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Chairman Manchin, Ranking Member Barrasso, and distinguished Members of the Committee, thank you for the opportunity to testify about the Department of Energy's (DOE's) leadership in the next generation of advanced computing research, application, and cybersecurity.

My name is Helena Fu, and I serve as the Director of DOE's Office of Critical and Emerging Technologies (CET). U.S. leadership in critical and emerging technologies such as AI, biotechnology, quantum information science, and microelectronics is key to enabling economic prosperity and maintaining our national security. These technologies are a major source of new discoveries and breakthroughs, strengthen our ability to counter national security threats, and increase access to clean, reliable, and affordable energy.

CET works to leverage capabilities and expertise across the DOE complex, including the NNSA, and the DOE's 17 National Laboratories to sustain and extend U.S. leadership in technology in support of the Department's energy, science, and national security missions. The office has primary responsibility for establishing and coordinating a strategic vision to ensure that the Department is unified and cohesive in executing its works to critical and emerging technologies. CET works with and through other DOE offices, enabling DOE leadership, as well as interagency, congressional, and external partners, to maximize the impact of DOE capabilities and investments in these key areas of national importance.

My testimony will discuss how DOE is advancing the development of the AI innovation ecosystem through its Frontiers in AI for Science, Security, and Technology (FASST) initiative, discuss the work to improve permitting with AI via DOE's VoltAIc initiative, outline the Department's ongoing, foundational efforts in quantum information science, highlight how the Department is leveraging advanced digital technologies and close industry partnerships to protect our energy infrastructure's cybersecurity, and, describe how the Department's work helps secure our national security.

Enhancing Artificial Intelligence Leadership for DOE's Science, Energy and Security Mission

As the Committee well knows, AI is a transformative technology that is evolving almost by the day. It has deep implications for all aspects of the nation's wellbeing, from its economic prosperity to its long-standing scientific leadership. DOE has a key role, together with leading science funding agencies, in ensuring that the United States does not fall behind in the accelerating race to establish global AI supremacy, and we thank Congress for the continued support it has provided to enable DOE's existing infrastructure and capabilities to be harnessed for cutting-edge AI research and development. Over

many years, this foundational work has allowed the Department to prepare revolutionary AI capabilities that our nation now requires more than ever.

- Thanks to DOE's experimental and computational capabilities, which are the world's largest collection of advanced experimental facilities, including particle accelerators and powerful light sources, we are the world's leading producer of **unclassified and classified scientific data** - the fuel that powers important AI models.
- DOE designed, developed, and operates **the world's two fastest supercomputers, with a third also currently being installed.** Some of our supercomputing assets are open and accessible to the U.S. scientific and academic community and industry via our user facilities. They provide a national capability that often supports our agency partners, and are strategic components of our national defensive capabilities.
- DOE has unparalleled experience in **mission-driven public-private collaborations**. Through the Exascale Computing Project (ECP), DOE worked with industry partners to co-design and develop critical components of the computer chips that power today's leading AI models. The ECP also helped deliver the world's first official exascale computing systems that used less than 20 megawatts of power—one tenth of what experts projected at the start of the initiative and a 400% improvement in energy utilization over our pre-exascale systems.
- And we can put all of these assets to work because of our most valuable resource at DOE: the nation's **largest skilled scientific workforce**, with over 40,000 scientists, engineers, researchers, and support personnel at our national laboratories.

DOE is already bringing our capabilities and expertise to bear in supporting the Executive Order on AI, from conducting red teaming, to evaluating the potential for AI to be misused for chemical, biological, radiological, and nuclear threats, to training an AI-ready science and engineering workforce through our National Laboratories, to building AI models to expedite environmental reviews and permitting.

Now we are at a pivotal moment. DOE and its National Laboratories recognize the immense opportunities and risks associated with AI. Other countries, including our adversaries, are already investing significantly to develop strategic national capabilities in AI. The United States must lead the world in the development of advanced AI systems for scientific, energy, and national security applications, and DOE has a critical role to play.

DOE's Frontiers in AI for Science, Security, and Technology initiative - FASST - would leverage DOE's existing capabilities, infrastructure, and partnerships to provide a national AI capability. DOE has the infrastructure needed to support frontier scale AI development for U.S. government capabilities that span from supporting open access scientific discovery to facilitating mission-driven applied energy applications and classified research and development. The National Nuclear Security Administration (NNSA), part of DOE, is uniquely positioned to both advance AI applications and identify and mitigate AI risks to NNSA's nuclear nonproliferation, counterterrorism, and counterproliferation missions. DOE aims to harness and develop AI-ready data, frontier scale compute platforms, and scientific foundation models to solve our most pressing challenges—including control and design of massive and complex systems like the electric grid, enhancing our knowledge of the subsurface for critical mineral development and accelerated modernization of the nuclear deterrent. FASST will also support further investment in improving the energy and water efficiency of AI models.

FASST is an ambitious AI initiative that would provide frontier-scale AI systems to solve critical challenges in science, energy, and national security. This kind of public capability is critical to extend the

United States' competitive edge in scientific innovation, to develop effective AI governance and safety measures, and train an AI-ready workforce. DOE is positioned to address the AI challenge from beginning to end, starting with data and ending with the development and implementation of AI applications for the critical challenges we face as a nation.

Improving Environmental Reviews and Permitting Outcomes

A core investment of the DOE's Frontiers in AI for Science, Security, and Technology initiative – FASST – instructs DOE to use AI to leverage the agency's existing world-class laboratory test facilities to improve siting and accelerate permitting decisions for clean energy deployment. Through strategic facilitation across public-private partnerships, local, state, Tribal, and federal governments, DOE is actively advancing artificial intelligence and machine learning research to improve permitting processes for Administration permitting priorities, such as energy-related projects and critical mineral infrastructure. Deploying our existing lab infrastructure and scientific expertise for AI instead of starting from scratch will reduce lengthy, time-consuming, and resource-intensive application processes. Public and private-sector clean energy investments depend on predictable project timelines and decision making.

When it comes to permitting, the Department is advancing a number of reforms and investments to help improve and accelerate permitting processes. Companies are investing hundreds of billions of dollars in manufacturing, clean energy, and infrastructure projects across America. To take advantage of this momentum, we need to improve the ways projects are sited and permitted at all levels. This moment demands efficiency without compromising environmental or community outcomes. In April, DOE announced the VoltAIc initiative to use AI to help expedite and improve siting and permitting at the Federal, state, and local level. As part of that initiative, DOE is building AI-powered tools to improve siting and permitting of clean energy infrastructure. For example, we are developing PolicyAI, a policy-specific large language model test bed that will be used to develop software to augment NEPA and related reviews. The PolicyAI research team is investigating potential uses of AI in the NEPA and permitting process, including extracting and organizing unstructured data, natural language processing, analyzing structured data to identify key performance indicators, and comment analysis and categorization.

Reauthorization of National Quantum Initiative to advance Quantum Information Science

While we are looking over the horizon toward the deployment of next-generation AI capabilities, the Department has already been pushing the boundaries of critical technology areas that our nation needs to maintain its strategic global position. Quantum Information Science (QIS) is one important area in which the Department has already invested significant resources and made correspondingly significant strides. The core of QIS uses the laws of quantum mechanics to store, transmit, manipulate, compute, and measure information. QIS could unlock forms of computing and information processing that can overcome the limitations of "classical" approaches by utilizing exotic quantum effects. Advances may help solve problems that are hard to address with even the largest supercomputers of today, enable extremely secure encryption, and could aid in understanding everything from biological systems to the nature of dark matter.

Recognizing the great potential of QIS, and aware of the growing international competition in this promising new area of science and technology, Congress passed the National Quantum Initiative Act (NQI Act), which became law in December 2018. The DOE Office of Science is a leading partner in the

National Quantum Initiative alongside other departments and agencies, and launched a range of programs in QIS. Research projects range from single investigators within specific disciplines to large integrated centers that span the Office of Science programs. QIS holds the potential to dramatically advance aspects of DOE's mission, and a major driver of DOE's quantum strategy in recent years has been the National Quantum Initiative Act.

The NQI Act authorized DOE to carry out a basic research program in QIS and DOE's Office of Science to establish and operate 2-5 National Quantum Information Science Research Centers to "conduct basic research to accelerate scientific breakthroughs in quantum information science and technology." In FY 2020, DOE's Office of Science established five National QIS Research Centers as called for in the NQI Act. These centers focus on accelerating transformational advances in basic science and quantum-based technology needed for world-leading capabilities in QIS. The National QIS Research Centers are led by five of the DOE National Labs and currently combine the expertise and resources of over 87 academic, industry, non-profit, and lab partners from 24 states, the District of Columbia, Canada, Italy, and the United Kingdom.

The National QIS Research Centers program, an investment of $575 million over five years, is co-designing algorithms, quantum devices, and engineering solutions to deliver quantum advantage in scientific applications; overcoming roadblocks in quantum state resilience, controllability, and scalability of quantum technologies; eliminating the decoherence mechanisms in superconducting 2D and 3D devices; and reducing limitations of today's Noisy Intermediate-Scale Quantum Computer systems.

The Centers have accomplished much since their inception in 2020, from establishing quantum foundries for advanced device fabrication, building underground facilities for characterizing quantum devices, developing highly successful open-source control-software, advancing innovative superconducting devices to improving the precision of critical atomic clocks.

Although the original authorization provided funding only through 2023, the Office of Science has continued to receive sufficient appropriations to support the current Centers. We will continue to fund this research, subject to appropriations, through the end of FY 2025.

At the same time, the National Nuclear Security Administration is also investing in mission-relevant quantum technologies. The Advanced Simulation and Computing (ASC) program at NNSA is making strategic investments in quantum computing to drive innovative computing designs that leverage new opportunities in the high-performance computing industry. One of ASC's guiding principles is to collaborate with vendors in co-design of all forms of computing technologies to benefit from innovation in the private sector. ASC is focused on accelerating the availability and increasing the scalability of advanced technologies in industry, with the goal of deploying quantum systems for its most demanding and complex national security challenges.

DOE is also working with other partners within the federal government. This summer, DOE and the Defense Advanced Research Projects Agency (DARPA) announced a Memorandum of Understanding to advance the field of quantum computing. The MOU establishes a framework for planning and coordinating future research, development, engineering, and test and evaluation activities related to quantum computing. Part of that work will include deep analysis of the current status of quantum computing and where it is going.

DOE continues to drive advances in quantum research and development and to explore and better understand the potential applications of QIS to all aspects of the Department's science, applied energy, and national security missions.

Advances in Computing and Impacts on Cybersecurity

While advances in computing have many beneficial uses, they may also be leveraged by those with malicious intent to disrupt systems that we all rely on every day, such as the country's energy infrastructure. The energy sector provides the power and fuel that all other U.S. critical infrastructure sectors depend on to operate. Any disruption in the energy system would have a devastating impact to national security, the U.S. economy, and the safety and livelihoods of millions of Americans.

At DOE, the Office of Cybersecurity, Energy Security, and Emergency Response (CESER) is focused on securing the Nation's energy infrastructure against all hazards, reducing the risks and impacts of cyberattacks, physical incidents and other disruptive events, and supporting state, local, tribal, and territorial governments, as well as industry, with response and restoration when a disruption occurs.

DOE is continuing to strengthen the energy sector's cyber defenses, invest in new capabilities, and reimagine how we think about cybersecurity to ensure the resilience of the nation's critical energy infrastructure. This includes enhancing cyber threat collaboration, such as through the DOE pilot of the Energy Threat Analysis Center (ETAC), which brings experts from government and industry together to analyze and address the growing cyber threats to U.S. electricity, oil, and natural gas systems.

Given that much of the nation's energy infrastructure is privately owned, meeting the shared responsibility to address threats to the sector requires government and industry to work together. The ETAC has been instrumental in addressing cyber threats, such as the PRC-sponsored Volt Typhoon activity, and other threats targeting our energy infrastructure. In addition to the private sector partnerships, we are leveraging the analytic capabilities, compute resources, and subject matter expertise of five DOE national laboratories. It will take the whole of the sector coming together to address the cyber threats that exist today, and those on the horizon.

In addition to the ETAC, DOE is prioritizing activities to harden current and future energy infrastructure. We are partnering with manufacturers to strengthen the cybersecurity of critical components in the grid and driving a paradigm shift in cybersecurity through the development of Cyber-Informed Engineering principles, and promulgating them through implementation guides. The principles set expectations for manufacturers from ideation to deployment. Most notably, the principles present a shared responsibility model by identifying the distinct roles of both suppliers and end users in meeting cybersecurity objectives. For example, supplier principles of secure development, continuous lifecycle support, and proactive vulnerability management are complemented by end user responsibilities to follow supplier guidance for secure implementation and hardening and sufficiently plan for maintenance and refresh cycles.

DOE is adept at deploying innovative solutions to complex problems and will continue to do so in service to the American people, ensuring the U.S. energy sector becomes only more secure and resilient with time.

Conclusion

As technology advances and evolves at an unprecedented pace, we appreciate the committee's steadfast work to provide the Department of Energy with the authorizations and resources we require to maintain national leadership in critical scientific and technological sectors. The scope of this challenge grows by the day, as illustrated by this hearing itself, which spans from advancing next generation AI technologies to guarding against cybersecurity threats to our energy infrastructure. The Department also knows our adversaries and competitors have an interest in stealing and undermining our pathbreaking progress on these topics. We collaborate closely across the Department on a daily basis to identify and minimize these concerns. However diverse our mission, the Department of Energy is meeting it head-on with a cohesive vision that centers on the following principles:

- **In-house technical capabilities for the national interest:** In order to understand, accelerate, and govern today's technological advancements, our government must have internal capabilities that respond to national imperatives first and foremost. Our Department, alongside our agency partners, is tasked with maintaining national security, including economic security; we cannot rely on external actors to assure our nation's energy resilience, scientific leadership, and strategic deterrence. As we execute on these missions, we simply *must* have the latest tools and brightest experts to maintain critical capabilities.

- **Dedicated and targeted public-private partnerships:** America's global leadership hinges on the strength and ingenuity of its private sector and innovation from academia. As we build internal capabilities, we must actively leverage our interagency and industrial partners and their advancements. For example, industry grounds our capabilities and strategic vision in today's rapidly changing world. That's why ETAC's technical analysts from industry and government physically sit shoulder-to-shoulder – we cannot have even small blind spots when protecting assets as critical as our electrical grid or petrochemical infrastructure. Under the National Quantum Initiative, DOE and the national labs operate the National QIS Research Centers in close partnership with industry and academia. As AI models continue to advance in their ability to reason, DOE has the scientific workforce and the scientific infrastructure to enable the development and application of AI to solve the critical national challenges at speed and at scale. Public-private partnerships are foundational to these programs, and we are eager to continue engaging with our industry partners to best accomplish the Department's diverse missions.

- **Close coordination with the interagency:** Advancing the nation's scientific and technological leadership inherently requires a whole-of-government approach. Each of the three bills establishes programs that are complementary to others across the interagency and include mechanisms to ensure coordination. For example, FASST will naturally enhance efforts in support of the Department of Commerce's AI Safety Institute's AI standardization and governance efforts, leveraging the national lab network to provide the requisite AI resources and an independent ability to detect inflection points in model capabilities. Similarly, ETAC is just one part of much larger cybersecurity apparatus distributed across the U.S. government and is built from the ground up to enhance this larger mission, leveraging actionable intelligence from across the government to better protect the nation's energy resilience and security.

The Office of Critical and Emerging Technologies and the whole of the DOE stand ready to ensure that the Department rises to the challenges posed by today's strategic technology landscape.

I want to again thank the Committee for its ongoing and bipartisan support for the DOE mission. Thank you for the opportunity to be here today, and we look forward to working with the Committee on these important issues. I am happy to answer your questions.