NUCLEAR INNOVATION ALLIANCE

Spent Nuclear Fuel Management

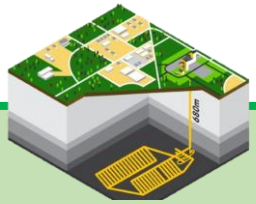
The U.S. nuclear industry has safely and effectively managed spent nuclear fuel (SNF) for decades. All commercial nuclear waste, including SNF, is tracked with great precision and stored to keep it isolated from the environment. SNF is currently stored at facilities on nuclear power plant sites, but several well-understood approaches could be used for long-term storage. Given the relatively small quantity of SNF compared to the energy generated, it is feasible to greatly expand nuclear energy production and still safely and effectively manage this spent fuel.

The U.S. nuclear power industry knows how to safely manage spent nuclear fuel:

- **Safety:** Commercial SNF has been stored safely in the United States for decades. No member of the public has ever been harmed by the commercially-generated spent nuclear fuel that is stored in 35 states.
- **Amount:** The total amount of SNF produced in the United States is very small in comparison to wastes from any other part of the energy sector and relative to the amount of energy it produces. In over 65 years of operation, the entire U.S. nuclear industry has produced around 90,000 metric tons of SNF, enough to cover one football field to a depth of about 10 yards. In contrast, coal power plants produce over 100 million metric tons of coal ash every year. For context, the amount of SNF generated from an individual's lifetime electricity consumption of electricity would only fill a soda can.
- **Management:** SNF is currently stored safely at reactor sites across the United States in dry casks or in wet storage, and it is precisely tracked and managed. Therefore, the nuclear energy industry is the only industry that is completely responsible for monitoring and managing every aspect of its waste and ensuring it does not negatively affect the public.

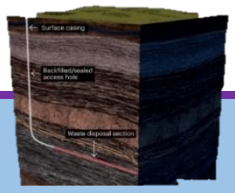
There are several approaches to disposing SNF :

While the current SNF management system in the United States is safe and effective, it is meant to only be a near-term solution. Under the original Nuclear Waste Policy Act (NWPA), the U.S. Department of Energy (DOE) is responsible for taking SNF from commercial reactor sites and putting it into long-term storage. However, DOE has yet to fulfill this responsibility. SNF will eventually need to be placed in a permanent storage facility. The good news is that solutions are available, and more are being explored by innovators, to help safely and permanently dispose of SNF. They include:



Geological Repositories

A geological repository is an underground facility designed for safe permanent disposal of SNF. Geological repositories are being implemented in several countries, including Finland and Sweden through successful consent-based siting implementation.



Deep Boreholes

Deep borehole technology would use advanced drilling techniques to safety store SNF deep underground in multiple boreholes. These boreholes could be easier to site and can be placed much deeper underground than mined repositories. Private companies like Deep Isolation, who recently received funding from ARPA-E, are already exploring this innovative solution.

Recycling

DOE is investing heavily into two SNF recycling programs to reduce the total amount needed to be stored and to provide fuel for advanced reactors. These include Optimizing Nuclear Waste and Advanced Reactor Disposal Systems (ONWARDS) and Converting SNF Radioisotopes Into Energy (CURIE). Projects within CURIE were recently awarded $38 million in funding.

Interim Storage

While not a permanent solution, DOE is considering establishing one or more interim storage facilities. DOE is in the process of developing a consent-based siting process that will be used when selecting an interim storage site and has recently published a request for information and a $16 million funding opportunity announcement on this topic.

SNF from Advanced Reactors:

Advanced reactors offer opportunities to change the conversation about SNF. Numerous advanced reactor designs, such as Oklo's Aurora Powerhouse reactor, plan to run on fuel recycled from existing SNF stockpiles. Additionally, advanced reactor designs generally offer greater efficiency and better utilization of nuclear fuel, reducing the rate at which SNF is generated per unit of nuclear energy produced.

Recent studies from Argonne National Laboratory and the National Academies found that the amount of SNF produced by small modular reactors (SMRs) and microreactors will be comparable to amount produced by conventional nuclear reactors. The table below shows the mass of SNF produced from several SMRs analyzed in the Argonne National Laboratory study, compared to a reference conventional pressurized water reactor (PWR). The amount of SNF from each SMR varies based on their unique design, but in general, they are roughly comparable to the reference PWR.

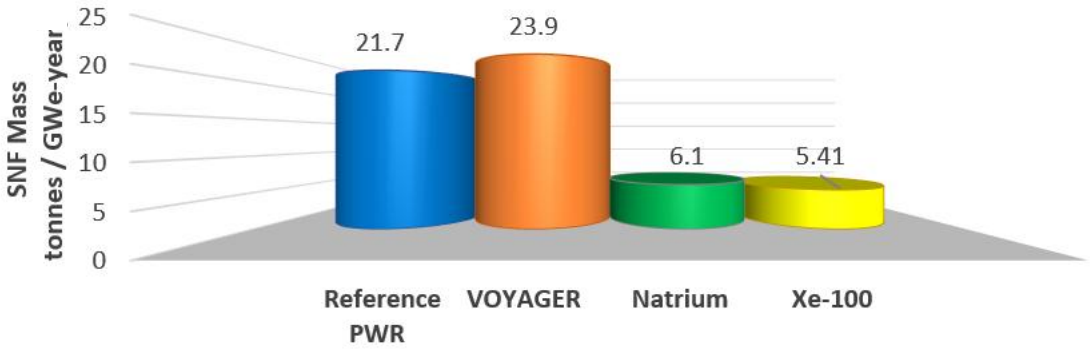


Table 1: Comparison of SMR SNF to a reference PWR

Additionally, some advanced reactors may also have the potential to reduce the lifetime of their SNF. Certain advanced reactor designs and fuel cycles can turn highly radioactive elements in SNF with extremely long half-lives into elements with much shorter half-lives. As a result, these designs could produce SNF that is radioactive for shorter time periods, which would significantly simplify the design and siting requirements for SNF disposal facilities.

Conclusion:

Existing SNF is the byproduct of generating nearly one fifth of the United States' electricity and nearly half of its clean energy, and the quantity of SNF is very small in the context of the energy produced. SNF is currently safely stored at existing nuclear power plant sites across the United States. Recent studies have shown that waste streams from advanced nuclear reactors will be comparable to the waste generated by the existing nuclear fleet. Therefore, our current SNF management system should be well equipped to handle SNF from advanced nuclear reactors as they are deployed towards the end of this decade, and beyond.

Although the United States' current solution to handling SNF is safe and effective, it is meant to only be a short to mid-term solution. While the United States has yet to implement a long-term solution to storing SNF, there are existing and potential new approaches to long-term disposal, some of which are being implemented in other countries.

For more information on advanced nuclear energy, please contact Erik Cothron, Analyst at NIA, at: ecothron@nuclearinnovationalliance.org