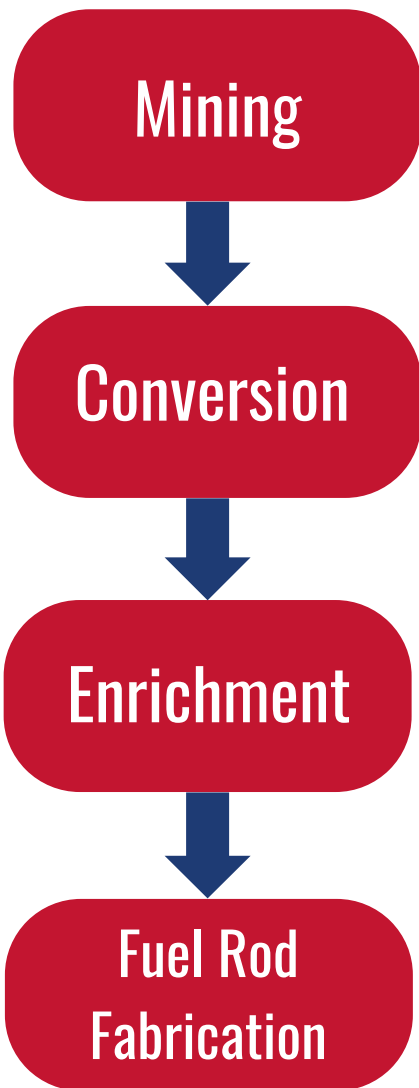


Key Facts

- Russia plays a significant role in global nuclear energy—from the fuel supply chain to the construction of nuclear reactors and the export of nuclear technology.
- Russia is currently the lowest-cost producer of enriched uranium.
- 50% of the uranium used to fuel U.S. nuclear power plants comes from Russia, Kazakhstan, and Uzbekistan.
- Russia has a near-monopoly on high-assay low-enriched uranium that will play an increasingly important role in the U.S. nuclear industry in the coming years.



The most widely used fuel in nuclear fission is uranium. Uranium is commonly found in rocks, but is considered a non-renewable energy source. There are four key steps in the process to convert raw uranium to nuclear fuel rods which are used in nuclear energy: mining/milling, conversion, enrichment, and fuel fabrication. Russia accounts for a large share of the global industry for two of these steps: uranium conversion and uranium enrichment.

Uranium Conversion

Uranium conversion is the second step in the nuclear fuel process. In this step, uranium-oxide, also known as "yellow cake," is converted into gaseous uranium-hexafluoride through a reaction with the chemical fluorine. Uranium-hexafluoride can then be enriched, the final step before the uranium is made into nuclear fuel rods. The only uranium conversion facility in the U.S. closed in 2017, however there are plans to re-open the plant in 2023.

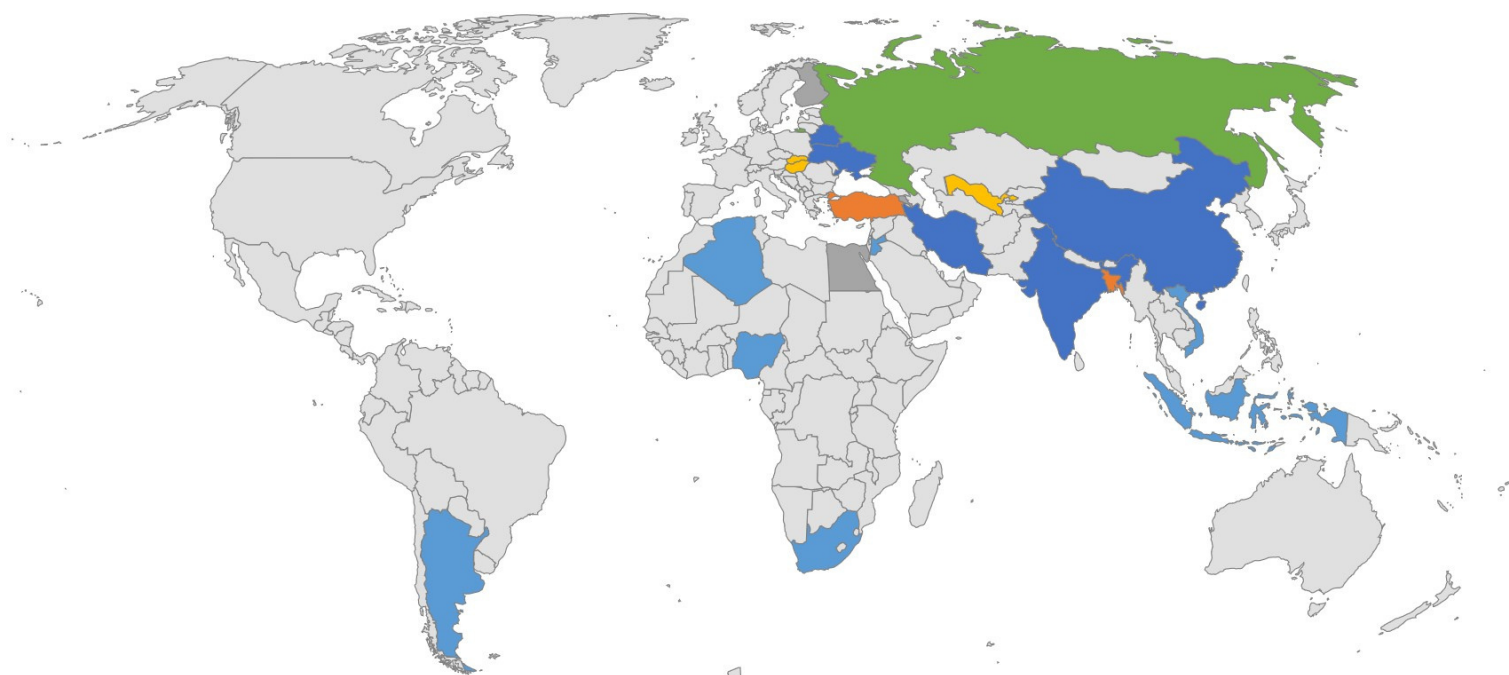
Uranium Enrichment

Uranium enrichment is the third step in the nuclear fuel process. This step is responsible for separating the heavier, and more common, U-238 isotope from U-235 and increasing the concentration of the isotope U-235 in uranium-hexafluoride to a level suitable for nuclear power. Enrichment is currently performed using a gas centrifuge that increases the concentration of U-235 from 0.7% to 3-5%. This 3-5% concentration of U-235 is what is currently used for most commercial nuclear power plants.

Russia's Influence on the Global Nuclear Marketplace

Russia is the lowest-cost producer of enriched uranium. Russia's state nuclear energy corporation, ROSATOM, consists of more than 350 companies and organizations and incorporates companies that includes "all stages of the technological chain, including uranium mining and enrichment, nuclear fuel fabrication, equipment manufactur[ing] and engineering, nuclear power plant operations, and management of spent fuel and nuclear waste." In 2020, Russia was responsible for 40% of global uranium conversion and in 2018 it was responsible for 46% of global uranium enrichment. Any sanctions or embargoes on Russian nuclear fuel would have an immediate impact on the market— disrupting global supply and creating upward price pressures.

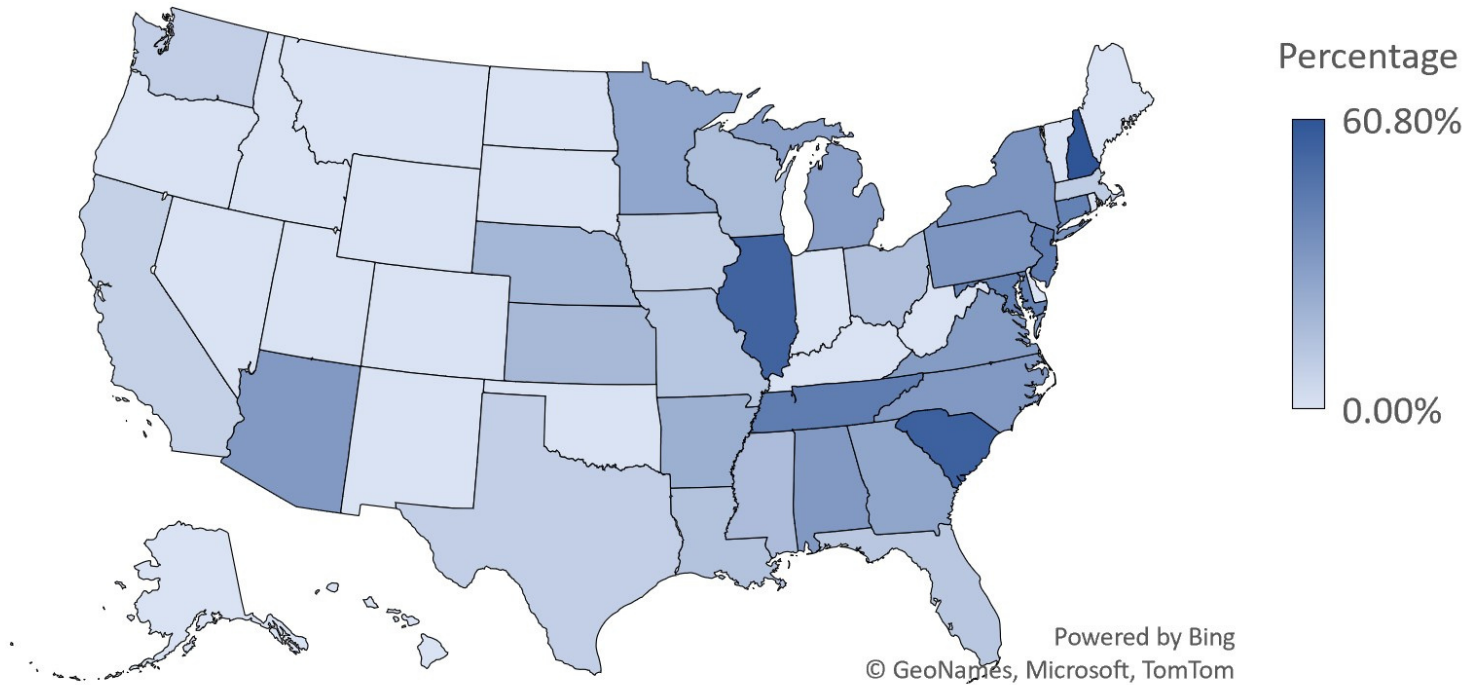
- Operating
- Under Construction
- Contracted
- Ordered
- Proposed
- Russia



The 2021 World Nuclear Association map above shows the countries where Russia has or plans to export its nuclear technology.

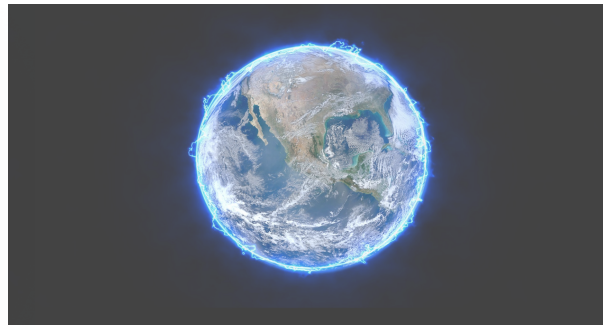
While Russia dominates the global nuclear fuel supply chain, the largest share of revenue for the state is generated through the export of nuclear technology and the construction of nuclear reactors abroad. As of 2022, there were 42 nuclear reactors operating outside of Russia using Russian technology, with 15 more being constructed. In 2019, the Russian State-owned company, Rosatom, made \$1.9 billion in overseas revenue from nuclear reactor construction, equipment, and services.

Percent of Electricity Sourced from Nuclear Power



Using 2019 data from the [Nuclear Energy Institute](#), the map above shows how the percent of electricity sourced from nuclear power by state.

Although a 2020 agreement between the U.S. Department of Commerce and ROSATOM calls for a decrease in the importation of Russian uranium over the next ten years, recent Russian aggression towards Ukraine has underscored vulnerabilities and the geopolitical complications if America continues to rely on Russian energy sources. Nuclear energy plays a significant role in the American clean energy market, currently supplying nearly 55% of all carbon-free electricity. Nuclear power plants generate roughly 20% of all U.S. electricity and produce more electricity on less land than any other zero-emissions energy source. 50% of U.S. nuclear fuel comes from Russia and its Central Asian allies, meaning 10% of American electricity is directly linked to Russian sources. Moreover, Russia currently has a near-monopoly on the commercial production of high-assay low-enriched uranium (HALEU), which will play an increasingly important role in nuclear energy production. HALEU, which has a U-235 concentration between to 5% and 20%, is to be used in most of the new advanced nuclear reactors currently being developed in the U.S.



Clean Energy Transition Implications

Nuclear energy can play a vital role in both the domestic and global clean energy transition. The International Energy Agency (IEA) states that nuclear power (and hydropower) "form the backbone of low-carbon electricity generation." Nuclear fuel produces zero-emissions and minimal waste, and requires relatively low amounts of land, it is a commercially viable alternative to fossil fuels and operates at a much higher capacity factor than other forms of clean energy. According to the U.S. Department of Energy and the Nuclear Energy Institute (NEI), nuclear energy also protects air quality by both preventing emissions and removing thousands of tons of harmful air pollutants that contribute to acid rain, smog, lung cancer, and cardiovascular disease. In 2020, the U.S. avoided more than 471 million metric tons of carbon dioxide emissions thanks to nuclear energy. Consequently, it is extremely important that America stays committed to nuclear energy production and prepare in case Russian uranium is no longer an option.

Domestic Nuclear Sector

Transitioning away from Russian-supplied nuclear fuel is possible, but it requires significant investment from the American government, including infant-industry protection. The U.S. has 90 reactors with operational licenses, but several have retired early, with "more at risk due to relatively low wholesale electricity prices." In 2020, the U.S. International Development Finance Corporation (DFC) revised its nuclear energy policy to allow financing for nuclear power projects and in 2021, the U.S. Department of Energy, through Argonne National Laboratory and the National Nuclear Security Administration (NNSA), stood up the U.S. Nuclear Nexus to support the domestic nuclear industry. There are plans to re-open America's only conversion site, but the plant does not have the capacity to immediately produce the roughly 12,000 tons needed to immediately replace Russian, Kazakh, and Uzbek uranium on the American market. U.S. nuclear power plants keep at least a two-year supply of nuclear fuel on site, so while American nuclear facilities could likely weather an abrupt end to Russian uranium imports, there remains a long-term vulnerability for fuel supply and a need for greater resilience and diversity of sources. Allies such as Canada and Australia have rich raw uranium deposits that could assist in diversifying supply, but the U.S. could greatly boost its own energy security and economic competitiveness by enhancing its domestic uranium enrichment and conversion capacities. The nuclear fuel industry would benefit from additional U.S. government incentives to protect and expand the industry.

Select Nuclear Fuel Supply Legislation

- **S.3856 - Bill to Prohibit the Importation of Uranium from the Russian Federation**
 - In March 2022, Senators John Barasso (R-WY), Cynthia Lummis (R-WY), Roger Marshall (R-KS), and Keven Cramer (R-ND) introduced legislation to ban Russian uranium imports.
- **S.3978 - National Opportunity to Restore Uranium Supply Services in America Act of 2022 (NO RUSSIA) Act of 2022**
 - Also in March 2022, Senators Brasso, Lummis, Marshall, and Cramer introduced S.3978 which would authorize the U.S. Department of Energy to establish a national strategic uranium reserve. It would also increase domestic uranium production, conversion, and enrichment to ensure existing U.S. nuclear reactors have sufficient fuel to continue operating.
- **S.4064 - International Nuclear Energy Act**
 - In April 2022, Senators James Risch (R-ID) and Joe Manchin (D-WV) introduced S.4064 to combat China and Russia's growing influence on the global nuclear market by strengthening the U.S. domestic nuclear sector. The bill calls for increased support to U.S. nuclear companies to both expand nuclear fuel generation and the exportation of nuclear technologies to U.S. allies and partner countries. If passed, the act would help solidify the domestic supply of nuclear fuel and re-establish the U.S. as a leader on the world nuclear market
- **S.4066 - Fueling Our Nuclear Future Act of 2022**
 - Also in April 2022, Senator Barrasso introduced S.4066, which would ensure a domestic supply of HALEU for advanced nuclear reactors. The bill also directs the Department of Energy to prioritize establishing a domestic HALEU enrichment capability and directs DOE to make HALEU available from their inventories to ensure advanced reactors have the fuel they need until U.S. commercial enrichment is available.

Key Takeaways

Russia dominates the international nuclear fuel supply market. It is a leader in global nuclear reactor construction and associated technology, and has been a source for relatively low-cost enriched uranium for American reactors. But in light of Russia's aggression in Ukraine, this influence creates a vulnerability that justifies strengthening the American nuclear sector and building resilience into the nuclear fuel supply chain. Regrowing the domestic nuclear sector will require significant investment from the U.S. government, but it is an investment that is arguably necessary to enhance American energy and national security.