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**Before the**  
**Subcommittee on Energy**  
**Committee on Science, Space and Technology**  
**U.S. House of Representatives**

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Chairman Weber, Ranking Member Grayson, and members of the Committee, thank you for your invitation to testify at today's hearing on the newly introduced *Nuclear Energy Innovation Capabilities Act* (H.R. 4084). I appreciate the Committee's interest in research and development (R&D) of advanced nuclear energy technologies. The Department of Energy (DOE) does not have a position on the legislation, but it is consistent with much of the work currently being done by DOE.

As has been noted before this committee in the past, nuclear energy continues to play a vital role in the President's energy strategy for a sustainable, clean energy future. Nuclear energy has provided nearly 20 percent of electrical generation in the United States over the past two decades and currently produces nearly 60 percent of America's carbon-free electricity. As a deployable power source with a high capacity factor, nuclear power is a promising option for low-carbon baseload power. As the United States leads the global transition to a low-carbon economy, the continued development of new and advanced nuclear technologies, along with support for currently operating nuclear power plants, is an important component of our clean energy strategy. Investing in the safe and secure development of nuclear power also helps advance other vital policy objectives in the national interest, such as maintaining economic competitiveness and job creation, as well as enhancing nuclear nonproliferation efforts, nuclear safety and security, and energy security.

To ensure that nuclear energy continues to provide affordable, carbon-free power, DOE's Office of Nuclear Energy (NE) focuses its programs to: improve the reliability and performance, sustain the safety and security, and extend the life of current reactors by developing advanced technological solutions; meet the Nation's energy security and climate change goals by developing technologies to support the deployment of economically competitive advanced reactors; improve energy generation, waste management, safety, and nonproliferation attributes by developing innovative nuclear fuel cycles; maintain key infrastructure to support cutting edge research on nuclear technologies; and advance U.S. civil nuclear energy priorities and objectives through international collaboration.

In the mission section of the proposed *Nuclear Energy Innovation Capabilities Act*, the Secretary of Energy is directed to "conduct programs of civilian nuclear research, development, demonstration, and commercial application," and six specific objectives are identified: (1) Providing research infrastructure to promote scientific progress and enable users from academia, the National Laboratories, and the private sector to make scientific discoveries relevant for nuclear, chemical, and materials science engineering; (2) Maintaining National Laboratory and university nuclear energy research and

development programs, including their infrastructure; (3) Providing the technical means to reduce the likelihood of nuclear weapons proliferation and increasing confidence margins for public safety of nuclear energy systems; (4) Reducing the environmental impact of nuclear energy related activities; (5) Supporting technology transfer from the National Laboratories to the private sector, and (6) Enabling the private sector to partner with the National Laboratories to demonstrate novel reactor concepts for the purpose of resolving technical uncertainty associated with the aforementioned objectives. This mission and these objectives are all consistent with the focus of NE's programs.

## **OFFICE OF NUCLEAR ENERGY PROGRAMS**

NE's current research programs focus on four general areas: maintaining the current fleet, performing R&D for advanced reactor technologies, developing sustainable fuel cycles, and investing in infrastructure. The work performed in these areas move forward the objectives in the proposed Act.

### **The Current Fleet**

One of NE's key programs, Light Water Reactor Sustainability (LWRS), addresses challenges facing the continued safe and economic operation of the current fleet. NE works in conjunction with industry and, where appropriate, with the Nuclear Regulatory Commission (NRC) to support and conduct the long-term research needed to inform major component refurbishment and replacement strategies for the current fleet. These areas include performance, cyber security, and safety; as well as, long-term operations through plant license extensions.

Research performed under LWRS supports utilities seeking to operate nuclear power plants beyond 60 years. A marker of the success for this program was demonstrated last month when the first U.S. utility notified the NRC of its intent to file a second license renewal to extend operation to 80 years.

### **Licensing and Construction of Nuclear Reactors in the United States**

Licensing and construction of new nuclear reactors are critical to meeting our clean energy future. In October, the NRC issued the operating license for Tennessee Valley Authority's Watts Bar Unit 2. This will be the first U.S. reactor to be completed this century. Additionally, construction of the first new nuclear plants in this country in more than 30 years continues for four new units, two at Plant Vogtle in Georgia and the other two at VC Summer in South Carolina. Both projects are deploying the NRC-certified, Generation III+ Westinghouse AP1000 – a new generation of passively safe reactors. Together, these newly constructed units will provide enough reliable, zero-emission, baseload electricity to power three million homes in the Southeastern United States.

Further headway has also been made with GE-Hitachi Nuclear Energy's Economic Simplified Boiling Water Reactor (ESBWR). ESBWR is a 1,600-megawatt reactor, which includes passive safety features that would cool the reactor after an accident. Earlier this year, the NRC issued the first combined license for an ESBWR for potential deployment in Michigan.

If the Nation's climate goals are to be realized, nuclear energy has to continue to be a component of the Nation's energy portfolio and barriers to the further deployment of new nuclear plants must be

overcome. Impediments to further plant deployments, even for designs based on familiar Light Water Reactor (LWR) technology, include the substantial capital cost of new plants and the uncertainties in the time required to construct those plants.

A high priority of the Department is to accelerate the timeline for commercialization and deployment of small modular reactor (SMR) technologies through the SMR Licensing Technical Support (LTS) program. The SMR LTS program is a six-year, \$452 million initiative focused on first-of-a-kind engineering support for design certification and licensing activities for SMR designs through cost-shared arrangements with industry partners to promote accelerated commercialization of the nascent technology. SMRs have the potential to achieve lower upfront capital cost, modular power additions, and simpler, predictable and faster construction than other designs. The Department believes strongly that SMRs can promote American competitiveness, create manufacturing jobs here at home, and reduce CO<sub>2</sub> emissions through clean, safe, and reliable nuclear power. These new SMRs, as well as the AP1000 and ESBWR reactors, are designed with passive safety features to minimize any requirement for prompt operator action and to prevent auxiliary system failures.

The Department has entered into cost-shared agreements with industry. Most recently, DOE signed a cooperative agreement with NuScale Power in May 2014, providing funds to support design development and NRC design certification with deployment scheduled for the 2025 timeframe.

### **Research and Development for Advanced Reactor Technologies**

Future-generation reactor systems may employ advanced technologies and designs to improve performance beyond what is currently attainable. More advanced reactor designs with coolants other than light water, often referred to as Generation IV designs, may enable reactors to operate at higher temperatures and with increased efficiencies – resulting in improved economics. These designs may also provide expanded fuel cycle options that can inform future policy decisions. Continued R&D in this area is essential for the long-term prospects of nuclear energy.

The Department's advanced reactor program performs research to develop technologies and subsystems that are critical for advanced concepts that could dramatically improve nuclear power performance through the achievement of goals related to sustainability, economics, safety, and proliferation resistance. Advanced reactor technologies considered in this program reside at different technology maturity levels with R&D efforts mainly focused on three advanced concepts: liquid metal-cooled fast reactors, including sodium-cooled fast reactors (SFRs); fluoride salt-cooled high-temperature reactors (FHRs); and high-temperature gas-cooled reactors (HTGR).

The Department of Energy has issued several awards over the past few years to support cost-shared R&D activities with industry totaling \$16.5 million in federal funding. These projects are addressing significant technical challenges to further the design, construction, and operation of next generation nuclear reactors, based upon the R&D needs identified by industry designers and technical experts. In many cases, new technologies are being developed to enable these advanced reactor designs.

The Department has also initiated studies on how to optimize the integration of nuclear energy and variable renewable energy sources through collaboration between the Offices of Nuclear Energy and Energy Efficiency and Renewable Energy. These studies will not only examine integration of current light water reactor technology, but also advanced reactor technologies that have the potential to provide high temperature process heat in addition to higher efficiency electricity.

For the past ten years, NE has conducted research on supercritical carbon dioxide (sCO<sub>2</sub>) Brayton cycles for use with advanced reactor concepts. Recent efforts to demonstrate this transformational energy conversion technology have been proposed in the Supercritical Transformational Electric Power (STEP) Generation Initiative which is being funded predominantly by the Office of Fossil Energy. Fossil Energy is intent on developing a directly fired supercritical CO<sub>2</sub> system which can significantly reduce the costs of carbon capture and storage (CCS). STEP will advance this technology by developing a 10-megawatt demonstration facility under a cost-share with industry.

### **Investing in Research and Development Infrastructure**

As noted in the proposed legislation, investments in the infrastructure to support advancement of nuclear technology are critical. Research, development, and demonstration programs are dependent on an infrastructure of experimental and computational facilities, access to critical materials and data, and highly trained scientists and engineers dedicated to meeting the needs of the Nation. The Nation's nuclear research, development, and demonstration infrastructure needs to incorporate a broad range of facilities, from small-scale laboratories to hot cells and test reactors. Computing facilities ranging from desktop workstations to parallel processors and supercomputers are routinely employed to gain new insights and guide experiment design. The high cost of creating and maintaining physical infrastructure for nuclear energy-related activities, including the necessary safety and security infrastructure, requires close alignment of infrastructure planning with programmatic needs to ensure capabilities are planned, maintained and available to support NE missions. To enable and facilitate R&D activities, NE's Idaho Facility Management program maximizes the utility of existing facilities and capabilities through focused sustainment activities and cost-effective rehabilitation.

Concurrent with these efforts to maximize the effectiveness of the established infrastructure, additional investments are being made to achieve further progress in advanced nuclear technologies. NE is currently focusing investments on reestablishing a domestic transient testing capability with the Transient Reactor Test Facility (TREAT) at INL. This capability will enable nuclear energy researchers and technology developers to understand fuel and material performance at the millisecond to second time scale as well as provide a capability to screen advanced concepts, including accident tolerant fuels, which allows for early identification of the limits of performance.

### **Nuclear Energy University Programs**

Like the proposed legislation, DOE has recognized the importance of investing in the next generation of nuclear energy leaders and advancing university-led nuclear innovation. Since 2009, these needs have been addressed primarily through the Nuclear Energy University Programs (NEUP). NEUP engages U.S. colleges and universities to conduct research and development, enhance infrastructure, and support

student education, thereby helping to sustain a world-class nuclear energy and workforce capability. Since 2009, NEUP has awarded over \$400 million to 104 colleges and universities in 39 states and the District of Columbia to advance nuclear energy innovation while training the next generation of nuclear engineers and scientists in the United States.

## **PROPOSED LEGISLATION**

The proposed legislation identifies three specific requirements for DOE to address in the areas of High-Performance Computation and Supportive Research, a Versatile Neutron Source, and Enabling Nuclear Energy Innovation. NE programs are currently addressing these three critical areas.

The Consortium for Advanced Simulation of Light Water Reactors (CASL), a DOE Energy Innovation Hub centered at Oak Ridge National Laboratory, was established to provide leading edge modeling and simulation (M&S) capability to improve the performance of currently operating light water reactors. This successful program has now expanded beyond operating reactors to support M&S for SMRs. Additionally, the Nuclear Energy Advanced Modeling and Simulation (NEAMS) program is addressing M&S needs for nuclear fuels and advanced nuclear reactors. As these tools are developed and integrated, NEAMS will be able to provide nuclear technology designers with a truly predictive capability that spans from the fuel pellets to the entire plant to better predict the performance, reliability and economics of advanced nuclear power plants.

With respect to a new versatile neutron source, DOE is evaluating the potential need for a new research reactor capability. To support the development of advanced reactor technology options, the Department has undertaken a study to determine the needs of the advanced nuclear reactor community and to develop options, including the key features and timing for a possible advanced test or demonstration reactor to support research, development and demonstration and eventual commercialization of advanced reactor systems. This study, being conducted with the assistance of industry, universities, and the National Laboratories, has included outreach and meetings with key stakeholders. The Nuclear Reactor Technology Subcommittee of the Nuclear Energy Advisory Committee (NEAC) has provided input, advice, and oversight to the process being used to conduct the study. The study will also include an examination of siting requirements, licensing options, international capabilities/partnering opportunities, human capital development, and U.S. leadership. It is our intention to complete the study by April 2016, so that it can be reviewed by the full NEAC during its June 2016 meeting, and ultimately used to inform future actions.

Finally, with respect to enabling nuclear energy innovation, NE identified that improvements can be made to accelerate the innovation of nuclear technologies. To further enable this goal, NE launched the Gateway for Accelerated Innovation in Nuclear (GAIN) during last month's White House Summit on Nuclear Energy. GAIN will provide the nuclear energy community with access to the technical, regulatory, and financial support necessary to move new and advanced nuclear energy technologies toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet. GAIN will provide the nuclear community with a single point of access to the broad range of resources – people, facilities, materials, and data – across the DOE complex and its

National Lab capabilities. Focused research opportunities and dedicated industry engagement will also be important components of GAIN, ensuring that DOE-sponsored activities are impactful to companies working to realize the full potential of nuclear energy. The response of the nuclear community to the GAIN program announcement has been enthusiastic. GAIN serves as the nuclear energy component of the Clean Energy Investment Center in DOE's Office of Technology Transitions, and INL is serving initially as the GAIN integrator for NE.

## **CONCLUSION**

Nuclear energy is a vital component of the U.S. clean energy strategy. The programs of DOE's Office of Nuclear Energy support many aspects of this important energy source, from reactors, to used fuel management, to infrastructure, and the next generation of engineers and scientists. NE strives to ensure both the current fleet and advanced technologies are available to meet the Nation's energy security and clean energy needs. In a manner that is consistent with the proposed *Nuclear Energy Innovation Capabilities Act*, the Department is performing research and development to move forward advanced nuclear energy technology and is engaging the broader nuclear community, including industry and universities. Additionally, DOE is maintaining and adding to the available infrastructure to enable this work while also working to make it more accessible to support nuclear innovation through the Gateway for Accelerated Innovation in Nuclear.

Chairman Weber, Ranking Member Grayson and members of the Committee, thank you for inviting me to discuss this legislation, and the work that the Department and the Office of Nuclear Energy are currently doing. I would be happy to answer any questions.

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