

Testimony of Under Secretary for Science and Energy Franklin Orr
U.S. Department of Energy
Before the
Appropriations Subcommittee on Energy and Water Development
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Chairman Simpson, Ranking Member Kaptur, and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the Department of Energy's (DOE) Budget Request for the Office of Science in fiscal year (FY) 2016. I appreciate the opportunity to discuss how the Budget Request advances the Department's mission in delivering fundamental scientific research.

At the end of 2013, policymakers came together on a bipartisan basis to partially reverse sequestration and to pay for higher discretionary funding levels with long-term reforms. We have seen the positive consequences of that bipartisan agreement for our ability to invest in areas ranging from research and manufacturing to strengthening our military. We have also seen the positive consequences for the economy, with an end to mindless austerity and manufactured crises contributing to the fastest job growth since the late 1990s. The President's Budget builds on this progress by reversing sequestration, paid for with a balanced mix of commonsense spending cuts and tax loophole closers, while also proposing additional deficit reduction that would put debt on a downward path as a share of the economy.

Meanwhile, the President has made clear that he will not accept a budget that reverses our progress by locking in sequestration going forward. Locking in sequestration would bring real defense and non-defense funding to the lowest levels in a decade. As the Joint Chiefs and others have outlined, that would damage our national security, ultimately resulting in a military that is too small and equipment that is too old to fully implement the defense strategy. It would also damage our economy, preventing us from making pro-growth investments in areas ranging from basic research to applied energy technologies at the Department of Energy. As the President has stated, he will not accept a budget that severs the vital link between our national and economic security, both of which are important to the Nation's safety, international standing, and long-term prosperity.

The Science and Energy Challenge

The use of energy is woven through every aspect of modern societies. We rely on the conversion of energy resources into services that fuel our nation's households and businesses, transportation sector, manufacturing, and the economy as a whole.

Today we are in the middle of an American energy renaissance. There is no shortage of primary energy resources in the United States, and we are poised to take full advantage of them. These include renewable sources from the sun, wind, and water; thermal energy within the earth's upper crust; fossil fuels; and nuclear resources. The question we face is how to convert them to energy services—how we apply our ingenuity to supply those services safely, reliably, and economically. In doing this, we must also work to harness energy in ways that are environmentally sound.

President Obama has directed Federal agencies to work towards a low carbon economy through his Climate Action Plan. More recently, he has made a historic commitment to reduce the United States' greenhouse gas emissions by 26-28 percent by the year 2025. To make these reductions a reality, we need to use all the greenhouse gas reduction technologies in our toolkit, and we must also invent new ones and develop them to be economically practical.

Through DOE, American people support over 30,000 experts across the Department's Science and Energy missions to carry out the research, development, demonstration and deployment that will serve as a foundation for a low carbon economy. When the Energy Secretary joined the Department almost two years ago, one of the first things he did was restructure it to create an Under Secretary for Science *and* Energy. He did this to more closely integrate the Office of Science with the applied energy offices focused on energy efficiency and renewables, fossil, nuclear and electricity delivery.

As Under Secretary, my job is to coordinate our scientific research efforts with the applied energy research and development that will lead the nation to a low carbon future. Fundamental science underpins everything we do in the energy sector, and the world of energy applications is rich with opportunity to put the science to work, and also for energy applications to illuminate the opportunities for science that could have game-changing impact. My office is working to foster productive links among the science and energy programs as we build and execute the Department's research, development, demonstration and deployment activities. The FY2016 Science and Energy Budget Request reflects these links.

Overview of the FY 2016 Science and Energy Budget Request

The FY 2016 Budget Request for the Department of Energy's science and energy programs supports the President's all-of-the-above energy strategy. The Department is investing across the innovation chain—from basic scientific and discovery research to the demonstration and deployment of energy technologies. The National Laboratories are key contributors to this work, providing the Nation with strategic scientific and technological capabilities. The applied energy programs are focused on innovating across a diverse portfolio of clean energy technologies to enhance economic competitiveness and secure America's long-term energy security and

infrastructure. The Budget Request also continues to implement the President's Climate Action Plan through the development and deployment of clean energy technologies that reduce carbon pollution.

The \$10.7 billion science and energy Budget Request in FY 2016, \$1.4 billion above the FY 2015 Enacted level, supports DOE's missions of enabling the transition to a clean energy future with low-cost, all-of-the-above energy technologies; supporting a secure, modern, and resilient energy infrastructure; and providing the backbone for discovery and innovation, especially in the physical sciences, for America's future prosperity.

I will briefly provide an overview of the Office of Science budget request. The acting Director of the Office of Science will provide more detail in her testimony.

Highlights of the Science FY 2016 Budget Request

The Office of Science delivers scientific discoveries and tools to transform our understanding of nature and advance the energy, economic, and national security of the United States. It accomplishes this through two principal thrusts: direct support of scientific research and direct support of the development, construction, and operation of unique, open-access scientific user facilities. In carrying out these missions, the Office of Science is the largest federal sponsor of basic research in the physical sciences, supporting 22,000 researchers at 17 National Laboratories and more than 300 universities.

In addition to sustaining operation of 10 National Laboratories and several user facilities, the Office of Science had several accomplishments in FY 2014. The Department completed construction on schedule and within budget on several facilities—the National Synchrotron Light Source II at Brookhaven National Laboratory, the 12 GeV Upgrade of the Continuous Electron Beam Accelerator Facility at Thomas Jefferson National Accelerator Laboratory, the Numi Off-axis electron neutrino (ν_e) Appearance (NOvA) project led by Fermilab, and the National Spherical Torus Experiment at Princeton Plasma Physics Laboratory with commissioning underway.

These facilities allow for fundamental scientific research and discovery that enable advances for industries of all sectors to benefit from. For example, last year a research team mapped the structure of a protein within a living cell using the Linac Coherent Light Source at SLAC National Accelerator Laboratory. DOE-funded university research also led to the development of a new class of polymer-based flexible electronics for solar cells and medical applications.

To continue to promote the nation's scientific capabilities, the FY 2016 Budget Request includes \$5.34 billion for the Office of Science—\$272 million above the FY 2015 enacted level. These funds will allow DOE to continue to lead basic research in the physical sciences and develop and

operate cutting-edge scientific user facilities while strengthening the connection between advances in fundamental science and technology innovation.

The Budget Request includes a significant funding increase in our Advanced Scientific Computing Research program to support new high performance computing technologies on the road to capable exascale computing. This investment will help maintain America's leadership in energy, biosciences, materials sciences, climate science and chemistry, areas in which new doors will be opened with the availability of next-generation computation capabilities that are 200-400 times faster than today's premier systems. This effort is closely coordinated with the National Nuclear Security Administration, which is using supercomputing to maintain our nuclear deterrent and support nonproliferation and counterterrorism.

Underpinning our ability to be world leaders in scientific research is the world's largest collection of scientific user facilities operated by a single organization in the world. Each year, they are used by 31,000 researchers. The FY 2016 Budget Request funds operation of these facilities and supports design work and construction at a number of new facilities. The Office of Science has a positive track record of completing large projects on time and on budget.

In June last year, DOE awarded \$100 million to fund 32 Energy Frontier Research Centers, which bring together interdisciplinary science teams to work together in a particular area—ranging from solar energy and biosciences to carbon capture and sequestration. These centers have already had an outsized impact in terms of scientific discovery and the FY 2016 Budget Request increases funding to create new research centers and continue to fund those in operation now.

Crosscutting Budget Initiatives

One of the ways the Department is increasing the productive links between the science and energy programs is through the budget crosscuts the Department introduced in the last budget cycle.

Building on the success of last year's crosscutting proposals, my office is continuing to bring together subject matter experts across our programs to overcome overarching challenges. The crosscuts embody the improved agency-wide coordination the Secretary envisioned when he created the Office of the Under Secretary for Science and Energy as part of the Department's FY 2013 reorganization.

Taking an enterprise-wide approach to research efforts will improve outcomes and avoid redundancy between program offices. The FY 2016 Budget Request includes just over \$1.2 billion in crosscutting research and development across six initiatives: cybersecurity; the energy-

water nexus; exascale computing; grid modernization; subsurface science, technology and engineering; and supercritical carbon dioxide electric power generation technology.

Five of these initiatives were established in FY 2015, and they have evolved and matured as their coordination resulted in high-impact proposals in the FY 2016 Budget Request. The sixth, on the energy-water nexus, is a new proposal in the FY 2016 budget request.

The Office of Science is participating in four of these crosscut initiatives. I will first detail the three crosscuts the Office of Science is continuing to participate in: cybersecurity; exascale computing; and subsurface technology and engineering, and then the one additional crosscut we introduced in the FY16 Budget Request on the energy-water nexus.

Cybersecurity: Protecting the DOE enterprise and improving cybersecurity in the energy sector

The Department of Energy is engaged in cyber-related activities to protect the DOE enterprise, including government-owned, contractor-operated sites, from a range of cyber threats that can adversely impact mission capabilities; and activities to improve cybersecurity in the electric power subsector and the oil and natural gas subsector. Strengthening cybersecurity to protect the DOE enterprise requires bolstering the Department's cybersecurity functional capabilities to identify, protect, detect, respond, and recover from the increasing incidence of cyber-attacks.

To this end, the Department has established a Cybersecurity crosscut to strengthen the coordination of budget activities related to cybersecurity so that cybersecurity is managed based on strategic priorities. The DOE Budget requests \$306 million to fund this Cybersecurity Crosscut initiative in FY 2016. DOE has also established an internal Cyber Council to serve as the principal forum for coordinating cyber-related activities across the Department and for consideration of cyber-related issues requiring decisions by DOE senior leadership.

Under the Presidential Policy Directive on Critical Infrastructure Security and Resilience (PPD-21), DOE is the Sector Specific Agency for the energy sector and has a number of responsibilities, including the following: 1) collaborating with infrastructure owners and operators to strengthen the security and resilience of critical infrastructure; 2) serving as the day-to-day Federal interface for the prioritization and coordination of sector-specific activities; 3) carrying out incident management responsibilities consistent with statutory authority and other appropriate policies; and 4) providing technical assistance to the energy sector to identify vulnerabilities and help mitigate incidents, as appropriate.

Exascale Computing: Enabling U.S. leadership in the next generation of high performance computing

Since the beginning of the digital era, the U.S. Federal government has made pivotal investments in high performance computing (HPC) at critical times when market progress was stagnating. HPC technology is at another turning point where fundamental innovations in hardware and software architectures are necessary to drive future advances in computing performance. Committed U.S. leadership in HPC is a critical contributor to our competitiveness in science, national defense, and energy innovation as well as the commercial computing market. Equally important, a robust domestic industry contributes to our nation's security by helping avoid unacceptable cyber-security and computer supply chain risks.

For these reasons, DOE is proposing \$272.6 million for the Exascale Computing crosscut initiative funded through the Office of Science and the National Nuclear Security Administration. A significant investment by the Federal government involving strong leadership from DOE, in close coordination with government, national laboratories, industry, and academia is required to address this national challenge. The Exascale Computing crosscut initiative focuses on three pillars: foundational research, development and deployment activities; application development to take full advantage of the emerging exascale hardware and software technologies; and platform deployment to prepare for and acquire two or more exascale computers. Funding for the first two pillars is included in the FY 2016 Budget Request.

Subsurface Technology and Engineering: Advancing a new era of capabilities across a range of energy applications

Subsurface energy resources provide more than 80 percent of total U.S. energy needs today. Next generation advances in subsurface technologies may enable greater access to renewable geothermal energy and safer and more environmentally sustainable development of domestic natural gas supplies, as well as potentially provide hundreds of years of safe storage capacity for carbon dioxide and opportunities for environmentally responsible management and disposal of energy waste streams. Thus, discovering and effectively harnessing subsurface resources while mitigating impacts of their development and use are critical pieces of the Nation's energy strategy.

DOE's FY 2016 Budget Request includes \$244 million for the Subsurface Technology and Engineering crosscutting initiative. The subsurface crosscut, SubTER, will address identified challenges in the subsurface through highly focused and coordinated research in wellbore integrity, stress state and induced seismicity, permeability manipulation, and new subsurface signals to ensure enhanced energy security, material impact on climate change via CO₂

sequestration, and significantly mitigated environmental impacts from energy-related activities and operations.

Energy-Water Nexus: Creating more resilient and efficient energy-water systems

The energy-water nexus crosscut initiative is new in our FY 2016 request.

Water and energy systems are interdependent. Water is used in all phases of electricity generation and energy production, accounting for over 40 percent of total water withdrawals and over five percent of total water consumption. Conversely, energy is required to extract, convey, and deliver water of appropriate quality for diverse human uses, and then again to treat wastewaters before return to the environment; this accounts for three percent of total electricity consumption. Current trends are increasing the urgency to address the energy-water nexus in an integrated way. Precipitation and temperature patterns, U.S. population growth and regional migration trends, and the introduction of new technologies could shift water and energy demands.

Building on DOE's report on Challenges and Opportunities in the Energy-Water Nexus, published in June 2014, the Department proposes a \$38M program in FY 2016 Budget Request that involves six DOE organizations. This effort comprises a coordinated set of cross-program initiatives that 1) builds and deploys DOE modeling and analysis to improve understanding and inform decision-making for a broad range of users; 2) strategically targets crosscutting technology RDD&D opportunities within the system of water and energy flows; and 3) is informed and supported by focused policy analysis and outreach and stakeholder engagement. Taken as an integrated whole, these investments position DOE to contribute strongly to the Nation's transition to more resilient energy-water systems.

Additional Avenues for Increased Coordination Across Science and Energy

Funding proposed through the crosscuts ultimately resides within DOE's existing programs, but my office is coordinating execution as well.

In addition, the Science and Energy program offices as well as laboratory staff are hard at work drafting the 2015 Quadrennial Technology Review. This rigorous review will examine where the technological capabilities and overall outlook stand on the most promising research, development, demonstration and deployment opportunities across the range of technologies that will address the nation's energy needs in the years to come. The report's release is planned for later this year and I look forward to briefing Congress when the review is complete.

Conclusion

As the largest federal sponsor of basic research in the physical sciences, the Department of Energy plays a key role in advancing our understanding of nature and advancing the energy, economic, and national security of the United States. The FY 2016 budget request continues funding the core programs within the Office of Science as well as expanding key initiatives to continue to advance the United States' competitiveness in key scientific areas.