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NUCLEAR WASTE POLICY ACTIONS FOR THE 117TH CONGRESS AND BIDEN ADMINISTRATION

BY DR. MATT BOWEN
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Introduction

In the 117th Congress, the United States Senate is evenly divided, 50-50, between the two major political parties, and the margin for control of the US House is small. One nonpartisan—and overdue—policy issue that Congress and the executive branch could focus on is the US nuclear waste management program. The US is currently paying billions to utilities to house spent nuclear fuel (SNF) at operating and shutdown facilities, and high-level waste (HLW) remains at former nuclear weapons complex sites around the country. Add to this the potential for greater future reliance on nuclear power in a decarbonizing economy, and the need to finally get a handle on managing radioactive waste is clear.

An earlier report from the Center on Global Energy Policy on the US nuclear waste management program examined larger structural changes that the federal government could pursue to help the program make progress, such as fixing the funding mechanism and updating regulatory standards.[1] This commentary discusses the US program as it stands in the 117th Congress and proposes a series of comparatively smaller actions that could be considered and perhaps pursued on a bipartisan basis in the next few years.

Reasons to Rethink the US Program

Yucca Mountain in Nevada was named in the amended Nuclear Waste Policy Act (NWPA) of 1982 as the only location in the United States where commercial spent nuclear fuel could

be disposed. However, the State of Nevada has opposed that decision for decades, and its congressional delegation has successfully prevented any appropriations for the repository since 2010. Quite apart from the stalemate over Yucca Mountain,[2] there have been a variety of developments since the Nuclear Waste Policy Act of 1982 was signed into law that argue for rethinking the US approach to nuclear waste management.

Progress on the Disposal of Some Defense Waste

The Waste Isolation Pilot Plant (WIPP) in New Mexico, a deep geologic repository for long-lived transuranic waste from defense activities, opened in 1998; the WIPP provides an alternate template—one whose development involved negotiations with the host state—for how to successfully site, license, and deploy a nuclear waste repository.

Emergence of Climate Change as an International Imperative

While concerns about climate change have existed for decades, they only gained urgency in recent years: national governments declared the objective of limiting temperature increases to well below 2 degrees Celsius in the Paris Accords of 2015. In recent years, numerous US states have passed clean energy standards requiring their power sectors to decarbonize by roughly midcentury, and certain major utilities have committed to reaching zero carbon by the same timeline. These actions have contributed to the recent relicensing of some existing nuclear power plants, some of which may operate out to 80 years. The private sector and the US government have also made substantial investments in advanced reactor development to create dispatchable zero-carbon options that address energy and environmental challenges. The continued operation of the existing fleet and any new reactors will produce long-lived nuclear waste that will require disposition.

Advancements of Other Countries' Commercial SNF Disposal Programs

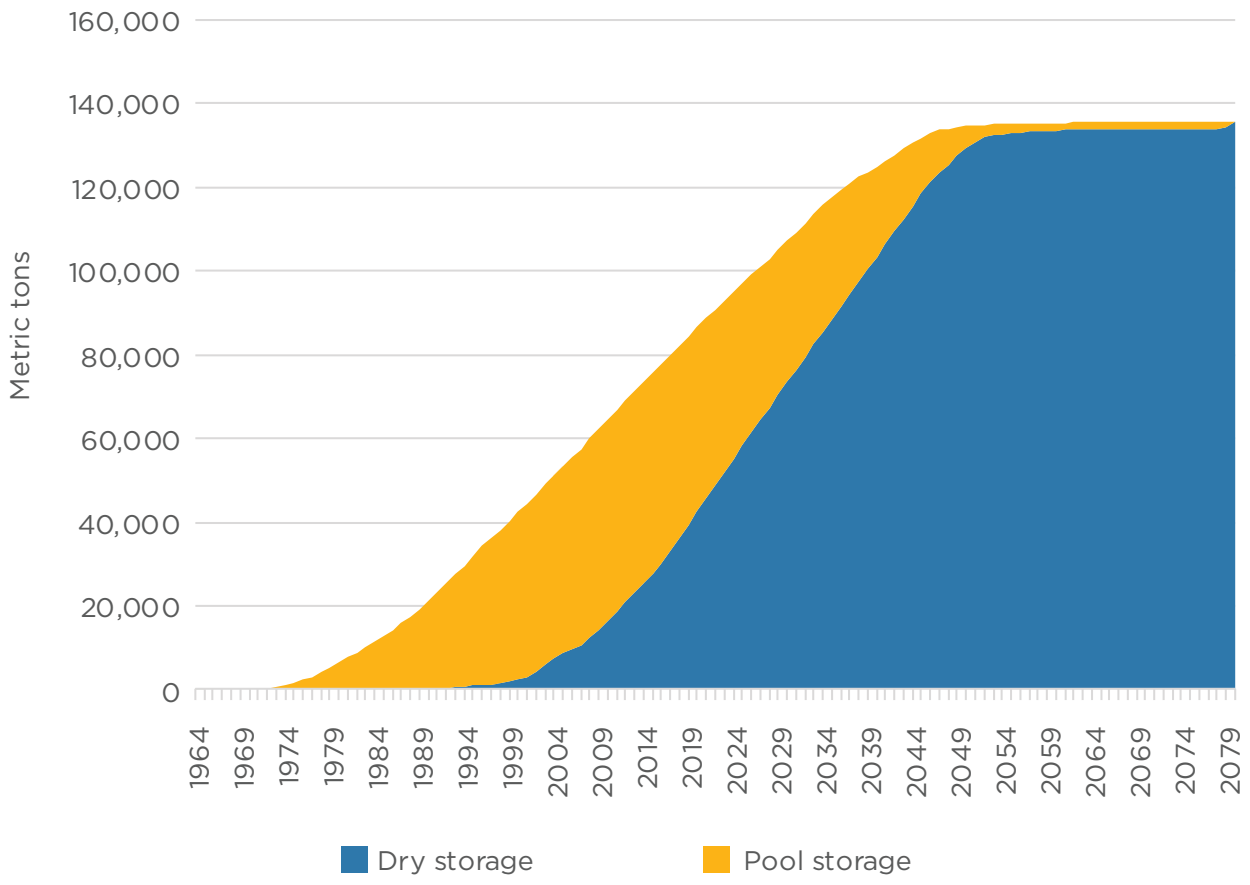
Other countries have made greater progress than the United States in spent fuel disposal, including Finland, which is now building a deep geologic repository after pursuing a consent-based approach where the local government voted in favor of the project. This contrasts with the top-down approach detailed in the 1982 NWPA where the federal government selected a site on its own. Finland, which expects to begin disposal operations in the next few years, would be the first country to dispose of commercial SNF anywhere in the world. That facility at Onkalo would provide an opportunity for state and local officials in the United States to visit an operating geologic repository to better judge for themselves the risks and benefits of hosting such a facility. Canada is within a few years of selecting a location to focus its repository efforts on, and like Finland it also pursued a consent-based approach to siting its repository rather than the top-down approach the United States took through the NWPA.

Prevalence of Interim Storage Facilities at Existing US Nuclear Power Plants

After SNF is removed from reactors, it generates so much heat that active cooling is generally necessary for about three years (and standard industry practice is to keep SNF in actively cooled pool storage for at least five years).[3] US nuclear power plant sites were originally built with limited pool storage as it was expected that the SNF would be sent off-site for

reprocessing after a short period of time. But this did not happen in part because of the falling price of uranium, which made reprocessing less economic, and also because the United States changed its policies on reprocessing in the 1970s due to nonproliferation concerns. In consequence, the storage pools ultimately approached their designed storage capacities. When that occurred, however, the older SNF had already cooled sufficiently to be removed from the pool and placed in dry, air-cooled storage systems (i.e., "dry casks"). The practice became common, and—in the absence of a disposal facility—the amount of SNF in dry storage canisters now rivals the amount in pool storage, with the former projected to dwarf the latter in a few decades, as shown in Figure 1.

Figure 1: Cumulative SNF in pool storage or dry storage with projections to 2080



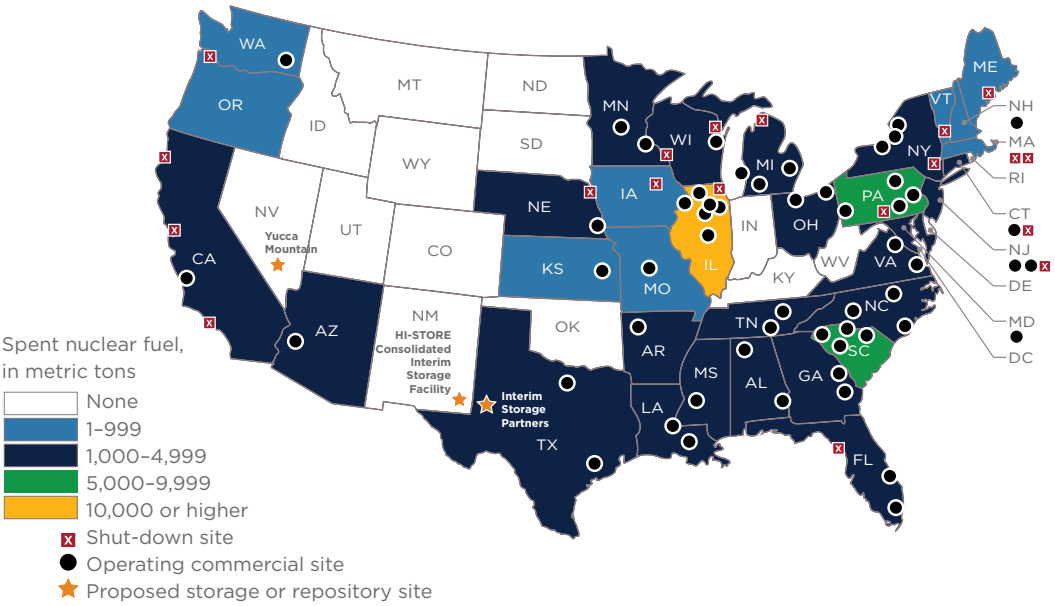
Source: SRNL, "Spent Fuel and Reprocessing Waste Inventory," FCRD-NFST-2013-000263, Rev. 7, September 2020.

The different temporary canisters used at nuclear power plants were not designed for long-term disposal in any geological environment per se, but it would be preferable—if possible—not to have to open the casks to transfer the SNF into canisters specifically designed for disposal. Doing so would incur additional costs (e.g., from buying new disposal casks and paying for equipment and workers to carry out the transfer) and potential operational risks (e.g., the potential for radiation exposures to workers performing the transfer). Therefore, the Department of Energy's (DOE) 2000s-era concept of removing SNF from pool sites and placing it directly into canisters designed for transportation and disposal will need to be reevaluated for the large and growing amount of waste already in interim storage casks. Research is underway to determine whether the SNF in them could be disposed of in certain geologic repository environments.[4]

Cost of Broken Federal Contracts with Utilities

At the end of 2019, SNF was stored at 75 operating or shutdown commercial nuclear power plant sites (as shown in Figure 2). Because of the federal government's failure to take possession of the waste in 1998, as required in federal contracts with utilities operating nuclear power plants, utilities have been successfully suing the federal government for hundreds of millions of dollars a year to pay the costs of interim on-site storage. The projected federal liability is tens of billions of dollars.

Figure 2: Stored commercial spent nuclear fuel amounts, through 2019, and locations, as of June 2021



Source: Government Accountability Office, "Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution," September 2021.

A Stable Defense Waste Inventory

The reactors at Hanford that were producing plutonium for the US nuclear weapons program were shut down in 1987, largely bounding what had been a growing defense waste inventory, except for the metric ton or two that US aircraft carriers and submarines still produce each year. A US government strategy to pursue disposal of defense waste first[5] would thus be able to work with essentially a fixed inventory, simplifying planning, as opposed to the commercial spent nuclear fuel inventory, which is increasing each year by roughly 2,000 metric tons.

Uneven Progress in Processing Nuclear Waste at Defense Sites

Some defense-generated waste inventories could be disposed of with relatively little additional processing, while other inventories may need many years or decades of treatment. For example, there have been extensive delays in vitrifying liquid high-level waste at the Hanford Site in Washington, calling into question when that particular inventory may be ready for disposal. The repository plan for Yucca Mountain had commercial and defense waste mixed together in disposal areas, but the nonavailability of some defense wastes could make this type of approach difficult to achieve for repositories in general.

Possible Signs of Movement

Some developments in the 117th Congress point to the possibility of restructuring the US approach to SNF management. In July 2021, a bipartisan group of representatives formed the Spent Nuclear Fuel Solutions Caucus to address the challenges of commercial SNF remaining at shuttered power plants (also called "stranded" fuel and sites).[6] Two months later, the GAO issued a report finding that congressional action was needed to break the impasse on SNF management because changes to the law are needed for the program to make progress.[7]

Additionally, Congress included $20 million in appropriations for fiscal year (FY) 2021[8] for consolidated interim storage efforts—that is, consolidating some of the temporary canisters at a single site. Part of the $20 million was to go toward identifying such a site using a consent-based approach, though Congress did not define what "consent-based" meant. The appropriations also directed the DOE to continue site preparation activities at shutdown nuclear power plant sites and undertake transportation coordination efforts.

A consent-based approach to identify a site for federal interim storage aligns with Energy Secretary Jennifer Granholm's comments about revisiting recommendations of the Blue Ribbon Commission on America's Nuclear Future (BRC) for nuclear waste management.[9] Most recently, on November 30, 2021, the DOE issued a request for information to seek input on a consent-based siting process to identify sites to store commercial SNF.[10] Consolidated interim storage could provide the US with a variety of strategic advantages—both monetary and nonmonetary[11]—including the following:

- allowing local communities to fully reclaim the land at shutdown power plants. This would also eliminate security-related site costs, reducing overall costs for maintaining many separate SNF storage facilities as compared to one consolidated site. This

type of consolidation appears to have broad support: the standard contract that utilities have with the DOE mentions the possibility of prioritizing acceptance of SNF from shutdown sites, which was recommended by the BRC. Two bills from the 116th Congress—the Nuclear Waste Administration Act of 2019 (S. 1234) and the Nuclear Waste Policy Amendments Act of 2019 (H.R. 2699)—contain the same prioritization.

- helping the federal government meet its commitments under the NWPA and, in the process, reducing taxpayer liability of hundreds of millions of dollars a year, paid out of the US Judgment Fund.
- providing time for additional cooling of SNF, while preserving disposition options for the future.

As of December 2021, it is unclear how the DOE will proceed with the $20 million that Congress has appropriated for consolidated interim storage efforts. The DOE could, for example, announce a funding opportunity, making money available to state, local, and tribal entities to study the risks and benefits of hosting a consolidated interim storage facility. The DOE could also take a more unorthodox approach and simultaneously solicit views from nongovernmental organizations that have been historically skeptical or even opposed to nuclear power on how best to proceed.

Perhaps most importantly, the DOE could solicit input from—and offer funding to support associated research at—state-level organizations such as the National Governors Association (NGA) and the National Conference of State Legislatures (NCSL) on how best to approach state governments. Historically, some local governments in the United States have been in favor of hosting nuclear waste storage and disposal projects, but in those limited cases, hesitation, concern, or outright opposition has come from the state level. This by itself argues for engaging organizations such as the NGA and NCSL on what programmatic elements could increase the chances of a state getting to a position of at least nonopposition to a local government deciding to move forward with such a project.

However, regardless of what consent-based provisions the DOE proposes in order to involve state, local, and tribal entities in the development of consolidated interim storage facilities, federal law (i.e., the NWPA) contains a number of relevant restrictions that will limit progress absent congressional action. Most immediately, the NWPA[12] does not permit the DOE to construct a consolidated interim storage facility until the Nuclear Regulatory Commission (NRC) has issued a license to construct a repository. Since the NRC has not issued a repository construction license, Congress has—through its 2021 appropriations—effectively directed the DOE to begin work on a facility it is not legally allowed to construct absent a breakthrough in the repository program or a change in law.

Apart from the legal prohibition, the absence of a federal government effort writ large to develop a disposal capability is probably more problematic. Reports in the past decade have noted that, in general, the US nuclear waste management program does not appear to be moving toward the end goal of a geologic repository,[13] as recent appropriations bills have directed the DOE waste program to perform only generic research and development (R&D) related to disposal and repositories with no funding related to siting a new repository.[14] Given

this lack of progress, states will likely be more hesitant to accept a consolidated interim facility on their land, worrying that "interim" will become long term if there is no final disposal site. For example, in July 2021, members of the New Mexico congressional delegation, along with the state's governor, sent a letter to Granholm opposing consolidated interim storage of SNF in New Mexico, citing the lack of a permanent disposal capability.[15] Texas Governor Abbott sent a letter to the NRC opposing consolidated interim storage in his state in part on these grounds, and Texas later passed a law that attempts to block these facilities.[16]

Does Congress actually want the executive branch to search for a new repository? Congress has not directed the DOE to do so through appropriations or other laws, and action will be needed elsewhere in multiple executive branch agencies (requiring funding from Congress in all cases). The Environmental Protection Agency (EPA), for example, will need to promulgate new, modern generic regulations that will apply to future repositories before much if any work can be done at any sites to assess their suitability. Here, Congress could choose to direct the EPA to produce these new regulations—or choose to prevent the EPA from doing so.

One area that the DOE has the authority to move forward on is siting repositories solely for disposal of defense-generated SNF and HLW. Section 8 of the NWPA provides authority for the president to find that such a repository is necessary, and President Obama made the requisite determination in 2015.[17] In this context, the DOE could begin a consent-based siting process for a geologic repository solely for defense waste. However, when the Obama administration undertook an initiative in this direction, the Armed Services committees denied funding for the effort. The Senate committee expressed a variety of concerns, including potentially higher costs and impacts on discretionary defense funds.[18]

A repository for defense waste would accommodate the removal of defense-generated nuclear waste from sites currently hosting it, allowing those sites to finish their environmental cleanup efforts. The government is required to remove spent naval reactor fuel from an Idaho facility by 2035, according to an agreement between the state, the DOE, and the US Navy. A successful defense waste repository would also provide another demonstration of deep geologic disposal of long-lived nuclear waste in the United States (as the WIPP has) but for HLW and SNF. This demonstration could potentially increase the likelihood that a state would consent to host a repository facility for commercial SNF and HLW disposal in the future

Actions for the Federal Government

Absent a broader decision by Congress with respect to additional repositories, smaller actions not requiring changes in law are outlined in this section, should lawmakers or the DOE seek more immediate options for advancing US nuclear waste management and disposal efforts.

Action 1: Publish a finalized consent-based siting plan for nuclear waste management facilities that includes an integral role for consolidated interim storage.

The DOE publishing a consent-based siting plan prior to seeking expressions of interest or issuing requests for proposals for consolidated interim storage would help clarify the role of such facilities in the broader system.

The Obama administration released a high-level strategy report with public input in 2016 on managing and disposing of SNF and HLW,[19] after which the DOE issued a draft document[20] outlining design principles for an effective consent-based siting process that included the prioritization of safety, environmental responsibility, regulatory requirements, recognizing Indian tribes' special trust relationship with the US federal government, environmental justice, informed participation, voluntariness/right to withdraw, transparency, and more.

Along these lines, the 2021 GAO report cited earlier included a recommendation that the DOE finalize this draft consent-based siting process. The draft had not been finalized due to changes in administration, but DOE officials told the GAO they were planning to resume work and complete the effort in 2022, pending an initial request for public input.

Senate bill S. 1234 from the previous Congress (mentioned earlier with regard to prioritizing waste acceptance)[21] would have required a new siting process to begin and would have removed restrictions on site-specific work on a second repository, restrictions that are currently contained in the NWPA. S. 1234 would have created a new organization whose sole purpose would be nuclear waste management and would require it to produce a "mission plan" for the development of both storage facilities and repositories.[22]

When the DOE first published a mission plan with similar objectives in 1985, it assessed that an integral role for consolidated interim storage "would significantly improve system operations and the timely implementation of system functions."[23] However, following the 1987 amendments to the NWPA, which annulled the DOE's selection of Oak Ridge in Tennessee for a consolidated interim storage facility and further constrained such efforts, the DOE's program plans ultimately moved away from consolidated storage as a part of its integrated waste management system. For example, when the DOE published its final environmental impact statement for the Yucca Mountain Project in 2002, the plan was for SNF assemblies to be shipped from commercial sites directly to the repository.[24]

Based on current realities (e.g., the use of dry cask storage at plant sites, the number of shutdown sites, and the lack of current disposal capacity), the DOE could prepare a new waste management system plan that clarifies the value of consolidated interim storage for SNF from shutdown reactors. The FY2021 appropriations bill language expresses congressional intent to prioritize moving SNF from shutdown reactors.

A finalized siting plan could also include an estimate of the additional costs that consolidated interim storage would entail (such as those incurred from needing two SNF transportation campaigns: first from shutdown reactors to the consolidated interim site and then from the latter to a repository site), weighed against the long-term savings achieved by reducing storage and security expenses through consolidation (in addition to any nonmonetary benefits). Given the legal constraints described earlier, the plan would likely need to note statutory changes that are necessary for the plan to be carried out as envisioned.

Action 2: Evaluate alternative approaches for repository development and operation.

A number of developments in the last two decades warrant revisiting the assumptions underlying the actual development and operation of a repository.

The increasingly large amounts of commercial SNF that reside in temporary dry storage casks was not envisioned in 1982. As discussed earlier, questions remain about whether such casks could be disposed of at a particular repository site without repackaging into disposal canisters, which would involve additional costs and operational risks. And given the delays in vitrifying high-level waste at Hanford,[25] there are uncertainties about when and how many defense HLW canisters will be available for codisposal with defense SNF standard canisters.

There are also ongoing debates over whether commercial SNF should be retained as an energy resource where the remaining fissile material could be recycled for additional energy production. There are also questions as to whether there are technically feasible and potentially preferable disposal alternatives to mined repositories (e.g., borehole disposal, discussed in Action 3).

With respect to repository development in general, there has been an evolution in thinking over the last several decades toward a phased, adaptive, and stepwise approach, as recommended by the National Academies[26] and the BRC, rather than an approach with set decision points fixed in congressional statute, such as the NWPA. As an initial step, the DOE could prepare a report that identifies and evaluates alternative approaches for disposing of SNF and HLW, including a phased repository development (described in the DOE's *Draft Plan for a Defense Waste Repository*) and concepts for the disposing of different types of waste in separate parts of a commingled repository. The latter could allow for decoupling the timing of defense and commercial waste emplacement (described in the DOE's *Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel*).

Action 3: Institute a robust R&D program on alternative disposal technologies.

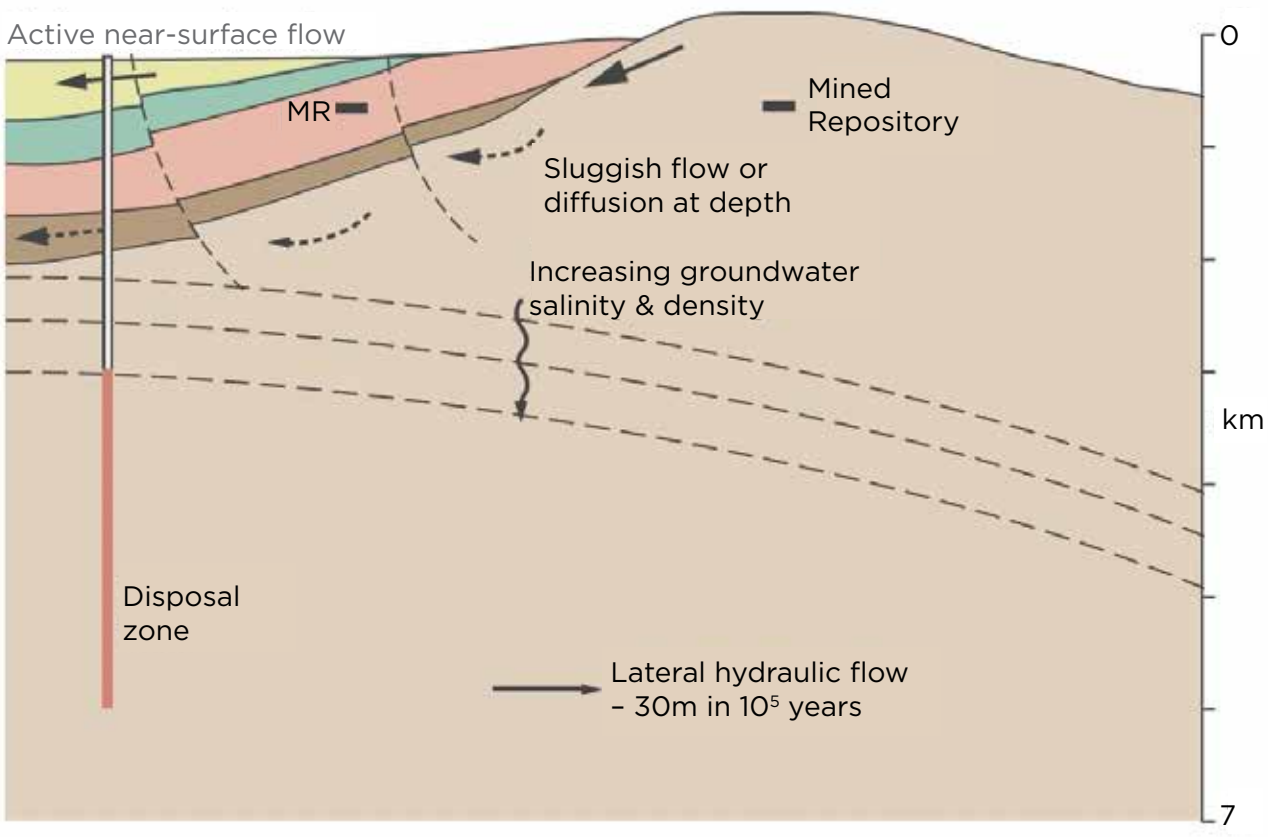
Although the DOE announced its decision in 1981 to develop mined geologic repositories for radioactive wastes, it also mentioned examining disposal under the seabed and in very deep holes as potential backup technologies.[27] Mined geologic repositories became the main thrust of the US program, but revisiting the other options with a robust R&D program could prove fruitful.

The report on the Senate Energy and Water Development FY2020 appropriations bill directed the DOE to use R&D funding to prepare a report on "innovative technological options" for the disposition of high-level waste and spent nuclear fuel.

Studies have identified boreholes as promising alternatives to repositories constructed from conventional mining techniques.[28] There are a number of attractive features for deep borehole disposal, including a prevalence of stable underground geologies that could accommodate

deep boreholes and the dense, salty water at these greater depths (as opposed to fresh groundwater resources at shallower depths) that would limit the possibility of radionuclide mobility to drinking water.[29] The width of drilled boreholes limits the size of the disposal packages,[30] but several small DOE-managed waste forms could be immediate candidates for borehole disposal.[31] Two externally created diagrams showing potential borehole configurations are provided in Figures 3 and 4.

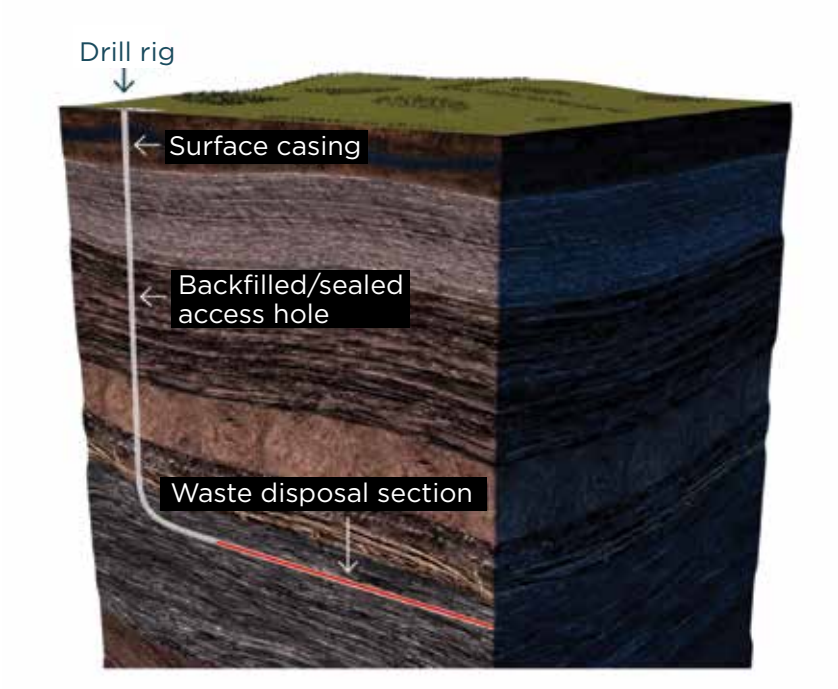
Figure 3: Vertical borehole concept



Note: The disposal of nuclear waste in deep boreholes would take place several kilometers below the earth's surface—at much greater depths than mined repositories. The lateral movement of water is substantially slower at these depths than movement at mined repository depths.

Source: Blue Ribbon Commission on America's Nuclear Future, "Report to the Secretary of Energy," US Department of Energy, January 2012.[32]

Figure 4: Horizontal borehole concept



Source: Deep Isolation.

The DOE could plan for and pursue a robust R&D program to further investigate borehole disposal approaches. This work began during the Obama administration, but a field test planned for North Dakota—despite it not involving actual nuclear material—was met with local resistance and ultimately canceled.[33] Research on boreholes was largely ended during the Trump administration. Should the Biden administration wish to restart the program, the North Dakota experience indicates that local and state government support would be critical to successfully conduct future field tests.

Boreholes may also be ripe for international R&D collaboration: they are being examined as a nuclear waste disposal option in countries such as Australia, China, Germany, South Korea, and the United Kingdom.[34] Dozens of other countries have nuclear power programs, and some that don't still have research reactors for basic science, medical, and industrial isotope production, resulting in a much smaller inventory of waste that nonetheless requires proper disposal.

Action 4: Create an integrated plan for developing transportation capabilities to move SNF away from shutdown reactor sites.

Some of the technical and institutional capabilities for transporting SNF away from reactor sites are known and needed regardless of when, where, and what types of facilities the SNF will be shipped to. Knowledge of the end destination is not necessary to do at least some of the planning for a transportation campaign and to develop needed capabilities. The Senate report on the FY2021 Energy and Water Projects appropriations bill called for, among other things, "accelerating the development of a transportation capability to move spent fuel from its current storage locations."[35]

The DOE has already been examining shutdown sites to identify infrastructure upgrades that may be needed to remove the SNF[36] and is also progressing toward design and development of railcars to meet the American Association of Railroads' requirements for spent fuel transportation.[37]

To ensure readiness to the degree possible before having a defined destination, the DOE could prepare a plan that integrates a broader set of issues, including the following:

- estimating the costs and lead time to procure sufficient hardware (railcars and transportation overpacks).
- completing the list of infrastructure upgrades needed at shutdown sites.
- continuing planning work (including total cost estimates for SNF removal) at shutdown plants, beyond the six sites already studied by the DOE.[38]
- engaging with the governments of states hosting shutdown sites, as well as the four state regional groups[39] that each have programs dealing with nuclear waste transportation issues, on route readiness and estimated funding for training[40] state, local, and tribal transportation officials.
- identifying a process for considering and responding to the transportation-related recommendations of independent groups including state regional groups,[41] the BRC, and the National Academies.[42]

This advance planning could help enable the initiation of pilot-scale operations of a storage facility for spent fuel from any of the shutdown sites, as well as provide decision makers insight on how best to begin the SNF acceptance process.

Action 5: Study and facilitate the potential transfer of responsibilities to a new waste management organization.

For decades, reports have noted that a separate organization solely focused on nuclear waste management would have implementation advantages over housing the US SNF and HLW waste management program within the DOE.[43] There are steps that the DOE could take now to inform the potential creation of such an organization.

The department could charter a joint National Academy of Sciences–National Academy of Public Administration[44] panel to provide analysis on the possible structural details and statutory foundations of a new organization. Their report could examine experiences inside the United States with federal entities not responsible for nuclear waste disposal implementation (such as the Tennessee Valley Authority and the NRC) and those outside of the United States that do have such duties (e.g., the single-purpose entity created to manage nuclear waste in Canada). The report could include statutory, regulatory, cultural, and organizational measures related to achieving higher levels of transparency, public trust, and successful implementation of SNF repository siting elsewhere in the world by single-purpose organizations as an input to congressional deliberations.

The DOE could otherwise develop a plan for reconstituting an office solely dedicated to the development and implementation of a robust waste management program, as the Office of Civilian Radioactive Waste Management was for several decades,[45] with an eye toward transferring that office's responsibilities to a new single-purpose organization outside of the DOE once established. A recent letter from eight organizations urged Secretary of Energy Granholm to establish an office within the DOE that would report directly to her and be dedicated to "developing and managing an integrated nuclear waste storage, transportation, and disposal program."[46] The physical office space could even be separate from current DOE buildings as a small step toward building a separate identity and different work culture.

Conclusion

Management of US nuclear waste is not a Democratic or Republican issue—states with nuclear power plants went blue and red in the 2020 elections. Idaho, South Carolina, and Washington have differing political environments, but all of them have defense-generated HLW at DOE sites in need of a disposal pathway. The tens of billions of dollars in federal tax liability from the broken contracts with utilities for failure to take possession of commercial SNF with no geologic repository to house it affects Republican and Democratic taxpayers.

Additionally, with the Biden administration's goal of the US emitting net-zero greenhouse gases by 2050 and greater government funding targeted to advanced nuclear reactor R&D, decarbonization efforts that involve nuclear power will only reinforce the need to get a handle on nuclear waste disposal. The actions suggested in this report could help the 117th Congress and Biden administration take the first steps toward restructuring the US nuclear waste program, a timely and nonpartisan issue demanding attention.

Notes

1. Matt Bowen, "Forging a Path Forward on U.S. Nuclear Waste Management: Options for Policy Makers," Center on Global Energy Policy, January 2021, https://www.energypolicy.columbia.edu/research/report/forging-path-forward-us-nuclear-waste-management-options-policy-makers.

2. Bowen 2021. See pages 11–17 for history on Yucca Mountain and the current stalemate.

3. National Research Council, *Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report* (Washington, DC: The National Academies Press, 2006), https://doi.org/10.17226/11263, 20.

4. Freeze et al., "Integration of the Back End of the Nuclear Fuel Cycle," Sandia Report, SAND2021-1044, August 2021, 77–85.

5. Bowen 2021. See pages 29–32 and pages 48–49 for a discussion of the disposing of defense waste first.

6. Nuclear Newswire, "Reps. Levin, Davis Form Bipartisan Caucus to Tackle Stranded Spent Fuel Issue," July 26, 2021, https://www.ans.org/news/article-3099/reps-levin-davis-form-bipartisan-caucus-to-tackle-stranded-spent-fuel-issue/.

7. GAO, *Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution,* September 2021.

8. Committee on Appropriations, *Report to Accompany the Energy and Water Development and Related Agencies Appropriations Bills,* 2021, https://docs.house.gov/meetings/AP/AP00/20200713/110879/HMKP-116-AP00-20200713-SD002.pdf.

9. The Blue Ribbon Commission on America's Nuclear Future released its report to the secretary of energy in January 2012: https://www.energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf.

10. US DOE, "DOE Restarts Consent-Based Siting Program for Spent Nuclear Fuel, Requests Input on Interim Storage Process," November 30, 2021, https://www.energy.gov/articles/doe-restarts-consent-based-siting-program-spent-nuclear-fuel-requests-input-interim.

11. Navigant Economics, "Spent Nuclear Fuel Management: How Centralized Interim Storage Can Expand Options and Reduce Costs," May 16, 2011. See pages 50–54.

12. Section 148(d).

13. E.g., *Reset of America's Nuclear Waste Management Strategy and Policy,* Stanford University Center for International Security and Cooperation/George Washington University Elliott School of International Affairs, October 15, 2018.

14. The 1987 amendments to the NWPA restricted the DOE to Yucca Mountain and no other sites in evaluating candidates for the first repository. Section 161(a) of the NWPA states: "The Secretary may not conduct site-specific activities with respect to a second repository unless Congress has specifically authorized and appropriated funds for such activities." Section 2 of the NWPA ("Definitions") does not provide a definition for "site-specific activities," nor is the term defined elsewhere in the act. The term is used in multiple places in the NWPA, including sections related to consolidated interim storage (called "monitored retrievable storage" in the NWPA). Section 145(c) states: "The Secretary may conduct such site specific activities at each site surveyed under section 144 [42 U.S.C. 10164] as he determines may be necessary to support an application to the Commission

for a license to construct a monitored retrievable storage facility at such site." This would seem to imply that "site-specific activities" involve technical evaluations that could be used to support an NRC license application. Similarly, section 145(d) states: "Site specific activities and selection of a site under this section shall not require the preparation of an environmental impact statement under section 102(2)(C) of the National Environmental Policy Act of 1969 [42 U.S.C. 4332(2)(C)]." This could support an interpretation that "site-specific activities" are earth disturbing in some way that might then require an environmental impact statement. In any case, the legal interpretation of "site-specific activities" would appear to place limits on what the DOE can do under current law with respect to beginning a search for a second repository. If the DOE's legal interpretation of "site-specific activities" is not overly restrictive, it could still allow for actions such as seeking expressions of interest from state, local, and tribal entities or publishing requests for information for answers from the same groups as initial activities at the beginning of a consent-based process. (Nothing about those two actions would, for example, involve technical or physical work at specific sites.) And nothing about the NWPA would appear to prevent the DOE from conducting educational campaigns directed at state, local, and tribal officials, which could include trips to the WIPP repository in New Mexico, the Onkalo repository in Finland, and other international projects to give those officials an informed view of the risks and benefits to hosting and operating such facilities.

15. "Members of N.M. Congressional Delegation, Governor Send Letter to Energy Secretary Opposing Holtec Nuclear Waste Interim Storage Site in New Mexico," July 2, 2021, https://www.heinrich.senate.gov/press-releases/members-of-nm-congressional-delegation-governor-send-letter-to-energy-secretary-opposing-holtec-nuclear-waste-interim-storage-site-in-new-mexico-.

16. Texas Governor Abbot's letter to the NRC: https://gov.texas.gov/uploads/files/press/O-NuclearRegulatoryCommission202011030767.pdf; Erin Douglas, "Texas Bans Storage of Highly Radioactive Waste, But a West Texas Facility May Get a License from the Feds Anyway," *Texas Tribune,* September 10, 2021, https://www.texastribune.org/2021/09/10/texas-nuclear-waste-ban/.

17. US DOE, "Defense Waste Repository," 2016. https://www.energy.gov/sites/prod/files/2016/04/f30/Defense%20Waste%20Repository_1.pdf.

18. Pages 398–399 of the Senate committee report discusses the defense-waste-only repository: https://www.congress.gov/bill/114th-congress/senate-bill/2943.

19. US DOE, *Designing a Consent-Based Siting Process: Summary of Public Input Final Report,* December 29, 2016.

20. US DOE, *Draft Consent-Based Siting Process for Consolidated Storage and Disposal Facilities for Spent Nuclear Fuel and High-Level Radioactive Waste,* January 12, 2017.

21. Senate Committee on Energy and Natural Resources, "Bipartisan Senate Coalition Reintroduces Comprehensive Nuclear Waste Legislation," https://www.energy.senate.gov/public/index.cfm/2019/4/bipartisan-senate-coalition-reintroduces.

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24. US DOE, *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada,* DOE/EIS-0250, February 2002, S-14.

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26. E.g., National Research Council, *One Step at a Time: The Staged Development of Geologic Repositories for High-Level Radioactive Waste* (Washington, DC: The National Academies Press, 2003), https://doi.org/10.17226/10611.

27. "Program of Research and Development for Management and Disposal of Commercially Generated Radioactive Wastes," 40 Fed. Reg. 26677 (May 14, 1981, dated April 16, 1981).

28. Patrick V. Brady et al., *Deep Borehole Disposal of High-Level Radioactive Waste,* SAND2009-4401 (Albuquerque, NM: Sandia National Laboratories), and S. Finsterle et al., "Post-closure Safety Calculations for the Disposal of Spent Nuclear Fuel in a Generic Horizontal Drillhole Repository," *Energies* 13, no. 10 (2020): 2599. https://doi.org/10.3390/en13102599.

29. See page 164 of the 2011 Massachusetts Institute of Technology report *The Future of the Nuclear Fuel Cycle.*

30. US DOE, *Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel,* 2014, 11.

31. These small wastes include 1,936 cesium and strontium capsules at the Hanford Site, untreated calcine HLW at Idaho National Laboratory (INL), salt wastes from the electrometallurgical treatment of sodium-bonded fuels, and some of the DOE-managed SNF stored in pools at INL and the Savannah River Site. See, Peter Swift, "Evaluating the Feasibility of Deep Borehole Disposal" (presentation, 31st Spent Fuel Management Seminar, Institute for Nuclear Materials Management, Washington, DC, January 13, 2016), 7, https://www.osti.gov/servlets/purl/1338881. Strontium capsules might be an ideal place to begin a borehole disposal campaign in that they are all under 3.5 inches in diameter and strontium-90's half-life is only 29 years, which means that after 300 years, greater than 99.9 percent of it would have decayed away. Strontium capsule disposal in deep boreholes that do not bisect any freshwater aquifers would further minimize the risk to any nearby populations.

32. The BRC report cites Bill W. Arnold, Peter N. Swift, Patrick V. Brady, S. Andrew Orrell, and Geoff A. Freeze, "Into the Deep," *Nuclear Engineering International,* March 25, 2010, https://www.neimagazine.com/features/featureinto-the-deep/. Those authors cite Neil Chapman and Fergus Gibb, "A Truly Final Waste Management Solution: Is Very Deep Borehole Disposal a Realistic Option for HLW or Fissile Material?," *Radwaste Solutions* 10, no. 4 (July/August): 26–35.

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34. Patrick V. Brady et al., "Deep Borehole Disposal of Nuclear Waste," in *Geological Repository Systems for Safe Disposal of Spent Nuclear Fuels and Radioactive Waste,* 2nd ed., eds. Joonhang Ahn and Michael Apted (February 27, 2016), https://arxiv.org/pdf/1707.05736.pdf.

35. Senate Appropriations Committee, *Explanatory Statement for Energy and Water Development and Related Agencies Appropriations Bill,* 2021, https://www.appropriations.senate.gov/imo/media/doc/EWRept.pdf.

36. US DOE, *Nuclear Power Plant Infrastructure Evaluations for Removal of Spent Nuclear Fuel,* April 30, 2021, https://www.energy.gov/sites/default/files/2021-04/NPP%20Site%20Evaluation%20Report%202021.pdf.

37. Patrick Schwab et al., "Update on Development of a U.S. Rail Transport Capability for Spent Nuclear Fuel and High-Level Waste" (Waste Management 2020 Conference, Phoenix, AZ, March 8–12, 2020).

38. The six sites are Kewaunee, Trojan, Humboldt Bay, Maine Yankee, and Big Rock Point. See Erica Bickford's presentation to the US Nuclear Waste Technical Review Board on June 13, 2018, for more background information: https://www.nwtrb.gov/docs/default-source/meetings/2018/june/bickford.pdf?sfvrsn=4.

39. The Southern States Energy Board, Western Interstate Energy Board, Council of State Governments Midwestern Office, and Council of State Governments Eastern Regional Conference.

40. Pursuant to Section 180(c) of the NWPA.

41. For example, one of the regional groups, the Western Interstate Energy Board, has published policy papers related to transportation issues: https://www.westernenergyboard.org/high-level-radioactive-waste-committee/hlrwc-policy-papers/.

42. Transportation Research Board and National Research Council, *Going the Distance?: The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States,* 2006, https://doi.org/10.17226/11538.

43. Mason Willrich and Richard K. Lester, *Radioactive Waste: Management and Regulation,* 1977; Office of Technology Assessment, *Managing Commercial High-Level Radioactive*

Waste: Summary Report, OTA-O-172, April 1982; and Advisory Panel on Alternative Means for Financing and Managing Radioactive Waste Management Facilities, *Managing Nuclear Waste—a Better Idea*, 1984.

44. National Academy of Public Administration, "Who We Are," https://napawash.org/about-us/who-we-are.

45. The Office of Civilian Radioactive Waste Management was created by the Nuclear Waste Policy Act of 1982 to carry out SNF and HLW management duties, but the office was eliminated early in the Obama administration, and the functions were transferred to the Office of Nuclear Energy, where the assistant secretary for nuclear energy has other responsibilities as well.

46. Letter to Secretary of Energy Granholm: http://thenwsc.org/wp-content/uploads/2021/05/Joint-Ltr-to-DOE-Secretary-Granholm-re-Dedicated-NW-Mgmt-Office-050321.pdf.

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About the Author

Dr. Matt Bowen is a Research Scholar at the Center on Global Energy Policy at Columbia University SIPA, focusing on nuclear energy, waste, and nonproliferation. He was formerly a Nuclear Policy Fellow at Clean Air Task Force and a Senior Policy Fellow at the Nuclear Innovation Alliance.

Dr. Bowen has written reports on federal and state policies to encourage advanced reactor development, and has also published papers on reforming U.S. nuclear export controls. During the Obama Administration, he was an Associate Deputy Assistant Secretary in the Office of Nuclear Energy and a Senior Advisor in the Office of Nonproliferation and Arms Control at the U.S. Department of Energy (DOE). Previous to working at DOE, he was an AAAS/APS Science Fellow for Senate Majority Leader Harry Reid. Dr. Bowen received a Bachelor of Science degree in physics from Brown University and a Ph.D. in theoretical physics from the University of Washington, Seattle. He has held positions at the National Academies with the Board on Physics and Astronomy, the Board on Energy and Environmental Studies, and the Division on Engineering and Physical Sciences.

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