Game changer

Prism aims to dethrone Mox

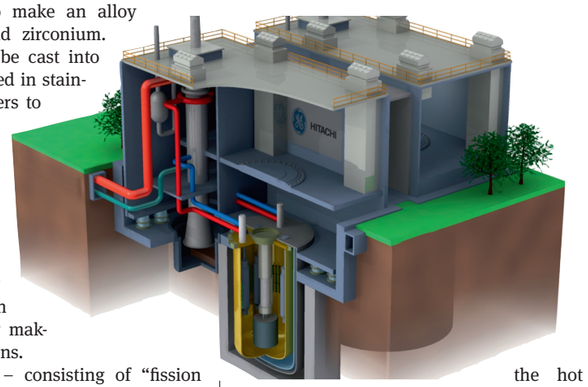
GE Hitachi claims its Prism reactor is a technically superior way of getting rid of the UK's stockpile of plutonium – and it generates electricity into the bargain. All it needs is a first adopter to prove it.

Proponents of nuclear power have never been able to say much to allay the fears of the anti-nuclear lobby when it comes to radioactive waste. But now a technology – long in development – might be deployed that could salve those fears. It would also contribute to UK electricity generation for at least 60 years.

Prism (Power Reactor Inherently Safe) is a fourth-generation nuclear reactor from GE Hitachi, a joint venture based in North Carolina, US. The reactor works on an integral fast reactor principle and uses metal rather than oxide fuel – distinguishing it from the vast majority of nuclear reactors around the world both "fast" and "slow".

Crucially, the metal fuel is made using plutonium – of which the UK has the largest civil stockpile in the world. It currently totals about 100 tons and is forecast to increase to about 140 tons over the next few years. The British government has made a binding commitment to ensure the plutonium is "dispositioned" so that it cannot be used in weapons. Apart from the obvious desirability of doing this, it is also very expensive to secure Sellafield to stop any ill effects of plutonium getting out and anyone with terrorist motives getting in.

Prism would use plutonium from the UK's stockpile (in the form of plutonium oxide powder) to make an alloy with uranium and zirconium. This would then be cast into chunks and stacked in stainless steel containers to form fuel pins. Waste from the Prism process is many orders of magnitude less radioactive than conventional waste from nuclear power generation – and useless for making nuclear weapons.



Prism's waste – consisting of "fission products" such as caesium and krypton – would take about 300 years to reach background radiation levels, a big improvement on the 300,000 years needed for conventional nuclear waste. Depending on whether the fission wastes of Prism naturally occur as minerals or metals, they would be turned into either ceramic or metal matrices and stored in geological disposal facilities. Emphasising the "robust" safety of this storage technique, Eric Loewen, chief consulting engineer for GE Hitachi and a world authorities on nuclear power, playfully tells *Utility Week* "even if some of this stuff got into the hot water for making your tea, it would not leach out its elements".

It sounds as though Prism is a no-brainer. So why hasn't the UK government, or others around the world, committed to building reactor modules?

Primarily, according to Jay Wileman, GE Hitachi's chief operating officer, it's because the development of Prism was stalled in the 1980s because of "budgetary refocusing" in the US. With Prism on the back boiler, another form of plutonium disposition came to the fore – Mox, the process of making mixed oxide fuel from civil plutonium.

Mox is now relatively well-established, accounting for about 5 per cent of the nuclear fuel used in the world today. And because we are talking about nuclear, it is hard to depose a technology once it has become established – especially, as is the case with Prism, if your technology has never yet been trialed as an integrated unit and at scale. Governments are understandably nervous about being the first to trial new nuclear technologies.

However, Wileman and Loewen are both optimistic about the prospects for Prism in the UK. In 2012, GE Hitachi successfully introduced the idea of Prism as an alternative technology for disposition to the Nuclear Decommissioning Authority (NDA). In early 2014, the NDA declared Prism a "viable" option. More news on the NDA's consideration of its disposition challenge is expected after the general election and a final decision about which technology will be pursued should be made in 2016.

In the meantime, GE Hitachi is on the hard sell, convinced that Prism is the best solution. Loewen and Wileman are practised ambassadors, emphasising both Prism's technical and economic benefits.

"Prism is the fastest and most flexible solution to the UK's disposition needs," says Wileman with confidence. A single Prism unit would take 60 years to disposition all 140 tons of the plutonium stockpile in the UK, and it would also offer the option to burn spent nuclear fuel – which Mox cannot – and hence superior flexibility.

"Regular light water reactors use fuel for about four to five years and then take it out," Wileman says. "At that point only about 5 per cent of the potential of that fuel has been used. Prism would allow you to recycle – not reprocess, recycle – that fuel to a point where up to 95 per cent of its potential is used."

Although the NDA's only remit is to ensure the UK's plutonium is taken care of, Wileman says he is hopeful that "once people are comfortable with the technology" more reactors could be built at Sellafield.

On the economic side, Wileman says that if the UK has the "technical courage" to adopt Prism, it would not only ensure the employment of thousands of people in the Sellafield region on the operation and maintenance of the unit and fuel fabrication facilities, it would also establish a supply chain for when Prism, he hopes, is adopted more widely.

Summing up the opportunity for the UK and the sheer significance of the Prism innovation, Wileman says that it could do for the nuclear industry what the invention of the jet engine did for aviation.

6 things you should know

- **Prism is vying with two other technologies, Candu and Mox, for the Nuclear Decommissioning Agency's favour as the right choice for dispositioning the UK's plutonium stockpile. (The UK has committed to ensuring that it's large plutonium stockpile is dispositioned for non-proliferation).**
- **The only suggested location for Prism in the UK is Sellafield, since the plutonium stored there cannot be transported without insupportable risk and public concern.**
- **Prism is an integral fast reactor that converts plutonium into a waste product that has a much shorter half-life than conventional nuclear waste.**
- **Electricity is a by-product of this disposition process.**
- **A single prism reactor has an electricity generation capacity of 300MW. The proposition for Sellafield is to deploy two reactors powering one turbine giving an overall capacity of 600MW.**
- **Prism can also use spent nuclear fuel as a fuel source.**

Ask an expert

GE Hitachi is clearly enthusiastic about Prism, but what do other experts think?

"[Fourth generation reactors and nuclear waste recycling] makes geological disposal much less of a challenge (and arguably even unnecessary) and nuclear waste a minor environmental issue compared to hazardous wastes produced by other industries."
Sir David King, former government chief scientific adviser

"The Prism reactor offered by GE Hitachi [is] a fourth-generation fast reactor design which can generate zero-carbon power by consuming our plutonium and spent fuel stockpiles, thereby tackling both the nuclear waste and climate problems simultaneously."
Stephen Tindale, former executive director of Greenpeace:

Factfile:

140 tons
size the of the UK's plutonium stockpile by 2018

60 years
time it would take a prism power unit to disposition all of the UK's plutonium

600MW
capacity for the proposed prism power unit at Sellafield

"The fundamental difference that makes Prism safer, cleaner and more cost effective than other reactor technologies is that it uses metallic fuel rather than oxide fuel."

Eric Loewen, chief consulting engineer, GE Hitachi Nuclear Energy

"If the UK has the technical courage, it will make sure that it has the initial supply chain and when the technology is adopted elsewhere, you become the experts."

Jay Wileman, senior vice president, nuclear plant projects and chief operating officer, GE Hitachi Nuclear Energy

Prism is no leap in the dark

Deploying a new kind a nuclear power technology seems an inherently risky business to the layperson, but Eric Loewen is nonchalant: "For the offering we have for the UK there are no unknowns. We would be within the known operating temperatures, fuel composition and materials that were used successfully in the US at Experimental Breeder Reactor-II for 30 years. And large elements, such as the cooling system and electromagnetic pumps, were tested at scale in the 1980s for advanced liquid metal reactors. So it's just a matter of systems integration to put them together for deployment in the UK."

Fuel for thought

Prism's primary fuel source is plutonium, but unlike Mox it can also reprocess spent nuclear fuel.