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The truth about... nuclear waste

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Nuclear energy is a key part of the new energy plan. But what plans do we have for disposing of the industry's highly toxic waste?

For over 50 years, the world has been generating radioactive waste without any clear idea of what to do with it.

In the UK alone, 365,000 cubic metres of high and intermediate-level radioactive waste will be accumulated from its existing nuclear programme that is coming to the end of its life. And with plans for a new breed of nuclear reactors now under debate, that inventory will only proliferate unless a long-term disposal plan is devised.

That plan is starting to take shape. In January 2008, the UK government came up with a policy to bury its long-lived high-level radioactive waste deep underground based on recommendations by the Committee on Radioactive Waste Management (CoRWM), a UK advisory group.

Most countries with substantial inventories of radioactive materials are following a similar policy. Finland has already begun work on a geological disposal facility for waste from its present and future nuclear reactors. France, Sweden and Japan are in the process of choosing sites.

But with green groups questioning the safety of geological disposal, US president Barack Obama withdrawing funding for a major deep disposal project in Yucca Mountain, Nevada, and most communities still unwilling to host disposal facilities, there is still an enormous amount of political, social and geological engineering to perform before deep disposal facilities become widespread.

And time is running out. Because if governments want to justify proposals for new nuclear reactors, they will be under pressure to prove they are capable of dealing with the waste they already have.

A 'final' waste solution

Final disposal facilities would be excavated several hundred of metres underground. In the case of the **Finnish Onkalo project** (based on the Swedish "**KBS3**" concept), the spent fuel is encased in a cast iron internal frame and surrounded by thick corrosion-resistant copper canisters. The canisters are then packed with a bentonite clay, with the surrounding bedrock acting as a further barrier.

According to **Posiva**, the company running the Onkalo facility, safety analyses have demonstrated that it is "likely that there would never be releases from the … repository that would be significant from the standpoint of environmental protection".

And these studies should offer some comfort, says Dr Ian Farnan from the Department of Earth Sciences at University of Cambridge. "The Fins and the Swedes have done a lot of modelling and most of that is based on some pretty solid science," he says.

But environmental groups are unconvinced. "It is an environmental time bomb for future generations," says Nathan Argent, nuclear campaigner for Greenpeace, pointing out that the copper canisters will corrode within 300 years leaving only the bedrock as defence. "There is no way of telling when the radioactive waste will get back into the environment."

Prof. Gordon MacKerron, director of the Science and Technology Policy Research unit at University of Sussex, and former chair of CoRWM, acknowledges the Scandinavian deep storage technology is not a "zero risk" option. But, he adds, "you have to be careful that the baseline you compare is not zero risk, but the lowest risk that we can reasonably manage."

"Storing [radioactive waste] at, or close to, the surface is a great deal more risky for the next several hundred years than putting it in a well-engineered geological repository," he says.

It is also the most practical option, says Robert Pickard, current chair of CoRWM. "The waste sitting at the surface is in containers that have limited lifetimes. It costs many millions of pounds to repackage them, it is a very long process and it puts workers at risk. So the sooner we can sort out a disposal process the better."

But Greenpeace voices concerns that if future generations come up with a way of neutralising radioactive waste, there would be no way of retrieving it if it was buried deep underground.

Pickard answer is that the burial process should be slow enough to allow science to keep up. "If in 100 or 200 years time someone came up with a way of neutralising it, this material could still be mined," he says, albeit at a price.

But he is not confident such a scientific breakthrough will take place. "None of the scientists I have spoken to have suggested that a way of neutralising radioactive waste is round the corner," he says.

Not in my back yard

The most difficult hurdle that deep disposal presents is finding a site that is both geologically secure and

also accepted by the local community.

Most governments are unwilling to foist a facility on communities and would prefer they volunteered instead.

Communities in the UK are being offered an added incentive to come forward in the form of a financial reward (to be determined following negotiation between the community and government) to build, for example, hospitals or improved infrastructure.

The invitation has been open since January 2008 but so far only two councils -- Copeland and Allerdale both in West Cumbria -- have expressed interest.

These councils already have a relatively willing community for nuclear having lived alongside the Sellafield facility for decades. The concern now is whether communities with less support for nuclear will come forward.

It is also far from guaranteed that the geology of West Cumbria will be suitable for a repository.

Back in 1997, Nirex – the body set up to develop plans for geological disposal before it was moved to the Nuclear Decommissioning Authority (NDA) – applied for planning permission to build a “rock characterisation facility” to evaluate the suitability of the Sellafield site for disposal of radioactive waste. The application was rejected.

John Dalton, head of communications at the NDA explains that the rejection in 1997 partly came down to a lack of transparency in the site selection process, which they plan to avoid this time around.

Science has also advanced since 1997 to enable a more accurate assessment of the geology, he says. “The geology hasn’t changed, but our interpretation of the data has,” he says.

The British Geological Survey will begin tests of the potential storage sites in the next few months. If the geology is found to be unsuitable, Dalton says plans will not go ahead and other areas in the UK will have to be explored.

“Plan B is to make Plan A work,” says Dalton. “The only way we are going to do that is by working in partnership with local communities. But doing nothing is not a viable option.”

One or two?

It is still unclear how many nuclear waste repositories will be needed in the UK.

The objective – as in all countries considering deep disposal – is to build a repository big enough to store waste from existing as well as new breed reactors.

But waste from the new generation European Pressurised Reactors (EPR), although significantly less in

volume (only 10% of the volume of waste from today's reactors) is also of a higher intensity and heat, so will also require more space for storage.

There is also uncertainty over whether it will be technically possible to co-dispose intermediate-level waste – that is encased in concrete – with the new high-level radioactive waste.

The decision, says Walton, will depend on the geology of the site that is chosen and the volumes of storage available in the rock.

But if two sites are required, costs for geological disposal (currently at £12 billion in the UK) would double.

Democratic challenge

Next up are the political tests that burying waste presents. "You are looking for a policy that will be handed on from government to government for hundreds of years," says Pickard. "And that is quite a democratic challenge."

This democratic challenge was laid bare last month when US president Barack Obama effectively pulled the plug on the proposed Yucca Mountain nuclear waste repository and the $10 billion that had already been invested in it.

In a letter to the Las Vegas Review-Journal in 2007, he said there were "significant questions about whether nuclear waste can be safely stored" at the site. Instead, he wanted states to store their own waste in intermediate storage facilities until a "safe, long-term disposal solution … based on sound science" was found.

Until governments can overcome these technical, social, political and ethical concerns of dealing with their legacy waste, the future of nuclear energy remains in the balance.

But even if governments do get deep disposal to work, neither should they let that justify plans to build more reactors, says former CoRWM chair Professor MacKerron. "With legacy waste we have no choice to manage it as best we can. But for future waste we have the possible choice not to create it at all."

The Facts: Where we are at

Finland, Onkalo

- Finland is on track to become the first country to permanently dispose of its nuclear waste. The Onkalo site is being developed by Posiva, a nuclear waste company owned by two Finnish reactor builders.
- The first canisters are expected to be buried within 15 years and then finally sealed around 2100.
- An estimated 5500 tonnes of spent fuel will be buried from the nation's four existing reactors and

Olkiluoto 3, the first European Pressurised Reactor (EPR) currently under construction.

- The cost of the facility is an estimated EUR 3 billion (£2.8 billion), paid entirely by the power companies from a nuclear waste management fund that they have been paying into since the nation's first reactors were built in the late 1970s. The power companies have raised the money through a small levy on the price of nuclear electricity.

UK

- The UK's inventory from the current nuclear programme includes 470,000 cubic metres of higher activity radioactive waste that includes 365,000 cubic metres of high and intermediate-level radioactive waste
- In 2006, following a three-year consultation, the Committee on Radioactive Waste Management (CoRWM) released recommendations that the best long-term solution for the disposal of the UK's nuclear waste should be to bury it deep in the ground.
- In January 2008, the UK government produced a white paper for nuclear energy that set out its policy for geological disposal. Government is asking for expressions of interest from UK councils for a site. No deadlines have been set.
- At the earliest, the first waste would be buried in 30-40 years. Final sealing of the facility would occur 120 years later.
- One high-level geological disposal facility would cost an estimated £12 billion, the majority of which will be funded by government. If new reactors are built, energy companies would meet the storage costs for new waste.
- But final costs will depend on the geology of the site chosen. Greenpeace believes the price tag could reach £20 billion.
- Government's policy is that before development consents for new nuclear power stations are granted, effective arrangements must exist to manage and dispose of the waste they will produce.

United States

- Nuclear waste in the US is currently stored at 121 temporary sites in 39 states across the country.
- In February, US President Barack Obama effectively abandoned the proposed Yucca Mountain nuclear waste repository by dramatically scaling back funding in his 2010 budget proposal.
- The Department of Energy will now establish a "blue ribbon" panel to a develop a long-term U.S. nuclear strategy that would include permanent disposal of nuclear wastes.
- A proposal is expected sometime this year.

Elsewhere (source Defra)

- In France an underground research laboratory (URL) has been constructed at Bure in the north east, where a geological disposal facility may be sited.
- Belgium is researching high-level waste (HLW) disposal in clay at its Mol URL
- Sweden runs an international URL project at Äspö and is investigating two potential sites for a disposal facility at which trial disposal could start in 2012
- Switzerland is investigating disposal of HLW some 1200m deep in the north of the country
- Site selection process is also underway in Germany, Japan and Canada

Nuclear waste glossary

“High-level waste" (HLW) is so radioactive that it generates heat and corrodes all containers. In the UK it accounts for less than 1 percent of the total volume of nuclear waste, but accounts for over 90 percent of the total radioactivity. HLW must be stored above ground for at least 50 years so it can cool before being transported and disposed.

- “Intermediate level waste” (ILW) arises mainly from the reprocessing of spent fuel and from general operations and maintenance at nuclear sites. It has lower levels of radioactivity than HLW and produces significantly less heat. Typically, ILW is packaged for disposal by encapsulation in cement in highly-engineered stainless steel drums or in higher-capacity steel or concrete boxes.

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