EIRP ENERGY INNOVATION REFORM PROJECT

ROSATOM: A DIFFICULT TARGET

Russia's Global Energy Role—Working Paper No. 1

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EXECUTIVE SUMMARY

- Through its state company Rosatom, **Russia is the world leader in nuclear power export markets**. The company controls almost half of the world uranium processing and enrichment market and holds 70% of the reactor export market. Setting aside some cancellations following Russia's invasion of Ukraine, Rosatom's portfolio of foreign orders appears stable at about $200 billion.

- In addition to its commercial role, **Rosatom is a foreign policy instrument** that may advance Russian strategic interests by establishing long-term official and commercial ties with governments and businesses in customer nations. Rosatom offers one-stop shopping for design, construction, fuel, training, maintenance, and spent fuel processing as well as attractive financing. **The company generally has strong support from Russia's government**.

- **The United States and several European Union (EU) member countries import nuclear fuel from Rosatom** and have been reluctant to impose stiff sanctions on the company that would compare to sanctions on Russian oil and gas firms. Eighteen Soviet-era nuclear reactors are operating in Bulgaria, the Czech Republic, Finland, Hungary, and Slovakia. In addition, France imports Rosatom's uranium products to manufacture nuclear fuel, some of which goes onward to other EU countries.

- While some of Rosatom's prewar aspirations for growth may no longer be realistic, and while the company is losing some business in the West, Rosatom appears to be largely on track with its non-Western projects, which comprise the bulk of the company's business. **Reducing Rosatom's global role will not be quick, easy, or cheap.**

01

Rosatom: A Global Business

When people talk about energy from Russia, they generally think of oil and gas. However, Moscow is a major global player in the nuclear energy market and one of the world's leading nuclear fuel suppliers. Today, US and European economic sanctions affect only select firms and individuals; in this form, sanctions appear unlikely to seriously damage Russia's position in international nuclear markets.

Russia's nuclear industry is concentrated in Rosatom, a state-owned company that is the successor to the Soviet Union's Ministry of Medium Machine Building and Russia's Ministry of Atomic Energy. Rosatom is a complex holding company consisting of over 360 subsidiary enterprises.[1] Table 1 identifies its principal civil nuclear business units and their core activities. Rosatom also builds Russia's nuclear weapons and operates other energy and technology businesses.[2]

TABLE 1. *Major Rosatom divisions and principal activities*

COMPANY	PRINCIPAL ACTIVITIES
Atomredmetzoloto Uranium Holding (ARMZ)	Mining
Atomstroyexport (ASE)	Engineering and construction
Atomenegromash	Manufacturing, engineering, research
Atomenergoprom	Civil nuclear energy holding company
Rosenergoatom	Domestic power generation
TVEL	Nuclear fuel manufacturing
TENEX	Nuclear fuel sales and trading

Source: Rosatom, Предприятия и организации Росатома, https://rosatom.ru/about/factories/.

1 Rosatom, Performance of State Atomic Energy Corporation Rosatom in 2021, p. 18, https://www.report.rosatom.ru/go_eng/go_rosatom_eng_2021/rosatom_2021_eng.pdf.

2 Julian Cooper, "The Funding of Nuclear Weapons in the Russian Federation," Changing Character of War Centre, Pembroke College, University of Oxford, October 2018, p. 1, https://static1.squarespace.com/static/55faab67e4b0914105347194/t/5bb1ea3ee4966b5320fa197c/1538386496442/The+funding+of+nuclear+weapons+in+the+Russian+Federation.pdf.

Rosatom currently holds over 70% of the global export market for nuclear power plants and has orders for 34 reactors in 11 countries.[3] Of these, seven are under active construction in Bangladesh, China, India, Russia, and Turkey. The projects include VVER-1200 pressurized water reactors (PWRs) and older VVER-440 PWR designs. According to Rosatom CEO Alexey Likhachev, Rosatom's exports exceeded $10 billion in 2022, and its portfolio of international orders over the next 10 years amounted to about $200 billion in December 2022.[4] As of May 2022, 80 of the world's 439 nuclear reactors used Soviet or Russian technology and required maintenance by Russian specialists; of these, 38 were in Russia and 42 were elsewhere.[5]

In addition to its role in supplying nuclear reactors, Rosatom is one of the world's largest nuclear fuel suppliers. While Rosatom produced only about 6% of the world's uranium in 2021,[6] the company controls 46% of global enrichment capacity.[7] In 2021, Rosatom subsidiary TVEL supplied 2,538 tons of uranium feedstock to the EU, accounting for almost 20% of all European uranium imports.[8] The EU sourced 2,753 tons, or 23% of its uranium imports, from Kazakhstan, where Rosatom holds a 70% stake in a firm that owns two mines and has significant shares in four others[9] through its international subsidiary Uranium One.[10]

3 РИА Новости, «Эксперт перечислил большие успехи "Росатома" в "технологиях будущего,"» January 11, 2023, https://ria.ru/20221201/rosatom-1835454523.html.

4 Ирина Цырулева, «Наш портфель зарубежных заказов стабильно держится на уровне $200 млрд,» Известия, December 26, 2022, https://iz.ru/1446276/irina-tcyruleva/nash-portfel-zarubezhnykh-zakazov-stabilno-derzhitsia-na-urovne-200-mlrd.

5 Catherine Clifford, "Russia Dominates Nuclear Power Supply Chains—and the West Needs to Prepare Now to Be Independent in the Future," CNBC, May 23, 2022, https://www.cnbc.com/2022/05/23/russia-dominates-global-nuclear-reactor-and-fuel-supply-chains.html.

6 World Nuclear Association, "World Uranium Mining Production," July 2022, https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx.

7 World Nuclear Association, "Uranium Enrichment," October 2022, https://world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/uranium-enrichment.aspx.

8 Euratom Supply Agency, Euratom Supply Agency Annual Report 2021, corrected edition, 2022, p. 19, https://euratom-supply.ec.europa.eu/system/files/2022-12/Euratom%20Supply%20Agency%20-%20Annual%20report%202021%20-%20Corrected%20edition.pdf.

9 Ibid.; А. Гончаренко, «Правительство Казахстана разрешило передать уранодобывающие активы дочке Росатома,» February 28, 2023, https://neftegaz.ru/news/companies/771601-pravitelstvo-kazakhstana-razreshilo-peredat-uranodobyvayushchie-aktivy-dochke-rosatoma-/.

10 Rosatom, "Uranium Mining" (accessed March 1, 2023), https://rosatom.ru/en/rosatom-group/uranium-mining/.

Beyond nuclear energy, Rosatom is responsible for building nuclear-powered icebreakers, managing Russia's Northern Sea Route, and conducting research related to nuclear power, nuclear radiation, and radiation safety. The company also has smaller divisions working on wind energy, hydrogen energy, and composite materials. Another division develops and sells digital products.[11]

Rosatom had revenues of $16 billion in 2020 and $19 billion in 2021, with assets of $62 billion and $69 billion, respectively. In the two calendar years before Russia's invasion of Ukraine, the company's return on sales was about 13%.[12]

Rosatom's foreign revenue almost doubled between 2011 and 2021, when it exceeded $8 billion, according to Likhachev.[13] At that time, the Rosatom CEO expected the company's international operations to produce over half its revenue by 2030. Rosatom's strategy assumed that the company would export nuclear fuel for nuclear power plants of non-Russian design and that it would sign four new contracts by the end of 2030, to supply 18 reactors.[14] Since then, however, Russia has lost some of its fuel supply contracts, including a contract with one of Sweden's nuclear plants.[15]

Rosatom's major projects in 2021 illustrate its operations. During that year, Rosatom's principal accomplishments included commissioning one unit in a nuclear plant under construction in Belarus and loading nuclear fuel in a second unit; starting construction of units 5 and 6 at India's Kudankulam nuclear plant; pouring concrete for one unit at both China's Tianwan and Xudabao plants; and securing the license to build unit 4 at Turkey's Akkuyu facility.[16] Rosatom continued work on these projects in 2022.

11 Rosatom, "Digital Products of Rosatom" (accessed March 1, 2023), https://www.rosatom.ru/en/rosatom-group/it-systems/.
12 Rosatom, Performance of State Atomic Energy Corporation Rosatom in 2021, p. 21, https://www.report.rosatom.ru/go_eng/go_rosatom_eng_2021/rosatom_2021_eng.pdf.
13 "Rosatom's Revenue in 2021 Will Amount to 1.5 Trillion Rubles," TASS, December 27, 2021, https://tass.ru/ekonomika/13307013.
14 «Всемирный 'Росатом,'» Коммерсантъ, June 8, 2021. https://www.kommersant.ru/doc/4848474.
15 Vattenfall, "Vattenfall Stops Deliveries of Russian Nuclear Fuel," February 24, 2022, https://group.vattenfall.com/press-and-media/newsroom/2022/vattenfall-stops-delivieries-of-russian-nuclear-fuel.
16 Rosatom, Performance of State Atomic Energy Corporation Rosatom in 2021, pp. 27–28, https://www.report.rosatom.ru/go_eng/go_rosatom_eng_2021/rosatom_2021_eng.pdf.

Over the last two decades, Russia has signed civil nuclear agreements in various areas with Algeria, Bolivia, Burundi, Cambodia, Democratic Republic of Congo, Cuba, Ecuador, Egypt, Ethiopia, Ghana, Indonesia, Jordan, Kenya, Laos, Morocco, Myanmar, Nigeria, Paraguay, Philippines, Qatar, Rwanda, Saudi Arabia, Sri Lanka, Sudan, Tajikistan, Thailand, Tunisia, Uganda, the United Arab Emirates, Uzbekistan, Venezuela, Vietnam, and Zambia.17 Other governments have signed a Memorandum of Understanding with Rosatom, usually through their nuclear energy agencies or ministries for energy, science, education, or foreign affairs. These agreements serve to express mutual interest in cooperation but are not binding.18 Table 2 presents Rosatom's prewar international projects and the countries in which they were underway. Many of Rosatom's Western partners are now disengaging from the company, like Ukraine.

TABLE 2. *Rosatom's international projects (2019)*

ACTIVITY	COUNTRIES
Uranium mining	Argentina, Kazakhstan, Tanzania, United States
Enriched uranium sales	Belgium, China, Finland, France, Germany, Japan, Mexico, South Africa, South Korea, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States
Nuclear fuel sales	Armenia, Bulgaria, China, Czech Republic, Egypt, Finland, France, Germany, Hungary, India, Iran, Kazakhstan, Netherlands, Poland, Slovakia, South Korea, Switzerland, Sweden, Ukraine, United Kingdom, Uzbekistan, Vietnam
Radiation products and services	Argentina, Armenia, Australia, Brazil, Canada, China, Czech Republic, Egypt, Germany, Hungary, Indonesia, Iran, Malaysia, Saudi Arabia, Spain, United Kingdom, United States, Vietnam
Nuclear plant construction	Armenia, Bangladesh, Belarus, China, Egypt, Finland, Hungary, India, Iran, Nigeria, Turkey
Construction of research reactors and other low-power reactors	Bolivia, Nigeria, Vietnam, Zambia
Nuclear plant services and maintenance	Armenia, Bulgaria, China, Czech Republic, Egypt, Hungary, Iran, Slovakia, Ukraine
Back end	Bulgaria, Czech Republic, Egypt, Germany, Iraq, Japan, Kazakhstan, Lithuania, Switzerland, Turkey, Ukraine

Source: D. S. Panteley, "Prospects for ensuring the competitiveness of Rosatom State Corporation, taking into account the transformations in the global economy," Eurasian Scientific Journal 2, no. 11 (2019), https://esj.today/PDF/99ECVN219.pdf (in Russian).

17 World Nuclear Association, "Emerging Nuclear Energy Countries," March 2023, https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx. See also Rosatom, "Rosatom Opens a Branch in Saudi Arabia," https://www.rosatom.ru/en/press-centre/news/rosatom-opens-a-branch-in-saudi-arabia/.

18 World Nuclear Association,"'Emerging Nuclear Energy Countries," March 2023, https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx.

02

Strength and Strategies

In addition to its commercial role, Rosatom serves as a foreign policy instrument that may advance Russian strategic interests even when a specific project is not commercially appealing in the short term. From this perspective, Rosatom nuclear projects not only deepen official and commercial ties between Russia and other governments; they also establish and build close and lasting contacts between key individuals and firms in the energy and nuclear sectors and create dependencies around reactor maintenance and fuel supplies.

Rosatom has two principal advantages over its non-Russian competitors. The first is what one could call one-stop shopping: Rosatom offers the full range of nuclear services to its prospective clients, including not only design and construction of nuclear power plants, but also training, maintenance, repair services, and fuel manufacturing, supply, and reprocessing, as well as financing.[1]

Rosatom's spent fuel take-back capability is especially attractive to many customers. The company brings spent fuel to Russia for temporary storage and reprocessing; after reprocessing, Rosatom returns lower-level radioactive waste to its customer and keeps the separated plutonium.[19] This significantly reduces costs for the customer by avoiding the need for spent fuel reprocessing facilities. Some sources suggest that Russia often presses prospective customers without established nuclear programs to accept spent fuel take-back provisions in new agreements.[20]

Rosatom's state support is its second advantage. Rosatom enjoys consistent government backing for international nuclear projects, which can speed the complex negotiations required to transfer nuclear technologies while also providing attractive financing options. Rosatom can build nuclear power plants with Russian government loans that cover up to 100% of the project cost. Often, Russia provides a client country with a state loan at a symbolic interest rate and payment beginning only after commissioning. This allows Rosatom customers to defer payments until a nuclear plant is generating revenue through electricity sales.

19 Miles Pomper, "The Russian Nuclear Industry: Status and Prospects," Nuclear Energy Futures Paper #3, Centre for International Governance Innovation, January 19, 2009, pp. 28–29, https://www.cigionline.org/publications/russian-nuclear-industry-status-and-prospects/. Before 2006, Russia kept all the spent fuel, without returning lower-level waste.

20 Nevine Schepers, "The Geopolitics of Nuclear Energy: New Dynamics of Supply and Demand," Workshop Report, International Institute for Strategic Studies, November 2, 2018, https://www.iiss.org/blogs/analysis/2018/12/geopolitics-nuclear-energy.

Notably, the Russian government at times allocates funds from Russia's National Wealth Fund—a sovereign fund initially established to back the pension system—for international nuclear plant construction loans.[21] Some Russian officials consider these and other international investments as a way to stimulate demand for Russian products outside the oil and gas sector (thus helping to diversify Russia's economy) in a manner that does not increase inflationary pressure.[22]

Ongoing projects illustrate Rosatom's varied financing arrangements. In Bangladesh, Russia is covering 90% of the cost of the Rooppur nuclear power plant with an $11.385 billion loan for the $12.65 billion project;[23] the loan represents about half the country's total outstanding external debt.[24] Russia is providing a loan of up to $10 billion for two reactors in Hungary's Paks II project.[25] In this case, though construction is slated to begin in 2024[26] and end in 2032,[27] Hungary will start making principal payments in 2031, with repayment ending in 2046.[28] Russia's loan to Egypt for the El Dabaa nuclear plant is for $25 billion, representing over 80% of the plant's projected $30 billion cost.[29]

Rosatom's contract to build Turkey's Akkuyu nuclear plant differs from the company's other projects in that it uses a build-own-operate (BOO) business model in which Rosatom maintains plant ownership and expects to make a guaranteed profit by selling electricity to a Turkish utility. Since Rosatom provides everything at its expense—the fuel, the plant, and trained staff—the BOO contract greatly simplifies (for Turkey) the otherwise extremely complex process of starting a civil nuclear power program. One Russian critic of the 2010

21 Alexandra Prokopenko, "Last Chance Saloon: The Race to Grab Russia's Reserves," Carnegie Endowment for International Peace, September 27, 2019, https://carnegiemoscow.org/commentary/79943.

22 Ibid.

23 Nuclear Engineering International, "Russia Initials Credit Agreement with Bangladesh for Rooppur NPP," May 30, 2016, https://www.neimagazine.com/news/newsrussia-initials-credit-agreement-with-bangladesh-for-rooppur-npp-4907672/.

24 Mycle Schneider, Antony Froggatt, et al., The World Nuclear Industry Status Report 2018, p. 153, https://www.worldnuclearreport.org/IMG/pdf/wnisr2018-v2-lr.pdf.

25 Сергей Тихонов, «Россия изменила условия выплаты кредита для Венгрии на строительство АЭС,» Российская Газета, December 6, 2021, https://rg.ru/2021/12/06/rossiia-vydelit-vengrii-kredit-dlia-stroitelstva-novoj-aes.html.

26 «Строительство АЭС "Пакш-2" в Венгрии начнется в 2024 году,» ТАСС, February 7, 2023, https://tass.ru/ekonomika/16985087.

27 «Срок сооружения АЭС "Пакш-2" в Венгрии по проекту Росатома сдвинут к 2032 году,» ТАСС, January 8, 2023, https://tass.ru/ekonomika/16754551.

28 Сергей Тихонов, «Россия изменила условия выплаты кредита для Венгрии на стáроительство АЭС,» Российская Газета, December 6, 2021, https://rg.ru/2021/12/06/rossiia-vydelit-vengrii-kredit-dlia-stroitelstva-novoj-aes.html.

29 "'Notice to Proceed' Contracts Signed for El Dabaa," World Nuclear News, December 11, 2017, https://www.world-nuclear-news.org/Articles/Notice-to-proceed-contracts-signed-for-El-Dabaa.

deal has enumerated its considerable financial risks to the company and to the Russian government; for example, the contract fixes the cost of electricity for 25 years without accounting for inflation or varying exchange rates.[30] This might explain Rosatom's apparent reluctance to take on new BOO projects.

As a part of its medium- to long-term business strategy, Rosatom is developing new reactor designs, including small and medium reactors (SMRs), some of which are already operating in a floating nuclear power plant. The Akademik Lomonosov, the country's first floating plant, carries two 35 MW reactors and can generate either 70 MW of electricity or 300 MW of heat.[31] Prior to Russia's invasion of Ukraine, Rosatom proposed building four floating power plants with 55 MW reactors by the end of 2028; like the Akademik Lomonosov, they would operate offshore in Russia's Far East.[32] The company plans to operate a land-based variant of the power plant in Yakutia by the end of 2030.[33] Rosatom is also developing small reactors with a view to deploying demonstration plants with 400 kW and 10 MW capacities for remote communities. In a prewar proposal, the company indicated it hoped to sign export contracts for its small nuclear power plants by the end of 2026.[34] Internationally, Rosatom works to include nuclear power in climate and other agreements as a source of clean energy; toward this end, in 2021, the company proposed spending over $300 million, of which over 40% would come from the Russian federal budget as opposed to Rosatom's coffers.[35] The firm combined pursuit of its commercial interests with an effort to advance Russia's diplomacy at the November 2022 Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC COP)—the world's principal annual climate summit—by organizing a side event to discuss nuclear energy's potential role in Africa's economic development.[36]

30 Булат Нигматулин, «Все риски проекта АЭС Аккую. Краткая справка,» Агенство ПРоАтом, April 18, 2012, http://www.proatom.ru/modules.php?name=News&file=article&sid=3715. Bulat Nigmatulin (author of the cited articled) is a former deputy minister of atomic energy in Russia. His ministry was converted to a state corporation in 2007 and became Rosatom.

31 Power Technology, "Akademik Lomonosov Floating Nuclear Co-Generation Plant," May 24, 2021, https://www.power-technology.com/projects/akademik-lomonosov-nuclear-co-generation-russia/.

32 "Rosatom 'Plans New Nuclear Technology Exports,'" World Nuclear News, June 11, 2021, https://world-nuclear-news.org/Articles/Rosatom-plans-new-nuclear-technology-exports.

33 Ibid. Both the 35 MW and 55 MW reactor designs derive from Russian nuclear icebreaker power plants.

34 Полина Смертина, «Всемирный 'Росатом,'» Коммерсантъ, June 8, 2021, https://www.kommersant.ru/doc/4848474.

35 "World 'Rosatom,'" Kommersant, June 8, 2021, https://www.kommersant.ru/doc/4848474.

36 Rosatom, "Rosatom Delegation Took Part in the UN's 27th Climate Change Conference," November 18, 2022, https://rosatom.ru/en/press-centre/news/rosatom-delegation-took-part-in-the-un-s-27th-climate-change-conference/.

03

Rosatom and the West

Notwithstanding systematic US and EU efforts to impose costs on Russia following its invasion of Ukraine, Western governments have thus far avoided targeting Rosatom to the same extent as Russia's oil and gas sectors.

Rosatom provided 14% of America's uranium and 28% of enrichment services in 2021.[37] Even before the war in Ukraine, Washington had been taking steps to reduce Russia's position in US nuclear fuel markets for both strategic and commercial reasons. In 2020, the Trump administration finalized an amendment to an agreement with Rosatom to suspend an anti-dumping investigation of the company, which limited Russian uranium product exports to 15 percent starting in 2028.[38]

The US Congress is currently considering a bill that would enact a ban on Russian uranium imports while allowing administration officials broad waiver authority.[39] The bill also establishes annual limits on Russian uranium imports that are not subject to waiver. The US nuclear industry has supported developing domestic fuel conversion and enrichment capabilities to replace Russian imports but urges a gradual approach that avoids disrupting fuel supplies.[40]

The recent imposition of US sanctions on several Rosatom-related companies, including Rusatom Overseas (a subsidiary responsible for Rosatom's non-energy portfolio and promoting small and medium reactors), has sparked concerns about the potential implications for the global market. However, America's approach in gradually sanctioning Rosatom's

37 Steven Mufson, "The U.S. Imports Uranium from Russia. What If Sanctions End That?" The Washington Post, January 21, 2023, https://www.washingtonpost.com/business/2023/01/21/uranium-imports-russia-nuclear/.

38 United States Department of Commerce, "U.S. Department of Commerce Finalizes 20-Year Amendment to the Suspension Agreement on Uranium from the Russian Federation," October 6, 2020 (archived site), https://2017-2021.commerce.gov/news/press-releases/2020/10/us-department-commerce-finalizes-20-year-amendment-suspension-agreement.html.

39 Reduce Russian Uranium Imports Act, S.763, 118th Congress (2023), https://www.congress.gov/bill/118th-congress/senate-bill/763/titles?s=1&r=12.

40 John Kotek, "Nuclear Energy Industry Committed to Secure Fuel Supply," Nuclear Energy Institute, June 16, 2022, https://www.nei.org/news/2022/nuclear-energy-industry-committed-to-fuel-supply.

subsidiaries may allow the mother company to prepare for the worst and minimize the fallout. This significantly reduces sanctions efficacy. For instance, in anticipation of possible asset freezes, Rosatom has already begun transferring ownership from European subsidiaries to Russian ones. In February, the company announced that it had transferred ownership shares in several Kazakh uranium companies from Dutch subsidiaries of Uranium One Group, controlled by Rosatom, to the Russian company Uranium One Group JSC.

In April 2022, the European Parliament passed a resolution calling for "an immediate full embargo on Russian imports of oil, coal, nuclear fuel, and gas."[41] Yet like the United States, the EU has thus far avoided banning nuclear fuel imports. While Poland and Lithuania reportedly pressed for tougher sanctions on Russia's nuclear sector in early 2023, the final sanctions package approved on February 24 did not include new nuclear measures.[42] Hungary—where Rosatom is building two new reactors—was reportedly the most firmly opposed to sanctions on Russia's civil nuclear industry and threatened to veto the sanctions package in its entirety.[43]

That said, Hungary is not alone in its dependence upon Rosatom. Eighteen Soviet-built nuclear power reactors continue to operate in European Union member countries—two each in Bulgaria and Finland, four each in Hungary and Slovakia, and six in the Czech Republic.[44] Nuclear energy provides a substantial share of electricity generation in these countries, approximately one-third in Bulgaria, the Czech Republic, and Finland, about 47% in Hungary, and around 52% in Slovakia.[45] In 2022, the EU waived a ban of Russian aircraft

41 European Parliament, "MEPs Demand Full Embargo on Russian Imports of Oil, Coal, Nuclear Fuel, and Gas," press release, July 4, 2022, https://www.europarl.europa.eu/news/en/press-room/20220401IPR26524/meps-demand-full-embargo-on-russian-imports-of-oil-coal-nuclear-fuel-and-gas.

42 Jorge Liboreiro, "EU Approves Fresh Round of Sanctions on Russia, Almost Missing Self-imposed Deadline of 24 February," Euronews, February 24, 2023, https://www.euronews.com/my-europe/2023/02/24/eu-approves-fresh-round-of-sanctions-on-russia-almost-missing-self-imposed-deadline-of-24-.

43 Leonie Kijewski and Jacopo Barigazzi, "EU Commission Scratches Russia Nuclear Sanctions Plans," Politico, February 16, 2023, https://www.politico.eu/article/rosatom-russia-ukraine-volodymyr-zelenskyy-vladimir-putin-eu-executive-scratches-russia-nuclear-sanctions-plans/.

44 World Nuclear Association, "Nuclear Power in the European Union," February 2023, https://world-nuclear.org/information-library/country-profiles/others/european-union.aspx. See World Nuclear Association country pages for each country's count.

45 Ibid.

in its airspace to permit Russia to deliver nuclear fuel to Hungary's Paks nuclear plant—a step that illustrates the need for Russian fuel supplies.[46]

Setting aside the countries with Soviet-era nuclear plants, France also deserves special attention. France relies on nuclear power for about 70% of its electricity supply and has a complex relationship with Rosatom that includes importing uranium products for its own reactors as well as for processing and export to other countries and shipment of reprocessed uranium to Russia.[47]

EU member states that rely upon Russian nuclear fuel can't stop importing it quickly—especially those with Soviet/Russian VVER reactors. These countries probably require not only Russian fuel imports, but also maintenance, including parts and services. As one European antinuclear activist put it, "the dependence on nuclear power is particularly strong because it is not simply a dependence on a material, but also on technologies and industrial capacities."[48]

Though not an EU member, Ukraine probably faces the greatest pressure to eliminate its dependence on Russian nuclear fuel. Due in part to the erosion of its relationship with Russia following Moscow's 2014 seizure of Crimea and support for militants in eastern Ukraine, Kyiv has been working to diversify the fuel supply for its 15 Soviet-built reactors. By 2021, Westinghouse had provided fuel for six reactors.[49] In June 2022, Ukraine signed an agreement with the firm to supply all its reactors.[50]

Nevertheless, it would be misleading to say that the horizon is cloudless for Rosatom in the EU. Following Russia's invasion of Ukraine, the Finnish-led consortium Fennovoima canceled construction of a Rosatom nuclear plant at Hanhikivi after a senior Finnish official declared that the government could not issue a construction permit.[51] While Western observers have considered the deal's collapse a setback for Rosatom, a person familiar with the company's plans asserts that corporate officials saw some advantages to the decision,

46 «ЕС разрешил авиарейс из России для доставки топлива на АЭС в Венгрии в виде исключения,» ТАСС, April 7, 2022, https://tass.ru/ekonomika/14316765.

47 Sylvie Corbet, "Russia's Nuclear Trade with Europe Flows Despite Ukraine War," AP, September 29, 2022, https://apnews.com/article/russia-ukraine-france-global-trade-only-on-ap-business-c521f2248c823f69f0a677735a78e89d.

48 World Nuclear Industry Status Report, "Le Monde (France): Russian Nuclear Energy, the Industry That Has Gone Unsanctioned by the West," December 29, 2022, https://www.worldnuclearreport.org/Russian-nuclear-energy-the-industry-that-has-gone-unsanctioned-by-the-West.html.

49 Nuclear Engineering International, "Westinghouse Fuel Assemblies Delivered to Rovno NPP," July 22, 2021, https://www.neimagazine.com/news/newswestinghouse-fuel-assemblies-delivered-to-rovno-npp-8919297.

50 World Nuclear Association, "Nuclear Power in Ukraine," January 2023, https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine.aspx.

51 Anne Kauranen, "Finnish Group Ditches Russian-built Nuclear Plant Plan," Reuters, May 2, 2022, https://www.reuters.com/world/europe/finnish-group-ditches-russian-built-nuclear-plant-plan-2022-05-02/.

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which allowed Rosatom to redeploy specialists to its projects in Hungary and Turkey.[52] The source did not expect the additional personnel to accelerate project delivery times, but asserted that the move would simplify Rosatom's project management and strengthen local teams.

In addition to Finland's move, a Czech state-controlled energy firm has signed new contracts with Westinghouse and France's Framatome to supply fuel assemblies for two reactors at one of the country's Soviet-era nuclear plants.[53] Sweden's Vattenfall, which owns seven reactors in Sweden and three in Germany,[54] announced on the day of Russia's invasion of Ukraine that it would immediately halt planned fuel deliveries and new orders from Rosatom.[55] Less than three months later, the company announced new fuel supply agreements with Westinghouse and Framatome.[56] Over the longer term, EU countries seem quite unlikely to contract with the company for any new nuclear plants.

The future of Russia's global nuclear role

Before the war in Ukraine, Rosatom aimed to increase its revenue to Rub 4 trillion, or nearly $54 billion, by 2030.[57] This is nearly triple the 2021 figure. The company projected that new products would generate 40% of this sum and that international sales would produce at least 50%.[58] Rosatom based its forecasts on the expectation that global nuclear electricity-generating capacity would continue to grow as governments seek clean power; in its "high case," the International Atomic Energy Agency (IAEA) projects that worldwide nuclear capacity could more than double by 2050, from 390 GW to 873 GW.[59] That said, the IAEA's high case foresees an increase of only 23% by 2030 and its low case sees a decline of 2%.[60]

Rosatom previously viewed a general global trend towards protectionism and rapid changes in the technological landscape as two major potential

52 Author's confidential interview.

53 "Czech Energy Company CEZ Switches away from Russian Nuclear Fuel," bne IntelliNews, June 29, 2022, https://www.intellinews.com/czech-energy-company-cez-switches-away-from-russian-nuclear-fuel-248913/.

54 Vattenfall, "Nuclear Power," https://group.vattenfall.com/what-we-do/our-energy-sources/nuclear-power. Only five of the seven reactors in Sweden are operating—two have been decommissioned. Germany is phasing out nuclear energy.

55 Vattenfall, "Vattenfall Stops Deliveries of Russian Nuclear Fuel," February 24, 2022, https://group.vattenfall.com/press-and-media/newsroom/2022/vattenfall-stops-delivieries-of-russian-nuclear-fuel.

56 Vattenfall, "Vattenfall Secures Long-term Nuclear Fuel Supply," May 5, 2022, https://group.vattenfall.com/press-and-media/pressreleases/2022/vattenfall-secures-long-term-nuclear-fuel-supply.

57 Rosatom, Performance of State Atomic Energy Corporation Rosatom in 2021, p. 32, https://www.report.rosatom.ru/go_eng/go_rosatom_eng_2021/rosatom_2021_eng.pdf

58 Ibid.

59 International Atomic Energy Agency, Energy, Electricity and Nuclear Power Estimates for the Period up to 2050, Reference Data Series No. 1, 2022 edition, p. 3, https://www.iaea.org/publications/15268/energy-electricity-and-nuclear-power-estimates-for-the-period-up-to-2050.

60 Ibid., p. 18.

obstacles to its expansion. Since Russia's invasion of Ukraine, sanctions and other geopolitical factors have added massive risk. Rosatom's CEO is under United Kingdom sanctions, though not US or EU sanctions;[61] Ukraine has imposed sanctions on Rosatom and 200 "Russian entities" over the company's operation of the Russian-occupied Zaporizhzhia nuclear power plant;[62] and the United States and its allies are sanctioning individual Rosatom subsidiaries connected to military industries.[63] Setting aside sanctions, the United States and most EU members are visibly working to reduce if not eliminate their dependencies on Russia, including in the nuclear sector.

According to public statements and interviews with multiple Rosatom employees, sanctions have not thus far materially affected Rosatom's work.[64] The deadlines for some of the projects in Bangladesh and India have been pushed back slightly, company officials have said, but nearly all the risks have been mitigated.[65] Except for the terminated project in Finland, Rosatom's most valuable projects—new reactor construction—are in countries that have not joined the wider sanctions against Russia.

Notably, a senior company official involved in Rosatom's Kudankulam project in India stated that the three biggest problems for the company have been moving funds (Rosatom and its customer have developed backup plans to use Indian or Russian currency), relocating production of some components from "sensitive spots" (perhaps a reference to manufacturing that had been located in the EU or Ukraine but had to be moved), and logistics (the official stated that the problem was resolved when Russia rather than India provided vessels to deliver equipment).[66]

After February 2022, Rosatom's international plan is still valid but has been put on hold, according to a person familiar with the matter who wants to remain anonymous. Nevertheless, in 2022, Rosatom submitted

61 "Rosatom Called British Sanctions a Threat to International Nuclear Security," Vedomosti, February 24, 2023, https://www.vedomosti.ru/business/news/2023/02/24/964247-v-rosatome-nazvali-sanktsii-ugrozoi.

62 "Ukraine Imposes Sanctions against Russia's Nuclear Industry," The Kyiv Independent via yahoo!news, February 5, 2023, https://news.yahoo.com/ukraine-imposes-sanctions-against-russia-210931899.html.

63 «США ввели санкции против производителя углеволокна Umatex из структуры 'Росатома,'» Интерфакс, February 24, 2023, https://www.interfax.ru/world/887656.

64 Irina Tsyruleva, "'Our Portfolio of Foreign Orders Is Stable at $200 Billion,'" Izvestia, December 26, 2022, https://iz.ru/1446276/irina-tcyruleva/nash-portfel-zarubezhnykh-zakazov-stabilno-derzhitsia-na-urovne-200-mlrd. The Rosatom employees interviewed by the author requested anonymity because they were not authorized to speak publicly on behalf of the company.

65 "Rosatom Said That the Sanctions Did Not Seriously Affect the Construction of the Kudankulam Nuclear Power Plant in India," TACC, December 7, 2022, https://tass.ru/ekonomika/16530285.

66 Ibid.

pre-bid documents for a tender in Saudi Arabia and awarded a contract to Korea Hydro and Nuclear Power to assist in the Russian firm's construction of a nuclear plant at El Dabaa, Egypt.[67] South Korean officials stated that their government consulted closely with their US counterparts about the deal.[68]

A Royal United Services Institute analysis of trade data shows that Russia's international nuclear fuel and technology sales grew by over 20% in 2022 despite sanctions and volatility, with EU member countries buying at the highest levels in three years.[69] Sales to China, Egypt, India, and Iran also reportedly increased.

Rosatom CEO Likhachev said in February that the company was negotiating with about 10 countries on new nuclear plants and that "three or four" were close to signing agreements.[70] In all the countries where Rosatom is already building nuclear plants, "everything is on track," he said.[71]

More generally, even if the West fully excludes Rosatom from its markets, governments outside the West appear willing to work with Russia. Of course, countries considering new reactors can choose other vendors, whether the United States, France, South Korea, or China. But if Russia continues to offer attractive state loans with new projects, its offers might be tough to beat. The company might also develop new demand inside Russia—the country's metallurgical giant Norilsk Nickel is working with Rosatom to deploy small nuclear reactors rather than US and German turbines that are no longer available, according to Norilsk Nickel CEO Vladimir Potanin.[72]

While Western governments are determined to reduce Russia's presence in the global energy market, this will be costly in the nuclear sector—as it has been in oil and gas. European countries depend heavily on Rosatom as a builder,

67 "Rosatom Has Filed Paperwork to Bid at Tender to Build Nuclear Power Plant in Saudi Arabia – Novak," Interfax, December 13, 2022, https://interfax.com/newsroom/top-stories/86039/; "South Korea Signs USD $2.2 Billion Contract with Rosatom for Dabaa Nuclear Plant," Enterprise, August 28, 2022, https://enterprise.press/stories/2022/08/28/south-korea-signs-usd-2-2-bn-contract-with-rosatom-for-dabaa-nuclear-plant-79231/.

68 Mirette Magdy, "Korea in $2.2 Billion Deal with Russia for Egypt Nuclear Plant," Bloomberg, August 25, 2022, https://www.bloomberg.com/news/articles/2022-08-25/korea-in-2-2-billion-deal-with-russia-for-egypt-nuclear-plant#xj4y7vzkg.

69 Jonathan Tirone, "Russia's Grip on Nuclear-Power Trade Is Only Getting Stronger," Bloomberg, February 14, 2023, https://www.bloomberg.com/news/features/2023-02-14/russia-s-grip-on-nuclear-power-trade-is-only-getting-stronger.

70 "Rosatom Sees Interest in Its NPP Projects from 10 Countries, 3–4 of which Close to Formalizing Relations—Likhachev," Interfax, February 6, 2023, https://interfax.com/newsroom/top-stories/87699/.

71 Ibid.

72 "Vladimir Potanin – RBC: 'No Need for Confiscations, No Need for Nationalization,'" RBC, January 23, 2023, https://www.rbc.ru/business/23/01/2023/63cbcc079a79475b43927320?from=column_1.

a supplier, and a service provider. The United States, which is much less dependent, appears set to decrease its imports of Russian uranium only incrementally between now and 2028. Truly winding down Russian supplies could take much longer, even with strong political will behind it.

About the Author

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From 2017 to 2022, Prokopenko worked as an adviser at the Central Bank of Russia and at the Higher School of Economics in Moscow. From 2008 to 2017, she was a reporter, first at the TASS news agency and then at Vedomosti, Russia's then-leading business newspaper. As a reporter, she covered Russia's civil nuclear cooperation with Egypt and Turkey.