Testimony of Under Secretary for Science and Energy Franklin Orr
U.S. Department of Energy
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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 applied energy programs in fiscal year (FY) 2016. I appreciate the opportunity to discuss how the Request advances the Department's mission to research, develop, demonstrate and deploy clean energy technologies.

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.

The President 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, the 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 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 (R&D) 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 enhance the productive links among the science and energy programs as we build and execute the Department's research, development, demonstration and deployment activities. The FY 2016 Science and Energy Budget Request reflects these links.

Overview of the FY16 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.

The FY 2016 Budget Request across the Department of Energy's applied energy portfolio is $4.76 billion. This funding will support important advances in fossil energy, energy efficiency and renewable energy, grid modernization, cyber security, nuclear energy, and Indian energy policy and programs while increasing funding for new initiatives and priorities.

I will briefly provide an overview of the Science and Energy program budget requests. The Assistant Secretaries will provide more detail on their specific program budget requests in each of their written testimonies.

Highlights of the Energy Efficiency and Renewable Energy FY 2016 Budget Request

DOE's Energy Efficiency and Renewable Energy program provides research, development, demonstration and deployment funding to foster advances in sustainable transportation, renewable power, and energy efficiency. Across the nation today, a renewable revolution is occurring, and the Department of Energy is working to further accelerate the deployment of clean energy technologies.

The FY 2016 Budget Request proposes $2.72 billion—$809 million above the FY 2015 Enacted level—to continue a diverse suite of sustained investment in sustainable transportation technologies ($793 million), renewable power technologies ($645 million), and development of manufacturing technologies and enhanced energy efficiency in our homes, buildings and industries ($1.03 billion).

EERE's renewable power efforts include programs in wind, water, geothermal, and solar energy. As an example of this work, EERE's solar program is focused on further accelerating the rapid downward trend in solar energy costs. Just four years into our SunShot Initiative's 10 year goal of achieving cost parity for utility scale solar, we are two thirds of the way there. The FY 2016 Budget Request includes robust funding for solar photovoltaic R&D and efforts to cut non-hardware "soft costs" in half. Not only is this industry creating clean energy for Americans to use in their homes, businesses, and even their cars, but it currently provides jobs to nearly 174,000 solar workers across all 50 states.

Regarding sustainable transportation, the nation's vehicle fleets are now lighter, more efficient, and less dependent on oil than ever before, and the budget request invests in technologies that will accelerate those trends as well as progress on vehicle electrification and biofuels. The FY 2016 Budget Request supports aggressive vehicle technology goals through continued R&D on lightweight materials performance, advanced power electronics, and battery storage, as well as funding a SuperTruck II initiative to improve freight hauling efficiency, pursuit of drop-in biofuels, and automotive fuel cells.

EERE's energy efficiency efforts include work to advance energy performance in buildings, homes, and advanced manufacturing processes. As an example of this work, in addition to providing continued support for the four planned and existing Clean Energy Manufacturing

Institutes, the FY 2016 Budget Request fully funds the deployment of two additional Institutes and supports high-impact R&D on critical materials.

Highlights of the Nuclear Energy FY 2016 Budget Request

Nuclear power provides over 60% of the Nation's non-greenhouse-gas-emitting electric power generation, and it is worth noting that the Nation's first new nuclear plant this century will come online in the near future. In the last year, the Office of Nuclear Energy has successfully completed the first 5-year program at the Consortium for Advanced Simulation of Light Water Reactors nuclear modeling Hub at the Oak Ridge National Laboratory and has initiated a second award for design and licensing support of a small modular nuclear reactor with advanced safety features. To build on these successes, the FY 2016 Budget Request increases funding for Nuclear Energy to increase safety and extend the life of the current commercial fleet, as well as to invest in new reactor technologies for a low-carbon, clean energy future.

In the FY 2016 Budget Request, DOE proposes $908 million ($74 million above the FY 2015 Enacted level) to continue supporting the pursuit of several new concepts in nuclear reactor design. The FY 2016 Budget Request also continues to lay the groundwork for full implementation of the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High Level Radioactive Waste released in January 2013, providing $108 million for research, development, and integrated waste management system activities in the areas of transportation, storage, disposal, and consent-based siting. Finally, the Request supports development and qualification of accident tolerant fuel concepts as well as critical safeguards and security upgrades at the Idaho National Laboratory.

Highlights of the Fossil Energy FY 2016 Budget Request

Research undertaken through the Fossil Energy program is a key component of environmentally-sound development of the Nation's domestic fossil resource wealth. Last year, the DOE achieved an important milestone of 9 million tons total of CO_2 stored in geologic reservoirs, and will reach the 10 million ton mark this summer. In addition, the DOE-supported and world's largest post-combustion carbon capture project, the Petra Nova Project at NRGEnergy's WA Parish generating station in Thompsons, TX, reached financial close and began construction.

Building on the many Recovery Act-funded demonstration projects and the fossil energy loan guarantee solicitation issued a year ago by the DOE Loan Programs Office, the FY 2016 Budget Request increases funding for transformational carbon capture and storage technologies relevant to coal and natural gas. For the Office of Fossil Energy, the Department is requesting $842 million—the majority of which ($560 million) is dedicated to fossil energy research and development.

The FY 2016 Budget Request also supports collaborative R&D efforts through the Multiagency Unconventional Oil and Natural Gas initiative joint research program with the Department of

Interior and the Environmental Protection Agency. These joint efforts leverage the impact of research funding by the agencies and avoids duplication.

The FY 2016 Budget Request proposes $15 million in funding to develop and demonstrate technologies to identify, measure, and reduce methane leaks from midstream natural gas infrastructure and $10 million to improve quantification of methane leaks for inclusion in the national Greenhouse Gas Inventory, both key parts of the Administration's initiative to reduce fugitive methane emissions.

Even with expanding domestic energy supply, it is important that the United States maintain a healthy reserve to protect against unexpected supply disruptions, so this Request supports full operational readiness and drawdown capability of the Strategic Petroleum Reserve, as well as continued inventory maintenance of the Northeast Home Heating Oil Reserve.

Highlights of the Electricity Delivery and Energy Reliability FY 2016 Budget Request

A modern electric grid is essential to sustaining economic growth, supporting clean energy, and maintaining our energy security. With aging infrastructure and a rapidly changing energy landscape, it is vital that the Nation's power grid be modernized to ensure that consumers have access to reliable, secure, and clean energy. The Department of Energy is working hard to advance the technology innovation and institutional support and alignment needed to enable a grid of the future that is cleaner and more reliable, resilient and secure.

Even as the grid becomes "smarter" and more advanced, devices and technologies are deployed across the country to improve the reliability and efficiency of the system, reduce the frequency and duration of outages, and help consumers better manage their electricity use, more work is needed. As the Nation makes important progress towards our clean energy goals through expanded renewable energy generation, it is increasingly critical to build a flexible grid that effectively integrates variable and distributed renewables and is adapted to more active consumer participation. Sustained investments in the development, demonstration, and deployment of advanced technologies, such as energy storage, that will further enhance the stability, resiliency, and reliability of the grid are crucial. Last May, with cost-share funding provided by the Office of Electricity Delivery and Energy Reliability, Southern California Edison constructed and installed equipment for a prototype 8 megawatt/32 megawatt-hour battery storage plant for wind integration in Tehachapi, CA—one of the world's largest battery storage systems to date.

To continue DOE's important work to enable modernization of our Nation's grid, the FY 2016 Budget Request supports foundational technology and tool development. Through targeted investments in advanced distribution management systems, energy storage, microgrids, and synchrophasor applications, to name a few, DOE can help develop technology options for the electricity sector to strengthen regional and local infrastructure and markets, help communities become more resilient, and improve grid services overall.

The FY 2016 Budget Request proposes $270 million, $123 million above the FY 2015 Enacted level, to support a smart, resilient electric grid for the 21st century and fund critical emergency

response and grid security capabilities, including grant programs to develop and update energy assurance plans for states, localities and tribes, and a new effort to support state and multi-state electricity reliability.

A major challenge the Nation must address is the grid's vulnerability to cyber-attack. The Request includes $52 million for R&D to strengthen protection of critical energy infrastructure against cyber threats. The FY 2016 Budget Request provides special focus on tool development for cybersecurity incident management, and establishes a virtual platform for advanced digital forensics analysis for the energy sector.

Highlights of the Office of Indian Energy Policy and Programs FY 2016 Budget Request

Fundamental challenges to broad clean energy deployment still exist in tribal lands and communities. To help address these challenges, the Department requests $20 million—$4 million above the FY 2015 Enacted level, to support DOE's partnership with the Department of the Interior to address the need for clean, sustainable energy systems on Indian lands. This Budget Request continues the program's deployment focus through an expanded grant program and continued technical assistance efforts.

In addition, the FY 2016 Budget Request includes $11 million for a new Tribal Indian Energy Loan Guarantee Program that would help tribes invest in small and medium sized generation projects. This program would leverage the underwriting infrastructure in the DOE's Loan Programs Office, to help improve access to capital for energy projects in Indian country. The Loan Programs Office is the Department's key financing arm, which works with private companies and lenders to mitigate the financing risks associated with clean energy projects.

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 Request includes just over $1.2 billion in crosscutting research and development across six initiatives: exascale computing; grid modernization; subsurface technology and engineering; supercritical carbon dioxide technology; cybersecurity; and the energy-water nexus.

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. I'll first detail the five crosscuts my office is continuing in the FY 2016 Request and then describe the one addition—the energy-water nexus crosscut.

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

Since the beginning of the digital era, the 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.

Grid Modernization: Provides tools to set the Nation on a cost-effective path to the grid of the future

The reliability and functioning of the Nation's electricity grid is often taken for granted. Whereas rolling blackouts are the norm in many developing countries, U.S. customers have historically benefitted from highly reliable and affordable power transported through long-lived transmission and distribution infrastructure and built on a foundation of safe and secure centralized power generation. Our extensive and resilient power grid has fueled the Nation's growth engine and long been an exemplar for other countries. Access to electricity is such a fundamental enabler for the economy that the National Academy of Engineering named electrification the greatest engineering achievement of the 20th century.

The FY 2016 Request includes $356 million for the Grid Modernization crosscut initiative, which draws from the work in the Office of Electricity Delivery and Energy Reliability. This funding supports strategic investments by DOE in foundational technology development, enhanced security capabilities, and greater institutional support and stakeholder engagement, which will provide tools necessary for the evolution to the grid of the future. Investment is critical now as the energy system is being transformed by increased distributed renewable energy

generation, interactive demand side technologies, and the need to ensure resiliency against more frequent and intense weather events, as well as cyber and physical attacks.

Subsurface Technology and Engineering: Advances 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 oil and 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 crosscut 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 CO_2 sequestration, and significantly mitigated environmental impacts from energy-related activities and operations.

Supercritical CO_2 Technology: Synchronizes R&D activities around a collective technology demonstration opportunity

Steam based power cycles are used for approximately 80 percent of the world's electricity generation. Power generation cycles based on supercritical carbon dioxide (sCO_2) as the working fluid, instead of steam, have the potential for significantly higher thermal efficiencies (upwards of 50 percent improvement) with smaller physical footprint and lower capital cost than state of the art steam-based power cycles. The supercritical carbon dioxide power generation cycle also has the potential to eliminate the need for water required to cool traditional power plants and a directly fired supercritical CO_2 cycle could have significant cost reduction benefits for carbon capture and storage. This technology therefore could have transformative applications in power generation through coal, nuclear energy, geothermal energy, and concentrated solar power.

There is broad industry interest in partnering with DOE to demonstrate the sCO_2 power cycle due to the unique features of sCO_2; the potential for lower capital cost and the compounding performance benefits from a more efficient cycle; as well as the resulting efficiency gains in balance of plant requirements, fuel use, emissions, and water use.

The FY 2016 Budget Request proposes $43.6 million for the sCO_2 crosscut initiative. This initiative is structured around a common objective to establish a 10 MWe scale Supercritical Transformational Electric Power (STEP) pilot scale facility for evaluating power cycle and

component performance over a range of operating conditions. Demonstrating favorable performance at this scale is the next step required to address technical issues, reduce risk, and mature this promising technology.

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 to improve cybersecurity in the electric power and the oil and natural gas subsectors.

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. DOE 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.

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

The energy-water nexus crosscut initiative is new in our FY 2016 Budget 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 3 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 $38 million program in FY 2016 that involves five 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 crosscuts ultimately resides within DOE's existing programs, but my office is coordinating execution as well. One avenue for doing this is through our newly established National Laboratory Consortia. For example, the Grid Modernization Laboratory Consortium has set up a framework to integrate the shared efforts under the leadership of three headquarters programs—the Office of Energy Efficiency and Renewable Energy, the Office of Electricity Delivery and Energy Reliability, and the Office of Energy Policy and Systems Analysis—and the experts at the national laboratories. Following the creation of the Grid Modernization Laboratory Consortium, the Department has now established one in Subsurface Engineering.

In addition, the Science and Energy programs 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. I look forward to briefing Congress when the review is complete.

Conclusion

The Department of Energy is focused on implementing the President's all-of-the-above energy strategy to lead the nation to a secure, low carbon future. The technologies the Department is researching, developing, demonstrating and deploying will become the portfolio of energy technology options in the decades to come that will help meet our greenhouse gas emissions reduction targets.