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BEFORE THE U.S. SENATE COMMITTEE ON ENERGY & NATURAL RESOURCES

"*Hearing to Examine the Status of Advanced Nuclear Technologies*"

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EXECUTIVE SUMMARY

- Nuclear power is a leading source of affordable, reliable, clean, American energy that powers our economy, protects our national security, preserves the environment, provides high-paying jobs for thousands of our fellow citizens, and generates substantial tax revenue for local, state, and federal governments. Our nation's current fleet of nuclear reactors is aging and will eventually need to be replaced with new reactors in order to ensure that nuclear power—an emission-free source of electricity—will continue to provide a significant share of America's electricity needs. New reactors also provide a valuable option for replacing other retiring electric generating units and for meeting energy demand growth.

- Southern Company is proud to lead the nation by constructing two first-of-a-kind, "Generation III+" nuclear units at the Vogtle Electric Generating Plant near Augusta, Georgia. Taken together, these state-of-the-art Westinghouse AP1000 units are projected to supply over 2,200 megawatts (MW) of new, baseload, zero-emission electric generation, creating more than 5,000 total construction jobs and over 800 permanent jobs.

- Even as we make significant progress toward commercial deployment of Generation III+ reactors, we are already exploring the next generation of nuclear technologies known as "Generation IV" (or "Gen-IV") reactors. On January 15, 2016, the Department of Energy (DOE) selected a Southern Company-led proposal as one of two recipients of approximately $6 million for this year (up to $40 million over the next five years) to explore, develop, and demonstrate advanced nuclear technologies. With non-federal cost-share contributions, this project represents up to $80 million in new advanced reactor research. Our partners in this public-private partnership are TerraPower, Oak Ridge National Laboratory (ORNL), the Electric Power Research Institute, and Vanderbilt University. We believe Gen-IV advanced reactors will build on the Gen-III+ advantages, with even more advanced safety systems, less byproduct materials, and greater cost efficiencies. Advanced reactors will also serve as a source of process heat for various industrial applications.

- Innovation and technology are engines of American greatness. Demonstration of advanced reactors by 2025 and commercial deployment in the 2030-2035 timeframe are ambitious yet achievable goals. This mission will require public-private collaboration, resulting in innovative policies, licensing frameworks, and regulatory structures that facilitate the efficient and predictable deployment of these new technologies and encourage private investment. As a range of technology options is explored, we will advocate for and encourage industry-led collaboration with DOE, vendors, utilities, universities and national labs to leverage capabilities and share some of the risks.

- Bringing advanced reactor technology to market will take a level of effort and commitment well beyond the status quo but the benefits to the American public, in terms of national security, global leadership and economic competitiveness, development of high paying jobs, and the environment, are immense and justify this Committee's close consideration of steps that the federal government can take to support these endeavors.

Good morning Chairman Murkowski, Ranking Member Cantwell, and Members of the Committee. Thank you for the opportunity to appear before you today.

My name is Steve Kuczynski, and I am the Chairman, President and CEO of Southern Nuclear Operating Company, Inc., where I am responsible for the operation of a fleet of six nuclear power reactors at three sites as well as the construction of two new reactors at Plant Vogtle near Augusta, Georgia. It is an honor to appear before this Committee to share my views on nuclear energy innovation and advanced nuclear technologies, an area that is pivotal to our nation's future and worthy of this Committee's interest and attention. I currently serve as chairman of the Advanced Reactor Working Group (ARWG), an initiative of the Nuclear Energy Institute (NEI) charged with developing an industry vision and execution strategy for a long-term sustainable program that will result in the development and commercialization of advanced reactors. An ambitious goal of the ARWG is to achieve demonstration of multiple advanced reactors by 2025 and commercial deployment in the 2030-2035 timeframe.

During my career, I have been responsible for a wide range of disciplines at nuclear power plants—from safety, training and emergency preparedness to radiation protection, operations, and construction. In my testimony today, I will discuss Southern Nuclear's fleet of nuclear power plants, including the ongoing construction of our two newest reactors. I will also share my personal perspectives on advanced nuclear reactors and the merits of continued governmental and private sector interest and investment. While other co-panelists represent the views of the entities designing and selling advanced reactors, my vantage point is that of an ultimate end-user of these technologies. I appreciate that the Committee has sought to hear from both views this morning.

Southern Nuclear

Headquartered in Birmingham, Alabama, Southern Nuclear is a subsidiary of Southern Company, the nation's premier energy company serving the Southeastern United States through its subsidiaries. Southern Company is a leading U.S. producer of clean, safe, reliable and affordable electricity. Southern Nuclear currently operates six nuclear reactors: Units 1 and 2 at Plant Farley near Dothan, Alabama; Units 1 and 2 at Plant Hatch near Baxley, Georgia; and Units 1 and 2 at Plant Vogtle near Augusta, Georgia.[1] We have been in the nuclear power business for almost 50 years, dating back to Southern Company's decision in 1967 to build Plant Hatch, our very first nuclear power plant, which began commercial operation in 1975. Together, Plants Farley, Hatch and Vogtle provide approximately 20% of the electricity used in Alabama and Georgia. This is made possible by our talented and committed workforce of over 4,000 men and women working at our power plants and corporate offices, who are also part of the larger Southern Company team of over 26,000 employees across the States of Alabama, Florida, Georgia, and Mississippi.

[1] Plant Farley is owned by Alabama Power Company. Plants Hatch and Vogtle are co-owned by Georgia Power Company, Oglethorpe Power Corporation, the Municipal Electric Authority of Georgia, and Dalton Utilities.

Nuclear power is a leading source of affordable, reliable, clean, American energy that powers our economy, protects our national security, preserves the environment, provides high-paying jobs for thousands of our fellow citizens, and generates substantial tax revenue for local, state, and federal governments. As a proud corporate citizen of the communities where we operate, Southern Nuclear's top priority is the safety and health of the public and our employees. We are committed to the safe operation of our nuclear generating facilities with equipment and systems that meet rigorous safety and design regulations. Plants Farley, Hatch and Vogtle are national leaders in safe operation and reliability with an average three-year fleet capability factor of 92.4% from 2013 to 2015, which exceeded the national average of 90.3% for the same period.[2] The U.S. Nuclear Regulatory Commission's (NRC) annual assessment for 2015 concluded that our nuclear power plants met all of the NRC safety and security performance objectives. With increasing focus on reducing emissions of carbon dioxide (CO_2), we are proud that our existing fleet of nuclear reactors prevents more than 56 million metric tons of CO_2 from entering the atmosphere, which is the equivalent of taking 10 million cars off the road—more than the number of cars registered in Alabama and Georgia, combined.

We are in the business of generating safe, clean, reliable and affordable energy through a relentless focus on safety, a culture of continuous improvement and innovation, and a commitment to providing value to our customers. Innovation is a central part of our strategy to achieve these objectives. Innovation and technology are engines of American greatness. It is within this context that Southern Company is investing in advanced reactor technology research and development and looking ahead toward the steps needed to promote the licensing, construction and utilization of these technologies.

Delivering the Current Generation of Nuclear Power

Southern Company supports an "all of the above" energy policy and strategy that balances the goals of clean, safe, reliable, and affordable energy and provides a full role for renewables, energy efficiency, new nuclear, 21st century coal, and natural gas. This approach necessitates strong investment in the future of nuclear power.

Nuclear energy provides approximately 20% of our nation's electricity needs and represents over 60% of our nation's emission-free generation. In 2014, nuclear energy facilities prevented 594 million metric tons of carbon dioxide emissions, the equivalent of taking 135 million cars off the road. Furthermore, the current nuclear fleet provides a substantial economic benefit to the country. The average nuclear power plant pays approximately $16 million in local and state taxes and $67 million in federal taxes a year, and provides thousands of high-quality, permanent jobs in their communities and significantly impact the local economies.

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[2] *See* Fourth Quarter 2015 Data File, World Ass'n of Nuclear Operators (on file with Southern Nuclear Operating Company, Inc.). Capability factor measures the amount of time the plant is on-line and producing electricity. For more information about the nuclear industry's 2015 performance measures, please visit http://www.nei.org/News-Media/Media-Room/News-Releases/Nuclear-Power-Plants-Set-Records-for-Safety,-Opera.

Wind and solar generation are making important contributions to the nation and will continue to do so, but nuclear power retains qualities that other emission-free generation sources do not possess. Nuclear energy's high capacity factor makes it perfectly suited for baseload power—the generation required to meet the minimum level of constant, continuous electricity demanded by electricity customers. Adequate baseload power helps to ensure grid stability, voltage control, and other features essential to reliably powering our economy. Renewables are intermittent sources of power that cannot provide the 24/7, baseload power that nuclear energy has consistently provided for decades. In addition, in order to generate an amount of electricity equal to that of a nuclear reactor, solar and wind plants demand a much larger footprint. Consider these facts: a 1,000-megawatt (MW) nuclear power plant requires just over one square-mile of land; to generate the same amount of power, a wind facility requires anywhere from 260 to 360 square-miles and a solar facility requires 45-75 square-miles.[3]

However, the current fleet of nuclear reactors is aging and will inevitably need to be replaced with new reactors in order for nuclear power to continue to provide a significant share of the nation's electricity needs and a majority of its emission-free generation. According to the Energy Information Administration, the nation will need over 285 GW of new electricity capacity by 2040. Nuclear reactors remain the best, cleanest, safest, and most reliable form of baseload electric generation to meet these energy needs. Additionally, the U.S. Environmental Protection Agency (EPA) has repeatedly acknowledged nuclear power's important contribution to achieving environmental goals.

Congress, too, has consistently endorsed a central role for nuclear power in our energy policies. The Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 sought to expand the commercial utilization of nuclear energy in the United States, while also reducing CO_2 emissions and ensuring affordable, reliable, and clean domestic energy for Americans. These laws were a catalyst for the construction of new reactors like those at Plant Vogtle Units 3 and 4. Federal policies have often wisely centered on incentivizing nuclear power and ensuring an efficient regulatory approval process. This has included essential loan guarantee programs, licensing reforms, and a host of other measures. Our state partners also recognize the pivotal role that nuclear power should play in our energy future.

Southern Company is proud to lead the nation by constructing first of a kind nuclear units at Plant Vogtle. Taken together, these state-of-the-art Westinghouse AP1000 units are projected to supply over 2,200 MW of new, baseload, zero-emission electric generation, creating more than 5,000 total construction jobs and 800 permanent jobs. These are some of the first new nuclear units to be built in the United States in over 30 years. The Vogtle site is among the largest ongoing construction projects in the United States. This is a joint effort with our power plant ownership team, which includes Georgia Power Company, Oglethorpe Power Corporation, Municipal Electric Authority of Georgia, and Dalton Utilities, and a construction team consisting of Westinghouse Electric Company LLC and WECTEC Global Project Services Inc. (formerly CBI Stone & Webster, Inc.). Throughout the duration of this construction project, just as with the

[3] Nuclear Energy Institute, "Land Needs for Wind, Solar Dwarf Nuclear Plant's Footprint," (July 9, 2015), available at http://www.nei.org/News-Media/News/News-Archives/Nuclear-Power-Plants-Are-Compact,-Efficient-and-Re

operation of our existing plants, safety always comes first. We remain focused on completing Vogtle Units 3 and 4 with safety, quality, and compliant construction as top priorities. We will not compromise. Similarly, South Carolina Electric & Gas Company is also demonstrating national leadership by constructing two AP1000 units at the Summer Nuclear Station.

Nuclear energy already has tremendous advantages over other forms of electric generation: zero emissions, capacity factors exceeding 90%, safety records that exceed those of other energy sources, as well as affordability over the long term without the price swings common to other fuels. The AP1000 design adds even more layers of safety redundancies and with a simplified plant design, the AP1000 is less expensive to build, operate and maintain. This includes substantially fewer valves, pumps, piping, building volume, and cable compared to earlier-generation nuclear plants.

Delivering the Next Generation of Nuclear Power

Even as we move toward commercial deployment of "Generation III+" reactors like the AP1000 at Plant Vogtle, we are already exploring the next generation of nuclear technologies known as "Generation IV" (or "Gen-IV") reactors. On January 15, 2016, DOE selected a Southern Company-led proposal as one of two recipients of approximately $6 million for this year (up to $40 million over the next five years) to explore, develop, and demonstrate advanced nuclear reactor technologies. With non-federal cost-share contributions, this project represents up to $80 million in new advanced reactor research. Our partners in this public-private partnership are TerraPower, Oak Ridge National Laboratory (ORNL), the Electric Power Research Institute, and Vanderbilt University. This project will bolster the development of molten chloride fast reactors (MCFR), an advanced concept for nuclear generation under development by TerraPower. As a company, we are proud to be afforded this opportunity and we look forward to seeing additional collaboration to strengthen this partnership through delivering results for our partners, DOE, and the American taxpayer. In addition to the MCFR, we are also assisting in the development of modern Prismatic Block High Temperature Gas Cooled Reactor (HTGR) technologies, which are expected to be significantly more efficient than current operating reactors. Lead-Cooled Fast Reactors, Sodium-Cooled Fast Reactors, Supercritical Water-Cooled Reactors, and other kinds of non-light water reactor technologies are being considered in the United States or abroad.

While Southern Company has not made any commitments toward construction of power plants with MCFR, HTGR, or other advanced reactor technologies, the potential for Gen-IV reactors is enormous. We believe these reactors will build on the Gen-III+ advantages, with more safety systems, less byproduct materials, and greater cost efficiencies. Many of the anticipated advantages to Gen-IV reactors are summarized below in Table 1.

Table 1. Summary of Potential Advantages to Gen-IV Advanced Reactors.

Advantages	Description
More Efficient	Designs are expected to generate more than 100 times the energy yield of current reactors using the same amount of fuel. Operation at high temperatures allows for the generation of process heat to support other industrial operations.
Less Byproduct	Numerous designs have the ability to consume existing used fuel, thereby reducing storage capacity needs.
Zero Emissions	Like existing reactors, Gen-IV reactors will produce no air emissions.
Enhanced Safety Features	While the nation's existing fleet of nuclear reactors is operating safely today, Gen-IV reactors will have increased safety features that far exceed NRC requirements for today's reactors. In fact, with some designs, there is a potential for reduced, or even eliminated, emergency planning zones. Many operate at low pressure and utilize fuels that cannot melt. Simpler designs require fewer components and are less prone to failure. Passive core protection functions can cool the reactor for days at a time without the need for off-site power. Non-water coolants reduce the risk of a loss of coolant accident.
Smaller Footprint	With fewer components, advanced designs take up even less land than the already compact designs of current reactors.
Lower Cost	Simpler designs allow faster, lower cost of construction. Because there is less waste, storage costs are reduced dramatically.
Fuel Diversity	Capable of using a broader range of fuel types including raw fuels that may not require an expensive enrichment process.
Scalable	Can be constructed in varying sizes from diesel generator replacement size to larger than those in the current nuclear fleet. Can adjust output to meet variable demands or supplement intermittent renewables.
Global Leadership & Competitiveness	Gen-IV reactors will further demonstrate the leadership position of the United States in advanced nuclear energy technologies and will enhance our nation's competitiveness in the global economy.

As this information demonstrates, Gen IV reactor technologies build on the advantages of the nation's existing nuclear reactor fleet and provide benefits that make it essential for us to evolve these technologies.[4] With these advantages and features, the U.S. military would also likely find advanced reactor technologies to be promising especially as the nation explores ways to equip and power a lighter, more mobile fighting force. Moreover, advanced reactors will also serve as a source of process heat for various industrial applications such as desalinization, oil refining, and hydrogen production.

In addition to the work we are doing with Gen-IV reactors, Southern Nuclear is also engaged with the industry's efforts to bring small modular reactors (SMRs) to market. In January of this year, Southern Nuclear and several other leading developers and potential customers announced a memorandum of understanding establishing a consortium called "SMR Start," which is designed to help accelerate SMR commercialization.

Innovation Requires Collaboration

As all of these potential technologies are explored, the federal government should support advanced reactor programs without picking the ultimate winners or losers. Innovation requires competition. Within our own company, we take great pride in our culture of innovation and desire for step-up performance improvement in all facets of our business. We also believe that our federal government partners have the capability to create the right environment for innovation in the nuclear technology arena to flourish. This includes public-private partnerships that can harness the power of collaboration.

A shining example of productive collaboration leading to continuous state-of-knowledge improvement is flying above us every day. The International Space Station (ISS) is a truly international scientific and technological collaboration. It orbits the Earth once every 90 minutes, seeing 16 sunrises and sunsets daily. The ISS has been continuously inhabited since 2000 by crews of three to six people from 15 different countries, involving collaboration of five different space agencies representing the United States, Canada, Russia, Japan, and Europe, with the European Space Agency funding coming from 11 European countries.

In much the same way, we cannot achieve sustainability in innovation by ourselves. Collaboration at the private sector, governmental, academic, and international levels will be key to achieving demonstration of advanced reactors by 2025 and commercial deployment in the 2030-2035 timeframe, an effort that will entail creation of innovative policies, licensing frameworks, and regulatory structures that facilitate the efficient and predictable deployment of these new technologies and encourage private investment. I believe it will also require our federal partners to share the cost of state-of-the-knowledge improvements. DOE, universities, vendors and our centers of knowledge will need to leverage the best talent our nation has to offer.

[4] For a more comprehensive list of North American Advanced Reactor Projects, please see the June 15, 2015 report, *The Advanced Nuclear Industry*, prepared by Third Way, available at www.thirdway.org/report/the-advanced-nuclear-industry.

Likewise, public-private partnerships are, in the context of advanced reactors, uniquely necessary as these technologies are subject to an extensive regulatory regime requiring complex technical work to assure regulators and the public of the safety of these new reactors. These endeavors also require new fuel types to be developed and tested, and supply chains for new kinds of equipment to evolve and mature. In addition, it will be necessary to design and test prototypes and, ultimately, a first of a kind commercial reactor will have to be designed, approved, constructed and operated. We are already seeing increased private sector investment in proposed new reactor startups and systems reaching, by some estimates, more than $1 billion.[5] Nonetheless, because of the expense, regulatory uncertainty and timeframes involved, continued public sector investment will be necessary to make the leap from the laboratory to commercial deployment.

Additionally, as was true in the early days of nuclear technology development, we must work with our national labs to safeguard the nation's significant investments in nuclear technology, ensure we remain the world leader in this area, and demonstrate newer, more advanced nuclear technologies. I greatly appreciate the testimony offered today by Dr. Mark Peters of the Idaho National Lab which, as DOE's lead Nuclear Energy Laboratory, is doing phenomenal work in the area of nuclear energy technologies.

I would also highlight the Oak Ridge National Laboratory (ORNL), home to Alvin Weinberg and Admiral Hyman G. Rickover, both pioneers in the development and use of nuclear energy. ORNL has established itself as an influential leader in the advancement of nuclear technology. Southern is proud to be partnering with ORNL for the DOE-awarded research project involving molten chloride fast reactor technology and we commend ORNL's role in supporting the use of nuclear technology for the nation's security as well as commercial interests. ORNL's efforts over many decades have resulted in development and operation of 13 nuclear reactors. Using nuclear energy for a host of applications, from fueling commercial nuclear power plants to powering nuclear submarines, ORNL has demonstrated the power of nuclear energy to protect national security and to drive economic growth. We salute ORNL's achievements and its commitment to build on Alvin Weinberg's "notion of a laboratory whose mission evolves and strengthens over time."[6]

In fact, the vision for the Molten Salt Reactor (MSR) technology was originally developed at ORNL. This technology, regrettably dismissed many decades ago for political and other reasons, is now benefitting from renewed national and international interest. MSR technology would have passive safety features to ensure safe operation without human or mechanical intervention, a considerably smaller nuclear waste profile, more efficient fuel use, and lower construction costs. As a range of technology options are explored, we will advocate for and encourage industry-led collaboration with DOE, vendors, utilities, universities and national labs to leverage capabilities and share some of the risks.

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[5] Third Way, *The Advanced Nuclear Industry* (June 15, 2015), available at http://www.thirdway.org/report/the-advanced-nuclear-industry.

[6] Oak Ridge National Laboratory, *History*, available at https://web.ornl.gov/ornlhome/history.shtml.

Modernizing the Licensing Framework for Advanced Reactors

A common element of all discussions about advanced reactors is the need to modernize the licensing framework to accommodate different kinds of reactors.[7] Our current regulatory framework for the licensing of nuclear power plants has its roots in the federal government's initial efforts to promote commercial nuclear power after the passage of the Atomic Energy Act of 1954 (the "AEA") when the Atomic Energy Commission ("AEC") began to encourage the development of commercial nuclear power production in the private market. The federal government helped spur innovation and investment in nuclear power production through research and development efforts such as test reactors and laboratories that would eventually share information with the private nuclear power industry. At the same time, the federal government provided economic assistance to those private companies willing to take the first steps to construct and license nuclear power plants. The AEC and the private sector researched and experimented with several different types of reactors, including light-water reactors, salt-cooled reactors, and fast-breeder reactors.

Prompted by the backing of the AEC, the commercial nuclear power industry started to take shape, and the United States led the world in innovation as the nuclear industry grew rapidly throughout the 1960s. Eventually, the AEC and industry focused on light-water reactor technology, and the federal government's reactor licensing framework grew up around, and was molded to fit the needs of, light-water reactor designs, resulting in a workable licensing process in which the nuclear power industry could remain generally assured of the regulatory framework for its investment.

With the passage of the Energy Reorganization Act of 1974, the AEC was abandoned, and its dual functions of regulating the nuclear power industry while simultaneously promoting nuclear power were split among the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Administration (ERDA), respectively. In 1977, ERDA's functions were transferred to DOE, an agency deserving of credit for much of the innovation in commercial nuclear power after the passage of the Act. Most of DOE's nuclear facilities and programs are exempt from NRC regulation, allowing DOE to research and develop technologies that may otherwise remain unexplored. Consequently, much of the research and development in the nuclear power industry hinges on decisions of the federal government.

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[7] In a recent article, MIT professor Richard Lester articulates a vision for a "new roadmap for nuclear innovation in the United States," forecasting "three successive waves of advances" including: (1) a first wave breaking during the next decade that will enable extended operating lives for the nation's existing fleet of nuclear reactors; (2) a second wave occurring in the 2030-2040 timeframe, which he describes as a "critical period" for "rapid scale-up of nuclear energy"; and (3) a third wave occurring in the post-2050 period with even further advances. Lester, Richard K. "A Roadmap for U.S. Nuclear Energy Innovation." *Issues in Science and Technology* 32, no. 2 (Winter 2016). The kinds of actions and ideas that Dr. Lester suggests align fairly well with those that I and others in the industry believe are needed to facilitate nuclear innovation in America. In particular, his roadmap calls for changes within the NRC, an expanded role for the national labs, and further support of international collaboration at DOE and elsewhere. Dr. Lester also correctly cautions that it is "premature at this stage to attempt to identify a winner among all [types of nuclear] innovations…" I would commend Dr. Lester's article to this Committee for review and consideration.

As the NRC adopted the AEC's regulatory duties, it continued to implement the reactor licensing process adopted by the AEC that required a licensee to first obtain a construction permit and then an operating license at a later point in time. Throughout the 1970s and 1980s, utilities constructing nuclear plants struggled to complete projects on time and experienced cost overruns associated with evolving licensing requirements in the two-step process. These licensing inefficiencies were magnified by new requirements imposed in response to the Three-Mile Island accident in 1979. Eventually, the financial and regulatory risks associated with development of commercial nuclear power plants resulted in an effective moratorium on construction. Technical innovation across the nuclear power industry slowed markedly and the infrastructure for the manufacture of materials and components needed for the construction of new plants in the United States was severely diminished.

In an effort to mitigate these difficulties, the NRC developed a new, combined construction and operating licensing process, codified at 10 C.F.R. Part 52, which allowed for the resolution of design and environmental licensing requirements prior to the start of construction. The Part 52 process provides for as much regulatory oversight and ensures the safety of the public every bit as much as the old two-step approach but with more regulatory stability and predictability, which encourages investment in commercial plants. Once again, the actions of the federal government spurred new research and investment in nuclear reactor technologies. The Part 52 licensing process paved the way for the construction of new nuclear reactors utilizing new reactor technologies, such as the Westinghouse AP1000 reactor that will be in operation at Plant Vogtle Units 3 and 4. The Energy Policy Act of 2005 further stimulated investment in new nuclear reactor technology through federal incentives such as tax credits and loan guarantees. Because of regulatory improvements implemented by the NRC and other means of support from the federal government, the nuclear power industry in the United States stood on the brink of what many called the "nuclear renaissance."

Today, the nuclear power industry stands at yet another crossroads. Commercial nuclear power is expanding across the world yet the United States is not currently at the center of the technological innovation driving much of the expansion. While the Part 52 licensing process proved beneficial to the industry, the fact that it, like the initial two-step licensing process, is based on light-water reactor technology limits its efficacy for the licensing of Gen-IV reactors. The current regulatory framework with its inefficient, exemption-based licensing approach will be ineffective for licensing non-light water reactor technology. Current procedures would require potential investors to spend billions of dollars without a defined path for licensing a Gen-IV reactor. The NRC, in a 2012 report to Congress, outlined the need to develop a regulatory approach that "supports the unique aspects of advanced designs" and includes, among other things, "identifying policy, technical, and licensing issues" and "developing the regulatory strategies to support efficient and timely reviews" for advanced reactors.[8] The NRC specifically identified the need to streamline its application process by developing a "new, risk-informed, performance-based regulatory structure for non-LWR advanced reactor designs."[9] We agree.

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[8] *See* NRC, Report Congress: Advanced Reactor Licensing, at p. iv (August 2012), available at http://pbadupws.nrc.gov/docs/ML1215/ML12153A014.pdf.

[9] *Id.*

Likewise, the NRC recognized that an advanced reactor design that "uses fuel that differs significantly from the current [fuel] type (zirconium-clad, low-enriched uranium dioxide) will require the evaluation of technical and regulatory approaches to the licensing of fuel fabrication, transportation, storage, and waste disposal operations."[10] A modernized regulatory framework that effectively addresses the needs associated with licensing a non-light-water reactor will signal to the private sector that it can invest in research and development of advanced reactors knowing that the licensing environment does not favor a single technology, thereby allowing various kinds of technologies to be developed and licensed.

When developing a licensing framework that can work for advanced reactors, I would endorse the "triple A" approach. That is, where existing regulations are appropriate, "adopt" them; where simple changes are needed to modify existing rules in order to make them a better fit for advanced reactors, "adapt" them; and where the characteristics of advanced reactors require new regulatory structures and programs, "advance" them. In all respects, the NRC – as the safety regulator – should determine the required safety performance metrics, while the industry and its partners should focus, through consensus standards organizations, on developing the "how" to comply with performance standards and design requirements. By doing so, we can prevent stagnation in the development of advanced reactor designs and ensure that the newest, safest, and most efficient nuclear reactors will be built in the United States.

While the licensing framework is improved, Congress will be called upon to provide adequate funding for the NRC to fulfill its responsibility in this regard. As this Committee is aware, ninety percent of the NRC's budget is currently derived from industry fees charged primarily against the nation's fleet of existing reactors. Cost associated with funding advanced reactor licensing improvements and related activities should not be borne by existing reactors, and I would encourage Congress to consider robust funding of advanced reactor programs and activities.

Advanced Reactor Working Group (ARWG)

At the outset of my testimony, I mentioned NEI's Advanced Reactor Working Group, which has representatives from seven electric utilities and ten reactor design companies. Over the next 30 years, a significant amount of the existing generating capacity will be retired. The ARWG was created with the understanding that decisions as to what technologies will replace recent and upcoming nuclear reactor retirements will be made within the next 10-20 years. In the short- to medium-term, light water reactors will remain the dominant and most economic means of electricity production from nuclear energy, but decisions about future energy investments will most certainly take into account the contributions of advanced non-light water reactors.

With this reality in mind, the ARWG is charged with developing an industry vision of a sustainable program to support the development and commercialization of advanced reactors, ultimately with commercial availability in the 2035-2040 timeframe. Currently, the working group is focused on:

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[10] *Id.* at v.

(1) Developing, communicating, and implementing an industry strategic plan for the development and commercialization of advanced reactor technologies.

(2) Developing legislative proposals at the federal level to appropriately support development of advanced reactors.

(3) Identifying and proposing changes to the NRC licensing framework for advanced reactors.

(4) Establishing a demonstration program for construction and operation of multiple advanced reactor designs at a DOE site, or utility site, or a yet to be developed test center.

ARWG looks forward to serving as a resource to this Committee, DOE, and other stakeholders.

Recent Positive Steps by the Federal Government

The ARWG is not the only new entity focused on advanced reactors. We also applaud the Secretary of Energy's Advisory Board (SEAB) Task Force on the Future of Nuclear Power, which has recognized that nuclear power is an "important carbon-free power source for the U.S. and the world." The SEAB Task Force, which has been proactively engaging with the nuclear industry, sees the need to explore the kinds of nuclear reactors that should be deployed in the 2030-2050 timeframe. As an industry, we look forward to the Task Force's final report at the end of this year and reviewing their findings and recommendations for achieving technical milestones on advanced reactor designs, certification, engineering, prototype testing, licensing, and deployment.

Similarly, in November of last year, the Administration announced a new program called "Gateway for Accelerated Innovation in Nuclear" (GAIN), which is intended to "provide the nuclear energy community with access to the technical, regulatory, and financial support necessary to move new or advanced nuclear reactor designs toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet." A key element of the GAIN initiative is to provide all nuclear stakeholders with a "single point of access" to the array of federal assets and programs including the DOE complex and national labs. Whether Congress, DOE, the states, or at the international level, a consensus exists that nuclear power should have a central role in meeting the world's energy demands into the future.

In addition, the Blue Ribbon Commission (BRC) noted in its final report that the benefits of advances in nuclear energy technology justifies sustained public and private-sector support for research and development into advanced reactor and fuel cycle technologies. Furthermore, the BRC strongly recommended increased effort in developing a regulatory framework for advanced nuclear technologies to help guide design research and lower barriers to commercial investment by increasing industry confidence that advanced reactors can be effectively licensed.

Finally, I applaud Congress for its continued interest and support of advanced reactor initiatives. Members of Congress on both sides of the aisle have been working proactively to promote the next generation of nuclear power and substantial legislative progress has been made particularly in the last few months. For example, the House of Representatives recently passed the Nuclear Energy Innovation Capabilities Act (H.R. 4084), a bipartisan bill to support federal research and development and stimulate private investment in advanced nuclear reactor technologies. A similar bill, S. 2461, introduced by Senator Crapo, was approved by the Senate in January with overwhelming support as an amendment to the bipartisan energy bill (which was ultimately passed by the Senate on April 20, 2016). Most recently, Senator Inhofe, Chairman of the Senate Environment and Public Works Committee, introduced bipartisan legislation with Senators Booker, Crapo, and Whitehouse to support advanced reactor licensing and to reform the NRC's budget and fee structure. We are deeply grateful for the investment of time and resources that this Committee and others in Congress are putting into this important national priority.

I would also highlight the important decision that Congress made just last year to fund the DOE Advanced Reactor Concepts (ARC) program for FY2016, including funds for "continued development of two performance-based advanced reactor concepts."[11] ARC supports the "research of advanced reactor subsystems and addresses long-term technical barriers for the development of advanced nuclear fission energy systems utilizing coolants such as liquid metal, fluoride salt, or gas." We are pleased that the Senate and House Fiscal Year 2017 Energy and Water Appropriations bills both include funding increases for the ARC program. We recognize Senators Alexander and Feinstein for their leadership in making advanced nuclear technologies a funding priority in the FY2017 Energy and Water Development Appropriations bill.

Conclusion

Other nations are investing in nuclear technologies, and a key question is whether the United States will be the global leader in nuclear energy in the future as we have been in the past. Today, over 40% of the nuclear power plants under construction globally are located in China. With a significant civilian nuclear capability, Russia is also taking a close look at advanced reactors, and France and other European Union members are currently working on several other advanced reactor designs. Our nation should not cede nuclear innovation to others.

Decades ago, senators looked to Admiral Rickover for vision and expertise on the potential for civilian nuclear power. He once said: "We must live for the future of the human race, and not for our own comfort or success. We realize that continuous change is difficult; it takes us out of our comfort zone. But our future existence relies on change, and the most impactful change comes through innovation." With the current fleet of LWRs and operation of previous advanced test reactors, it took just a decade to progress from concept to commercial operation. This required innovation and collaboration. As we look ahead to Gen-IV reactors, I believe our nation has the knowledge and expertise to make this kind of technological progress in nuclear energy happen again. As before, innovation and collaboration will provide the keys to success.

Thank you for allowing me to appear before this Committee today. I will be glad to answer any questions you might have.

[11] *See* Explanatory Statement, Division D, at p. 29.