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Laying The Groundwork For Next-Generation Nuclear Energy

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If you don't watch "The Simpsons" or live near a nuclear power plant, you might not think about nuclear energy much. Solar panels and wind turbines have drawn our collective gaze in recent years, and have, at times, distracted us from the fact that nuclear power remains the single largest source of carbon-free electricity in the United States. In 2019, more than 95 nuclear reactors provide approximately 20% of our nation's electricity.

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The prominence of nuclear power in the United States, however, should not come as a surprise because of the following:

- No greenhouse gases: Nuclear power plants do not emit greenhouse gases; they are essential in addressing climate change.
- Baseload power: Nuclear power plants provide baseload power, operating at a relatively constant power level, 24 hours a day, 7 days a week.
- Reliability: Nuclear power plants are extremely reliable, operating to produce carbon-free power more than 92% of the time.
- National security: The United States' involvement and leadership in the international commercial nuclear market promotes key nonproliferation goals and the export of U.S. technology and services, and supports our national defense.
- Enormous capacity: One uranium fuel pellet — which is approximately the size of a pencil eraser — creates as much energy as one ton of coal, 149 gallons of oil or 17,000 cubic feet of natural gas. Nuclear waste is correspondingly about a million times smaller than fossil fuel waste, is encapsulated and is separated from the biosphere at all times.

Next-Generation Nuclear Technologies

So what's new? Dozens of companies are developing new reactor technologies, some of which are smaller and more adaptive than their historical brethren — both in physical footprint and in capacity.

These technologies incorporate advanced materials, innovative fuels and passive safety systems. They are designed to be less expensive to construct than existing technologies, and because they will be even safer than existing technologies, they can be located closer to city centers.

The designs include small modular water-cooled reactors, molten salt-fueled reactors, sodium-cooled fast reactors, high-temperature gas reactors, lead-cooled reactors and heat-pipe reactors.

U.S. Government Support for Next-Generation Nuclear

Development of next-generation nuclear energy technology enjoys broad bipartisan support. This support has grown ever stronger as concern over climate change has escalated.

Many policymakers and leading environmental groups recognize that the most affordable and technically feasible approaches to decarbonizing the electric grid will depend on, among other things, developing and deploying next-generation nuclear facilities. Over the past year, Congress has taken significant steps to encourage developing and deploying these technologies.

The Nuclear Energy Innovation Capabilities Act, or NEICA, was signed into law by President Donald Trump almost a year ago. Among other things, NEICA directs the U.S. Department of Energy to make the national laboratories more available for private sector use, to develop a test reactor plan and to increase collaboration with the U.S. Nuclear Regulatory Commission.

More specifically, NEICA directs the DOE to: (1) determine the need for a versatile reactor-based fast neutron source, which would operate as a national user facility, and put forward a plan to construct and operate such a facility by the end of 2025; (2) enhance its high-performance computation modeling and simulation techniques for advanced reactors; and (3) lead a program for testing advanced reactor concepts (including physical testing).

Congress then allocated, for FY 2018 and 2019, a total of about $100 million to the DOE's Office of Nuclear Energy to begin developing a conceptual design, cost estimate and schedule for the test reactor — now known as the Versatile Test Reactor. Universities, industrial partners and four national laboratories are collaborating on this initial phase.

As a follow-up to NEICA, Trump signed the Nuclear Energy Innovation and Modernization Act, or NEIMA, on Jan. 14. Among other things, NEIMA attempts to streamline an NRC licensing framework for advanced reactors. NEIMA directs the NRC to develop and implement strategies for licensing advanced nuclear reactors by this fall.

NEIMA also requests that the NRC identify those actions that Congress should take to support development of advanced nuclear reactors. To support these initiatives, NEIMA provides $14.4 million dollars annually over five years to assist the NRC.

As authorized by NEICA and as announced by Idaho National Laboratory on Aug. 15, a National Reactor Innovation Center will provide private sector technology developers support from the national

laboratories to test and demonstrate their reactor concepts and assess their performance. Proponents believe that the center will help accelerate the licensing and commercialization of these next-generation nuclear technologies.

This is in addition to the $75 million in funds that the DOE has granted to advanced nuclear technology companies through vouchers awarded under the Gateway for Accelerated Innovation in Nuclear program, and the $128 million the DOE has awarded through the Office of Nuclear Energy's recent funding opportunities.

In addition, several bills supporting the development and deployment on next-generation nuclear technologies are pending in Congress.

Advanced Nuclear Fuel Availability Act

Rep. Bill Flores, R-Texas, introduced H.R. 1760, the Advanced Nuclear Fuel Availability Act, on March 14. The act requires the U.S. Secretary of Energy to implement a program to make available an enriched nuclear fuel (known as high-assay low-enriched uranium, or HALEU) that would be used by some of the advanced reactor designs.

The act also would authorize the secretary to provide financial assistance to developers designing and licensing transportation packages for HALEU, and to establish a consortium to partner with the DOE to make HALEU available for domestic commercial use.

Nuclear Energy Leadership Act

Rep. Elaine Luria, D-Va., introduced H.R. 3306, the Nuclear Energy Leadership Act, or NELA, on June 18. The act — which is nearly identical to the previously-introduced Senate bill S. 903 — is designed to help the United States regain its global nuclear leadership, and calls on the DOE to create a 10-year nuclear energy strategic plan.

NELA requires the DOE to establish a long-term nuclear power purchase agreement pilot program and to enter into an agreement to purchase power from a commercial nuclear reactor by Dec. 31, 2023. (S. 903 requires that the commercial reactor be a new reactor.)

In addition, NELA requires the DOE to complete at least two "advanced nuclear reactor" demonstration projects by 2025, and to demonstrate between two and five additional operational advanced reactor designs by 2035. For designs that "are not developed sufficiently for demonstration" by the 2025 deadline but that could be sufficiently developed to meet the 2035 deadline, NELA directs the DOE to take certain steps to support their development.

Advanced Nuclear Energy Technologies Act

Rep. Clay Higgins, R-La., introduced H.R. 3358, the Advanced Nuclear Energy Technologies Act, on June 19. The act directs the Secretary of Energy to carry out advanced nuclear demonstration projects aimed at (1) demonstrating different advanced nuclear reactor technologies; (2) identifying research areas that the private sector is unable or unwilling to undertake; and (3) helping the private sector access federal research facilities and personnel and the results of civil nuclear technology research funded by the federal government.

Nuclear Energy Renewal Act

Sen. Chris Coons, D-Del., introduced S. 2368, the Nuclear Energy Renewal Act of 2019, on July 21. The act, among other things, directs the Secretary of Energy to (1) develop certification and licensing criteria with respect to next-generation reactors; (2) assist eligible applicants regarding the certification and licensing of those reactors; and (3) support licensing and relicensing of certain nuclear facilities and nuclear energy research, demonstration and development.

Strategic Energy for America Act

Sen. Lisa Murkowski, R-Alaska, introduced a discussion draft of the Strategic Energy for America Act of 2019 on Aug. 15. The act, among other things, directs the Export-Import Bank of the United States to establish an energy portfolio focused on providing financing for civil nuclear energy projects in certain identified foreign countries.

Key Takeaways for the Nuclear Industry

Although there has been motivation from within the nuclear industry to develop next-generation nuclear technologies for decades, Congress is increasingly supporting that motivation through new federal authorizations. This is a much-needed step on the path to reviving the domestic advanced nuclear industry, which has been hampered for decades by a variety of headwinds.

But Congress will need to do more than just continue to authorize transformational programs that align stakeholders' interests. It will need to fund those programs at meaningful levels through multiple administrations. And because the NRC must license next-generation technologies for commercial applications, Congress should continue to incentivize the NRC's ongoing efforts to develop regulatory processes that meet the business needs of both developers and licensees.

Such processes should include the development of a staged licensing framework that appreciates the many technologies that comprise next-generation nuclear, and the commercial realities regarding the development of those technologies. In turn, developers and licensees are encouraged to prioritize their activities consistent with recent Congressional mandates and funding, and to continue to coordinate with both the NRC and lawmakers regarding their priorities.

This coordination should be a part of a larger, industry-wide effort to understand and overcome threshold issues — such as the long-term availability of advanced nuclear fuels — consistent with the commercial realities that face developers and licensees. In addition, developers should to continue to work with Congress to explain the importance of the successes achieved as a result of congressional approvals and funding, and to cast those successes as a part of a larger, ongoing effort to develop advanced nuclear technologies.

With the U.S. Energy Information Administration projecting that world energy consumption will grow by 28% by over the next 20 years, the U.S. government's renewed interest in the development and deployment of next-generation nuclear technologies will likely be welcomed by developers and environmentalists alike.

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