'NEW' REACTOR TYPES ARE PIE IN THE SKY

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There's an Alice in Wonderland flavour to the nuclear power debate. Lobbyists are promoting all sorts of non-existent reactor types. But the designs they are promoting have two severe problems. They don't exist. And they have no customers.

Some nuclear enthusiasts favour non-existent Integral Fast Reactors, others favour non-existent Liquid Fluoride Thorium Reactors, others favour non-existent Pebble Bed Modular Reactors, others favour non-existent fusion reactors. And on it goes.

Two to three decades ago, the nuclear industry promised a new generation of gee-whiz 'Generation IV' reactors in two to three decades. That's what they're still saying now, and that's what they'll be saying two to three decades from now. The Generation IV International Forum website states: *"It will take at least two or three decades before the deployment of commercial Gen IV systems. In the meantime, a number of prototypes will need to be built and operated. The Gen IV concepts currently under investigation are not all on the same timeline and some might not even reach the stage of commercial exploitation."*

The World Nuclear Association notes that *"progress is seen as slow, and several potential designs have been undergoing evaluation on paper for many years."*

Integral Fast Reactors

Integral Fast Reactors (IFRs) are a case in point. According to the lobbyists they are ready to roll, will be cheap to build and operate, couldn't be used to feed WMD proliferation, etc. The US and UK governments have been analysing the potential of IFRs.

The UK government found that the facilities have not been industrially demonstrated; and waste disposal issues remain unresolved and could be further complicated if it is deemed necessary to remove sodium from spent fuel to facilitate disposal.

The US government has also considered the use of IFRs (which it calls Advanced Disposition Reactors – ADR) to manage US plutonium stockpiles and concluded that: the ADR approach would be more than twice as expensive as all the other options under consideration; it would take 18 years to construct an ADR and associated facilities; and the ADR option is associated with *"significant technical risk"*.

Unsurprisingly, the IFR rhetoric doesn't match the sober assessments of the UK and US governments. As nuclear engineer Dave Lochbaum from the Union of Concerned Scientists puts it: *"The IFR looks good on paper. So good, in fact, that we should leave it on paper. For it only gets ugly in moving from blueprint to backyard."*

Small Modular Reactors

In any case, IFRs are yesterday's news. Now it's all about Small Modular Reactors (SMRs). The Energy Green Paper recently released by the Australian government is typical of the small-is-beautiful rhetoric: *"The main development in technology since 2006 has been further work on Small Modular Reactors (SMRs). SMRs have the potential to be flexibly deployed, as they are a simpler 'plug-in' technology that does not require the same level of operating skills and access to water as traditional, large reactors."*

The rhetoric doesn't match reality. Interest in SMRs is on the wane. Thus Thomas W. Overton, associate editor of POWER magazine, wrote in a recent article: *"At the graveyard wherein resides the "nuclear renaissance" of the 2000s, a new occupant appears to be moving in: the small modular reactor (SMR). ... Over the past year, the SMR industry has been bumping up against an uncomfortable and not-entirely-unpredictable problem: It appears that no one actually wants to buy one."*

Overton notes that in 2013, MidAmerican Energy scuttled plans to build an SMR-based plant in Iowa. This year, Babcock & Wilcox scaled back much of its

SMR program and sacked 100 workers in its SMR division. Westinghouse has abandoned its SMR program. As he explains: *"The problem has really been lurking in the idea behind SMRs all along. The reason conventional nuclear plants are built so large is the economies of scale: Big plants can produce power less expensively per kilowatt-hour than smaller ones. The SMR concept disdains those economies of scale in favor of others: large-scale standardized manufacturing that will churn out dozens, if not hundreds, of identical plants, each of which would ultimately produce cheaper kilowatt-hours than large one-off designs. It's an attractive idea. But it's also one that depends on someone building that massive supply chain, since none of it currently exists. ... That money would presumably come from customer orders – if there were any."*

Can't find customers, can't find investors

Dr Mark Cooper, Senior Fellow for Economic Analysis at the Institute for Energy and the Environment, Vermont Law School, notes that two US corporations are pulling out of SMR development because they cannot find customers (Westinghouse) or major investors (Babcock and Wilcox). Cooper points to some economic constraints: *"SMR technology will suffer disproportionately from material cost increases because they use more material per MW of capacity. Higher costs will result from: lost economies of scale; higher operating costs; and higher decommissioning costs. Cost estimates that assume quick design approval and deployment are certain to prove to be wildly optimistic."*

Academics M.V. Ramana and Zia Mian state in their detailed analysis of SMRs: "*Proponents of the development and large scale deployment of small modular reactors suggest that this approach to nuclear power technology and fuel cycles can resolve the four key problems facing nuclear power today: costs, safety, waste, and proliferation. Nuclear developers and vendors seek to encode as many if not all of these priorities into the designs of their specific nuclear reactor. The technical reality, however, is that each of these priorities can drive the requirements on the reactor design in different, sometimes opposing, directions. Of the different major SMR designs under development, it seems none meets all four of these challenges simultaneously. In most, if not all designs, it is likely that addressing one of the four problems will involve choices that make one or more of the other problems worse."*

Likewise, Kennette Benedict from the *Bulletin of the Atomic Scientists* states: *"Without a clear-cut case for their advantages, it seems that small nuclear modular reactors are a solution looking for a problem. Of course in the world of digital innovation, this kind of upside-down relationship between solution and problem is pretty normal. Smart phones, Twitter, and high-definition television all began as solutions looking for problems In the realm of nuclear technology, however, the enormous expense required to launch a new model as well as the built-in dangers of nuclear fission require a more straightforward relationship between problem and solution. Small modular nuclear reactors may be attractive, but they will not, in themselves, offer satisfactory solutions to the most pressing problems of nuclear energy: high cost, safety, and weapons proliferation."*

Or as Westinghouse CEO Danny Roderick said: *"The problem I have with SMRs is not the technology, it's not the deployment – it's that there's no customers."*

Westinghouse is looking to triple the one area where it really does have customers: its decommissioning business. *"We see this as a $1 billion-per-year business for us"*, Roderick said. With the world's fleet of mostly middle-aged reactors inexorably becoming a fleet of mostly ageing, decrepit reactors, Westinghouse is getting ahead of the game.

Some SMR R&D work continues but it all seems to be leading to the conclusions mentioned above. Argentina is ahead of the rest, with construction underway on a 27 MWe reactor – but the cost equates to an astronomical US$15.2 billion per 1,000 MWe. Argentina's expertise with reactor technology stems from its covert weapons program from the 1960s to the early 1980s.

And while the 'small is beautiful' approach is faltering, so too is the 'bigger is better' mantra. The 1,600 MW Olkiluoto-3 European Pressurized Reactor (EPR) under construction in Finland is nine years behind schedule (and counting) and US$6.9 billion over-budget (and counting). The UK is embarking on a hotly-contested plan to build two 1,600 MW EPRs at Hinkley Point with a capital cost of US$24.5 billion and mind-boggling public subsidies. Economic consulting firm Liberum Capital said Hinkley Point will be *"both the most expensive power station in the world and also the plant with the longest construction period."*