

ENDING GLOBAL RELIANCE ON RUSSIA'S NUCLEAR ENERGY SECTOR

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As Russia's war of aggression against Ukraine approaches its one-year anniversary, Western governments continue working to reduce Moscow's revenue sources, including its energy sector exports. Russia's robust nuclear industry, however, has largely been immune from pressure. In December 2022, Rosatom State Nuclear Energy Corporation, the Russian state-owned atomic company, said it has a 10-year portfolio of overseas orders worth \$200 billion and that 2023 revenue will grow by 15 percent.¹

Rosatom is a key revenue-earning arm of the Russian state. At the start of the conflict, the coalition supporting Ukraine reportedly contemplated sanctions against Rosatom but ultimately abstained, likely due to tight energy supplies and high prices worldwide.² Despite the war, Rosatom continues to meet the civilian nuclear energy needs of the United States and many of its allies and partners. As Boris Arseev, the company's director for international business, said in August 2022, "We at Rosatom strongly believe that nuclear cooperation must not stop in these turbulent times."³ Unfortunately, Washington and its European allies have largely agreed.

Yet if he so chooses, Russian President Vladimir Putin could leverage Rosatom's influence over the nuclear supply chain to inflict pain now or in the future on Western countries that support Ukraine. Washington and its allies therefore need to wean themselves from dependence on Russian nuclear supply. The Biden administration should announce sanctions against Rosatom and its subsidiaries. This should include a grace period for customers to wind-down relationships for which alternate partners are harder to find, such as in-progress nuclear reactor projects and reactor fuel supplies. The administration should strengthen efforts to identify alternative nuclear supplies for itself and its partners, a process that could take years. If the administration fails to take these steps, the U.S. Congress should compel the White House to act by requiring it to submit a strategy within 180 days to end domestic and global reliance on Rosatom.

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1. Lidia Kelly, "Russia's Rosatom Sees 2022 Exports Growth at 15% - Report," *Reuters*, December 25, 2022. (<https://www.reuters.com/business/energy/russias-rosatom-sees-2022-exports-growth-15-report-2022-12-26>)

2. Tony Wesolowsky, "The Rosatom Exemption: How Russia's State-Run Nuclear Giant Has Escaped Sanctions," *Radio Free Europe/Radio Liberty*, June 15, 2022. (<https://www.rferl.org/a/rosatom-russia-nuclear-giant-escapes-sanctions/31899192.html>)

3. 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>)

ROSATOM'S GLOBAL DOMINANCE AND THE HUNT FOR ALTERNATIVE SUPPLIERS⁴

The Russian nuclear industry is a pivotal supplier for every key nuclear technology, from nuclear reactors to the uranium fuel cycle.⁵ Alternative suppliers have not emerged and will take time to do so. Just as it weaponized Europe's ill-considered dependence on Russian gas, the Kremlin could exploit global reliance on the Russian nuclear industry to undermine support for Ukraine.⁶

Rosatom CEO Alexei Likhachev noted in February 2021 that his company was “actively working” in 12 countries. The company's 2021 annual report boasted record earnings of more than \$20 billion.⁷ Rosatom builds a competitive and reliable pressurized water-moderated power reactor known as the VVER. As of 2021, the company reported it had built 35 such reactors worldwide.⁸ Rosatom subsidiaries typically service VVERs, which often utilize a fuel specific to those reactors. Many countries also import Russian-mined and -milled uranium from Rosatom, along with products and services such as converted uranium, enriched uranium reactor fuel, reactor spent fuel takeback, and spare parts. Rosatom also provides training and safety tutorials on the use of nuclear materials. The company's 2021 annual report says it ranks first globally in the uranium enrichment market, second in uranium production, and third in nuclear fuel.⁹

Being a state-owned company also aids Rosatom's dominance, allowing it to set prices and sell services below market costs.¹⁰ The company has thus been able to dump products onto the market, reducing incentives for non-Russian companies to invest in alternatives. The absence of sanctions has created little incentive for the private sector to plan, invest in alternatives, and replace Rosatom's global portfolio of projects and services.

COUNTRIES MOVING AWAY FROM ROSATOM

Before the war in Ukraine began last year, the United States, several European countries, and some EU agencies were already urging nations to transition away from Russian nuclear supply. The European Union's REPowerEU plan recommended diversification. The European atomic energy community's Euratom Supply Agency's (ESA) 2021

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4. This list is non-exhaustive. Additional areas of cooperation are described in: Rosatom Corporation, “Rosatom Highlights in 2021,” January 2022. (<https://rosatomnewsletter.com/2022/01/31/rosatom-highlights-in-2021>)

5. Matt Bowen and Paul Dabbar, “Reducing Russian Involvement in Western Nuclear Power Markets,” *Columbia University, Center on Global Energy Policy*, May 23, 2022. (<https://www.energypolicy.columbia.edu/research/commentary/reducing-russian-involvement-western-nuclear-power-markets>); “Nuclear Explained: The Nuclear Fuel Cycle,” *U.S. Energy Information Administration*, last updated July 12, 2022. (<https://www.eia.gov/energyexplained/nuclear/the-nuclear-fuel-cycle.php>)

6. Brenda Shaffer, “With Winter Coming, Europe is Walking Off a Cliff,” *Foreign Policy*, September 29, 2022. (<https://foreignpolicy.com/2022/09/29/europe-energy-crisis-russia-policies-gas-nuclear-renewable-electricity-prices>)

7. Government House (Russia), “Встреча Михаила Мишустина с генеральным директором государственной корпорации «Росатом» Алексеем Лихачёвым (Mikhail Mishustin's Meeting with Director General of Rosatom State Corporation Alexei Likhachev),” February 4, 2021. (<http://government.ru/news/41456>); Rosatom Corporation, “Rosatom Highlights in 2021,” January 2022. (<https://rosatomnewsletter.com/2022/01/31/rosatom-highlights-in-2021>); Rosatom Corporation, “Performance of State Atomic Energy Corporation Rosatom in 2021,” pages 20-21. (https://www.report.rosatom.ru/go_eng/go_rosatom_eng_2021/rosatom_2021_eng.pdf)

8. Rosatom Corporation, “Performance of State Atomic Energy Corporation Rosatom in 2021,” pages 18-19.

9. Ibid.

10. Dory Castillo-Peters and Frank von Hippel, “US and EU Imports of Russian Uranium and Enrichment Services Should Stop. Here's How,” *Bulletin of the Atomic Scientists*, August 5, 2022. (<https://thebulletin.org/2022/08/us-and-eu-imports-of-russian-uranium-and-enrichment-services-could-stop/amp>)

report noted, “100% reliance on a single design and supplier of VVER fuel remains a matter of highest concern.”¹¹ However, given Rosatom’s large market share in Europe and a dearth of replacement suppliers, diversification is not easy.

Since Russia’s 2022 invasion of Ukraine, some European countries have made efforts to reduce or eliminate their dependence on Russia for nuclear products. The Czech Republic will receive fuel for one of its VVERs from France’s Framatome and the U.S. firm Westinghouse starting in 2024.¹² The French nuclear fuel producer Orano announced after the invasion that it had “suspended all new shipments of nuclear materials to and from Russia.”¹³ Sweden has also shifted to other mined and milled uranium and reactor fuel suppliers.¹⁴ In May 2022, Finland backed out of a major nuclear reactor deal with Rosatom, reportedly losing several hundred million euros, but it has other reactors that the Russian nuclear giant built and currently services.¹⁵

Ukraine began even earlier — after Russia’s 2014 occupation of Crimea — to gradually eliminate its dependence on Moscow to fuel its fleet of 15 Russian-built VVERs.¹⁶ In June 2022, Ukraine and Westinghouse concluded a deal for the company’s Swedish-built plant to provide all of Ukraine’s future VVER-1000 reactor fuel. By 2024, the deal will provide an experimental fuel load for the Rivne-based VVER-440 models, which are more difficult to supply.¹⁷ Westinghouse will also build nine additional AP1000 reactor units for Ukraine.¹⁸ Westinghouse, through support from the U.S. Department of Energy (DOE) and Argonne National Laboratory, is also developing the capability to service the VVER-1000 units in lieu of Rosatom.¹⁹ However, the company will likely require years to scale up its ability to provide such services globally.

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11. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, and the Committee of the Regions, “REPowerEU Plan,” adopted on May 18, 2022. (<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0230&from=EN>); Euratom Supply Agency, “Annual Report,” 2021, page 29. (<https://euratom-supply.ec.europa.eu/system/files/2022-12/Euratom%20Supply%20Agency%20-%20Annual%20report%202021%20-%20Corrected%20edition.pdf>)

12. “Jaderné palivo do Temelína dodá americký Westinghouse a francouzská Framatome (American Westinghouse and French Framatome Will Supply Nuclear Fuel to Temelin)” *Radio Prague International* (Czech Republic), April 13, 2022. (<https://cesky.radio.cz/jaderné-palivo-do-temelina-doda-americky-westinghouse-a-francouzská-framatome-8747591>)

13. Orano Group, “Orano Group Statement,” May 20, 2022. (<https://www.business-humanrights.org/en/latest-news/orano-group-statement>)

14. Investigate Europe, “Russia’s €200M Nuclear Exports Untouched by EU Sanctions,” *EU Observer* (Belgium), October 7, 2022. (<https://euobserver.com/world/156226>); Adnan Munawar, “Vattenfall Ends Nuclear Fuel Deliveries from Russia, Citing Ukraine Conflict,” *S&P Global Market Intelligence*, February 25, 2022. (<https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/vattenfall-ends-nuclear-fuel-deliveries-from-russia-citing-ukraine-conflict-69101159>)

15. “Finnish Group Scraps Nuclear Power Plant Deal with Russia’s Rosatom,” *Agence France-Presse* (France), May 2, 2022. (<https://www.france24.com/en/live-news/20220502-finnish-group-scraps-nuclear-plant-deal-with-russia-s-rosatom>)

16. “Nuclear Power in Ukraine,” *World Nuclear Association*, updated June 2022. (<https://world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine.aspx>)

17. The model number following each VVER model denotes a larger or smaller megawatt thermal power. Natalia Zinets, “Ukraine Signs Deal with Westinghouse to End Russian Nuclear Fuel Needs,” *Reuters*, June 3, 2022. (<https://www.reuters.com/business/energy/ukraine-signs-deal-with-westinghouse-end-russian-nuclear-fuel-needs-2022-06-03>)

18. “Energoatom and Westinghouse Begin AP1000 Plant License Process in Ukraine,” *Westinghouse Electric Company*, July 11, 2022. (<https://info.westinghousenuclear.com/news/energoatom-and-westinghouse-begin-plant-license-process>)

19. “Westinghouse and NT-Engineering Sign MoC to Increase Nuclear Reactor Power,” *Westinghouse Electric Company*, September 22, 2021. (<https://info.westinghousenuclear.com/news/westinghouse-and-nt-engineering-sign-moc>)

Nearly 20 percent of EU imports of mined and milled uranium comes from Russia, and while supplies are available elsewhere — France, for example, obtains its mined and milled uranium only from Kazakhstan, Australia, Niger, and Uzbekistan²⁰ — alternate sources will potentially have a higher cost.²¹

SOME EU COUNTRIES STILL DEPENDENT ON ROSATOM

Rosatom still fuels and services many nuclear reactors in Europe, including in Belgium, the United Kingdom, the Netherlands, Spain, Sweden, and Switzerland.²² All these countries are strong supporters of Ukraine and thus potential targets of Russian pressure. In addition, Bulgaria and Slovakia are dependent on Rosatom's TVEL Fuel Company for fuel supplies to VVERs.²³ A Slovakian official told *Politico* in April 2022 that those countries and two others in the EU were in talks with Westinghouse to have it supply them with fuel to replace what they currently buy from Russia. He added, however, that a steady supply would not be available for “two years, because there is no immediate option.”²⁴ Westinghouse and France's Framatome eventually signed deals with Bulgaria to supply its two Soviet-era reactors, assisting the nation to diversify fuel imports.²⁵

France's Électricité de France (EDF) and Framatome collaborate extensively with Rosatom and sell their own products to the Russian company.²⁶ The two French companies do not appear to offer immediate reactor or reactor fuel supply alternatives. While France's 56 reactors supply half of the EU's electricity, and Paris relies on nuclear power for 70 percent of its own electricity, EDF has struggled to meet domestic demand,²⁷ having faced reactor

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20. Pierre Breteau, “L'indépendance énergétique de la France grâce au nucléaire : un tour de passe-passe statistique (France's Energy Independence Thanks to Nuclear Power : A Statistical Sleight of Hand),” *Le Monde* (France), January 24, 2022, updated February 21, 2022. (https://www.lemonde.fr/les-decodeurs/article/2022/01/24/l-independance-energetique-de-la-france-grace-au-nucleaire-un-tour-de-passe-passe-statistique-et-100-d-importation_6110781_4355770.html)

21. Barbara Moens, Zia Weise, America Hernandez, and Leonie Kijewski, “Russia Faces Threat of Sanctions on Nuclear Power Industry as Germany Backs Uranium Ban,” *Politico*, April 29, 2022. (<https://www.politico.eu/article/russia-nuclear-power-uranium-plants-europe-imports-germany-sanctions-ukraine-war>)

22. Sylvie Corbet, “Russia's Nuclear Trade with Europe Flows Despite Ukraine War,” *Associated Press*, September 29, 2022. (<https://apnews.com/article/russia-ukraine-france-global-trade-only-on-ap-business-c521f2248c823f69f0a677735a78e89d>)

23. Investigate Europe, “Russia's €200M Nuclear Exports Untouched by EU Sanctions,” *EU Observer* (Belgium), October 7, 2022. (<https://euobserver.com/world/156226>)

24. Barbara Moens, Zia Weise, America Hernandez, and Leonie Kijewski, “Russia Faces Threat of Sanctions on Nuclear Power Industry as Germany Backs Uranium Ban,” *Politico*, April 29, 2022. (<https://www.politico.eu/article/russia-nuclear-power-uranium-plants-europe-imports-germany-sanctions-ukraine-war>)

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26. “Framatome and Rosatom Expand Cooperation,” *World Nuclear News* (UK), December 2, 2021. (<https://www.world-nuclear-news.org/Articles/Framatome-and-Rosatom-expand-cooperation>); “Equipment for Deconversion Arrives at Zheleznogorsk,” *World Nuclear News* (UK), December 23, 2021. (<https://www.world-nuclear-news.org/Articles/Equipment-for-deconversion-arrives-at-Zheleznogorsk>); Sylvie Corbet, “Russia's Nuclear Trade with Europe Flows Despite Ukraine War,” *Associated Press*, September 29, 2022. (<https://apnews.com/article/russia-ukraine-france-global-trade-only-on-ap-business-c521f2248c823f69f0a677735a78e89d>)

27. Liz Alderman and Stanley Reed, “Nuclear Power Could Help Europe Cut Its Russia Ties, but Not for Years,” *The New York Times*, April 26, 2022. (<https://www.nytimes.com/2022/04/26/business/russia-nuclear-power-europe.html>); Pierre Breteau, “L'indépendance énergétique de la France grâce au nucléaire : un tour de passe-passe statistique (France's Energy Independence Thanks to Nuclear Power : A Statistical Sleight of Hand),” *Le Monde* (France), January 24, 2022, updated February 21, 2022. (https://www.lemonde.fr/les-decodeurs/article/2022/01/24/l-independance-energetique-de-la-france-grace-au-nucleaire-un-tour-de-passe-passe-statistique-et-100-d-importation_6110781_4355770.html); Liz Alderman, “French Nuclear Power Crisis Frustrates Europe's Push to Quit Russian Energy,” *The New York Times*, June 18, 2022. (<https://www.nytimes.com/2022/06/18/business/france-nuclear-power-russia.html>)

issues and construction delays that render it unable to provide maximum output. It is so deeply in debt that the government is considering full nationalization.²⁸ EDF is also unable to meet foreign reactor construction deadlines.

U.S. AND OTHER EU COUNTRIES PARTIALLY RELIANT ON ROSATOM

Key European countries and the United States remain partially reliant on Rosatom.

Germany, which has nearly completed a domestic phase-out of nuclear power and relies on reactors for less than 12 percent of its energy needs, advocated in April 2022 for EU sanctions on Russian uranium imports.²⁹ But Berlin still planned to honor existing nuclear contracts with Rosatom.³⁰ In October, Germany announced it would temporarily extend the operation of remaining nuclear plants to allay energy shortages.³¹

Like Germany, Belgium had been phasing out nuclear power. Brussels has since reversed that decision and is now extending the life of operating plants and planning additional reactors to reduce overall reliance on Russian energy.³² Brussels must replace nearly 40 percent of its mined uranium supplies, which it obtains from Russia and a Russian subsidiary in Kazakhstan.³³

The United States also partially relies on Russia for nuclear imports. Since 2011, the two countries have had a civil nuclear cooperation agreement that covers a variety of joint efforts as well as nuclear trade.³⁴ In 2021, 14 percent of U.S.-mined and -milled uranium purchases were from Russia, while the remainder came from Kazakhstan (35 percent), Canada (15 percent), Australia (14 percent), Namibia (7 percent), U.S. domestic sources (5 percent), and five other countries (10 percent).³⁵

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28. Matthew Dalton, “France’s Nuclear Reactors Malfunction as Energy Crisis Bites,” *The Wall Street Journal*, October 23, 2022. (<https://www.wsj.com/articles/frances-nuclear-reactors-malfunction-as-energy-crisis-bites-11666517581>); Liz Alderman and Stanley Reed, “Nuclear Power Could Help Europe Cut Its Russia Ties, but Not for Years,” *The New York Times*, April 26, 2022. (<https://www.nytimes.com/2022/04/26/business/russia-nuclear-power-europe.html>)

29. “Nuclear Power in Germany,” *World Nuclear Association*, updated October 2022. (<https://world-nuclear.org/information-library/country-profiles/countries-g-n/germany.aspx>); Ari Natter, Nick Wadhams, and Saleha Mohsin, “U.S. Weighs Sanctions on Russian Uranium Supplier Rosatom,” *Bloomberg*, March 9, 2022. (<https://www.bloomberg.com/news/articles/2022-03-09/u-s-weighs-sanctions-on-russian-nuclear-power-supplier-rosatom>)

30. Tony Wesolowsky, “The Rosatom Exemption: How Russia’s State-Run Nuclear Giant Has Escaped Sanctions,” *Radio Free Europe/Radio Liberty*, June 15, 2022. (<https://www.rferl.org/a/rosatom-russia-nuclear-giant-escapes-sanctions/31899192.html>)

31. Petra Sorge, Arne Delfs, and Michael Nienaber, “Scholz Extends Germany’s Last Nuclear Plants to Quell Feud,” *Bloomberg*, October 17, 2022. (<https://www.bloomberg.com/news/articles/2022-10-17/germany-to-extend-lifetime-of-all-three-nuclear-power-plants>)

32. “Lifetime Extension of Doel 4 and Tihange 3 Nuclear Power Plants,” *Website of the Prime Minister of Belgium*, March 18, 2022. (<https://www.premier.be/en/lifetime-extension-doe1-4-and-tihange-3-nuclear-power-plants>); Liz Alderman and Stanley Reed, “Nuclear Power Could Help Europe Cut Its Russia Ties, but Not for Years,” *The New York Times*, April 26, 2022. (<https://www.nytimes.com/2022/04/26/business/russia-nuclear-power-europe.html>)

33. Liv Klingert, “Russia’s Energy Chokehold: 40% of Uranium Used in Belgium Linked to Russia,” *The Brussels Times* (Belgium), May 5, 2022. (<https://www.brusselstimes.com/222425/russias-energy-chokehold-40-of-uranium-used-in-belgium-linked-to-russia>)

34. “Nuclear Explained: Where Our Uranium Comes From,” *U.S. Energy Information Administration*, updated July 7, 2022. (<https://www.eia.gov/energyexplained/nuclear/where-our-uranium-comes-from.php>); Mary Beth Nikitin, “U.S.-Russian Civilian Nuclear Cooperation Agreement: Issues for Congress,” *Congressional Research Service*, January 11, 2011. (<https://sgp.fas.org/crs/nuke/RL34655.pdf>)

35. *Ibid.*

The U.S. government has also invested in revitalizing the flagging U.S. uranium mining industry, which has been unable to compete internationally.³⁶ A U.S. anti-dumping law prevents Washington from importing more than 20 percent of its uranium supplies from Moscow, including natural, converted, or enriched uranium. This cap will drop to 15 percent by 2028.³⁷ Reduced U.S. dependence on Russia is critical to defunding the Kremlin; Rosatom's Technabexport (TENEX) claimed it sold \$775 million worth of uranium products to the United States in 2020.³⁸

The U.S. government is also attempting to revive domestic uranium conversion and enrichment to meet domestic and foreign needs, but this endeavor will take several years to bear fruit.³⁹ The only commercial enrichment plant in operation, in New Mexico, is a joint venture with the British, German, and Dutch nuclear services company Urenco.⁴⁰ In 2021, the Department of Energy gave approval to the American company Centrus Energy to make high-assay low-enriched uranium fuel (HALEU) for future smart reactors at its Ohio facility, which the government hopes will be competitive internationally and help revive the U.S. nuclear industry.⁴¹ Pursuant to the Energy Act of 2020, in December 2022, the DOE also established a HALEU fuel consortium to identify partners “to support the availability of [HALEU] for civilian domestic demonstration and commercial use.”⁴²

Russia is currently the only other country that produces HALEU. U.S. industry experts believe that to meet more immediate domestic fuel demand, the United States could temporarily import enriched uranium from France or Japan, which would give it time to find alternative fuel sources, since fuel is only loaded into reactors periodically.⁴³ Urenco could also become a future HALEU supplier. The DOE estimates the government will need to spend over a billion dollars to supplant Russian nuclear supplies.⁴⁴

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36. U.S. Energy Information Administration, “2021 Domestic Uranium Production Report, Table 2: U.S. Uranium Mine Production and Number of Mines and Sources 2007-21,” May 2022. (<https://www.eia.gov/uranium/production/annual/pdf/uminetbl2.pdf>); Tom DiChristopher, “Nuclear Wasteland: the Explosive Boom and Long, Painful Bust of American Uranium Mining,” *CNBC*, August 4, 2018. (<https://www.cnbc.com/2018/08/04/the-miners-that-fuel-americas-nuclear-power-and-atomic-arsenal-are-di.html>)

37. 2020 Amendment to the Agreement Suspending the Antidumping Investigation on Uranium from the Russian Federation, International Trade Administration, 85 Federal Register 64112, September 10, 2020. (<https://www.federalregister.gov/documents/2020/10/09/2020-22431/2020-amendment-to-the-agreement-suspending-the-antidumping-investigation-on-uranium-from-the-russian>); Valerie Volcovici, “U.S. Seeks to Lower Russian Uranium Imports to Boost U.S. Nuclear Industry,” *Reuters*, September 14, 2020. (<https://www.reuters.com/article/us-usa-nuclear-russia-idUKKBN2652YK>)

38. Glenn Kessler, “Does Russia Sell Nearly \$1 Billion in Uranium to the U.S. a Year?” *The Washington Post*, April 20, 2022. (<https://www.washingtonpost.com/politics/2022/04/20/does-russia-sell-nearly-1-billion-uranium-us-year/>)

39. U.S. Department of Energy, Nuclear Fuel Working Group, “Restoring America’s Competitive Nuclear Energy Advantage: A Strategy to Assure U.S. National Security,” April 2020. (<https://www.energy.gov/sites/prod/files/2020/04/f74/Restoring%20America%27s%20Competitive%20Nuclear%20Advantage-Blue%20version%5B1%5D.pdf>)

40. “Uranium Enrichment,” *U.S. Nuclear Regulatory Commission*, updated December 2, 2020. (<https://www.nrc.gov/materials/fuel-cycle-fac/ur-enrichment.html>)

41. “Centrus Becomes First U.S. Licensed HALEU Production Facility,” *U.S. Department of Energy*, June 23, 2021. (<https://www.energy.gov/ne/articles/centrus-becomes-first-us-licensed-haleu-production-facility>); “Advanced Small Modular Reactors (SMRs),” *U.S. Department of Energy*, accessed January 3, 2022. (<https://www.energy.gov/ne/advanced-small-modular-reactors-smrs>)

42. Notice of Establishment: High-Assay Low-Enriched Uranium (HALEU) Consortium, Department of Energy, 87 Federal Register 75048, December 7, 2022. (<https://www.federalregister.gov/documents/2022/12/07/2022-26577/notice-of-establishment-high-assay-low-enriched-uranium-haleu-consortium>)

43. Ari Natter, Nick Wadhams, and Saleha Mohsin, “U.S. Weighs Sanctions on Russian Uranium Supplier Rosatom,” *Bloomberg*, March 9, 2022. (<https://www.bloomberg.com/news/articles/2022-03-09/u-s-weighs-sanctions-on-russian-nuclear-power-supplier-rosatom>)

44. William Freebairn, “Replacing Russian Uranium in Case of Ban Might Cost Over \$1 Billion: DOE,” *S&P Global Commodity Insights*, March 17, 2022. (<https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/031722-replacing-russian-uranium-in-case-of-ban-might-cost-over-1-billion-doe>)

In August 2021, the Biden administration enacted sanctions against Russia that included stronger Commerce Department controls on nuclear- and missile-related goods.⁴⁵ This executive action provides a basis for additional measures to wind down nuclear trade with Russia.

COUNTRIES DEEPENING TIES WITH ROSATOM

Countries friendly toward Russia, as well as several that have close relations with the United States, are moving forward with Rosatom projects rather than seeking alternatives.

China is a key Rosatom partner, purchasing reactors, fuel, and services, and has a number of joint projects underway aimed at enhancing the independence of Beijing's burgeoning nuclear industry.⁴⁶ Rosatom is also working on Turkey's first fleet of four VVER-1200s at the Akkuyu nuclear power plant (financed by Russian state-owned banks) and on a new power plant at Sinop. The company is also building Egypt's four VVER-1200s at the planned nuclear power plant in El Dabaa. Belarus, a close Russian ally, has a Rosatom reactor project underway and receives fuel from Russia.⁴⁷ Hungary, an EU member that maintains friendly ties with the Putin regime, is moving forward with Rosatom's construction of two new VVER-1200s at its Paks II nuclear power plant with a loan from the Russian government.⁴⁸

In addition, Rosatom services Iran's reactor at Bushehr. Under the 2015 nuclear deal, formally known as the Joint Comprehensive Plan of Action, Tehran contracted with Moscow to build two more reactors.⁴⁹ In March 2022, the Biden administration reportedly provided assurances to Russia that if the nuclear deal is revived, it will not sanction Moscow's atomic work in Iran, despite its invasion of Ukraine and its potential to earn more than \$10 billion from Bushehr and other Iran contracts.⁵⁰

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45. U.S. Department of State, Press Release, "Fact Sheet: United States Imposes Additional Costs on Russia for the Poisoning of Aleksey Navalny," August 20, 2021. (<https://www.state.gov/fact-sheet-united-states-imposes-additional-costs-on-russia-for-the-poisoning-of-aleksey-navalny>)

46. "China Signs Up to Four New Units from Russia," *World Nuclear News* (UK), June 8, 2018. (<https://www.world-nuclear-news.org/Articles/China-signs-up-to-four-new-units-from-Russia>); "Fuel Despatched for China's CFR-600 Fast Neutron Reactor," *World Nuclear News* (UK), September 30, 2022. (<https://www.world-nuclear-news.org/Articles/Fuel-despatched-to-China-for-CFR-600-fast-neutron>); "First Concrete Poured for Xudabao 3," *World Nuclear News* (UK), August 3, 2021. (<https://www.world-nuclear-news.org/Articles/First-concrete-poured-for-Xudabao-3>); "Construction Starts on Eighth Tianwan Unit," *World Nuclear News* (UK), February 25, 2022. (<https://www.world-nuclear-news.org/Articles/Construction-starts-on-eighth-Tianwan-unit>)

47. "Rosatom's Work Overseas Unaffected by Pandemic, Says DG," *World Nuclear News* (UK), February 5, 2021. (<https://www.world-nuclear-news.org/Articles/Rosatom-s-overseas-work-unaffected-by-pandemic-sa>); "Fuel Loading Begins at Ostovets 2," *World Nuclear News* (UK), December 22, 2021. (<https://www.world-nuclear-news.org/Articles/Fuel-loading-begins-at-Ostovets-2>)

48. "Hungary and Rosatom Push Ahead on Paks II Nuclear Project," *World Nuclear News* (UK), May 6, 2022. (<https://www.world-nuclear-news.org/Articles/Hungary-and-Rosatom-push-ahead-on-Paks-II-nuclear>); "Russia Extends Loan Period for Hungary's Paks-II," *Nuclear Engineering International* (UK), May 4, 2021. (<https://www.neimagazine.com/news/newsrussia-extends-loan-period-for-hungarys-paks-ii-8718825>)

49. "Iran Accelerated Projects for Phase 2&3 of Bushehr Nuclear Plant," *Iran International* (UK), July 22, 2022. (<https://www.iranintl.com/en/202207220250>); Adam Kredo, "Exposed: The Russian Companies That Will Get Billions from the New Iran Nuclear Deal," *Washington Free Beacon*, April 8, 2022. (<https://freebeacon.com/national-security/exposed-the-russian-companies-that-will-get-billions-from-new-iran-nuclear-deal>)

50. Ibid.

In August 2022, South Korea signed a major deal with Rosatom to provide buildings, components, and materials for Egypt's El Dabaa plant.⁵¹ Seoul said it consulted closely with Washington on the terms. Rosatom is also working on a joint venture to build four new reactor units at India's Kudankulam facility.⁵² These close American allies have little reason to eschew ties with the company if the United States is unwilling to impose sanctions.

Rosatom is also building two reactors in Bangladesh and is working on a nuclear technology center in Bolivia.⁵³ In projects supported by the European Bank for Reconstruction and Development, which is funded by numerous European countries and the United States, a Rosatom subsidiary of TVEL has contracted to perform environmental remediation and uranium mining cleanup in Tajikistan and Uzbekistan.⁵⁴ In 2022, Armenia, Uzbekistan, Myanmar, and Brazil signed memoranda of understanding (MOUs) to purchase nuclear infrastructure and training from Rosatom.⁵⁵ The company also signed MOUs with many other countries in previous years.⁵⁶ It also planned several other ventures, such as projects with Serbia and the Philippines.⁵⁷

THE U.S. AND EU ARE RELUCTANT TO IMPOSE SANCTIONS

Limited and expensive energy supplies worldwide, in addition to a lack of alternative suppliers, explain the West's reluctance to sanction Rosatom. The Biden administration also understands that certain EU member states oppose sanctioning Rosatom and is hesitant to proceed without a consensus.

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51. 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>)

52. "Construction Begins on Fourth Turkish Reactor," *World Nuclear News* (UK), July 21, 2022. (<https://www.world-nuclear-news.org/Articles/Construction-begins-of-fourth-Turkish-reactor>); Marina Lorenzini and Francesca Giovannini, "Five Reasons Why Russia's Nuclear Exports Will Continue, Despite Sanctions and the Ukraine Invasion: But for How Long?" *Bulletin of the Atomic Scientists*, May 17, 2022. (<https://thebulletin.org/2022/05/five-reasons-that-russias-nuclear-exports-will-continue-despite-sanctions-and-the-ukraine-invasion-but-for-how-long>); Selcan Hacaoglu, "Turkey Asks Russia to Build Another Nuclear Plant, Defying U.S.," *Bloomberg*, October 20, 2022. (<https://www.bloomberg.com/news/articles/2022-10-20/turkey-asks-russia-to-build-another-nuclear-plant-defying-us>); "Construction of Egypt's First Nuclear Power Plant Under Way," *World Nuclear News* (UK), July 20, 2022. (<https://www.world-nuclear-news.org/Articles/Construction-of-Egypt-s-first-nuclear-power-plant-u>); "Reactor Plant Equipment Installed at Kudankulam 3," *World Nuclear News* (UK), July 19, 2022. (<https://www.world-nuclear-news.org/Articles/Reactor-plant-equipment-installed-in-Kudankulam-3>)

53. "Containment Dome in Place at Rooppur 2," *World Nuclear News* (UK), June 30, 2022. (<https://www.world-nuclear-news.org/Articles/Containment-dome-in-place-at-Rooppur-2>); "Nuclear Research and Technology Centre in Bolivia into Pilot Operation," *World Nuclear News* (UK), August 9, 2022. (<https://www.world-nuclear-news.org/Articles/Nuclear-research-and-technology-centre-in-Bolivia>)

54. "Contract Cleanup of Tajik Uranium Legacy Site," *World Nuclear News* (UK), September 7, 2022. (<https://www.world-nuclear-news.org/Articles/Contract-for-cleanup-of-Tajik-uranium-legacy-site>); "Cleanup of Two Uzbek Sites to Start in Early-2023," *World Nuclear News* (UK), September 5, 2022. (<https://www.world-nuclear-news.org/Articles/Cleanup-of-two-Uzbek-sites-to-start-in-early-2023>)

55. "Rosatom Signs Agreement on Possible New Reactors for Armenia," *World Nuclear News* (UK), January 21, 2022. (<https://www.world-nuclear-news.org/Articles/Rosatom-signs-agreement-on-possible-new-reactors-f>); "Rosatom and Uzbekistan Sign MoU on Nuclear Infrastructure Development," *World Nuclear News* (UK), July 14, 2022. (<https://www.world-nuclear-news.org/Articles/Rosatom-and-Uzbekistan-sign-MoU-on-nuclear-infrac>); "Russia's Rosatom and Myanmar Sign Nuclear Energy MoUs," *World Nuclear News* (UK), July 13, 2022. (<https://www.world-nuclear-news.org/Articles/Russia-s-Rosatom-and-Myanmar-sign-nuclear-energy-M>); "Brazil's ENBPar and Rosatom Agree to Cooperate," *World Nuclear News* (UK), October 5, 2022. (<https://www.world-nuclear-news.org/Articles/Brazils-ENBPar-and-Rosatom-agree-to-cooperate>)

56. "Rosatom Expands Overseas Links with New Agreements," *World Nuclear News* (UK), May 16, 2018. (<https://www.world-nuclear-news.org/C-Rosatom-expands-overseas-links-with-new-agreements-16051801.html>)

57. "Nuclear Technology Centre Planned for Serbia," *World Nuclear News* (UK), December 9, 2021. (<https://www.world-nuclear-news.org/Articles/Nuclear-technology-centre-planned-for-Serbia>); "PH, Russia Reaffirm Efforts on Potential Use of Small Reactors," *Philippine News Agency* (Philippines), January 21, 2022. (<https://www.pna.gov.ph/articles/1166066>)

After Russia invaded Ukraine, the Biden administration and the EU considered sanctions against Rosatom, which likely would have applied to parts of its vast conglomerate of domestic and foreign subsidiaries.⁵⁸ The president signed an executive order in March 2022 prohibiting “new investment in the energy sector in the Russian Federation by a United States person, wherever located,” but the administration did not specifically target Russia’s nuclear energy sector, including supplies, products, or services.⁵⁹

By March, reports of potential sanctions against Rosatom sent shares of major uranium production companies soaring.⁶⁰ Even after the likelihood of sanctions decreased, uranium prices remained nearly double those of mid-2021.⁶¹ In September 2022, the Ukrainian Ministry of Energy stated in a press release that Kyiv and Washington’s respective energy secretaries discussed Rosatom sanctions, among other issues.⁶² Shortly thereafter, for unknown reasons, the ministry deleted the reference to Rosatom sanctions from its press release.⁶³

On its own, Kyiv has enacted sanctions against Rosatom and has continuously called for Western sanctions, particularly since Moscow’s military occupied Ukraine’s Chernobyl nuclear site early in the war. Russian forces then seized the Zaporizhzhia nuclear power plant (ZNPP) and installed Rosatom officials to oversee operations.⁶⁴ Moscow may have occupied the plant to seize electricity for Russian-controlled provinces in Ukraine. Russia has also carried out dangerous shelling and military actions against the ZNPP and has terrorized and committed atrocities against the plant’s Ukrainian staff, some of whom remain at their posts. Conditions at ZNPP call into question Rosatom’s commitment to nuclear safety and security.

Hungary may be the lone holdout among EU countries resisting sanctions against Rosatom. The EU discussions are still in the exploratory stage, and additional objections could emerge if the effort to ban Rosatom business

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58. Ari Natter, Nick Wadhams, and Saleha Mohsin, “U.S. Weighs Sanctions on Russian Uranium Supplier Rosatom,” *Bloomberg*, March 9, 2022. (<https://www.bloomberg.com/news/articles/2022-03-09/u-s-weighs-sanctions-on-russian-nuclear-power-supplier-rosatom>)

59. Executive Order 14066, “Prohibiting Certain Imports and New Investments with Respect to Continued Russian Federation Efforts to Undermine the Sovereignty and Territorial Integrity of Ukraine,” March 8, 2022. (<https://www.whitehouse.gov/briefing-room/presidential-actions/2022/03/08/executive-order-on-prohibiting-certain-imports-and-new-investments-with-respect-to-continued-russian-federation-efforts-to-undermine-the-sovereignty-and-territorial-integrity-of-ukraine>)

60. Ari Natter, Nick Wadhams, and Saleha Mohsin, “U.S. Weighs Sanctions on Russian Uranium Supplier Rosatom,” *Bloomberg*, March 9, 2022. (<https://www.bloomberg.com/news/articles/2022-03-09/u-s-weighs-sanctions-on-russian-nuclear-power-supplier-rosatom>)

61. “Uranium Summary,” *Trading Economics*, accessed December 14, 2022. (<https://tradingeconomics.com/commodity/uranium>)

62. “Ukraine, U.S. Energy Chiefs Talk Rosatom Sanctions,” *Ukrinform* (Ukraine), September 22, 2022. (<https://www.ukrinform.net/rubric-economy/3577345-ukraine-us-energy-chiefs-talk-rosatom-sanctions.html>)

63. Max Hunder, “Ukraine Energy Ministry Deletes Statement on Talk of Possible Rosatom Sanctions,” *Reuters*, September 22, 2022. (<https://www.usnews.com/news/world/articles/2022-09-22/ukraine-us-energy-ministers-discuss-sanctions-on-rosatom-ukrainian-energy-ministry>)

64. “Ukraine Expands Sanctions on the Rosatom Group,” *The Odessa Journal* (Ukraine), September 2, 2022. (<https://odessa-journal.com/ukraine-expands-sanctions-on-the-rosatom-group>); Zaini Majeed, “Zelenskyy Calls for Sanctions Against Russia’s Rosatom Over Situation at Zaporizhzhia NPP,” *Republicworld.com* (India), August 30, 2022. (<https://www.republicworld.com/world-news/russia-ukraine-crisis/zelenskyy-calls-for-sanctions-against-russias-rosatom-over-situation-at-zaporizhzhia-npp-articleshow.html>);

Yogita Limaye, “Inside Chernobyl: We Stole Russian Fuel to Prevent Catastrophe,” *BBC News* (UK), April 9, 2022. (<https://www.bbc.com/news/world-europe-61048256>);

“The Ministry of Foreign Affairs Calls for Sanctions Against Rosatom Due to Russia’s Declaration of Control Over the ZNPP,” *Ukrainska Pravda* (Ukraine), October 5, 2022. (<https://news.yahoo.com/ministry-foreign-affairs-calls-sanctions-184945313.html>);

Matthew Mpoke Bigg, “Russian Shellfire Cuts Power to Ukraine’s Zaporizhzhia Nuclear Power Plant for a Second Time in Five Days,” *The New York Times*, October 12, 2022. (<https://www.nytimes.com/live/2022/10/12/world/russia-ukraine-war-news#zaporizhzhia-nuclear-power-plant-power-cut>);

Drew Hinshaw and Joe Parkinson, “Russian Army Turns Ukraine’s Largest Nuclear Plant into a Military Base,” *The Wall Street Journal*, July 5, 2022. (<https://www.wsj.com/articles/russian-army-turns-ukraines-largest-nuclear-plant-into-a-military-base-11657035694>)

moves forward because some of the EU's 27 members remain dependent on Russian fuel imports and servicing of VVERs. Others are under contractual obligations with Rosatom for years to come.⁶⁵ Hungary's Foreign Minister Peter Szijjarto, whose government is moving forward with construction of Russian reactors, has gone so far as to say that EU restrictions on Hungary's ability to purchase nuclear power plants from Russia would amount to "attacks on our sovereignty."⁶⁶

Eliminating Western and other foreign ties with Rosatom will not be fast or simple. Cancelling projects that began before the invasion of Ukraine could be prohibitively expensive and could have legal ramifications. In some cases, the Russian state has already secured project financing for its customers. Moreover, nuclear power is becoming a more attractive energy source due to fossil fuel shortages and climate change considerations.

RECOMMENDATIONS

The United States should lead a multi-year effort to restrict Moscow's revenue from nuclear exports while curtailing Western dependence on the Russian nuclear industry. Washington should coordinate closely with European allies but be prepared to act alone. It should also move fast enough to have an impact on Rosatom without needlessly rattling energy markets.

Washington and its partners should identify alternative nuclear suppliers and assist Rosatom's other customers in doing the same. The United States should increase its efforts at "friendshoring" — relying on allies and partners, instead of adversaries, for critical supplies — while assisting the U.S. nuclear industry and providing incentives for it to fill gaps, both foreign and domestic.

Sanction Rosatom with Wind-Down Periods. The Biden administration should send a strong signal to the market by sanctioning Rosatom under Executive Order 14024, "Blocking Property With Respect to Specified Harmful Foreign Activities of the Government of the Russian Federation," which the president signed in April 2021.⁶⁷ The sanctions should target entities and individuals who continue business with Rosatom for the construction of new reactors — including projects under contract — and those who send payments to Rosatom.

The administration should inform Rosatom's current partners that the sanctions would eliminate their ability to conduct transactions in U.S. dollars and that Washington is willing to punish those who attempt to circumvent sanctions by using a different currency. The wind-down period for reactor construction could be anywhere from 6-12 months. The sanctions should also apply to other Rosatom-related transactions, specifically the purchase of reactor fuel and other services. These activities could have a longer wind-down period of 1-4 years since alternatives providers may be difficult to identify. The sanctions would put a significant dent in Rosatom's revenue and ensure that international business with Rosatom is on a downward slope leading to a forced exit from the marketplace.

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65. Gabriela Baczyńska, "Poland, Lithuania Want Lower Russian Oil Cap, Nuclear Curbs in New EU Sanctions," *Reuters*, January 13, 2023. (<https://www.reuters.com/world/europe/poland-lithuania-want-nuclear-curbs-new-eu-sanctions-russia-2023-01-13>); Investigate Europe, "Russia's €200M Nuclear Exports Untouched by EU Sanctions," *EU Observer* (Belgium), October 7, 2022. (<https://euobserver.com/world/156226>)

66. "Hungary Opposes EU Sanctions on Russian Nuclear Sector," *EURACTIV.com with Agence France-Presse and Reuters*, September 26, 2022. (<https://www.euractiv.com/section/energy/news/hungary-opposes-eu-sanctions-on-russian-nuclear-sector>)

67. Executive Order 14024, "Blocking Property with Respect to Specified Harmful Foreign Activities of the Government of the Russian Federation," April 15, 2021. (<https://home.treasury.gov/system/files/126/14024.pdf>)

Untangling different countries' dependence on each Rosatom entity, let alone identifying target entities for sanctions, would be a major U.S. government undertaking. Rosatom's dozens of subsidiaries often have their own daughter companies and branches located in Russia and abroad. The International Working Group on Russian Sanctions at Stanford University identified some "262 subsidiaries and 50 affiliated companies."⁶⁸ Such entities include TENEX, which handles uranium enrichment services; TVEL Fuel Company, which produces reactor fuel; Atomenergomash and Atomstroyexport (ASE), which facilitate nuclear power and mechanical engineering projects; Rosenergoatom management; and Rusatom Overseas, which handles reactor construction. Rosatom also provides training to local staff, which presents additional challenges. A full U.S. interagency effort will be required to identify sanctionable entities and potential partners, including senior Rosatom officials.

Identify and Support Alternative Suppliers. Alternative suppliers are emerging or are already available for all stages of the fuel cycle. Nevertheless, for some services, such as uranium conversion and enrichment for reactor fuel, full replacement of Russian services will take time to implement on a commercial scale. In addition, most nuclear service providers prefer to have at least two potential suppliers in case of disruptions. Yet most nuclear reactors already have fuel on hand to last two years or more, providing adequate time to identify alternative suppliers, including for Russian VVERs.

Several countries could readily provide the mined and milled uranium that Russia supplies today: Australia, Canada, Kazakhstan, Namibia, Niger, Tanzania, Uzbekistan, and eventually the United States. For converted uranium, France, Canada, and Japan could begin to serve as suppliers and ramp up production over the course of a few years to replace Russian supplies. Eventually, the United States could as well. In addition, France, Urenco, Urenco USA, and soon other services in the United States could, over the course of several years, supply the enriched uranium fuel that Rosatom provides today. To meet more immediate HALEU needs, the United States is considering down-blending, or making available in a lower purity, its large stock of atomic weapons-grade uranium for HALEU production until enrichment services can meet this demand.

Washington and Europe would need to assist the International Atomic Energy Agency's international low-enriched uranium fuel bank in Kazakhstan, which relies in great part on Russian fuel, to mitigate shortages through supply from alternative sources. The imposition of sanctions on Rosatom will necessitate new sources for this fuel bank. The United States should also resist the urge to rely on Chinese supplies, as this would mean replacing one problem with another.

To encourage new suppliers to enter the marketplace, Washington and its allies will have to make clear they seek a permanent decoupling from the Russian nuclear industry. A study by Columbia University's Center on Global Energy Policy underscored the positive effect of market guidance for the nuclear fuel sector: "mining, conversion, and enrichment suppliers in the West will be looking to national governments to provide clear policies before they invest money in new facilities and capabilities. Their worry will be that in a year or two — perhaps less — Russian uranium products will be allowed back into national markets and will undercut them, causing them to lose out on their investments."⁶⁹

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68. "Working Group Paper #8: Rosatom and Civilian Nuclear Power: Recommendations for Sanctions Against the Russian Federation," *Stanford University, International Working Group on Russia Sanctions*, November 14, 2022. (<https://drive.google.com/file/d/13gO2tQuOaHYFCBTzCMXcaEmNulKEO8fD/view>).

69. Matt Bowen and Paul Dabbar, "Reducing Russian Involvement in Western Nuclear Power Markets," *Columbia University, Center on Global Energy Policy*, May 23, 2022. (<https://www.energypolicy.columbia.edu/research/commentary/reducing-russian-involvement-western-nuclear-power-markets>)

Congress Should Mandate a Strategy to End Reliance on Rosatom. Congress can provide an important — and hopefully bipartisan — imprimatur for these efforts by requiring the president to produce a strategy within 180 days that articulates a multi-year plan to roll back Rosatom’s market share, identify alternative suppliers, and use sanctions authorities — both present and future — to ensure compliance with the strategy. This congressional action should also require the administration to determine whether it should sanction Rosatom under authorities such as the Countering America’s Adversaries through Sanctions Act or the International Emergency Economic Powers Act.⁷⁰

Review the U.S.-Russia Civilian Nuclear Cooperation Agreement. Once the United States has weaned itself off reliance on Russia’s nuclear sector, the Biden administration or a future administration should review the 2011 U.S.-Russia Civilian Nuclear Cooperation Agreement to ensure it codifies the U.S. position opposing future nuclear cooperation with Russia, with potential exceptions for nuclear safety, security, and nonproliferation-related efforts.

CONCLUSION

When the war in Ukraine ends, some may advocate the restoration of the status quo ante in economic relations with Russia. Yet Moscow’s actions have underscored that it is an undesirable and unreliable energy partner. Therefore, trade relationships must change. The long arm of U.S. sanctions would help ensure that countries diversify away from Russian resources and stop enriching the Putin regime.

70. See: Richard Nephew, “The Wisdom of Nuclear Carve-Outs from the Russian Sanctions Regime,” *War on the Rocks*, March 17, 2022. (<https://warontherocks.com/2022/03/the-wisdom-of-nuclear-carve-outs-from-the-russian-sanctions-regime>)

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