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Summary

The Department of Energy's scientific user facilities are the nation's shared toolbox for research and innovation. These tools, too large for any organization other that the government to build, play a vital role in the economic and scientific leadership of the United States.

The DOE Office of Science, through its several program offices, has created and operates 26 user facilities. Additional department facilities support the security mission of the National Nuclear Security Administration. The total suite of facilities offers an extremely diverse set of technical capabilities.

More than 30,000 scientists from university, industry and government laboratories perform experiments at one or more user facilities. These researchers are from all 50 states, as well as from other countries. 375 companies, including more than 50 of the Fortune 500, use the facilities as part of their internal research and development.

The user facilities are essential centers for technical innovation. As part of the critical infrastructure of the United states, they must be strongly supported, maintained and upgraded. Current rates of investment risk the United States falling behind in the international competition in science, technology, and innovation.

Statement of

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Before

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Chairman Upton, Ranking Member Rush and Members of the Subcommittee,

My name is Stephen Wasserman. It is a pleasure to be at this hearing on Modernization of the Department of Energy to discuss the Department's scientific user facilities. DOE's creation and operation of these facilities, an important part of its support of research in energy and the physical sciences, is a major success story of the Department.

This morning I appear on behalf of the Society for Science at User Research Facilities, SSURF, on whose Board of Directors I currently serve. SSURF is a new scientific association, founded in 2016. It continues efforts that began more than 25 years ago to foster cooperation between the large scientific research facilities of the US government, as well as between the facilities and the scientists who use them. Today SSURF links facilities supported by the Department of Energy and the National Science Foundation, of which the majority are operated by DOE. Our society is a community of communities, a place where facility managers, staff and users work together to discover and provide cutting-edge science and capabilities. An important goal of SSURF is to assist the stakeholders of the user facilities, so that impact is as great as possible.

As we peer into the Department of Energy's future, it is useful to briefly look back at the path that has led to today. The genesis of the DOE User Facilities is found more than 70 years ago. In 1945, Dr. Vannevar Bush, the Director of the Office of Scientific Research and Development during World War II, issued a report, *Science, the Endless Frontier*, in response to a Presidential request a year earlier. The report described a new framework for the scientific future of the United States which included government funding of research in universities and national laboratories. In his text Dr. Bush stated that "research involving expensive capital facilities beyond the capacity of private institutions should be advanced by active Government support". The current DOE User Facilities are the result of such

support. The role of the government in providing them, both up to now and in the future, is critical.

The User Facilities are the nation's shared toolbox for research and innovation. The individual tools are large, often extremely so. They are located throughout the country. Access to the facilities is merit-based, with each operating an independent peer review system for proposed experiments. For researchers who will publish their results in the open literature, there are no fees. Organizations that undertake proprietary research reimburse the government for the full-cost to the facility of the experiments undertaken.

The Department of Energy's Office of Science, through its several program offices, operates 26 user facilities, many with multiple capabilities. Additional facilities support the security missions of the National Nuclear Security Administration. The facilities include X-ray sources, neutron sources, high-performance computers and computer networks, and particle accelerators for high energy physics. No other nation has the sheer number and variety of scientific capabilities that US scientists can avail themselves of here at home.

The User Facilities are imbedded in our scientific psyche. Over 30,000 scientists from university, industry and government laboratories currently perform experiments at one or more user facilities.[1] These researchers come from all 50 states and from every continent except Antarctica. 375 companies use the DOE facilities, including more than 50 members of the Fortune 500. An indication of the facilities' effect on innovation can be seen in the fact that over 150 US small businesses make use of the experimental capabilities of the facilities.

[1] User statistics are from *Office of Science User Facilities Fiscal Year 2015*. https://science.energy.gov/~/media/_/pdf/user-facilities/Reports/DOE-SC-User-Facilities-FY2015-report.pdf

Most Federal agencies, which have a scientific component to their mission, sponsor or perform research at the User Facilities. These include the National Science Foundation, the National Institutes of Health, NASA, the Environmental Protection Agency, the US Geological Survey, the Centers for Disease Control, the National Oceanic and Atmospheric Administration, the Nuclear Regulatory Commission and the Departments of Energy, Defense, Homeland Security, Agriculture, and State.

Like the facilities themselves, the science undertaken is incredibly wide-ranging. Some experiments probe the fundamental characteristics of atoms and nuclear particles. Others yield results that can impact future technologies and products in the relative near term. Smart phones, pharmaceuticals, the strategic nuclear stockpile and environmental quality have all benefited from the existence of these often unique instruments.

Today I would like to provide two examples of the impact of the facilities. These represent only a minute sample of the thousands of research projects, ranging in focus from the fundamental to the applied, that are pursued each year through the resources available at the user facilities.

The first example comes from the Oak Ridge Leadership Computing Facility, OLCF. The General Electric company manufactures large turbines, fueled by natural gas, for the generation of electrical power. In 2014 GE noticed an instability in the combustion flame of their then current turbine design. Although the instability did not affect performance, GE wondered whether a similar instability would occur in the next generation turbine, scheduled to be tested in late 2015. GE, in cooperation with software provider Cascade Technologies, used the Titan supercomputer at OLCF to simulate both turbines. The calculations reproduced the instability found in the old turbine and predicted that such a phenomenon would not alter performance in the new one. Full-scale physical tests of the

new turbine several months later confirmed the simulations. The first of the new turbines, which increase efficiency by 2%, a major improvement in the field of power generation, were installed in Texas in mid-2017. And GE now has an effective predictive modeling tool for future design work, a breakthrough that would not have been reached without Titan.

The DOE X-ray sources are vital to research and development in human health. Virtually every major pharmaceutical company in the US uses these sources to probe the structures, atom by atom, of proteins implicated in human disease. This area is one in which I have been involved for 20 years, currently at Eli Lilly and Company where I am director of the company's facility at the Advanced Photon Source (APS) of Argonne National Laboratory. My colleagues at Lilly and in the pharmaceutical industry continually investigate how potential new medicinal compounds interact with their biological targets to enhance or inhibit their function. These efforts have aided the development of drugs to treat cancer, diabetes, hepatitis, and autoimmune diseases, as well as ongoing research to find approaches to the treatment of Alzheimer's. New medicines whose developments included experiments at one of the DOE synchrotrons can be found in each year's approvals by the Food and Drug Administration. In a recent example that is for me close to home, in September the FDA granted approval for abemaciclib, a new treatment for certain forms of breast cancer that was developed by Lilly. I and my Lilly co-workers performed experiments at the APS as part of the research that led to this medicine.

The type of cooperation between national laboratories and industry in the second example can also be found in cooperative interagency research between the user facilities and the National Science Foundation and the National Institutes of Health. Examples include the joint NSF/DOE partnership in basic plasma science and engineering, which includes use of the DOE user facilities. NIH has agreements with all four of the DOE synchrotron X-ray sources (Advanced Light Source, Advanced Photon Source, Stanford Synchrotron Radiation

Lightsource, National Synchrotron Light Source-II) to support beamlines for studies on biological materials.

An often overlooked facet of the User Facilities is their staffs. The scientific personnel consist of dedicated and talented women and men who work, often at unusual hours, to enhance the capabilities of the facility equipment and the quality of the experiments undertaken by the users. At the same time the administrations of the facilities seek to continually improve the user experience. While most users only interact with the scientists and the user office, the facilities have cadres behind the scenes who ensure that the equipment functions properly, the experiments are as effective as possible and that the users, and those who fund them, obtain the results they need.

Today our country is focused on the need to upgrade the nation's infrastructure. The user facilities are a type of infrastructure that, like transportation and utilities, needs to be maintained and improved. Renewal of the facilities does occur. Examples include the creation of the National Synchrotron Light Source-II to replace the then 30-year old NSLS as well as planned or proposed upgrades to three other DOE X-ray sources and the Spallation Neutron Source. The DOE Office of Science has been an excellent steward of this infrastructure. However, the Office has been handicapped by budgets whose buying power has significantly decreased over the last decade. Current fiscal constraints mean that renewal often occurs at a slower pace than the facilities age and that timelines for upgrades are lengthened or delayed. The latter increases the cost of modernization. Timely funding of these projects offers better value for the American people. The current levels of support have already left our nation behind in the capabilities available at a small subset of the facilities. Continuing this trend risks expanding the gap in innovation and technology between the United States and other nations.

In conclusion, I would like to return to *Science, the Endless Frontier*. The title of Dr. Bush's report indicates that the quest for scientific knowledge and the innovative technologies derived from that knowledge is continual. But this quest and the methodologies employed for it are not static. The User Facilities have evolved with time, ensuring that the tools available remain up to date and relevant.

Near the end of his summary, Dr. Bush observed that "responsibilities (for scientific research) are the proper concern of the Government, for they vitally affect our health, our jobs, and our national security…. The government should foster the opening of new frontiers and … (science) is the modern way to do it." We at SSURF and our colleagues in the user facility community could not agree more. The user facilities are a critical part of the greatness of the US scientific endeavor. We urge the continued and expanded support of these "crown jewels" of our science and technology ecosystem. We need them for our economy, security and quality of life.

Thank you.