

Why Finland now leads the world in nuclear waste storage

Other nations hope to learn from approval of the world's first deep repository for spent nuclear fuel.

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Posiva Oy

Researchers working at a test facility for storing spent nuclear fuel on the island of Olkiluoto, Finland.

Nuclear-power plants have been around since the 1950s, and provide around 11% of the world's electricity. But the spent nuclear fuel that they produce is highly radioactive and there are no facilities that can permanently and safely store it.

Last month, Finland's government became the first to approve construction of such a store — a deep underground repository — after more than 30 years of efforts to find a suitable site.

Nature examines how Finland did it, and which countries are likely to follow suit.

How will Finland store its nuclear waste?

A €3-billion (US\$3.2-billion) facility on Olkiluoto, an island off Finland's west coast, will start storing waste in a deep underground repository from about 2023. It will pack up to 6,500 tonnes of uranium into copper

canisters. The canisters will be lodged into a network of tunnels cut out of granite bedrock 400 metres underground; the canisters will be packed in with clay. Once the facility is sealed — which Finnish authorities estimate will be in 2120 — it should safely isolate the waste for several hundred thousand years. By then, its radiation levels will be harmless.

Where do other countries put their spent nuclear fuel?

Most nations store it above ground in temporary storage facilities: either in canisters, or within pools or vaults lined with concrete and steel. There are deep underground repositories — the first were created in 1959 — but they do not handle high-level radioactive waste such as spent nuclear fuel.

In the 1960s, Russia injected high-level liquid waste into natural rock formations, but not into purpose-built facilities.

Why don't other countries use deep underground stores?

The main problem is agreeing on where to put a repository. The United States, which has the largest number of nuclear-power stations in the world, selected a site at Yucca Mountain in Nevada in 1987, and has invested \$15 billion in it. But Nevada politicians are opposed to the plans, and the White House said in 2010 that it [wanted to scrap the idea](#). Today the plans are in limbo.

Governments in Japan, the United Kingdom and Canada have declared plans to build deep geological repositories, but have yet to begin the thorny process of picking sites, meaning that these facilities wouldn't open until the 2040s at the earliest. In Germany, salt formations at Gorleben in the north were studied for decades before the government called off the work in 2000. In 2013, a new search for a disposal site began.

So how did Finland get an agreement?

Nuclear-power company Teollisuuden Voima (TVO) picked Olkiluoto — which already hosted a nuclear-power facility — as one of five potential sites in 1987. The local council that serves the island was initially firmly opposed to the proposals, says Matti Kojo, a social scientist at Finland's University of Tampere. Only after the company pushed the financial benefits of hosting the facility — including tax revenues and a municipal compensation package — and improved their community-engagement programme, did councillors change their minds, he says. By 1999, when nuclear management firm Posiva (which took over from TVO) came to finalize its site selection, the council for Olkiluoto had effectively volunteered itself for the job.

According to Cherry Tweed, chief scientific adviser at Radioactive Waste Management (a firm in Didcot, UK, which handles the UK's effort to create a deep geological repository), Finland's case shows that two elements are crucial to getting approval for permanent storage: "One is a safe site. The other is a supportive community who will work together with the developer to shape the project," she says.

Why don't other countries use the same process?

Some of them have. Sweden has already used a similar engagement process, and its government is currently considering a licence to build a facility using the same technology. Last month the Swedish Radiation Safety Authority gave its formal backing to building a repository at the chosen site, in Forsmark, and a final decision is expected around 2017.

Following previous aborted attempts, both the United Kingdom and Canada have opted for a "volunteer first" policy, which means that communities must put themselves forward to host the site, and would get financial compensation. But the process will probably require a much greater scale of debate and engagement than did the Finnish process two decades ago, which occurred in a time and place when the public were relatively trusting of authorities, says Kojo.

Will Finland's approval make it easier to find willing hosts in other countries?

Tweed thinks so. "One of the questions we're asked really frequently is, 'What are other countries doing?'" she says. "People find that it gives them a lot of confidence to hear that countries in places like Scandinavia, where we know the people set very high standards of environmental responsibility, have taken this decision."

Rod Ewing, who chairs the US Nuclear Waste Technical Review Board, agrees. "Sometimes there's discussion in the US that maybe people are just against it. But progress in other countries shows that actually a strong technical case combined with genuine social engagement might work."

Which countries might be next to approve a permanent storage site?

Besides Sweden, [plans in France are also well advanced](#). The French nuclear-waste agency ANDRA hopes to apply in 2017 for a licence to build a facility in Bure. This would use a different technology designed for clay rocks, which stores waste by blending it into molten glass.

What are the other options for disposing of spent nuclear fuel?

Countries have considered different ways to get rid of nuclear waste, including [firing it into space and trapping it within Antarctic ice sheets](#). These have either failed to pass safety criteria, or would have flouted international agreements. Some nations are looking at reactors that can burn reprocessed spent fuel, but these would produce waste too. Now, most countries agree that permanent burial underground is the best solution, although [research continues into the best ways of doing it](#).

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