Senate Energy and Water Development Appropriations Testimony
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I'd like to thank Chairman Alexander, Ranking Member Feinstein, and other members of the Subcommittee for this opportunity to testify today. This subcommittee has continued to be a staunch supporter of nuclear innovation through initiatives such as the Advanced Reactor Concepts Program and initiatives for Small Module Reactor (SMR) research. I come to this discussion as an entrepreneur-turned-philanthropist-turned-energy policy advocate. After donating the money from the sale of my last company to create ClearPath Foundation, I developed a passion for better energy policy, and have been studying it with our expert policy team ever since. At ClearPath, we focus on accelerating conservative clean energy. We don't make any money at this, and so I hope that today I can contribute an independent perspective on nuclear energy policy.

Energy drives everything we do. Our businesses and households depend on reliable, affordable energy. And Americans increasingly expect cleaner energy sources to reduce environmental risks. However, as the saying goes, "What got us here, won't get us there."

We know how critical energy diversity is to reducing the risks of price spikes, supply shortages and natural disasters. We are now putting pressure on our energy system to modernize, and, while doing so, it is important that we maintain the diversity of our energy mix. Intermittent renewables such as wind and solar can be good additions to our energy supply. But unlike other energy sources, as their system penetration increases, costs rise rather than fall due to the burden of compensating for their intermittency. Greatly scaling up these intermittent resources requires expensive backup sources when the sun isn't shining or the wind isn't blowing. Germany has shown what happens: it's trying to both close its nuclear plants and dramatically increase solar and wind, a plan which has only raised electricity prices and increased reliance on inefficient lignite coal.

Nuclear remains our most reliable clean energy source. It is our clean energy workhorse, supplying almost 20 percent of our energy supply and more than 60 percent of our clean power. On average, the plants operate year-in, year-out at about 90 percent of their theoretical maximum (and 95 percent of the time during the extreme temperatures of winter and summer) – significantly higher than any other source of electricity. Fuel is a relatively small fraction of the cost of electricity produced by nuclear plants and is stored onsite. By comparison, fuel represents 80-90 percent of the cost of electricity from a gas-fired combined cycle plant, and gas supply can be interrupted during periods of extreme weather, when gas is diverted to homes and businesses.

A healthy nuclear industry is also vital to our national defense. Our preeminence in nuclear science and engineering allows us to lead globally on nuclear safety and nuclear weapons non-proliferation. Ceding that leadership to other countries is not in our national interest and could

prove to be dangerous. A robust domestic nuclear energy infrastructure and supply chain is vital to maintain global leadership.

However, since the 1980s, only four new reactor construction projects have been started in the US, all of them in the last five years. This drastically reduces our ability to deliver new projects affordably, given the complexity of building a large new nuclear power plant. The supply chain and experience base for new construction has been decimated by years of inactivity.

This factor, coupled with unusually cheap natural gas, subsidized renewables, and a complicated regulatory system make building more large light-water nuclear plants a difficult proposition – at best. Like all of our infrastructure, our existing fleet is aging. A number of them may retire prematurely in the coming years, in part due to the market distortions caused by highly subsidized wind generation, outdated price controls in the wholesale markets, and the painfully slow pace of new transmission build-out. Most of today's reactors will operate for at least 60 years. But this decline places our entire energy infrastructure and national security at risk and will almost certainly result in increased carbon emissions.

Despite these challenges, I believe that *nuclear should be between 30 and 40 percent of our electricity mix* if we are to maintain price stability, affordability, and reliability while greatly reducing emissions.

2040 is an aggressive but achievable goal for this level of penetration. Doing so requires three categories of actions: 1) support our existing fleet of nuclear power plants by removing the distortive, non-market barriers and disincentives; 2) reduce bureaucracy to enable substantial investment in the construction of new nuclear power plants using proven light water technology; and 3) accelerate and remove the obstacles to research, development and commercial deployment of a new generation of advanced nuclear energy technologies. This testimony focuses on that third pillar, aggressively moving forward with advanced nuclear energy technologies.

Increasing the amount of nuclear energy made in America by 2040 would require dozens of new reactors to be built in the late 2020s and 30s to replace some of our aging light-water reactors, to meet additional demand growth, and to gain market share. The speed and scale of this build-up cannot be accomplished with today's technologies: Advanced reactors are the answer to increase nuclear penetration and to preserve this critical industry. Before committing to those commercial projects, industry will need to participate in multiple demonstrations of advanced—mostly non-light water—reactors in the 2020s to prove out their feasibility and economics. Federal policy should embrace this goal and provide the support necessary to achieve it.

Forty to fifty years ago, when America was the world's innovator in the peaceful use of nuclear technology. We demonstrated many advanced nuclear power approaches beyond light water reactors. Recently, American nuclear entrepreneurs have dusted off, and begun to refine, these alternatives – designing reactors that most estimate will cost significantly less than the current

leading reactor from Westinghouse. There are now 44 companies and organizations working on advanced nuclear designs across America.

These concepts, some many years in the making, have attributes and can provide services beyond those available from today's large light-water reactors, including:

- Many can be built on an assembly line and delivered to the site, reducing construction costs and delays.
- Many can ramp up and down quickly, which complements the intermittency of renewables and variations in demand.
- Many of the concepts have passive safety features automatically halting a nuclear reaction if a malfunction occurs.
- Many are expected to have far lower operating costs.
- Many can recycle used fuel, and therefore potentially help deal with our nuclear waste problem.
- Many operate at low pressure, requiring a fraction of the concrete and steel associated with current pressurized reactors, at tremendous cost-savings.
- All excite the new generation of engineers desperately needed to replace an aging workforce and breathe life into the industry as a whole.

Given the extraordinary regulatory and financial hurdles faced by the nuclear industry, government can contribute in four areas to enable private sector investment:

First, it must create a rational regulatory environment for advanced nuclear.

The Nuclear Regulatory Commission's (NRC) overly conservative regulatory approach could squelch advanced nuclear efforts even before they get off the ground. The Commission is focused on traditional light-water reactors and is not prepared to oversee new technologies in an efficient and effective manner. As a result, some of our nuclear entrepreneurs are moving their development and testing overseas to countries that are eager to embrace these innovative technologies. We chronicled one such promising company, ThorCon, and its decision to move offshore to Indonesia. Recent leadership changes in the NRC's Office of New Reactors is a major step in the right direction, and we applaud this progress. However, reluctance by line reviewers to embrace new concepts and technologies could still scuttle entrepreneurial efforts. NRC's mission needs to be clarified to explicitly encourage advanced reactor licensing.

Recent legislation in Senate Bill 2795 and House Bill 4979 represent a step in the right direction by developing a potential framework that is staged, risk-informed, and performance based. The proposed budget to begin developing this separate regulatory pathway inside the NRC is only $5 million. We were pleased to see this money make it into the committee's markup earlier this year and hope the advanced licensing capacity at NRC continues its growth in the future.

Second, the government must provide a new framework that works with industry to set ambitious technology goals.

The Department of Energy's (DOE) continued support for SMR technology will help lay the groundwork for advanced reactor licensing. The DOE's recent draft goal of two advanced reactors licensed by 2030 as well as the Advanced Reactor Concepts (ARC) program to help achieve that goal have started us in this direction. Considering the need to demonstrate multiple technology pathways (as some will fail), we can surely do better than our current goal. Some advanced reactor developers are also planning construction for the mid-2020's, which is faster than the current 2030 licensing expectation. While a step in the right direction, the $2 million in Gateway for Accelerated Innovation in Nuclear (GAIN) vouchers, for private companies to access national lab resources, is insufficient to support the technologies beyond the ARC programs.

Any effective goal must be understood by contributors at all levels, and used to actively guide and prioritize efforts. The current DOE portfolio is aimed at early research -- as appropriate -- but such research should be targeted at commercially relevant problems. The goal should be based on price points, time, and performance characteristics. It should be broad enough not to automatically exclude technologies, but specific enough to act as a forcing mechanism to identify cross-cutting research priorities, work through licensing issues, and guide cost-sharing with industry on new demonstrations.

For example, one possible goal would be for DOE to provide research facilities to enable the *demonstration of at least four different advanced light water and non-LWR reactor technologies by 2026*—a decade from now—producing power at *$65*-70*/MWh* (or below) for the nth of the kind reactor in competitive markets*.*

While ambitious, I believe this is achievable. NuScale already has an arrangement with Idaho National Lab to deploy an SMR on site–targeting the early 2020's. The ARC program has begun development of two specific technologies with the private sector, both of which would need to be accelerated to achieve this goal. It is now a question of broadening the technology portfolio, providing funding support, and accelerating the timing.

Third, <u>government should work more closely with industry by complementing, not replacing, private sector innovation.</u>

Advanced nuclear companies have already raised over $1.5 billion in private capital, and the government and philanthropy need to leverage–not replace–that investment. End users of technologies—utilities and other potential customers—often make better decisions than government alone. DOE and the Office of Science and Technology Policy should collaborate closely with an advisory board of reactor designers, utilities, and other end-users and innovators to efficiently co-invest public and private capital to accelerate innovation efforts. Independent guidance from the private sector can identify research, commercialization, and deployment priorities with potential to help a broad range of technologies, keep that research on track, and result in technologies that are more innovative and commercially realistic than might be produced with DOE going it alone.

This private sector board's mandate will include a strategy that supports development of more nascent but less mature technologies as well as demonstrating more mature technologies. DOE efforts should encourage a broad portfolio of technologies at different stages of maturity.

Focused in this way, DOE should see its role as investing in enabling tools and capabilities. Most of these tools exist today, but DOE should expand access to the private sector.

For example, advanced reactor companies need a supply and a technical understanding of a variety of fuel forms. The current process for qualifying new fuels takes 10 to 20 years, which alone could prove a nearly insurmountable barrier for most companies. Despite significant improvements in analytical capabilities, the fuel qualification process has not been simplified for many decades. Providing alternatives, such as use of analytical modeling of advanced nuclear fuels, is an area where DOE-funded research may prove essential to the rapid development of advanced reactors. Better communication on the quality of these tools will also enable NRC to leverage them to speed licensing.

In addition, we should learn from, and not repeat the mistakes of FutureGen or Solyndra—both recent examples of the government deciding to invest huge amounts of money into technologies with questionable commercial prospects. The DOE and NRC should continue recent efforts in the spirit of the GAIN initiative, and enable the private sector to develop their designs, remove regulatory roadblocks to enhance efficiency, create and maintain high-quality user facilities, and solve fundamental challenges. Recognizing that technology development benefits company profits as well as our energy system, industry cost-share must be part of the equation.

Fourth, <u>our government must eliminate the silos that stifle progress on innovation.</u>

Appropriators should work together with the Department to better enable crosscutting nuclear initiatives outside of the standard funding framework. This is more effective than allotting specific budgets for various offices and specific national labs to work on specific individual line items.

We should stop funding tools, and start funding outcomes. DOE should be given the flexibility to work towards a goal, even when that goal spans multiple office and lab jurisdictions. This level of cooperation requires setting an ambitious national goal for advanced reactor development. Quantitative goals provide both accountability and flexibility. Research isn't locked into programs that are deemed ineffective, and price and time targets help select efficient research pathways.

Two potential models for this approach that have generated results are the SunShot Initiative and the Joint Bioenergy Institute (JBEI). SunShot is a 10 year DOE initiative to reduce the cost of solar electricity to $1/watt (.06¢/KWh) by 2020. Although only 5 years in, the initiative is already 70 percent of the way there. SunShot works closely with utilities, industry, and universities to conduct its work.

JBEI is a program working across multiple national labs with industry to drive cost reductions in biofuels and biopower. JBEI has a private sector board of advisors, continuously assesses which strategies are working and which are failing, and is about to hit its cost target of $2.20/gallon of highly efficient, gasoline-equivalent biofuel. While we can't predict whether their technology is the future of transportation fuel, their goal-based research model has produced results.

Each of these programs demonstrates that the DOE can work well with industry and achieve significant technology improvements when given a strong vision and checkpoints along the way. The same could be possible in nuclear energy.

America has an opportunity to continue to lead the global market for clean, safe, affordable, reliable, proliferation-resistant advanced nuclear reactors. Without a more focused government effort, we will not sustain our vital nuclear industry and control nuclear proliferation. We do not want these innovative American reactor designs to move offshore because of regulatory over conservatism and government inertia. ClearPath and our advisors are eager to assist in realizing this opportunity and currently have multiple cost benefit projects underway to support our positions in great detail. We look forward to making these reports publicly available.