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U.S. Department of Energy

before the

House Committee on Science, Space, and Technology

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Chairman Lucas, Ranking Member Lofgren, and Members of the Committee, it is an honor to appear before you today to discuss the Department of Energy's science and technology priorities.

Serving the American people as the 16th Secretary of Energy, I am entrusted with the awesome responsibility to lead a highly talented DOE workforce. I am continuously amazed by their steadfast dedication to our mission and the innovative solutions they bring to some of our nation's most pressing problems. As a result of their tireless efforts, the Department has made significant strides in ensuring America's security and prosperity by addressing our energy, environmental, and nuclear security challenges through transformative science and technology solutions.

We are strengthening America's place as a trailblazer in the clean energy economy of the future and a leader in the fight against the climate crisis. The scientists and engineers at our National Laboratories, the crown jewels of the nation's research and innovation ecosystem, are producing scientific breakthroughs that will have an enormous impact on the world in which we live. In collaboration with States, Tribal nations, institutions of higher education, and local governments around the country, we are helping to create thousands of good-paying jobs in fields that are critical to the success of the American economy. And we are training thousands of students who will become a technology-driven workforce of the future, ensuring that we have a diverse, highly prepared workforce to discover, design, develop, and manufacture new technologies that will drive our economy well into the future.

The Department is committed to advancing this Administration's energy, climate, and nuclear security and nonproliferation goals. I want to thank this Committee for the ongoing, bipartisan support for the Department of Energy and your continued, thoughtful efforts to enhance our science and innovation activities.

Investing in the Future of Science to Catalyze Innovation

The CHIPS and Science Act was a historic bill designed to revitalize America's scientific research and technological leadership and strengthen America's economic and national security. This Committee was instrumental in the development and passage of the CHIPS and Science Act, authorizing activities at the Department of Energy that we are uniquely positioned to carry out. It was also the first-ever comprehensive authorization of the Department's Office of Science, supporting fundamental and use-inspired research to sustain U.S. leadership in the sciences and engineering as the engine for American innovation. CHIPS and Science authorized

$50 billion for the Office of Science over five years to enable cutting-edge research and development in clean energy to fight the climate crisis as well as emerging technology, such as artificial intelligence and fusion, to boost American competitiveness. The passage of this bill was a strong statement of support for the work that DOE, and the Office of Science in particular, does and we are very excited to carry out research and development activities to meet the full potential of this authorization.

The President's Fiscal Year 2024 Budget Request for the Office of Science demonstrated our commitment to the CHIPS and Science Act. The Budget requested $8.8 billion for the Office of Science, advancing toward the authorized level in the CHIPS and Science Act, to support cutting-edge research at the Department's National Laboratories and university partners, and to build and operate world-class scientific user facilities.

As members of this Committee know, the DOE Office of Science's core mission is to deliver both the scientific discoveries and major scientific tools that will transform our understanding of nature and advance the energy, economic, and national security goals of the U.S. Global leadership in emerging innovation areas— including artificial intelligence (AI), machine learning (ML), fusion, quantum information science (QIS), microelectronics, advanced computing, transformative and sustainable manufacturing, particle accelerator technologies, and next-generation biology—is critical to maintaining U.S. national security and economic strength. The DOE is well-poised to accelerate progress in these emerging technology fields enabled by the depth and breadth of our research talent and infrastructure. With adequate funding provided, the Office of Science is uniquely positioned within the federal R&D structure to enhance our nation's innovation capabilities and deliver new technologies critical to our future economy and national security.

DOE also is maintaining America's international leadership in computing by delivering next-generation simulation and computing technologies. This year, DOE deployed Aurora, its second exascale computer, at Argonne National Laboratory, which joins Frontier at Oak Ridge National Laboratory, which came online last year and is the fastest supercomputer in the world. A third, El Capitan at Lawrence Livermore National Laboratory, will be the first exascale computer for national security when it comes online later this year. At over two exaflops, it will be the world's most powerful supercomputer. Critically, these computers will combine leading AI capabilities with DOE's unique portfolio to develop trustworthy AI solutions appropriate for high-consequence applications from modernizing the grid for clean-energy deployment and enhanced resilience to our next-generation nuclear deterrent.

Recent advances in AI are enabling enormous progress and breakthroughs that will help address these key challenges of our time. However, increasing global competition and high consequence uses of AI are driving the need for the Federal government to harness AI breakthroughs for good and mitigate its considerable risks. DOE has a vast array of resources and infrastructure which, if brought to bear to meet this moment, can utilize our unique computing capacity, comprehensive and well-curated data-sets from experiments and simulations, our algorithms and methods, relationships with industry, and skilled scientific workforce to help discover, design, manufacture and deploy AI to harness its transformational opportunities in the service of this nation.

Additionally, DOE is making history in fusion energy science. In December 2022, thanks to decades of investment and research, the DOE/NNSA teams achieved fusion ignition and scientific energy breakeven at the Lawrence Livermore National Laboratory's National Ignition Facility (NIF). And in August, NIF again achieved net energy gain in a fusion reaction. The NIF achievement was enabled by DOE/NNSA's longstanding support of its inertial confinement fusion program, which led to the scientific, computational, and technological advances needed to reach this milestone. For the DOE/NNSA, this milestone allows scientists to study and further our understanding of physics at extreme conditions, enabling us to build confidence in our nuclear deterrent without nuclear explosive testing.

In FY 2023, under the Fusion Development Milestone program, DOE provided $46 million to eight fusion companies to develop designs and roadmaps for fusion pilot plants. Under the Innovation Network for Fusion Energy (INFUSE) program, 90 awards totaling $19.3 million have been made since 2019, enabling ten DOE national labs and ten universities to collaborate with 26 distinct private fusion companies. Additionally, the FY 24 Presidential Budget Request proposed major increases in the Fusion Energy Sciences program within the Office of Science. The increase will accelerate fusion development in support of the Administration's Bold Decadal Vision for Commercial Fusion Energy. This includes increased support for partnerships with the private fusion sector and the establishment of new fusion research and development centers focused on materials, simulations, enabling technologies, and fuel-cycle challenges that remain. Even with recent advances in fusion, significant research and innovation is needed to support the development of a fusion pilot plant to meet our clean energy goals.

As this nation's largest Federal sponsor of basic research in the physical sciences, the Office of Science's programs probe fundamental questions to address nature's most compelling mysteries—from fundamental subatomic particles, atoms, and molecules that form the building blocks of our universe, to highly complex and dynamic systems, such as energy storage processes, microbial cells, and carbon cycling in the environment. Over the decades, the investments we have made in basic research and enabling research capabilities have yielded advances that have provided the foundation for countless new technologies that have benefited large and small businesses and has even launched new businesses. For example, fundamental research in materials and chemistry, aided by computational modeling, imaging, and characterization at DOE's user facilities, have produced advances in battery technologies utilized by new start-ups.
The Department's investments in research in high energy and nuclear physics expands our understanding of the universe, from the subatomic scale to the cosmic scale, and ensures that the United States maintains its leadership in these international efforts. Support for research in fundamental physics includes investment in the development of cutting-edge technologies, including those for accelerator science, detectors, and computational tools—and many of these advances have had impact in fields as diverse as medical treatment and diagnostics and production of isotopes.

Many of these transformative scientific discoveries are enabled by our stewardship of 28 scientific user facilities, which are available to all researchers based on the scientific merit of their proposed research. These tools include the world's most powerful computers, brightest X-

ray light sources, most intense neutron sources, and specialized capabilities, such as nanofabrication and state-of-the-art imaging modalities available in our nanoscience centers, as well as bio-characterization facilities. The Department continues to invest in the development of the next generation of scientific tools that are critical for maintaining U.S. leadership in scientific discovery and technology development that underpin our Nation's economic competitiveness and national security.

Leading the Way to a New Era of Science and Innovation

The Department of Energy has long been the leader of coupling basic science discoveries to applications that have produced new technologies that have impacted our everyday lives, such as new materials for batteries and solar power and biological processes for producing ethanol and other fuels for transportation. With this long history, DOE is positioned to lead the new era of integrated science within the US Government and the world. Linking distributed science and technology resources is becoming paramount to modern collaborative science. The challenges of our time call upon DOE and its national laboratories to be an open innovation ecosystem to accelerate discovery & innovation, democratize access to resources, draw new talent, and advance open science. The DOE National Laboratories will work collaboratively with the Office of Science to establish the Integrated Research Infrastructure (IRI) program to empower researchers to meld DOE's world-class research tools, infrastructure, and user facilities seamlessly and securely in novel ways to accelerate discovery and innovation. Building on the success of the National Virtual Biotechnology Laboratory, DOE will be at the forefront of integrated science to accelerate progress towards high priority integrated science goals.

Delivering our missions requires effective stewardship and promotion of diverse and inclusive research environments and workplaces that value and celebrate people with different ideas, cultures, and educational backgrounds. Harnessing a broad range of views, expertise, and experiences drives scientific and technological innovation and enables our community to push the frontiers of scientific knowledge for U.S. prosperity and security. For example, the Office of Science recently established two new initiatives: Reaching a New Energy Sciences Workforce (RENEW) and Funding to Accelerate Inclusive Research (FAIR). RENEW will support undergraduate and graduate training opportunities for students and institutions historically underrepresented in the Office of Science research community. FAIR will build research capacity, infrastructure, and expertise at minority-serving institutions (MSIs). The FAIR initiative complements an Office of Science–wide effort to substantially increase outreach to MSI faculty to encourage applications to Office of Science funding opportunity announcements.

Further, through these initiatives, we will be able to strengthen our retention and growth of scientific and engineering talent at the National Laboratories and universities, ensuring strong leadership into the future. We also have great confidence in our scientific leadership within our SC programs and have recently appointed new Associate Directors in Fusion Energy Sciences and High Energy Physics, and we are in the final stages of filling the remaining two positions, Biological and Environmental Research and Advanced Scientific Computing Research. We have worked diligently to identify the best qualified individuals that can provide strong leadership, support and develop our program and support staff, and serve as stewards of their disciplines for the next decade or more. These are incredibly important positions, and we are taking appropriate care in filling them.

Applied Research and Technology Development

The Department's applied research, development, and demonstration activities are securing U.S. preeminence in accelerating the transition to a clean energy economy. Our investments seek to improve clean power technologies, strengthen clean energy-enabling transmission and distribution systems, decarbonize transportation, advance carbon management technologies, and improve energy efficiency in industry and buildings.

The work of the Department's applied technology programs over four decades have set the table for the global clean energy transition we are seeing in 2023. For example, enabled by the Sunshot Initiative launched in 2011, the price of residential solar installation has fallen by 54% to $3.80/watt and the price of utility-scale solar installation has fallen by 43% to $2.00/watt. The FORGE project supported by the Geothermal Technologies Office demonstrated an 80% improvement of on-bottom drilling rates. RD&D led by DOE's office of Energy Efficiency and Renewable Energyhas helped enable steep cost reductions over the last decade in important technologies like land-based wind (down 42%), lithium-ion batteries (down 85%), and LED light bulbs (down 92%). This has led to significant impacts for the American consumer: EV adoption has increased one-hundredfold over the last decade, the number of publicly available EV charging ports has grown by 50% since 2019, and switching to LEDs has saved American consumers nearly $15 billion per year in electricity costs.

We are working to maintain and accelerate this record of success by setting measurable goals and formalizing intra-agency collaboration on specific technology sectors. Modeled off of the successful Sunshot Initiative, the Department established Energy Earthshots to accelerate breakthroughs of more abundant, affordable, and reliable clean energy solutions within the decade. These Energy Earthshots focus RD&D efforts Department-wide to reduce the technological risk of investing in emerging and nascent clean energy technologies with the goal of bolstering domestic energy industries, onshoring jobs, creating and securing new supply chains, and eventually reaching 2050 net-zero emissions goals. Additionally, the Earthshots allow the Department to be responsive to Congressional direction in coordinating technology development efforts across the applied energy research offices. To date, we have launched seven Energy Earthshots, which target the most challenging technical problems across our energy economy:

- **Hydrogen Shot** seeks to reduce the cost of clean hydrogen by 80%, to $1 per 1 kilogram in 1 decade ("1 1 1");
- **Long Duration Storage Shot** seeks to reduce the cost of grid-scale energy storage by 90% (from a 2020 baseline) for systems that deliver 10+ hours of duration within the decade;
- **Carbon Negative Shot** seeks to enable durable and scalable CO_2 removal under $100 per net metric ton CO_2e within a decade;
- **Enhanced Geothermal Shot** seeks to reduce the cost of enhanced geothermal systems (EGS) by 90%, to $45 per megawatt-hour by 2035;
- **Floating Offshore Wind Shot** seeks to reduce the cost of floating offshore wind in deep waters by more than 70%, to $45 per megawatt-hour by 2035;

- **Industrial Heat Shot** seeks to develop cost-competitive industrial heat decarbonization technologies with at least 85% lower greenhouse gas emissions by 2035; and
- **Clean Fuels and Products Shot** seeks to develop cost-effective fuels and products from sustainable carbon sources to achieve >85% lower net greenhouse gas emissions by 2035.

The Department has also supported and continues to develop comprehensive roadmaps, vision studies and Pathways reports, which help to both guide investments across the Department and channel the activities of the private sector and academia. These include:

- Wind Vision Report (updated 2018)[1]
- GeoVision Study (2019)[2]
- Solar Futures Study (2021)[3]
- Pathways to Commercial Liftoff: Advanced Nuclear (2023)[4]
- Pathways to Commercial Liftoff: Clean Hydrogen (2023)[5]
- Pathways to Commercial Liftoff: Carbon Management (2023)[6]
- Pathways to Commercial Liftoff: Long Duration Energy Storage (2023).[7]

In addition, DOE regularly reevaluates the missions of its applied Research, Development, and Demonstration (RD&D) programs to ensure they are serving the American public and staying at the cutting edge of the energy technology landscape. In 2021, we renamed the Office of Fossil Energy Research and Development as the Office of Fossil Energy and Carbon Management (FECM) to reflect the program's work not just on the safety, environmental footprint and efficiency of energy production from fossil fuels, but also a renewed emphasis on research to support the capture, transport, utilization, and safe permanent storage of the carbon dioxide associated with the use of fossil fuels. In 2023, the Department formally realigned the Advanced Manufacturing Office into the Advanced Materials and Manufacturing Technologies Office and the Industrial Efficiency and Decarbonization Office, reflecting our commitment to good governance and targeted oversight over narrowly focused RD&D portfolios. This realignment reflects the pivotal role that materials science, critical materials, and industrial technologies RD&D play across all of America's industries in the 21st century. By concentrating resources into these two offices with narrowed scope, we can support industrial decarbonization through innovation, targeted investment, and technical assistance and continue our work to secure domestic supply chains of critical materials and technologies while more nimbly responding to

[1] https://www.energy.gov/eere/wind/articles/updates-wind-vision-roadmap
[2] https://www.energy.gov/eere/geothermal/geovision
[3] https://www.energy.gov/eere/solar/solar-futures-study
[4] https://liftoff.energy.gov/wp-content/uploads/2023/03/20230320-Liftoff-Advanced-Nuclear-vPUB.pdf
[5] https://liftoff.energy.gov/wp-content/uploads/2023/05/20230321-H2-Pathways-to-Commercial-Liftoff-Webinar-vF_web.pdf
[6] https://liftoff.energy.gov/wp-content/uploads/2023/04/20230424-Liftoff-Carbon-Management-vPUB_update.pdf
[7] https://liftoff.energy.gov/long-duration-energy-storage/#:~:text=LDES%20includes%20several%20technologies%20that,week%20LDES%2C%20and%20seasonal%20shifting

Congressional direction.[8] DOE will continue to evaluate the scope and mission of its applied programs to ensure we are pursuing activities that are both inadequately supported by the private sector and that meet the economic moment in a constantly changing energy economy.

The Department's RD&D activities also play a substantial role in achieving the goals of DOE's Environmental Management (EM) and Legacy Management (LM) programs. DOE is committed to maximizing the benefit of RD&D investments while maintaining the momentum of cleanup progress, meeting regulatory milestones, and bringing EM sites closer to completion. Additionally, EM has developed a program charter for the incremental and high impact technology development program at Savannah River National Laboratory. EM is accounting for the directions received under the 2021 National Defense Authorization Act (NDAA) or High-Impact and Incremental Technology Development Programs as well as a University Program in this effort.

Bipartisan Infrastructure Law and Inflation Reduction Act Progress

Through the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA), Congress provided more than $62 billion for programs under the purview of the Department of Energy. The BIL requires DOE to stand up 60 new programs – including 16 demonstration and 32 deployment programs – and expands funding for 12 existing Research, Development, Demonstration, and Deployment (RDD&D) programs. The BIL also provides funding for many programs authorized by the bipartisan Energy Act of 2020, including energy storage demonstration projects, the Advanced Reactor Demonstration Program, carbon capture demonstration and pilot programs, industrial emissions demonstration projects, and more.

Further, through the IRA, Congress invested approximately $35.5 billion in programs administered by the Department of Energy, including $8.8 billion for the Home Energy Rebates Program, nearly $6 billion for industrial decarbonization, and increased loan authority for our Loan Programs Office (LPO) to help bolster burgeoning American innovation and domestic energy production.

As of September 6, 2023, the Department has released 60 Requests for Information (RFI) for input from the public on BIL and IRA program design and released a total of 101 funding opportunities worth more than $67.5 billion in initial investments for BIL and IRA programs. We also conditionally awarded $1.1 billion in credits for zero-emission nuclear energy generation, made available $4.25 billion in formula funding to state and local governments and Tribal Nations for energy efficiency and other clean energy projects. We have selected nearly $3 billion in awards for battery material processing, manufacturing, and recycling for negotiation, and shovels are in the ground for many of those projects. We have announced our first two selectees for Direct Air Capture Hubs, one located in Texas and the other in Louisiana, and made nine awards for carbon capture demonstration front-end engineering design (FEED) studies. We have selected three partners for FEED studies on carbon dioxide (CO2) transport. We have announced five new Industrial Assessment Centers, which will help their community partners identify opportunities that optimize energy efficiency and environmental performance at manufacturing

[8] https://stage.energy.gov/eere/amo/about-amo-restructure

and other industrial facilities. And we expect to announce selectees under the $10.5 billion Grid Resilience and Innovation Partnerships (GRIP) program in the very near future.

The Department continues to look for opportunities to enhance its internal structures and operations to best facilitate the effective and efficient implementation of these laws. This includes making sure our Under Secretariat for Infrastructure is working closely with their research and development counterpart programs in the Office of the Under Secretary for Science and Innovation. The sharing of cross-departmental subject matter expertise in the development and execution of our funding opportunities for demonstrations and deployments, as well as the continued participation of scientific experts in evaluating and accommodating the lessons learned from each DOE project, are critical to the success of our investments. The Under Secretariats are constantly collaborating so that investments tackle the most critical barriers first; so National Laboratory expertise underlies analysis, and so technology and adoption readiness informs year-over-year strategy and impact. We are laser-focused on stewardship of the taxpayer dollar and maximizing positive outcomes for the American people while moving these new resources expediently, in keeping with Congressional intent.

Conclusion

I am extraordinarily proud of both our scientists and engineers and our broad and deep capabilities that place the United States at the forefront of science and technology internationally and ensures this nation's future economy and national security. The importance of the efforts of these scientists and engineers at our National Laboratories and at institutions of higher learning cannot be overstated—they are producing scientific breakthroughs that underpin innovations that are critical to our nation's future. Your continued support has helped sustain these efforts—including recruiting and retaining the brightest scientists and engineers, maintaining world-leading capabilities at our 28 user facilities, and training a diverse and talented workforce of the future.

The Department is committed to advancing this Administration's energy, climate, and nuclear security and nonproliferation goals. In addition, the Department will continue to work with our peer agencies within the federal RDD&D structure to enhance our nation's innovation capabilities and deliver new technologies critical to our economic and national security. I thank the Committee for its support for the DOE mission, and I am happy to answer your questions.