PROMOTIONAL FEATURE

Innovation generating clean energy

By bringing together proven technologies, we can turn Britain's plutonium stockpile into a great resource. By **Dr Eric Loewen** & **David Powell**

R&D and innovation have always been at the heart of GE's business. From the founding innovation, Thomas Edison's lightbulb and his thousands of other inventions, through to being the company which developed the world's first civil nuclear power station and the Mars Rover, the technology that comes from R&D and innovation is what GE does and who we are.

Everything GE has learned from 130 years of innovation leads us to something we think is incredibly relevant to the plutonium management challenge Britain faces today. GE believes that innovation comes not just from the creation of wholly new technologies, but actually most often from taking existing technologies that are already proven and bringing them together to create something new. And that is exactly what GE Hitachi (GEH) has done to create PRISM, a high energy neutron (fast) reactor which offers a proven but still innovative way to handle Britain's plutonium stockpile by burning the plutonium to create low carbon electricity.

The other thing we've learnt is that first mover advantage is everything. Those who develop and support new technology first gain greatly from doing so. And this is the great opportunity for the UK – the chance to lead the world in a new generation of nuclear technology and reaffirm West Cumbria's position as a global centre of nuclear industry excellence with all the economic benefits that will flow from that, both now and for many decades into the future.

GE saw the benefits of that advantage at first hand when the company became a first mover with the boiling water reactor after Argonne National Laboratory completed about three years of experimental work. We brought this technology to market and are still improving the technology with our current offering of the ESBWR being the best in class water cooled reactor (low energy neutrons). This time, with the PRISM high energy neutron technology we have learnt more. Argonne National Laboratory operated its experimental test reactor for thirty years. PRISM as a first mover, uses that proven technology (such as fuel, fuel handling, pumping, materials, etc.) yet commercialises it with improvements such as an air cooling system to remove decay heat from the reactor requiring no power, no valves, no automatic system and no human intervention. Further commercial improvements are the below grade construction for seismic and aircraft impactand, an improved robust dual containment system to prevent off-site radioactive release. GEH's heritage also includes the first naval propulsion system using a sodium coolant, a fuel test reactor in Arkansas, supplying components to the US test reactor (Fast Flux Test Facility) and supporting components of the two sodium reactors in Japan. It is this sound technology experience, ability to reactivate the supply chain and technology improvements which this first mover project will leverage.

Turning Britain's plutonium headache into an opportunity

Britain's 112 tonnes of plutonium stored in Cumbria represents the largest civil stockpile anywhere in the world. The country spends millions of pounds each year storing the plutonium safely and securely, and there is a widespread consensus that this temporary storage solution cannot last forever.

The Nuclear Decommissioning Authority (NDA) and the Department of Energy & Climate Change (DECC) have various options to deal with the UK's plutonium stockpile against the alternative of permanent storage, and their clear conclusion is that plutonium re-use is the right answer for Britain. We agree – permanent storage imposes permanent costs on the country, creates a permanent security and proliferation threat, irresponsibly passes the problem onto future generations, and would miss the opportunity to generate low carbon energy from the plutonium we hold.

Viewing plutonium as a problem is understandable given the challenges long term storage poses. But if we look at plutonium another way, it is undoubtedly also a resource. That's why it was recovered in the first place. As a resource, plutonium can generate low carbon energy for decades in the future and provide baseload power, enhancing Britain's energy security and supporting the introduction of more renewable energy onto the grid.

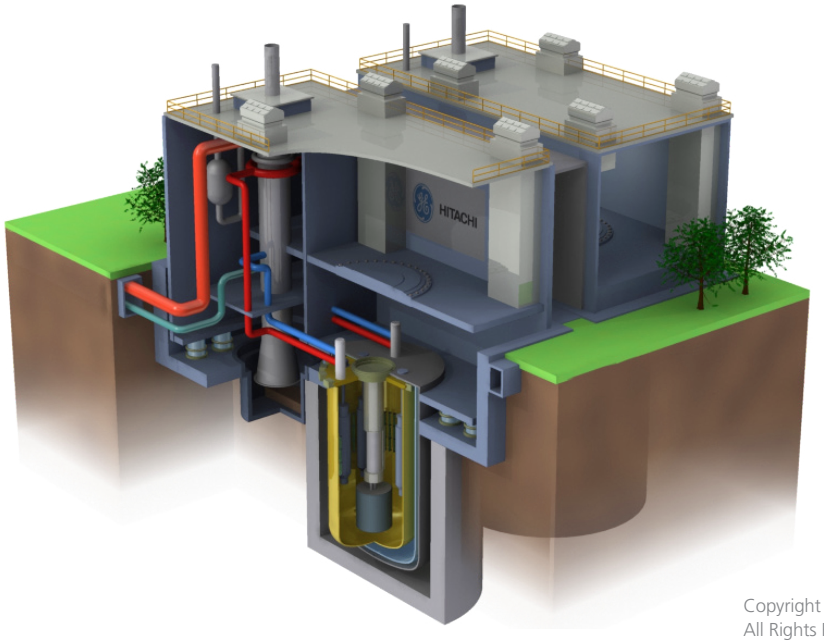
Marrying proven technology to create innovation

So how does PRISM turn plutonium into low carbon power? And how does it bring together proven technologies to create something innovative?

The story of PRISM commences with the development of the first fast reactors which GE has been involved with since 1951 supporting the U.S. first mover nuclear reactor concept in submarines in the post World War II era. This followed in the 1960's with efforts to move this high energy neutron technology into the commercial market with prototype tools such as EBR II and the SouthWest Experimental Fast Oxide Reactor. The PRISM evolution from EBR II started development in the 1980s as an internal GE project. Then in 1984 in a major US government programme (Advanced Liquid Metal Reactor) this internal concept was improved with a national industrial team (nine US companies with international support). The reactor was authorised for construction in the Energy Policy Act 1992 but despite this authorisation, the reactor was not built due to U.S. government policy changes initiated by President Clinton.

PRISM is based on the EBR II and therefore on 30 years of live testing.

The Argonne National Laboratory operated their experimental test



reactor for thirty years to better develop the fuel and operations, and close the fuel cycle. This thirty years of testing provided the safety and economic case for metallic fuel use in sodium cooled reactors whilst thirty year of operation also provided operation insights to the safety case as a system that can lose primary flow to the core or the ultimate heat sink without any control rod motion and shut down without fuel damage. The operation also showed lower radiation exposure to the operating staff per MWe generated. To commercialise this technology the Industry team during the ALMR program made significant improvements. The learning from these three decades of experience can be found today embodied in PRISM.

A safe, secure and clean solution

We believe the benefits of PRISM to the UK are compelling, and our reactor provides a safe, secure and clean solution for plutonium disposition. PRISM is a modern reactor design, featuring advanced passive safety systems, removing decay heat without automatic or operator actions and eliminating the risk of a loss of coolant accident.

It also offers the most secure disposition option because PRISM could be built local to Sellafield and close to the existing Plutonium storage facilities. This eliminates the need for transportation of plutonium and thus reduces the proliferation risk or security threat, both of which are very real with non-PRISM alternatives.

And PRISM is a clean solution because it is not only capable of processing impure plutonium, with minimal need for chemical pre-clean up of contaminants, but also directly generates low carbon electricity with no intervening steps in the process.

A flexible solution with a flexible commercial model

A key attribute of PRISM is its flexibility. If required, it could disposition all UK plutonium within five years. Alternatively, low carbon energy output could be increased with slower dispositioning and more PRISM modules. But based on the assumption of a single PRISM power block, we envisage PRISM would operate for 60 years generating over 600MW of low carbon baseload energy for the UK grid.

PRISM's efficiency in use of plutonium allows a range of flexible commercial models which could work in any one of a number of ways. But the key proposition we have made to the UK government and the NDA is that PRISM could work on a 'payment by results' model which involved payment per tonne of plutonium dispositioned supported by a secondary revenue stream from the sale of the low carbon electricity onto the grid. This model, if chosen, transfers risk away from UK Government, with industry taking the lead for managing the UK's plutonium stockpile and the UK taxpayer only paying as plutonium is dispositioned. In such a scenario, the UK Government would neither own nor operate the facilities so risk to UK taxpayer is minimised.

Creating a world class centre of innovation and excellence in the UK

Should the UK elect to move forward with PRISM, the benefits from marrying proven technologies in an innovative way could be huge. Aside from the immediate economic benefits stemming from the plant creating what could be thousands of permanent and construction jobs, the Cumbria coast would host a world first technology in which many other countries are already expressing an interest. West Cumbria's position as a global centre of nuclear industry excellence would be reaffirmed and the region would be perfectly positioned as a hub for expanding into the next generation of nuclear technology and R&D.

GEH has already hosted one conference to introduce potential local suppliers to the PRISM concept and have signed MOU's with the University of Manchester, the National Nuclear Laboratory and the CAP (Costain, Arup & Poyry) Alliance to work on further development of the plans. This unique marriage of proven technologies to create something new offers the UK the perfect opportunity to strengthen its global leadership position in the field of civil nuclear power, taking advantage of the unique challenge – and unique opportunity – stemming from its plutonium stockpile.

Dr Eric Loewen, Chief Consulting Engineer, GE Hitachi Nuclear Energy
eric.loewen@ge.com

David Powell, Vice President, Nuclear Power Plant Sales, GE Hitachi Nuclear Energy
davidj.powell@ge.com