Testimony of J. Clay Sell, Chief Executive Officer

X-energy

Senate Energy and Natural Resources Committee

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Good Morning Chairman Manchin, Ranking Member Barrasso, and Members of the Committee.

I am Clay Sell, CEO of X-energy, one of the leading companies to help the U.S. develop a next generation of advanced nuclear reactors, which we believe, is one of the cornerstones of our nation's efforts to develop reliable carbon-free energy at scale to help fuel a growing global economy. Advanced nuclear reactors build upon a decade of technology development and risk reduction that enable them to be safer and far less prone to proliferation. They are the cutting edge of America's efforts to be innovative in the energy sector. If allowed to reach their potential, with the help of this Committee and its partners in the Congress and the Administration, advanced reactors can usher in a new era of cleaner energy, and high paying U.S. jobs, allow us to reduce our carbon footprint and compete globally for new energy infrastructure projects.

The Opportunity: A little background on me. Twelve years ago, I left the Department of Energy and Washington, DC to build the renewables energy portfolio company at Hunt Consolidated/Hunt Oil Company. I came back to the nuclear industry two years ago to work for X-energy. I have a passion for nuclear energy—I have for 20 years. But that is not why I came back. I came back to nuclear energy because of the immensity of the business opportunity before us. It is simply massive. And we at X-energy see a different future for nuclear power than what has gone on before, and we are creating it with the help of visionary leaders in the Congress and the Executive branch. Advanced nuclear technologies like our Xe-100 system have reached a level of technical readiness to be able, by the second half of this decade, to provide a significant contribution to U.S. energy independence and clean energy for our allies around the globe. To achieve any of the proposed policy objectives with respect to greenhouse gasses and, including to be net carbon zero by 2050, the U.S. alone will need to generate more than 1,100 to 3000 gigawatts of new power, and globally, that number jumps probably by a factor of five, as the US consumes about 17% of all world energy today. In fact, based on outside market analysis for SMRs, the Total Addressable Market to 2050 is 170 gigawatts of electricity—not including China. That is an incredible business opportunity. In addition, advanced reactors can contribute to non-electric uses such as heating and industrial processes and can be a significant source in the production of hydrogen. Another significant feature of advanced reactors is their ability to load follow. This means they can serve as an attractive base

load power in combination with intermittent renewables because they are able to adjust their power output as demand for electricity fluctuates throughout the day.

These combined factors point to a transformed energy future for America and our planet, while reviving our energy manufacturing supply chain and creating good paying jobs. The continued support of our industry by the Congress and the Administration is critical so we can actually build and operation these future plants. As you can tell I am passionate about making this happen. You have my commitment that I will do everything that I can to ensure that X-energy meets its schedule, budget and deployment plans as we embark on the Advanced Reactor Demonstration Program.

I believe the revitalization of the U.S. nuclear industry is a strategic imperative for our country. As I sit here with Mr. Levesque from Terrapower, the other U.S. company to recently be awarded a demonstration project under ARDP, let me make clear, Terrapower is not the competition – it is the Chinese and the Russians. They have replaced the United States as the dominant nuclear energy powers on the world stage. Let me spend a couple of minutes on the opportunities in the global new nuclear energy marketplace. The next potential market opportunity we see is in Canada. The Canadians have set aggressive clean energy goals and have very clearly articulated the critical role of nuclear power in meeting those goals. They are very intent on deploying advanced nuclear energy technology and their schedule is only a year or so behind the United States. While Canada will clearly choose Western technology, as we look to other countries around the world, the competitive landscape is more wide open.

As noted by the Atlantic Council, The World Nuclear Association has identified thirty countries as emerging markets for nuclear energy technologies, and most of the countries in question are not members of the OECD. The regions focused on acquiring civil nuclear capabilities include: Eastern Europe; the Middle East and North Africa; Western, Central, and Southern Africa; Central and South America; and East and Southeast Asia". Make no mistake, the Chinese and the Russians, through their State-controlled businesses and as part of their stated diplomatic goals, are very much engaged in marketing their nuclear reactors to all these regions. As a nation, we need to recognize, as have the Chinese and the Russians, that nuclear power relationships are 80-100 year relationships that become tightly woven into the fabric and destiny of a country's energy and industrial critical infrastructure. If we do not, or cannot participate at the same level as our adversaries in that development, the tremendous global re-alignment potential that will likely result, will negatively impact our national security interests and international influence. While exporting nuclear technology can be challenging, the implications of not being able to compete in the global market now will be felt most significantly in the long term. However, to compete – we will have to have deployed our reactors domestically. Almost no other country will buy a first-of-a-kind reactor.

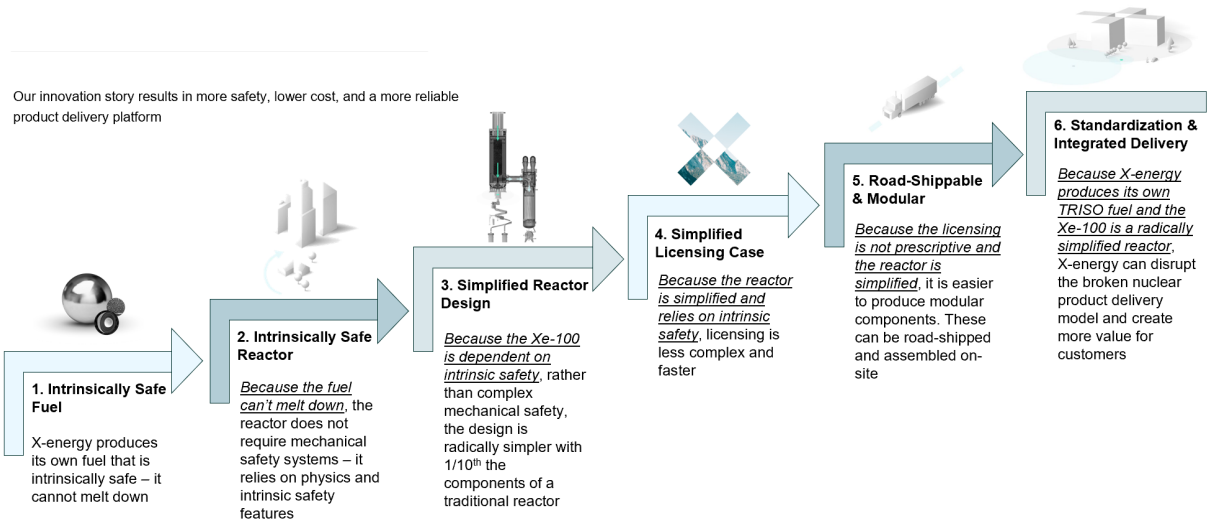
In this geopolitical light, the Advanced Reactor Demonstration program takes on even greater importance and value. I do believe the Congress has recognized this, and does see the ARDP as a necessary and powerful tool in developing the overall nuclear energy landscape, which also

includes international financing, uranium production and domestic enrichment capabilities, and a licensing framework that aligns appropriately with the risks of advanced reactors.

The Technology: X-energy was founded 12 years ago by Kam Ghaffarian our Executive Chairman and lead investor. The choice of a High Temperature Gas-Cooled pebble-bed Reactor (HTGR) was based in large part on the maturity of the technology and the previous investments that the U.S government has made in this technology – both on the reactor side, and the fuel qualification side. We have been able to take what has been done in the past – in Germany, the United States, and South Africa -- learn from those operating reactors and experiences in the 1970's and 1980's, and design the reactor and plant in a way that offers a safe, modular, and affordable approach to deployment.

The heart of the safety case for HTGR reactors is the graphite and ceramic encased fuel: TRi-structural ISOtropic particle fuel, or "TRISO fuel". The Department of Energy has hailed TRISO fuel as "the most robust nuclear fuel on Earth." Five years ago, when X-energy won its first cooperative agreement with DOE, we decided that we needed to make our own fuel so that we could meet the schedule, quality and the quantity of fuel that we would need for our reactors and was a pivotal part of our business case. This decision was made building on over $350M of Federal investment in TRISO fuel manufacturing, characterization, irradiation, and post radiation evaluations, as well as licensing qualification activities that have been conducted by DOE's Oak Ridge National Lab (ORNL) and Idaho National Lab (INL). It is precisely this government investment that gave us the confidence to transition what had been done in the labs to commercial scale. Using our initial 5-year funding of $53M ($40M from the Department of Energy and $13M X-energy cost-share) we built a TRISO pilot-scale manufacturing facility at ORNL that we have been running since 2016. We chose to build not a lab, but a commercial scale facility, utilizing what would represent one line of fabrication equipment. We view this as a critical part of the fuel facility licensing process. Indeed, we have been producing particles and pebbles, analyzing them, and comparing them to the specimen utilized in the various Advanced Gas Reactor campaigns. We have also been allocated a small amount of high assay low enriched uranium "HALEU" which will allow us to begin irradiation on our particles in their final form later this year.

So, how are we using this HTGR and TRISO heritage? We started with a design approach that is focused on safety and its ability to be licensed by the Nuclear Regulatory Commission. We separated the nuclear island from the conventional island to enable us to utilize as many non-customized systems as possible, and we are making the plant affordable to the market. We accomplish this in what we call our "Ladder of Innovation":



As you can see, HTGR technology is not new, but we are designing it in innovative ways so it will be cost effective to customers, lowering the chance of increased costs to consumers and other rate payers, while enabling vastly improved safety, more agile construction and efficient operations.

Our HTGR reactor technology -together with TRISO-X fuel - is the linch-pin of the company. With innovative approaches we have recently been able to grow in related areas. So today we are actually in four business areas:

- **Xe-100**: Our commercial, grid-scale High Temperature Gas-Cooled reactor that will be first deployed through the Advanced Reactor Demonstration Program and then globally
- **TRISO-X Fuel**: All our reactors use tri-structural isotropic (TRISO) particle fuel, developed and improved over 60 years. We manufacture our own proprietary version (TRISO-X) to ensure supply and quality control.
- **Xe Mobile Reactor**: To address the need for ground, sea and air transportable small power production. We've developed reactor concepts with potential military and civilian government, remote community and critical infrastructure applications.
- **Space Nuclear Applications**: We have been supporting NASA, DOE, and DOD in applying our technology and fuel for nuclear thermal propulsion and fission power for the lunar surface

The Advanced Reactor Demonstration Program: First, I would like to commend the leadership of this Committee and the Congress for creating of the Advanced Reactor Demonstration Program and making sure it is funded annually in DOE's appropriations bill. The Nuclear Energy Leadership Act (NELA) coalesced various initiatives needed by the advanced reactor community

into an overall policy. ARDP is a remarkably bold policy initiative designed to restore U.S. leadership by demonstrating advanced reactor designs that will allow the U.S. industry to begin the process of reclaiming its position of global leadership and influence in the 2025-2027 timeframe.

X-energy understands the stakes, has developed its own market entry plans, and has signed our cooperative agreement with the U.S. Department of Energy (DOE) to deliver the first-ever commercial-grid-scale advanced reactor to the market by 2027. The construct of this program, while extremely challenging, is really the key needed to achieve deployment. The ARDP program is not like a conventional government procurement. We must deliver an advanced reactor at a commercial grid-size whose First-of-a-Kind system will attract additional customers and enable the U.S. to be the world leader in producing these advanced reactors. Government funds must be matched with non-Federal capital on a dollar-for-dollar basis – a 50%-50% costshare. We must have a customer/utility that is willing to participate from the time of selection. Finally, we must have a business plan that shows real potential for multiple sales beyond the first reactor and which will enable us to have multiple customers. We strongly believe our team will deliver on this!

X-energy has partnered with Energy Northwest for our ARDP deployment. Energy Northwest is a consortium of 27 public utility districts and municipalities across Washington state that provide power to 1.5 million public customers. Energy Northwest operates numerous sources of power generators. However, in 2019, Governor Inslee signed into law the Clean Energy Transformation Act, which requires Washington state to be 100% clean energy by 2045. This was a key driver in Energy Northwest evaluating their options and in choosing to be a leader in potential advanced reactor deployment. The partnership of X-energy and Energy Northwest proposed the demonstration of a four unit 320 MWe Nuclear Power Plant (NPP) to be owned and operated by Energy Northwest as NRC licensee. We will locate the plant on Energy Northwest's existing Washington Nuclear Project #1 (WNP-1) site, which is on a portion of the land it has leased on the Hanford Reservation near Energy Northwest's Columbia Generating Station.

Our ARDP goal is to demonstrate that our flagship reactor, the Xe-100, can be affordably built to compete with other energy sources to provide electricity to Energy Northwest's public utility customers. Our ARDP Project will accomplish two objectives:

1. Construct and perform commercial-scale operations of a nuclear power plant based a "four-pack" of our Xe-100 reactor at Energy Northwest's WNP-1 site within 7 years.

2. Construct a commercial-scale TRISO Fuel Fabrication Facility (FFF) with sufficient supporting infrastructure and transportation capabilities to initially support our four-pack plant, with growth capacity to support multiple plants, various reactor concepts, and terrestrial and space applications. This is an extension of X-energy's working commercial-scale equipment and processes for kernel, TRISO particle, and compact fabrication at our TRISO-X Pilot Facility at Oak

Ridge National Lab (ORNL). The facility equipment and stations are state-of-the-art, commercial-scale, and criticality safe.

The Challenges: There is no doubt that this is an ambitious program. However, given the high level of private investment, and the high level of risk reduction which X-energy has done over the last dozen years, we believe it a public private partnership that will achieve the critical objectives DOE has set out for the program. That does not mean there are not challenges. I would like to highlight the three challenges that we believe will drive the success of this program and determine whether or not this sector of the energy industry will grow to meet the challenges we face over the next three decades:

1. Availability of High Assay Low-Enriched Uranium (HALEU) in time to ensure that the fuel we need can be fabricated to meet our reactor schedule.
2. Assurance that the NRC meets the schedule it has set out for licensing review and approval.
3. Appropriated funds from the Government that recognizes of the funding profiles associated with construction of our reactor and associated elements and demonstrates that the government is a reliable partner, as we seek matching capital.

HALEU: Our biggest concern is the availability of High Assay Low Enriched Uranium (HALEU) to meet the first core load of the reactors, and then to have it available to meet other customer needs. Current reactors run on uranium fuel that is enriched up to 5% with uranium-235. Many advanced reactors, including those that utilize TRISO fuels, require uranium enriched between 5% and 20%. This is due to our smaller designs that get more power per unit of volume. HALEU will also allow developers to optimize their systems for longer life cores, increased efficiencies and better fuel utilization. Unfortunately, there are no domestic commercial providers of HALEU available today.

The Congress recognized this issue of the front end of the fuel cycle in the Consolidated Appropriations Act for FY21 by including $75 million as a down payment to create a uranium stockpile/reserve. In addition, section 2001 of the Energy Policy Act, included as part of Division Z of the Consolidated Appropriations Act, sets forth elements to develop a demonstration effort to achieve a domestically produced source of advanced nuclear fuel. While we appreciate greatly this step towards a domestic HALEU capability, section 2001 would not require any consortium that emerges from this program to make HALEU available for commercial advanced reactors until 2026. This would significantly jeopardize our schedule to deliver under the ARDP by as much as two years**. Moreover, we also believe that the DOE should create a strategic HALEU reserve, and such a stockpile could then lead to the creation of a viable U.S. market under which multiple domestic providers of TRISO fuel would emerge**. So, there is actually a short-term challenge that specifically addresses the needs of the early demonstration reactors that must be met under schedule constraints, and there is a longer

term challenge which is to develop a domestic enrichment capability that will meet the market needs in 2026 and beyond. The near-term path might be an extension or complement of the uranium stockpile provision that includes the government procuring enough HALEU to meet the timetable and amounts needed for the next 10 years. Then the utilities or reactor companies can buy HALEU from the government when they need it. Without a timely source of HALEU, the breakthrough in advanced reactors on which we are on the verge of achieving will be at great risk.

NRC Licensing: The next few years represent a nexus of significant regulatory activities that will consume the collective attention and resources of the industry, NRC staff, and other stakeholders: rolling out and implementing near-term guidance for advanced reactor licensing applications, rulemakings on emergency planning and security, efforts to streamline environmental reviews, an extremely important effort to develop the transformational regulatory framework of Part 53, and multiple advanced reactor designs coming into the NRC for various review activities. Make no mistake: advanced reactors like the Xe-100 undergoing licensing as part of ARDP must address the licensing risks and uncertainty associated with draft review guidance, limited precedents, and a lot of historical bias – as in, "This is the way we've always done it", - in order for us to demonstrate our business case and deploy on schedule.

This also represents some of our greatest opportunities. We have risk-informed, performance-based activities like the Licensing Modernization Project guidance to help applicants and the NRC staff focus on the most important elements of the reactor's safety design approach. We also have the opportunity to use ARDP as a vehicle to demonstrate, through trial use and pilot activities, new approaches that will transition us from an existing prescriptive, often inflexible regulatory framework towards a set of regulations that are truly technology-inclusive, risk-informed, and performance-based. A transformational regulatory framework is vital to deploying advanced reactors more broadly in the late 2020's and 2030's in a predictable, efficient, cost-effective, and timely manner.

USG funding stability – ARDP is indeed a public private partnership which we all believe will lead to a thriving advanced nuclear industry. The structure of the program requires us to raise over $1billion of private capital for the first-of-a kind nuclear plant. I would like to stress that this is unprecedented in the history of nuclear reactors. At X-energy, we have taken on this challenge and we will be successful. The demonstrations are very large projects and basically follow a bell-shaped spending profile: design is completed, the licensing process gets underway, long lead systems and subsystems are ordered and built, the fuel facility is built and fuel manufacturing begins, and at the plant site environmental assessments are done, and preparation and construction begins. To meet the timetable of 2027, there are many of these activities that will occur in parallel rather than sequentially. While we proposed this project knowing that it would be subject to annual appropriations, I would like to impress on this Committee the criticality of the government investment being funded to match the necessary spend profile. We are often asked about the government's support of this project by potential

investors, and the implied risk of that funding uncertainty to impact schedule and cost. We need funding certainty for such a large, complex, and lengthy project. We know you will be watching us carefully and taking note of us meeting our progress and milestones. I can only ask, then, that you consider full funding of this demonstration program to ensure that with both sides meeting its commitments, we will see a successfully operating reactor in 2027! In the event that the Congress considers an extraordinary infrastructure package this year that includes investment in Clean Energy, we think it imperative that serious discussion should occur to fund both a strategic HALEU reserve and supplementary funds to accelerate investment in the ARDP. Both are critical for the nation to achieve a viable clean energy future and we believe that is a horizon in which American companies and their technology should be the world leader.

The Success: I hope I have provided you some insight into the value of ARDP to X-energy and the excitement of new market opportunities. We do seriously consider it our window of opportunity to demonstrate that advanced reactors can be built affordably, deliver what we say we can deliver, and will spark an excitement that will propel the nuclear industry to new heights for decades to come.

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.