Hearing of the Subcommittee on Energy, House Committee on Science, Space and Technology

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Background

The Electric Power Research Institute (EPRI) conducts research and development relating to the generation, delivery, and use of electricity for the benefit of the public. An independent, non-profit organization, EPRI brings its scientists and engineers, as well as experts from academia, government and the industry, to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 35 countries.

The subject of my testimony today is EPRI's collaborative research efforts related to long term operation of the existing nuclear fleet and future commercial nuclear plant options including small modular and advanced reactors.

EPRI sees a plausible future where deep carbon reductions will require continued focus on energy efficiency, cleaner energy, electrification and advanced fuels. Nuclear power plays an important part of cleaner energy and advanced technologies needed to achieve carbon emissions reductions, affordable energy for the customer and a strong gross domestic product (GDP).

Location

It is fitting that we have this discussion just down the road from the site of the Shippingport Atomic Power Station. Shippingport was the first demonstration of large-scale commercial nuclear power in the United States, and the first dedicated solely to peaceful use of atomic energy worldwide. It was connected to the grid in 1957 and operated for 25 years prior to being shut down in 1982. The plant has been decommissioned and the land released for unrestricted use.

Over its 25-year lifetime, Shippingport operated with three very different core designs. With these different designs, the plant demonstrated many aspects of fuel, materials, and operation that underpin light water plants currently in operation. It also successfully demonstrated core designs and fuel cycles that are more characteristic of many advanced reactors under development today, including so-called "seed-and-blanket" core configurations and the ability to breed more fissile fuel than consumed.

Currently operating at the same site is the Beaver Valley Power Station with two pressurized water reactors. The first unit at Beaver Valley was licensed in 1976. With a license extension granted by the Nuclear Regulatory Commission in 2009, the plant is currently licensed to operate until 2036. The second unit came on line in 1987 and is currently licensed to operate until 2047. However, in 2018, Beaver Valley plant owner FirstEnergy announced a potential premature closure in 2021 due to market challenges. Beaver Valley's future is still uncertain.

On one site, what we would now think of as an advanced reactor has been demonstrated, extended operation of the two pressurized water reactors is well underway and a successful decommissioning effort has been completed.

Current status and license extension

Nuclear plants have long been valued for their reliable operation and contribution to baseload power generation. Many stakeholders, including owners and operators, regulators and government agencies, financial institutions and researchers are reappraising them as a foundation for sustained decarbonization – both on their own and in conjunction with renewables. Stakeholders are also assessing nuclear plants' economic contributions, local environmental footprint, and many other societal benefits.

The Beaver Valley plants are just two of 98 reactors currently operating in the U.S. These 98 reactors provide nearly 20 percent of the electricity generated in the US. Even with rapid deployment of wind and solar generation over the past decade, nuclear plants still comprise approximately 60 percent of our carbon-free electricity. While a significant number of units are currently under financial stress, that picture can change dramatically if the U.S. places even a modest value on carbon emissions reductions. And in a low-carbon future, reliable, dispatchable generation provides growing value as variable generation deployment expands.

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The Nuclear Regulatory Commission (NRC) originally licensed plants to operate for 40 years, with the potential for extended license periods of 20 years. Currently 90 of the operating reactors have received approval to extend their license out to 60 years, and more than half of the plants have operated for greater than 40 years. This forms a strong foundation of operating experience for second license renewals.

The NRC and plant owners are now focusing on renewals that would extend licenses out to 80 years. Absent second extensions, U.S. nuclear units will retire as they reach the end of their 60-year lives, and nuclear generation would begin a steep downward slope in the early 2030s. By 2035, approximately 30,000 of today's 100,000 megawatts of nuclear capacity would be offline and by 2050, the current light water reactor fleet would be nearly gone.

License renewal involves a systematic review of the plant, identification of potential degradation mechanisms and the development of aging management programs. It proceeds through coordinated efforts on three distinct fronts – regulatory, technical and environmental reviews.

Over the last 20 years, EPRI has been engaged with utilities, the Department of Energy (DOE) and the NRC to develop appropriate aging management programs. EPRI draws on a broad body of technical expertise and decades of research in materials, engineering and plant operations. The results of our research help provide the technical basis that can inform utilities' license renewal efforts and aging management programs.

For second license renewal, the key components of EPRI's research and guidance included:

- Reactor pressure vessels
- Reactor core internals
- Concrete and civil structures
- Electrical cables

Effective aging management requires an understanding of the aging mechanisms, when and how to inspect, along with thorough evaluation of inspection results and informed repair and replacement decisions.

Based on extensive research, evaluation of inspection results, and development of the aging management programs, we have found no technical barriers to safely and reliably extending the life of nuclear plants out to 80 years. This depends, of course, on nuclear plant owners effectively implementing the aging management programs.

So far, three companies have submitted applications for second license renewal. Experience from the Turkey Point, Surry and Peach Bottom license renewals will inform second license renewal decisions for other U.S. utilities. Success in the U.S. also is helping to inform international license renewal guidelines and safe operations in countries where nuclear plants are often 5 to 10 years younger.

New technologies for existing plants

New technologies and process improvements can also enable extended operations in existing plants, providing improved economics while maintaining reliability and safety. Two examples of initiatives that EPRI is working on are Accident Tolerant Fuels and Plant Modernization.

EPRI has been working with the DOE, fuel vendors, plant operators and other stakeholders to understand the application of different types of reactor fuels that are more robust and have improved performance during normal and accident conditions. The first accident tolerant designs have already been loaded into U.S. reactors on a limited basis and additional designs will be loaded in the near future.

EPRI's Plant Modernization initiative is investigating the potential to leverage various technological innovations that can increase efficiencies, thus improving the economics of operating a nuclear plant. These innovations include areas such as digital upgrades, on-line monitoring, digital worker tools and automation.

The longer and more efficient operation of today's fleet provides a bridge to the next wave of nuclear generating facilities. This is important to provide additional time for development and deployment of new plant types and to help maintain the national nuclear expertise and supply chain.

New Plants, SMRs and Advanced Reactors

Large light water reactors similar to those in the U.S. fleet continue to be built around the world with 56 plants currently under construction. In our country, while the NRC has issued combined licenses for 14 plants, only two are under construction at the Vogtle plant in Georgia.

Considerable research is underway to bring new technologies to commercial availability. Small modular reactors are a likely near-term option targeting the mid to late 2020s.

The NuScale Power small modular reactor is currently under design certification review by the NRC, and other SMR technology developers are at various stages of design and development. Utah Associated Municipal Power Systems has announced it is investigating the feasibility of building the first-of-a-kind multi-unit NuScale power plant on a site at the Idaho National Laboratory. NuScale estimates that the first plant will be in commercial operation by 2027.

EPRI has worked with the DOE, current nuclear operators and small modular reactor developers to help develop a common understanding of the requirements operators will have for the construction and operation of these plants. This is published as an EPRI report titled "Utility Requirements Document." Additionally, EPRI has conducted research to better understand the behavior of these containment designs and has evaluated how the plants can leverage new technologies to optimize staffing.

EPRI is also conducting research activities to demonstrate advanced manufacturing solutions which could help reduce the cost and streamline the schedule of building small modular reactors while improving performance of these components.

Looking beyond small modular light water reactors, EPRI has been engaged with the growing community of advanced reactor developers. Increasing industry and government interest in these reactors has coincided with unprecedented influx of private investment. A primary driver for renewed interest in advanced reactor technology is the desire for scalable generation options in the 2030–2050 timeframe to address the approaching scheduled retirement of traditional baseload capacity, while meeting future energy demand and planning for uncertainty resulting from policy, regulatory, and market changes.

Many technologies are being explored today, with several of these designs based on experimental work done prior to the build out of the current large, light water reactor fleet. Shippingport is one example of these early demonstration projects.

Some of the technologies being developed for commercialization include: gas-cooled fast reactors, lead-cooled fast reactors, molten salt reactors, sodium-cooled fast reactors, supercritical-water-cooled reactors, and very-high-temperature reactors. Other forms of advanced nuclear technology are being pursued for applications including energy production, but are still in the fundamental research stage. These include fusion, fission-fusion hybrids and accelerator-driven systems.

Supporting research underway at EPRI includes development of advanced reactor owner-operator requirements, developing methods for early integration of safety assessments during design, and economic modeling to explore the future role for nuclear in the U.S.

Opportunities for nuclear power increase substantially if decarbonization of transportation, building and industrial sectors is seriously pursued via economy-wide electrification or through low-carbon energy carriers such as green hydrogen. Both SMRs and advanced reactors offer unique features and attributes, including substantial increases in safety, to support new applications and disruptive business cases through greater operational, deployment, and product flexibility not as readily available from current technology.

Concluding Remarks

The nation's nuclear fleet continues to perform safely and reliably. While some of today's plants are facing economic pressures, several companies are working on extending the life of current plants out to 80 years and beyond. EPRI's research can inform these decisions as well as help provide the technical basis for effective aging management.

Small modular and advanced reactors provide new options beyond traditional large nuclear plants. Many companies are working on developing various designs for advanced reactors. EPRI is working collaboratively with several stakeholders on the development and demonstration of new technologies that may help inform utilities and vendors in achieving their objectives for design, construction and operation.

Research to optimize and extend the life of existing plants and demonstrations of advanced nuclear technologies offer utilities and other stakeholders several options, which is arguably among the most valuable resources they can have at their disposal in the future.