

**ONE MAN’S TRASH: SPENT FUEL RECYCLING AS A
PATH FORWARD FOR THE U.S. NUCLEAR ENERGY
INDUSTRY**

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ABSTRACT

The U.S. nuclear energy industry currently operates using an open fuel cycle in which uranium is mined for fuel, used in reactors once, and then disposed of. The alternative is a closed fuel cycle where spent nuclear fuel from reactors is reprocessed and reused. As the modern-day nuclear industry seeks to expand, the shortcomings of the closed fuel cycle are becoming apparent and may stifle further growth. This Note explores a series of historical events and policy choices dating back to the early days of the country's nuclear industry to explain why the United States currently has an open fuel cycle. It then compares the parallel history of France's nuclear industry as an example of why and how a country might choose a closed fuel cycle. Through this comparative and by underscoring the harms of the country's current system for sourcing nuclear fuel and disposing of nuclear waste, I argue that it is not only possible but fundamentally necessary for the United States nuclear industry to shift towards a closed fuel cycle, and propose methods for doing so, including a tax credit for fuel reprocessing.

INTRODUCTION

This Note was written at what feels like a crossroads. While renewable energy generation methods like solar and wind have become more efficient and widespread, our overall electricity demand has skyrocketed due to the proliferation of data centers and electric vehicles. As we search for ways to generate more electricity than ever before while still meeting our decarbonization goals, we have given renewed attention to nuclear energy. This Note examines a problem that throttled the industry during its early development and remains unsolved in the United States: the safe disposal of spent nuclear fuel. I argue that the best path forward for the expansion of the U.S. nuclear energy industry is to adopt a "closed cycle" system, in which spent nuclear fuel is recycled and reused for electricity generation.

In Part One, I explain why the United States' current open fuel cycle for nuclear energy production is insufficient to meet increased

demand. This Part discusses the problems that arise at both ends of the cycle, namely sourcing new fuel and storing spent fuel.

In Part Two, I explore past efforts to recycle spent nuclear fuel in the United States and the regulatory and economic reasons that led us away from reprocessing. This section will provide the necessary historical and technical foundation to understand the current state of nuclear waste policy, why the United States nuclear industry currently operates using an open fuel cycle, and why a closed fuel cycle is the best path forward for the future of nuclear energy.

In Part Three, I provide a comparative analysis of the world's largest nuclear energy producer: France, whose industry operates using a closed fuel cycle. France's successful implementation of a closed fuel cycle chiefly influenced the system advocated for herein, evidencing that large-scale fuel reprocessing is possible, and is achievable for the U.S.

In Part Four, I discreetly recommend how to close the fuel cycle in the United States, guided by France's leadership in this area and past shortcomings in the U.S. industry. These recommendations are tax subsidies for private recycling operations, or the creation of a centralized, federally operated recycling facility.

PART I: THE WASTE PROBLEM

A. THE UNITED STATES' INCREASING ENERGY DEMAND

In our popular imagination, nuclear waste is the stuff of nightmares. It's the glowing green ooze overflowing from barrels at Mr. Burns's power plant in *The Simpsons*, causing Springfield's fish to grow extra eyes.¹ It's what blinded the Marvel superhero Daredevil and mutated the Teenage Mutant Ninja Turtles.² People or ideas considered unpleasant and controversial are deemed

1. THE SIMPSONS: *Hello Gutter, Hello Fadder* (Fox television broadcast, aired Nov. 14, 1999).

2. Michael Jung, *Ninja Turtles and Marvel's Daredevil Share The SAME Origin*, SCREEN RANT (Feb. 1, 2020), <https://screenrant.com/ninja-turtles-daredevil-same-origin-ooze/>.

“radioactive.”³ Public concern about the safe disposal of waste is one of the primary reasons the nuclear power industry has stagnated in the United States,⁴ with more than a third (and in some polls, over half) of Americans disfavoring the use of nuclear power for electricity generation entirely.⁵

Nuclear power is primed for a renaissance. The need for energy generation is increasing. After more than a decade of flat demand, electricity consumption in the United States has grown at a rate of 1.7% per year since 2020.⁶ As the rise of power-hungry AI data centers reshapes the energy landscape, that number may double to a 3.5% increase per year between 2025 and 2040.⁷ Planned projects from OpenAI alone would draw more electricity than New York City and San Diego combined,⁸ and electricity supply is the biggest bottleneck on continued AI development.⁹

Electric vehicles and rail will further increase electricity demand as the country seeks to decarbonize the transportation sector.¹⁰ A long-

3. *Radioactive*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/radioactive> (last visited Apr. 8, 2026).

4. *See generally* PUBLIC REACTIONS TO NUCLEAR WASTE: CITIZENS' VIEWS OF REPOSITORY SITING (Riley E. Dunlap, Michael E. Kraft, & Eugene A. Rosa eds., 1993), <https://doi.org/10.2307/j.ctv125jtmg>.

5. Megan Brenan, *Nuclear Energy Support Near Record High in U.S.*, GALLUP (Apr. 9, 2025), <https://news.gallup.com/poll/659180/nuclear-energy-support-near-record-high.aspx>.

6. Mark Schipper & Tyler Hodge, *After More than a Decade of Little Change, U.S. Electricity Consumption Is Rising Again*, U.S. ENERGY INFO. ADMIN. (May 13, 2025), <https://www.eia.gov/todayinenergy/detail.php?id=65264>.

7. Adam Barth et al., *Powering A New Era Of US Energy Demand*, MCKINSEY & CO. (Apr. 29, 2025), <https://www.mckinsey.com/industries/public-sector/our-insights/powering-a-new-era-of-us-energy-demand>.

8. Eva Roytburg, *Sam Altman's AI Empire Will Devour as Much Power as New York City and San Diego Combined. Experts Say It's 'Scary'*, FORTUNE (Sept. 24, 2025), <https://fortune.com/2025/09/24/sam-altman-ai-empire-new-york-city-san-diego-scary/>.

9. *See* Cy McGeady et al., *The Electricity Supply Bottleneck on U.S. AI Dominance*, CTR. FOR STRATEGIC & INT'L STUD. (Mar. 3, 2025), <https://www.csis.org/analysis/electricity-supply-bottleneck-us-ai-dominance>.

10. U.S. DEP'T OF ENERGY ET AL., *THE U.S. NATIONAL BLUEPRINT FOR TRANSPORTATION DECARBONIZATION: A JOINT STRATEGY TO TRANSFORM TRANSPORTATION* 43 (2023), <https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf>.

term strategy plan published by the White House in 2021 called for an 80-100% reduction of carbon emissions from transportation by 2050.¹¹ Doing so could require up to 3,000 terawatt-hours of electricity per year for plug-in electric vehicles.¹²

The United States must accommodate this spike in demand while reducing carbon emissions overall. Failure to increase supply could result in grid instability, rolling blackouts, and increased prices for consumers.¹³ Failure to use clean energy sources, on the other hand, would mean contributing to the worsening gap between current global emissions and those necessary to limit warming to two degrees Celsius.¹⁴ The Biden White House's target of reducing its net greenhouse gas emissions by 61–66% below 2005 levels by 2035¹⁵ is both feasible and necessary.¹⁶ As the world's largest producer of greenhouse gas emissions historically,¹⁷ the United States must play its part in reaching global net-zero by 2050.¹⁸ The overwhelming scientific consensus is that failure to do so would have catastrophic consequences for climate change, including rising sea levels,

11. U.S. DEP'T OF STATE & EXEC. OFF. OF THE PRESIDENT, THE LONG-TERM STRATEGY OF THE UNITED STATES: PATHWAYS TO NET-ZERO GREENHOUSE GAS EMISSIONS BY 2050 (2021), <https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf>.

12. Christopher Hoehne et al., *Exploring Decarbonization Pathways for USA Passenger and Freight Mobility*, 14 NATURE COMM'NS 6913 (2023), <https://doi.org/10.1038/s41467-023-42483-0>.

13. Ken Silverstein, *As AI Booms, Data Centers May Create Electricity Scarcity Among Users*, FORBES (Dec. 15, 2025), <https://www.forbes.com/sites/kensilverstein/2025/12/15/as-ai-booms-data-centers-may-create-electricity-scarcity-among-users/>.

14. See U.N. ENVTL. PROGRAMME, EMISSIONS GAP REPORT 2025: OFF TARGET – CONTINUED COLLECTIVE INACTION PUTS GLOBAL TEMPERATURE GOAL AT RISK (2025), <https://wedocs.unep.org/items/9f0bf855-2069-42a6-a856-4b389f740c5c>.

15. U.S. DEP'T OF STATE, THE UNITED STATES' NATIONALLY DETERMINED CONTRIBUTION: REDUCING GREENHOUSE GASES IN THE UNITED STATES: A 2035 EMISSIONS TARGET 2 (2024), <https://unfccc.int/sites/default/files/2024-12/United%20States%202035%20NDC.pdf>.

16. Jake Schmidt & Amanda Levin, *U.S. 2035 Climate Target Is Ambitious, Achievable & a Call to Action*, NAT'L RES. DEF. COUNCIL (Dec. 19, 2024), <https://www.nrdc.org/bio/jake-schmidt/us-2035-climate-target-ambitious-achievable-call-action>.

17. *Id.*

18. *Net Zero Coalition*, UNITED NATIONS, <https://www.un.org/en/climatechange/net-zero-coalition> (last visited Oct. 27, 2025).

worsening extreme heat events and storms, and droughts and flooding that may affect food availability.¹⁹

B. THE UNITED STATES' PREFERENCE FOR NUCLEAR ENERGY

Whether the increased demand described above can be met by renewables is uncertain, as the One Big Beautiful Bill Act, passed in July of 2025, removed or reversed many of the federal tax credits on which the industry previously relied for new development.²⁰ The second Trump administration²¹ has been openly opposed to funding renewable energy projects, even discontinuing funding for projects already underway. In October of 2025, the U.S. Department of Energy cancelled 321 financial awards amounting to \$7.5 billion, which would have provided funding support for 223 clean energy projects.²² The administration is particularly hostile to the wind industry²³ and has targeted offshore wind, cancelling \$679 million in federal funding for wind power²⁴ and issuing a moratorium on new

19. *See generally* RICHARD JOY, UNSUSTAINABLE: THE URGENT NEED TO TRANSFORM SOCIETY AND REVERSE CLIMATE CHANGE (2021), <https://doi.org/10.2307/j.ctv20hcs3q>; CONG BUDGET OFF., THE RISKS OF CLIMATE CHANGE TO UNITED STATES IN THE 21ST CENTURY (2024), <https://www.cbo.gov/publication/61146>.

20. One Big Beautiful Bill Act § 70512, Pub. L. No. 119-21, 139 Stat. 72 (2025); *See* PHILLIP BROWN, CONG. RSCH SERV., R42576, U.S. RENEWABLE ELECTRICITY: HOW DOES THE PRODUCTION TAX CREDIT (PTC) IMPACT WIND MARKETS? 3–5 (2012).

21. Donald Trump's second term as President began on January 20, 2025. *See* Amy Tikkanen & Kenny Chmielewski, *Second Cabinet of Donald Trump*, ENCYC. BRITANNICA, <https://www.britannica.com/topic/Second-Cabinet-of-Donald-Trump> (last updated Mar. 4, 2026).

22. Press Release, U.S. Dep't of Energy, Energy Department Announces Termination of 223 Projects, Saving Over \$7.5 Billion (Oct. 1, 2025), <https://www.energy.gov/articles/energy-department-announces-termination-223-projects-saving-over-75-billion>.

23. Donald Trump has been an outspoken critic of wind power for decades, stemming from his personal feelings about the aesthetics of the turbine, which he refers to as “windmills.” Kevin Keane & Aimee Stanton, *How Trump's Loathing for Wind Turbines Started with a Scottish Court Battle*, BBC (Jul. 29, 2025), <https://www.bbc.com/news/articles/c1513knp4xyo>.

24. Michael Copley, *Trump Administration Halts Work on an Almost-Finished Wind Farm*, NPR (Aug. 23, 2025), <https://www.npr.org/2025/08/23/nx-s1-5513919/trump-stops-offshore-wind-renewable-energy>; Lauren Sommer, *Trump*

offshore wind leasing on the Outer Continental Shelf.²⁵ Trump's Department of the Interior even issued a stop work order on the Revolution Wind project off the coast of Rhode Island, which was already around 80% complete, citing vague "concerns related to the protection of national security interests."²⁶

If the second Trump administration's energy policy can be defined by an animosity toward renewables, it can also be defined by an enthusiasm for nuclear. In May of 2025, President Trump issued a series of four executive orders to "usher in a nuclear energy renaissance."²⁷ The first ordered the reform of the Nuclear Regulatory Commission (NRC) and overhaul of its process for new reactor licensing.²⁸ The second shifted responsibility over deploying new reactor designs away from the NRC and towards the Department of Energy (DOE).²⁹ The third directs the Department of Defense (DOD) to create a program for using nuclear energy to power U.S. military bases abroad, and to deploy a nuclear reactor at a domestic

Administration Cancels \$679 Million for Offshore Wind Projects at Ports, NPR (Aug. 31, 2025), <https://www.npr.org/2025/08/31/nx-s1-5522943/trump-offshore-wind-energy-ports>.

25. Presidential Memorandum of January 20, 2025, "Temporary Withdrawal of All Areas on the Outer Continental Shelf from Offshore Wind Leasing and Review of the Federal Government's Leasing and Permitting Practices for Wind Projects," The White House, <https://www.whitehouse.gov/presidential-actions/2025/01/temporary-withdrawal-of-all-areas-on-the-outer-continental-shelf-from-offshore-wind-leasing-and-review-of-the-federal-governments-leasing-and-permitting-practices-for-wind-projects/>.

26. That order was later overturned by a federal judge, and the project, which will supply 704MW of energy to Rhode Island and Connecticut when completed, was allowed to resume. Letter from Matthew N. Giacona, Acting Director, Bureau of Ocean Energy Mgmt., to Rob Keiser, Head of Asset Mgmt., Ørsted N. Am. Inc. (Aug. 22, 2025), https://www.boem.gov/sites/default/files/documents/renewable-energy/Director%26%23039%3BsOrder-20250822.pdf?VersionId=VO3AWAHsV_kDvT048xf8dG7A.Rsj6HZJ; *Revolution Wind LLC v. Burgum*, No. 1:25-cv-02999, slip op. (D.D.C. Sept. 22, 2025) (order granting preliminary injunction); *About Revolution Wind*, REVOLUTION WIND, <https://revolution-wind.com/about-revolution-wind> (last visited Nov. 12, 2025).

27. Press Release, The White House, President Trump Signs Executive Orders to Usher in a Nuclear Renaissance, Restore Gold Standard Science (May 23, 2025), <https://www.whitehouse.gov/articles/2025/05/president-trump-signs-executive-orders-to-usher-in-a-nuclear-renaissance-restore-gold-standard-science/>.

28. Exec. Order No. 14300, 90 Fed. Reg. 22587 (May 23, 2025).

29. Exec. Order No. 14301, 90 Fed. Reg. 22591 (May 23, 2025).

military base or installation by September 30, 2028.³⁰ The fourth calls for improvements to domestic fuel cycle infrastructure, including uranium enrichment and conversion as well as spent fuel recycling and disposal.³¹ These Executive Orders pave the way for the DOE's goal of quadrupling American nuclear energy capacity from 100 gigawatts (GW) to 400GW by 2050.³²

C. ROADBLOCKS TO THE EXPANSION OF THE U.S. NUCLEAR INDUSTRY

1. *The Waste Problem*

None of the executive orders previously described address the green elephant in the room: spent nuclear fuel. As this paper will demonstrate, there exists a supply problem and a storage problem. Our current “once-through”³³ or “closed cycle” system, in which nuclear fuel is mined, processed, used for a period of only several years, and then discarded while still highly radioactive and dangerous (and still full of energy generation potential), is needlessly wasteful and presents significant problems that will limit the development of the nuclear energy industry. This paper will advocate for shifting towards an “open cycle” in which spent nuclear fuel is recycled and reused.³⁴ “Nuclear waste” only exists as a policy choice; a better U.S. nuclear policy must embrace once-used uranium fuel not as waste, but as an untapped resource.

2. *The Supply Problem*

Any increase in nuclear energy production will require a corresponding increase in fuel supply. But our current system for sourcing nuclear fuel relies on extracting raw uranium from the earth

30. Exec. Order No. 14302, 90 Fed. Reg. 22595 (May 23, 2025).

31. Exec. Order No. 14303, 90 Fed. Reg. 22601 (May 23, 2025).

32. Exec. Order No. 14300, 90 Fed. Reg. 22587 (May 23, 2025) (Ordering the Reform of the Nuclear Regulatory Commission).

33. MARK HOLT & LANCE N. LARSON, CONG. RSCH. SERV., R48364, CONSIDERATIONS FOR REPROCESSING OF SPENT NUCLEAR FUEL 3 (2025).

34. See INT'L ATOMIC ENERGY AGENCY [IAEA], THE NUCLEAR FUEL CYCLE (2019), <https://www.iaea.org/sites/default/files/19/02/the-nuclear-fuel-cycle.pdf>.

at increasing economic and environmental cost.³⁵ Because carbon emissions from nuclear energy are drastically lower than those from fossil-fuel-generated energy,³⁶ nuclear is sometimes erroneously classified alongside other low-carbon methods of energy generation, like wind and solar, as a renewable energy source.³⁷ Alternatively, some proponents of nuclear believe that because uranium is abundant in nature, uranium fuel exists in functionally unlimited supply.³⁸ Neither is the case.

It's true that uranium is not a rare mineral, and in fact, it is more common in the earth's crust than gold, silver, and tin. But only uranium, in its mineral form, located close enough to the earth's surface to be mined economically, is useful for energy production.³⁹ *The Red Book*, a report by the Nuclear Energy Agency and the International Atomic Energy Agency (IAEA), estimates the amount of uranium that can be mined at an economically viable cost of \$130 per kg to be 5,925,700 metric tons globally.⁴⁰ To recover a few million more, up to 7,935,000 metric tons, the cost per kilogram would double to \$260.⁴¹ The report estimates that uranium fuel resources will be depleted in about 100 years based on current usage.⁴²

Putting aside concerns about supply, uranium mining is destructive to both the natural environment and human health. The

35. See discussion *infra* section I(C)2.

36. Olivia Lai, *Nuclear Energy Carbon Emissions Lowest Among Electricity Sources*, UN Reports, EARTH.ORG (Nov. 24, 2021), <https://earth.org/nuclear-energy-carbon-emissions-lowest-among-electricity-sources-un-reports/>.

37. See *Nuclear Plant Failure (TL0208)*, U.N. OFF. FOR DISASTER RISK REDUCTION (Jun. 7, 2023), <https://www.undrr.org/understanding-disaster-risk/terminology/hips/tl0208>.

38. See *Will We Run Out of Uranium?*, CANADIAN NUCLEAR SOC'Y, <https://www.cns-snc.ca/learn-nuclear/basics-of-nuclear/will-we-run-out-of-uranium/> (last visited Apr. 8, 2022).

39. *What is Uranium?*, URANIUM PRODUCERS OF AM., https://www.theupa.org/what_is_uranium/ (last visited Apr. 8, 2026).

40. NUCLEAR ENERGY AGENCY [NEA] & INT'L ATOMIC ENERGY AGENCY [IAEA], URANIUM 2024: RESOURCES, PRODUCTION AND DEMAND 26 (30th ed. 2025), https://www.oecd-nea.org/jcms/pl_103179/uranium-2024-resources-production-and-demand?details=true.

41. *Id.*

42. *Id.*

overwhelming majority of uranium is extracted through pit mining, divided about evenly between open-pit and underground mines.⁴³ In either case, a milling operation, typically on-site, is employed to separate yellowcake uranium⁴⁴ from the rest of the ore.⁴⁵ After the yellowcake is extracted, up to 99.6% of the ore is disposed of as tailings, which, in addition to being radioactive, contain toxic heavy metals including arsenic and mercury.⁴⁶ Even if tailings are safely managed, this operation produces dust that is extremely toxic if inhaled.⁴⁷ Lung diseases, including cancer, are recognized as job hazards for uranium mine workers,⁴⁸ and while most uranium mines are sited a considerable distance from population centers, a recent spike in cardiovascular and metabolic disease in the Navajo population near Grants Mining District in New Mexico is thought to be linked to exposure to dust contaminated with uranium.⁴⁹

There are myriad environmental harms from open-pit mining, which involves removing soil from the surface to access a mineral deposit; this creates a pit that becomes progressively deeper and wider as mining progresses, and ceases once all the ore has been

43. *Id.* Open pit mining is done by removing soil and rock directly from the surface to get to the ore; the pit grows deeper and wider as time goes on in order to reach new deposits. *Id.* Underground mining is done using shafts and tunnels and has less disruption to the surface. *Id.*

44. Yellowcake is a powdered concentrate of approximately 80% uranium oxide that is recovered from the raw ore, named for its bright yellow color. Yellowcake is an intermediate step in the creation of uranium fuel. *Yellowcake*, U.S. NUCLEAR REGUL. COMM'N, <https://www.nrc.gov/reading-rm/basic-ref/glossary/yellowcake> (last visited Mar. 6, 2026).

45. Cathy J. Dewar, Linda Harvey & Cathy Vakil, *Uranium Mining and Health*, 59 CANADIAN FAM. PHYSICIAN 469, 469 (2013), <https://pmc.ncbi.nlm.nih.gov/articles/PMC3653646/>.

46. *Id.*

47. See generally Eshani Hettiarachchi et al., *Mineralogy Controlled Dissolution of Uranium from Airborne Dust in Simulated Lung Fluids (SLFs) and Possible Health Implications*, 5 ENVTL. SCI. & TECH. LETTERS 158 (2019), <https://pmc.ncbi.nlm.nih.gov/articles/PMC6372124/>.

48. Health Res. & Servs. Admin., *Radiation Exposure Screening & Education Program: Clinical Guidelines: Uranium Mine Workers*, U.S. DEP'T OF HEALTH & HUM. SERVS., <https://www.hrsa.gov/sites/default/files/hrsa/rural-health/grants/mine-worker-clinical-guidelines.pdf> (last visited Nov. 12, 2025).

49. Hettiarachchi et al., *supra* note 47.

extracted.⁵⁰ One such site, the Jackpile-Paguate open pit mine complex in New Mexico, covered 7,900 acres with a maximum depth of 625 feet.⁵¹ That represents 7,900 acres of habitat destruction, notwithstanding the water, soil, air, and noise pollution resulting from active mining. Though mining operations ceased in 1982, the area remains a superfund site.⁵² Remediation of pit mines after operations cease can be costly, time-consuming, and litigious, if it occurs at all.⁵³ Pit mines are scars on the surface of the earth, and no amount of remediation can fully cure the harm caused by such drastic demolition of the landscape.

While uranium may currently be relatively cheap and abundant, more fuel cannot be mined indefinitely, and uranium ore will become continuously more costly, difficult, and harmful to acquire as the most accessible deposits are used up. If we want to grow the nuclear industry, we must move beyond the idea that the best way to generate more fuel is to mine more yellowcake uranium. Recycling spent nuclear fuel can drastically reduce or eliminate the need to continually mine uranium ore.

3. *The Storage Problem*

In the New Mexico desert, there is a hole in the ground that cost federal taxpayers about \$15 billion to dig.⁵⁴ It is currently not being used for any purpose. This is the legacy of the Yucca Mountain Nuclear Waste Repository, a failed project that represents one of the enduring roadblocks to expanding the U.S. nuclear industry: storage

50. Scott Rhode & Antonio Lopez, *Open Pits or Underground Ops*, ALASKA BUS. MAG., no. 11, Nov. 2021, <https://digital.akbizmag.com/issue/november-2021/open-pits-or-underground-ops/>.

51. Bruce Thomson, *The Environmental Legacy of Uranium Mining and Milling in New Mexico*, in NEW MEXICO GEOLOGICAL SOCIETY 195 (Bonnie A. Frey et al. eds., 2021), <https://doi.org/10.56577/FFC-71.195>.

52. *Superfund Site: Jackpile-Paguate Uranium Mine, Laguna Pueblo, NM*, U.S. ENVTL. PROT. AGENCY, <https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0607033> (last visited Nov. 12, 2025).

53. *United States v. Newmont USA Ltd.*, No. CV-05-020-JLQ, 2008 WL 4614230 (E.D. Wash. Oct. 17, 2008).

54. U.S. GOV'T ACCOUNTABILITY OFF., GAO-21-603, COMMERCIAL SPENT NUCLEAR FUEL: CONGRESSIONAL ACTION NEEDED TO BREAK IMPASSE AND DEVELOP A PERMANENT DISPOSAL SOLUTION 2 (2021), <https://www.gao.gov/products/gao-21-603>.

of spent fuel. The storage of spent fuel is an existential problem in an open or once-through fuel cycle, as energy generation creates a byproduct that remains extremely hazardous and difficult to dispose of. In this section, I will discuss the federal government's attempt and failure to create a central nuclear waste repository, and problems emerging from private industry's efforts to handle spent fuel, both of which threaten to bottleneck the United States' ability to expand nuclear energy production.

The debate over who should be responsible for storing nuclear waste, and where, has raged for decades. In 1987, the DOE isolated Yucca Mountain, about 100 miles northwest of Las Vegas, as a potential site to permanently store spent nuclear fuel produced by commercial nuclear power plants.⁵⁵ Fifteen years later, the agency finally determined that the site would be technically feasible as a repository location. Congress passed a resolution⁵⁶ to approve the facility that same year, to almost immediate opposition.

Had the facility been built, it would have been situated approximately 1,000 feet below the surface of a mountain ridge, and 1,000 feet above the water table.⁵⁷ The planned forty miles of tunnels would have accommodated an estimated 70,000 tons of nuclear waste, or about 85% of the spent fuel produced by U.S. commercial reactors since the 1950s.⁵⁸ The site itself was chosen after a stringent safety assessment, with favorable characteristics including isolation (no permanent residences were within fourteen miles) and dryness (given the project needed to be effective for millennia, the corrosiveness of water on steel was a major concern).⁵⁹ The project also had to comply with extremely strict Environmental Protection

55. Luisa Kenausis, *Nuclear Waste Issues in the United States*, CTR. FOR ARMS CONTROL & NON-PROLIFERATION (Aug. 22, 2018), <https://armscontrolcenter.org/nuclear-waste-issues-in-the-united-states/>.

56. H.R.J. Res. 87, 107th Cong. (2002), <https://www.govtrack.us/congress/bills/107/hjres87>.

57. *Why Yucca Mountain?*, AM. NUCLEAR SOC'Y, <https://wx1.ans.org/pi/np/yucca/> (last updated Jul. 12, 2012).

58. Off. of Pub. Affairs, *Backgrounder on Licensing Yucca Mountain*, U.S. NUCLEAR REGUL. COMM'N, <https://www.nrc.gov/docs/ML0815/ML081550392.pdf> (last updated Oct. 31, 2024).

59. Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada, 73 Fed. Reg. 61, 256 (Oct. 15, 2008) (to be codified at 40 C.F.R. pt. 197).

Agency (EPA) standards, which mandated that someone living near the repository, eating locally grown food, and drinking local water could receive only a dose of fifteen millirem per year through radiation leaking from the site.⁶⁰ By comparison, the average person is subjected to about 620 millirem of radiation per year through “background sources” including naturally radioactive minerals and cosmic rays.⁶¹

The extensive safety research and strict regulatory requirements failed to satisfy the Nevada public, or its state government, whose official position is that Yucca Mountain is not a suitable site for nuclear waste storage.⁶² The state’s concerns about safety and national security, including the supposed danger to people living near waste transportation routes and the possibility of a terrorist attack on fuel shipments or the site itself⁶³, seem to disfavor building a central repository anywhere, rather than simply finding a new site outside Nevada. Work on the Yucca Mountain project has been stalled since 2009,⁶⁴ and the United States has yet to identify a better long-term solution for the storage of waste generated by reactor operation.

The Yucca Mountain site’s failure has also cost the federal government billions of dollars in payouts to utilities.⁶⁵ The 1982 Nuclear Waste Policy Act, which authorized the DOE to establish the central repository, also mandated that nuclear power stations enter

60. *Id.*

61. *Radiation Sources and Doses*, U.S. ENVTL. PROT. AGENCY, <https://www.epa.gov/radiation/radiation-sources-and-doses> (last visited Apr. 24, 2026).

62. *The Fight Against Yucca Mountain*, NEV. ATT’Y GEN., https://ag.nv.gov/Hot_Topics/Issue/Yucca/ (last visited Apr. 8, 2026).

63. *Oversight Hearing on the Status of the Yucca Mountain Project: Hearing Before the S. Comm. on Env’t & Pub. Works*, 108th Cong. (2004) (statement of Sen. Harry Reid), https://www.epw.senate.gov/public/index.cfm/hearings?Id=DA19ACBE-802A-23AD-4357-2F58816A73F0&Statement_id=91AFF8E2-8C55-46DE-9BF2-AC50C7194721.

64. Richard Harris, *Obama Cuts Funds to Nuclear Waste Repository*, NPR (Mar. 11, 2009), <https://www.npr.org/2009/03/11/101689489/obama-cuts-funds-to-nuclear-waste-repository>.

65. *No End in Sight to Cases Over Lack of Nuke Waste Storage*, LAW360 (Feb. 10, 2021), https://www.law360.com/governmentcontracts/articles/1353820/no-end-in-sight-to-cases-over-lack-of-nuke-waste-storage?nl_pk=2f1c5335-68a3-41ff-a6f5-c2fb7d72ffef.

into contracts with the DOE for fuel disposal and pay into a fund for costs.⁶⁶ Owing to its continued inability to meet these obligations for disposing of reactors' nuclear fuel, the government has had to pay out approximately \$9 billion in breach of contract damages to nuclear energy producers to date.⁶⁷ These costs will continue to grow as the government has billions more in liability under the aforementioned terms of the Act.

Despite the project's grand scope and cost, Yucca Mountain would not have been large enough to hold even the spent nuclear fuel that has already been produced, never mind future waste produced by an expanding industry.⁶⁸ But, as of writing, additional plans for any large central repository operated by the U.S. government seem unlikely.⁶⁹

Nor is storage at privately owned facilities an easy solution. The majority of waste is currently stored on-site using dry cask storage.⁷⁰ In this process, fuel is cooled in water at the reactor's "spent fuel pool" for at least a year, then placed into a steel container filled with inert gas and welded or bolted closed.⁷¹ These are then stored underground in vaults with additional concrete shielding. The U.S. Nuclear Regulatory Commission considers dry cask storage to be a safe and effective solution, and notes that dry storage has resulted in no environmental leaks or attempts to sabotage cask facilities.⁷² Nonetheless, such facilities are subject to a strict licensing scheme and periodic inspections.⁷³

66. Nuclear Waste Policy Act of 1982, 42 U.S.C. §§ 10101–10270 (2018) [hereinafter Nuclear Waste Policy Act of 1982].

67. U.S. GOV'T ACCOUNTABILITY OFF., *supra* note 54.

68. *Id.*

69. *Id.*

70. *Id.*

71. *Dry Cask Storage*, U.S. NUCLEAR REGUL. COMM'N, <https://www.nrc.gov/waste/spent-fuel-storage/dry-cask-storage> (last visited Apr. 24, 2026).

72. *Backgrounder on Dry Cask Storage of Spent Nuclear Fuel*, U.S. NUCLEAR REGUL. COMM'N, <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dry-cask-storage>.

73. *Spent Fuel Storage in Pools and Dry Casks: Key Points and Questions & Answers*, U.S. NUCLEAR REGUL. COMM'N, <https://www.nrc.gov/waste/spent-fuel-storage/faqs> (last visited Mar. 6, 2026).

Some have argued that private industry should fill in the gap that the federal government left when its central repository project failed and create commercial fuel storage facilities using dry cask technology.⁷⁴ But this still-emerging industry has already faced legal challenges that appear to stem from the same environmental and safety concerns that sunk Yucca Mountain. In June of 2025, the U.S. Supreme Court decided *Nuclear Regulatory Commission v. Texas*, a case about nuclear waste storage sites.⁷⁵ The State of Texas disputed the federal government's authority to allow temporary storage of spent nuclear fuel at privately-owned facilities. The plaintiffs, who included the State of Texas and private landowners, sought to block the Nuclear Regulatory Commission's (NRC) approval of a private nuclear waste storage facility company called Interim Storage Partners.⁷⁶ The NRC granted a 40-year, renewable license for an AFR (away-from-reactor) facility⁷⁷ that, under the terms of the license, would store spent nuclear fuel "pending its ultimate disposal".⁷⁸ The proposed site was in Andrews County, West Texas.

One plaintiff, Fasken Oil and Ranch, is one of Texas's largest private landowners, and operates upwards of 750 oil and gas wells on its largest site, a 165,000-acre contiguous spread referred to as the C-Ranch.⁷⁹ Andrews County, owing to its site on the Permian Basin, has thousands of active oil and gas wells.⁸⁰ Fasken, which still does

74. David Klaus, *Private, Centralized Storage for Spent Nuclear Fuel: A Dead End or Path Forward?*, BULL. ATOMIC SCIENTISTS (Nov. 6, 2020), <https://thebulletin.org/2020/11/private-centralized-storage-for-spent-nuclear-fuel-a-dead-end-or-path-forward/>.

75. Devin Dwyer, *Supreme Court Takes Dispute Over Nuclear Waste Storage Sites*, ABC NEWS (Mar. 5, 2025), <https://abcnews.go.com/Politics/supreme-court-takes-dispute-nuclear-waste-storage-sites/story?id=119395853>.

76. *America's Nuclear Solution*, INTERIM STORAGE PARTNERS, <https://interimstoragepartners.com/> (last visited Apr. 20, 2026).

77. *Nuclear Regul. Comm'n v. Texas*, 605 U.S. 665 (2025).

78. *Id.*

79. *Fasken Oil & Ranch, Ltd.*, Tex. H.R. Comm. on Nat. Res., 86th Leg., R.S. (Feb. 6, 2019), <https://www.legis.state.tx.us/tlodocs/86R/handouts/C3902019020614001/faf21643-d2de-4477-879c-11b5bbd83b73.PDF>.

80. *Oil & Gas Activity in Andrews County, TX*, SHALEXP, <https://www.shalexp.com/texas/andrews-county> (last visited Apr. 2, 2026).

raise some cattle on its euphemistically named “ranch,” objected on environmental grounds, citing fears of contamination.⁸¹

The Court’s decision did not formally address the merits, instead holding that Texas lacked standing to challenge the licensing agreement.⁸² Nonetheless, several pages of dicta in response to the dissent indicate that the Court may support such licensing agreements.⁸³ Specifically, the majority argued against the dissent’s assertion that the 1982 Atomic Energy Act restricted spent nuclear fuel storage to on-site and federal facilities.⁸⁴ Rather, they felt the later Act preserved the existing law, which was to permit the licensing of off-site facilities per the 1954 Act (according to the Court’s previous interpretation of the Act).⁸⁵ At the time of writing, the law is unsettled as to whether these private storage facilities are permissible.

Yucca Mountain’s failure and the litigation around private storage underscores that no one wants nuclear waste in their backyard. And even when done successfully, dry cask storage is only considered a temporary solution, as the highly radioactive fuel still requires long-term disposal.⁸⁶ If nuclear energy generation is to quadruple under the Trump administration and continue to grow beyond to meet increasing electricity needs, it’s critical to find a new way to manage spent fuel.

PART II: THE RECYCLING SOLUTION

There is a process for handling spent nuclear fuel that confronts both the storage and supply problems: recycling. This section

81. *Nuclear Regul. Comm’n v. Texas*, *supra* note 77, at 5.

82. *Id.* at 23.

83. David G. Cabrales & Peter A. Tomasi, *Has SCOTUS Pre-Decided Whether the NRC Can License Private Off-Site High-Level Nuclear Waste Storage Facilities?*, *JD SUPRA* (Jul. 3, 2025), <https://www.jdsupra.com/legalnews/has-scotus-pre-decided-whether-the-nrc-9990597/>.

84. *Nuclear Regul. Comm’n v. Texas*, *supra* note 77, slip op. at 20.

85. *NRC v. Texas*, No. 23-1300, slip op. (U.S. Jun. 18, 2025).

86. *Backgrounder on Radioactive Waste*, U.S. NUCLEAR REGUL. COMM’N, <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste> (last visited Nov. 13, 2025).

describes how nuclear fuel recycling works, its function within a closed cycle, and how the world leader in recycling, France, does it.

The term “spent” is, in fact, misleading, as nuclear fuel that’s used once retains 95% of its energy-generating potential.⁸⁷ Calling it “waste” also implies what’s left is unusable, but the same radioactivity that makes spent fuel dangerous and difficult to store makes it a potential resource for further electricity generation. In fact, it’s almost entirely recyclable, and doing so is not only feasible, it’s common practice in places outside the United States.⁸⁸ Recycling has the added benefit of removing what is truly “waste” in a manner that makes it safe for long-term storage.⁸⁹ By looking to France, the world leader in nuclear fuel recycling, the United States can apply lessons it should use to build its own recycling industry.

The gold-standard recycling facility is operated by Orano in La Hague, in northwestern France.⁹⁰ The company is under contract with French utility Électricité de France (EDF) to reprocess and recycle fuel from all the country’s fifty-six currently operating nuclear reactors.⁹¹ To date, the Orano facility has recycled over 27,000 tons of used fuel for EDF, plus 5,400 tons for Germany, 2,900 for Japan, and smaller amounts for Switzerland, Belgium, the Netherlands, and Italy.⁹² This is about half the amount of fuel that would have been stored at the Yucca Mountain facility, but rather than being buried

87. *Recycling Gives New Purpose to Spent Nuclear Fuel*, PAC. NW. NAT’L LAB. (May 14, 2021), <https://www.pnnl.gov/news-media/recycling-gives-new-purpose-spent-nuclear-fuel>.

88. Laura Rodríguez-Penalonga & B. Yolanda Moratilla Soria, *A Review of the Nuclear Fuel Cycle Strategies and the Spent Nuclear Fuel Management Technologies*, 10 ENERGIES 1235 (2017).

89. *See infra* note 92.

90. *World Leader in Recycling Used Nuclear Fuels*, ORANO, <https://www.orano.group/en/nuclear-expertise/from-exploration-to-recycling/world-leader-in-recycling-used-nuclear-fuels> (last visited Nov. 13, 2025) (explaining that Orano provides uranium nuclear fuel products across the entire fuel cycle).

91. *Nuclear Power in France*, WORLD NUCLEAR ASS’N, <https://world-nuclear.org/information-library/country-profiles/countries-a-f/france> (last visited Nov. 13, 2025).

92. *55 Years Experience*, ORANO, https://www.orano.group/en/nuclear-expertise/from-exploration-to-recycling/world-leader-in-recycling-used-nuclear-fuels/expertise_world_leader_55-years-experience (last visited Nov. 13, 2025).

underground and forgotten, it has been repurposed for electricity generation.

Orano's recycling process recovers 96% of the material in used fuel, 95% of which is uranium and 1% of which is plutonium, with the remaining 4% being fission products that are truly waste.⁹³ After fuel arrives at the facility, it's first kept in a temporary storage pool to allow its heat and radioactivity to decrease naturally.⁹⁴ Then, a chemical process is used to dissolve the fuel and separate the waste products.⁹⁵ The remaining uranium and plutonium are then further separated from each other and purified.⁹⁶ The reprocessed uranium and plutonium can be used in one of two ways: the uranium can be re-enriched to create standard reactor fuel, or the uranium and plutonium can be mixed to create mixed-oxide fuel (MOX).⁹⁷ MOX fuel can burn longer and more safely, and allow the waste plutonium to be used for electricity generation, but not all current reactors are equipped for it.⁹⁸ The remaining waste fission materials are vitrified, or baked into glass, creating a safe and stable material that's a fraction of the volume of the original spent fuel product and can be easily stored.⁹⁹ Vitrification is a "final storage" solution, meaning that the product is stable for up to thousands of years.¹⁰⁰

While the facility at La Hague proves recycling of spent nuclear fuel is possible at an industrial scale, it doesn't necessarily prove that doing so is economically viable. Both Orano and EDF are owned by the French state,¹⁰¹ meaning the facility is not a profit-generating

93. *Id.* As will be discussed *infra* section II(A)1, the fact that fuel recycling necessarily creates plutonium is one reason the United States chose to discontinue its recycling operations.

94. *Id.*

95. *Id.*

96. *Id.*

97. *Id.*

98. Mariana C. Betancourt et al., *Mixed-Oxide Fuel Strategies in an Integral Pressurized Water Reactor*, 139 PROGRESS NUCLEAR ENERGY 103844, 103845 (2021).

99. See generally G. Roth & S. Weisenburger, *Vitrification of High-Level Liquid Waste: Glass Chemistry, Process Chemistry and Process Technology*, 202 NUCLEAR ENG'G & DESIGN 197 (2000).

100. *Id.*

101. *JNFL and MHI Become Shareholders of Orano - 2017 Revenue*, ORANO (Feb. 26, 2018), <https://www.orano.group/en/news/news-group/2018/february/jnfl->

enterprise. Operations at La Hague may cost up to \$300 million per year.¹⁰² It's difficult to compare this cost to what France would have to spend on sourcing new yellowcake uranium and storage of high-level waste if it were not to recycle. Orano estimates that its recycling operations cost each French household only ten euros per year,¹⁰³ and electricity costs in France are relatively low compared to other E.U. countries.¹⁰⁴

A. SPENT FUEL REPROCESSING IN THE UNITED STATES

Anyone advocating for the United States to adopt a closed nuclear fuel cycle must not ignore the fact that private industry once tried, and failed, to make fuel recycling profitable. Further, a series of deliberate policy choices throttled that industry before it could grow.¹⁰⁵ This culminated in an outright ban on nuclear fuel reprocessing in the 1970s.¹⁰⁶ Though that ban was eventually lifted, private industry has not attempted to create any new fuel reprocessing facilities.¹⁰⁷ It's reasonable to assume that, given the past commercial failure of fuel reprocessing for profit, most would see this as a risky investment without government intervention. This section discusses why the United States lacks a fuel recycling industry, and thus provides a framework for the errors any future

[mhi-become-shareholders-orano-2017-revenue; The French State Becomes the Sole Shareholder of EDF Again](https://chile.edf.com/en/news/the-french-state-becomes-the-sole-shareholder-of-edf-again), EDF POWER SOLS. (Jun. 15, 2023), <https://chile.edf.com/en/news/the-french-state-becomes-the-sole-shareholder-of-edf-again>.

102. Benjamin Mallet, *France Seeks Strategy as Nuclear Waste Site Risks Saturation Point*, REUTERS (Feb. 3, 2023), <https://www.reuters.com/business/environment/france-seeks-strategy-nuclear-waste-site-risks-saturation-point-2023-02-03/>.

103. *Understanding Nuclear Fuel Recycling*, ORANO, <https://www.orano.group/en/unpacking-nuclear/all-about-used-fuel-processing-and-recycling> (last visited Nov. 13, 2025).

104. Leon Xu, *See How France's Electricity Prices Compare with Others in Europe*, CONNEXION FR. (Sept. 19, 2023), <https://www.connexionfrance.com/practical/see-how-frances-electricity-prices-compare-with-others-in-europe/137656>.

105. *See discussion infra* section II(A)2.

106. *See infra* note 133.

107. *See* IAEA, *supra* note 34.

policy must correct if the United States nuclear industry is to implement fuel reprocessing at a large scale.

Technology for reprocessing spent nuclear fuel was developed in the United States during World War II, namely as a method of sourcing plutonium for use in nuclear weapons.¹⁰⁸ Interest in commercial reprocessing emerged in the 1950s, and, in 1966, the Atomic Energy Commission (AEC) approved a permit to Nuclear Fuel Services, Inc. (NFS) for a plant on state-owned land in West Valley, New York.¹⁰⁹ The project was heavily subsidized by the federal government, as the AEC planned to pay NFS to reprocess fuel from its Hanford, Washington, facility.¹¹⁰ The AEC would also buy back plutonium produced from the reprocessing of commercial reactor fuel.¹¹¹ The 150-acre West Valley Demonstration Project complex included spent fuel reprocessing facilities and two on-site radioactive waste disposal areas,¹¹² but it would only operate for six years.¹¹³

In 1972, the facility temporarily shut down in order to make upgrades to comply with new, stricter regulatory requirements, including earthquake and tornado protection and waste management; it also sought to increase reprocessing capacity and reduce radiation exposure to workers.¹¹⁴ But as the work progressed, its operator, NFS, determined that operations would no longer be economically viable.¹¹⁵ It ceased operations and turned the facility, including the

108. HOLT & LARSON, *supra* note 33, at 6.

109. *Id.*

110. Frank von Hippel, *Decommissioning the Reprocessing Plant in West Valley, New York*, INT'L PANEL ON FISSILE MATERIALS BLOG (Sept. 2, 2020), https://fissilematerials.org/blog/2020/09/decommissioning_the_repro.html.

111. *Id.*

112. *Fuel Reprocessing History*, N.Y. STATE ENERGY RSCH. & DEV. AUTH., <https://www.nyserda.ny.gov/All-Programs/West-Valley/Fuel-Reprocessing-History> (last visited Nov. 22, 2025); *West Valley Demonstration Project (WVDP)*, U.S. DEP'T OF ENERGY, <https://www.energy.gov/em/west-valley-demonstration-project-wvdp> (last visited Nov. 22, 2025).

113. *Id.*

114. *Id.*

115. *Id.*

radioactive waste remaining on-site, over to the state.¹¹⁶ It had only reprocessed 640 metric tons of fuel during its entire lifecycle.¹¹⁷

NFS left a significant amount of radioactive waste on-site; beyond some un-reprocessed but still viable spent fuel, there were four tanks containing 612,000 gallons of high-level liquid waste, including 30,000 gallons of “sludge” with high levels of plutonium and strontium-90; 100,000 cubic feet of buried high-level solid waste, consisting mostly of the discarded hulls that contained spent fuel; 2 million cubic feet of buried low-level solid waste; and 42 ruptured fuel rods the facility was unable to reprocess.¹¹⁸ The operator executed a contract provision that allowed it to surrender the facility to the state, thereby dodging responsibility for the cleanup.¹¹⁹ That process, and the question of who was liable for funding the site’s remediation, dragged on for decades,¹²⁰ but the clear contractual provision in their favor allowed NFS to make a clean exit. Nuclear Fuel Services continues to exist, and serves as a supplier of uranium fuel for Naval submarines, as well as reprocessing Cold War-era surplus weapons-grade uranium into commercial reactor fuel in a process known as “downblending.”¹²¹

The State of New York did not have the funding for a cleanup operation, which it estimated would cost in the hundreds of millions of dollars; nor did it have the funding to complete the in-progress upgrades and repairs to bring the facility within regulations.¹²² Instead, New York lobbied the Energy Research and Development

116. *Id.*

117. *Id.*

118. U.S. GOV’T ACCOUNTABILITY OFF., EMD-77-27, ISSUES RELATED TO THE CLOSING OF THE NUCLEAR FUEL SERVICES, INCORPORATED, REPROCESSING PLANT AT WEST VALLEY, NEW YORK I (1977).

119. *Id.* at 31.

120. *A Brief History of Reprocessing and Cleanup in West Valley, NY*, UNION OF CONCERNED SCIENTISTS (Jul. 15, 2008), https://www.ucsusa.org/nuclear_power/making-nuclear-power-safer/handling-nuclear-waste/a-brief-history-of.html.

121. In downblending, high-enriched uranium is mixed with depleted uranium to create low-enriched uranium. This creates a fuel that’s no longer potent enough to use in weapons, but can be used in reactors. *See Nuclear Fuel Services*, BWX TECHS., INC., <https://www.bwxt.com/sectors/nuclear-fuel/nuclear-fuel-services/> (last visited Nov. 22, 2025).

122. U.S. GOV’T ACCOUNTABILITY OFF., *supra* note 118.

Administration (ERDA), a federal agency formed after the dissolution of the AEC in 1975, to take control of the site.¹²³ In 1980, Congress passed the West Valley Demonstration Project Act, which directed the Department of Energy (DOE) to “solidify” the liquid high-level waste through vitrification or other methods, and to transport and dispose of both low- and high-level waste at a federal repository for permanent disposal.¹²⁴ Yet, this left questions unanswered; namely, the law did not determine who should pay for disposal fees or who was responsible for other elements of site cleanup, such as mitigating soil contamination. And, as discussed *supra*, the federal repository (Yucca Mountain) would never come to fruition. New York State (NYS), New York State Energy and Research Authority (NYSERDA), and the NYS Department of Environmental Conservation sued the federal government and the Department of Energy in 2006 to resolve the debate; New York argued that since the AEC had encouraged and licensed the plant, and was the source of all the spent fuel reprocessed there, the federal government should be primarily responsible.¹²⁵

The parties would eventually settle, and a 2010 consent decree ordered that the federal government pay 90% of the cleanup costs for the main reprocessing facility.¹²⁶ Costs were split evenly for a new on-site disposal area.¹²⁷ But, litigation continued in 2009 when an environmental advocacy group sued the DOE over its handling of the cleanup.¹²⁸ The Coalition on West Valley Nuclear Wastes alleged that the DOE had violated the National Environmental Policy Act (NEPA) by improper “segmentation” of the project, or arbitrarily splitting the project into smaller “phases” to avoid conducting an Environmental Impact Study (EIS) of the entire project.¹²⁹ In this case, the first phase was for disposal of the waste left on-site, while

123. *Id.*

124. West Valley Demonstration Project Act, Pub. L. No. 96-368, 94 Stat. 1347 (1980).

125. Complaint, *New York v. United States*, No. 06-CV-810 (W.D.N.Y. filed Dec. 11, 2006).

126. Consent Decree, *New York v. United States*, No. 06-CV-810 (W.D.N.Y. filed Aug. 17, 2010).

127. *Id.*

128. *Coal. on W. Valley Nuclear Wastes v. Chu*, 592 F.3d 306 (2d Cir. 2009).

129. *Id.* at 311.

the second phase would be for closure and long-term management of the entire 3,345-acre site; work then proceeded, with the DOE only having completed an EIS for phase one.¹³⁰ The Second Circuit ruled in the DOE's favor, finding that not all segmentation was impermissible, as agencies may sometimes validly split a project into multi-faceted stages with distinct environmental impacts.¹³¹ The court found that, in this case, the waste disposal and long-term closure actions were distinct enough such that they were justified in deferring the EIS of the second phase, and that the partial EIS was enough for the waste disposal phase to continue.¹³²

The cleanup has proceeded on schedule, but at staggering cost. In June of 2025, contractors completed the demolition and disposal of the 35,100-square-foot Main Plant Process Building, including seven miles of contaminated piping and fifty tons of contaminated equipment.¹³³ But, there is still much more work to be completed, and the overall project is still only in Phase 1.¹³⁴ A 2020 study by the Government Accountability Office found that the DOE had spent \$3.1 billion on contracted cleanup activities to date.¹³⁵ And in 2024, BWXT—of which the site's original operator, NFS, is a subsidiary—was awarded a contract worth up to \$3 billion over fifteen years for additional cleanup operations.¹³⁶ For 640 metric tons of reprocessed fuel, U.S. taxpayers will have paid about \$6 billion in cleanup and remediation costs by the end of Phase 1 alone, amounting to

130. *Id.* at 309.

131. *Id.* at 311.

132. *Id.* at 313.

133. Off. of Env'tl. Mgmt., *EM Priority: West Valley Accomplishes Demolition of Main Plant Process Building*, U.S. DEP'T OF ENERGY (Jun. 18, 2025), <https://www.energy.gov/em/articles/em-priority-west-valley-accomplishes-demolition-main-plant-process-building>.

134. Off. of Env'tl. Mgmt., *EM Marks Major Cleanup Milestones in 2024, Lays Groundwork for 2025 Goals*, U.S. DEP'T OF ENERGY (Jan. 17, 2025), <https://www.energy.gov/em/articles/em-marks-major-cleanup-milestones-2024-lays-groundwork-2025-goals>.

135. U.S. GOV'T ACCOUNTABILITY OFF., GAO-21-115, NUCLEAR WASTE: CONGRESSIONAL ACTION NEEDED TO CLARIFY A DISPOSAL OPTION AT WEST VALLEY SITE IN NEW YORK (2021), <https://www.gao.gov/products/gao-21-115>.

136. Press Release, BWX Techs., Inc., BWXT-Led Team Awarded \$3 Billion Cleanup Contract for Department of Energy's West Valley Demonstration Project (Dec. 2, 2024), <https://investors.bwxt.com/news-releases/news-release-details/bwxt-led-team-awarded-3-billion-cleanup-contract-department>.

approximately \$9.3 million per ton. Compare this to the market cost of reactor fuel fabricated from natural uranium at between \$200,000 and \$400,000 per ton.¹³⁷ To say that the West Valley Demonstration Project failed to demonstrate the commercial viability of spent fuel reprocessing would be a dramatic understatement.

While the West Valley project was killed by economics, another major reprocessing project was killed by policy changes. In 1971, the AEC granted a license to Allied General Nuclear Services (AGNS), a partnership between Allied Chemical, Gulf Oil, and Royal Dutch Shell, for a construction license for a reprocessing facility in Barnwell County, South Carolina.¹³⁸ South Carolina was a major player in the country's nuclear industry at the time; the nearby Savannah River Plant employed 8,000 people in the production of nuclear materials for weapons, and the state's three private electric utilities all had experimental or operational reactors.¹³⁹ As construction progressed through the early 1970s, AGNS began to doubt whether the plant would be profitable; interest in new reactors among the utilities was beginning to slow down, and the market price of mined uranium remained low.¹⁴⁰ The company would quietly ask the federal government to create a "cooperative program"—a bailout—in 1975.¹⁴¹ But the nail in the coffin could come a year later, when President Ford issued a moratorium on reprocessing. As the official announcement read:

[T]he reprocessing and recycling of plutonium should not proceed unless there is sound reason to conclude that the world community can effectively overcome the associated risks of proliferation . . . [and] that the United States should no longer regard reprocessing of used nuclear fuel to produce plutonium as a necessary and inevitable step in the

137. *Recycled Nuclear Fuel Cost Calculator - HELP*, WISE URANIUM PROJECT, <https://www.wise-uranium.org/nfccrh.html> (last updated Feb. 15, 2016).

138. Suzanne Rhodes, *Barnwell: Achilles Heel of Nuclear Power*, S. EXPOSURE, no. 4, Dec. 1979, at 44–45, <https://www.facingsouth.org/sites/default/files/2023-02/Tower%20of%20Babel%201979%20Vol%207%20No%204%20-%20Reduced.pdf>.

139. *Id.*

140. *Id.*

141. *Id.*

nuclear fuel cycle, and that we should pursue reprocessing and recycling in the future only if they are found to be consistent with our international objectives.¹⁴²

A year later, President Carter affirmed the policy with an indefinite deferral on commercial reprocessing operations.¹⁴³ Concerns about the potential for the plutonium created through spent fuel recycling—even if that plutonium was only a byproduct—overshadowed the benefits a closed fuel cycle would bring.¹⁴⁴

Allied-General sued the federal government over its policy to ban reprocessing, which effectively revoked the plant's license, and which they argued constituted a taking under the Fifth Amendment.¹⁴⁵ In its decision, the court aptly described the Barnwell facility as “one of the most remarkable white elephants in our American history . . . a plant which is completely useless but has absorbed, according to its owners, over \$200,000,000 in their capital plus unstated amounts in public funds.”

1. *The Reprocessing Ban*

In the mid-1970s, a series of world events led the United States to drastically reshape its nuclear policy with widespread repercussions for the domestic nuclear power industry. That series of events began on May 18, 1974, when India shocked the world by successfully detonating a nuclear bomb, nicknamed the “Smiling Buddha.”¹⁴⁶ Especially disturbed were Canada and the United States, which had supplied the technology that made the test possible; a Canada Deuterium Uranium (CANDU) research reactor developed under the “Atoms for Peace” initiative and twenty-one tons of heavy water,

142. Gerald R. Ford, Nuclear Policy: Statement by the President, 3 PUB. PAPERS 1625–26 (Oct. 28, 1976).

143. Jimmy Carter, Nuclear Power Policy: Statement on Decisions Reached Following a Review, 1 PUB. PAPERS 588 (Apr. 7, 1977).

144. HOLT & LARSON, *supra* note 33, at 8.

145. *Allied-General Nuclear Servs. v. United States*, 839 F.2d 1572, 1572 (Fed. Cir. 1988).

146. Emma Claire Foley, “Smiling Buddha” Ushered India into the Nuclear Age, GLOBAL ZERO (May 18, 2020), <https://www.globalzero.org/updates/smiling-buddha-ushered-india-into-the-nuclear-age/index.html>.

respectively.¹⁴⁷ India accepted the reactor and materials necessary to operate it, under the promise that it would not use it to develop weapons.¹⁴⁸ After the 1974 test, Prime Minister Indira Gandhi tried to argue there was no violation of the agreement, and that the Smiling Buddha was not a bomb, but a “peaceful nuclear explosion.”¹⁴⁹ But few were convinced by this argument, especially in Pakistan, which saw India’s nuclear capability as an existential threat, and vowed to create a nuclear weapon of its own.¹⁵⁰ The U.S. and Canada scrambled to conduct a “post-mortem” on how India had managed to develop a bomb under the radar of both countries’ intelligence networks.¹⁵¹ Canadian nuclear scientists determined that the spent fuel from CANDU reactors could be reprocessed into weapons-grade plutonium, and that India may have up to 100kg of weapons fuel.¹⁵² What was intended to be a peaceful civilian reactor, they feared, could be used as a “do-it-yourself bomb kit.”¹⁵³

In an attempt to prevent a second global nuclear arms race, the United States invited the other nuclear powers—Canada, West Germany, France, Japan, the Soviet Union, and the United Kingdom—to meet and discuss non-proliferation strategies.¹⁵⁴ The resulting Nuclear Suppliers Group (NSG) would serve as a cartel, tightly controlling other countries’ access to both fuel and technology. It was now clear that limiting exports of plutonium was insufficient to prevent the creation of bomb-making material; the restrictions they would develop included not only fissionable material (namely uranium, plutonium, and thorium) but a comprehensive list

147. Victor Gilinsky & Paul Leventhal, Opinion, *India Cheated*, WASH. POST (Jun. 15, 1998), <https://www.nci.org/06nci/04/India%20Cheated.htm>.

148. *Id.*

149. *Id.*

150. See FERAZ HASSAN KHAN, *EATING GRASS: THE MAKING OF THE PAKISTANI BOMB* 5–7 (2012).

151. Telegram from U.S. Embassy in Ottawa to U.S. Dep’t of State, No. 1670, “Technical Aspects of Indian Nuclear Test,” NAT’L SEC. ARCHIVE (Jun. 3, 1974), <https://nsarchive.gwu.edu/document/33148-document-5-us-embassy-canada-telegram-1670-state-department-technical-aspects-indian>.

152. *Id.*

153. *Id.*

154. Ian Stewart & Adil Sultan, *India, Pakistan and the NSG*, KING’S COLL. LOND. (Jun. 10, 2019), <https://www.kcl.ac.uk/news/india-pakistan-and-the-nsg>.

of equipment used in civilian energy reactors.¹⁵⁵ The export of any items on the list would trigger a series of strict safeguards established by the IAEA to ensure they could not be put to any use that could lead to the creation of an explosive device.¹⁵⁶ Explicitly included in the so-called “Trigger List” was equipment used for the reprocessing of spent reactor fuel.¹⁵⁷

Domestically, the shift from promotion of new nuclear energy development under the Atoms for Peace policy to a hard stance on non-proliferation led to an overhaul of the U.S. nuclear regulatory landscape and industry.¹⁵⁸ The Atomic Energy Commission was already under fire from critics who considered the agency’s dual responsibilities for developing and regulating new technology to be a conflict of interest, akin to “letting the fox guard the henhouse.”¹⁵⁹ Among these critics were the environmentalists driving a burgeoning anti-nuclear movement, who felt the agency was not doing enough to mitigate the ecological harms of thermal and radioactive waste.¹⁶⁰ This came to a head in 1971, when the D.C. Circuit passed down its decision in *Calvert Cliffs’ Coordinating Committee, Inc. v. United States Atomic Energy Commission*, finding that the agency was not fulfilling its obligations under the newly minted National Environmental Policy Act (NEPA).¹⁶¹ Congress passed the Energy Reorganization Act in January 1975, splitting the AEC into two agencies: the Nuclear Regulatory Commission (NRC) would oversee safety and licensing, while the Energy Research and Development Administration (ERDA, which would subsequently be folded into the

155. Int’l Atomic Energy Agency [IAEA], *Communications Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment or Technology*, IAEA Doc. INFCIRC/254 (Feb. 1978), <https://www.iaea.org/sites/default/files/infcirc254.pdf>.

156. *Id.*

157. *Id.*

158. See generally J. SAMUEL WALKER & THOMAS R. WELLOCK, A SHORT HISTORY OF NUCLEAR REGULATION, 1946–2009, (2010), <https://www.nrc.gov/docs/ML1029/ML102980443.pdf>.

159. *Id.* at 48–49.

160. *Id.* at 44.

161. *Calvert Cliffs’ Coordinating Comm., Inc. v. United States Atomic Energy Comm’n*, 449 F.2d 1109 (1971).

Department of Energy) would continue to promote new development.¹⁶²

In 1974, the AEC had published a draft of its Generic Environmental Statement on Mixed-Oxide Fuel (GESMO), in which it formally recommended the widespread use of MOX fuel created by reprocessing spent commercial reactor waste.¹⁶³ This statement would have amounted to a formal policy recommendation for a closed fuel cycle in the U.S. The new, safety-focused NRC picked up the draft and released a final version in August 1976 that similarly found MOX fuel to be safe, economical, and advantageous, noting its ability to reduce mining and enrichment operations and extend domestic uranium reserves.¹⁶⁴

But the new environmental impact report still did not consider the safety of creating plutonium that could potentially be misused in weapons. The President's Council on Environmental Quality sent the agency a letter not long after its founding that included the opinion that:

[A]lthough the draft environmental statement was well done and reflected a high quality effort, it was incomplete because it failed to present a detailed and comprehensive analysis of the environmental impacts of potential diversion of special nuclear materials and of alternative safeguards programs to protect the public from such a threat. The Council believed that such a presentation should be made by the Nuclear Regulatory Commission before its final decisions on plutonium recycle.¹⁶⁵

162. Energy Reorganization Act of 1974, Pub. L. No. 93-438, 88 Stat. 1233 (codified as amended at 42 U.S.C. §§ 5801–5891).

163. U.S. NUCLEAR REG. COMM'N, NUREG-0002, VOL. 1, FINAL GENERIC ENVIRONMENTAL STATEMENT ON THE USE OF RECYCLE PLUTONIUM IN MIXED OXIDE FUEL IN LIGHT WATER COOLED REACTORS (GESMO) (Aug. 1976), <https://www.nrc.gov/docs/ml0710/ml071000110.pdf>.

164. *Id.*

165. *Id.* at ES-2.

In deference to this recommendation, the final report promised to follow with a “safeguards supplement” that would factor safety concerns into the cost-benefit analysis.¹⁶⁶

For some, the promise to follow up about safety at an unspecified future date was not enough. The NRC had made the decision to bifurcate the report in a 1975 order, in which it also decided to allow interim licensing of fuel recycling activities and the use of plutonium in light water reactors, pending the release of the final environmental safety analysis and supplement.¹⁶⁷ The National Resources Defense Council (NRDC) immediately challenged the order as a violation of NEPA.¹⁶⁸ Its argument centered around the idea that public safety and health risks of the plutonium separated from spent fuel being stolen, diverted, or sabotaged were significant enough that it could not be separated from the discussion of environmental impacts.¹⁶⁹ The NRC, meanwhile, argued that the order was not a reviewable final decision and therefore did not need to comply with NEPA.¹⁷⁰ The Second Circuit sided with the NRDC, finding that allowing licensing to proceed would result in significant investment and construction, notwithstanding any final decision on operation, and that ad-hoc compliance with future safety mandates would become more difficult.¹⁷¹ Consequently, the NRC’s decision to grant licenses without completing the full environmental impact study and supplement made a “mockery” of NEPA’s procedural requirements.¹⁷² The Court ordered the agency to refrain from granting any additional licenses for fuel reprocessing or plutonium separation until the final version of the GESMO and supplement were published.¹⁷³

But politics would intervene before the safety review process could reach its conclusion. President Ford was under pressure from then-

166. *Id.* at 1.

167. *NRDC v. United States NRC*, 539 F.2d 824, 829 (2d Cir. 1976).

168. *Id.* at 833.

169. *Id.*

170. *Id.* at 837.

171. *Id.* at 846.

172. *Id.* at 844.

173. *Id.* at 846.

candidate Jimmy Carter, a former nuclear engineer¹⁷⁴ who had made non-proliferation a key campaign issue; Carter had advocated for an international prohibition on the creation of both enrichment and reprocessing facilities.¹⁷⁵ In October 1976, two months after the release of the final GESMO and before completion of the supplement, President Ford attempted to appease Carter's supporters by issuing his own statement affirming his office's commitment to non-proliferation.¹⁷⁶ His statement also contradicted earlier AEC recommendations by asserting that "the reprocessing and recycling of plutonium should not proceed unless there is sound reason to conclude that the world community can effectively overcome the associated risks of proliferation."¹⁷⁷

The reason for the sudden policy shift, the President explained, was not only growing concern about the potential for plutonium from recycled fuel to be misappropriated and used for weapons, but due to the conclusion that reprocessing was "of doubtful economic value".¹⁷⁸ Large deposits of uranium had been discovered in Australia¹⁷⁹ and Canada¹⁸⁰ in the 1970s, leading to a reassessment of how scarce uranium actually was as a resource. A project to search for new domestic uranium deposits had been implemented in 1973 and was still ongoing.¹⁸¹ The market was especially turbulent in preceding years due to changing expectations about supply and

174. Jimmy Carter, THE CARTER CTR., <https://www.cartercenter.org/people/jimmy-carter/> (last visited Dec. 16, 2025).

175. Jimmy Carter, *Remarks on Nuclear Weapons Proliferation in San Diego, California*, AM. PRESIDENCY PROJECT (Sept. 25, 1976), <https://www.presidency.ucsb.edu/node/347547>.

176. Gerald R. Ford, Statement on Nuclear Policy, 3 PUB. PAPERS 2763 (Oct. 28, 1976).

177. *Id.* at 1625.

178. *Id.* at 1630.

179. RANGER URANIUM ENVTL. INQUIRY, SECOND REPORT 19 (1977) <https://www.dccew.gov.au/science-research/supervising-scientist/publications/ranger-uranium-environmental-inquiry-report-final>.

180. *Uranium in Canada*, WORLD NUCLEAR ASS'N, <https://world-nuclear.org/information-library/country-profiles/countries-a-f/canada-uranium> (last visited Apr. 24, 2026).

181. Steven M. Smith, *History of the National Uranium Resource Evaluation Hydrogeochemical and Stream Sediment Reconnaissance Program*, U.S. GEOLOGICAL SURV., Open-File Report 97-492 (2006), <https://pubs.usgs.gov/of/1997/ofr-97-0492/nurehist.htm>.

demand, most notably in 1975 when Westinghouse triggered a panic by defaulting on its contracts for 70 million pounds of uranium.¹⁸² The economic uncertainties likely refer to projections about future market prices, which would determine the viability of recycling over mining and enriching uranium ore.

Just days later, Ford would lose the 1976 Presidential election to Jimmy Carter.¹⁸³ Not surprisingly, President Carter would finish what his predecessor started, issuing a policy statement in April 1977 that turned the moratorium on spent fuel recycling into an outright ban and pledged to increase U.S. production of enriched uranium.¹⁸⁴ That included withdrawing federal support for the in-progress Barnwell facility discussed above.¹⁸⁵ Under the President's orders, the NRC abandoned its ongoing reprocessing study and ceased issuing new licenses.¹⁸⁶ With this statement, the U.S. nuclear industry would continue to develop with a closed, not open, fuel cycle.

The decision was not without controversy. Westinghouse had heavily invested in the nuclear economy and had become the largest manufacturer of reactor equipment, opening three new plants in the late 1960s at a cost of \$100 million.¹⁸⁷ They also operated the world's largest fuel fabrication plant in Hopkins, South Carolina, which opened in 1969; the Westinghouse Columbia Fuel Fabrication Facility is still operational and is the largest for-profit fuel production plant anywhere in the world.¹⁸⁸ They had also announced plans for a

182. Paul L. Joskow, *Commercial Impossibility, the Uranium Market and the Westinghouse Case*, 6 J. LEGAL STUD. 119, 119 (1977).

183. *Jimmy Carter Event Timeline*, AM. PRESIDENCY PROJECT, <https://www.presidency.ucsb.edu/documents/jimmy-carter-event-timeline> (last visited Dec. 16, 2025).

184. Jimmy Carter, *Nuclear Power Policy: Statement by the President on His Decisions Following a Review*, 1 PUB. PAPERS 588 (Apr. 7, 1977), <https://www.nrc.gov/docs/ml1209/ML120960615.pdf>.

185. *Id.*

186. ANTHONY ANDREWS, CONG. RSCH. SERV., RS22542, *NUCLEAR FUEL REPROCESSING: U.S. POLICY DEVELOPMENT* 4 (2008).

187. *Power Equipment Moves South*, S. EXPOSURE, no. 4, Dec. 1979, at 30, <https://www.facingsouth.org/sites/default/files/2023-02/Tower%20of%20Babel%201979%20Vol%207%20No%204%20-%20Reduced.pdf>.

188. *Nuclear Chemical Processing Operations*, WESTINGHOUSE <https://westinghousenuclear.com/government/our-capabilities/nuclear-chemical-processing-operations/> (last visited Dec. 17, 2025).

second fuel plant in Anderson, South Carolina, which would use recycled materials from the Barnwell reprocessing facility discussed previously (in which Westinghouse was also an investor) to create plutonium fuel.¹⁸⁹ Extensive work had already been completed toward the construction of the plant, including archaeological and environmental surveys of the site.¹⁹⁰ The NRC's decision to stop the licensing of recycling facilities meant that both the Barnwell plant and the planned plutonium fuel fabrication facility would be impossible.

Westinghouse, along with a group of twenty utility companies, brought suit against the NRC to challenge its termination of the GESMO, arguing that the decision violated both the Atomic Energy Act (AEA) and NEPA.¹⁹¹ The NRDC and several states intervened in support of the NRC.¹⁹² In a holding somewhat contradictory to the Second Circuit's in *NRDC v. NRC*, the Third Circuit found that NRC's order was *not* a final order that triggered NEPA, as the moratorium officially remained open-ended pending further study.¹⁹³ They further ruled that NRC had acted within its authority under the AEA and that its decision making was not arbitrary and capricious.¹⁹⁴

The sudden pivot from a closed to open fuel cycle created an immediate waste storage crisis.¹⁹⁵ The majority of U.S. power plants had been licensed and built under the assumption that spent fuel would be temporarily stored on-site to cool before being taken off-site for reprocessing and disposal.¹⁹⁶ These cooling pools, which consist of a stainless steel-lined concrete basin filled with water to absorb radiation and heat, were never intended for long-term storage,

189. *Power Equipment Moves South*, *supra* note 187, at 31.

190. John D. Combes, *An Archeological Survey of the Westinghouse Electric Corporation's Proposed Nuclear Recycling Plant Near Iva, Anderson County, South Carolina* (S.C. Inst. of Archaeology & Anthropology, Rsch. Manuscript Series No. 27, 1972).

191. *Westinghouse Elec. Corp. v. U.S. Nuclear Regul. Comm'n*, 598 F.2d 759, 762 (3d Cir. 1979).

192. *Id.* at 765.

193. *Id.* at 774.

194. *Id.* at 776.

195. *See Minn. by Minn. Pollution Control Agency v. U.S. Nuclear Regul. Comm'n*, 195 U.S. App. D.C. 234, 602 F.2d 412, 413 (1979).

196. *Id.* at 413-14.

and capacity was limited.¹⁹⁷ This left plant operators in a position where the NRC had prohibited their planned waste disposal solution (off-site reprocessing), without providing any alternative (as the central repository initiative would not develop until later).¹⁹⁸ Some plants would be forced to shut down as early as spring 1978 due to their cooling pools hitting capacity.¹⁹⁹ Meanwhile, the Sierra Club and other organizations demanded an investigation into the environmental and safety risks of extended storage of spent fuel in cooling pools.²⁰⁰

In late 1976, after Ford's initial suspension of new reprocessing facility licenses, operators of the Prairie Island nuclear facility in Goodhue County, Minnesota, and Vermont Yankee Nuclear Power in Vernon, Vermont, applied to the NRC for emergency amendments to their licensing permits to allow for expansion of their existing on-site storage pools; both applications were granted and the licenses were amended.²⁰¹ Environmental groups, including the Minnesota Pollution Control Board, challenged the approvals, arguing that the failure to consider the long-term safety and environmental impacts of long-term on-site storage should have been considered before a decision was made; the approval process only included an examination of the impact of the individual pool expansions requested.²⁰² The D.C. Circuit ultimately found that the NRC, in its decision making, improperly relied on the unproven assertion that a long-term fuel storage solution would materialize, and was obligated to conduct a further review of available off-site storage solutions in subsequent decades.²⁰³ Nonetheless, the court declined to vacate the amended permits, which it acknowledged would be the practical equivalent of ordering the plants to be shut down.²⁰⁴

The federal government attempted to clean up the mess by implementing a public waste management program to replace the private-sector solution that was now prohibited. In 1978, Carter

197. *Id.* at 414.

198. *Id.*

199. *Id.*

200. Waste Confidence Decision, 49 Fed. Reg. 34,658, 34,667 (Aug. 31, 1984).

201. *Minnesota*, 602 F.2d at 414.

202. *Id.*

203. *Id.* at 418.

204. *Id.*

brought together members of the DOE, NRC, and EPA to form an Interagency Review Group on Nuclear Waste Management to explore other possibilities.²⁰⁵ The report urged a federally managed master plan to develop a central underground repository, and for Congress to enact legislation that would delegate responsibility for doing so, including mandating an appropriate site.²⁰⁶ The challenge, they acknowledged, would be earning the public's confidence and trust that it could be done safely.²⁰⁷

Congress followed through on the recommendation in 1982 with the passage of the Nuclear Waste Policy Act (NWPA).²⁰⁸ The bill represented a number of compromises: between Eastern and Western states, environmentalists and industrialists, and advocates for federal power and states' rights.²⁰⁹ Its central tenet was to authorize the "construction, operation, and maintenance of a deep geologic test and evaluation facility."²¹⁰ This would be enabled by the creation of a federal Nuclear Waste Fund, into which all nuclear operators would pay at a per-kilowatt-hour rate.²¹¹ By paying into the fund, operators would enter into a contract that obligated the federal government to collect and dispose of their spent fuel by January 31, 1998.²¹² To bridge the gap, the NWPA ordered research and development on "alternate storage technologies" that could be used for on-site temporary storage until the central repository was completed.²¹³ Namely, that meant "fuel storage casks, caissons, or silos."²¹⁴ The act does not specifically address reprocessing as part of any future fuel

205. U.S. GOV'T ACCOUNTABILITY OFF., EMD-79-77, THE NATION'S NUCLEAR WASTE—PROPOSALS FOR ORGANIZATION AND SITING 11 (1979), <https://www.gao.gov/assets/emd-79-77.pdf>.

206. *Id.* at 12.

207. *Id.*

208. Nuclear Waste Policy Act of 1982, *supra* note 66.

209. Robert J. Halstead et al., *Remaking the U.S. Nuclear Waste Program: A Window of Opportunity for Change?*, in PROCEEDINGS OF THE WASTE MANAGEMENT 2015 SYMPOSIUM 1 (2015), <https://anp.nv.gov/uploadedFiles/nucwastenvgov/content/HotTopics/Remaking%20the%20US%20Nuclear%20Waste%20ProgramADA.pdf>.

210. Nuclear Waste Policy Act of 1982, 42 U.S.C. § 10138(b)(2)(A) (2001).

211. *Id.* § 301(a)(1).

212. *Id.*

213. *Id.* § 218(a).

214. *Id.*

management plan, but orders the needs of the repository to be calculated on the assumption that no commercial reprocessing would occur.²¹⁵

In the following years, plant operators and the NRC worked to develop new solutions for expanding on-site storage. First, the NRC recommended “re-racking,” or retrofitting existing storage pools with new racks in a configuration that could accommodate a higher density of spent fuel rods.²¹⁶ But this, too, was only a temporary fix, and worse, packing the still-hot fuel rods so closely together ran the risk of a criticality accident.²¹⁷ One such plant facing over-full cooling pools was the Surry Power Station, operated by Virginia Power.²¹⁸ Its facility consisted of two Westinghouse pressurized water reactors with 157 fuel assemblies each; the on-site storage pool had total space for 1,044 assemblies.²¹⁹ It calculated that after the scheduled refueling of their reactors in March 1985 and subsequent off-loading of spent fuel, the available capacity would shrink to 159, meaning that at least one of the plant’s reactors would effectively be shut down.²²⁰ It found any further expansion of the storage pools, which had already expanded once, not viable.²²¹

In October 1982, Virginia Power submitted an application for a license to construct and operate a Dry Cask Independent Spent Fuel Storage Installation (ISFSI) on-site at the Surry facility.²²² The DOE decided to use Surry as a test case, and entered into a cooperative agreement with Virginia Power and independent researcher EPRI to

215. *Id.* § 301(a)(9).

216. *OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications*, U.S. NUCLEAR REGUL. COMM’N, Generic Letter 78-11 (Apr. 14, 1978), <https://www.nrc.gov/docs/ML0312/ML031280383.pdf>.

217. *Id.*

218. U.S. NUCLEAR REGUL. COMM’N, ENVIRONMENTAL ASSESSMENT RELATED TO THE CONSTRUCTION AND OPERATION OF THE SURRY DRY CASK INDEPENDENT SPENT FUEL STORAGE INSTALLATION 1 (1985), <https://www.nrc.gov/docs/ML1316/ML13165A154.pdf>.

219. *Id.* at 7.

220. *Id.*

221. *Id.*

222. *Id.* at 1.

study the safety and effectiveness of dry cask storage.²²³ The first series of tests was conducted on the CASTOR-V/21, a cast-iron unit manufactured by the German company GNS.²²⁴ The casks were loaded with twenty one spent fuel assemblies from the Surry Power Station and limit-tested for heat and radiation leakage.²²⁵ EPRI considered the testing a success and a “major milestone in the qualification of large metal casks for on-site storage of spent nuclear fuel,” finding them to be not only effective at containing radiation but practical, and that “handling and loading of these large containers [was] a straightforward process that made no unusual demands on personnel or facilities.”²²⁶ Further testing was completed on the Transnuclear TN-24P, a stainless-steel cask that could contain the fuel rods in either a vacuum, nitrogen, or helium.²²⁷ These too were deemed safe and effective.²²⁸

After dry casks were determined to be a safe solution for containing heat and radiation from spent fuel rods, the NRC streamlined the licensing process so that all nuclear facilities could integrate the technology. Beginning in July 1990, within all licenses to operate nuclear power reactors is a general license for the storage of spent fuel on-site.²²⁹ Operators choose from a list of pre-approved cask designs provided by the NRC.²³⁰ Then, they must submit a site report to ensure the site conditions are within the cask’s safety ratings for things like seismic or tornado activity.²³¹ On-site storage in dry casks remains the standard solution for spent fuel rods in the U.S.

223. J.M. CREER ET AL., *THE TN-24P PWR SPENT-FUEL STORAGE CASK: TESTING AND ANALYSES* (Pac. Nw. Lab; Va. Power Co.; EG&G Idaho Nat’l Eng’g Lab, Rep. No. NP-5128, 1987).

224. M.A. MCKINNON ET AL., *THE CASTOR-V/21 PWR SPENT-FUEL STORAGE CASK: TESTING AND ANALYSES* (Pac. Nw. Lab; Va. Power Co.; EG&G Idaho Nat’l Eng’g Lab, Rep. No. NP-4887, 1986).

225. *Id.*

226. *Id.*

227. J.M. CREER ET AL., *supra* note 223.

228. *Id.*

229. *Id.*

230. *Dry Spent Fuel Storage Designs: NRC Approved for General Use*, U.S. NUCLEAR REGUL. COMM’N, <https://www.nrc.gov/waste/spent-fuel-storage/designs> (last updated Sept. 26, 2025).

231. Constellation Energy Generation, LLC; Peach Bottom Atomic Power Station Units 2 and 3; Independent Spent Fuel Storage Installation; Exemption, 90

PART III: WHAT MAKES FRANCE THE WORLD LEADER IN RECYCLING?

France's success at recycling spent nuclear fuel was driven by policy, not profit. The next section discusses the policy choices that led to France's early adoption of a closed fuel cycle for its nuclear fleet; this will shed light on why they succeeded where the American fuel recycling industry failed. A survey of French energy policy through the twentieth century reveals the motivations for building a strong nuclear program, including recycling, and the mechanisms used to implement it.

Reprocessing was an element of the French nuclear program since its inception.²³² President Charles de Gaulle created the Commissariat à l'Énergie Atomique in 1945 to develop nuclear technology in three fields concurrently: medicine, energy, and defense.²³³ The latter two, energy and defense, developed a symbiotic relationship early on. As discussed above, reprocessing spent uranium fuel yields plutonium that is separated from uranium and waste material.²³⁴ If the goal is to produce more uranium fuel for energy generation, the plutonium may be considered a byproduct. But the plutonium naturally created by the fission of uranium in nuclear reactors, when separated from the spent fuel, can be used in nuclear weapons.²³⁵ Marcoule, France's pioneering nuclear facility, was the site of the country's research and development operations for both civilian and military purposes. There, 13,000 tons of reactor fuel

Fed. Reg. 13503 (Mar. 24, 2025), <https://www.govinfo.gov/content/pkg/FR-2025-03-24/pdf/2025-04921.pdf>.

232. MYCLE SCHNEIDER & YVES MARIGNAC, SPENT NUCLEAR FUEL REPROCESSING IN FRANCE (Int'l Panel on Fissile Materials 2008), <https://fissilematerials.org/library/rr04.pdf>.

233. *France: A Study of French Nuclear Policy After Fukushima*, COLUMBIA UNIV. CTR. FOR NUCLEAR STUD. (Jul. 17, 2012), <https://k1project.columbia.edu/news/french-nuclear-policy-after-fukushima>.

234. ORANO, *supra* note 90.

235. Gregory S. Jones, *Reactor-Grade Plutonium and Nuclear Weapons: Ending the Debate*, 26 THE NONPROLIFERATION REV. 61, 61–81 (2019).

were reprocessed between 1958 and 1997.²³⁶ This fuel was sourced from both energy reactors and plutonium production reactors, which create plutonium from the fission of uranium as the end product rather than as a byproduct of energy creation.²³⁷

France's nuclear energy generation program began to boom during the oil crises of the 1970s.²³⁸ France was hit especially hard during the "Oil Shock" of 1973, having no domestic oil production and thus entirely reliant on imports.²³⁹ Turning to its European allies, it found cooperation lacking as each country competed to secure cheap oil.²⁴⁰ The ultimate insult came when the French state-owned company ERAP discovered oil in the North Sea off the coasts of Scotland and the Netherlands, but was not invited to share in the wealth, as both countries took the reserves for themselves.²⁴¹

This was compounded by France having been recently cut off from an oil source upon which it had relied heavily: its former colonial territory of Algeria, which gained independence in 1962.²⁴² France initially enjoyed a special relationship with Algeria post-independence and avoided the nationalization of its companies there, despite the Algerian government taking over the rest of the country's oil fields.²⁴³ But in the decade following, relations between the two remaining French-owned oil production companies operating in Algeria and the latter country's government became increasingly

236. SCHNEIDER & MARIGNAC, *supra* note 232.

237. *Id.*

238. R.H. Taylor, S.D. Probert & P.D. Carmo, *French Energy Policy*, 59 *APPLIED ENERGY* 39 (1998).

239. Marino Auffant, *Oil for Atoms: The 1970s Energy Crisis and Nuclear Proliferation in the Persian Gulf*, 5 *TEX. NAT'L SEC. REV.* 59 (2022), <https://tnsr.org/2022/05/oil-for-atoms-the-1970s-energy-crisis-and-nuclear-proliferation-in-the-persian-gulf>.

240. See Lucas Schramm, *The Neglected Integration Crisis: France, Germany and Lacking European Co-operation During the 1973/1974 Oil Shock*, 62 *J. COMMON MKT. STUD.* 583, 583–602 (2024).

241. *Id.*

242. Kathleen K. O'Mara, *Algeria Gains Independence from France*, EBSCO RSCH. STARTERS (2023), <https://www.ebsco.com/research-starters/history/algeria-gains-independence-france>.

243. DEP'T OF STATE, OFF. OF THE HISTORIAN, NATIONAL INTELLIGENCE ESTIMATE 62–71, ALGERIA'S INT'L RELS. (Jul. 31, 1971).

strained.²⁴⁴ Ultimately, the Algerian government would take over a 51% share of those companies, allowing them to implement their own managers and sharply raise prices.²⁴⁵ In the following years, France still imported significant amounts of fossil fuels from Algeria, including 15% of its natural gas, albeit at a higher cost.²⁴⁶ But in December 1973, a major Algerian gas terminal broke down, forcing the French government to ration gas to customers in the middle of a frigid winter.²⁴⁷ It was against this backdrop of dual energy independence crises that the PEON Commission, the state advisory committee on nuclear power, met in January of 1974.²⁴⁸ Its reports would lead to a remarkable transition, in which the country would go all-in on nuclear electricity generation.

In December of 1974, Prime Minister Pierre Messmer unveiled a plan to build eighty new nuclear power reactors by 1985 and 170 by 2000.²⁴⁹ This meant the wholesale creation of an industry, as at the time France had only a single commercial nuclear power plant, Chinon A-1, which had begun operations earlier in 1964.²⁵⁰ In the most literal sense, Messmer's plans were not realized, as the country currently has 57 nuclear reactors in operation.²⁵¹ But that is only because those 1964 numbers failed to anticipate the productivity of modern reactors and the rise of other non-fossil fuel methods of generating electricity, namely renewables. France has indeed managed to largely decarbonize its power grid through these low-carbon strategies, which combine to provide 95% of its electricity.²⁵²

244. *Id.*

245. *Id.*

246. Auffant, *supra* note 239.

247. *Id.*

248. *Id.* PEON is an acronym for "Commission consultative pour la production d'électricité d'origine nucléaire."

249. Nicholas Anway, *The Messmer Plan: France's Nuclear Reactor Program*, THE INNOVATION ATT'Y (Substack) (Mar. 12, 2024), <https://theinnovationattorney.substack.com/p/the-messmer-plan-frances-nuclear>.

250. *Chinon A 1*, WORLD NUCLEAR ASS'N, <https://world-nuclear.org/nuclear-reactor-database/details/Chinon-A-1> (last visited Apr. 24, 2026).

251. *France - Country Nuclear Power Profiles*, INT'L ATOMIC ENERGY AGENCY, <https://cnpp.iaea.org/public/countries/FR/profile/highlights> (last visited Nov. 19, 2025).

252. *Id.*

How was France able to achieve such a rapid and successful decarbonization of its energy generation industry, and what lessons can be learned? Some of the reasons were due to the structure of the French political system in the 1970s, and would be difficult to replicate in the United States. The Prime Minister was operating under the Constitution of the Fifth Republic, enacted by Charles de Gaulle in 1958 to create a strong executive and stabilize a government suffering from legislative paralysis.²⁵³ This allowed Messmer to implement his nuclear strategy by decree, without either parliamentary or public approval; parliament had little or no oversight as to the rollout of the plan, either as decisions were made by the executive committee.²⁵⁴ Equally important was France's model of centralized economic planning in the twentieth century, which fell somewhere in between an open, liberal market and the completely state-operated system of the U.S.S.R.²⁵⁵ Under "planification souple" or "soft planning," the French government gave high-level direction and served an information-gathering function to facilitate cooperation between industries.²⁵⁶ Independent operators were not explicitly directed, but strongly incentivized to conform with the central plan through access to low-cost capital from state-owned banks and the Treasury.²⁵⁷ With guaranteed financial backing, operators may have been more willing to adopt a new and potentially risky technology.

Another key element of France's successful nuclear rollout was a loose regulatory and safety environment, officially referred to as "technical dialog," but which international observers would dub "French cooking."²⁵⁸ Safety decisions were reached behind closed doors through consensus among a small group of experts and regulators, and the EDF, the operator;²⁵⁹ they determined best

253. *The Constitution of the Fifth Republic*, ÉLYSÉE, <https://www.elysee.fr/en/french-presidency/constitution-of-4-october-1958> (last visited Nov. 21, 2025).

254. Alex Chalmers, *Liberté, Égalité, Radioactivité*, WORKS IN PROGRESS (Sept. 4, 2025) <https://worksinprogress.co/issue/liberte-egalite-radioactivite/>.

255. *See generally* VERA LUTZ, *FRENCH PLANNING* (1965).

256. *Id.* at 97.

257. *Id.* at 59.

258. Michaël Mangeon & Frédérique Pallez, *Supplely Regulating Nuclear Risks: The Origins of a French Exception (1960-1985)*, GÉRER & COMPRENDRE – ENG. LANGUAGE ONLINE SELECTION, No. 3, 2017, at 61.

259. *Id.*

practices and created guides, rules, “letters of orientation,” and other flexible, non-binding types of direction.²⁶⁰ This is a noted exception to the norms of the time, where nearly every other rule and regulation was encoded into public law through a complex administrative system.²⁶¹ Many within this small circle of experts had been working together for decades by this time, having received their education at the same schools and later training at the INSTN (Institut National des Sciences et Techniques Nucléaires), meaning their decision making was informed by the same shared body of technical knowledge.²⁶² This collegial atmosphere lent itself more to easy agreement and rubber-stamping than to strict regulation.

Despite the opaqueness of this oversight process, the anti-nuclear movement among the French public was relatively subdued.²⁶³ Scientists and engineers enjoy a place among the “cultural elite” in France, and many high-ranking French politicians and civil servants were trained in these fields.²⁶⁴ Public trust in technocrats was the norm, and the nuclear rollout was only one in a series of large, government-managed technology projects.²⁶⁵ And despite actual safety decisions being made behind closed doors, EDF took steps to make nuclear power feel safe and comfortable. To that end, it invited the public, including student groups, to take tours of their facilities, and continue to do so; through this program, six million French citizens have seen firsthand how a nuclear reactor works, demystifying the technology.²⁶⁶ Education campaigns also leaned into France’s nuclear legacy; Marie Curie is a national hero,²⁶⁷ and

260. See generally LUTZ, *supra* note 255.

261. *Id.* at 56.

262. *Id.* at 59.

263. See Herbert P. Kitschelt, *Political Opportunity Structures and Political Protest: Anti-Nuclear Movements in Four Democracies*, 16 BRIT. J. POL. SCI. 57, 70 (1986).

264. Jon Palfreman, *Why the French Like Nuclear Energy*, PBS FRONTLINE (1997), <https://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html>.

265. *Id.*

266. *Id.*

267. Jon Henley, *France Baffled by List of National Heroes*, THE GUARDIAN (Mar. 16, 2005), <https://www.theguardian.com/media/2005/mar/16/france.broadcasting>.

her daughter, Irène, and son-in-law, Frédéric, would make discoveries that were fundamental to reactor technology.

At the same time, while the French citizenry was not invited to participate in decision making, the government took steps to sway public opinion in favor of the transition to nuclear.²⁶⁸ Public relations campaigns emphasized the importance of nuclear for energy independence, playing into France's strong sense of national identity.²⁶⁹ A famous government-sponsored TV commercial delivered the slogan "En France, on n'a pas de pétrole, mais on a des idées" ("In France, we do not have oil, but we have ideas").²⁷⁰

A final element of France's rapid nuclear rollout was standardization. In one sense, that meant consolidating all the country's reactors under the control of one operator: EDF. By contrast, in 1980, there were a dozen operators in the United States and five in Germany.²⁷¹ But they also used a single type of reactor, based on Pressurized Water Reactor (PWR) technology licensed from Westinghouse.²⁷² These were manufactured by a Franco-American enterprise called Framatome under the intense supervision of EDF, which helped develop a specialized supply chain and conducted rigorous cost controls.²⁷³

From the beginning, France's nuclear industry was intended to use a closed fuel cycle,²⁷⁴ to transition away from fossil-fuel-based power generation and gain energy independence. France had to confront the fuel scarcity problem discussed above early in the development of its industry; unlike the United States, France has only a small amount of domestically available uranium, and it burned through the majority of its supply by the mid-1980s.²⁷⁵ From there, domestic production

268. *Id.*

269. *Id.*

270. Marco Pandazani, *Advertisement in 1974 Oil Shock. In France We Don't Have Oil, but We Have Ideas. 50 Years Later . . . ?* (YouTube, Oct. 25, 2021), <https://www.youtube.com/watch?v=UC1v8-QLSzg>.

271. LUTZ, *supra* note 255, at 59.

272. Chalmers, *supra* note 254.

273. *Id.*

274. D. DEROUBAIX, *THE FRENCH VIEW FOR SPENT FUEL TREATMENT: REPROCESSING, CONDITIONING AND RECYCLING* 19 (1999).

275. Masahide Takahashi, *France's Nuclear Power Industry Makes Its Presence Felt During the Ukraine Crisis — Energy Cooperation with Europe and the United States and the Future of the Procurement of Uranium from Niger*, SASAKAWA

slowed drastically as the remaining ore became more difficult, and thus less economical, to mine before operations ceased entirely in 2001.²⁷⁶ France still imports up to 22,000 tons of uranium a year, mostly from Kazakhstan.²⁷⁷ This is actually considerably more than is necessary to supply the country's energy needs; the excess goes towards electricity exports to neighboring countries and a strategic stockpile.²⁷⁸ With a combination of domestic reprocessing capability and existing reserves, France's nuclear fleet could operate for up to eight years without requiring additional imports.²⁷⁹ This insulates the country from future "shocks" like occurred in the global oil trade in the 1970s. One such reminder of the dangers of over-reliance on foreign imports came in June 2025, when the government of Niger nationalized a mine operated by Orano, mirroring Algeria's nationalization of its oil fields decades earlier.²⁸⁰ But this time, there is no evidence that instability in supply corresponded to any increase in power costs.²⁸¹

A. WASTE MANAGEMENT POLICY: A COMPARATIVE

The modern legislative framework for dealing with nuclear waste in France comes from the National Radioactive Material and Waste

PEACE FOUND. (Jan. 9, 2025), https://www.spf.org/iina/en/articles/takahashi_04.html.

276. *Id.*

277. Assma Maad, *How Dependent Is France on Niger's Uranium?*, LE MONDE (Aug. 4, 2023), https://www.lemonde.fr/en/les-decodeurs/article/2023/08/04/how-dependent-is-france-on-niger-s-uranium_6080772_8.html.

278. Katherine Antonio & Slade Johnson, *France's Increase in Nuclear and Hydropower in 2024 Led to More Electricity Exports*, U.S. ENERGY INFO. ADMIN. (Jul. 21, 2025), <https://www.eia.gov/todayinenergy/detail.php?id=65785>.

279. *Nuclear Energy: An Asset for France's Energy Independence*, ORANO (Sept. 5, 2023), <https://www.orano.group/en/unpacking-nuclear/nuclear-energy-an-asset-for-france-s-energy-independence>.

280. *Niger to Nationalise Uranium Mine Operated by French State-Affiliated Firm*, AL JAZEERA (Jun. 20, 2025), <https://www.aljazeera.com/news/2025/6/20/niger-nationalises-uranium-mine-as-spat-with-french-nuclear-giant-worsens>.

281. *France Electricity Price (Spot Prices)*, TRADING ECON., <https://tradingeconomics.com/france/electricity-price#:~:text=France%20Electricity%20decreased%2017.40%20EUR,1130.00%20in%20August%20of%202022> (last visited Apr. 18, 2026).

Management Plan, enacted in 2006 and updated every few years.²⁸² The most recent, the fifth edition, was enacted in 2022 and will remain in place through 2026.²⁸³ But notably, the ASNR, the French Nuclear Safety and Radiation Protection Authority, *does not* categorize spent fuel as waste, and therefore does not include spent fuel under its waste management policy.²⁸⁴ Rather, under the law, nuclear waste means the unusable materials that remain post-reprocessing, along with contaminated maintenance equipment, decommissioned parts from nuclear plants, and low-level waste from the medical industry.²⁸⁵ This illustrates the fundamental difference in the French system; under its closed fuel cycle, nuclear material becomes waste only when it can no longer be reprocessed. Low-to-intermediate waste products are managed by Andra, a French state-operated company under the supervision of the ministers of energy, research, and environment, which operates several surface-level disposal facilities.²⁸⁶ High-level waste is stored in the vitrified state discussed above at La Hague, while plans for a long-term “deep geological” disposal facility are still planned.²⁸⁷

Article L. 542-1-1 of the French Environmental Code provides an explicit legal definition for radioactive waste: “Radioactive waste consists of radioactive substances for which no subsequent use is planned or envisaged . . . ;” by contrast, “A radioactive **material** is a

282. *See, e.g.*, MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE ET SOLIDAIRE & AUTORITÉ DE SÛRETÉ DE NUCLÉAIRE [FRENCH MINISTRY FOR AN ECOLOGICAL AND SOLIDARY TRANSITION & NUCLEAR SAFETY AUTHORITY], FRENCH NATIONAL PLAN FOR THE MANAGEMENT OF RADIOACTIVE MATERIALS AND WASTE 2016-2018: SUMMARY 2017.

283. Décret no 2022-1547 du 9 décembre 2022 prévu par l’article L. 542-1-2 du code de l’environnement et établissant les prescriptions du plan national de gestion des matières et des déchets Radioactifs [Decree No. 2022-1547 of December 9, 2022, issued pursuant to Article L. 542-1-2 of the Environment Code and establishing the requirements for the National Plan for the Management of Radioactive Materials and Waste], JOURNAL OFFICIEL DE LA RÉPUBLIQUE FRANÇAISE [J.O.], Dec. 10, 2022.

284. Autorité de Sûreté de Nucléaire [Nuclear Safety Authority], *Radioactive Waste: How to Implement Lasting Solutions to Protect Human Health and the Environment?*, 2024 LES CAHIERS DE L’ASN 32.

285. *Id.* at 8.

286. *Our Missions*, ANDRA, <https://international.andra.fr/about-andra/our-missions> (last visited Nov. 20, 2025).

287. Nuclear Safety Authority, *supra* note 284, at 8.

radioactive substance for which a subsequent use is planned or envisaged, if necessary after processing.”²⁸⁸ The distinction matters in part because producers retain control of radioactive *material* and move it to temporary storage before reprocessing,²⁸⁹ but must pay Andra to manage and dispose of radioactive *waste*.²⁹⁰ The State retains the possibility of reclassifying “material” as “waste” if the industry cannot prove a realistic path to reprocessing and reuse.²⁹¹ Inducing companies to pay for waste material disposal helps encourage recycling of whatever is recyclable.

The preference for reprocessing is also explicitly encoded into law. French law 91-1381, also known as the Bataille law, was passed in 1991 and mandated a fifteen-year research period on three potential avenues for managing high-level waste: transmutation, deep geological storage, and disposal.²⁹² The culminating report found that transmutation, or chemical decomposition of radioactive waste, was potentially feasible but not yet practicable.²⁹³ It did, however, note that a reduction in waste volume can be accomplished by reprocessing.²⁹⁴ Reflecting those findings, the 2006 waste management law states that “[t]he national plan and the decree establishing its requirements shall respect the following guidelines: 1. The reduction of the quantity and toxicity of radioactive waste is sought in particular by the reprocessing of spent fuels”²⁹⁵ Reprocessing then accomplishes the first waste management pillar, while planned geological storage and the Andra-operated low level waste disposal facilities meet the second and third. The 2006 report

288. Code de l’environnement [Environmental Code] art. L. 542-1-1 (Fr.).

289. See ORANO, *supra* note 90.

290. *Management of Radioactive Waste*, ÉLECTRICITÉ DE FR., <https://www.edf.fr/en/the-edf-group/producing-a-climate-friendly-energy/nuclear-energy/edf-unique-expertise-in-nuclear-power-creation/management-of-radioactive-waste> (last visited Nov. 20, 2025).

291. Code de l’environnement [Environmental Code] art. L. 542-13-2 (Fr.).

292. ÉLECTRICITÉ DE FR. (EDF), 2007 DOCUMENT DE RÉFÉRENCE [2007 REFERENCE DOCUMENT] 2008 AUTORITÉ DE MARCHÉS FINANCIERS 42.

293. ASSEMBLÉE NATIONALE [NATIONAL ASSEMBLY], RAPPORT NO. 3793 SUR LA GESTION DES DÉCHETS RADIOACTIFS (Rep. No. 3793 2001), <https://www.assemblee-nationale.fr/12/rap-off/i3793.asp>.

294. *Id.*

295. Code de l’environnement [Environmental Code] art. L. 542-1-2 (Fr.).

also highlights the possibility that future reactor technologies, including fusion, may play a role in waste management.²⁹⁶

PART IV: SOLUTIONS

While the nuclear waste storage and disposal problem is complex, I would argue that the solution is relatively simple. As discussed *supra*, the technology for reprocessing spent nuclear fuel is readily available, and France has paved the way in proving that a closed-cycle nuclear industry is possible. Two policy changes could revive spent fuel recycling in the United States: tax subsidies for private recycling operations, or the creation of a centralized, federally operated recycling facility.

A. TAX SUBSIDIES

A production tax credit could be used to fix the market failure that currently prevents commercial reprocessing from being profitable. The existing Carbon Capture and Storage Tax Credit²⁹⁷ provides a useful model, in that it supports the development of an industry with high up-front capital investment costs by mitigating the risk of losses for operators.

The Section 45Q Tax Credit for Carbon Sequestration was intended to incentivize technologies that trap carbon dioxide from the atmosphere and sequester it underground, reducing atmospheric levels of CO₂.²⁹⁸ The credit provides up to \$40.89 per metric ton of CO₂ captured in 2023, increasing to \$50 by 2026 and then adjusted according to inflation.²⁹⁹ It's applicable to equipment placed into service after December 31, 2022, and facilities that begin construction before January 1, 2033.³⁰⁰ This credit encourages investment in an unproven technology that has a beneficial use in the fight against climate change. Another useful model is the production

296. NATIONAL ASSEMBLY, *supra* note 293.

297. I.R.C. § 45Q. (2022).

298. ANGELA JONES & DONALD MARPLES, CONG. RSCH. SERV., IF11455, THE SECTION 45Q TAX CREDIT FOR CARBON SEQUESTRATION 1 (2023).

299. *Id.* at 2.

300. *Id.*

tax credit for wind enacted under the Inflation Reduction Act,³⁰¹ which allotted up to 2.5 cents per kilowatt-hour of electricity generated by wind projects that met certain requirements.³⁰² These credits lowered the net cost of development for large wind projects and helped ensure cost parity with fossil-fuel generated electricity,³⁰³ providing a significant boost to the industry by reducing the risk involved with the initial capital investment.³⁰⁴ As much as wind energy should be subsidized for its social value of reducing greenhouse gas emissions, nuclear fuel reprocessing should be subsidized in recognition of its social value of reducing high-level waste.

A similar credit for spent nuclear fuel could be either input-based (i.e., a credit for accepting spent fuel from electricity generators, acknowledging the social value of disposing of the highly radioactive and hazardous spent fuel via recycling and reducing the total amount of high-level waste) or output-based (i.e., a per-kilogram credit for producing MOX fuel). In either case, the credit could either be fixed or indexed to the price of uranium to ensure that raw uranium fuel cannot outprice MOX fuel. Just as the carbon capture tax credit requires monitoring and verification by EPA to confirm permanent storage,³⁰⁵ a fuel reprocessing credit could require oversight by the NRC and DOE to ensure safety and non-proliferation.

The basis of that oversight would be nuclear material accountancy, or the tracking of fissile material at each stage of the process from its arrival at the facility through the MOX fuel and vitrified waste that leaves the facility.³⁰⁶ Existing NRC regulations already cover this by mandating that facilities that handle nuclear material must implement

301. I.R.C. § 45.

302. *Inflation Reduction Act Tracker: IRA Section 13101 – Production Tax Credit for Electricity Produced From Certain Renewable Sources*, SABIN CTR. FOR CLIMATE CHANGE L., <https://iratracker.org/programs/ira-section-13101-production-tax-credit-for-electricity-produced-from-certain-renewable-sources/> (last visited Mar. 7, 2026).

303. *§48E and §45Y Tech-Neutral Tax Credits: Guide + FAQs*, CRUX CLIMATE (Mar. 26, 2025), <https://www.cruxclimate.com/insights/tech-neutral-tax-credits>.

304. BROWN, *supra* note 20, at 12.

305. *Id.*

306. *Material Control and Accounting of Special Nuclear Material*, 10 C.F.R. pt. 74 (2024).

a Material Control & Accounting System.³⁰⁷ This accountancy chain would serve as the measurement of reprocessed fuel eligible for the tax credit and as a safeguard against proliferation.

DOE's role could be to implement the "closed cycle" by verifying that the reprocessed fissile material is turned into MOX fuel and ultimately used in reactors. A chain of custody system mirroring EPA's system for confirming CO₂ is stored permanently underground and not merely captured could be used to certify that the reclaimed material is reused in fuel and does not sit idle after the reprocessing stage.

The tax credit could be subsidized using the existing Nuclear Waste Fund enabled by the Nuclear Waste Policy Act discussed *supra*.³⁰⁸ The money is earmarked for a central repository, but reprocessing works directly in service of any future repository by reducing the volume of material that requires long-term disposal.³⁰⁹ It also reduces the liability to which the federal government is exposed by its failure to collect spent fuel from operators.³¹⁰ Congress could amend the NWPA to authorize expenditures for reprocessing facilities and operations, either by allocating a portion of the existing fund or directing future funding toward that purpose. Pushback from the industry against redistributing what the federal government has already collected or is authorized by law to collect would likely be minimal compared to an additional tax to fund reprocessing.

B. CENTRALIZED REPROCESSING

A way to quickly move to a closed fuel cycle without relying on private industry would be for the federal government to create a central reprocessing facility, much like the Orano facility at La Hague discussed *supra*. This would require a top-down, national decision to implement fuel reprocessing, and while possible, structural differences in the United States' government and economy would make replicating Orano's success challenging. The primary difference is that, while France's state-owned utility EDF owns the

307. *Id.*

308. Nuclear Waste Policy Act of 1982, *supra* note 66.

309. *Id.*

310. *Id.*

spent fuel and may contract with Orano for reprocessing, in the United States, spent fuel is owned by individual operators.

Currently spent nuclear fuel is defined as high-level waste that will eventually be entered into a repository.³¹¹ But legislative changes to the Nuclear Waste Policy Act could reclassify spent nuclear fuel as distinct from high-level waste. Recoverable material could be a distinct category under the NWPA, allowing for the creation of a separate waste stream that could include reprocessing. A wholly or partially government-owned corporation could, as detailed above, use funding already collected in the Nuclear Waste Fund to develop a reprocessing operation. However, this may result in the same siting difficulties as the central repository.

PART V: CONCLUSION

In this Note, I have demonstrated that nuclear waste management is an obstacle to the proliferation of nuclear energy in the United States. But solving this problem is critical to implementing nuclear power at a large scale, thereby meeting our increased electricity demands with a low-carbon source. Reprocessing spent fuel to recover the still-usable fissile material will result in better energy independence, longevity of the uranium supply, and an overall reduction in high-level waste that must be disposed of. While moving to a closed fuel cycle would be challenging, it is not impossible. Nuclear “waste” only exists as a policy choice; should we decide to, we can unlock the power contained in material we have in abundance.

311. Nuclear Waste Policy Act of 1982, 42 U.S.C. § 10101(9) (2018); *Id.* 42 U.S.C. § 10101(23).