**Testimony of Paul Kearns**

**Director of Argonne National Laboratory**

**Before the**

**Energy Subcommittee of the Committee on Science, Space, and Technology**

**U.S. House of Representatives**

***From Transformational Science to Technological Breakthroughs: DOE's National Laboratories***

**February 12, 2025**

## Introduction

Chair Babin, Ranking Member Lofgren, Subcommittee Chair Weber, Subcommittee Ranking Member Ross, and distinguished members of the Subcommittee, thank you for the opportunity to appear before you today. It is my honor to discuss how the Department of Energy's national laboratories drive scientific and technological innovations that are key to our nation's economic and national security.

I am Paul Kearns, Director of Argonne National Laboratory, one of the nation's first and largest multidisciplinary science and engineering laboratories within the DOE complex. Argonne is located in Lemont, Illinois, near Chicago, and we have been accelerating science and technology for American prosperity and security for almost 80 years.

I have spent the majority of my career in the DOE national laboratory system, driven by a deep commitment to the labs' unique mission of advancing transformative science and technology. I served as Argonne's Chief Operations Officer for seven years before becoming laboratory director. Prior to joining Argonne, I held leadership roles at Battelle Global Laboratory Operations, Idaho National Engineering and Environmental Laboratory, and Pacific Northwest National Laboratory. It was also a privilege to serve two terms as chair of the National Laboratory Directors Council, which provides a forum for advising DOE senior leadership on areas that affect the laboratories and their ability to contribute to the DOE mission.

These experiences shaped my passion for the national laboratories, the talented people who work there, and our collective impact on matters of global scale and consequence. The laboratories spur new discoveries in fundamental science, and harness those breakthroughs to enhance our quality of life, develop new technologies that underpin our economy, and make our nation more secure. National laboratory discoveries have transformed our understanding of the universe, from confirming the Big Bang and discovering dark energy to identifying 16 new elements, including those crucial for medical imaging and safety devices. Their contributions also played a key role in the digital revolution by bringing the first web server to North America, laying the foundation for modern internet infrastructure.

Argonne is managed by UChicago Argonne, LLC for the DOE Office of Science. We are one of the 17 DOE national laboratories that together form a world-leading research enterprise that is foundational to the U.S. innovation ecosystem. At Argonne, the breadth of our research initiatives includes:

- Fundamental science, including materials science, chemistry, physics, and biology
- Support of large-scale experiments in high-energy and nuclear physics, both technically and scientifically
- High-performance computing, Artificial intelligence (AI), quantum information science, and microelectronics
- Advanced nuclear energy and other solutions for generating, storing, distributing and using energy
- Nuclear and electric grid security
- Large-scale, complex engineering systems which power a world-leading light-source 1 km in size and supercomputers that are among the fastest and most capable on the global stage
- Securing domestic supply chains for scarce materials
- Advanced manufacturing
- Critical infrastructure including energy, water, communications, and transportation

At Argonne, we trace our history back to the Manhattan Project and the experiments at the University of Chicago that created the world's first self-sustaining nuclear reaction. From our initial mission to develop nuclear energy, Argonne has grown into a world-leading multi-program research laboratory. Every day, we leverage the expertise of our researchers, our academic and industrial partnerships, and specialized scientific facilities to address national challenges and advance U.S. prosperity. Argonne has driven transformative advancements across multiple fields from advancing next generation battery technologies to providing critical insights for the development of treatments for HIV, RSV, and other viral diseases.

Our work in nuclear energy also remains robust. We are integrating AI and machine learning to optimize reactor operations and maintenance and pioneering nuclear fuel recycling technologies to reduce waste while maximizing domestic fuel resources to strengthen energy abundance. We're also leveraging advanced modeling and simulation to make reactor development and deployment more cost effective and leading nuclear waste management to ensure safe, long-term storage solutions.

### Sustaining U.S. Science and Technology Leadership

Our country stands at a pivotal moment, when the pace of science and technology is rapidly accelerating and driven by fierce global competition. Geopolitical adversaries like China are making strategic investments across key science research areas and facilities, seeking to achieve global technological leadership. In a July 2024 report "Ensuring U.S. Leadership in a Competitive Future", the National Laboratory Directors Council noted: "In 2003, the United States produced 20 times more high-impact scientific papers than did China. By 2022, China achieved parity with the U.S. and has since surpassed it."

To maintain U.S. innovation leadership that powers our world-leading economy and best positions us in this evolving geopolitical landscape, we must lean into our core strengths in research and development, leverage our unique scientific assets, and bolster partnerships with our private sector and academic partners. DOE's national laboratories are, collectively, home to the largest scientific workforce and the most powerful collection of research facilities. Together, we are committed to making breakthrough discoveries and translating them into technological innovations that will ensure a strong, secure, prosperous future for our country.

### Science at Scale

Breakthroughs in fundamental science are a prerequisite to the development of transformational technologies at scales large enough to meet the energy challenges facing our nation. As the United States' largest funder of the physical sciences and through its stewardship of 10 national laboratories, the DOE Office of Science has a unique and central role to play in helping the new Administration meet its energy and national security targets.

The Office of Science maintains a vast research enterprise—spanning approximately 24 million square feet of laboratory space across 38,000 acres of land. These facilities are incubators of world-changing science.

The impact of this investment is profound. More than 11,200 permanent PhD researchers, along with 5,200 graduate students and 3,300 postdoctoral associates, are supported by the Office of Science, working on the most pressing scientific challenges of our time. Their work is amplified by nearly 40,000 users at 28 state-of-the-art scientific facilities, fostering collaboration and discovery across disciplines.

From advancing discoveries in materials science, high-energy physics and nuclear physics research to driving innovations in fusion energy, isotope production, and computational science, the Office of Science fuels research that spans all 17 DOE national laboratories, engages over 300 universities and higher-learning institutions, and impacts every state in the nation, Puerto Rico, and Washington, D.C.

The Office of Science is playing an increasingly impactful role in the field of biological research, which has an immense societal and economic impact. The U.S. biomedical industry alone contributes over $69 billion a year to the U.S. GDP.  For example, U.S. light sources and their partner institutions have contributed more than 27% of the 223,790 protein structures available in the Protein Data Bank, with more than 50% of the U.S. contribution coming from Argonne's Advanced Photon Source alone. AI-based prediction of protein folding structures from an input sequence of amino acids, a major milestone, was simply an intractable problem historically, until deep learning methods were developed and trained on these datasets. These breakthroughs are critical for furthering our understanding of fundamental biology, medicine, and energy, among others.

Last year, the Nobel Prize in Chemistry was won by a trio of researchers for their AI-assisted studies of protein folding that were conducted in part at Argonne's Advanced Photon Source and Leadership Computing Facility. One of the Laureates, David Baker of the University of Washington, is a longtime user of those facilities. Another, John Jumper of Google DeepMind, is a University of Chicago alum who also conducted research at the APS. This recognition underscores the role that Argonne and the national laboratories play in advancing high-impact scientific discovery and represents only a fraction of the overall impact of the Office of Science on the national economy and our daily life.

One of the largest scientific endeavors of our time is the Large Hadron Collider (LHC), the world's largest and most powerful particle accelerator, at the CERN laboratory in Geneva Switzerland.  DOE Office of Science has played and continues to play a major role in the LHC; the greatest breakthrough in high energy physics in the last 20 years is the discovery of the Higgs Particle at the LHC in 2012, leading to a Nobel Prize in the following year. Scientists and engineers as well as the technical infrastructure at the DOE Laboratory complex were an essential part of this discovery and continues to be a vital part of the research at the LHC.

**Advancing Innovation through Unique User Facilities**

Office of Science national laboratories host world-leading user facilities that provide scientific capabilities to the entire research community on a competitive, peer-reviewed basis. These facilities are unique not just in the tools they provide, but in the access to world-class expertise among the national laboratory staff at these facilities. These are vital resources for accelerating scientific discovery, supporting American innovation through partnerships with industry, and supporting STEM workforce development. Researchers can gain access to light sources, neutron sources, particle accelerators, nanoscale science research centers, microscopy centers, environmental research facilities, and advanced computing and data-analytics resources.

These facilities—essential enablers of big science—are too large and complex for any single company or university to manage independently, making the national labs their ideal steward. They also attract a diverse array of international researchers, further enriching our collaborative efforts and ensuring that scientific advancements benefit from a global pool of talent and expertise.

Last year was a year of transformation at Argonne where we completed the upgrade of the Advanced Photon Source (APS) and installation of the Aurora supercomputer. These facilities are complex engineering marvels. The $815 million upgrade to the APS replaced the electron storage ring with a state-of-the-art machine and increased X-ray brightness by up to 500 times—that means the upgraded beam delivers up to 500 times more X-rays onto a structure of interest, enabling scientists to either focus the X-ray beam into much smaller areas and obtain higher-resolution images that reveal intricate details of the structure that were previously difficult to discern, or to observe changes and processes with dramatically improved sensitivity or time resolution.

The new storage ring at the Advanced Photon Source incorporates 1,321 powerful new magnets, each up to five times stronger than the ones that made up the original storage ring. These magnets were assembled into 200 modules, and the centers of each magnet are precisely aligned, within a 30-micron tolerance to steer and focus the electron beam into a much tighter shape. Together, these innovations combine to create a facility that will deliver world-leading ultrabright, high-coherence X-ray beams for the global scientific community.

Aurora joins Frontier at Oak Ridge National Laboratory and El Capitan at Lawrence Livermore National Laboratory (a National Nuclear Security Administration laboratory) as the three fastest supercomputers in the world. These supercomputers dramatically accelerate research: cosmological simulations that took years can now be done in months and months of drug discovery are reduced to days. The Aurora exascale computer, which delivers a new class of system with remarkable high computing speed and AI capabilities to drive unprecedented discoveries, weighs 600 tons. This equates to the weight of an

Airbus 380, one of the world's largest passenger aircraft in use today.  Aurora's computing racks account for 10,000 square feet or four tennis courts, and are supported by 300 miles of optical cables, and 44,000 gallons of cooling water. Integrating these infrastructure components at scale and developing the codes to run on these systems is made possible by the expertise of our scientists and engineers.

Individually, APS and Aurora at Argonne represent a massive leap forward in technology. Together, they spur revolutionary science by enhancing capabilities in real-time imaging and enabling rapid interpretation of results and trends. Their co-location on the Argonne site means that they can exchange data practically instantaneously, working as an integrated tool for science and driving significant advances in energy security, grid resilience, and breakthroughs in cancer and drug discovery.

Other user facilities include the Linac Coherent Light Source at the SLAC National Accelerator Laboratory, the world's most powerful X-ray laser, enabling groundbreaking research in quantum materials. The Continuous Electron Beam Accelerator Facility at the Thomas Jefferson National Accelerator is a world leader in superconducting radiofrequency accelerator technology, advancing nuclear physics research.

The maintenance and upgrades of these facilities, alongside the development of new ones like the Electron-Ion Collider at Brookhaven National Laboratory and the Long-Baseline Neutrino Facility at Fermi National Accelerator Laboratory, are foundational to the nation's ability to compete in the global technological race.

The extensive portfolio of national laboratory scientific facilities, instrumentation, and support infrastructure has been developed over more than 80 years and needs continual improvement and investment. Addressing aging core infrastructure, such as utility and energy systems, and other deferred maintenance needs is also critically important to improve safety, mitigate operational risks, and increase the reliability of infrastructure that underpins our innovation ecosystem.

**Pioneering Frontiers in AI, Quantum, and Microelectronics**

The national laboratories are working to expand America's leadership in critical and emerging technologies and establish the U.S. as the pacesetter in the race of nations vying for supremacy in science, technology, and economic power—a competition where each breakthrough in AI, quantum, and microelectronics potentially shifts the balance of leadership. The labs are seeking not only individual discoveries but an integration that enables ever greater and transformative leaps forward.

By advancing cutting-edge AI models, constructing AI-optimized supercomputing infrastructure, convening national and international collaborators, and forging strategic industry partnerships, the laboratories are positioning the U.S. to lead in the next era of AI-driven scientific discovery.

For example, Argonne is leveraging AI to design novel materials by accelerating simulations that predict how materials will behave under extreme conditions, leading to breakthroughs in semiconductor design. AI-driven models are being used to improve medium-range weather forecasting, helping scientists predict hurricanes and other natural hazards with greater accuracy. Argonne-developed AI tools can make the energy grid more resilient by combining large language models with real-time diagnostic tools; this enables faster detection of and response to faults in nuclear power plants and renewable energy systems. In healthcare, AI expedites drug discovery, with Argonne researchers using AI-based algorithms to identify potential cancer treatments and develop predictive models for virus evolution to aid disease responses.

The Aurora supercomputer at Argonne is optimized for AI; it is being used to train AI models capable of processing massive data streams like those of the Advanced Photon Source. Argonne is also advancing next-generation AI platforms and infrastructure. Beyond its technical advances, Argonne partnered with other labs to convene over 1,300 scientists from all 17 DOE labs, more than 30 universities, and dozens of companies through a series of AI-focused town halls and workshops. These efforts crystalized the immense opportunity of AI to accelerate progress in national security, energy, and science, and informed the national laboratories' vision for a bold, comprehensive AI initiative at scale to usher in a new era of American discovery.

The DOE national laboratories are leading the charge in quantum information science, accelerating breakthroughs that will define the next generation of computing, sensing, and secure communication. Over the past four years, DOE's five National Quantum Information Science Research Centers have driven advancements in quantum device physics, developed state-of-the-art quantum processors and sensors, and expanded our understanding of quantum algorithms and materials. These efforts have laid the groundwork for a robust quantum ecosystem, uniting national labs, universities, and industry.

The national labs, through the DOE quantum research centers and engagement in regional organizations such as the Chicago Quantum Exchange, are working with a broad range of industry partners to accelerate quantum innovation. Collaborations with Fortune 500 companies, specialized quantum technology start-ups, and high-tech research institutions ensure that DOE's quantum initiatives remain at the forefront of scientific and technological advancement.

Argonne, in particular, has achieved significant quantum milestones that are paving the way for future technological advancements. The laboratory spearheaded the development of a 52-mile quantum loop, serving as a critical testbed for quantum communication and laying the foundation for a future quantum internet. Building upon this, Argonne expanded the network to a 124-mile quantum network, in collaboration with the University of Chicago's Pritzker School of Molecular Engineering and industry partner Toshiba. This expanded network actively runs quantum security protocols, distributing quantum keys over optic cables at high speeds, and stands as one of the nation's first publicly available testbeds for quantum security technology.

As the lead institution for Q-NEXT, Argonne has contributed to more than 4,000 citations in quantum information science research and recently demonstrated the first superconducting qubit operating at millimeter-wave frequencies—an advancement with implications for quantum computing speed, scaling, and sensitivity. Investments in quantum foundries, including the Argonne Foundry, have dramatically accelerated device fabrication and characterization, reducing development cycles from months to days.

In microelectronics, a multifaceted approach again defines the laboratories' work. We are conducting cutting-edge scientific experiments, focused on discovering advanced materials and architectures for AI computing. This includes pioneering energy-efficient designs and reducing reliance on critical minerals. In this space as in others, the laboratories foster strategic partnerships, internal and external to the complex, to drive innovation and address global energy challenges. And we're leveraging investments in state-of-the-art facilities—at Argonne, for example, we are using the Advanced Photon Source and the Center for Nanoscale Materials for materials characterization and nanoscale fabrication. These facilities, combined with interdisciplinary expertise, enable Argonne to develop novel technologies and sustainable manufacturing practices, bolstering U.S. leadership in advanced computing and manufacturing while addressing critical global challenges.

Continued U.S. leadership in AI, quantum and microelectronics is not guaranteed. Countries like China are investing heavily in these technologies and seek to outpace us. Without sustained investment, progress could slow, and other nations will close the gap. Ongoing support for research and infrastructure remains essential to secure U.S. scientific and technological leadership, strengthen national security, and enable future economic prosperity.

**Convening the Best and Brightest for U.S. Competitiveness**

One of the most significant roles of the national laboratories is their ability to convene multidisciplinary teams to address complex challenges. A key strength of this convening power is the deep collaboration within DOE itself, where the Office of Science works across DOE offices to integrate fundamental research with applied innovation. This intra-agency coordination ensures that scientific discovery aligns with national energy, economic, and security priorities, creating a strong foundation for broader collaboration. Building on this internal strength, the Office of Science extends its impact through partnerships with other federal agencies and leverages complementary expertise and resources to tackle challenges that span national security, energy abundance, and economic competitiveness. These inter-agency collaborations, combined with strategic engagement with academia, industry, and state and local governments, accelerate innovation and drive breakthroughs in areas such as energy storage and high-performance computing, strengthening the nation's scientific and technological leadership.

Building on the strength of collaboration within the DOE complex, the labs also foster strategic cooperation with industry and academic institutions to accelerate scientific discovery and innovation. For example, an Argonne-led, dynamic collaboration with the Greater Houston Partnership, formalized in early 2024, brings labs and industry together to advance carbon management in the region. Engaging with companies including Chevron and ExxonMobil and marshaling the labs' advanced manufacturing, life cycle analysis, and other expertise, Argonne is helping to address challenges such as lower-carbon systems for base chemicals.

Argonne sees similarly great potential in its academic partnership with institutions like Purdue University; we are collaborating across multiple scientific and engineering domains, with a strong focus on pharmaceuticals, steel manufacturing, and data science. Late last year, Argonne and Purdue began exploring collaborations on next-generation microelectronics, focusing on advanced materials, materials characterization, and packaging to develop smaller, faster, and more energy-efficient devices.

Strategic partnerships with industry leaders like Oklo and TerraPower are helping Argonne advance the future of nuclear energy. Collaborating with Oklo, Argonne supports the development of fast reactors and advanced fuel recycling, leveraging world-class facilities to validate reactor safety, thermal-hydraulic models, and fuel cycle innovations. With TerraPower, Argonne contributes expertise in sodium fast reactors and molten salt energy storage, aiding in materials testing, fuel qualification, and component validation for the Natrium™ reactor. These collaborations are key to helping accelerate the commercialization of next-generation nuclear technologies that will enable solutions to enhance grid reliability and deliver affordable and abundant nuclear energy.

### Securing Our National Science Enterprise

While we thrive on global collaboration, we are equally committed to safeguarding our research, ensuring that our partnerships strengthen—not compromise—our national security. Our managed research environments ensure safe operations and secure access, fostering an ecosystem that supports innovation while mitigating risks. By integrating secure data platforms and trustworthy AI systems, the labs enhance research security, ensuring the U.S. remains a global scientific leader.

National laboratories are vital to the nation's security infrastructure. As formal members of the U.S. Intelligence Community, our labs leverage scientific and technological expertise to support national security missions across defense, homeland security, cybersecurity, and energy security. The labs' deep understanding of frontier science enables them to anticipate and mitigate global security threats, from nuclear proliferation to cyberattacks. By advancing technologies such as AI, advanced semiconductors, and new materials, the labs play a crucial role in modernizing the U.S. nuclear deterrent and strengthening our national defense capabilities.

### Enabling Economic Prosperity and Developing the Next Generation Workforce

The economic impact of the national laboratories is profound and quantifiable. Our labs are engines of economic growth, generating billions of dollars in economic activity and supporting thousands of jobs across the nation.

Cutting-edge science fuels industry growth and technological progress. For example, Sepion Technologies and Form Energy, spun off from the Argonne-led Joint Center for Energy Storage Research, advance lithium batteries and pioneer low-cost, long-duration energy storage solutions poised to transform the renewable energy sector. Princeton Stellarators, a spinoff from Princeton Plasma Physics Laboratory, focuses on advancing fusion energy technologies, while Optokey, a startup originating from Lawrence Berkeley National Laboratory, developed a miniaturized sensor based on Raman spectroscopy. The technology enables rapid and accurate molecular-level detection, with applications in food safety, environmental monitoring, and medical diagnostics.

Our ability to drive progress relies on a skilled workforce. The national laboratories are committed to building this workforce through comprehensive development programs that prepare scientists and engineers for the challenges of tomorrow.

Argonne's educational programs reach nearly 30,000 students and families each year, fostering interest and supporting development in science, technology, engineering and mathematics (STEM) fields. Lawrence Berkeley National Lab similarly shapes the STEM workforce; over the last several years the lab has engaged hundreds of interns and transitioned many of them into full-time roles. Our labs help ensure a steady pipeline of talent to support the U.S. innovation ecosystem, maintaining the nation's competitive edge in the global economy.

**Pursuing Future Opportunities**

The national laboratories, along with their university and industry partners, can bring the necessary expertise and capabilities to solve complex challenges and sustain America's global competitiveness. These challenges require focused, sustained investment in fundamental science and infrastructure to fuel progress long into the future.

Now is not the time to hold back—innovation is the key to seizing the opportunities that define this moment. The stakes are high. Artificial intelligence is reshaping how we live and work, next-generation medicine is unlocking new frontiers in human health, and rising energy demand calls for harnessing vast energy resources to power modern life. With world-class expertise, state-of-the-art facilities, and an unrelenting drive for discovery resident in its national laboratories, the U.S. is positioned to expand scientific leadership, strengthen the reliability of our energy system, and secure the nation's industrial and economic future.

I am proud of the work we do at Argonne and across the national laboratory system, and I am grateful for your continued support. Thank you for the opportunity to testify today. I look forward to answering any questions you may have.