Recycling Reconsidered: Unlocking the Value of Spent Nuclear Fuel

October 2025

NUCLEAR INNOVATION ALLIANCE

Recycling Reconsidered:

Unlocking the Value of Spent Nuclear Fuel

NUCLEAR INNOVATION ALLIANCE

Author:
Erik Cothron

Acknowledgements:
NIA would like to thank Oklo, SHINE Technologies, and Zeno Power, and the Atlantic Council Nuclear Energy Policy Initiative for their valuable contributions to the development of this report. Their input, feedback, and subject matter expertise helped inform the development of this publication, strengthen the analysis performed, and improve the final product.

October 2025

This report is available online at:
https://nuclearinnovationalliance.org/resources

Table of Contents

Executive Summary:

Spent nuclear fuel (SNF) reprocessing and recycling makes it possible to recover valuable radioactive isotopes to fuel new nuclear reactors, support life-saving medical treatments, and even power deep-sea and deep-space missions.[1, 2,3] At the same time, it can reduce the total volume of SNF by up to 80% and lower its radiotoxicity by 90%.[4]

Despite these advantages, SNF reprocessing and recycling has historically been considered economically prohibitive because of the low cost of uranium, the high cost of building reprocessing and recycling infrastructure, and a policy status quo that favors a once-through fuel cycle. However, the nuclear energy landscape has undergone significant changes over recent years. Advanced reactor designs, new fuels, and evolving political and social dynamics open the door to a more practical and economically viable future for SNF reprocessing and recycling.

To take full advantage of this new landscape and accelerate progress, the current U.S. policy framework for SNF management must adapt. The goal must be a coherent, industry-led, government-enabled system that enables reprocessing and recycling innovation.

This report highlights the commercial, political, and social value proposition of SNF reprocessing and recycling in today's nuclear landscape (*see chapters 1 and 2*) and recommends policy changes that can help accelerate private sector reprocessing and recycling efforts (*see chapter 3*). The policy recommendations provided in chapter 3 are as follows:

- DOE's Loan Programs Office should finance SNF reprocessing and recycling projects.
- DOE should affirm it will retain responsibility for accepting and disposing of residual waste generated during private-sector reprocessing and recycling activities.
- DOE should establish policies that enable industry to access DOE-owned SNF for reprocessing and recycling activities.

Together, these recommendations will help the United States move toward a national SNF reprocessing and recycling strategy that establishes clear responsibilities for ownership, liability, and disposal obligations before, during, and after reprocessing.

---

[1] In this report, *reprocessing* refers to the chemical separation of usable materials while *recycling* refers to the reuse of recovered nuclear materials.
[2] World Nuclear Association | Radioisotopes in Medicine
[3] Zeno Power | Nuclear Batteries Powering the Frontier
[4] Orano | From Exploration to Recycling

Introduction:

While countries such as France, Japan, and Russia have developed robust commercial reprocessing and recycling programs, the United States has not. The only U.S. commercial-scale recycling facility, located in West Valley, New York, operated from 1963 to 1972 but ultimately closed due to several issues, including economic viability.[5] Decades later, in 2007, construction began on another U.S. reprocessing and recycling facility called the Mixed Oxide Fuel Fabrication Facility (MFFF) at the Department of Energy's (DOE's) Savannah River Site in South Carolina. However, the project was terminated in 2018 due to cost overruns, construction delays, and shifting federal priorities. Since then, DOE has funded research into SNF reprocessing and recycling, but the United States remains without a single operational commercial-scale reprocessing or recycling facility.

Today, more than 95,000 metric tons of commercial SNF remain in dry and wet storage at reactor sites nationwide.[6] The federal government is contractually obligated to take ownership of this SNF and move it to a permanent repository or consolidated interim storage facility, but no such facility currently exists. As a result, the federal government is in breach of contract with nuclear energy utilities and continues to reimburse them for storing SNF onsite, with expenditures already exceeding $11.1 billion.[7] On top of that, DOE estimates its future liability to exceed $44.5 billion, and that amount increases by roughly $2.5 billion each year.[7] This stockpile of SNF, while safely managed for decades, represents political gridlock, unresolved social concerns, significant costs borne by taxpayers, and a missed opportunity to repurpose this valuable material. However, recent advances in nuclear energy technologies, fuels, and bipartisan national security priorities could transform this liability into a strategic asset. These advances reflect how the nuclear energy landscape has undergone significant changes over recent years.

While the primary purpose of SNF reprocessing and recycling is to recover fuel for commercial power reactors, it can also provide valuable radioisotopes that can be sold for reuse in nuclear medicine, deep-sea and deep-space applications, and other industries (see Figure 1 below). This wide range of opportunities offers new revenue streams that can improve the value proposition of SNF reprocessing and recycling and shift the underlying economic conditions that govern it. At the same time, new political and social rationales can also shift that value proposition. Recycling offers a path to a more reliable and secure supply of U.S. nuclear fuel for advanced reactors, lowering our dependency on foreign suppliers like Russia, while reducing our SNF inventory. These political and social rationales reflect

---

[5] Two other recycling facilities, the Morris Facility in Illinois and the Barnwell Facility in South Carolina, were constructed in the 1970s but never became operational.
[6] U.S. Department of Energy | Inside One of the Nation's Biggest Research Projects on Spent Nuclear Fuel
[7] American Nuclear Society | U.S. spent fuel liability jumps to $44.5 billion

increased federal interest in recycling, as evidenced by Executive Orders 14299 and 14302, as well as the introduction of the bipartisan Nuclear REFUEL Act.[8]

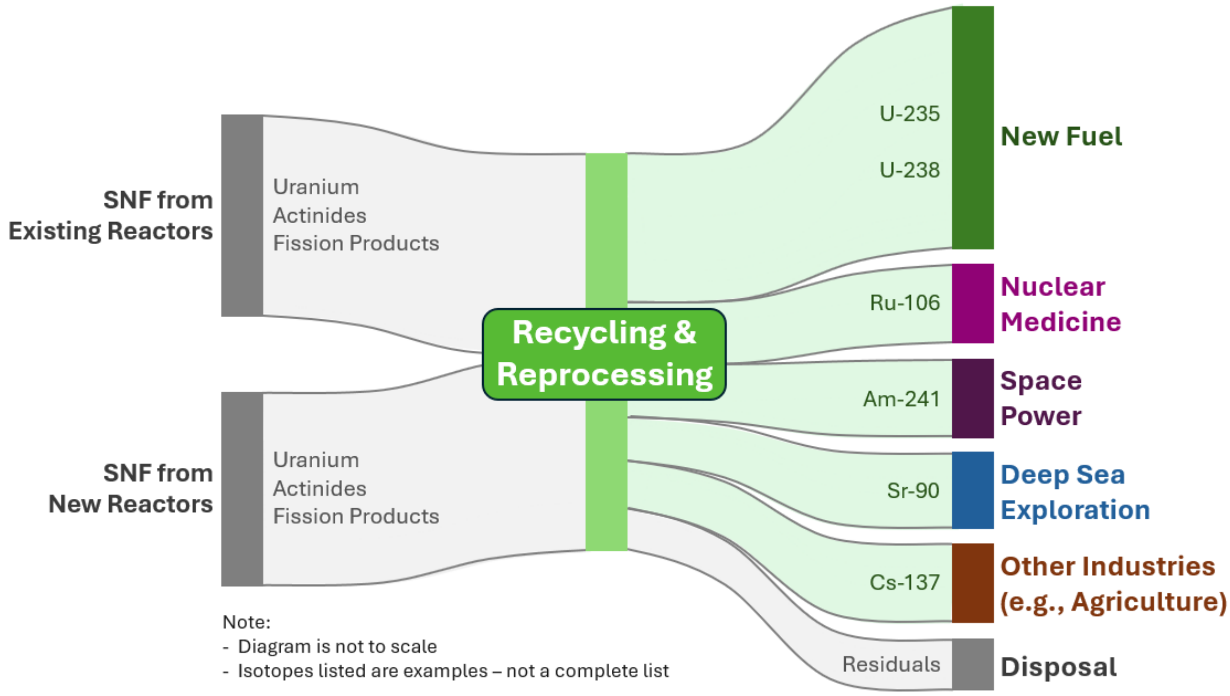

Figure 1: Sankey Diagram of the SNF Reuse

Despite this new nuclear energy landscape, the status quo is that the broader federal policy landscape does not incentivize private sector-led reprocessing and recycling. Existing federal policies do not yet fully reflect the needs of a rapidly evolving nuclear energy sector to enable reprocessing and recycling innovation. An industry-led, government-enabled reprocessing and recycling strategy is needed.

While nuclear weapons proliferation issues are beyond the scope of this report, it is important to acknowledge that any reprocessing and recycling efforts must be paired with robust safeguards and nonproliferation measures. An effective reprocessing and recycling strategy must prevent the diversion or theft of nuclear material, the misuse of dual-use technologies, and the operation of undeclared facilities.[9] With that in mind, the goal of this report is to inform a forward-looking strategy for SNF reprocessing and recycling by identifying its commercial, political, and social value proposition, and outlining how the federal government can help accelerate private-sector efforts.

---

[8] Executive Order 14299 | Deploying Advanced Nuclear Reactor Technologies for National Security; Executive Order 14302 | Reinvigorating the Nuclear Industrial Base; Nuclear REFUEL Act
[9] American Nuclear Society | Policy Statement 55 - Nonproliferation

1. Commercial Rationale for Reprocessing and Recycling

While historically viewed as cost-prohibitive, new reactor technologies along with advanced fuel designs and emerging business models are reshaping the underlying economic principles that govern reprocessing and recycling.

1.1 Innovative Technologies

The economics of reprocessing and recycling depend on the characteristics of the fuel itself, including its level of enrichment, fuel form, isotopic composition, burnup, and the compatibility of SNF with specific reprocessing methods. More highly enriched fuels, like high-assay low-enriched uranium (HALEU), contain a greater concentration of fissile material, which greatly impacts the economic viability of recovering valuable radioisotopes. New fuel forms, like metallic fuels, can be more easily recycled compared to oxide-based fuels, reducing the complexity and cost of recycling. This new technological landscape represents a significant departure from the recycling economics of traditional low-enriched uranium (LEU) oxide fuels.

New reprocessing methods like pyroprocessing offer several advantages over traditional aqueous techniques such as Plutonium Uranium Recovery by Extraction (PUREX). Pyroprocessing is an electrochemical process that separates usable uranium and transuranics from SNF (see Figure 2 below). Unlike traditional aqueous reprocessing methods like PUREX, pyroprocessing uses molten salts and metal electrodes to separate usable materials from waste without producing pure plutonium, which enhances proliferation resistance. It offers a wider range of potential pathways to commercialize reprocessing and recycling technologies, allowing industry to evaluate and select approaches that best align with their economic and operational needs.

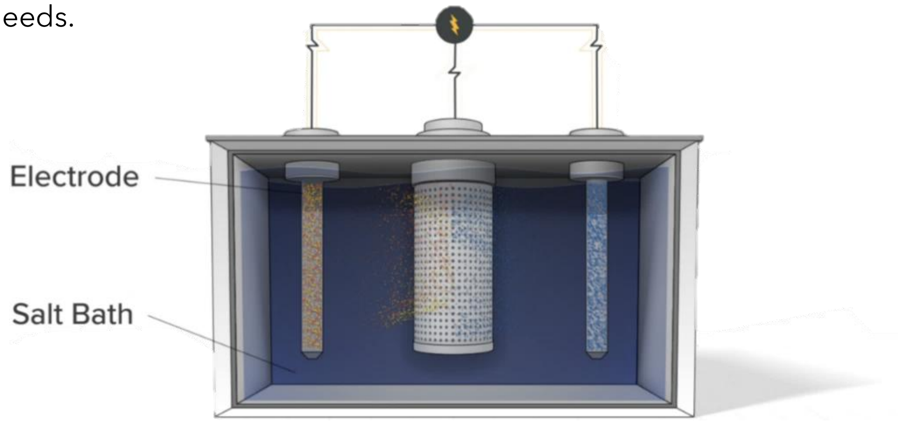

Figure 2: Depiction of the Pyroprocessing Reprocessing Method[10]

[10] Oklo | Fuel Recycling

Pyroprocessing is currently being performed at Idaho National Laboratory (INL) to reprocess legacy SNF from the EBR-II reactor.[11] Some of the material that is being recovered from EBR-II will go to the advanced reactor developer Oklo and will power their sodium-cooled reactor. This effort is supported by federal agencies such as the Advanced Research Projects Agency (ARPA-E) and is enabled by Oklo's collaboration with the national laboratories, underscoring the critical role of public-private partnerships in advancing nuclear innovation. Additionally, Oklo plans to use pyroprocessing for their recently announced $1.68 billion recycling facility that they plan to construct in Oak Ridge, Tennessee.[12]

Liquid-fueled molten salt reactors (MSRs) offer an entirely new pathway to reprocess and recycle SNF. These designs enable in-situ separation and recycling by chemically treating the fuel while the reactor is in operation, allowing for continuous reprocessing without the need to extract solid SNF (see Figure 3 below). Similarly, fast neutron reactors offer the capability to consume and recycle transuranic elements from legacy SNF, converting long-lived isotopes into usable energy. These new and innovative use cases for radioisotopes also strengthen the commercial rationale for reprocessing and recycling.

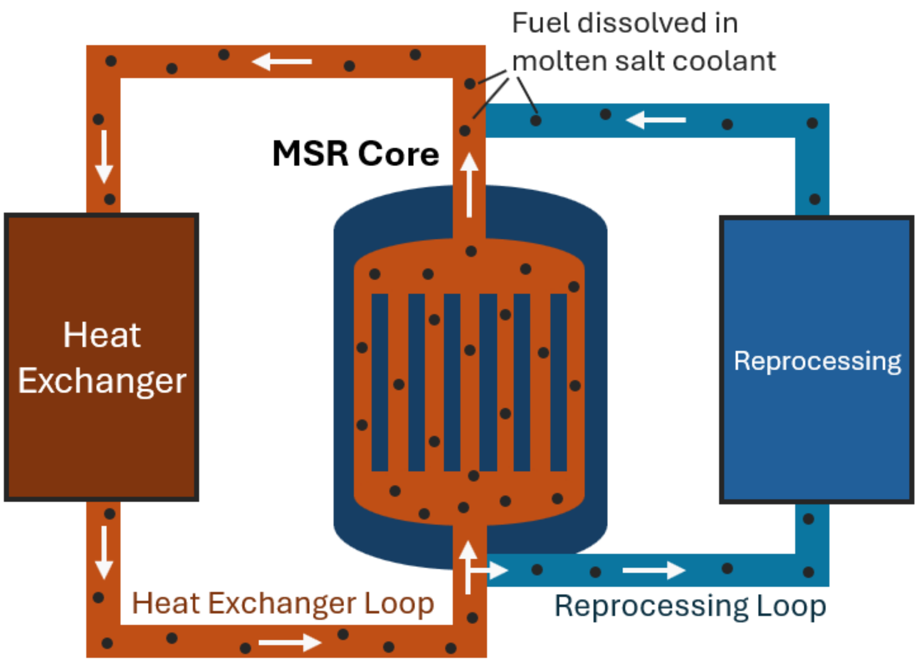

Figure 3: In-Situ Reprocessing in a Molten Salt Reactor[13]

---

[11] The EBR-II (Experimental Breeder Reactor-II) was a sodium-cooled fast reactor that operated from 1964 to 1994.
[12] Oklo | Oklo Announces Fuel Recycling Facility as First Phase of up to $1.68 Billion Advanced Fuel Center in Tennessee
[13] Adapted from: Wu et al. "A Review of Molten Salt Reactor Multi-Physics Coupling Models and Development Prospects", 2022

1.2 Powering New Frontiers

Certain deep-space, deep-sea, and Arctic missions require compact, long-duration power systems when alternative forms of energy are not feasible or reliable. Recycled isotopes such as strontium-90 and americium-241 can be used in “nuclear batteries” which convert heat generated from radioactive decay into electricity to provide mission-critical power. For example, strontium-90 is a radioactive isotope that is generally viewed as waste but generates a small amount of heat by emitting a beta particle (i.e., an electron) each time it decays. That heat can be captured by a thermoelectric generator, which converts thermal energy into electricity without the need for a reactor or moving parts. With a half-life of 28.91 years, strontium-90 can provide reliable power for decades, making it ideal for long-duration missions.

Companies such as Zeno Power are developing next-generation radioisotope power systems (RPSs) that use radioisotopes like strontium-90 and americium-241 to provide clean, reliable power for deep-space, deep-sea, and Arctic missions. Because these isotopes are found in SNF, they can be recovered and sold to companies that need them, thereby increasing the value proposition of reprocessing and recycling.

Removing isotopes like strontium-90 and americium-241 for use in RPSs can also simplify the management of SNF because they account for a substantial portion of SNF’s heat load and radiotoxicity when the SNF is less than 100 years old. By extracting them for productive use, the remaining material becomes significantly cooler and less hazardous, reducing radiological handling challenges and expanding the range of viable geological repository options.

1.3 Enabling Nuclear Medicine & Diagnostics

Radioisotopes have a wide range of applications in the medical industry, from diagnosing diseases through advanced imaging techniques such as PET scans, to treating cancers with targeted radiotherapy, and even sterilizing medical equipment. Radioisotopes such as cesium-137, Strontium-90, and americium-241 are found in SNF and could be recovered from SNF reprocessing and sold for use in the medical industry to create a valuable revenue stream that supports future recycling efforts.

Cesium-137 is a common fission product found in SNF that is used in a cancer treatment known as brachytherapy, where sealed radioactive sources are placed directly into or near a tumor.[14] The gamma radiation from cesium-137 helps shrink or destroy cancer cells, and it has been used to treat cancers like cervical and prostate cancer.

[14] Washington State Department of Health | Cesium-137 Fact Sheet 320-077

Strontium-90 and ruthenium-106 are beta-emitting fission products also found in SNF.[15] Both isotopes are used in cancer treatment by delivering radiation directly to small or hard-to-reach tumors. They are especially useful for treating eye cancers, where a small device containing these isotopes can be placed near the tumor to deliver a focused dose of radiation. Strontium-90 also decays to yttrium-90, an isotope widely used to treat liver cancer by injecting tiny radioactive beads into blood vessels that feed tumors. This method targets cancer while minimizing damage to healthy tissue. In some cases, strontium-90 has also been used to help relieve pain caused by cancer that has spread to the bones.

Americium-241 is a decay product of plutonium-241 and is used in certain medical imaging devices, particularly for scanning the thyroid.[16] Instead of putting radioactive material into the body, doctors can use a small external source of americium-241 to emit gamma rays toward the thyroid. These rays cause iodine in the thyroid to emit a detectable signal that can captured and converted into an image. This technique helps visualize the thyroid without exposing the patient to internal radiation.

1.4 Strengthening Agricultural Production

Certain radioisotopes are used in several agricultural processes. Food irradiation for sterilization helps ensure that foods can be stored for years without refrigeration. Sterilized foods are also critical in hospitals, particularly for patients with severely compromised immune systems.

Irradiation can also be used for environmentally friendly pest control. Sterile Insect Technique (SIT) is a process that uses ionizing radiation to sterilize male insects that have a significant negative impact on agricultural production. Cesium-137, an isotope found in SNF, can be used for each of these agricultural processes.

1.5 Navigating Uranium Market Volatility and the Front End of the Fuel Cycle

Dramatic swings in uranium prices over the past two decades and uncertainty about future prices have created significant volatility in global uranium markets (see Figure 4).[17] Over the past several years, uranium prices have risen sharply. In July 2021, the long-term price of uranium was $33.50 per pound. Just four years later, in July 2025, the price had increased by a factor of 2.4 to $80 per pound.

---

[15] National Library of Medicine | The Use of Strontium-90 Beta Radiotherapy as Adjuvant Treatment for Conjunctival Melanoma; BMC | Ruthenium-106 eye plaque brachytherapy in the management of medium sized uveal melanoma
[16] Springer Nature | Medical Uses: Americium-241; Californium-252
[17] Cameco | Uranium Price

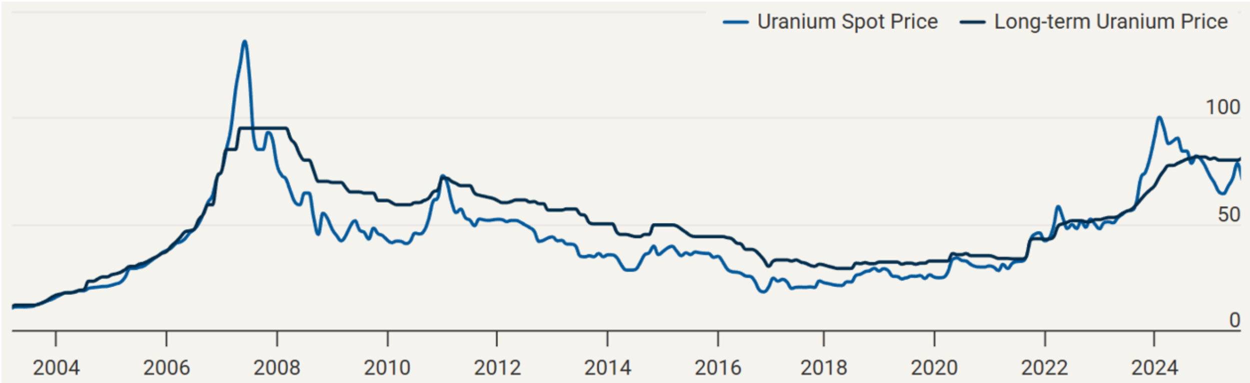

Figure 4: Price of uranium over the past two decades[18]

This recent price increase stems from several factors, including geopolitical tensions and rising global energy demand driven by AI and data centers. These trends have renewed interest in nuclear energy and increased uranium demand. The Russian invasion of Ukraine also underscored Russia's position as an unreliable trading partner. This, in turn, disrupted uranium supply chains by limiting uranium supply and forcing many countries to seek access to new sources of uranium to meet their demand. U.S. energy security concerns over dependence on Russian uranium have also intensified as a result. In May 2024, Congress passed the Prohibiting Russian Uranium Imports Act, which bans imports of natural and low-enriched uranium from Russia beginning in August 2024, with limited waivers allowed through 2027.

One significant impact on the price of uranium also occurred in March 2021 when China released its 14th Five-Year Plan.[19] This plan called for the construction of nearly 150 new nuclear reactors over the next 15 years. At that time, prices were near their lowest point in two decades but started to increase dramatically due to this new massive demand signal. Before that announcement, prices had actually dramatically decreased from the record highs seen during the "nuclear renaissance" era in the late 2000s.

The high volatility of uranium prices, combined with recent price increases, strengthens the value proposition and commercial rationale for SNF reprocessing and recycling. As commodity costs increase and geopolitical instability grows, reprocessing may present a commercially more attractive pathway to improve fuel security and reduce lifecycle costs for advanced nuclear systems.

In addition to fluctuations in the price of uranium, uncertainty exists in the United States' ability to expand its capacity to convert, enrich, deconvert, and fabricate new nuclear fuel.

---

[18] Cameco | Uranium Price
[19] Center for Security and Emerging Technology | Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035

These processes are essential for transforming mined uranium into reactor-ready fuel, yet they face significant bottlenecks due to limited U.S. infrastructure to support the front end of the fuel cycle. The United States has several initiatives aimed at overcoming these bottlenecks;[20] however, reprocessing and recycling SNF offers a strategic solution to relieve pressure on the front end of the fuel cycle. By recovering usable fissile material from SNF, recycling can reduce the amount of fresh uranium that must be mined, converted, enriched, and fabricated into nuclear fuel. This not only lowers dependence on volatile commodity markets but also reduces the scale of the capacity expansion required across the front end. In effect, recycling allows the nuclear fuel supply chain to be partially sustained from the back end, creating a more resilient and diversified system.

2. Political and Social Rationale for Reprocessing and Recycling

SNF reprocessing and recycling presents a compelling case on both political and social levels. Politically, it supports global nuclear leadership, strengthens energy security, enables advanced reactor deployment, and builds resilient supply chains. Socially, it offers a pathway to foster public trust in SNF management, reduce waste volume and toxicity, address legacy stewardship concerns about SNF in host communities, and unlock broader support for new nuclear development. Together, these political and social rationales are integral to advancing a commercial SNF reprocessing and recycling strategy that aligns with U.S. policy objectives and public interests.

2.1 Global Leadership and Export Competitiveness

It is critical that the United States develop commercial SNF reprocessing and recycling capabilities to strengthen its position as a global leader in nuclear innovation. Doing so would also enhance U.S. competitiveness in the international nuclear energy export market.

Countries such as France and Russia have existing capacity to recycle and offer closed fuel-cycle solutions as part of their nuclear export packages. For example, France has a long-standing history of reprocessing and recycling SNF from nations including Japan, Germany, and Belgium. These international partnerships demonstrate how reprocessing and recycling can support global collaboration and establish lasting relationships, all within a broader export strategy. Meanwhile, China is currently operating a pilot-scale reprocessing facility and is actively constructing a commercial-scale plant to expand its domestic recycling capacity.

[20] U.S. Department of Energy | HALEU Availability Program; U.S. Department of Energy | Defense Production Act Consortium

Without a U.S. option for recycling and closed fuel-cycle services, countries may look elsewhere to meet their long-term fuel management needs.

Establishing U.S. reprocessing and recycling capabilities will enhance the nation's ability to compete in global nuclear markets, offer full-service nuclear partnerships to allies, and become global leaders in SNF recycling. To enable this full-service model, the U.S. must establish not only domestic reprocessing and recycling capabilities, but also a clear policy framework for responsibly managing foreign SNF. By developing secure take-back policies with strong safeguards, the U.S. can unlock strategic partnerships, strengthen global competitiveness, and lead the next generation of closed fuel-cycle innovation.

2.2 Advanced Reactor Supply Chain Security

Reprocessing and recycling strengthen the nuclear fuel supply chain by reducing reliance on foreign suppliers such as Russia and enabling a more resilient fuel cycle for both civilian and defense applications. By establishing domestic reprocessing and recycling capabilities, the United States can recover usable fissile material from SNF to produce new fuel, such as high-assay low-enriched uranium (HALEU), for use in advanced reactor designs.

A steady HALEU supply is critical to the success of DOE-supported public-private initiatives and future deployments, including the Advanced Reactor Demonstration Program (ARDP), Generation III+ Small Modular Reactor Program, DOE's Reactor Pilot Program, and follow-on commercial projects. While DOE is actively working to establish domestic enrichment capacity for HALEU, reprocessing and recycling can serve a valuable supplemental and complementary role.

The Department of Defense (DoD) also requires access to HALEU to support emerging mobile nuclear power systems, such as Project Pele, while NASA is pursuing Fission Surface Power systems for the Moon. These projects will depend on a reliable HALEU supply chain to ensure operational readiness.

2.3 Supply Chain Security

The supply chain for certain medical isotopes and isotopes used in RPSs is at high risk of disruption due to aging production facilities, a limited number of global suppliers, and geopolitical instability.[21] For example, global production of ruthenium-106 is limited.[22] This critical isotope, as discussed in section 1.3, is used to treat ocular melanoma and prostate cancer, and only a handful of reactors and facilities are capable of producing it at scale.

---

[21] World Nuclear Association | Radioisotopes in Medicine

[22] PW Consulting Chemical & Energy Research Center | Ruthenium-106 Market

Russia currently dominates the global ruthenium-106 supply chain, accounting for most of the global output. This raises concerns about the resilience of international access to this isotope. Expanding domestic production of these isotopes through recycling presents a key opportunity to improve supply chain resilience and reduce dependence on foreign sources.

RPSs deliver a reliable source of energy for many DoD and NASA applications but a large-scale supply chain for RPS radioisotopes does not currently exist. While strontium-90 and americium-241 are abundant in SNF, they are only easily accessible when SNF is reprocessed. NASA and the DoD have expressed concerns that legacy supplies of these isotopes will not meet their future RPS demands.

By establishing reprocessing and recycling facilities that incorporate the separation of isotopes for both medical treatments and RPS applications, the United States can meet critical national security and scientific needs for the DoD and NASA while securing more reliable access to life-saving radioisotopes.

2.5 Public Acceptance Through Innovation

Social concerns about nuclear waste management are among the main reasons that the public and communities oppose new nuclear projects. This opposition can significantly delay or even derail efforts to deploy advanced nuclear energy technologies. While reprocessing and recycling cannot completely eliminate the need for long-term disposal of radioactive material, it significantly reduces the volume of that material, offering a viable path forward.

A long-term recycling strategy that closes the fuel cycle demonstrates that industry is seeking to address these concerns head-on. If the public sees that SNF inventories can be repurposed, reused, or removed, opposition to new nuclear power plants may lessen.

Public acceptance is especially critical in communities currently hosting SNF, many of which never consented to long-term storage. Recycling provides a pathway to remove SNF from these sites, potentially allowing host communities to avoid waiting for the establishment of a permanent repository or a consolidated interim storage facility.

Earning public support through reprocessing and recycling can unlock additional political support to advance policies and investments needed to scale advanced nuclear technologies. Concerns about long-term waste management are a key reason federal, state, and local policymakers object to supporting new reactor projects. When policymakers see that the industry is pursuing credible long-term solutions, and that public concerns are being addressed, it becomes easier to move the nuclear energy industry toward a closed fuel-cycle.

Reprocessing and recycling offer an innovative approach to SNF management. It can help overcome political opposition during siting and development and strengthen the overall case for nuclear energy deployment.

3. Enabling Private-Sector Leadership in Reprocessing and Recycling

A domestic commercial recycling program must be driven by private-sector innovation. Industry is best positioned to develop the technologies, business models, and deployment strategies needed to make recycling technically viable and economically scalable, but policy changes are needed to create the right incentives and reduce taxpayer liability. DOE has a critical role in enabling private-sector innovation by creating the conditions for success.

Historically, federal support for SNF reprocessing and recycling has been inconsistent. For example, the Bush administration established the Global Nuclear Energy Partnership (GNEP) to demonstrate technologies needed to implement a closed fuel-cycle, but the program was canceled under the Obama Administration before any demonstration projects could proceed.[23] This lack of sustained support has persisted for decades, undermining progress and contributing to political uncertainty.

Most recently, the second Trump administration signed Executive Orders 14299 and 14302, which include multiple directives intended to support reprocessing and recycling to strengthen the domestic nuclear fuel cycle.[24] For example, Section 5(c) of Executive Order 14299 authorizes DOE and DoD to utilize all available legal authorities to site, approve, and authorize the construction of a privately funded nuclear fuel reprocessing and recycling facility. Section 5(a) of the Executive Order also directs DOE to identify all useful uranium and plutonium material within DOE's inventories that may be recycled or processed into nuclear fuel for reactors in the United States. This new political environment presents a major opportunity for the federal government and the private sector to act decisively and translate this momentum into lasting progress.

DOE must establish a stable policy foundation to enable private sector innovation and accelerate the efforts to commercialize SNF reprocessing and recycling. A national SNF reprocessing and recycling strategy should establish clear responsibilities for ownership, liability, and disposal obligations before, during, and after reprocessing. This includes during transportation, operations, and storage. To unlock private-sector investment in reprocessing and recycling, DOE needs to work collaboratively with industry to identify needs, clarify responsibilities, and make full use of existing programs such as DOE's Loan Program's Office (LPO) to ultimately provide the contracts, guidance, and policies needed to accelerate progress.

---

[23] Federal Register | Notice of Cancellation of the Global Nuclear Energy Partnership (GNEP) Programmatic Environmental Impact Statement (PEIS)

[24] Nuclear Innovation Alliance | Fact Sheet: President Trump's Nuclear Energy Executive Orders

3.1 Enabling LPO to Finance Reprocessing and Recycling

DOE's LPO provides direct loans and loan guarantees for emerging technologies that have been technically demonstrated but are not currently commercially viable.[25] It has issued tens of billions of dollars of loans to private companies to help transform the energy sector and is used as a tool to de-risk first-of-a-kind energy infrastructure and support commercialization efforts.

LPO currently supports projects across advanced nuclear generation, renewable energy, advanced fossil technologies, advanced manufacturing, and more. However, LPO does not issue loans or loan guarantees for reprocessing and recycling projects. Congress, through the Energy Policy Act of 2005 (codified at 42 U.S.C. § 16513), explicitly authorized LPO to support "advanced nuclear energy facilities, *including manufacturing of nuclear supply components for advanced nuclear reactors*."[26] This authority allows LPO to finance projects that are part of the front-end of the fuel cycle, including uranium conversion, enrichment, and fuel fabrication, but excludes back-end projects like reprocessing and recycling.

Reprocessing and recycling arguably fall within the definition of "*manufacturing nuclear supply components for advanced nuclear reactors*" and should therefore be eligible for LPO financing. However, DOE has determined that these activities are not currently covered under existing authority. Therefore, DOE should revise its interpretation of this statutory language to include reprocessing and recycling facilities. If DOE determines that it cannot do this under existing law, Congress should amend the Energy Policy Act of 2005 to explicitly authorize LPO to issue loans and loan guarantees for reprocessing and recycling projects.

Reprocessing and recycling face the same financing challenges that LPO was created to solve, i.e. large capital costs, long project timelines, and a need to complement private financing with federal support. Thus, allowing LPO to finance reprocessing and recycling aligns directly with its statutory mission to accelerate high-impact energy projects.

If LPO can finance front-end fuel cycle projects that provide fuel for reactors, it should be able to finance reprocessing and recycling projects that also help provide fuel. Extending eligibility to reprocessing and recycling would ensure consistent policy across the entire nuclear fuel cycle. It would acknowledge that strengthening the nuclear fuel supply does not end with enrichment and fabrication but also includes recovering usable material from SNF. Recycling enables reactors, and enabling technologies are exactly what LPO was created to support.

---

[25] U.S. Department of Energy Loan Programs Office | Overview
[26] 42 U.S.C. § 16513

Policy Recommendation: *DOE's Loan Programs Office should finance SNF reprocessing and recycling projects. Either DOE should revise their interpretation of 42 U.S.C. § 16513 or through other means or, if DOE determines a statutory change is needed, Congress should amend the Energy Policy Act of 2005 to explicitly include reprocessing and recycling among LPO's eligible project categories.*

3.2 Ownership and Disposal Obligations

SNF reprocessing and recycling generates residual radioactive materials with varying levels of radiotoxicity. This "residual waste" requires different handling and disposal methods depending on its specific nuclear waste classification, and some material will require permanent disposal in a geological repository. Under the Nuclear Waste Policy Act (NWPA), the federal government's current disposal obligations focus on taking title to SNF and high-level waste (HLW) from commercial nuclear reactors for final disposal. This assumes a once-through fuel cycle and does not specifically address how ownership and disposal responsibilities work in a closed fuel-cycle where reprocessing and recycling occur.

Under this framework, it is generally assumed that DOE will retain the responsibility for disposing of residual waste generated during reprocessing and recycling, but this obligation is not explicitly defined in statute or in the standard disposal contracts (SDCs) that govern DOE's role. While DOE's disposal obligation likely extends to residual waste generated during reprocessing and recycling facilities, additional clarification from DOE to confirm this would provide greater certainty and predictability for the private sector.

It would also be beneficial for DOE to affirm its disposal obligations when material ownership transfers between private entities, such as when original generators of SNF lease or transfer ownership to a separate private entity responsible for performing reprocessing activities. This additional certainty would help determine whether DOE's statutory and SDC obligations remain when a change in private ownership occurs, or whether agreements under the SDC can be assigned to a new entity.

To support industry-led reprocessing and recycling efforts, DOE must retain responsibility for accepting and disposing of the residual waste generated, regardless of changes in ownership. But first, DOE must clearly affirm their ownership and disposal responsibilities under existing law. DOE could do this by issuing guidance, codifying its responsibilities, or by other means. Ideally, DOE would work with industry and key stakeholders to identify the solution that is best suited to help accelerate private-sector-led reprocessing and recycling efforts.

Policy Recommendations: *DOE should affirm it will retain responsibility for accepting and disposing of residual waste generated during private-sector reprocessing and recycling activities.*

3.3 Private-Sector Access to DOE-Owned SNF for Reprocessing and Recycling

If industry pursues recycling activities after DOE has taken title of SNF, DOE will need to make the SNF available to industry for reprocessing and recycling, either through lending the SNF or temporarily transferring ownership of the material. This scenario would occur if DOE accepted ownership of SNF for storage at a consolidated interim storage facility or permanent repository before industry starts recycling activities. While most recycling activities are likely to occur before DOE takes title to SNF, it is possible that some may begin afterward, so this scenario is worth addressing.

Currently, there is no mechanism for DOE to lend or transfer SNF back to industry for reprocessing and recycling and then take back the residual HLW generated during reprocessing and recycling for disposal. Without such a mechanism, industry would lose access to SNF once DOE has taken title, effectively blocking private-sector efforts to recycle it. This would limit the nation's ability to recover valuable materials, reduce waste, and support advanced fuel cycles. Therefore, a solution is needed to allow DOE to temporarily make SNF available for reprocessing and recycling while maintaining federal responsibility for disposal. To enable private sector reprocessing and recycling efforts, DOE must develop clear policies that allow for providing DOE-owned SNF to industry for reprocessing and recycling purposes. DOE must also determine if additional authorizations from Congress or amendments to existing statute (e.g., the NWPA) are needed to establish these policies. Ultimately, DOE and industry must work together to identify what changes must be made to existing statute, including the NWPA, and Congress must work to enact those changes.

DOE's Office of Environmental Management (EM) handles the transfer and disposal of low-level waste (LLW) and has established mechanisms for transferring LLW to industry or commercial disposal facilities. This is typically done through Basic Ordering Agreements (BOAs) and task orders with private vendors, allowing DOE to retain ownership of the waste while outsourcing treatment and disposal.[27] These activities show that DOE already has useful mechanisms to transfer LLW to commercial entities. DOE should leverage this model and expand its application to enable the transfer and recycling of SNF.

---

[27] U.S. Department of Energy | DOE Awards Basic Ordering Agreements for Nationwide Low-Level and Mixed Low-Level Waste Treatment Services

Policy Recommendation: *DOE should establish policies that enable industry to access DOE-owned SNF for reprocessing and recycling activities.*

Conclusion

As the nuclear sector evolves, SNF reprocessing and recycling is becoming an even more viable strategy to fuel new nuclear reactors, recover valuable isotopes for other applications, and reduce SNF inventories. Reprocessing and recycling can transform the United States' SNF liability into a strategic asset. It offers a pathway to reduce the volume, heat load, and long-term toxicity of SNF, while also unlocking valuable materials for advanced reactors, national security missions, and commercial applications.

The current U.S. policy framework for SNF management assumes a once-through fuel cycle that does little to accelerate private-sector innovation in reprocessing and recycling. If the United States seeks to remain a global leader in nuclear energy innovation, it must apply the same level of focus and attention to closing the fuel cycle as it does to advancing reactors and front-end fuel cycle technologies.

Policy changes, including the ones discussed in this report, can help establish a stable foundation for a domestic, successful, private sector-led reprocessing and recycling industry. By embracing an industry-led, government-enabled approach, the United States can catalyze innovation, strengthen its global leadership in reprocessing and recycling, and build a more resilient and sustainable nuclear future.