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US Government Accountability Office pours cold water on advanced reactor concepts

NM810.4491 The US Government Accountability Office (GAO) has released a report on the status of small modular reactors (SMRs) and other new reactor concepts in the US.

Let's begin with the downbeat conclusion of the GAO report:

"While light water SMRs and advanced reactors may provide some benefits, their development and deployment face a number of challenges. Both SMRs and advanced reactors require additional technical and engineering work to demonstrate reactor safety and economics, although light water SMRs generally face fewer technical challenges than advanced reactors because of their similarities to the existing large LWR [light water] reactors. Depending on how they are resolved, these technical challenges may result in higher cost reactors than anticipated, making them less competitive with large LWRs or power plants using other fuels. ...

"Both light water SMRs and advanced reactors face additional challenges related to the time, cost, and uncertainty associated with developing, certifying or licensing, and deploying new reactor technology, with advanced reactor designs generally facing greater challenges than light water SMR designs. It is a multi-decade process, with costs up to $1 billion to $2 billion, to design and certify or license the reactor design, and there is an additional construction cost of several billion dollars more per power plant.

"Furthermore, the licensing process can have uncertainties associated with it, particularly for advanced reactor designs. A reactor designer would need to obtain investors or otherwise commit to this development cost years in advance of when the reactor design would be certified or available for licensing and construction, making demand (and customers) for the reactor uncertain. For example, the price of competing power production facilities may make a nuclear plant unattractive without favorable rates set by a public authority or long term prior purchase agreements, and accidents such as Fukushima as well as the ongoing

need for a long-term solution for spent nuclear fuel may affect the public perception of reactor safety. These challenges will need to be addressed if the capabilities and diversification of energy sources that light water SMRs and advanced reactors can provide are to be realized."

Many of the same reasons explain the failure of the Next Generation Nuclear Plant Project. Under the Energy Policy Act of 2005, the US Department of Energy (DoE) was to deploy a prototype 'next generation' reactor using advanced technology to generate electricity, produce hydrogen, or both, by the end of fiscal year 2021. However, in 2011, DoE decided not to proceed with the deployment phase of the project.

Small modular reactors

Four companies have considered developing SMRs in the US in recent years. NuScale has a cost-sharing agreement such that the DoE will pay as much as half of NuScale's costs − up to $217 million (€194m) over five years − for SMR design certification. NuScale expects to submit a design certification application to NRC in late 2016, and may begin operating its first SMR in 2023 or 2024. (However the timeframe is unrealistic, and the project may be abandoned − as other SMR projects have.)

The other three companies are a long way behind NuScale:

- mPower, a subsidiary of Babcock & Wilcox, enjoyed a cost-sharing agreement with the DoE but in 2014 scaled back its R&D efforts because of a lack of committed customers and a lack of investors.
- Holtec says it is continuing R&D work, but does not have a detailed schedule.
- In 2014 Westinghouse suspended its efforts to certify its SMR design, because of a lack of committed customers (and the lack of a DoE cost-sharing agreement).

The GAO report states that the development of light water SMRs may proceed without serious difficulties as they are based on existing light water reactor technology. That said, standardization is a key pillar of SMR rhetoric, and members of an expert group convened by the GAO noted that component standardization has proven challenging for the construction of the larger Westinghouse AP1000 that has some modular components.

Another pillar of SMR rhetoric is mass production (to make them economic), and the development of a massive construction chain to allow for mass production is a radically different proposition to NuScale's plan to build just one reactor over the next decade.

Not-so-advanced reactor concepts

According to the GAO report, SMRs and new reactor concepts "face some common challenges such as long time frames and high costs associated with the shift from development to deployment − that is, in the construction of the first commercial reactors of a particular type."

The report notes the US government's generous financial support for utilities developing SMRs and advanced reactor concepts − DoE provided US$152.5 million (€137m) in fiscal year 2015 alone. Advanced reactor concepts attracting DoE largesse are the high temperature gas cooled reactor, the sodium cooled fast reactor, and to a lesser extent the molten salt reactor (specifically, a sub-type known as the fluoride salt cooled high temperature reactor).

DoE and Nuclear Regulatory Commission (NRC) officials do not expect applications for advanced reactors for at least five years. In other words, an application may (or may not) be submitted some time between five years and five centuries from now.

Advanced reactor designers told the GAO that they have been challenged to find investors due to the lengthy timeframe, costs, and uncertainty. Advanced reactor concepts face greater technical challenges than light water SMRs because of fundamental design differences. Thus designers have significantly more R&D issues to resolve, including in areas such as materials studies and fuel certification, coolant chemistry studies, and safety analysis. Some members of the expert group convened by the GAO noted a potential need for new test facilities to support this work. Furthermore, according to reactor designers, certifying or licensing an advanced reactor may be particularly time-consuming and difficult, adding to the already considerable economic uncertainty for the applicants.

The process of developing and certifying a specific reactor design can take 10 years or more for design work and nearly 3.5 years, as a best case, for NRC certification. Even that timeframe is more hope than expectation. Recent light water reactor design certifications, for the Westinghouse AP1000 and the GE Hitachi ESBWR, have taken about 15 and 11 years respectively. Both the AP1000 and ESBWR are modifications of long-established reactor types, so considerably longer timeframes can be expected for advanced concepts.

The cost to develop and certify a design can range from US$1−2 billion (€0.9−1.8b). Developers hope that costs can be reduced as they move from certification to the construction of a first-of-a-kind plant to the construction of multiple plants. But the GAO report notes that those hopes may be unfounded:

"[S]ome studies suggest that existing, large LWRs have not greatly benefitted from industry-wide standardization or learning to date for reasons including intermittent development and production. In fact, some studies have found that "reverse or negative learning" occurs when increased complexity or operation experience leads to newer safety standards. On a related point, another reactor designer said that the cost and schedule difficulties associated with building the first new design that has been certified by the NRC and started construction in the United States in three decades − the Westinghouse AP1000, a recently designed large LWR − have made it harder for light water SMRs to obtain financing because high-profile problems have made nuclear reactors in general less attractive. ... The AP1000 was the first new design that has been certified by the NRC and started construction in the United States in three decades. However, construction problems, including supply chain and regulatory issues, have resulted in cost and schedule increases."

US Government Accountability Office, July 2015, 'Nuclear Reactors: Status and challenges in development and deployment of new commercial concepts', GAO-15-652, www.gao.gov/assets/680/671686.pdf

(Written by Nuclear Monitor editor Jim Green.)