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BEFORE THE
SENATE ENERGY AND NATURAL RESOURCES COMMITTEE
ON
THE STATE OF ENERGY INNOVATION
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Thank you, Chairman Murkowski, Ranking Member Manchin, and Members of the Committee. I am honored to discuss the state of our nation's energy innovation.

Before I begin, I and the rest of the current DOE leadership team would also like to extend a special thanks to Secretary Moniz, as well as Deputy Secretary Poneman, for their outstanding leadership of the Department and their exceptional stewardship of our National Laboratories. The National Laboratory Complex (Lab Complex) was created long before we were born, and will continue long into the future after we are all gone. And it is incumbent upon us in leadership to commit to these institutions, add to them, and help accomplish a part of their lifetime of missions, and hand them off to the next leadership team a bit stronger. We say thank you to the previous team, for the strong current state of the National Labs.

As Secretary Perry noted at Secretary Moniz's portrait unveiling this past fall, from the first Secretary of Energy James Schlesinger to Secretary Bill Richardson to today, this Department has grown in stature and importance in serving our nation in driving innovation.

The Department's innovation enterprise consists of more than 60,000 people in program offices, across the Lab Complex, and among the researchers across the country at universities in all fifty states supported by our grant programs. The Department has benefited from the bipartisan support we have received for more than four decades.

The Department holds the legacy and mission-driven science and innovation that helped win World War II, and then helped keep the peace in the Cold War. Fermi and Lawrence, Rickover and Oppenheimer, as well as the others who followed, were individuals who combined brilliance with a bias for action. Their profound impact, beyond science and innovation, includes protecting and strengthening the economic and national security of our nation.

Today, the talented and dedicated individuals who serve at the Department are proud to be part of that tradition, and even prouder to still serve that mission. One of the most noteworthy examples of the impact of our individuals is that the Lab Complex is the greatest generator of Nobel Prize Laureates in the world, with over 40% of the prizes in physics, and over 25% of the prizes in chemistry, awarded to people who have worked in our National Laboratories.

This last week, I posted our policy paper, "American Scientific Leadership in the 21st Century," and we submitted that paper also to this Committee for this hearing. In it, we highlight the importance of federal support for science and innovation, as well as our focus areas for FY 2019. I also submitted to this Committee a copy of the "75 Breakthroughs" of the DOE National Laboratories that summarizes some of the world's top innovations discovered or supported by our National Laboratories.

I will identify six areas of special interest today: Artificial Intelligence, Quantum Technologies, Advanced and Sustainable Energies, Space and the Universe Exploration, Advanced Mobility, and Genomics. And we at the Department, with your significant support over the years, are taking a lead on all six of these areas.

Within the areas of innovation, I will segment our research into two areas: Applied Energy and Science, and discuss some of our innovation research efforts.

Applied Energy:

The American energy revolution, driven by the National Laboratories, universities, and the private sector, has dramatically improved emissions, costs, and energy production in the last decade. And this technology revolution is based on American innovation.

In the last decade, there has been a significant increase in public policy proposals with mandates or taxation for energy to drive energy and emissions goals. These positions are being driven without full understanding that there has been a very significant jump in energy technologies.

The following are some of the dramatic technology jumps that have occurred in the past decade:

- Wind turbine capacity factors have increased by more than 50%[1]
- Solar all-in production costs have dropped 90%[2]
- Utility-scale batteries are now cost competitive with natural gas turbines[3]

Our costs, energy production, and emissions rates, have dramatically improved because of American technology innovation, driven by broad bipartisan support for federal research at the National Laboratory Complex, as well as in academic institutions and the private sector.

What is on the horizon for American Innovation for energy?

We believe that U.S. scientific research will continue to deliver significant reductions to emissions and costs as replacement cycles drive modification or replacement of older plants with newer technologies, whether in fossil, nuclear, or renewables.

[1] https://www.energy.gov/eere/wind/downloads/2017-wind-technologies-market-report
[2] https://www.seia.org/research-resources/solar-market-insight-report-2018-q4
[3] Vistra West Texas battery, 375-megawatt Visra Moss Landing battery, 182.5-megawatt Tesla Moss Landing battery

There will be significant jumps in new energy technologies, such as new battery chemistries three to five times better than lithium ion, carbon capture based on just-developing new materials, and next generation nuclear. New distributed grid technologies to integrate these are moving fast. And we expect to become a net energy exporter, and expand our leadership in energy technologies globally.

Battery storage is a great example of a key technology that millions of people see, need, and want to use.

Increasing electric vehicle ranges, portable device battery lives, and optimal use of renewable and fossil power sources – such as harvesting daytime solar power for use through the night – are possible with improved chemistry, materials, and manufacturing processes that DOE's National Laboratories are pursuing.

Battery recycling also gives us an opportunity. Lithium-ion batteries are currently collected and recycled at a rate of less than five percent, which is why we recently announced the launch of a Lithium-Ion Battery Recycling Prize and the establishment of an associated Battery Recycling R&D Center. Through those efforts, we hope to profitably capture 90 percent of all lithium-based technologies in the United States, making an impact not just in battery storage but also critical materials.

I would like to highlight renewables and grid modernization, as a second area of Applied Energy high-impact research.

Grid modernization was the focus of our most recent Innovation XLab event, and with our National Laboratories, we're conducting innovative research and development designed to move us toward a stronger, more reliable North American energy system.

There are five priorities driving those grid modernization efforts:

1. Developing a dynamic North American Energy Resilience Model to understand risks to infrastructure and identify potential investments to be made by asset owners;
2. Exploring opportunities to improve the resilience of the transmission assets that feed critical sectors, particularly for defense-related infrastructure;
3. Supporting the development of sensor technologies that will allow system operators and utilities to anticipate, identify, and respond to issues on the grid more quickly;
4. Advancing grid-scale storage technology megawatt-scale storage capable of supporting regulation, ramping and energy management for bulk and distribution power systems; and
5. Helping Puerto Rico and the U.S. Virgin Islands in their efforts to improve the long-term recovery and resilience of their electric infrastructure.

We also recently announced $40 million in funding for the Grid Modernization Initiative, to develop technology innovations to modernize the nation's grid and ensure that it remains resilient, reliable and secure.

Renewables are an essential and growing part of our nation's energy portfolio. They increase our energy diversity and grid resiliency. That's why renewables, along with energy storage and energy efficiency, are critical elements of our overall energy and economic strategy.

The Office of Energy Efficiency and Renewable Energy is also making advances in a number of critical areas at the grid edge, including energy storage, the integration of distributed energy resources, and behind-the-meter systems.

Science Innovation:

Innovation begins with discovery. New energy technologies have their root in basic science. A strong, continued effort in basic science is essential to fuel technology development and keep the engine of innovation running. America's leadership in basic science remains a cornerstone of our security and prosperity.

Through the Office of Science, the Department of Energy is the largest federal sponsor of research in the physical sciences. The DOE Office of Science also is the lead federal agency for basic energy research.

In recent years, the DOE Office of Science has sought to accelerate energy innovation by developing new modalities for sponsoring research, which have resulted in successful programs such as the DOE Energy Frontier Research Centers, the DOE Energy Innovation Hubs, and the DOE Bioenergy Research Centers.

The key to the approach is assembling as a virtual center a multidisciplinary team of researchers from multiple institutions dedicated to making rapid progress in a particular area—and providing proactive oversight of the effort to ensure success. The goal of this team-building is to create a whole that is greater than the sum of its parts.

In addition, these effort are explicitly designed to bridge the usual gap between science and technology by being ever alert to discoveries in basic science that are ripe for technology development and commercialization—and by facilitating the latter through patent applications. As a result, in addition to producing multiple discoveries and breakthroughs in basic science, these programs have generated substantial intellectual property.

In all, these efforts have been enormously productive, producing thousands of peer reviewed publications as well hundreds of inventions at various stages of the patent process.

A second major contribution of DOE's Office of Science is the array of major scientific user facilities at the DOE National Laboratories, which forms part of the backbone of the nation's scientific infrastructure.

DOE supercomputers have recently dominated the headlines. High performance computing has become an enormous powerful tool of both scientific discovery and industrial innovation. The Department of Energy leads the world in high performance computing for science and industry.

Today the U.S. owns five of the top ten supercomputers in in the world, include the #1 and #2 systems, and all five of those U.S. machines are at the DOE National Laboratories.

In addition to the supercomputers, there are the five x-ray light sources—the Linac Coherent Light Source and Stanford Synchrotron Radiation Light Source at SLAC National Accelerator Laboratory; the Advanced Light Source at Lawrence Berkeley National Laboratory; the Advanced Photon Source at Argonne National Laboratory; and National Synchrotron Light Source II at Brookhaven National Laboratory. These have become indispensable instruments for materials science and chemistry as well as biology, medicine, and pharmaceutical discovery.

They, too, are a major source of innovation, as are our neutron scattering facilities and our Nanoscale Science Research Centers.

We are laying the groundwork for a new bio-economy in which a range of environmentally friendly fuels and other products will be produced using engineered microbes and renewable plant feedstocks. A key to that effort is the DOE Joint Genome Institute at LBNL, the world's largest genomic sequencing center for microbes and plants related to energy.

It may be recalled the original idea and impetus for the Human Genome Project came from the Department of Energy, and we continue to be a leader in advancing the science of genomics.

Let me discuss one of these Science Innovations in more detail. Quantum technologies to use the basic theories of quantum mechanics for practical information technology solutions has the real chance of transforming the world, and the National Labs are a key part of U.S. current leadership in this area.

When I testified to this Committee this past September, I noted that Quantum Information Science (QIS) will not only open new vistas for science and technology development, it will also open new commercial markets. There are three areas of applications for QIS: computing, networking, and sensing. Each of these areas can have major jumps in performance as a result of quantum technologies.

The Office of Science has had a significant role in many aspects of QIS research and development. This includes work in basic quantum science, including materials synthesis and processing, instrumentation for quantum control, and theory and modeling of quantum

entanglement. It also includes work on quantum devices and systems including qubit technologies, quantum sensors and detectors, novel architectures for quantum computing technologies, software implementation and reliability and quantum networks.

On the last point, I would note that Argonne and Fermilab, along with Caltech, the University of Chicago and the University of Illinois at Urbana-Champaign, are deeply engaged in quantum networking research and development in Chicago. A number of projects are underway there, including a DOE-supported effort to create the Quantum Link, the world's first entangled quantum network, between Argonne and Fermilab."

That network will ultimately teleport information across the 30-mile distance between the two labs, and is expected to be among the longest in the world to send secure information using quantum physics. It offers a completely new way to send information and will be a testbed for developing the science and technology for new quantum possibilities.

This past September, we also announced $218 million in funding for 85 research awards in Quantum Information Science. Scientists at 28 institutions of higher learning and nine DOE National Laboratories developed hardware and software for a new generation of quantum computers, which will synthesize and characterize new materials with special quantum properties and probe how quantum computing and information processing can provide insights into dark matter and black holes.

Finally, I'd also like to acknowledge the National Quantum Initiative Act that the Congress passed and the President signed into law this past December. Through that measure, we'll work with our partners across the federal government to further the frontiers of QIS research and technology and scientific development. We are grateful for your confidence and recognize what it means, in innovation as well as in staying ahead of our competitors overseas.

Innovation Commercialization Efforts:

We are also committed to developing and promulgating policies that support innovation and commercialization -- policies that combine the expertise and capabilities of the National Laboratories with the energy and ideas of the private sector in order to foster commercialization and speed the movement of products from the bench to the marketplace.

For example, we've taken a number of approaches to increasing the impact of CRADAs, Cooperative Research and Development Agreements and SPPs, Strategic Partnership Projects.

This past November, we announced the approval of the Laboratory Agreement Processing Reform initiative, which is designed to streamline the ability of contractors at our National Labs to enter into certain lab partnering agreements within a DOE-approved portfolio of routine work. We anticipate that this will significantly reduce the processing time for agreements, enabling the National Laboratories to concentrate on more complex, potentially higher-impact transactions.

At the same time, we also announced a Liability Reform initiative, which provides more flexibility for the Labs to address indemnity requirements. Indemnity requirements are a common barrier to engagement with the private sector, so we anticipate that this Liability reform will increase the ability of potential partners to work with the National Laboratories by tailoring associated risk to specific circumstances.

Building on a pilot launched under the previous Administration, in late 2017, we made permanent Agreements for Commercializing Technology (ACT), a tool that allows the National Laboratories to be more flexible in working with industry on research and technology projects. We've also expanded the use of ACTs by authorizing a new pilot program called FedACT. This program extends the benefits of ACT to those who wish to partner with DOE's National Labs on federally-funded projects.

DOE is leading the Administration's Lab-To-Market CAP Goal in the President's Management Agenda as co-chair of the interagency committee, by focusing on reducing regulatory and administrative burdens through greater clarity and consistency; increasing private sector engagement through agile, streamlined partnering and licensing agreements based on best practices; and building a more entrepreneurial R&D workforce by leveraging entrepreneurship programs that represent best practices and better managing conflicts of interest.

The Administration, led by the Department of Commerce's National Institute of Standards and Technology, recently released a draft Green Paper detailing 15 key actions to modernize the U.S. system of technology transfer and innovation to meet America's economic and national security needs for the 21st Century. DOE is working closely with NIST and other partners on this important effort.

In addition, we have designated the Director of the Office of Technology Transitions as the Department's Chief Commercialization Officer. Led by the Chief Commercialization Officer, the office will have elevated status and visibility in driving and promoting DOE technology, showcasing our capabilities and facilities, and increasing the impact of our investments. They will continue to oversee OTT's Partnerships and Investment outreach team, the Technology Commercialization Fund, the Technology-to-Market program, and the coordination of technology transfer activities and best practices across the DOE complex.

Just last month, DOE established a Research and Technology Investment Committee (RTIC) following requirements of the DOE Research and Innovation Act that became law last fall. The purpose of the RTIC is to convene key elements of the Department that support research and development activities to share and coordinate their strategic research priorities, identify potential cross-cutting opportunities in both basic and applied science and technology, and ensure key upcoming decisions are effectively leveraged.

Additionally, DOE has kicked off a new series of Summits called Innovation XLab, the most recent of which was on Grid Modernization, as I mentioned earlier. The XLab Summits are designed to increase the engagement of the National Labs with the private sector on high-impact, and potentially transformative, innovations and technologies.

Innovation XLab Summits facilitate a two-way exchange of information and ideas between industry, universities, investors and customers with innovators and experts at DOE and our National Labs. We both highlight research from the laboratories that is approaching commercial application and, just as importantly, hear from industry about its current and emerging technical challenges, risk appetite, and investment criteria.

In this way, DOE incorporates "market pull" as an important input into our R&D portfolio planning. This is already leading to promising connections to ensure our economic and energy dominance. Our first XLab Summit highlighted energy storage technology, and our second addressed grid planning, cyber and behind-the-meter technology. We will be hosting future events on advanced manufacturing, genomics, and other topics.

OTT also recently launched the Lab Partnering Service, or LPS. The LPS is an online, single-access platform for investors, innovators and institutions, enabling them to locate and obtain information from and easily contact our 17 National Labs regarding research, capabilities and intellectual property. It represents a significant step in reducing barriers that often limit investors from partnering with our Labs, in consolidating information and increasing access, and in encouraging industry and academia to fully use our world-class resources.

These activities represent only a small portion of our efforts in innovation at the Department of Energy. And this New Year, this new Congress offers new duties, new possibilities, and new opportunities.

We are determined to make the most of them.

As our predecessors have shown the way, we are determined to lead the Department of Energy in making an impact in science and security, in innovation and commercialization. Above all, we are committed to our mission, and to renewed service to our nation.

Thank you, and I look forward to answering your questions.