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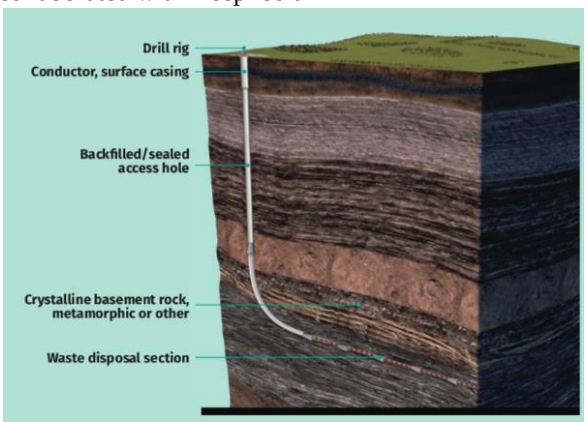
THE LATEST DEVELOPMENTS IN SPENT FUEL MANAGEMENT AND TRANSPORTATION

Deep Isolation Study Shows Potential for Nuclear Waste Disposal in Estonia

Fermi Energia, the Estonian privately-held energy company working to develop a small modular reactor (SMR) to ensure the country's energy supply, commissioned Berkeley-based Deep Isolation to conduct a study to examine the potential suitability of certain areas in Estonia that are under consideration for siting a deep horizontal borehole repository for nuclear waste. Early planning for waste generated from any future nuclear power plants prevents the proverbial "kick the can down the road" so that the generator is responsible for waste resulting from electricity production instead of later generations that did not benefit from such energy sources having to resolve waste management issues. Fermi Energia is the first European company to contract with Deep Isolation on a preliminary geologic study to manage advanced reactor waste.

Engineering Bureau STEIGER LLC, Estonia's foremost geologic and drilling company, collaborated with Deep Isolation for this study to provide a qualitative geological assessment of the country's crystalline basement rock to evaluate geological conditions and potential risk factors for Estonia's 15 counties, each of which was screened for their potential to host a deep borehole repository.



Note: Not to scale: drillhole is about 0.5m, and the depth is 1500m. The curved section is so gradual that steel casing easily moves around it during installation. **Source:** Deep Isolation Inc.

Deep Isolation's preliminary study, titled, "Qualitative Geological Readiness Assessment of Deep Isolation's Borehole Solution in Estonia," states there are no fundamental geologic limitations to disposing of nuclear waste in deep horizontal boreholes, which can be drilled in sedimentary, metamorphic, or igneous rocks. The study also notes that Estonia has a wide range of locations that could comply with International Atomic Energy Agency (IAEA) Safety Regulations for geologic disposal.

Two significant advantages to a deep borehole repository are that these boreholes can be placed near the reactors or interim storage facilities to minimize transportation, and the disposal cost per ton of waste can be kept substantially lower than for mined repositories because of the smaller repository size, reduced infrastructure needs, and staged implementation.

Furthermore, an important safety benefit of this approach is the approximately 1,500-meter depth at which the waste will be stored, which would be far below aquifers and would provide an extremely long time for waste to diffuse to the surface, even if it penetrates the engineered barriers; therefore, most of the radioisotopes would decay naturally. The borehole repository would isolate radioactive elements from the surface for 1.3 million years, at which point anything that might reach the surface would be three orders of magnitude below radiation levels deemed safe and allowable by international standards.

Fermi Energia plans to develop new nuclear generation in Estonia by 2035 to restore energy independence with clean energy generation that is safe, affordable, and carbon-neutral. However, like most nuclear countries around the world, the unresolved issue of how to permanently dispose of spent nuclear fuel is a major obstacle to deploying new nuclear power plants.

Kalev Kallemets, CEO of Fermi Energia, said, "If we are to be successful in our efforts to see Estonia become the first European Union country to deploy an SMR in the 2030s, it is important that we take responsibility now in planning for spent fuel disposal."

According to the IAEA, about 50 SMR designs and concepts are under development globally. Fermi Energia is evaluating several of these designs, will monitor the development of SMRs, and select the most suitable design after the first one is built and proven in the US, Canada, or the United Kingdom.

"As Estonia considers the role that advanced nuclear power generation can play in delivering a low-carbon future for the country, citizens and policymakers can feel confident there is a safe and affordable way to dispose of the resulting spent nuclear fuel," said Chris Parker, Managing Director, Deep Isolation EMEA (Europe, the Middle East, and Africa) Limited. "We applaud Fermi Energia for doing the right thing by planning for disposal of the nuclear waste up front.

This is a significant step forward in confirming that regions across Estonia, in particular along the northern coast near a potential SMR site, could potentially safely host a borehole repository."

The basic conclusions of the study are that:

- Deep borehole disposal represents a safe, affordable, and flexible disposal route for spent fuel, if the Estonian government decides to take forward the SMR option as a potential part of Estonia's future energy strategy.
- There are potential geological host environments across Estonia, and the optimum area in which to focus a site selection process is situated in the north east of Estonia and the islands off the north-eastern coastline.

Deep Isolation therefore recommended that "the Estonian Government should, in parallel with its consideration of the SMR option, also develop a strategy for managing the resulting spent fuel. This strategy should be based on deep borehole disposal and should aim to establish a clear implementation plan at or before granting the operating license for the nuclear power plant."

By establishing a waste management strategy before a nuclear power plant produces waste, Estonia would be established as a "world leader in responsible, sustainable energy production," and would be "the only country in the world to have established a clear disposal route for nuclear waste before it starts to produce that waste."

Deep Isolation also recommended that the Estonian government partner with them to develop a detailed business case, safety case, and implementation plan for its disposal strategy.

Background – Estonia began considering the possibility of nuclear power in 2006 when the prime ministers of the three Baltic States (Lithuania, Latvia, and Estonia) signed a joint statement in support of the construction of a new nuclear power plant in Lithuania. This plant, to be located in Visaginas, would replace the RBMK-type Ignalina Nuclear Power Plant that was required to be permanently shut down as one of the conditions of the Treaty of Accession to the European Union for Lithuania.

Several years later, NGO Estonian Nuclear Power Plant was formed with the aim of analyzing the possibilities of building a nuclear power plant in Estonia after the Lithuanian nuclear plant was put on hold due to domestic political struggles. After Lithuania issued a negative decision in the referendum on the construction of a nuclear power plant, Eesti Energia, Estonia's national state-owned energy company, began to look for suitable locations for a nuclear power plant. The Ministry of Economic Affairs and Communications drafted the Nuclear Energy Act.

Nuclear power plant construction in Europe slowed at this point and a recession reduced the demand for energy, which lowered Estonia's interest in building a nuclear power plant.

Industry Calendar

- March 8-12, 2021
  WM Symposia
  https://wmsym.org
  Online
- March 8-11, 2021
  NRC Regulatory Information Conference
  https://nrc.gov/public-involve/conference-symposia/ric/
  Online
- April 20-21, 2021
  Nuclear Decommissioning & Waste Management 2021
  https://www.virtual.prosperoevents.com/nuclear-decommissioning-and-waste-management
  Online
- May 4-6, 2021
  NEI Used Fuel Management Conference
  https://nei.org
  Online
- May 10-13, 2021
  International Conference on Fast Reactors and Related Fuel Cycles
  https://iaea.org/events/fr21
  Beijing, China
- June 7-11, 2021
  Sixth International Conference on Geological Repositories (ICGR)
  https://www.oecd-nea.org/confdb/confdb/conf?id=432
  Sirkus Hall of Pasasitorni Helsinki, Finland
- August 21-26, 2021
  INMM & ESARDA Joint Annual Meeting
  https://www.inmm.org/inmmesarda2021
  Austria Center Vienna
  Vienna, Austria
- November 1-5, 2021
  International Conference on Radioactive Waste Management
  https://www.iaea.org/events/international-conference-on-radioactive-waste-management-2021
  Vienna, Austria
- November 30 – December 2, 2021
  WNE – World Nuclear Exhibition 2021
  https://www.world-nuclear-exhibition.com
  Paris Nort Villepinte, Paris, France

Details are available at:
https://www.uxc.com/c/data-industry/Calendar.aspx

The government instead decided to build a new 300 MWe oil shale power plant in Auvere. Estonia now has the highest CO_2 emissions per kilowatt hour of electricity produced among EU Member States because it is largely dependent on oil shale as an energy source.

The idea of nuclear power in Estonia remained idle for many years until two local experts met and discussed the opportunity to build a new generation nuclear power plant

based on SMRs licensed in the US and Canada. After thorough preliminary work, Estonia's top experts on nuclear energy, Kalev Kallemets, Sandor Liive, Henri Ormus, Kaspar Kööp, Marti Jeltsov, Merja Pukari and Mait Müntel, founded OÜ Fermi Energia.

Fermi Energia signed Memorandums of Understanding (MOUs) in January 2020 with Finnish energy company Fortum and the Belgian engineering company Tractebel Engie to begin enhanced cooperation on studying SMR deployment project in Estonia. The parties focused on researching a licensing model suitable for SMRs and preliminary siting study for light-water SMR deployment.

On November 30, 2020, Fermi Energia signed a Letter of Intent with Vattenfall, one of Europe's largest electricity utilities, to expand upon their cooperation on exploring the possibilities of SMR deployment in Estonia. Vattenfall had already been participating in a feasibility study to explore SMR possibilities.

Torbjörn Wahlborg, Senior Executive Vice President Generation at Vattenfall, said, "Recently, we've seen a growing interest in small-scale nuclear reactors. Vattenfall's intent with this project and in stepping up our cooperation is to support Fermi Energia to achieve a successful European SMR initiative. We will now deepen our studies in specific work areas and extend our collaboration until the submission of an application for a decision in principle by the Estonian Parliament. This will provide know-how to Vattenfall in an area where we're building up our competence."

Deep borehole repositories would be much more suitable for Estonia than building a mined repository, which is on track in countries such as Finland, Sweden, and France. As already noted, the waste is buried much deeper and a repository would be about a quarter of the cost compared to a mined repository. Deep boreholes are more quickly deployed, given that drilling can be done in weeks, while mining can take years or even decades. Another benefit is that no workers are needed underground, increasing the safety for the crews. Deep Isolation's solution would place the waste in corrosion-resistant canisters within deep boreholes drilled into rock formations that have been isolated from the biosphere for a million years or more. The waste can be retrieved during a determined timeframe or permanently secured.

Chris Parker of Deep Isolation will present the results of this study as part of Fermi Energia's one-day online SMR conference, New Generation Nuclear Energy in Estonia, on February 9. Go to Conference - Fermi Energia to register for the conference.

Engineering Bureau STEIGER named its company after the old German mining term "steiger," meaning foreman of the mine. The word is derived from the German world "steige(r)nd" – to rise up or to come to the light, which was a term used in the Middle Ages. The company's motto is to ensure that the people who descend into the mine would come back safely to see the light again, representing STEIGER's main concerns of safety.

SpentFUEL Issue No. 1213, published on June 1, 2018, provides a further in-depth explanation of Deep Isolation's approach to deep horizontal borehole repository drilling and we have covered developments in *SpentFUEL* in a number of subsequent issues, most recently in No. 1343, which highlighted a reported prepared by the Electric Power Research Institute about deep borehole disposal. All current subscribers have access to past issues on the UxC website.

Top Story

Upcoming back-end webinars of interest

Four webinars that address issues related to the back-end of the nuclear fuel cycle are scheduled this month. On Wednesday, February 10, the International Atomic Energy Agency (IAEA) will host a 1.5-hour webinar titled, "Integrated View of the Spent Fuel Management Steps for Decision Making." Experts from Idaho National Laboratory, Orano, and the Swedish Radiation Safety Authority (SSM), will discuss the importance of taking an integrated view of spent fuel management, from core discharge to recycling or disposal. Information about the IAEA's back-end webinar series, including how to register for this webinar, may be found here: https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy/division-of-nuclear-fuel-cycle-and-waste-technology/nuclear-back-end-webinar-series

On February 17, the Stimson Center will host a one-hour webinar titled "Bringing the Back-End to the Forefront: Looking Ahead to the Future Nuclear Fleet." During this webinar, the Stimson Center's Rowen Price will introduce her findings contained in a working paper that explores how emerging or "advanced" reactors will differ from the current fleet in spent fuel disposal, processing, and nuclear safeguards. Price will examine how these reactors will "disrupt conventional spent fuel management and international safeguards." Price's working paper, "Bringing the Back-End to the Forefront: Spent Fuel Management and Safeguards Considerations for Emerging Reactors," will be available prior to the event. The webinar is part of the Stimson Center's Nuclear Safeguards Program. Information may be found here: https://www.stimson.org/event/bringing-the-back-end-to-the-forefront-looking-ahead-to-the-future-nuclear-fleet/

On Wednesday, February 24, the Organization for Economic Development's (OECD) Nuclear Energy Agency (NEA) and the International Framework for Nuclear Energy Cooperation (INFEC) will host a two-hour webinar to discuss the findings of a new NEA report on strategy and considerations for the back-end of the nuclear fuel cycle. More information may be found here: