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Good afternoon. Thank you, Chairwoman Fletcher, Ranking Member Weber, and Members of the subcommittee. I appreciate the opportunity to appear before you today to discuss the role of the Department of Energy (DOE) national laboratories in making progress toward an economic recovery and a long-term, clean-energy future.

My name is Lee Cheatham, and I lead the Office of Technology Deployment and Outreach at Pacific Northwest National Laboratory (PNNL), a DOE national laboratory located in Richland, Washington. My office is responsible for all technology transfer from PNNL's intellectual property portfolio. I also serve as Chair of the National Laboratory Working Group on Technology Transfer (NLTT.) This working group is comprised of the technology transfer principals at each of the national laboratories.

My testimony today is on behalf of my work at PNNL and my role serving as Chair of the NLTT but does not represent the views of DOE.

The Energy Department's seventeen national laboratories are a system of intellectual assets unique among world scientific institutions that serve as regional engines of economic growth for states and communities across the country. Today, I will address three perspectives on our role in the nation's capacity for science, engineering. and innovation.

First, national laboratories promote and develop broad interactions with industry, allowing a natural handoff of lab-developed technology to companies creating market-serving products.

Second, the technology developed and transferred to private-sector partners draws on research conducted in all of DOE's mission areas. Such programs include the broad set of basic and fundamental sciences, energy research and technologies, and national security.

And third, successful transfer and commercialization begins with a research staff who understand the market. By providing laboratory staff with exposure to companies and markets, researchers better understand the value of increasing the speed and frequency of transitioning new ideas and technology from lab to market.

The interplay of these three perspectives – strong industry connections, broad mission-related research, and unique science and engineering workforce – allows the National Laboratory System to successfully meet the DOE mission challenges of scientific breakthroughs, scale-up engineering, and innovation-based economic competitiveness.

Each of the seventeen national laboratories has as its primary steward a major DOE office. (See the list of DOE Laboratories and DOE Office stewards at the end of this testimony.) DOE's Office of Science is the nation's largest federal sponsor of basic research in the physical sciences. It stewards ten national laboratories. Three laboratories are stewarded by the National Nuclear Safety Administration. Four national laboratories are stewarded by other DOE program offices. Sixteen of the national laboratories are federally funded research and development centers (FFRDC) and are managed by non-federal entities through Management and Operations Contracts with DOE. One laboratory, National Energy Technology Laboratory (NETL), is a fully federal laboratory and all staff members are federal employees.

Research and development conducted by the national laboratories aligns with the mission areas for which DOE has responsibility, including basic science, national security, energy, environmental management, and nuclear technologies. Each laboratory has an identified core mission area in which it conducts research. At the same time, most national laboratories conduct research across many of DOE's mission areas. The National Laboratory System has a unique asset in the 27 user facilities, funded by DOE's Office of Science. These large-scale scientific facilities are beyond what any single research organization can afford. They operate as shared-access resources to the scientific community. Researchers gain access through competitive, peer-reviewed proposals and agree to make publicly available their findings.

All national laboratories actively engage in transferring research and technology to the private sector. The Report on the Utilization of Federal Technology developed by the DOE Office of Technology Transitions for the most recent five-year period shows more than 2,300 active agreements each year with private sector and non-DOE federal partners and more than 750 active cooperative agreements each year with non-federal partners. During that same five-year period, the national laboratories reported an average each year of 1,700 new inventions, nearly 1,000 patents filed and 3800 active licensed technologies.

Before proceeding with discussion of the three perspectives outlined above, let me acknowledge that the situation we face in the COVID-19 pandemic and associated economic downturn requires the highest level of attention for those of us in the national laboratory system. With respect to technology transfer, the national labs have responded in two ways. First is to identify existing technologies, then support and promote them to address the COVID-19 risks. One example is a micro aerosol disinfecting technology called Paerosol. Developed at PNNL, it was licensed in 2018 to NanoPure, a South Carolina company. Preliminary test results are now showing Paerosol's effectiveness in eliminating COVID-19 particles. As one demonstration, Florida State Firefighters Association has deployed multiple response units to disinfect fire stations, restaurants, businesses, hospitals, schools and first response vehicles using Paerosol.

Second, national laboratories have opened access to our portfolio of technologies for evaluation by reducing the time required, administrative barriers and cost. Again, using PNNL as just one example, we waived the fee for an exploratory license on each of our available technologies through December 31, 2020. The easy, two-page license agreement, now with no fee included, has been exercised numerous times by companies seeking to address the COVID-19 challenge.

Direct interaction enhances transition of national laboratory research to the market

<u>National laboratories work directly with private sector companies</u>

The national laboratories have unique capabilities that can help companies differentiate their products. These capabilities are developed through federally funded research and development programs. They are available to companies on a cost-reimbursement basis. Such Lab-Industry projects can be fully funded by the company (or companies) involved to address specific technical challenges the company faces. Alternatively, cooperative research and development projects provide a way for national laboratories and companies to work jointly, when technical contributions from the laboratory and company are required.

The DOE Office of Science user facilities, operated by the national laboratories, provide unique capabilities available for use by outside organizations. Tens of thousands of researchers from universities, companies and other institutions use these capabilities, generally without charge if the results of their research are published.

In addition to these collaborative research mechanisms, companies can access commercially available technologies developed at the national laboratories through standard intellectual property licensing. All laboratories have technology transfer officers. DOE's Office of Technology Transitions maintains an access point to more than 40,000 technologies developed by the national laboratories in an online database, the Laboratory Partnering Service.

> Examples of laboratory-company partnerships:
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> Argonne National Laboratory (ANL) developed engine models and software for computer simulations to provide understanding of how engine parameters interact. In partnership with Caterpillar and Convergent Science, the team conducted simulations of a Caterpillar engine. The result was reduced cost and time for new engine development and enabling adaptation of fuels from new sources and improved fuel economy.
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> Ames National Laboratory researchers developed a lead-free, drop-in replacement for solder used in electronics. The new technology was licensed to Iowa-based Johnson Manufacturing Co. When regulations on lead precluded its use in electronics, this technology was the basis for broad international adoption.

Sandia National Laboratories (Sandia) and various partners, including Ford Motor Company, agreed to transition Sandia's ducted fuel injection technology from the laboratory to production engines. Developed at Sandia's Combustion Research Facility, ducted fuel injection eliminates 50-100% of the soot from engine exhaust. Engine manufacturers are interested in the technology, in part, because it doesn't require extensive changes to their production processes. It can also be retrofitted onto existing engines.

Creating space to collaborate

One lesson from the creation of the DOE User Facilities is that dedicated, purpose-built facilities are important for effective collaboration leading to innovation breakthroughs. National laboratories are also creating physical spaces tailored to specific laboratory-industry interactions. These facilities are designed to support research, development, and testing for technologies, such as next-generation manufacturing or battery systems. A benefit of these facilities is the opportunity for direct interaction between laboratory researchers and company staff to advance both the laboratory's capabilities and the company's product development.

The Grid Storage Launchpad (GSL) is a new collaboration facility planned for the PNNL campus to advance the next generation of grid energy storage technologies. Within GSL, researchers will validate innovative energy storage materials under realistic grid operating conditions. The facility also provides collaboration laboratory space for researchers and industry experts to accelerate the deployment of these materials and technologies.

The Manufacturing Demonstration Facility (MDF) at Oak Ridge National Laboratory (ORNL) was the first user facility with the DOE Office of Energy Efficiency and Renewable Energy (EERE) as its steward. It was established in 2012 to perform early-stage research and development in advanced manufacturing, including additive manufacturing, carbon fiber development, composites advance machining, roll to roll processing, and digital manufacturing. It currently has more than 180 industrial and more than 50 university partners. One of its notable successes is demonstration of new polymer deposition equipment that prints fiber-reinforced polymer structures that are up to ten-times larger and 2,400 times faster than previously available.

The Advanced Manufacturing Laboratory (AML) is a 14,000 square-foot facility supporting the development of new materials and processes. Lawrence Livermore National Laboratory (LLNL) uses this facility to advance its national security missions. Industry partners develop new products and services. AML was dedicated in early 2020. Partnerships with energy, security, and manufacturing companies were established within the first few month of operations.

Meeting Expectations / Addressing Challenges

The national laboratories have hundreds of ongoing projects with companies at any one time. Each interaction between a national laboratory (a federal entity) and a private sector company, group of organizations, or other non-federal entity is treated as a business transaction to ensure all expectations about the federal investment in the public-private partnership are met. While funding may not always flow between the partners, a clear statement of the work to be accomplished and other relevant conditions is established.

Establishing how the project will be conducted takes time. However, the market challenges each company partner faces are time sensitive. The national laboratories, in partnership with DOE, continually look for ways to provide certainty to the project teams and streamline the startup process. For example, two changes recently initiated by DOE allow the national laboratories simplify project startup with private sector partners. First a Master Scope of Work process has been implemented that allows national laboratories to gain pre-approval for a clearly defined, low-risk activity that will be performed for multiple sponsors. This pre-approval of scope shortens the approval time for each specific project. Second, national laboratories are able to relax the contract terms for a set of predefined low-risk activities.

The Technology Commercialization Fund program has provided an important opportunity to encourage company engagement with the national laboratories. Because a company partner is required, the program directly supports a laboratory's work with a company to address a market opportunity or issue. In this way, it highlights the role national laboratories can serve in addressing key technical challenges for product development, especially for small businesses.

Research in all national laboratory mission areas contributes to technology transfer

Each of the national laboratories has a DOE program office as steward. While these steward relationships establish the major focus and operating environment for each laboratory, they do not limit the range of research and development activities that the laboratory undertakes. As a result, the research and development portfolios for each laboratory are broad. For example, almost all laboratories conduct some level of basic research and many conduct national security research.

A review of DOE's program offices gives a sense of the scope of research and development areas included (see end notes.)

Energy technologies represent a large portion of laboratories' research and commercialization

National laboratories continuously develop new ideas to meet our nation's energy demand. From batteries to lightweight materials to recycled carbon to the next generation electric grid, national laboratory researchers are inventing and engineering new innovations. Laboratory researchers engineer these new concepts into energy systems for vehicles, buildings, and electrical services.

Examples of energy sciences, research and technology:

Two major DOE-sponsored initiatives are underway leading the development of high-performance battery materials. The Joint Center for Energy Storage (JCESR) is a long-term effort creating transformative batteries for transportation and the electric grid. Led by ANL, it includes three national laboratories, fourteen universities, and other research organizations. Private sector affiliates include GE Global Research, General Motors, Dow-Corning and Lockheed-Martin Advanced Energy Systems, as well as industry organizations such as the Electric Power Research Institute.

Battery 500 is a consortium of four national laboratories and five universities. Led by PNNL, this team is focused on electric vehicle batteries with three times the available energy to weight ratio of today's technology. Private sector partners include IBM, Tesla, Livent Corp., and NaatBatt, with project participation by General Motors, Mercedes-Benz and Navitas Systems.

Idaho National Laboratory (INL) formed a partnership with Oklo Inc. to demonstrate a power plant design for use in remote or off-grid locations. It combines a micro-reactor based on small advanced fission technology with integrated solar technology.

<u>Nearly all laboratories engage in fundamental research at some level</u>

Basic and fundamental science is a key part of the national laboratory system's research portfolio. The outcomes of a basic research investigation are expected to be new knowledge and principles about natural phenomena. While these concepts do not generally provide a basis for translation into a company's products and services, the experimental equipment, data acquisition, and control systems required for the experiments many times do represent innovations with market value.

Examples of technology transfer from fundamental research:

The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) is a DOE Office of Science user facility designed and operated to explore the most basic ingredients that make up the universe. At points where RHIC's two opposing beams of heavy ions collide, special high-performance detectors and data collection systems measure and track the released particles. The software that drives RHIC's data systems contains algorithms that prove useful for other challenges – such as managing internet traffic congestion. A local startup company has been formed to commercialize this technology in partnership with BNL.

The Illinois Accelerator Research Center (IARC) at Fermi National Accelerator Laboratory (FNAL) is using electron beam applications to eradicate perfluoroalkyl substances (PFAS.) PFAS are difficult to break down and therefore accumulate in the environment. In partnership with 3M, IARC researchers are searching for economical methods to eliminate these "forever chemicals."

> Imagion Biosystems and the Center for Integrated Nanotechnologies (CINT), a DOE Office of Basic Energy Sciences Nanoscale Science Research Center operated by Los Alamos National Laboratory (LANL) and Sandia, have worked together since 2006 on synthesizing nanoparticles. Bob Proulx, CEO of Imagion Biosystems, stated that "the fact that CINT has a user program that allows industry to access the facilities and equipment that, otherwise, would be too expensive for a small company like ours was valuable. The initial work we did with CINT to develop a method to give precise control over the size of the nanoparticle was key for our MagSense magnetic relaxometry technology for the detection of cancer."

<u>Labs engage and support small business needs</u>

The national laboratories have a long-standing role in supporting the needs of small businesses. This support may take one of several forms. First is direct support toward a technical challenge that the small business does not have the expertise to address. Second may be a partnership between the small business and laboratory in developing the company's products. One example of the latter case is a national laboratory partnering with a small business to propose to a federal agency's Small Business Innovation Research (SBIR) program. Third, a small business or startup company may license technology from a national laboratory. In conjunction with the license, a research agreement may be established to ensure full understanding about the licensed technology is transferred to the company's personnel.

DOE has several current and past programs effective in establishing the partnership between a small business and a national laboratory. They include:

> Laboratory Partnering Service (LPS) – LPS, operated by DOE's Office of Technology Transitions, was mentioned previously as a source of all patents from DOE national laboratories. In addition, LPS offers companies access to key technical experts at the national laboratories. The LPS user can search for an appropriate expert or user facility. then contact the laboratory to request information and discuss their technical challenge. LPS also includes profile information about the full set of resources available at each laboratory.
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> Technology Commercialization Fund (TCF) – TCF provides funding to partnerships of national laboratories and companies intending to commercialize laboratory-developed technology. DOE/OTT manages this annual, competitive solicitation of proposals. A cooperative research and development agreement (CRADA) is executed between the partners to enable the project to begin.
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> Technology Assistance Program (TAP) – Several of the national laboratories have had technology assistance programs that address the technical questions a small business may have. These engagements can be likened to a consulting activity. TAP is intended to address activities in which no new research content or intellectual property is created. Most TAP programs have been funded by national laboratory discretionary funds.

A specific version of the technology assistance was launched in 2020 in response to the COVID-19 pandemic. DOE/OTT provided funding for laboratories to support small businesses with technology needs for addressing the impacts of the pandemic.

Small Business Vouchers (SBV) – DOE's SBV program was created to allow small businesses to call on national laboratory capabilities when technical development was required. In that way, it can be considered to fill the gap between the TAP and TCF programs. SBV is currently dormant and not accepting applications.

This set of small business programs has proven extremely valuable to both the affected businesses and to the national laboratories.

Lab researchers' direct experience with industry enhances technology transfer

<u>Researchers find direct experience with companies through research engagements valuable</u>

Programs that provide exposure to entrepreneurial skills and experiences, co-development with industry, or direct support of small business allow researchers to understand company and market perspectives through direct learning. Not all national laboratory researchers want to become startup entrepreneurs nor move to a company. They are committed to their research priorities at the national laboratory. They do find the exposure to a company's opportunities, challenges, and business model provides a fresh perspective and increases their success in developing new research programs.

The programs mentioned previously also provide this experience. Interactions within TCF and TAP projects provide opportunities for working with a company to address their issues. Requests for advice through LPS provide the opportunity to diagnose how the national laboratory can assist the company. Each of these experiences expand the researcher's perspective.

<u>Entrepreneur training helps broaden and validate researchers' innovation concepts</u>

DOE's Energy I-Corps program is the centerpiece of most national laboratory efforts to expose their researchers to entrepreneurial training. Based on industry-standard practices, it provides exposure to the initial stages of building a business case around a laboratory technology, including direct interaction with potential customers. Since its inception in 2015, 111 teams from eleven national laboratories have participated in the Energy I-Corps program.

The national laboratories have individually augmented the core program with introductory programs that provide a brief exposure to the Energy I-Corps concepts. Its value is to engage more researchers in entrepreneurial training than is possible through the core program alone. In addition, laboratories have created pitch sessions where laboratory researchers gain feedback from investors and startup professionals.

> An example of the value of entrepreneurial training:
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> One of the inventors of the RHIC data collection system mentioned earlier participated in basic entrepreneurial training at BNL. It was through these sessions the researcher became aware of the possibility to apply the high throughput data technology to applications outside of experimental equipment for fundamental physics.

<u>Entrepreneurial leave programs</u>

For some national laboratory researchers, the attraction of a startup company is enticing enough they decide to join one. To support this transition, many of the national laboratories have created entrepreneurial leave programs. These programs must deal with two primary issues. First is establishing the length of the leave and the conditions that must be addressed when anyone moves from a federal entity to the private sector. Second are the residual benefits and commitments, if any, provided to the staff member while on leave.

Of the national laboratories that have implemented entrepreneurial leave, no two are identical. They all do, however, address the core set of issues outlined above.

Recently, the existence of an entrepreneurial leave program has become an important incentive in recruiting researchers. Stated differently, we find the lack of a program to be a disincentive for researchers to join a laboratory – or any other science and engineering organization. This is especially true for early career researchers.

Conclusions

In this testimony, I have outlined three perspectives on how the DOE National Laboratory System uses partnerships with industry to inform our research across broad and diverse mission spaces, to result in positive impact on the U.S. economy. Through direct interactions with companies, universities, federal agency sponsors, and other organizations, national laboratory researchers can better align their research to the future scientific needs and current market opportunities. This continues to keep our nation at the forefront of science and technology.

Some of the programs I've discussed today are relatively new; some are not. They all offer important advantages in translating laboratory technologies to market solutions. For that reason, we in the national laboratory system are committed to supporting them to the extent possible.

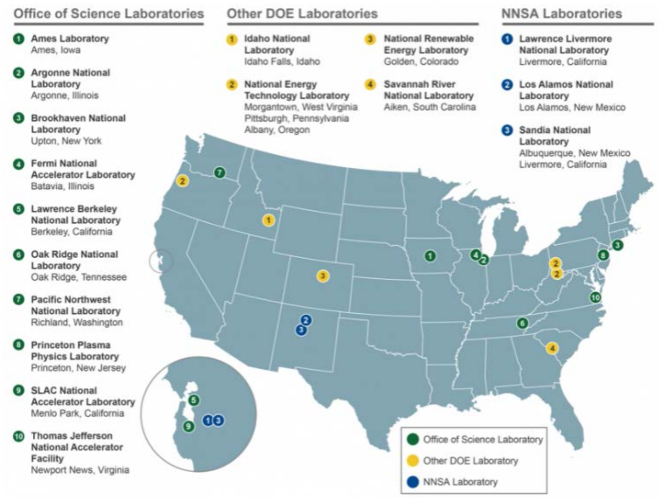
The purposes of this hearing today are well aligned with the needs and opportunities I believe are necessary to continue and expand the economic impact from the science and technology developments generated across the seventeen DOE national laboratories. We look forward to continuing our efforts to help realize that benefit.

Thank you for your attention to these challenges. And, once again, I thank you for the opportunity to testify on this important topic. I would be happy to answer any questions you may have.

Additional Information

National Laboratories and DOE Program Office Stewards

DOE's Office of Science stewards ten national laboratories: Argonne National Laboratory (ANL), Ames Laboratory (Ames), Brookhaven National Laboratory (BNL), Fermi National Accelerator Laboratory (FNAL), Thomas Jefferson National Accelerator Facility (JLab), Lawrence Berkeley National Laboratory (LBNL), Oak Ridge National Laboratory (ORNL), Pacific Northwest National Laboratory (PNNL), Princeton Plasma Physics Laboratory (PPNL), and Stanford Linear Accelerator Laboratory (SLAC).



Each of the 17 DOE National Laboratories is stewarded by a program office in the Department. The Office of Science stewards 10 of these, ranging from single-purpose laboratories like Fermilab to broad, multiprogram laboratories such as Argonne.

Three laboratories are stewarded by the National Nuclear Safety Administration: Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL) and Sandia National Laboratory (Sandia).

Four laboratories are stewarded by other DOE program offices: Idaho National Laboratory (INL), National Energy Technology Laboratory (NETL), National Renewable Energy Laboratory (NREL), and Savanah River National Laboratory (SRNL).

DOE's mission areas cover the breadth of physical sciences

The 17 national laboratories contribute to nearly all of DOE's mission areas. As a result, the research and development portfolios for each laboratory are broad. A review of DOE's program offices that serve as national laboratory stewards and major program sponsors gives a sense of the areas included:

- Office of Science includes basic and fundamental research in physics, basic energy sciences, biological sciences, environmental sciences, and advanced scientific computing
- National Nuclear Security Administration includes maintaining the stockpile nonproliferation, counterterrorism and counterproliferation, and powering the nuclear navy
- Office of Energy Efficiency & Renewable Energy
- Office of Electricity
- Office of Fossil Energy
- Office of Nuclear Energy
- Office of Environmental Management

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Lee Cheatham has an extensive track record of leadership in advancing science, technology, and commercialization in the DOE laboratory system, academia, and private industry. He joined Pacific Northwest National Laboratory as Director of Technology Deployment and Outreach in 2017, focusing on industrial partnerships to expand the impact of PNNL's science and technology.

Before joining PNNL, he launched and led Brookhaven National Laboratory's Office of Strategic Partnerships, where he expanded and diversified the lab's research portfolio and oversaw technology commercialization and economic development. He previously served as Chief Operating Officer and General Manager of Commercialization for the 500-person Biodesign Institute at Arizona State University. Before that, Lee served as Executive Director of the Washington Technology Center, connecting businesses with research institutions in the state. Lee began his professional career at PNNL as a computer science researcher and manager, including leading a $40M/year nationwide DOE-industry cooperative research project.

In the private sector, he launched businesses in commercialization consulting and software sales. Notably, he served as Vice President, Worldwide Engineering for a software company serving a majority of US libraries as well as globally.

Lee holds three degrees in electrical engineering: a Ph.D from Carnegie-Mellon University, an MS from Washington State University, and a BS from Oregon State University. He currently serves on the National Science Foundation Director's Business and Operations Advisory Committee.