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Small nuclear may be the wave of the future

They are less capital-intensive and flexible, but it's not yet clear how regulators should weigh their safety.

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Whether people's reading habits include *The Wall Street Journal*, *The Washington Post* or *Physics Today*, the chances are that they have seen a little of the buzz about small and modular nuclear reactors.

Before ground is broken on even one of the new generation of large-scale reactors undergoing licensing at the Nuclear Regulatory Commission (NRC), many are looking toward the next generation of new reactors that are smaller, less capital intensive and more flexible. Small and modular nuclear reactors (SMRs) generally have a capacity of 300 megawatts or less, compared to the 1,000 to 1,700 MW capacity of large power reactors. As a result, they can serve remote locations and small power grids and meet the needs of smaller utilities, providing carbon-free power on a 24/7 basis.

All large power reactors in the United States and most in the rest of the world are based on "light water" designs — that is, they use uranium fuel and ordinary water for cooling. By contrast, an emerging class of small reactors come in widely varying designs and use a variety of fuels and cooling systems. They range from downsized light-water reactors to more exotic liquid metal-cooled fast reactors, with the smallest designs beginning at a 10 MW capacity.

SMRs are different in other ways, as well. Some SMRs will be factory-built and delivered in sealed containers ready to operate. Some are intended for underground operation. Some will never need to be refueled, but rather can be removed by truck and replaced like a battery. Some will produce considerably less radioactive waste. The modular designs allow adding increments of capacity as power needs increase over time. This kind of variety in nuclear power generation is largely unprecedented.

A number of developers of SMRs have been talking to the NRC about their designs and their preliminary intent to seek design certification and construction and operating licenses. Among the proponents of SMR designs are companies well-known for their work on large-scale nuclear power plants, including Westinghouse Electric Co. with its 335 MW IRIS reactor, Toshiba Corp. with its 10 MW 4S reactor, GE-Hitachi Nuclear Energy Inc. with its 311 MW PRISM reactor and Babcock & Wilcox Nuclear Power Generation Group Inc. with its 125 MW mPower reactor. Still others are high-tech startups, including Hyperion Power Generation Inc. with its 25 MW HPM Reactor and NuScale Power Inc. with its 45 MW reactor. Still other companies are working on additional SMR designs but have not yet opened discussions with the NRC.

NRC LICENSING PROCESS

The biggest challenge to getting SMRs to market in the United States is almost certainly the NRC licensing process. The NRC's current licensing requirements, contained in 10 C.F.R. 50 and 52, are geared toward certifying a design and then conducting a site-specific construction and operating licensing proceeding for large-scale nuclear reactors — a process that can take as long as a decade. The NRC recognizes that its existing regulations need to be re-examined to address these new technologies, and the agency has begun to review the potential policy and technical issues for SMRs.

The commission has taken the initiative in accelerating the development of a risk-informed licensing framework for SMRs. Last month, the NRC commissioners directed the NRC staff to report to the commission within six months on how risk insights can be used to improve the licensing process for SMRs. The industry's hope is that the commission's initiative has set in motion a process that will appropriately tailor what is otherwise a long and costly process to recognize that some SMR designs are inherently safer and more secure than their large-scale counterparts and that all of the SMR designs present some licensing issues that are distinct from those associated with large-scale nuclear power.

No one would argue that SMRs should be spared rigorous safety and licensing reviews by the NRC. Rather, the need is to figure out what safety standards make sense based on the nature of the potential risks associated with smaller capacity and particular SMR design features. Under the current NRC process, an applicant for a design certification for an SMR would need to try to determine for itself which of the standards in the regulations, 10 C.F.R. 50 and 52, apply to its design and which ones should not be applicable. Risk-informed, generic guidance from the NRC on those issues would ease the burden and reduce regulatory uncertainty for SMR developers.

As the NRC works to improve its licensing process for SMRs, it should be guided by certain principles. First, it is in the interest of all for the NRC to build on its existing licensing regime rather than start from scratch to promulgate a whole new set of rules for SMRs — a process that could take years and introduce new regulatory uncertainty. By customizing only as necessary the existing licensing standards in parts 50 and 52 for SMRs, the NRC can develop a usable licensing process in a reasonable amount of time, while allowing those who are already in preapplication discussions with the NRC to proceed with submission of their license applications during the next few years pursuant to their current schedules. Any other approach could put the entire SMR community on hold while NRC staff resources are devoted to a new rule-making. Additionally, using the existing regulations allows the NRC and applicants to benefit from the NRC staff's experience with an already established and understood process.

Second, the NRC can continue to communicate openly with the SMR vendors, and the SMR community in turn can continue to work actively with the NRC, in order to achieve a "right-sized" regulatory process for SMRs. Vendors will need to identify and promote specific changes and will need to support those changes by providing the NRC with the technical basis, including risk information, to justify them. SMR vendors will be most effective if they work collectively

on targeted reforms, providing clear indication to the NRC about what issues they share and what issues may be unique to specific designs and technologies.

In the end, cost will be a critical issue in the licensing process for SMRs. The key will be to find the right risk-informed balance between preserving a process that the industry and regulators understand and eliminating unnecessary requirements so that sponsors of SMR designs can survive the licensing process and can proceed to deployment.

DEPARTMENT OF ENERGY ASSISTANCE

The Department of Energy (DOE) is seeking to promote SMRs, and it understands that economic viability is essential. Therefore, it is seeking to structure a multipronged assistance program that will help get new SMR designs into the power generation mix through a phased process.

Although not all agree, the DOE believes that SMRs based on light-water reactor technology that is already understood by the NRC should move ahead first. Thus, in its 2011 budget request, the DOE asked for funding to help two SMRs based on light-water reactor principles get through the NRC licensing gate.

In its DNA, however, the DOE is a technology agency — supporting research and development for new ideas in energy and pushing them to the threshold of commercialization. Thus, the DOE also wants to fund research and development on more advanced designs, moving the designs that represent significant technology shifts to market during a 10- to 25-year period. Among other things, the DOE sees an important role for its high-speed computing capability to simulate and test new SMR designs, which could accelerate the resolution of safety questions.

In addition to supporting research and development, DOE will play an important role in working with the international nuclear community to develop codes and standards that make sense for SMR technologies and ultimately in facilitating export approvals so that SMR technology can be deployed overseas.

SMRs enjoy bipartisan support in Congress. The House Committee on Science and Technology and the Senate Energy and Natural Resources Committee have both approved legislation designed to promote the development and deployment of SMRs. Although the bills differ in their details, when Congress passes an energy bill, it seems likely the legislation will strongly support an SMR program along the lines DOE has proposed.

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