theoretical foundations, methods and means of harnessing wind energy for the production of mechanical, electrical and thermal energy, and determines the areas and scales of appropriate use of wind energy in the national economy [Klimov, 2013]. Wind energy consists of wind engineering, which develops the theoretical bases and practical methods for designing technical means (units and installations), and wind use, which includes theoretical and practical issues of optimal use of wind energy, rational operation of installations and their technical and economic indicators, and generalisation of experience in the use of installations in the national economy. Wind energy is based on the results of aerological studies, on the basis of which a wind energy cadastre is being developed.

Wind power plants (WPPs) convert the kinetic energy of the wind into electrical energy. Wind power plants are grouped into wind power plants (WPPs). Such plants are classified as onshore and offshore depending on their location. Onshore WPPs are located on land, while offshore WPPs are located above the water surface.

Wind power is one of the most efficient and environmentally friendly sources of renewable energy in the world. In Russia, which has a huge potential for wind energy resources, the development of wind energy is of great importance for increasing the country's energy security and reducing its environmental impact. The

[1] Current status and prospects for the development of wind energy. https://eenergy.media/news/29774?ysclid=m345k6kwk166671424.
[2] Green energy: sun and wind instead of oil and gas. https://tass.ru/ekonomika/4083895.
[3] Order of the Government of the Russian Federation dated 08.01.2009 N 1-r (as amended on 03.09.2024) 'On the Main Directions of State Policy in the Field of Increasing the Energy Efficiency of the Power Industry on the Basis of the Use of Renewable Energy Sources for the Period up to 2035'. LRS 'Consultant+'.
[4] The government has clarified the target indicators and conditions for supporting green energy projects. http://government.ru/docs/42377/.
[5] Current status and prospects for the development of wind energy. https://eenergy.media/news/29774.

wind energy industry is relatively young, both in Russia and globally, but has great potential for development.

Historically, people have used wind power to move sailing ships and to power windmills to grind grain. The first research into wind power in the USSR began in the 1930s. In 1931, the All-Union Committee for the Study of Wind and Wind Energy began research into the possibilities of using wind to generate electricity. As a result of these studies, the first wind engines and wind generators were created to supply energy to remote settlements and radio stations. Research institutes were opened to study wind power. The world's first modern horizontal axis wind turbine with a capacity of 100 kW was built in Crimea in 1931.

Throughout the 1940s and 1950s, research continued and many new wind turbine technologies and designs were developed. One of the first examples of successful wind energy use in the USSR was an experimental station on the Kola Peninsula, which began operating in 1954. The period from the 1960s to the 1980s was characterised by the development of new technologies and designs for wind turbines.

However, the development of wind energy in the USSR was more of a scientific interest than an economic one, given the abundance and availability of traditional energy sources such as oil, gas, coal and nuclear power. However, some wind energy projects have been successfully implemented in remote areas of the country where the use of wind was economically viable. After the collapse of the Soviet Union in 1991, research into wind energy declined due to a lack of funding and government support.

Since the early 2000s, interest in wind energy has been growing in Russia, in line with the global trend towards the development of renewable energy sources and the global trend towards the reduction of greenhouse gas emissions. In 2009, the Russian government adopted the first Federal Target Programme for the Development of Renewable Energy for the period up to 2020, which includes the development of wind energy in the country. The programme was later extended to 2025 and then to 2030. As a result, the first large-scale wind farm in Russia was commissioned in 2017 - the Ustyansky wind farm in the Republic of Karelia with an installed capacity of 35 MW. Several other large projects were implemented in the following years: Kochubeevsky (Krasnodar Region) and Adygeysky wind farms with an installed capacity of 60 MW and 150 MW respectively. In 2020, the Rodnikovsky wind farm in Stavropol Krai will be commissioned with an installed capacity of 210 MW[6].

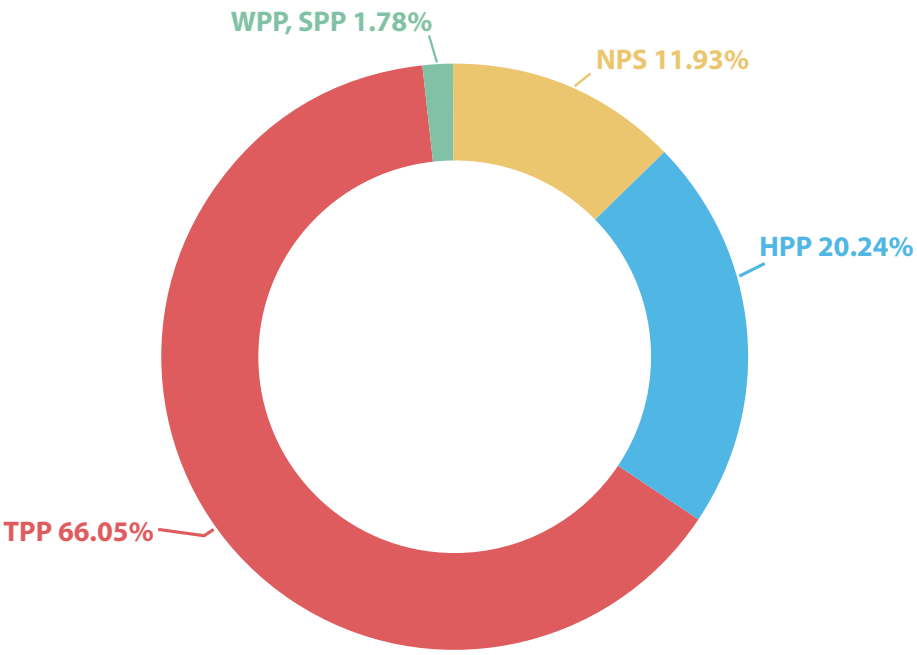
2. Current state of the wind energy market in Russia

According to some estimates, about 65-70% of the territory of Russia, with a population of 20-25 million people, either has no centralised energy supply or the facilities are in poor condition[7], which makes the development of alternative energy sources extremely important for the country's national economy.

In Russia, the main wind energy zones are located on the coast of the Arctic Ocean, on the islands of the sea from the Kola Peninsula to Kamchatka, in the Lower and Middle Volga and Don regions, on the coasts of the Caspian, Okhotsk, Barents, Baltic, Black and Azov Seas. Separate zones are also found in Karelia, Altai, Tuva and Lake Baikal, areas with the highest average wind speed in the autumn-winter period of the year.

The current state of the Russian energy system by type of energy produced is shown in Fig. 1. The total installed capacity of Russian power plants at the beginning of 2023 was 247,601.8 MW, which is 0.41% higher than

Fig. 1. Structure of the installed capacity of the UES in Russia as of 01.01.2023



Source: Kindratyshin R. (2023). Energy system of Russia: forecast for 2023-2028. https://conomy.ru/analysis/articles/1020.

[6] Russia revives wind power. https://www.cdu.ru/tek_russia/issue/2024/8/1289/.
[7] Renewable energy as a new evolutionary step for oil and gas companies. https://assets.kpmg/content/dam/kpmg/ru/pdf/2019/12/ru-ru-renewable-energy-sources-for-oil-and-gas.pdf.

Table
Installed capacity and electricity production of wind farms in Russia, 2019–2023

Indicator	2019	2020	2021	2022	2023
Installed capacity (MW)	184	1 027	2 036	2 218	2420
Electricity generation (thousand GWh)	0.32	1.38	3.62	5.5	5.49
Share of wind power in electricity generation (%)	0.03	0.13	0.32	0.47	0.49

Source: compiled by the authors based on: WWEA annual report 2023: Record year for windpower. https://wwindea.org/AnnualReport2023.

the values at the beginning of 2022 (246,590.9 MW). In 2022, 1610.7 MW of new generating capacity came on stream and 972.2 MW was decommissioned. As a result, the change, taking into account the re-labelling of existing plants (372.4 MW), is +010.9 MW.

In 2022, total electricity generation from power plants in Russia was 1121.6 billion kWh, 0.63% higher than in 2021 (1114.55 billion kWh), and only 1.78% of the total energy generated was from wind power.

Russia first embarked on a course to develop renewable energy sources in 2009, setting a target of 4.5% of total production by 2024 (excluding hydroelectric plants over 25 MW). The programme to promote the construction of renewable energy sources was launched in 2013. It is based on supporting investments in this sector at the expense of energy market consumers with a fixed tariff for capacity over 15 years with a return of 12%.

The main foreign investors in the construction of Russian wind farms in 2022 were Enel (Italy), Fortum (Finland), Lagerwey (Holland), Siemens Gamesa (Germany). Russian companies - major investors in wind farms - Gazprombank, Rosatom, Rusnano, RDIF, etc.

Russia's wind energy zones, promising for wind energy development, cover almost 5 million km [8]. Across Russia, the technical potential of wind energy is estimated at 17,100 billion kWh at a height of 100 metres (the height of the hub of a modern wind turbine), which is almost 17 times higher than the power generation in the Unified Energy System of Russia for 2023. At the same time, the duration of wind energy flow is from 2000 to 5000 h/year[9]. It is clear that the technical potential of wind energy in Russia exceeds the volume of electricity consumption in the country.

The most promising areas for the installation of wind turbines are the coasts of the seas and parts of their shelves. The development of wind energy is most expedient in the Astrakhan, Volgograd and Rostov regions, the Krasnodar and Stavropol territories, the Republic of Kalmykia, the North-West, North Caucasian, Siberian and Ural Federal Districts, the Arctic, Kamchatka and Sakhalin.

By the end of 2023, Russia will have 37 wind power plants in operation, 7 isolated power systems, 17 under design and construction, and 6 decommissioned[10]. Data from previous years from the World Wind Energy Association (WWEA) annual report for the first half of 2023 are summarised in a table, reflecting the gradual growth of installed capacity and electricity production of wind power plants in Russia in 2019-2023. It is no coincidence that WWEA's 2023 Annual Report is entitled: 'A record year for wind energy'.

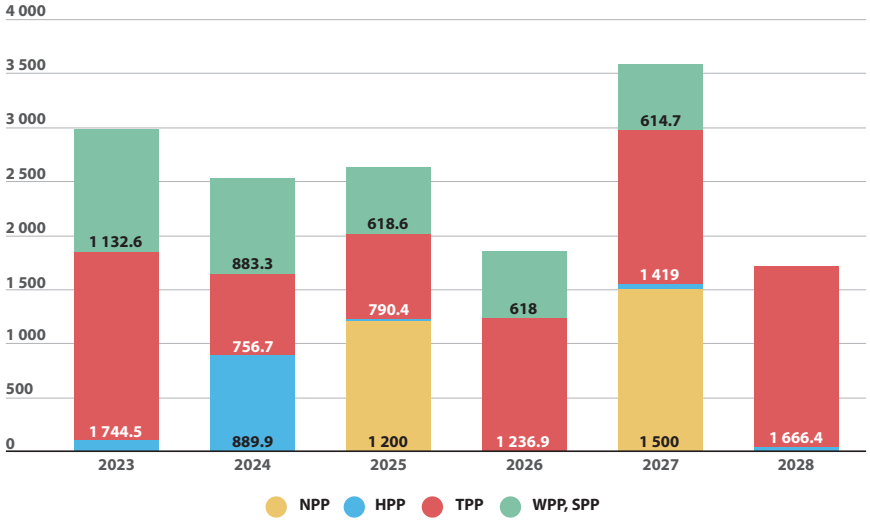
Wind farms are being built most actively in the south of Russia. In the Rostov region, for example, there are 6 wind farms with a total capacity of 610 MW. The Adygeya wind farm consists of 60 wind turbines, each with a capacity of 2.5 MW. The Kochubeevskaya wind farm in Stavropol consists of 84 such turbines spread over 75 hectares and is capable of supplying electricity to a city of 200,000 people.

Russia's largest export wind farm is to be built in the Amur region; the project aims to export up to 3 billion kWh of energy per year to China. The wind farm will have a capacity of 1058 MW and an investment of 100 billion roubles, part of which will be provided by Chinese partners.

In Stavropol Krai, three major projects for the construction and commissioning of renewable energy production facilities with a total capacity of 163.8 MW are planned for 2024-2029: the second stage of the Trunovskaya wind farm with a capacity of 35 MW, to be commissioned in 2024; the Simonovskaya wind farm with a capacity of 57.5 MW and the Sotnikovskaya wind farm with a capacity of 71.3 MW, to be commissioned

[8] Green energy: sun and wind instead of oil and gas. . https://tass.ru/ekonomika/4083895.
[9] Current status and prospects for the development of wind energy. https://eenergy.media/news/29774.
[10] Current status and development prospects of wind energy. https://eenergy.media/news/29774.

Fig. 2. Russian energy system in 2023–2024, forecast for 2025–2028



Source: Kindratyshin R. (2023). https://conomy.ru/analysis/articles/1020.

in 2025[11]. The capacity of the power stations is expected to increase by a further 6 MW as a result of equipment modernisation.

Overall, the Russian Wind Industry Association (RAWI) predicts that the total installed capacity of wind turbines will reach 8 GW by 2035[12].

Today, the wind energy sector in Russia is gradually regaining momentum after a decline in 2022 caused by the geopolitical situation and sanctions. The structure of the wind energy market has remained stable, and the total amount of electricity generated by wind farms has increased. Despite the withdrawal of foreign companies from the Russian market, domestic companies are continuing to expand their own activities, adapting to the changed operating conditions and rebuilding logistical routes for the receipt of necessary technologies.

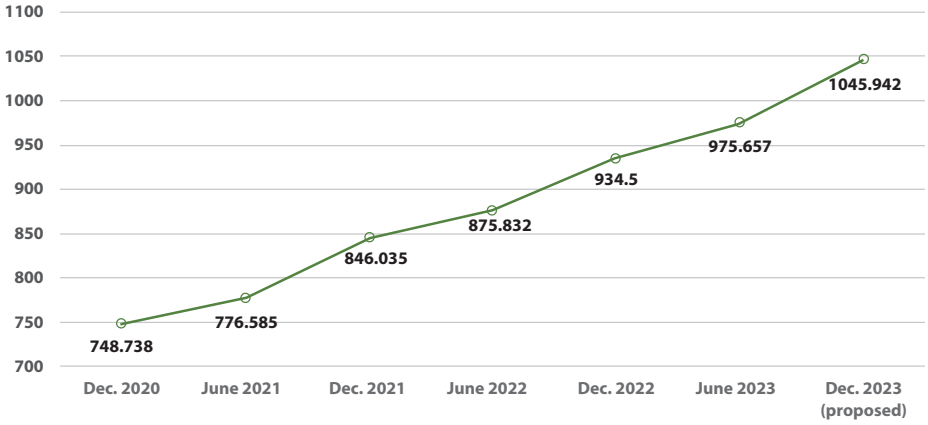
The ratio of energy produced from different types of sources in Russia and the forecast for the medium term are shown in Fig. 2.

Wind energy is currently seen as an alternative to traditional energy and should be used as a complement to the main forms of electricity generation.

3. World wind energy

According to the World Wind Energy Association (WWEA), 41.2 GW of wind power capacity was installed worldwide in the first half of 2023, 38% more than in the same period of 2022[13]. The most effective way of harnessing wind energy abroad is to combine wind turbines into wind power plants that operate on unified electricity grids of large and comparable capacity to wind power plants. Such wind farms, operating in parallel with

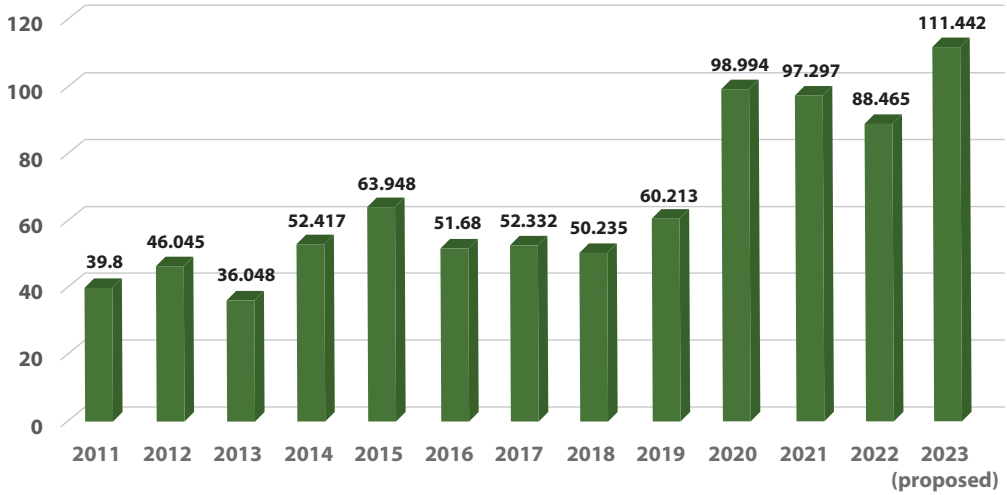
Fig. 3. Global installed wind power capacity



Source: WWEA annual report 2023: Record year for windpower. https://wwindea.org/AnnualReport2023.

[11] Five power plants will be built and modernised in Stavropol by 2029. https://www.metalinfo.ru/ru/news/157534.
[12] Wind energy: is it cheaper than conventional kilowatts? https://nangs.org/news/renewables/wind/energiya-vetra-deshevle-li-ona-v-sravnenii-s-traditsionnymi-kilovattami.
[13] This year, the world is expected to see a record increase in wind power - more than 110 GW. https://www.in-power.ru/news/alternativnayaenergetika/53648-v-tekuschem-godu-ozhidaetsja-rekordnyi-prirost-vetroenergetiki-v-mire.html.

Fig. 4. Dynamics of change in global wind power capacity, 2011–2023



Source: WWEA annual report 2023: Record year for windpower. https://wwindea.org/AnnualReport2023.

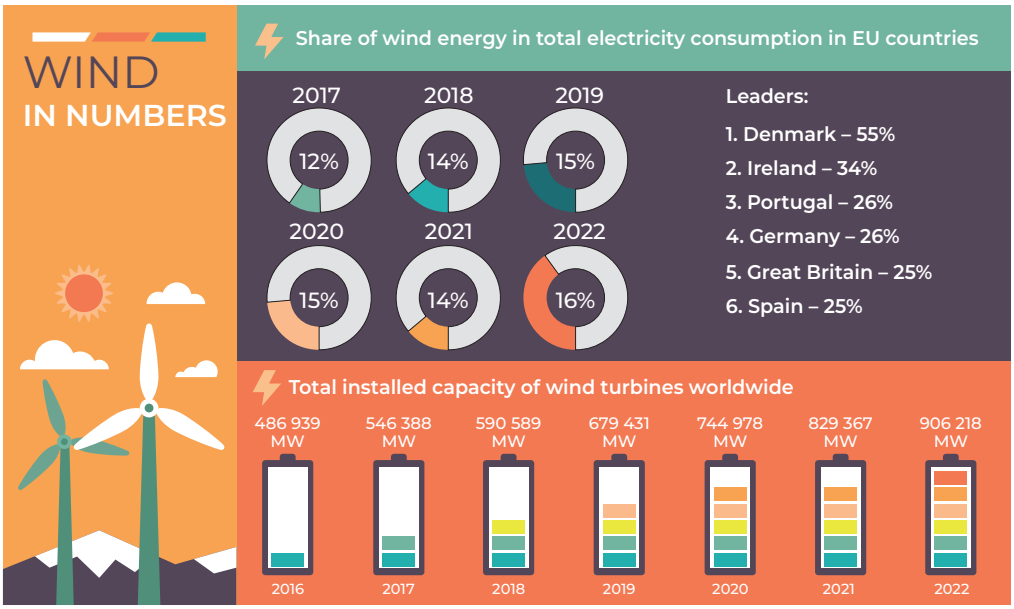
electricity grids, produce about 95% of the world's wind power.

Analysis of the WWEA[14] report data for the first half of 2023 shows a smooth and stable trend in global wind power capacity growth (Fig. 3).

From 2011 to 2023, there is a general upward trend in installed wind power capacity (Figure 4), with small periods of fluctuation, and global installed wind power capacity reaches more than 1045 GW by the end of 2023, in line with the report's forecast.

According to the WWEA report, China leads the world market with 23.8 GW of installed capacity in the first half of 2023. China was the first country to pass a renewable energy law on 1 January 2006 (Ontario, Canada did not pass the Green Energy Act until 2009). China is followed by India, Brazil and the US, each of which added more than 2 GW. In Europe, Germany and France had the highest growth in wind power, adding more than 1 GW each[15]. Russia is not included in this assessment. Figure 5 shows the distribution of

Fig. 5. Distribution of the share of wind energy in electricity consumption in EU countries



Source: World Wind Energy: 2022 Results. https://www.eprussia.ru/epr/460/1978524.htm

[14] WWEA annual report 2023: Record year for windpowerhttps://wwindea.org/AnnualReport2023.
[15] WWEA annual report 2023: Record year for windpower. https://wwindea.org/AnnualReport2023.

the share of wind energy in the provision of electricity consumption in the EU countries.

In 2022, 16,000 MW of new wind power capacity will be installed in EU countries, 40% more than in 2021. Germany leads the way, followed by Sweden, Finland, France and the UK. There is currently 255,000 MW of wind power capacity in operation in Europe and the share of wind power is growing[16] and the share of wind power is growing.

The European Union will add 17 GW of new wind power in 2023, more than ever before in a calendar year[17]. However, this is well below the EU's targets for 2030: 30GW of new wind capacity should be installed in the Union each year. Possible reasons include the deteriorating economic situation in EU countries due to the outflow of EU budget funds to support military conflicts and resolve humanitarian crises.

The European Commission has set a target of 43% of electricity consumption coming from wind power by 2030. To achieve this, the EU will need to build an average of 31,000 MW per year until 2030, with investment in wind energy declining from 2022. It should be noted that 87% of the new wind capacity to be built in Europe in 2022 were onshore, while only 2.5 GW of new offshore wind capacity were commissioned.

However, the Global Wind Energy Council (GWEC[18]) previously made an encouraging forecast of 680 GW of wind power installed worldwide by 2027, enough to power around 657 million homes per year. This forecast is likely to be revised for geopolitical reasons.

4. Problems with wind energy in Russia

The main directions of development of modern wind energy include:

- creation of large network wind power plants;
- creation of commercial megawatt-class wind power plants;
- reduction in the cost of electricity produced by them;
- environmental protection.

The Russian wind energy industry is influenced by a number of factors that need to be taken into account when developing the renewable energy grid:

- threats of non-use of renewable energy sources due to the vast reserves of natural resources used in traditional methods of generating electricity;
- low level of investment in the industry, insufficiently developed system of state support in this area;
- the impact of the geopolitical situation and sanctions restrictions;
- lack of own promising technologies and equipment necessary for the development of generation capacities on the territory of Russia;
- inadequate government regulation of the industry;
- high import dependency for wind energy, hence the importance of technical independence;
- lack of domestic competition;
- unfavorable economic indicators in the country (high inflation, price volatility, floating exchange rates, etc.).

An obstacle to the active use of alternative energies could be the Russian government's initiative to increase the tariffs for the technical connection of consumers to the power grid. The industry therefore needs well-considered government decisions.

There is some disagreement among Russian economists and engineers on the choice of methodology for calculating the efficiency of wind farms, issues of financing investment projects in the field of wind energy and some financial and economic aspects [Becker, 2007; Zinatullin, Chibisova, 2011; Sheryazov, Shelubaev, 2014; Kiryanov, Kudelin, 2021; Mokshin, Putilov, 2023]. The reasons for this were difficulties in accurately forecasting the energy supply for the project, uncertainty or irrelevance of data, the choice of design option for the wind farm energy equipment, etc. Thus, when calculating the financial efficiency indicators, the cost forecast does not raise any questions, but it is much more difficult to forecast the revenues of the project, since the bulk of them will be generated by the sale of the energy produced by the wind farm. There is a difficulty in predicting the price of energy resources over a long period of time, as this prediction is directly related to a random variable - the average annual wind speed.

The cost of electricity generated by wind power plants in Russia is 3.5 roubles/kWh (set from 1 March 2023), which is cheaper than traditional electricity. This price can be fixed for 15 years, which allows wind turbine owners to plan their investments and returns in the long term. The price of electricity generated by wind turbines is highly dependent on the economic, regulatory and geographical characteristics of the region to which it is supplied. Despite the methodological difficulties in accounting and planning, evaluating investments in wind farms, assessing efficiency, etc., the wind energy market is promising and has the necessary potential for long-term growth.

In addition to the economic and environmental impacts of wind energy, there are also negative environmental impacts associated with wind turbines, such as noise ('wind generator syndrome'[19]), which is audible to humans, and low-frequency vibrations that can only be

[16] Mogilenko A. World wind energy: results of 2022. https://www.eprussia.ru/epr/460/1978524.htm.
[17] The EU built 17 GW of new wind power in 2023. https://www.interfax.ru/world/940213.
[18] Global Wind Energy Council (GWEC). https://gwec.net/.
[19] People living near the wind turbine received a large sum of money: the power station caused serious damage to their health. https://www.techinsider.ru/science/1572635-zhivushchie-ryadom-s-vetryakom-lyudi-poluchili-krupnuyu-summu-deneg-elektrostanciya-nanesla-sereznyy-vred-ih-zdorovyu/.

detected with the use of equipment (impact on the human vestibular system).

5. Prospects for wind energy development in Russia

Russia plans to introduce 3 GW of wind power capacity by 2030, according to the Renewable Energy Development Association (REDA). Domestic wind power technologies are currently being developed. An important feature of wind farm projects is their low-cost operation, and the main investments are required for the construction of wind power plants[20].

In the long-term perspective of wind energy development in Russia, the share of renewable energy sources in the country's energy balance is expected to increase to 7-10% by 2035. To achieve this goal, the Russian government plans to hold additional auctions for the construction of new wind power plants, including with partners from countries friendly to Russia.

Particular attention will be paid to the development of wind energy in the northern and eastern regions of Russia, where wind has the greatest potential. There are also plans to develop a distributed generation network based on wind power plants to supply remote settlements and industrial enterprises. Wind energy is already included in Russia's energy strategy, and the reasons for this interest are as follows:

- the transition of developed countries to the next technological order [Glazyev, 2012] - the 'hydrogen economy', in which renewable energy sources can be easily integrated;
- the enormous energy potential of the country's wind energy sector, which makes it possible to include this area of renewable energy in the country's strategic energy plans;
- fast payback for wind farms - within 10 years;
- technical simplicity and speed of construction of wind farms;
- expanding the capabilities of the Rosatom Corporation, which has a range of solutions from nuclear to renewable energy;
- the climatic conditions in Russia are favourable for the development of wind farms;
- the absence of a fuel component in renewable energy generation that affects tariff formation and the environment;
- Government programmes for the development of wind energy, including investment.

In the area of research and development, Russia continues to work actively on improving technologies and materials to create more efficient and reliable wind turbines. Of particular interest are innovative technologies such as the creation of vertical axis wind turbines and the development of energy storage systems to improve the stability of wind farms.

It is also worth mentioning the introduction of digital technologies and solutions in wind energy, especially in the nuclear industry, which will improve management efficiency, optimise planning processes and electricity production in different regions, taking into account local characteristics [Mokshin, Putilov, 2023].

Meanwhile, the Russian government's initiative to increase tariffs for the technical connection of consumers to the electricity grid may become an obstacle to the active use of such electricity. As already mentioned, according to the decision of 30 June 2022, these rates have increased by 82 times[21].

By 2035, Russia plans to build about 12 GW of green power (based on wind, solar and small hydro), which will represent 4.8% of current total generation capacity[22].

Conclusion

Energy dependence is the main problem of the modern world economy and a national problem of every country's economy. In an attempt to solve this problem, engineers are using alternative renewable energy sources. The most effective and promising direction in the use of green renewable energy sources is considered to be wind energy, the development of which has recently received more attention in Russia due to the peculiarities of the country's territory. The use of wind power to supply energy to industrial and social facilities has developed in a number of countries in Europe, Asia and North America. According to some data, the total share of electricity generated by wind generators has exceeded the total output of nuclear energy[23].

The economic aspects of wind energy development, as opposed to its technical and technological features, are not yet sufficiently reflected in Russian scientific journals, since this is a new direction and wind energy occupies an insignificant share of the total volume of energy production in Russia. Therefore, the main sources of information here are statistical data, policy documents from government agencies and analytical reviews by experts, which are publicly available on the Internet [Golovko et al, 2022].

The new history of wind energy in Russia shows that despite the difficulties and limitations associated with the development of the energy sector in the country, wind energy continues to demonstrate its potential and prospects for ensuring energy security and sustainable development. Completed projects and ambitious plans

[20] Russia revives wind power. https://www.cdu.ru/tek_russia/issue/2024/8/1289/.
[21] Decree of the Government of the Russian Federation of 30 June 2022 No. 1178... https://www.consultant.ru/document/cons_doc_LAW_420866/92d969e26a4326c5d02fa79b8f9cf4994ee5633b/.
[22] By 2035, Russia could add 6.7 GW of hydroelectric capacity and 12.2 GW of nuclear capacity. https://tass.ru/ekonomika/17035803.
[23] Development of wind power in Russia. https://pkckinematika.ru/info/articles/ekonomika/razvitie-vetroenergetiki-v-rossii/.

for the future are opening up new opportunities to harness the country's wind resources, increase energy efficiency and reduce environmental impact.

An important aspect of the further development of wind energy in Russia is state support for investment projects and scientific research, as well as stimulating the development of industry companies and creating favourable conditions for their work. In this area, measures can be implemented to provide tax incentives and loan guarantees, as well as the development of specialised training programmes for industry in the context of the digital economy [Rimskaya et al, 2021].

Despite the geopolitical situation, Russian energy companies and research institutes are ready to cooperate with international partners and participate in global green energy initiatives, facilitating the exchange of experience and technologies, accelerating the development of new solutions and increasing the competitiveness of domestic wind energy in the global market.

Wind energy in Russia has every chance of becoming an important element of the country's energy system and playing a key role in the transition to sustainable and environmentally friendly development.

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About the aurhors

Mikhail Y. Mokshin

Postgraduate student, Faculty of Business Informatics and Integrated Systems Management, National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) (Moscow, Russia). ORCID: 0000-0002-0985-2192; Web of Science Researcher ID: LRC-2876-2024; SPIN: 8914-1453; Author ID: 1230549.

Research interests: wind energy, green energy, energy cost management in industry and energy.

mokshin.my@mail.ru

Alexander V. Putilov
Doctor of technical sciences, professor, dean of the Faculty of Business Informatic and Management of Integrated Systems of the National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) (Moscow, Russia); academician of the Russian Academy of Natural Sciences (Moscow, Russia); award winner of Government of the Russian Federation in field of science and technology. ORCID: 0000-0002-5373-7506.
Research interests: wind energy, green energy, energy cost management in industry and energy.
avputilov@mephi.ru

Olga N. Rimskaya
Candidate of economic sciences, associate professor, expert of the Federal Register of the Scientific and Technical Sphere of the Russian Federation (Moscow, Russia). ORCID: 0000-0002-1548-0815; Scopus Author ID: 5581148210; Researcher ID: 583440; SPIN: 4185 4532; Author ID: 583440.
Research interests: global economy, digital economy, innovation, labour economics, continuous education, European systems and models of education, human resource management, motivation and incentives for labor, problems of humanitarian crisis.
olgarim@mail.ru

作者信息

Mikhail Y. Mokshin
商业信息学和综合系统管理学院研究生, 国立核能研究大学莫斯科工程物理学院(俄罗斯，莫斯科). ORCID: 0000-0002-0985-2192; Web of Science Researcher ID: LRC-2876-2024; SPIN: 8914-1453; Author ID: 1230549.
科学兴趣领域：风能、绿色能源、工业能源成本管理和电力工程。
mokshin.my@mail.ru

Alexander V. Putilov
技术科学博士、教授、商业信息学和综合系统管理学院院长, 国立核能研究大学莫斯科工程物理学院(俄罗斯，莫斯科); 俄罗斯自然科学院院士（俄罗斯, 莫斯科); 俄罗斯政府科技奖金获得者。ORCID: 0000-0002-5373-7506.
科学兴趣领域：风能、绿色能源、工业和能源领域的能源成本管理。
avputilov@mephi.ru

Olga N. Rimskaya
经济学博士，副教授，俄罗斯联邦科技领域联邦登记册专家（俄罗斯莫斯科）。ORCID: 0000-0002-1548-0815; Scopus Author ID: 5581148210; Researcher ID: 583440; SPIN: 4185 4532; Author ID: 583440.
科学兴趣领域：世界经济、数字经济、创新、劳动经济、继续教育、欧洲教育体系和模式、人力资 源管理、劳动动机和激励、人道主义危机问题。
olgarim@mail.ru

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