Summary of Statement by Christopher Smith, Assistant Secretary for Fossil Energy
U.S. Department of Energy
Subcommittee on Energy, Committee on Science, Space and Technology
U.S. House of Representatives
May 11, 2016

Our fossil fuel resources are essential to the Nation's security and economic prosperity. At the same time, a dramatic shift in the way we use fossil fuels will be critical to meeting our national and global climate goals.

Through the Fossil Energy Research and Development (FER&D) program, FE is working to develop and demonstrate technologies such as carbon capture, utilization, and storage (CCUS) that will enable the continued use of our fossil fuel resources for clean, affordable, and reliable energy. To this end, FE plays an important role in DOE's effort to support Mission Innovation, a landmark initiative launched by the U.S. and 19 other countries to double public clean energy research and development (R&D). This is in addition to commitments for private investments led by a coalition of 28 private investors from ten countries.

The FER&D program is administered by FE and implemented by the National Energy Technology Laboratory (NETL). The program advances technologies related to the reliable, efficient, affordable, and environmentally sound use of fossil fuels that are important to our Nation's security and economic prosperity. The CCS and Advanced Power Systems program is focused on reducing carbon emissions by advancing the environmental performance and efficiency of fossil energy systems integrated with CCUS technologies.

The FER&D portfolio includes several major integrated CCUS demonstration projects encompassing different innovative technological approaches and applications of CCUS. To date, DOE's major demonstration projects and Regional Carbon Sequestration Partnerships have stored 11.8 million metric tons of CO_2.

The Fuel Supply Impact Mitigation portfolio under FER&D is focused on environmentally prudent and efficient development, as well as responsible stewardship, of the Nation's natural gas resources. The program continues to implement priority collaborative R&D, together with Department of the Interior and the EPA, to ensure that resource development is conducted in a manner that is environmentally sound and protects human health and safety.

Finally, NETL is carrying out congressionally-mandated research on the feasibility of extracting rare earth elements (REE) from coal and coal byproducts.

The Department of Energy is committed to working with industry, our National Labs, and other stakeholders to develop the science and innovative technologies that will allow the Nation to use its abundant fossil energy resources in a way that meets our energy needs, ensures environmental responsibility, and secures U.S. leadership in the global clean energy economy. Technology innovation is critical to this effort. Our programs have made substantial progress toward meeting these goals, and we believe these continued advances will help ensure that the U.S. will continue to lead the world in clean energy technology innovation.

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Assistant Secretary for Fossil Energy
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Fossil Energy Research and Development

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Thank you Chairman Weber, Ranking Member Grayson, and members of the Committee. I appreciate the opportunity to discuss the programs and activities within the Department of Energy's (DOE) Office of Fossil Energy (FE).

Our fossil fuel resources are essential to the Nation's security and economic prosperity. At the same time, a dramatic shift in the way we use fossil fuels will be critical to meeting our national and global climate goals. According to the International Energy Agency (IEA), fossil fuels are projected to remain a major feature of the energy mix even as the world acts to limit temperature increases to 2 degrees Celsius. In the IEA 2 Degree Celsius Scenario (2DS), fossil fuels account for approximately 40 percent of primary energy use in 2050. As we transition to a low carbon energy future, FE will continue working to develop innovative and cost-effective technologies for the environmentally sound use of fossil fuels that will be essential for economic growth, energy security, and U.S. competitiveness going forward.

MISSION INNOVATION

Through the Fossil Energy Research and Development (FER&D) program, FE is working to develop and demonstrate technologies such as carbon capture, utilization, and storage (CCUS) that will enable the continued use of our fossil fuel resources for clean, affordable, and reliable energy. To this end, FE plays an important role in DOE's effort to support Mission Innovation, a landmark initiative launched by the U.S. and 19 other countries to double public clean energy research and development (R&D). This is in addition to commitments for private investments led by a coalition of 28 private investors from ten countries.

Going forward, FE has the opportunity to strengthen the Department's tangible contribution to Mission Innovation. As proposed in the FY2017 Budget, this initiative would build on FER&D advances and accomplishments to bring to market revolutionary methods and technologies that capture, use, and store CO_2 from power plants, as well as from industrial sources.

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

The FER&D program is administered by FE and implemented by the National Energy Technology Laboratory (NETL). Through this program, FE is working with partners in industry and academia to develop new innovative technologies that will enable the environmentally sound and more efficient use of fossil energy resources in the face of climate change.

CCS and Advanced Power Systems

The Fossil Energy Research and Development (FER&D) program advances technologies related to the reliable, efficient, affordable, and environmentally sound use of fossil fuels that are important to our Nation's security and economic prosperity. The CCS and Advanced Power Systems program is focused on reducing carbon emissions by advancing the environmental performance and efficiency of fossil energy systems integrated with CCUS technologies. This program is concentrated on the following research areas:

Carbon Capture

Carbon Capture R&D is focused on developing post-combustion and pre-combustion carbon dioxide (CO_2) capture, as well as advanced combustion technologies, such as oxy-combustion and chemical looping. This research is targeted at 2nd generation and transformational technologies that can reduce the cost and increase the efficiency of CO_2 capture in fossil-fueled power plants. In addition to existing research, the President's Fiscal Year (FY) 2017 Budget request includes $31 million to support a Front End Engineering Design (FEED) study and initial construction of a large pilot facility to capture CO_2 from a natural gas power system. Funding would also be used to test existing post-combustion capture systems on natural gas that are currently field testing technologies from the bench to small slipstream pilot-scale.

Research partners from national labs, universities, and the private sector are developing these new carbon capture technologies. The technologies are evaluated first in a laboratory environment, and then tested at the DOE-sponsored National Carbon Capture Center (NCCC) in Wilsonville, Alabama. The NCCC has tested more than 30 advanced carbon capture technologies, totaling more than 78,000 hours of combined testing. The NCCC recently assumed leadership of the International Carbon Capture Test Center Network, which was established under the Carbon Sequestration Leadership Forum. The purpose of the network is to share best practices and learning from the carbon capture test facilities throughout the world to advance the development and deployment of 2nd generation and transformational carbon capture technologies.

In FY 2015, DOE selected six projects as part of a Phase 1 effort under the Post-Combustion Capture Systems R&D to develop advanced, 2nd generation post-combustion carbon capture technologies. In FY 2016, up to two of these projects will be selected to move on to Phase 2, in which a 10 – 25 megawatt (MW) unit will be built and tested. These projects will accelerate development of next-generation CO_2 capture technologies by validating the potential of advanced solvents, advanced

sorbents and novel process configurations to reduce the energy penalty and cost associated with capturing carbon dioxide.

Carbon Storage

Carbon Storage R&D is focused on developing and validating technologies to ensure safe and permanent geologic storage of captured CO_2 from fossil fuel systems. The Carbon Storage subprogram significantly contributes to DOE's cross-functional Subsurface Science, Technology and Engineering RD&D (SubTER) Technical Team activities related to subsurface technologies. Therefore, much of the work being conducted by FE under the Carbon Storage subprogram is being coordinated with other DOE offices through the SubTER Technical Team to maximize the value of this research across the Department.

Recent accomplishments under the Carbon Storage subprogram include the release of the fifth edition of Carbon Storage Atlas (Atlas V), which identifies prospective CO_2 storage resources of at least 2,600 billion metric tons across the U.S. and other portions of North America. The Atlas contains updated information on DOE's carbon storage activities and field projects, including large-scale field projects conducted by the Department's Regional Carbon Sequestration Partnerships. Additionally, the National Risk Assessment Partnership, led by NETL, has developed simulation tools designed to help evaluate environmental risks of carbon storage.

The Carbon Storage subprogram is also exploring the potential of producing fresh water from produced brines at CO_2 storage sites, which could prove highly beneficial for regions that face water shortages. In FY 2015, DOE selected five Phase 1 projects to evaluate the potential benefits of brine extraction associated with carbon storage as a pressure management and enhanced water recovery operation. These projects were included in the November 2014 joint announcement between President Obama and President Xi Jinping of China. They serve as counter-facing projects with China under the US-China Climate Change Working Group.

Using prior appropriations, the Carbon Storage program is funding R&D on technologies that have the potential to reduce CO_2 emissions and the near-term cost of CCUS by developing beneficial uses for captured CO_2 other than enhanced oil and gas recovery. These beneficial uses include the conversion of CO_2 to chemicals, plastics, building materials, curing for cement, and the integration of carbon utilization technologies with fossil fuel power plants, including biological conversion systems.

In FY 2016, DOE selected two projects that will focus on biological CO_2 use/conversion. One project will integrate microalgal production systems into a coal-fired power plant to study the ability to use and mitigate CO_2 emissions from flue gas. The other project will study microalgae-based CO_2 capture with conversion of the resulting algal biomass to fuels and bioplastics. The FY2017 Budget requests no funding for CO_2 use and reuse.

Advanced Energy Systems

Advanced Energy Systems (AES) R&D includes gasification, turbines, and fuel cell energy conversion systems. The AES subprogram's mission is to increase the availability and efficiency of fossil energy systems integrated with CO2 capture, while maintaining the highest environmental standards at the lowest cost. Many of these technologies require new approaches to electricity generation, and simultaneously achieve higher efficiencies while capturing CO_2 as part of the conversion process. The research is targeted at improving overall system efficiency, reducing capital and operating costs, and enabling affordable carbon capture.

FE is currently exploring a number of innovation pathways to improve power generation efficiency and optimize the operation and utilization of the plant itself. More efficient turbines that incorporate pressure gain combustion technology can be employed in both coal and natural gas systems. In addition, the use of supercritical CO_2 (in place of steam) as a primary working fluid can enhance the performance of fossil fuel plants with the potential for application in other thermoelectric power cycles (e.g., nuclear, geothermal, and concentrated solar power). Activities in this subprogram support the Supercritical Transformational Electric Power (STEP) initiative, which is a central component of DOE's Supercritical CO_2 crosscut effort targeted at technology development for supercritical CO_2-based power conversion cycles.

Crosscutting Research and Analysis

Crosscutting Research and Analysis fosters the development of innovative systems for improving availability, efficiency, and environmental performance of advanced energy systems integrated with carbon capture and storage (CCS). The subprogram targets research gaps identified in the rest of the CCS and Advanced Power Systems portfolio that have potential to be solved through computational means or by examination through university research programs. It also includes technologies that can apply to a variety of different power systems. For example, the Carbon Capture Simulation Initiative, led by NETL, has developed simulation tools designed to accelerate the development of 2nd generation and transformational carbon capture technologies.

Research areas include: sensors and controls critical to the implementation and optimization of advanced fossil fuel-based power generation systems; materials that can be applied to the full range of fossil fuel power generation technologies; simulation-based engineering design tools that reduce the risk and time required to deploy advanced technologies; and water management improvements in thermoelectric systems, which contributes to DOE's Energy-Water Nexus Crosscut R&D.

Major Demonstrations

Scale-up of innovative technologies is inherently risky and investors in large-scale, capital-intensive projects are inherently risk-averse. To enable widespread commercial CCS deployment and realize the emissions reduction potential, commercial-scale demonstration projects are important to validate that CCUS technologies can be deployed while maintaining reliable, predictable, and safe operations. Therefore, the FER&D portfolio includes several major integrated CCUS demonstration projects

encompassing different innovative technological approaches and applications of CCUS. To date, DOE's major demonstration projects and Regional Carbon Sequestration Partnerships have stored 11.8 million metric tons of CO_2.

Advances through this R&D include demonstrating the business case for carbon capture utilization and storage at commercial-scale using an existing coal-fired generating facility, which is being done by NRG's Petra Nova project. The project is expected to capture 1.4 million tons of CO_2 annually. The CO_2 will then be used to extract additional, hard-to-access oil from a previously depleted oil field 80 miles away, safely storing the carbon underground in the process. NRG scaled up the Petra Nova project from the original 60MW to the 240MW currently being built to improve project economics and support more economically viable CO_2 flooding of the candidate oil field for enhanced oil recovery.

At the same time, Southern Company's Kemper project is building a new, first-of-its-kind, low-carbon power plant using very low-cost and abundant local lignite coal. The successful completion and operation of the project will fully assess the ability of this kind of low-carbon power system to provide reliable baseload electricity generation. The Kemper project is designed to capture and store around 3 million metric tons of CO_2 annually. In addition to selling electricity to power the grid, Kemper will sell products that are co-produced by their technology. These products include ammonia, sulfuric acid, and CO_2 for EOR.

In addition to projects in the power sector, DOE-funded projects are also deploying CCUS technologies in industrial operations. As part of the Illinois Industrial Carbon Capture and Storage (Illinois ICCS) project, the Archer Daniels Midland Company (ADM) has been testing large-scale industrial carbon capture technologies, gathering crucial scientific and engineering data related to large-scale carbon dioxide storage in saline formations in the Southern Illinois Basin. The Illinois ICCS project will demonstrate an integrated system for collecting CO_2 from an ethanol production plant and geologically sequestering it deep underground in a sandstone reservoir. ADM is awaiting final Environmental Protection Agency (EPA) authorization to begin CO_2 injection operations.

The Air Products and Chemicals hydrogen facility in Port Arthur, Texas has been in operation since December of 2012 and achieved full production in March of 2013. The company is using a technology called vacuum swing adsorption, allowing for the capture of over 90 percent of the CO_2 contained in the product streams from the two steam methane reformers at the site. The project has already successfully captured over 2.8 million metric tons of CO_2 and is well on its way to capture 3 million metric tons of CO_2 by July 2016.

The development of any innovative technology is a difficult endeavor. Businesses face significant challenges as they work to introduce innovative, early-stage energy technologies to markets. Consequently, some major demonstration projects in the FER&D portfolio have failed to reach critical milestones. One of those projects, which has a great deal of support from members of this Committee, is Summit Power Group's Texas Clean Energy Project (TCEP).

Over the past six years, FE has worked closely with TCEP to help enable the success of their project. Unfortunately, while Summit Power has made some recent progress in negotiating engineering,

procurement, and construction agreements with the private sector, many major milestones remain unmet, including, most critically, obtaining financing for the project.

Consequently, after an extensive and careful review, FE determined that advancing additional Federal funding at this time would not substantively increase the likelihood of the project's success, and that no additional taxpayer funds should be put towards the project. We have issued a no-cost time extension through May 13, 2016, to allow additional opportunity for the project to make progress, and are continuing to monitor the project closely.

Despite the fact that some projects have faced difficulties, DOE has acquired valuable information and tangible benefits from the work accomplished to date. The Department remains committed to advancing CCUS through deployment at commercial-scale and the development of next generation technologies that help to increase efficiency and continue to further drive down cost.

Fuel Supply Impact Mitigation

In addition to R&D on CCUS and advanced power systems, FER&D also develops technological solutions for the prudent and sustainable development of the Nation's natural gas resources. The Fuel Supply Impact Mitigation portfolio under FER&D is focused on environmentally prudent and efficient development, as well as responsible stewardship, of the Nation's natural gas resources. The program continues to implement priority collaborative R&D, together with Department of the Interior and the EPA, to ensure that resource development is conducted in a manner that is environmentally sound and protects human health and safety.

<u>Environmentally Prudent Development</u>

FE is pursuing research to continually narrow the bounds of uncertainty and risk in resource development. Areas of research include well design and engineering, induced seismicity, and water quality and availability, where innovative technologies have been developed to treat produced water for reuse, rather than disposal.

Research on induced seismicity has determined that the causes are specific to regions and need to be studied individually. To that end, DOE-funded research is assessing the risks in different oil and gas producing regions; establishing seismic monitoring networks; developing tools for assessing seismic risk; and providing access to wastewater disposal volumes.

Subsurface science research has resulted in improved design, monitoring, and control of fractures and stimulations. It has advanced our understanding of the properties and behavior of the reservoir rock, the well, and the fluids. At the same time, DOE-funded research has assessed the nature and scale of unconventional resource plays in an effort to minimize the footprint of development. The Department and its partners have developed tools and technologies to assist with well pad siting and density decisions, to identify location-specific subsurface geologic and wellbore (oil, gas, and underground injection) risks to the surface, and to minimize environmental impacts of well pad access roads.

Emissions Mitigation and Quantification

FE is currently focused on quantifying and mitigating methane emissions from natural gas infrastructure. This includes the development of technologies and methods for identifying and mitigating leaks and improving the operational efficiencies of pipelines, storage facilities, and compressor stations.

The methane emissions quantification research is targeted at improving emissions estimates published in the national Greenhouse Gas Inventory. In FY2016, these efforts will be supported by competitively awarded grants issued through a Funding Opportunity Announcement that was recently posted on Grants.gov.

In addition, NETL has developed a natural gas life cycle model to calculate the emissions from the natural gas sector, identify key supply chain dependencies, and prioritize methane emission reduction opportunities. FE has collaborated with the Environmental Defense Fund, using the NETL model as a framework for integrating new methane emission measurements. This analysis identified emissions sources that were previously overlooked, analyzed emission sources with skewed emission distributions, and helped to prioritize methane emission reduction opportunities. Methods and findings of this work have been published in reports and peer-reviewed publications. Working in collaboration with academic researchers, NETL also has related projects located in Colorado's Denver-Julesburg Basin, Utah's Uintah basin, and the Marcellus region in Pennsylvania.

The recent natural gas leak at the Aliso Canyon site in California underscored the importance of ensuring the safety and integrity of the nation's natural gas infrastructure. Therefore, in addition to our ongoing research, DOE has partnered with the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) to launch a new Interagency Task Force on Natural Gas Storage Safety. In addition to DOE and PHMSA, the Task Force will include technical experts from the EPA, the Department of Health and Human Services, the Department of Interior, the Federal Energy Regulatory Commission, and the National Oceanic and Atmospheric Administration.

The Task Force will work with state and local governments, as well as industry, to avoid future incidents and ensure the safe storage of natural gas. Specifically, FE will hold workshops with industry, state and local leaders, and other interested stakeholders to support them in the development of best practices for ensuring well integrity and proper response plans, safe operations of storage facilities, and assess the potential vulnerabilities to energy reliability posed by the loss of use of storage facilities.

Gas Hydrates

DOE is conducting resource characterization investigations, in coordination with the U.S. Geological Survey, to confirm the nature and regional context of gas hydrate deposits in the Gulf of Mexico, and the physical properties and characteristics of gas hydrate-bearing sediments. DOE will also provide technical leadership and contribute to the initial phases of the primarily Japanese–funded Alaska North Slope test. DOE recently issued a Funding Opportunity Announcement for fundamental Gas Hydrate

research to include laboratory and numerical studies of reservoir response to depressurization and climate effects.

Crude Oil Characterization Study

FE and PHMSA are collaborating to better understand and mitigate risks associated with the transportation of conventional and tight crude oil. Sandia National Laboratories was commissioned to conduct a study of available crude oil chemical and physical property data and literature related to crude oil potential for ignition, combustion, and explosion.

That study identified gaps in important crude oil characterization data; sampling, testing and analysis methods; and deficiencies in the understanding of the relationships between crude oil properties and the potential for accidental ignition, combustion, and explosion. At DOE and DOT's request, Sandia prepared a comprehensive Crude Oil Characteristics Research Sampling, Analysis and Experiment Plan, which contained recommendations on research needed to improve the understanding of transport-critical crude oil, especially tight crude oil properties. Historically, crude oil characterization has been done by industry organizations such as the American Petroleum Institute. However, the data on certain properties believed to be related to safety was not included in their standard classification systems.

Activities include evaluating up to five different sampling methods for application to crude oils containing higher concentrations of volatile hydrocarbons and conducting pool fire and fireball experiments to compare tight and conventional crude oils. This work, funded by congress in FY 2016 will be completed in 2017 with FY 2016 funds.

Rare Earth Elements

Finally, NETL is carrying out congressionally-mandated research on the feasibility of extracting rare earth elements (REE) from coal and coal byproducts. In March 2016, nine projects were selected to conduct research as directed by Congress on Recovery of Rare Earth Elements from Coal and Coal By-Products. This research is focused on the development of bench-scale and pilot-scale technology to determine if it is possible to economically separate, extract, and concentrate mixed REEs from coal and coal byproducts, including solids and liquids from coal-related operations.

Conclusion

The Department of Energy is committed to working with industry, our National Labs, and other stakeholders to develop the science and innovative technologies that will allow the Nation to use its abundant fossil energy resources in a way that meets our energy needs, ensures environmental responsibility, and secures U.S. leadership in the global clean energy economy. Technology innovation is critical to this effort. Our programs have made substantial progress toward meeting these goals, and we believe these continued advances will help ensure that the U.S. will continue to lead the world in clean energy technology innovation.

Christopher A. Smith

Christopher Smith serves as Assistant Secretary for Fossil Energy at the U. S. Department of Energy. President Obama nominated Smith for the position in November 2013. He was confirmed by the U. S. Senate and sworn into office in December 2014.

As Assistant Secretary, Smith leads the Department of Energy's Office of Fossil Energy, including scientists and engineers working at eleven sites across the United States. In this capacity, he oversees the Department's fossil energy's research and development program (coal, oil and natural gas) and the National Energy Technology Laboratory. He is also responsible for the U.S. Petroleum Reserves, the largest strategic petroleum stockpile in the world.

Prior to his Senate confirmation, Smith served as Principal Deputy Assistant Secretary for Fossil Energy and as Deputy Assistant Secretary for Oil and Natural Gas. During that tenure, he served as the Designated Federal Official for the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, established by President Obama to investigate the root causes of the Gulf oil spill.

Before his appointment in October 2009, Smith served in managerial and analytical positions of increasing responsibility in the private sector. Most recently he spent eleven years with two major international oil companies focused primarily on upstream business development and LNG trading, including three years negotiating production and transportation agreements in Bogotá, Colombia.

Smith began his career as an officer in the U. S. Army and served tours in Korea and Hawaii. He subsequently worked for Citibank and JPMorgan in New York City and London in the area of emerging markets and currency derivatives. Smith holds a bachelor's degree in Engineering Management from the United States Military Academy at West Point and an MBA from Cambridge University.