Summary of Statement for Harlan W. Bowers
President, X Energy, LLC
Before the Committee on Science, Space & Technology,
Subcommittee on Energy
For Hearing on Advancing Nuclear Energy: Powering the Future
September 27, 2018

X Energy, LLC (X-energy) was founded almost 10 years ago on the altruistic desire to make a difference in the world – to find ways to deliver clean, safe, secure, and affordable energy to the U.S. electrical industry and serve the needs of foreign countries.

X-energy is focused on two products – a 75 MWe high temperature gas-cooled (HTGR) pebble bed reactor and the complementary uranium fuel, based on the DOE's investment in tristructural isotropic (TRISO) fuel pebbles. We are working to complete our first demonstration reactor by the mid-to-late 2020s.

We have continuously evolved our Generation IV advanced reactor concept, focused on defining a design that employs mature technologies, delivers electricity at competitive rates, and can be readily licensed by the U.S. Nuclear Regulatory Commission (NRC).

Private/Public Partnerships: Solid private/public partnerships are needed for advanced nuclear success. Several hundred million dollars will be required to complete our design and secure a license from the NRC. That is why we were pleased to see the cost-share provision in the Nuclear Energy Innovation Capabilities Act (NEICA) legislation.

National Labs: National Labs also play a vital role in supporting nuclear industry competitiveness and advanced reactor deployment. X-energy has extensive partnerships with Idaho National Laboratory (INL) and Oak Ridge National Laboratory (ORNL). At ORNL, through our Cooperative Agreement, X-energy has established a TRISO fuel fabrication facility to be utilized to begin the fuel qualification process.

NRC: The NRC recognizes at the highest levels that they must modernize and improve the way they have historically carried out their regulatory mandate. Toward that end goal, the NRC, DOE, Southern Company, and the industry, through the Nuclear Energy Institute, have been working together on the Licensing Modernization Program – a joint effort to define a new licensing framework that enables advanced reactors to be licensed more efficiently. We have been very supportive of this effort.

International Competition: We are in an energy race to get U.S. advanced reactors to market. The Chinese and others are already marketing their advanced reactors to the Middle East, Africa and European countries.

Continued investment is critical. We ask that Congress continue to focus on the end goal of getting advanced reactors deployed by 2025-2030. To accomplish that, program funding over the next two years becomes absolutely critical to making deployment a reality. To qualify and fuel these reactors, we must have HALEU available by 2023 in order to manufacture fuel by 2025 for the initial set of advanced reactors. This means we must construct and license the appropriate fuel fabrication facilities in the early 2020s.

At X-energy we are proud to join with the outstanding leadership of this Committee in executing upon the policies that will allow the U.S. to *reclaim* its global leadership position in this great American born industry, for our own energy and national security, and to ensure the highest standards for safety for our world.

Prepared Statement of Harlan W. Bowers
President, X Energy, LLC
Before the Committee on Science, Space & Technology,
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Thank you, Chairman Weber and Ranking Member Veasey for your leadership and to members of the Energy Subcommittee for this opportunity.

X Energy, LLC (X-energy) was founded almost 10 years ago on the altruistic desire to make a difference in the world – to find ways to deliver clean, safe, secure, and affordable energy to the U.S. electrical industry and serve the needs of foreign countries.

We express our sincere appreciation for the leadership shown by this Committee, the Congress, and the U.S. Department of Energy (DOE) for prioritizing the deployment of advanced nuclear technology. The Nuclear Energy Innovation Capabilities Act (NEICA) and the other advanced nuclear energy bills currently being considered in Congress are genuinely trying to address the obstacles that our industry face.

Today, our company is focused on two products – a 75 MWe high temperature gas-cooled (HTGR) pebble bed reactor and the complementary uranium fuel, based on the DOE's investment in something called tristructural isotropic, or TRISO fuel pebbles.

We have continuously evolved our Generation IV advanced reactor concept – focused on defining a design that employs mature technologies, delivers electricity at competitive rates, and can be readily licensed by the U.S. Nuclear Regulatory Commission (NRC). X-energy is working to complete our first demonstration reactor by the mid-to-late 2020s. To achieve this goal, we need partnerships– partnerships that encourage industry, the DOE, the National Labs, the NRC, the investment community, and Congress to work collectively to help us meet the challenges before us.

We've been able to complete almost 50 percent of our Xe-100 reactor conceptual design to date. To ensure a timely reactor demonstration, we have taken responsibility for ensuring the nuclear fuel will be available concurrent with the reactor. The TRISO fuel is recognized by the DOE and the NRC as a safer fuel form, because the sand-sized grains of uranium are encased in graphite and silicon carbide, retaining the radionuclides and fission gases that form during the reaction. This means that the nuclear plant safety case is based strongly on the fuel design and performance, making the need for a large,

complex, and expensive containment structure over the reactor completely unnecessary. The DOE has spent over $300M utilizing the national R&D infrastructure to test and characterize this fuel. We continue that effort today.

The National Labs also play a vital role in supporting nuclear industry competitiveness and advanced reactor deployment. X-energy has partnered with Idaho National Laboratory (INL) and Oak Ridge National Laboratory (ORNL). At Oak Ridge, our teams work side-by-side to understand the research performed during the previous decade, to replicate their successes, and then to expand the laboratory scale capability to using equipment and techniques needed at a commercial level – the planning necessary to produce hundreds of thousands of fuel forms annually.

At ORNL, through our Cooperative Agreement, X-energy has established a TRISO fuel fabrication facility, with commercial-scale equipment, for the purpose of finalizing our commercial techniques, methods, and processes. We are currently producing particles and pebbles. Next year we will be utilizing HALEU. This collaboration represents one of the most important missions of our National Labs – to perform research, to identify and quantify game-changing technologies, then support their deployment into industry, whereby making the U.S more competitive and ensuring a technological advantage for U.S. companies and workers.

Private/public partnerships are needed for advanced nuclear success. The Office of Nuclear Energy at the DOE, with Congressional funding, has supported our industry. We thank Deputy Assistant Secretary Ed McGinnis and his team for their leadership. Through the award of competitively selected cooperative agreements to X-energy – one for $53M and a second awarded this year, currently funded to $10M – we can more quickly advance our reactor design and complete design and licensing of a commercial-scale TRISO fuel fabrication facility. These, and other similar awards propel forward the entire advanced reactor industry. In particular, our TRISO-X fabrication facility will be able to fabricate using uranium at higher enrichment levels than is available commercially today and supply fuel to all HTGRs and several other advanced reactor designs in development.

But investing in nuclear is not for the faint of heart. Several hundred million dollars will be required to complete our reactor design and secure a license from the NRC. That is why we were pleased to see the cost-share provision in the NEICA legislation. The "first customer" will not commit to purchase until we are able to build a first-of-a kind reactor and demonstrate economic performance. Consequently, it is very difficult to obtain typical financing for the development of the first reactor.

Additionally, the construction of our fuel fabrication facility will require $100-200M. We have engaged with investment banks to understand their requirements on risk and return. We intend to pursue every mechanism available to ensure we are successful – additional DOE cooperative agreements, loan guarantee program backing, and investment by other entrepreneurs with a vision similar to our Founder and Chief Executive Officer, Dr. Kam

Ghaffarian – to assemble the funding necessary to be first to market with an advanced reactor, and to compete globally in an industry that must reinvent itself to be competitive.

Another essential voice is the NRC. The NRC recognizes at the highest levels that they must reinvent and modernize the ways they have historically carried out their regulatory mandate. The NRC must broaden their skill sets to understand multiple advanced reactor technologies. They must streamline their analysis processes to accomplish their reviews quicker, in a way that facilitates nuclear plant investment. It means adopting methods that define what acceptable safety is, as opposed to prescribing the specific design techniques the developer must employ to satisfy NRC safety requirements.

After decades of licensing the same light water technology many times, redirecting their licensing approach is not an easy task to accomplish. The NRC, DOE, Southern Company, and the industry, through the Nuclear Energy Institute, have been working together on the Licensing Modernization Program – a joint effort to define a new licensing framework that enables advanced reactors to be licensed more efficiently. X-energy applauds the efforts undertaken to date and looks forward to engaging with the NRC staff in the licensing process.

Internationally, X-energy has been engaged, with the support of the U.S. Department of Commerce and the DOE, in discussions with Poland, Indonesia, Saudi Arabia, and the Kingdom of Jordan. All are intrigued by the attributes that an HTGR brings – passive safety, cost-competitive electricity generation in a smaller package, and the ability to produce very high temperature steam for industrial processes, including desalination. These smaller reactors are particulary suitable for power in remote communities as well as providing load-following capabilities to complement renewable energy sources. Each country expressed their interest in creating a peaceful, domestic nuclear industry and desired partners to help them. That's fine, but we are interested in promoting our Xe-100 design, developed domestically using a U.S. supply chain. Who is our strongest competition in these markets? The Chinese, who have completed a pebble bed HTGR plant for commercial electricity generation. They are crowding out U.S. leadership in international nuclear markets, replacing U.S. products with theirs through innovative financing and a government-funded design. They are, unfortunately, 5-8 years ahead of us.

One of the sections not always focused on in NEICA is on modeling and simulation. This is vital to the success of the advanced reactor community and is a capability residing in the National Labs. For example, the neutronics codes for simulating reactor operation that are familiar to the NRC today are for light water reactors. Most advanced reactors will have to develop new codes. In X-energy's case, we developed, in collaboration with INL and ORNL, a neutronics roadmap to outline what is necessary for a robust neutronics code development. This is a $10-12M effort and the National Labs are best suited to address this type of initiative. The codes they create will then be used by industry and the NRC to verify safe design.

Continued investment is critical. Congress needs to continue to focus on the end goal of getting advanced reactors deployed by 2025-2030. To accomplish that, program funding over the next two years becomes absolutely critical to making deployment a reality.

At X-energy we are proud to join with the outstanding leadership of this Committee in executing upon the policies that will allow the U.S. to *reclaim* its global leadership position in this great American born industry. Our use of the word "reclaim" is intentional. Because as of today, we have ceded global leadership to the nuclear industries in China, certainly, but also to Russia, South Korea and France. The U.S. designed the structures and protections inherent in international nuclear commerce in the 1950s, 1960s and 1970s. Those systems, while not perfect, have generally served the safety and security of the world well. But those systems will also evolve over time, and without a strong U.S. commercial nuclear industry leading and changing the world for the better, we will lose our ability to influence inclusion of the highest levels of safety and security. The U.S. must reclaim our global leadership role, for our own energy security, national security, and to ensure the highest standards for safety for our world.

We at X-energy stand ready to continue to work with this Committee and Congress in this grand endeavor.

Harlan Bowers, *President*

As president of X-energy, Harlan defines corporate strategy, implementation and oversees the development of a smaller, safer, next-generation nuclear reactor that expands reliable, zero-emission nuclear energy into entirely new markets. Harlan has over 32 years of experience managing very large, complex new business initiatives and highly technical engineering development programs. Much of his background has involved aerospace systems projects with NASA and commercial customers, as well as engineering services contracts up to $750M in value. Harlan has managed 50+ large proposal efforts for contracts with the Department of Energy, Department of Defense, Federal Aviation Administration, United States Geological Survey, and the Internal Revenue Service. His most recent responsibilities were with Stinger Ghaffarian Technologies (SGT) where he was Senior Vice President, Business Development, achieving new contract bookings of $1.36B for 2014 and 2015. Prior to that, he was VP/Program Manager for a $130M/year NASA engineering services contract, delivering systems for Hubble Space Telescope servicing, satellite remote sensing, and International Space Station operations. Harlan received a B.S. in Aerospace and Ocean Engineering from Virginia Tech and an MBA from the University of Maryland, College Park.