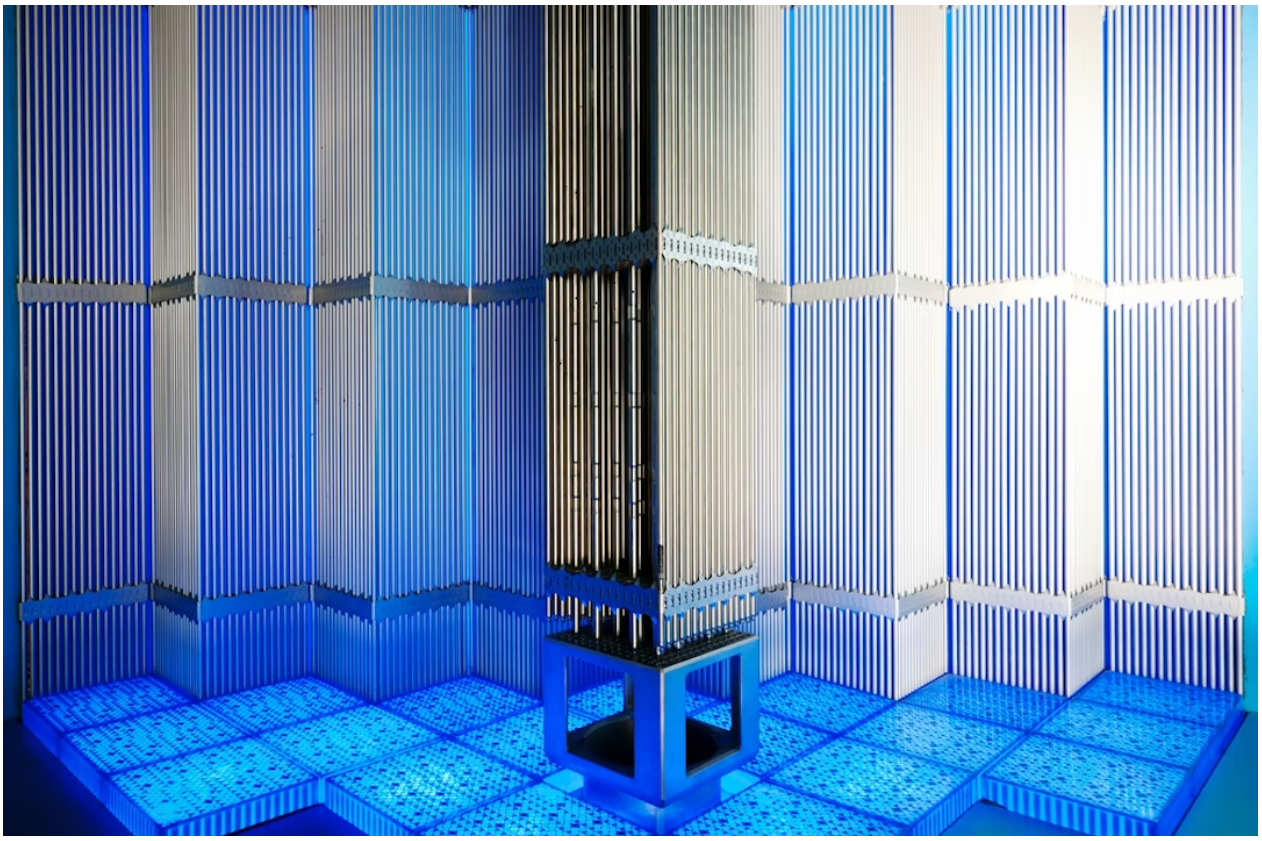
THIRD WAY

BLOG *Published January 14, 2022 • 6 minute read*

Back-end to Innovation: How Disposal of Nuclear Waste is Breaking New Ground



Dr. Cindy Vestergaard
Senior Visiting Fellow

Much of the recent focus regarding innovation in civil nuclear technology has been on advanced reactors and their development, deployment, and commercialization. At the same time, there have been exciting innovations taking place in the management of the back-end of the nuclear fuel cycle. Countries that are most advanced in their approach to licensing deep geological repositories (DGRs) for used fuel are leading not only on how they incorporate safety, security, and safeguards (the "3S principles") into DGR planning, but also how community-driven approaches are addressing—and achieving—what could be called the fourth "S" nuclear principle: social acceptance.

Although it is internationally accepted that geological disposal is the most effective and safest method of containing and disposing of used fuel, most governments push decisions on a final strategy to future generations. The challenges can seem intimidating: "used" or "spent" fuel requires a heightened level of oversight given its radioactive properties necessitate long-term

storage and protection. It also contains weapons-usable material which is accompanied by international verification measures, such as physical inspection of nuclear material, that cannot be applied once the material is encapsulated and placed underground. Other challenges involve the multigenerational lifespans of DGRs and constant changes to their design and quantities of material over those lifespans.

International Progress on Spent Fuel Storage and Disposal

Finland is the first, and only, country to have issued a construction license (in 2015) for a deep geological repository for spent nuclear fuel (SNF). The facility is based on Sweden's "KBS-3" disposal concept which involves encapsulating SNF in copper canisters and embedding them in bentonite clay in tunnels approximately 500 meters below ground. The concept is based on decades of technical development, geological surveys, and safety assessments that involve a multi-barrier design including a series of natural and engineered barriers to contain and isolate used fuel from people and the environment. In Sweden, the application for a construction license for its DGR was submitted in January 2018 and is awaiting final government approval. France's National Radioactive Waste Management Agency (Andra) submitted a Public Utility Decree file in August 2020, the first major step towards licensing of its disposal facility for high level nuclear waste and long-lived intermediate-level waste resulting from reprocessing operations (rather than for SNF).

Countries that are advancing towards geological disposal of their SNF are demonstrating technical and operational competence alongside public acceptance. In cooperation with the International Atomic Energy Agency (IAEA), they are spurring research in safeguards instrumentation utilizing a range of technologies for surveillance, monitoring, and measuring nuclear material underground such as 3-D laser measurements applied to underground excavations, seismic and acoustic sensors, satellite imagery, and ground penetrating radar. Finland's nuclear regulator, STUK, has also funded research that developed SLAFKA, the first blockchain prototype developed for tracking nuclear material at the national level. Recognizing that "the significance of data integrity," in safeguarding SNF underground, "is immense," [1] SLAFKA demonstrates distributed ledger technology can be a tool for enhancing confidence that the material stored underground is reflected in the books above ground.

Innovations in Social Acceptance: International Cases

DGRs are therefore breaking new ground in terms of engineering, instrumentation, and even data management, but one of the greatest innovations is the approach to social acceptance. Community-driven processes to site selection are based in their historical, political, and cultural contexts, but all involve public involvement in decision-making and site selection. As noted in a book produced for the Clean Energy Ministerial a few years ago: "This community-driven

collaborative process has been a democratic policy innovation as crucial as any advance in engineering and technology to making a permanent solution for nuclear waste a reality."

Community engagement on DGRs involves a dedicated, multigenerational effort. In Finland, national legislation mandates public involvement from the local to national level in the process. Power companies are wholly responsible for the treatment, storage, and disposal of their nuclear waste and must obtain a "Decision in Principle" from the government that affirms the project benefits society as a whole before they can apply for a DGR construction license. In 1987, when five sites were selected for further study, offices were opened in each community to provide information and engagement [2] which was sustained as the field narrowed and the municipality of Eurajoki in south-western Finland was eventually proposed. In January 2000 the Municipality Council voted 20 for, and 7 against the construction of the DGR. A favorable Decision by the government was issued in December 2000 [3] and in May 2001, the Parliament ratified the decision by 159 votes to 3.

Canadian legislation also mandates nuclear utilities to form, operate, and fund a waste management organization which in turn proposed the Adaptive Phased Management (APM) approach that was adopted by the Government in 2007. The approach calls for used fuel to be geologically stored with an inclusive process to select a site with informed and willing hosts. In 2010, 22 communities initially expressed interest to learn more and explore the potential to host Canada's DGR. After multi-year field studies, geophysical surveys, and environmental assessments, the selection is now down to two communities. Communities have been engaged throughout the process. Canada's Nuclear Waste Management Organization (NWMO) prioritizes a commitment to reconciliation and weaving Indigenous knowledge into the process. Much of this work is guided by the Council of Elders and Youth and involves workshops, cultural awareness and Reconciliation training for employees, and platforms for sharing news and thoughts related to Reconciliation and Indigenous Knowledge. The approach is about "cocreating a different future based on fairness, equality and respect." [4]

In Switzerland, communities are consultative bodies rather than authorities able to veto siting. Since 2008, public hearings and discussions have been held as part of a method of "regional participation," in line with the National Cooperative for the Disposal of Radioactive Waste's (Nagra) 3-stage plan to undergo site selection and licensing for a DGR. [5] Regions were encouraged to provide details by 2021 on their particular needs if they should be selected as the final site. [6] Final site selection is anticipated during 2022.

Conclusions: Implications for a Consent-Based Siting Process in the United States

Countries such as Canada, Finland, France, Sweden, and Switzerland are showing how demonstrations of technical and operational competence alongside community-driven approaches are foundational to DGR timelines. These countries have reported an increase in confidence in

nuclear waste activities and in the regulators over time from the communities involved. They are also collaborative with other radioactive waste management organizations and on R&D, including at underground research laboratories, to learn from other countries' experiences and keep pace with developments in repository design. They are innovating and modernizing approaches to nuclear waste management, translating emerging facility concepts into actionable strategies.

TOPICS

ADVANCED NUCLEAR 159 | NUCLEAR WASTE 1

ENDNOTES

1. STUK (Olli Okko, ed.), "Implementing Nuclear Non-proliferation in Finland: Regulatory Control, International Cooperation and the Comprehensive Nuclear-Test-Ban Treaty," Annual Report 2019, p. 39: https://www.julkari.fi/bitstream/handle/10024/139830/stuk-b246.pdf?sequence=1&isAllowed=y

2. Henry Fountain, "On Nuclear Waste, Finland Shows U.S. How It Can Be Done," New York Times, June 9, 2017. https://www.nytimes.com/2017/06/09/science/nuclear-reactor-waste-finland.html, Accessed October 17, 2021.

3. To dispose of a maximum of 4,000 metric tons of uranium in spent fuel from the four operating nuclear power plants in the country at the time.

4. NWMO, "The NWMO issues Reconciliation Statement collaboratively with Indigenous Elders and youth," July 2018: https://www.nwmo.ca/en/More-information/News-and-Activities/2018/07/16/16/47/The-NWMO-issues-reconciliation-statement-collaboratively-with-Indigenous-Elders-and-youth, Accessed Oct 17, 2021.

5. United Kingdom, Nuclear Decommissioning Authority, "Geological Disposal: Overview of International Siting Processes," (2013), 26. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/456820/Overview_of_international_siting_processes_September_2013.pdf; Switzerland, Nagra, "Site Selection," https://www.nagra.ch/en/siteselection.htm, Accessed Aug 24, 2021.

6. Switzerland, Nagra, "Cooperation With the Siting Regions," https://www.nagra.ch/en/approach.htm, Accessed Aug 24, 2021.