Highlights of GAO-15-652, a report to the Ranking Member, Subcommittee on Energy and Water Development, Committee on Appropriations, U.S. Senate

July 2015

TECHNOLOGY ASSESSMENT

Nuclear reactors

Status and challenges in development and deployment of new commercial concepts

Why GAO did this study

Energy demand in the United States is expected to continue to grow over the coming decades, and DOE considers nuclear energy to be one way to help meet this increased demand without producing air pollution. However, the current domestic commercial nuclear reactor fleet, consisting of 99 large LWRs that provide about 20 percent of U.S. electricity, is aging, and some reactors have shut down in recent years. LWRs use light, or ordinary, water to cool the reactor. New reactor concepts are under development as alternative energy options. Light water SMRs have some similarities, including the coolant used, to the existing large LWRs, and advanced reactors differ more from the large LWRs. Both new reactor concepts differ from the existing large LWRs in potential applications.

GAO was asked to conduct a technology assessment of these new reactor concepts in the United States. This report discusses (1) the status of light water SMR and advanced reactor concepts under development; (2) the intended benefits of these new reactor concepts; and (3) the challenges associated with developing and deploying these new types of reactors. GAO reviewed documents from DOE and NRC, and interviewed DOE and NRC staff as well as industry representatives involved in developing reactors. GAO, with the assistance of the National Academies, convened a meeting with a group of 20 experts on nuclear reactor development and related issues to provide additional information.

View GAO-15-652. For more information, contact Chief Scientist Timothy M. Persons at (202) 512-6522 or personst@gao.gov or Frank Rusco at (202) 512-3841 or ruscof@gao.gov

What GAO found

In the United States, four light water small modular reactors (SMRs)—nuclear power reactors with a generating capacity of less than 300 MW of electricity—have been developed to the point that the reactor designers have begun discussing design certification and license applications with the Nuclear Regulatory Commission (NRC), and one SMR designer has established time frames for applications to NRC and construction of a power plant. The Department of Energy (DOE) has provided financial support to the designers of two SMRs for reactor certification and licensing work. DOE supports the SMR design by NuScale through a cost-sharing agreement in which DOE will pay as much as half of NuScale's costs—up to $217 million over 5 years—for certifying the design. The SMR design by mPower has a similar cost-sharing agreement with DOE, but DOE is no longer providing funds because mPower has scaled back its efforts while it looks for additional investors. NuScale expects to submit a design certification application to NRC in late 2016, with its first power plant beginning operation as early as 2023. Other SMR designers do not yet have established time frames for such applications. DOE also supports research and development (R&D) activities on advanced reactor concepts that focus on the high temperature gas reactor and the sodium fast reactor. DOE provides this support in areas such as fuels and material qualification and reactor safety studies. DOE and NRC officials do not expect applications for advanced reactors for at least 5 years.

According to DOE officials and reactor designers, both SMRs and advanced reactors are intended to provide benefits that could facilitate the use of nuclear reactors in new markets or commercial applications. SMR designers plan to decrease the overall cost and time for reactor construction, compared with existing large light water reactors (LWRs), without significantly increasing ongoing operational costs. They told GAO they expect that the smaller size of SMRs may expand the locations where a nuclear power plant could be constructed. For example, they may be used in remote or rural areas that have lower electricity demands or smaller distribution systems. DOE officials and reactor designers expect advanced reactors to operate at higher temperatures and therefore they could generate electricity more efficiently. Furthermore, they told GAO heat from these higher temperature reactors could be used directly in certain industrial processes that currently depend on fossil fuels. Some advanced reactors may also allow for improved spent nuclear fuel recycling and management.

DOE officials and SMR and advanced reactor designers told GAO they face challenges in developing and deploying these reactors. SMR designers face technical challenges in demonstrating economic feasibility and safety without increasing reactor complexity, and advanced reactor designers face greater technical challenges because advanced reactors differ more from current reactors than SMRs. Reactor designers told GAO they face challenges associated with the up to $1 billion to $2 billion cost of developing and certifying a design. Even with a reactor design ready to submit to NRC, the licensing and construction can take nearly a decade or more before a reactor is operational. DOE officials, members of GAO's expert group, and reactor designers said that the cost and time needed to certify or license a reactor design and construct it, along with uncertainty about the energy market in the future and potential customer interest, create obstacles to the development and deployment of new reactors.