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Russia's Renewable Energy: Prospects in an Era of Geopolitical Confrontation

Russia's Global Energy Role—Working Paper No. 2

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EXECUTIVE SUMMARY

- **Russia has the largest technical potential for renewable energy in the world and could be a major clean energy exporter if it developed these resources.**
- In the wake of Russia's invasion of Ukraine, various stakeholders have called for a review of Russia's greenhouse gas emissions reductions goals, but **top officials in several ministries as well as State Duma leaders have repeatedly stated that they do not plan radical revisions in Russia's climate policies, notwithstanding Western sanctions.** Yet Russia's net zero strategy relies less on reducing CO_2 emissions than on a twofold increase in natural carbon sinks in forests, which reduces the need to develop renewable power or to pursue wider decarbonization of Russia's economy.
- **Russia's government is seeking "technological sovereignty" in the energy sector and other areas, including in renewable power technologies.** This means domestic development of and control over key technologies and eventual rejection of imports for any critical equipment. With respect to solar and wind power, it has included mandatory local content requirements that are gradually tightening. By the early 2030s, solar and wind manufacturing will lose eligibility for subsidies if they do not use almost entirely local content and generate significant revenue from exporting equipment.
- Nevertheless, **considerable cost disadvantages will make it difficult if not impossible for Russian renewable energy component manufacturers to compete with lower-priced international suppliers, such as Chinese companies.** Russia's manufacturers need economies of scale to reduce costs, which in turn require a large domestic market that Russia will not have without policies to support renewable power.
- Though at the center of Russia's hydrogen strategy prior to the invasion of Ukraine, **hydrogen exports will face similar challenges as well as even greater technological obstacles, in that Russia's hydrogen technologies are even less developed than its solar and wind technologies.**

01

Renewable Energy Potential in Russia

With its enormous size and diverse geography, including vast territories across different climate zones, 11 time zones, and 13 seas, Russia has abundant natural resources. The country boasts 4 of the 10 largest rivers in Eurasia, several large volcanic zones, and thermal water deposits, as well as annual production of billions of tons of biomass. Russia's renewable water resources rank second in the world. These factors indicate that Russia has immense technical potential for renewable energy, including hydro, solar, wind, bio, tidal, and geothermal energy. Nevertheless, both Russia's ongoing confrontation with the United States and its European allies and its broader long-term energy policy trends are significant obstacles to developing this potential.

Hydro

Russian and Soviet governments have focused on hydropower for decades and have directed enormous resources at studying and exploiting it. The economically viable potential of Russian rivers is estimated to be around 850 TWh/year; for comparison, Russia's total electricity generation over the last 10 years did not exceed 1,100 TWh/year.[1] However, Russia's hydro resources are concentrated in large rivers in the Asian part of the country, while electricity consumption is concentrated in European Russia. Overall, Russia has developed only about 20% of its hydro potential and only 6% in the remote Far East.[2] From the 1950s to the 1980s, the USSR added hydropower generation by building massive cascades of large-scale dams with hundreds and thousands of megawatts in capacity. This approach flooded vast territories and transformed ecosystems. Russia designed its last major hydropower plants in the late 20th century; the Boguchanskaya and Bureyskaya dams started full-scale operations in the early 2010s with a total capacity of 5 GW. Russia ranked 14th globally in hydropower capacity growth during 2012–2021, with an increase of 2.6 GW, behind China (which added 53 times as much capacity as Russia) and Brazil (which added approximately 10 times as much).[3] For comparison, Russia added 39.8 GW in total electric generating capacity in 2008–2017, primarily in gas-fired power plants.[4]

1 International Hydropower Association, "Country Profile–Russia," April 7, 2023, https://www.hydropower.org/country-profiles/russia; International Energy Agency, "Russia," April 7, 2023, https://www.iea.org/countries/russia.

2 Ekaterina Grishkovets, "Eternal Energy" (in Russian), Kommersant, August 30, 2011, https://www.kommersant.ru/doc/1756419 .

3 Author's estimations based on International Renewable Energy Agency (IRENA), Renewable Energy Statistics 2022 (Abu Dhabi: International Renewable Energy Agency, 2022), https://www.irena.org/publications/2022/Jul/Renewable-Energy-Statistics-2022.

4 Anatoly Chubais, "How Did the RAO UES Reform End?" (in Russian), Vedomosti, June 18, 2018, https://www.vedomosti.ru/opinion/articles/2018/06/29/774143-reforma-rao-ees.

Wind and Solar

Russia began systematic assessments of its wind and solar resources in the late 1990s.[5] The first studies found that Russia's total technical wind potential exceeded 11,000 TWh/year.[6] The coastal northern and landlocked southwestern regions of European Russia, the Far North, and the Far East emerged as most promising. Later assessments using a top-down methodology showed a broadly similar wind potential of 17,100 TWh/year.[7]

Russia's technical solar potential exceeds 87,700 TWh/year, though a significant portion is in remote areas in Siberia and the Far East.[8] Average theoretical solar photovoltaic (PV) potential in Russia is about 3.1 kWh/m^2.[9] Meeting Russia's total electricity demand would take only 0.1% of the country's landmass; the levelized cost of electricity (LCOE) generated by solar PV could reach $0.17–0.28/kWh.[10]

Other Renewables

Decades-old estimates of tidal power suggest that Russia's northern and eastern seas could provide several tens of gigawatts in generating capacity. However, such projects are much riskier and more complex than large hydropower stations on rivers, so the Russian government is not currently considering them.[11] Estimates place Russia's biomass-to-energy potential at approximately 4,800 TWh/year,[12] while identified reserves of geothermal water (under 200°C) at depths up to 3.5 km are equivalent to 244 TWh/year.[13]

Renewable Energy Export

In 2020, Russia's total final energy consumption was about 5,885 TWh,[14] many times smaller than its total renewable energy potential. This difference indicates opportunities for Russia to develop and export renewable energy as electrons (electricity via transmission lines) or molecules such as green

5 V. G. Nikolaev, S. V. Ganaga, and K. I. Kudriashov, National Cadastre of Wind Resources of Russia and Methodological Grounds for their Determination (Moscow: Atmograph, 2008).
6 Ibid.
7 B. V. Ermolenko et al., "Wind and Solar PV Technical Potentials: Measurement Methodology and Assessments for Russia," Energy 137 (2017): 1001–12, DOI: 10.1016/j.energy.2017.02.050.
8 Ibid.
9 Energy Sector Management Assistance Program (ESMAP), Global Photovoltaic Power Potential by Country (Washington, DC: World Bank), http://documents.worldbank.org/curated/en/466331592817725242/Global-Photovoltaic-Power-Potential-by-Country.
10 Ibid.
11 "The Electricity Market Is Not a Bazaar" (in Russian), Kommersant, October 10, 2021, https://www.kommersant.ru/doc/5064914.
12 TP Bioenergy, "Bioenergy in the Russian Federation: Roadmap for 2019–2030," Moscow, 2019 (in Russian).
13 Leonid Khazanov, "What Is the Potential of Geothermal Energy in Russia?" (in Russian), Kislorod, December 8, 2017, https://kislorod.life/question_answer/kakov_potentsial_geotermalnoy_energetiki_v_rossii/.
14 International Energy Agency, "Energy Statistics Data Browser," August 18, 2022, https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser.

hydrogen and its derivatives (by tanker or pipeline).

In recent years, Russia has exported electricity to the European Union (Finland, Latvia, and Lithuania), as well as to China, Georgia, Kazakhstan, and Mongolia.[15] In 2021, Russia's total electricity exports were about 29 TWh, or less than 3% of its electricity production. In 2022, this figure decreased sharply after the European Union (EU) stopped importing electricity from Russia. While these exports were not renewable electricity, the carbon footprint of Russian electricity is comparatively low—significantly lower than that of China, Kazakhstan, or Mongolia.[16]

In the early 2000s, Russia proposed to its neighbors a huge project called the Asian Energy Ring, which would have united the power systems of eastern Russia, China, Mongolia, South Korea, and Japan[17] and enabled more optimal use of power plants.[18] Since then, this project has been the subject of numerous feasibility studies and memoranda of underestanding, with capacity additions estimated at several GW and the volumes of electricity flows between countries estimated at 400 TWh.[19] The stakeholders involved have implemented almost none of these plans so far.

McKinsey and the Hydrogen Council estimate Russia's potential hydrogen production at 260 Mtpa[20] by 2050 (at a price of no more than $1.8/kgH2, or $16/MMBtu); they estimate Russia's potential hydrogen exports to Europe and Asia at about 6–15 Mtpa by 2050.[21] In February 2022, Russia's draft national hydrogen strategy considered exports of up to 2.3 Mtpa by 2030 and 9.4 Mtpa by 2050,[22] although during the drafting of this document, there was talk of export potential of up to 50 Mtpa.[23] Russia plans to capture up to 20% of the global clean hydrogen market by 2050.[24]

15 Observatory of Economic Complexity, "Electricity in Russia," April 7, 2023, https://oec.world/en/profile/bilateral-product/electricity/reporter/rus?redirect=true.

16 Our World in Data, "Carbon Intensity of Electricity, 2022," April 7, 2023, https://ourworldindata.org/grapher/carbon-intensity-electricity.

17 "Japanese Will Adjust Chubais' Plans," Kommersant, September 6, 2000, https://www.kommersant.ru/doc/157142.

18 Sergei Podkovalnikov, "Power Grid Interconnection in Northeast Asia: Perspectives from East Russia," Energy Systems Institute, Russian Academy of Sciences, Siberian Branch, January 2012, http://www.nautilus.org/wp-content/uploads/2012/01/podkovalnikov.pdf.

19 "Energy Ring of the East" (in Russian), Kommersant, October 17, 2016, https://www.kommersant.ru/doc/3113919.

20 One million tons (Mt) of hydrogen is equivalent to approximately 3.6 bcm of natural gas; 1 Mtpa is one Mt per annum (per year). In 2021, Russia produced 763 bcm of natural gas and exported 251 bcm.

21 Hydrogen Council and McKinsey & Company, "Global Hydrogen Flows: Hydrogen Trade as a Key Enabler for Efficient Decarbonization," October 2022, https://hydrogencouncil.com/wp-content/uploads/2022/10/Global-Hydrogen-Flows.pdf.

22 Yury Melnikov, "The Ephemeral Being of Hydrogen" (in German), Kilmareporter, October 5, 2022, https://www.klimareporter.de/international/das-fluechtige-sein-des-wasserstoffs.

23 Ian Barlow and Nikos Tsafos, "Russia's Hydrogen Strategy," Center for Strategic and International Studies, October 14, 2021, https://www.csis.org/analysis/russias-hydrogen-energy-strategy.

24 Evgenia Mamonova, "Russia Has Set a Goal to Occupy 20% of the Global Hydrogen Market by 2050. What Has Been Done and What Is Yet to Come" (in Russian), RGRU, September 9, 2022, https://rg.ru/2022/09/13/vodorod-pojdet-na-eksport.html.

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Key Policies and Drivers

To understand the prospects for realizing Russia's huge renewable energy potential, it is important to consider Russia's long-term energy policy and low-carbon development, as well as its regulatory framework for renewable energy. In the 20th century, Russia's hydropower development and hydropower projects around the world were driven by simple desires: to use an economically efficient natural source of energy, and to diversify power generation. Today, however, achieving sustainable development goals and mitigating the global climate crisis are much more important drivers of renewable energy development.

Low-Carbon Development Policy

When Russia ratified the Paris Agreement in 2019, it was one of the last countries to do so, ahead of only Turkey, which ratified the agreement in 2021, and the United States.[25] Following Russia's accession, its government and parliament became much more active in setting policy on clean energy and greenhouse gas emissions. During the next two years, Russia adopted the law On Limiting Greenhouse Gas Emissions, and the government approved the Low-Carbon Development Strategy until 2050.[26] In October 2021, President Putin announced Russia's ambition to achieve carbon neutrality by 2060.[27] While the Low-Carbon Development Strategy does not set renewable power targets, it demonstrates the government's positive attitude toward this sector and toward hydrogen exports, provided that equipment production and supply chains are localized in Russia.

In the wake of Russia's invasion of Ukraine, the introduction of sanctions, corporate exits from the Russian, market and subsequent energy market disruptions, there have been calls from various stakeholders to review the goal of net zero by 2060 and the Low-Carbon Development Strategy; nevertheless, top officials in several ministries (Energy,[28] Economic Development,[29] and Natural

25 The United States signed the agreement in 2016, withdrew in 2020, and signed again in 2021, though neither the Obama administration nor the Biden administration, which signed the agreement, sought formal Senate ratification.

26 Russiåan Federation, "Strategy of Socio-economic Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050," September 5, 2022, https://unfccc.int/documents/613780.

27 "Råussia Striving to Be Carbon Neutral No Later than 2060, Says Putin," Reuters, October 13, 2021, https://www.reuters.com/business/environment/russia-striving-be-carbon-neutral-no-later-than-2060-says-putin-2021-10-13/.

28 "Nikolai Shulginov: 'Low-Carbon Energy Is Both Challenges and Opportunities'" (in Russian), Vedomosti, October 12, 2022, https://www.vedomosti.ru/press_releases/2022/10/12/nikolai-shulginov-nizkouglerodnaya-energetika—eto-odnovremenno-i-vizovi-i-vozmozhnosti.

29 Valery Voronov, "Eco-business: The State Duma Proposed to Abandon the Paris Agreement," Izvestia, May 19, 2022, https://iz.ru/1335953/valerii-voronov/eko-delo-v-gd-predlozhili-otkazatsia-ot-parizhskogo-soglasheniia.

Resources and Ecology[30]) and State Duma leaders[31] have repeatedly stated that they do not plan radical revisions. That said, Russia's net zero strategy relies less on reducing CO_2 emissions than on a twofold increase in natural carbon sinks in forests. This approach reduces the need to develop renewable power or to pursue wider decarbonization of Russia's economy. More important, Russia's decarbonization strategy lacks a countrywide carbon pricing system or other means to penalize emissions. (A regulatory experiment on carbon pricing will be conducted solely in the Sakhalin region—again, with a focus on forests—but the results of this experiment will not be available before 2028.[32]) Policies require some Russian companies to begin reporting their GHG emissions but not to pay for them. In the absence of mandatory emissions limits or a price on emissions—and with an end to pressure from Russia's former customers in Europe—Russian firms have few incentives to develop renewable power.

Long-Term Energy Policy

The Russian government's current energy strategy, which runs until 2035, was adopted in June 2020 and was based on models and documents drafted and discussed several years earlier. This delay, along with the COVID-19 pandemic and Russia's Paris Agreement ratification, helped make the strategy outdated even before its formal approval. Like the low-carbon development plan, the energy strategy does not include targets for renewable power deployment; it forecasted that the energy supply and demand mix in Russia would remain almost unchanged until 2035.[33]

In 2021, the Ministry of Energy announced plans to revise the energy strategy by mid-2023, extending its horizon to 2050.[34] Nevertheless, renewable energy's role in the forthcoming strategy remains unclear, as conflict with Ukraine, the United States, and Europe has rearranged Moscow's priorities. One priority is to redirect coal, oil, and natural gas exports from Europe toward Asia and—crucially for renewable energy's future—toward the domestic market.

30 Anna Geroeva, "The Ministry of Economic Development Approved the Rules for the Implementation of Climate Projects" (in Russian), Vedomosti, June 1, 2022, https://www.vedomosti.ru/ecology/regulation/news/2022/06/01/924731-minekonomrazvitiya-utverdilo-pravila-realizatsii-klimaticheskih-proektov.

31 "Russia Has No Plans to Withdraw from the Paris Climate Agreement" (in Russian), RIA Novosti, May 19, 2022, https://ria.ru/20220519/soglashenie-1789507555.html.

32 Ecosphera, "Sakhalin Experiment: How the World's First Zero-Emissions Region Is Being Created" (in Russian) October 31, 2022, https://ecosphere.press/2022/10/31/sahalinskij-eksperiment-kak-sozdaetsya-pervyj-v-mire-region-nulevyh-vybrosov/.

33 Alexander Popov, "Energy Strategy 2035: The Future Is Not Predetermined" (in Russian), Kislorod, April 10, 2020, https://kislorod.life/analitics/energostrategiya_2035_budushchee_ne_predopredeleno/.

34 "The Ministry of Energy Will Be Preparing an Energy Strategy for the Year 2050" (in Russian), TASS, October 13, 2021, https://tass.ru/ekonomika/12646813.

Another is to attain "technological sovereignty" in the energy sector and other areas, meaning Russia's domestic development of and control over key technologies and eventual rejection of imports for any critical equipment.

Industrial Policy and Technological Sovereignty

The additions to Russia's power generation capacity between 2007 and 2017 were primarily from new fossil fuel power plants. These plants extensively incorporated technologies and equipment from European, American, and Japanese suppliers, in large part because Russia did not have domestic gas turbine technologies of comparable scale and quality. The withdrawal of these firms from the Russian market following Russia's invasion of Ukraine, either due to sanctions or voluntarily, raises questions about ongoing maintenance at a significant portion of these facilities and has effectively closed Russia's path to further modernization of its existing fossil fuel power plant fleet (at least over the medium term).

Russia's government has taken a different approach to renewable power technologies and has prioritized developing Russian-based manufacturing facilities that can produce solar and wind power equipment and components and even export them.[35] This has included mandatory local content requirements that are gradually tightening. By the early 2030s, solar and wind manufacturing will use almost entirely local content and generate significant revenue from exporting equipment; otherwise, they will not be able to participate in renewable energy subsidy programs. These programs include subsidies for factory investors who ensure that revenue from PV equipment exports is at least three times greater than the subsidy received by 2035.

President Putin has long expressed concern about the country's technological capabilities. In a 2018 address to Russia's parliament, he argued that "technological lag and dependence translate into reduced security and economic opportunities of the country and, ultimately, the loss of its sovereignty."[36] As economic and technological sanctions against Russia intensified during 2022, Russian officials began to talk increasingly about technological sovereignty.[37]

In this environment, key performance indicators for increasing import substitution—i.e., growing the share

35 Alexey Khokhlov and Yury Melnikov, "Market Liberalization and Decarbonization of the Russian Electricity Industry: Perpetuum Pendulum," Oxford Institute for Energy Studies, May 2018, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2018/05/Market-liberalization-and-decarbonization-of-the-Russian-electricity-industry-perpetuum-pendulum-Comment.pdf.

36 Vladimir Putin, "Presidential Address of the Federal Assembly," President of Russia official website, March 1, 2018, http://www.en.kremlin.ru/events/president/news/56957.

37 Anna Nadibaidze, "Understanding Russia's Efforts at Technological Sovereignty," Foreign Policy Research Institute, September 8, 2022, https://www.fpri.org/article/2022/09/understanding-russias-efforts-at-technological-sovereignty/.

of domestic equipment in new projects and existing assets—have become very important for executives and managers in energy companies. Russia's government may see the state nuclear energy company Rosatom as a model; the firm claims that "95% of Russian nuclear power plants are made in Russia . . . and the remaining five percent are not critical."[38] Rosatom is also the dominant player in the global market for nuclear reactors and nuclear fuel, with a 70% market share in reactors, a 38% share in uranium conversion, and a 46% share in uranium enrichment capacity, in addition to significant roles in decommissioning reactors and reprocessing nuclear waste. Rosatom has become the driving force behind Russian nuclear diplomacy; as a key supplier for Western nuclear utilities, it has so far avoided significant sanctions.[39]

As a result of this policy approach, only projects with the maximum local content share will receive government support. During 2022, major international wind power original equipment manufacturers (OEMs) left the Russian market.[40] This decision by leading global firms such as Lagerwey (Enercon), Siemens Gamesa, and Vestas left their former Russian partners at different stages of localizing equipment and component production. Because of this decision, and because the top-10 global wind turbine OEMs have abided by Western sanctions against Russia[41] (including the Chinese company Goldwind), Russian firms are able to work with only "second- and third-tier companies" from China and India to acquire licenses or components.[42] Though it will take many years for Russia to achieve technological sovereignty in renewables (especially in wind), Russia's government will continue to strive for it.

Another challenge to pursuing high localization requirements is their cost. In 2021, the actual total installed cost of solar PV in Russia was $1,700/kW. During the same period, the actual total installed cost in Canada and India was $1,100/kW and $600/kW, respectively.[43] This considerable cost disadvantage will make it difficult if not impossible for Russian renewable energy component manufacturers to compete with

38 President of Russia official website, "Meeting with Rosatom CEO Alexei Likhachev," May 19, 2022, http://en.kremlin.ru/events/president/news/68446.

39 Kacper Szulecki and Indra Overland, "Russian Nuclear Energy Diplomacy and Its Implications for Energy Security in the Context of the War in Ukraine," Nature Energy, February 27, 2023, https://doi.org/10.1038/s41560-023-01228-5.

40 John Engel, "Wind Turbine Maker Vestas Exits Russia over Ukraine Invasion," Renewable Energy World, April 6, 2022, https://www.renewableenergyworld.com/wind-power/wind-turbine-maker-vestas-exits-russia-over-ukraine-invasion/#gref; Siemens, "Siemens to Wind Down Russian Business," May 12, 2022, https://press.siemens.com/global/en/pressrelease/siemens-wind-down-russian-business.

41 Alexander Volobuiev, "Technological Sovereignty in Wind Energy Postponed for Several Years" (in Russian), Vedomosti, March 4, 2023, https://www.vedomosti.ru/business/articles/2023/03/04/965293-tehnologicheskii-suverenitet-v-vetroenergetike-otlozhen.

42 Ibid.

43 International Renewable Energy Agency, Renewable Power Generation Costs in 2021 (Abu Dhabi: International Renewable Energy Agency, 2022), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Power_Generation_Costs_2021.pdf.

lower-priced international suppliers, such as Chinese companies. Russia's manufacturers need economies of scale to reduce costs, which in turn require a large domestic market that Russia will not have without different policies.

Russia has long had independent technological capabilities in hydropower. For example, the Russian company Power Machines was among the top-10 global suppliers of hydro turbines and generators from 2000 to 2021.[44] However, Power Machines has been under sanctions since 2018, when it provided turbines for use in Crimea.[45] This situation has severely limited its international opportunities. Nevertheless, the company and its various Russian suppliers can provide a high level of local content for retrofits and new construction projects.

Reducing Electricity Price Growth and LCOE of Renewables

Russian regulators have traditionally considered reducing electricity price growth as an important tool in combatting inflation and maintaining social stability, particularly when it comes to directly regulated prices for households. However, even quasi-market electricity prices for commercial and industrial consumers are heavily influenced by regulatory decisions rather than market signals.

The role of nonmarket regulatory instruments in the electricity market continues to grow.[46] In addition, the government regulates the price of natural gas, which is the main source of electricity in the country, and fixes prices at a level much lower than the global market.[47] Finally, as noted above, Russian energy companies do not pay for GHG emissions from power plants. Structurally, excess capacity in the Russian power system (estimated to be around 10–15%) and low rates of growth in electricity demand (around 1%/year over the last 10 years) also help to keep electricity prices down.[48] For example, when electricity prices were

44 Russian Hydropower Association and Center for Strategic Research, "Analytical Review of Hydropower in Russia and Foreign Countries" (in Russian), December 2022, https://hydropower.ru/lib/detail.php?list_id=55&element_id=11045.

45 US Department of the Treasury, "Treasury Sanctions Additional Individuals and Entities in Connection with the Conflict in Ukraine and Russia's Occupation of Crimea," January 26, 2018, https://home.treasury.gov/news/press-releases/sm0266.

46 Yu. Orlova, "Wholesale Electricity and Capacity Market: Revival of Regulation?," ECO 49, no. 4 (2019): 113–31, DOI: https://doi.org/10.30680/ECO0131-7652-2019-4-113-131; Olga Gore et al., "Russian Electricity Market Reform: Deregulation or Re-regulation?," Energy Policy 41 (2012) : 676–85, https://doi.org/10.1016/j.enpol.2011.11.031.

47 J. Henderson and T. Mitrova, "Natural Gas Pricing in Russia: Between Regulation and Markets" (in Russian), SKOLKOVO Energy Centre, 2017 (accessed April 20, 2023), https://energy.skolkovo.ru/downloads/documents/SEneC/research02.pdf.

48 Elena Vavina, "Clear Action Plan Is the Key to Modernization" (in Russian), EPRussia.ru, May 2019, https://www.eprussia.ru/epr/365/7511224.htm.

soaring in the EU and the US in 2022, prices in Russia remained largely unchanged—within the range of Rub 1,200–1,600/MWh, or $16–21/MWh, only a small average increase over 2021 prices.[49]

As Russia is effectively subsidizing fossil fuel power, renewable electricity projects must provide a very low LCOE to be competitive. Currently, the LCOE for renewables in Russia is significantly above what is necessary to compete with existing generation or new fossil fuel projects. Technological and financial sanctions will only widen the gap and make renewable power even less competitive. Absent significant long-term subsidies, Russia's renewable power sector will continue to stagnate.

Regulatory Framework for Renewables in Electricity Sector

Russia's government launched some subsidies for renewables in 2013. The program initially focused on solar and wind energy, and to a lesser extent on small hydropower plants (now under 50 MW capacity). Large hydropower plants are not eligible for subsidies.

Russia's government is subsidizing renewable power using the same mechanism that it applied to new fossil fuel power plants in the 2010s: monthly payments for capacity. The government collects a fee from large electricity consumers participating in the wholesale market (primarily industrial enterprises and electricity retail companies) and transfers the funds to renewable project investors, who receive this payment for the first 15 years of power plant operation. Including revenue from selling electricity, the projects can produce a 12% return on investment. The market regulator body selects projects through a competitive process, in which the average cost of electricity is weighted. Projects that fail to meet local content requirements face penalty reductions in the subsidy amount, which could render a given project unprofitable.[50]

The first stage of this program will end when the last planned plants commence operations in 2024. This stage, which began in 2013, is set to add 5.4 GW in capacity. A second stage (with some modified conditions) will follow in 2025–2035 and is slated to provide approximately Rub 360 billion in subsidies, probably enough to add about 6.7 GW in new capacity. The first competition under the second stage of the subsidy program took place in fall 2021, though the regulator canceled the second round, scheduled for 2022. In spring 2023, this competition was finally held

49 Author's assessment based on weekly monitoring data for the electricity and power market released by the Market Council Association, January–December 2022, https://www.np-sr.ru/ (in Russian).

50 Alexander Volobuiev, "Technological Sovereignty in Wind Energy Postponed for Several Years," Vedomosti, March 4, 2023, https://www.vedomosti.ru/business/articles/2023/03/04/965293-tehnologicheskii-suverenitet-v-vetroenergetike-otlozhen.

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and resulted in the selection of 738 MW of wind power projects at an average LCOE of Rub 4.6/kWh and about 1,050 MW of solar PV projects at an average LCOE of Rub 7.5–8.6/kWh. The power stations are expected to be commissioned between 2025 and 2029.[51] However, the results of the competition have been called into question by Sergey Morozov, the head of the Russian Wind Industry Association and a State Duma deputy. He claims that a Chinese wind turbine supplier operating under the guise of a little-known company was awarded all the wind energy projects in violation of the state's industrial policy and urges that the awards be canceled.[52]

Some support mechanisms for renewables also exist in the retail electricity market and in the microgeneration segment (rooftop solar panels). However, both these sectors are extremely limited and do not contribute notably to the overall picture.

Russia's Renewables Sector Today and in the Future

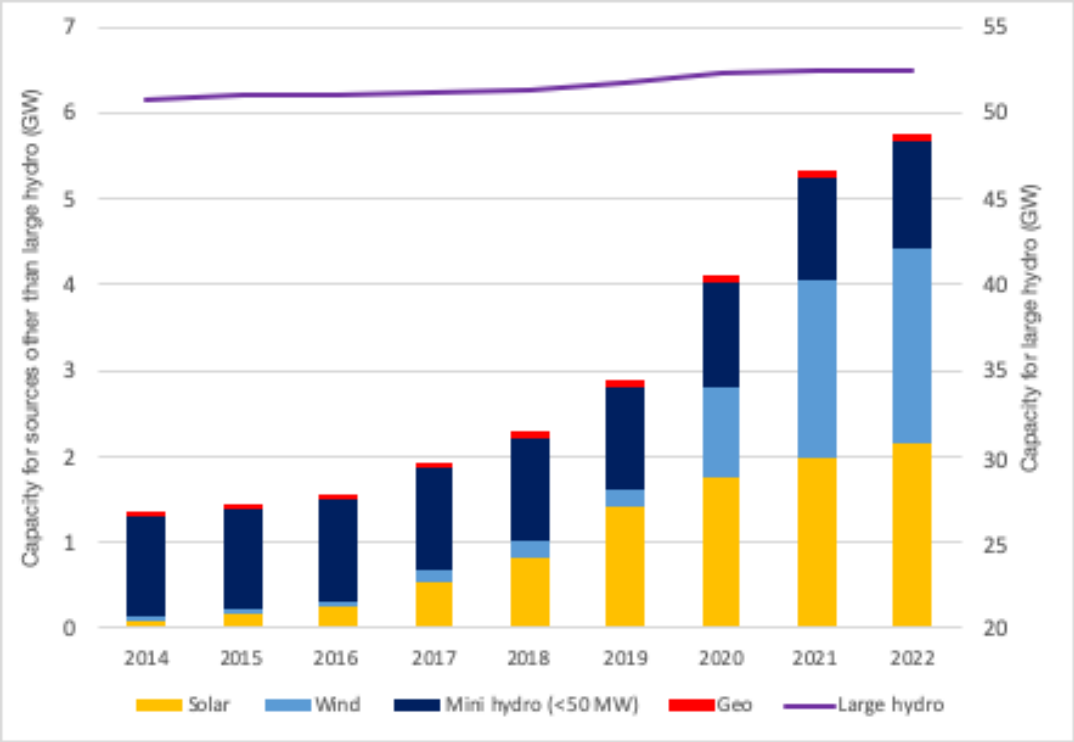
Russia's renewable energy potential is as enormous as it is untapped. Renewable energy provided about 20% of Russia's electricity in 2020—overwhelmingly hydropower with negligible shares of solar and wind; but renewables comprise a far smaller share in total final energy consumption, just 3.2% in 2019.[53] Renewable energy is concentrated almost exclusively within the electricity sector; the transportation sector and heating in residential and commercial buildings rely nearly entirely on fossil fuels.

From 2014 to 2022, the installed capacity of large hydroelectric power plants grew by 1.6 GW, which is around 3%. In contrast, the installed capacity of other renewable energy sources increased by more than four times, i.e., by 4.4 GW. This was primarily due to the introduction of new solar and wind power plants under the subsidy program. Hydropower capacity is slowly increasing as old powerful units are modernized. Nevertheless, these increases are quite small in comparison with Russia's total electricity generation capacity.[54]

51 "Finnish Keep Wind Power on the Ground" (in Russian), Kommersant, April 6, 2023, https://www.kommersant.ru/doc/5915638.
52 "Adverse Winds Are Blowing onto the Blade" (in Russian), Kommersant, April 7, 2023, https://www.kommersant.ru/doc/5925211.
53 International Energy Agency, "Russia," 2023, https://www.iea.org/countries/russia.
54 Russia's total electricity generation capacity was 283 GW in 2021. See US Energy Information Agency, "Russia," January 17, 2023, https://www.eia.gov/international/analysis/country/RUS.

Renewables in Electricity Sector: Recent Trends

FIGURE 1. *Installed renewable capacity in Russian electricity sector by source (GW)*
Source: Author's analysis based on Russia Renewable Energy Development

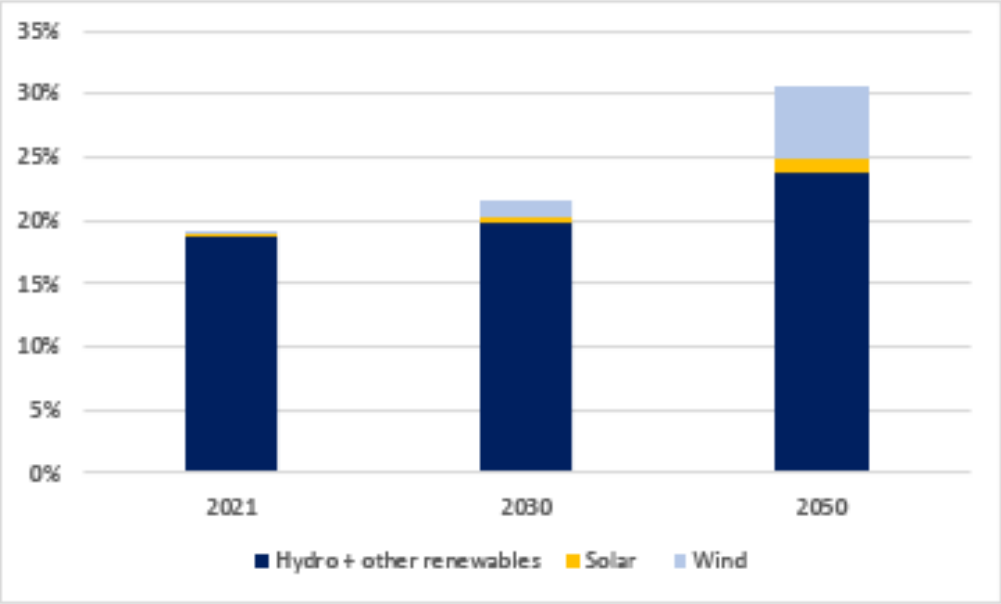


Association (RREDA), Annual Report 2022 (in Russian), February 2023, https://rreda.ru/reports; Russian Hydropower Association and Center for Strategic Research, "Analytical Review of Hydropower in Russia and Foreign Countries" (in Russian), December 2022, https://hydropower.ru/lib/detail.php?list_id=55&element_id=11045.

Possible Scenarios for Medium- and Long-Term Development

The International Energy Agency (IEA) estimates slow growth in the share of renewable power in Russia's electricity generation, from about 20% in 2021 to 30% in 2050.[55] Hydropower and wind power will drive this growth.

FIGURE 2. *Renewables share in electricity generation in Russia*



Source: IEA, World Energy Outlook 2022, 2022, https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf.

Note: The figure shows the average between the stated policies and announced pledges.

55 Figures represent averages across the stated policies and announced pledges in International Energy Agency, World Energy Outlook 2022, 2022, https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf.

Some may consider this forecast to be pessimistic, given that it sees China achieving a 50–80% renewable power share by 2050.[56] Yet the Russian government's target for renewable power (excluding large hydro) is just 6% by 2035. In January 2023, a Russian Ministry of Energy official announced plans to attain a 12.5% share of renewable power in the electricity sector by 2050 (again, excluding large hydro).[57]

These levels are insignificant when compared to Russia's technical potential and are also below global average long-term trends. Furthermore, Russian researchers have long warned that continuing business as usual will lead Russia to a dead end. Many argue that achieving carbon neutrality through real decarbonization, which includes increasing the share of solar and wind electricity up to 30% by 2060, is the only way to "save Russia from stagnation and degradation."[58]

Medium-term trends are unlikely to facilitate a shift toward this path:

1. Russia is unlikely to prioritize developing renewables to achieve its target of net zero by 2060 if officials are confident that the growth of natural carbon sinks in forests will be largely sufficient.

2. Cheap natural gas, and an excess of gas resulting from sharply reduced exports to Europe, will allow Russia to maintain low electricity prices in its domestic market for an extended period with its existing electricity infrastructure. Renewables will struggle to compete with these low prices.

3. The departure from the Russian market of leading foreign manufacturers (especially in wind energy) seriously hinders future project implementation even within the framework of existing subsidy mechanisms. As slow as they were, capacity additions in recent years (0.5–1 GW annually in wind and solar combined) relied upon international cooperation. Sustaining this pace requires additional government support to compensate for the negative effects of sanctions and supply chain disruptions.

4. Technological sovereignty in the renewable energy sector effectively shields Russian vendors from international competition and creates barriers to the long-term reduction of LCOE. These results will limit renewable power's competitiveness with cheaper fossil fuel electricity. The small scale of Russia's

56 Lauri Myllyvirta, "Chinese Energy Institutes Present New Net-Zero Scenarios for 2050," Energy Post, November 6, 2020, https://energypost.eu/chinese-energy-institutes-present-new-net-zero-scenarios-for-2050/.

57 EP Russia, "It Is Important for Russia to Continue the Qualitative Restructuring of the Electric Power Industry (in Russian), January 16, 2023, https://www.eprussia.ru/news/base/2023/3849285.htm.

58 Igor Bashmakov et al., "Russia's Carbon Neutrality: Pathways to 2060," Center for Energy Efficiency, June 2022, https://cenef-xxi.ru/uploads/Report_CENEF_XXI_0076074542.pdf.

renewables market exacerbates this situation by preventing economies of scale and discouraging foreign partners. Official export targets for Russian equipment appear unattainable; these circumstances will probably make it more difficult to achieve economies of scale and to reduce the LCOE of domestically sourced renewable projects.

5 Hydropower may have an advantage over solar and wind power because relevant local content goals are far easier to achieve. However, there is no specific subsidy program for hydropower, and in the segment of large-scale low-carbon generation, nuclear power plants currently enjoy much greater government support.

Notwithstanding past policies to encourage renewable power development, Russia's renewable energy market is insignificant; consider, for example, that China alone added close to 200 GW in capacity in 2022, an amount comparable to the total capacity of all power plants in Russia.[59] Even if Russian factories built in the 2010s can find adequate replacements for their foreign suppliers (a serious problem in the context of sanctions), they will likely be unable to participate in the global race to reduce renewable energy's costs. Russia's most promising international opportunities will likely be in demonstration projects in individual countries in Africa or Asia. In these cases, Moscow might offer the projects with preferential financing through intergovernmental agreements.

Hydrogen exports, which were at the center of Russia's hydrogen strategy prior to the invasion of Ukraine, are likely to face the same fate. The most developed export-oriented project in the country—Novatek's Ob LNG (liquified natural gas) blue ammonia project—has been postponed indefinitely.[60] Germany and Japan, which had been Russia's top prospective hydrogen markets, are building partnerships with other countries, while Middle Eastern/North African hydrogen production mega-projects focusing on exports to Europe are already at the final investment decision stage.[61] At the end of December 2022, Russia approved a hydrogen strategy until 2030, but as of April 2023, it had not been published. According to unofficial data, the strategy sets a target for the production of 0.55 Mtpa of low-carbon hydrogen by 2030 with an

59 China's capacity reportedly increased by about 185.5 GW to 2,564.1 GW, an increase of 7.8%. S&P Global, "China Data: 2022 Power Demand Growth Eases to 3.6% in 2022 from 10.3% a Year Earlier," January 19, 2023, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/coal/011923-china-data-2022-power-demand-growth-eases-to-36-in-2022-from-103-a-year-earlier.

60 Vladimir Afanasiev, "Novatek to Drop Yamal Blue Ammonia Project in Favour of LNG," Upstream, October 14, 2022, https://www.upstreamonline.com/energy-transition/novatek-to-drop-yamal-blue-ammonia-project-in-favour-of-lng/2-1-1334755.

61 Polly Martin, "Saudi Neom Green Ammonia Project Reaches FID," Hydrogen Economist, March 1, 2023, https://pemedianetwork.com/hydrogen-economist/articles/green-hydrogen/2023/saudi-neom-green-ammonia-project-reaches-fid/.

insignificant volume of exports;[62] this is a fundamental change from the draft strategy in February 2022, which included plans to export 2.3 Mtpa by 2030.

A greater problem is that Russia's hydrogen technologies in most supply chain segments are even less developed than its solar and wind technologies. Selective integration of individual Russian companies into global hydrogen technology supply chains might be possible—Cryogenmash, Russia's largest company in the air separation and industrial gas segments, became a member of the Brussels-based Hydrogen Council in January 2022.[63] Nevertheless, this phenomenon is unlikely to become widespread.

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Conclusions

Renewable power lags behind global trends, in no small part due to the Russian government's limited commitment to developing and deploying renewable technologies and to the limited role of these technologies in the country's energy and decarbonization strategies. Modest wind and solar capacity have been added in recent years, thanks to a subsidy program, but this trend will be difficult to maintain in the face of sanctions, supply chain disruptions, and the departure of major global manufacturers from Russia. Russian firms face a hard road to achieving technological sovereignty and expanding exports beyond a very small domestic market. And officials will likely continue to have other priorities.

That Russia's enormous renewable power potential will likely remain untapped for some time is bad news—not only for Russia and its renewable power industry, but for a world that needs new sources of clean energy to manage the global climate crisis.

62 Denis Deryushkin, "We Cannot Miss the Opportunities for the Development of Hydrogen Energy" (in Russian), April 3, 2023, https://itek.ru/analytics/denis-derjushkin-rf-ne-dolzhna-upustit-vozmozhnosti-tehnologicheskogo-razvitiya-vodorodnoj-energetiki/.

63 Hydrogen Council, "Hydrogen Council Membership Grows to More than 130 Members, with Eleven New Companies Committing to Foster Development of the Hydrogen Economy," January 6, 2022, https://hydrogencouncil.com/en/hydrogen-council-membership-grows-to-more-than-130-members-with-twelve-new-companies-committing-to-foster-development-of-the-hydrogen-economy/.

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