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Fully Fueled: Strengthening America's Nuclear Toolkit

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Takeaways

- A secure nuclear fuel supply chain is a national security imperative. With demand for nuclear energy growing worldwide, the need for nuclear fuel is urgent and critical to international competitiveness.
- Russia and China are boxing the US out of the global nuclear market by dominating uranium enrichment and luring reactor customers with attractive nuclear fuel supply deals. If we don't act, Russia and China will dictate the future of nuclear energy—eroding the highest international standards for safety, security, and nonproliferation.
- The US is racing to catch up by expanding uranium enrichment capacity, but the bipartisan investments Congress has made are not getting out the door quickly enough for US demand, forcing reactor companies to look elsewhere for fuel.
- The Department of Energy must act now. Without swift and strategic action to implement its nuclear fuel availability programs, the US will cede its energy future to geopolitical rivals.

The Race for Global Nuclear Energy Leadership

Nuclear energy demand is surging, and with it, the need for more nuclear fuel. In the US, that need for nuclear energy has spurred bipartisan Congressional legislation, strong Administration support, and private investments. Globally, interest in nuclear is growing rapidly, with over 30 countries, including the US, pledging to triple nuclear energy capacity by 2050.

But we're not the only ones recognizing the need for nuclear power, and therefore nuclear fuel. China and Russia are racing ahead of the US, locking in long-term relationships with other countries through civil nuclear cooperation agreements and dominating the nuclear fuel market while providing further incentives for countries to partner with them. By monopolizing fuel supply chains, they are making the US and our partners dependent on unreliable geopolitical actors. This weakens our ability to enforce the highest standards for nuclear safety, security, and nonproliferation standards.

Developing a nuclear fuel supply chain, especially uranium enrichment, is not just a competition for market share—it's a national security imperative. If we don't act fast, we risk falling behind. We've made some landmark Congressional investments into our fuel supply, but we need to turn those investments into action if we are going to reclaim our place in the global nuclear market.

The Urgency and Scale of the Problem

China and Russia have vastly outpaced the US in global nuclear fuel supply. If we fail to strengthen domestic nuclear fuel production and offer it in the global market, our adversaries will take control of the supply chain. This will leave us vulnerable and cost us a critical opportunity to build up US economic competitiveness.

Our Adversaries Box Us Out of the Nuclear Fuel Market With Attractive Fuel Provisions

Turning uranium ore into usable nuclear fuel requires a complex supply chain. The process of enriching, or concentrating, fissile uranium has long been a key chokepoint in building a robust nuclear fuel supply in the US. [1] For decades, the US has relied on cheap uranium imports from Russia rather than increasing its own domestic enrichment capacity. As a result, US enrichers can only meet about a third of the country's annual need for low-enriched uranium (LEU) for existing reactors.

The capabilities to enrich the high-assay low-enriched uranium (HALEU) needed for advanced and small modular reactors are even more dire. We do not yet have large-scale commercial capacity to produce HALEU fuel. We'll need to scale up enrichment capacity to keep pace with rapidly increasing domestic demand, compete in the global market, and prepare for the next generation of reactors.

Who does have commercial HALEU capacity? Russia. Russia and China also together comprise over 50% of global LEU enrichment capacity. Combine that significant (and cheaper) supply with the inroads they've made into broader nuclear energy cooperation agreements, and they've cracked the code to dominating the nuclear sector and imposing their geopolitical whims on their customers.

China and Russia are also outpacing the US in nuclear cooperation agreements—formal deals that form the foundation for any nuclear exports. Often, Chinese and Russian nuclear agreements with other countries contain fuel cycle provisions to make them more attractive. Russia has been taking this approach to its intergovernmental agreements around the world. Here are recent examples from agreements on construction of new nuclear facilities: [2]

Fuel Provision Examples in Russian Agreements on Construction of New Nuclear Facilities

KEY: YES NO

Client Country	Year	Guaranteed Fuel Supply?	Spent Fuel Takeback?	Fuel Reprocessing in Russia?
Uzbekistan	2018	YES	NO	NO
Egypt	2015	YES	NO	NO
Bangladesh	2012	YES	NO	NO
Belarus	2011	YES	NO	NO
Vietnam*	2011	YES	YES	YES
Türkiye	2010	YES	YES	YES
Venezuela	2010	YES	YES	YES

*Specific fuel reprocessing provision in Russia would return reprocessed material to Vietnam for storage. See attached spreadsheet for full agreement details.

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China has been prioritizing domestic nuclear buildout with 29 reactors under construction, but is poised to rapidly mobilize internationally and offer similar provisions. For example, China's deal to provide nuclear plants to Pakistan includes supplying Chinese fuel to those plants. China is also building out its fuel cycle infrastructure, aiming to meet the entirety of its enrichment needs domestically. While it has focused on meeting its own needs, US and European entities' shift away from purchasing Russian enrichment services has opened the door for China to play a larger role in the enrichment market as Western suppliers hurry to overcome the gap. The US cannot afford to trade its fuel dependence on Russia for dependence on China.

These provisions are attractive because customers in partner countries know they can simply buy fuel from the same entity providing the reactor itself—and when they're done using the fuel (in many cases), they can simply return it to the seller, reducing the burden of spent fuel management. In

addition, in contrast to US nuclear cooperation agreements, these agreements do not restrict partner countries from pursuing uranium enrichment and plutonium reprocessing capabilities—technologies that the US has long and rightfully sought to constrain the spread of due to their sensitivity and potential misuse in advancing nuclear weapons programs.

> *"We chose Russia because they will take back the spent fuel—no other country has agreed to do that."*
> *- former Ambassador of Bangladesh in Russia, Dr. Saiful Hoque.* [3]

Clearly, our adversaries have leveraged their fuel cycle services to incentivize and compel their customers to rely on their products. In contrast to these State-owned suppliers, the US does not include such fuel supply provisions in its cooperation agreements—it's up to the customer to procure fuel from US—or other—companies. Without a "one-stop-shop," the US needs to find other ways to be competitive in the global nuclear market, and that will require swiftly strengthening its own supply chain.

The threat here is twofold. First, such fuel supply agreements further deepen countries' dependencies on China and Russia, leaving them vulnerable to geopolitical pressures from Beijing and Moscow. This weakens global energy security and destabilizes the nuclear fuel supply chain even more. Second, Russia and China's fuel deals expand their market dominance while ignoring strict security and nonproliferation standards, such as restrictions on enrichment and reprocessing. Without a competitive US alternative, we cede market influence, undermine our national security, and lose our ability to shape global nuclear markets.

The US Needs Fuel, Fast

At home, the situation is also dire. In the US, nuclear fuel demand is rising as new "hyperscalers" like data centers drive interest in nuclear energy.

Prior to the ban on Russian uranium imports, Russia supplied nearly 30 percent of US entities' enriched uranium. Currently, the commercial capacity in the US can meet about a third of domestic demand. While the enrichment supplier Urenco is expanding its capacity at its New Mexico facility, the US will still need to build more capacity to keep up with projected nuclear growth. When it comes to ensuring a smooth transition away from reliance on Russia and China, it's important to consider how to do so without creating supply gaps for US-enriched uranium buyers, particularly when utilities

typically only have 1-3 years' worth of fuel in their stockpiles. Compounding the problem is the lack of capacity in other steps of the fuel cycle, especially conversion, to scale up with new enrichment.

At the same time, new small modular reactors (SMRs) and advanced reactors are increasing demand for HALEU. The total quantity the first movers need is much less than the fuel demand for large light water reactors. But unlike LEU, the HALEU market is starting from scratch. There are very clear timelines underway for the first operations of these next-generation reactors, and increasing demand for reactor deployments following initial demonstrations. The most mature projects under the Department of Energy's (DOE) Advanced Reactor Demonstration Program (ARDP) aim to demonstrate their reactors by 2030—and for that, they need fuel. [4]

The longer the US waits for HALEU, the more it jeopardizes advanced nuclear's chance to grow at home. The US and UK are gradually creating HALEU capacity, with the UK investing in its own Urenco HALEU production, but with those capabilities not yet available, reactor developers are forced to look elsewhere—and it's already happening. Terrapower, a flagship recipient of ARDP funding, recently announced they are investigating a partnership with ASP Isotopes, Inc., an American company with operations based in South Africa, to purchase HALEU. Delays in establishing US fuel capacity will only continue to drive companies away from US and allied suppliers.

With many potential export markets eagerly watching the progress of the ARDP, the pressure is on to complete these projects and demonstrate to domestic and international buyers that the US can successfully fuel, license, construct, and operate advanced nuclear. If we are going to keep our adversaries from expanding their influence through nuclear supply agreements, fueling these "first of a kind" (FOAK) projects at home is pivotal.

What Have We Done So Far?

Congress and the previous Administration took significant steps to secure a US fuel supply through legislation with massive bipartisan support and recognition of the national security threat further nuclear fuel reliance on adversaries poses:

- **Funding for HALEU in the Inflation Reduction Act (2022):** Along with other provisions supporting nuclear buildout, including multiple valuable tax credits, the IRA authorized $700M for the HALEU Availability Program—authorized in 2020 under the first Trump Administration—to pursue fuel supply expansion, plus transportation and fuel cycle innovation.

- **Nuclear Fuel Security Act Authorizations (FY24 NDAA):** The NFSA was passed as an amendment to the FY24 National Defense Authorization Act. It built on the IRA's investments to authorize DOE to secure both HALEU and LEU fuel supply chains from Russian suppliers.

- **$2.72B in Appropriations for Fuel Availability (FY24 Appropriations Omnibus):** Authorized by the NFSA, Congress reprogrammed nearly $3B from the Civil Nuclear Credit Program to allow DOE to invest in US HALEU and LEU enrichment capacity.

- **Ban on Russian Uranium Imports (2024):** This ban on the import of Russian enriched uranium provided a forcing mechanism to kickstart US fuel cycle buildout in earnest, particularly for the existing LEU market. Acknowledging the lead time for fuel cycle contracts, this ban includes waivers for decreasing import quantities through 2027.

Meanwhile, DOE has been working to implement the IRA's mandate. A pilot HALEU enrichment plant is operational with DOE's support through the HALEU Demonstration Project. DOE has also issued awards for HALEU enrichment and deconversion. A newer award authorized by the NFSA also aims to increase LEU production capacity in the US. All awardees have been announced—but not a single cent has been spent.

The problem is not a lack of funding or commitment—it's execution. The Department of Energy's Request for Proposal (RFP) process has unfortunately progressed slowly, and risks failing to meet the needs of early advanced reactor developers. Adding to that urgency, Russia could abruptly cut off LEU exports to preempt the waiver drawdown. Moscow has already countered with its own ban and waiver program, although the long-term impact of this restriction is unclear–and the timelines for both HALEU and LEU demand are in danger. However, acting decisively can help mitigate lag and ensure that the investments to date are put to good use.

How Do We Get This Done?

The answer may not be surprising: we must move faster. The longer the US delays standing up reliable supply chains for HALEU and LEU, the more constricted US fuel stockpiles become, and therefore the more leverage our adversaries hold. The substantial funds appropriated and authorized by a bipartisan Congress for DOE's nuclear fuel activities *must* be disbursed to awardees quickly and decisively. Over four years since the Advanced Nuclear Fuel Availability Program was authorized in the 2020 Energy Act, little progress has been made toward fueling new reactors. Now, the Administration has the opportunity for a quick win on nuclear. To effectively implement nuclear fuel programming, the Administration and DOE must do the following:

- **Prioritize review and release of federal funds for nuclear fuel availability pursuant to Executive Order 14154:** President Trump's Day 1 Executive Order, "Unleashing American Energy," calls for halting federal disbursements from programs tied to the Inflation Reduction Act for 90 days or until further review. Given the urgency of establishing a reliable fuel supply and deploying nuclear energy at home and abroad, the Administration must prioritize any necessary review and unfreezing of affected HALEU funds to allow DOE to implement the Advanced Nuclear Fuel Availability Program as quickly as possible and work to meet future deployment needs.

- **Speed task order creation and funds disbursement for HALEU awardees**: DOE has issued one task order (TO) for the four HALEU enrichment awardees, and they do not yet have the financial assurances to truly begin enrichment preparation and activities. To effectively implement this program, DOE must engage closely with awardees to understand what TOs would help advance HALEU enrichment capacity and prioritize timely issuance, collaboration, review, and disbursement for TOs. Unless the HALEU enrichment program is implemented both quickly and in a targeted manner, advanced reactors will remain non-operational, waiting for fuel. At the same time, China and Russia will surge ahead.

- **Design more targeted LEU task orders (TOs) to reduce competition with existing buyers:** As a new market, US HALEU production benefits from government guarantees to purchase quantities of HALEU. However, the mature LEU market already has interested buyers among utility companies and other end users. Therefore, the government purchase contracts proposed for both the HALEU and LEU programs may be counterproductive for LEU by further straining a limited supply by resulting in federal competition with industry buyers. The LEU TOs can be made significantly more effective through alternative approaches that focus on capital expenditures or other incentives that help pay for LEU capacity expansion construction costs at the outset rather than making DOE enter the market as a new buyer and reseller. Reducing upfront uncertainty for potential investors will be the key enabler for an expanded LEU supply—so the TOs to stimulate expansion will require a thoughtful approach.

- **Investigate gaps remaining in the fuel supply chain**: Capacity increases along the fuel cycle will need to rise in tandem to successfully scale up US fuel supply. While the focus is currently on enrichment, there are still serious bottlenecks elsewhere in the fuel cycle: for example, in uranium conversion needed prior to enrichment. DOE should investigate options to support the conversion buildout needed to ensure enrichment facilities can operate at full expanded capacity.

- **Coordinate with allies on strengthening fuel supply:** Regardless of US investment into the fuel cycle, the future of fuel supply will be international. Having exceeded the Sapporo Five Initiative goal of $4.2B in international investments into fuel supply, the US and its allies are now implementing their fuel supply commitments. During this vital implementation period, multilateral or bilateral coordination with our allies is needed to create the most robust, sustainable nuclear fuel supply possible. Leveraging existing capabilities to create a targeted and collaborative plan for fuel cycle development can help reduce redundancies and ensure that the most essential capacity investments are implemented effectively.

Conclusion: Can We Compete?

In short, yes. But we have to act quickly to make sure the massive bipartisan investments of the past several years are not in vain, and enable demonstration and deployment of new reactors. We know that support for this endeavor exists—Secretary Wright's first Secretarial Order detailed the emphasis the Department of Energy places on continuing to make nuclear energy a priority. Now, it's time to support our fuel industry by targeting incentives to kickstart their buildout. The longer we wait, the more entrenched our adversaries become in the nuclear market. If we are going to offer premier nuclear fuel services for domestic reactors and customers abroad, we need to make these efforts a priority.

ENDNOTES

1. While enrichment has been prioritized in Congress, significant gaps exist—and will continue to widen—elsewhere in the fuel cycle, particularly in uranium conversion prior to enrichment.

2. Specific reprocessing provision would return reprocessed material to Vietnam for storage. See attached spreadsheet for full agreement details.

3. deCarbonnel, Alyssa. "Russian Nuclear Ambition Powers Building at Home and Abroad." *Reuters*, 22 Jul 2013. https://www.reuters.com/article/russia-nuclear-rosatom/russian-nuclear-ambition-powers-building-at-home-and-abroad-idUSL5N0F90YK20130722/. Date accessed 26 Feb 2025.

4. Martucci, Brian. "TerraPower Begins Construction at 345-MW Advanced Reactor Site in Wyoming, *Utility Dive*, 12 Jun 2024, https://www.utilitydive.com/news/terrapower-smr-advanced-nuclear-reactor-bill-gates/718722/. Date accessed 26 Feb 2025.; X-energy, "Advanced Nuclear Reactor Project in Seadrift, Texas," https://x-energy.com/seadrift/#timeline. Date accessed 26 Feb 2025.