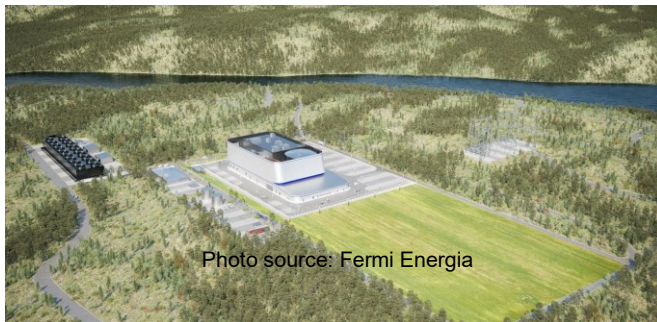


Spent Fuel Management Options in Estonia if the Country Goes Nuclear

Estonia's government may decide next year if it will build a nuclear power plant and is studying several sites across the country to see if any are suitable. In 2021, a nuclear energy working group was established, chaired by the chancellor of the Ministry of Climate. In early 2023, Fermi Energia, a privately held company established in 2019 to build a small modular reactor (SMR) in Estonia, announced it has selected GE Hitachi's BWRX-300 as the most suitable for development in Estonia. The photo below shows a site rendering of the BWRX-300.



In April, the nuclear energy working group selected 15 locations across the country that might be suitable for the SMR, and in May, Fermi Energia announced it had identified two preferred locations in northeastern Estonia to host it. Two of the working group sites coincide with Fermi Energia's two preferred locations in Viru-Nigula and Ida-Viru. The Viru-Nigula area is close to the sea, which would provide a good source of water needed for cooling purposes. The Ida-Viru site is a former oil shale quarry that is already close to other industrial activity. Geological studies have been completed in the Viru-Nigula municipality.

The Riigikogu (Estonia's Parliament) will use the final report of the nuclear energy group to decide if building a nuclear power plant in Estonia will contribute to ensuring energy security and climate goals. The report is expected to be completed by the end of this year.

One of the tasks of the working group was to analyze waste management options and solutions, including providing an assessment of the costs of final disposal and an overview of funding strategies. *ERR News*, the English-language service of *Estonian Public Broadcasting*, reported September 20 that a recent analysis by the nuclear energy working group concluded that a single nuclear reactor in Estonia would likely generate 12 tons of spent fuel each year, or 720 tons over the 60-year life of the reactor.

Steiger OÜ, a mining consulting company in Estonia, conducted a study into where the waste, including low- and intermediate-level waste and spent fuel, could be stored until a disposal facility is available. Experts evaluated the quantities of radioactive waste generated by a nuclear power plant, as well as options for the treatment and storage. The analysis used estimates based on data for the GE Hitachi BWRX-300 reactor and on current nuclear power plant experiences. They concluded that waste produced by a future new power plant could be stored on the same site as the plant.

Radioactive waste expert Peter Breitenstein, who conducted the analysis, recommended Estonia keep its spent fuel management options open. He noted that while reprocessing a "relatively small quantity of spent fuel may be an interesting high-level radioactive waste (HLW) management approach," it might not be "immediately feasible." He stressed, however, that "it is essential not to impose legal restrictions on the option of fuel reprocessing, as it may still prove to be a practical solution in the future."

The government will decide between an open or a closed fuel cycle. If a closed fuel cycle is chosen, France would be the only potential place to recycle spent fuel. The cost of transporting spent fuel to France for reprocessing would have to be considered, and Estonia would have to find a buyer for the mixed oxide (MOX) fuel produced if the country has no use for that type of fuel. Furthermore, the amount of waste resulting from reprocessing would be returned to Estonia and that waste would still require disposal.

If Estonia chooses an open fuel cycle, the analysis looked at three options – establishing a deep geological repository (DGR); using deep borehole disposal; or participating in the establishment of a regional disposal site.

Antti Tooming, chair of the nuclear energy working group and undersecretary of biodiversity and environmental protection at the Ministry of Climate, said the operator of the nuclear power plant should consider using nuclear fuel produced from spent fuel. "Using such fuel does not require major technical changes in the design of the reactor," he noted. "Besides, the possibilities for reprocessing spent fuel are constantly being developed throughout the world."

Regardless of which approach to the nuclear fuel cycle is adopted, the Estonian government must develop a legal framework for the establishment and management of a fund

for the disposal of radioactive waste and for future costs of decommissioning the reactor.

Fermi Energia has already investigated deep borehole disposal as a waste management option. The company partnered with Deep Isolation in 2021 on a preliminary study that concluded most of Estonia's underground geology provides access to suitable rock formations that could safely isolate spent fuel in a horizontal borehole repository a kilometer underground (*SF* No. 1347 February 5, 2021).

On October 27, 2022, Deep Isolation announced it will again partner with Fermi Energia to "further explore a deep borehole repository solution for a proposed small modular reactor design that developers hope will help Estonia in its efforts to achieve net zero emissions." The two companies will analyze the costs and benefits of both open and closed fuel cycle options, using deep borehole disposal for direct disposal of spent fuel or for vitrified waste produced from reprocessing that spent fuel (*SF* no. 1434 October 28, 2022).

"New nuclear energy investments in the European Union will be officially considered sustainable, under the recently adopted EU Taxonomy of Sustainable Finance, if they have in place by 2050 a nationally documented plan for an operational, final repository of spent fuel," said Kalev Kallamets, CEO of Fermi Energia. "In our view, only the Deep Isolation solution can meet that criterion for new small modular reactor deployments in the EU, and that is why Deep Isolation is our go-to spent fuel repository solution."

Top Story

IAEA and Japan formalize the continuous monitoring of Fukushima water discharge

The International Atomic Energy Agency (IAEA) and Japan have formalized the full scope of the agency's "comprehensive and continuous safety review of the discharge of treated water from the Fukushima Daiichi Nuclear Power Station (FDNPS), paving the way for decades of independent monitoring, sampling and analysis at the site and at sea," the IAEA said in a September 18 press release.

IAEA Director General Rafael Mariano Grossi and Japanese Foreign Minister Kamikawa Yoko signed the Memorandum of Cooperation at the United Nations General Assembly in New York. Japan began discharging stored water from the FDNPS that has been treated through the Advanced Liquid Processing System (ALPS) on August 24 (*SF* No. 1475 August 25, 2023). The IAEA has been reviewing the safety of Japan's plan on how to manage the treated water since it was first announced in 2021. The agreement signed this week focuses on the agency's long-term activities during the decades-long process to discharge the water into the ocean.

The agreement identifies five main areas of the IAEA's work:

Industry Calendar

- November 6-10, 2023
International Conference on the Safety of Radioactive Waste Management, Decommissioning, and Environmental Protection and Remediation
<http://iaea.org/evends/icwedr2023>
IAEA headquarters, Vienna (In-person and virtual)
- November 12-15, 2023
ANS Winter Meeting and Technology Expo
<https://www.ans.org/meetings>
Washington Hilton, Washington, DC
- December 5-8, 2023
Extended Storage and Transportation workshop
https://www.oecd-nea.org/jcms/pl_83970/extended-storage-and-transportation-for-current-and-future-reactor-technologies-waste-streams
Hotel Westin Mount Laurel, Camden, New Jersey, USA
- May 27-31, 2024
Seventh International Conference on Geological Repositories
https://www.oecd-nea.org/jcms/pl_81426/seventh-international-conference-on-geological-repositories-icgr-7
Busan, Korea
- June 10-14, 2024
IAEA International Conference on the Management of Spent Fuel From Nuclear Power Reactors
<https://conferences.iaea.org/event/356/>
IAEA Headquarters, Vienna, Austria
- July 27 – August 1, 2025
PATRAM 2025
<https://www.inmm.org/page/patram2025>
San Antonio Marriott Rivercenter, San Antonio, Texas

Details are available at:

<https://www.uxc.com/c/data-industry/Calendar.aspx>

- Monitoring and assessment, focused on the protection of people and the environment
- The IAEA's presence in Japan and at the FDNPS site, including performing onsite analysis
- Regular agency review missions
- Corroboration of Japan's source and environmental monitoring based on independent sampling and analysis
- Outreach and awareness activities, including sharing key information with the public.

Director General Grossi said the activities set forth in the agreement "are indispensable for transparency and for building confidence – both in Japan and abroad – that the discharge will neither harm people nor the environment." He added, "We will stay and carry out our technical work until the last drop of the treated water has been safely discharged into the sea. Through its independent and scientific work, the IAEA will be able to provide assurances to people around the world that the discharge will cause no harm."

The IAEA has already conducted its first independent