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Thank you, Mr. Chairman and Members of the Committee. I appreciate this opportunity to provide testimony on the U.S. Department of Energy's (DOE's) advanced coal research, development, and demonstration program to develop low-carbon emission coal technologies.

INTRODUCTION

Fossil fuel resources represent a tremendous national asset. An abundance of fossil fuels in North America has contributed to our Nation's economic prosperity. Based upon current rates of consumption, the United States probably has sufficient coal to meet its need for the next century. Making use of this domestic asset in a responsible manner will help the United States to meet its energy requirements, minimize detrimental environmental impacts, positively contribute to national security, and compete in the global marketplace.

Fossil fuels will play a critical role in our Nation's future energy strategy. By developing technologies to mitigate the release of carbon dioxide (CO_2) into the atmosphere, we can continue to use our extensive domestic coal resource while reducing the impacts on climate

change. Carbon capture and storage (CCS) can play a central role in fossil fuels remaining a viable energy source for our Nation. CCS is the primary pathway DOE is pursuing to allow continued use of fossil fuels in a carbon-constrained future.

Through fossil energy provisions in the American Recovery and Reinvestment Act and annual appropriations, DOE's advanced coal program is working to accelerate the development of CCS to meet future energy needs.

The remainder of my testimony will highlight CCS activities that are underway in the advanced coal program.

NEAR-ZERO EMISSIONS PROGRAM

DOE provides a national leadership role in the development of advanced coal technologies. DOE's advanced coal program has returned substantial benefits to consumers and taxpayers across a broad range of innovative technologies that are now in use throughout the world. For example, DOE and the private sector responded to the challenge of dramatically reducing the emissions of particulate, sulfur, nitrogen oxide, and mercury from coal-based energy systems with the development of technologies that enable coal-based power plants to meet environmental controls and limits placed on these pollutants. These technological innovations have resulted in significant environmental benefits: reducing pollutant emissions, reducing water use, minimizing wastewater discharge, and reducing solid wastes. DOE research and demonstration capabilities are well suited to address new challenges associated with the reduction of greenhouse gas emissions as a climate change mitigation strategy.

The advanced coal program – administered by DOE's Office of Fossil Energy and implemented by the National Energy Technology Laboratory – is designed to address climate concerns of coal usage by developing a portfolio of revolutionary advanced carbon capture and

storage technologies. In partnership with the private sector, efforts are focused on maximizing efficiency and performance, while minimizing the costs of these new technologies. In recent years, the Program has been restructured to focus on CCS. The Program pursues the following two major strategies:

1) capturing carbon dioxide; and

2) storing it in geologic formations.

Capturing and storing carbon dioxide and improving the fuel-to-energy efficiency of CCS will help address pollutant emissions reduction, water usage, and carbon emissions on a per unit of electricity basis. These plans strive to achieve dramatic reductions in emissions and ensure that current and future fossil energy plants will meet all emerging requirements for a safe and secure energy future.

Coal research has resulted in important insights regarding future innovations. New engineering concepts have been developed to convert coal into gases that can be cleaned and then used to generate power or produce fuels. New approaches to clean power generation are emerging that hold promise for integration with coal-based or combined coal and biomass energy plants. Technologies for achieving CCS are stretching beyond basic research, defining pathways in which greenhouse gas emissions can be permanently diverted from the atmosphere. With these building blocks, a new breed of coal plant can be created — one that generates power and produces high-value energy with much less environmental impact. DOE's work includes a focus on high priority CCS enabling technologies, such as advanced integrated gasification combined cycle, advanced hydrogen turbines, carbon capture, and fuel cells. These research areas provide the supporting technology base for all CCS development.

CARBON CAPTURE & STORAGE (CCS) INNOVATIONS

As part of our advanced coal program, we are addressing the key technology challenges that confront the wide-scale deployment of CCS through research on cost-effective capture technologies; monitoring, verification, and accounting technologies to ensure permanent storage; permitting issues; liability issues; public outreach; and infrastructure needs. As an example, today's commercially available CCS technologies will add around 80 percent to the cost of electricity for a new pulverized coal plant, and around 35 percent to the cost of electricity for a new advanced gasification-based plant.[1] The program is aggressively pursuing developments to reduce these costs to less than a 10 percent increase in the cost of electricity for new gasification-based energy plants, and less than a 30 percent increase in the cost of electricity for pulverized coal energy plants.[2]

The existing research program has been performing CCS field tests for many years, where the Regional Carbon Sequestration Partnerships are drilling wells in potential storage locations and injecting small quantities of CO_2 to validate the potential of key storage locations throughout the country. Substantial progress has occurred in the area of monitoring, verification, and accounting of CO_2 storage with the development and refinement of technologies to better understand storage stability, permanence, and the characteristics of CO_2 migration.

Research is also focused on developing technology options that dramatically lower the cost of capturing CO_2 from fossil fuel energy plants. This research can be categorized into three pathways: post-combustion, pre-combustion, and oxy-combustion. Post-combustion refers to capturing CO_2 from the stack gas after a fuel has been combusted in air. Pre-combustion refers

[1] Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity, U.S. Department of Energy/National Energy Technology Laboratory, DOE/NETL-2007/1281, Final Report, May 2007.

[2] The goal for pulverized coal is under development.

to a process where a hydrocarbon fuel is gasified to form a synthetic mixture of hydrogen and carbon dioxide, and CO_2 is captured from the synthesis gas before it is combusted. Oxy-combustion is an approach where a hydrocarbon fuel is combusted in pure or nearly pure oxygen rather than air, which produces a mixture of CO_2 and water that can easily be separated to produce pure CO_2. This research is exploring a wide range of approaches: membranes; oxy-combustion concepts; solid sorbents; CO_2 hydrates; and advanced gas/liquid scrubbing technologies. These efforts cover not only improvements to state-of-the-art technologies but also development of several revolutionary concepts, such as metal organic frameworks, ionic liquids, and enzyme-based systems, in conjunction with basic research in these areas now being conducted by the DOE's Office of Science.

A central piece of our CCS research is DOE's field test program, which is being implemented through the Regional Carbon Sequestration Partnerships. DOE's field test program reflects the geographic differences in fossil fuel use and potential storage sites across the United States and targets the use of regional approaches in addressing CCS. It encompasses approximately 97 percent of coal-fired and industrial CO_2 emissions, about 96 percent of the total land mass, and essentially all the geologic storage sites in the country that can potentially be available for carbon sequestration. The field tests are conducted through partnerships comprised of state agencies, universities, and private companies, with the goal of developing the knowledge base and infrastructure for the wide-scale deployment of CCS technologies. The seven Regional Partnerships represent more than 350 unique organizations in 42 States, 3 Indian Nations, and 4 Canadian Provinces. It is important to note that the non-Federal cost share for the field test program is greater than 35 percent, which is a key indicator of industry and other partner interest

that will lead to the success of this program. Each partnership is focused on a specific region of the country with similar characteristics relating to CCS opportunities.

DOE is addressing key infrastructure issues related to permitting, pore space ownership, site access, liability, public outreach, and education. DOE works closely with the Environmental Protection Agency (EPA) and others in developing CCS regulation strategies, which will provide additional certainty for future CCS deployments.

Over the course of these research initiatives, DOE will jointly develop Best Practice Manuals on topics such as site characterization, site construction, operations, monitoring, mitigation, closure, and long-term stewardship. These Manuals, which will be developed in conjunction with DOE's Office of Science and the U.S. Geological Survey, will serve as guidelines for a future geologic sequestration industry in their regions, and help transfer the lessons to all regional stakeholders.

LARGE-SCALE DEMONSTRATION AT COMMERCIAL SCALE

The success of our research on CCS and advanced coal technologies will ultimately be judged by the extent to which emerging technologies are deployed in domestic and international marketplaces. Both technical and financial challenges associated with the deployment of new integrated CCS technologies must be overcome in order to be capable of achieving success in the marketplace. Commercial-scale demonstrations help the industry understand and overcome start-up issues, component integration issues, and gain the early learning commercial experience necessary to reduce risk and secure private financing and investment for future plants.

DOE is implementing large-scale programs such as the geologic storage field tests and the Clean Coal Power Initiative (CCPI). Phase III of the geologic storage field test program is focused on large-scale field tests of geologic carbon sequestration on the order of 1 million

metric tons of CO_2 per year, and addressing the liability, regulatory, permitting, and infrastructure needs of these projects. CCPI is primarily focused on component testing at commercial scale. The CCPI Round 3 Funding Opportunity Announcement (FOA) specifically targets advanced coal-based systems and subsystems that capture or separate CO_2 for sequestration or for beneficial use.

THE AMERICAN RECOVERY AND REINVESTMENT ACT

The American Recovery and Reinvestment Act (Recovery Act) appropriates $3,400,000,000 for "Fossil Energy Research and Development." As reflected in the Joint Explanatory Statement of the Committee of Conference leading to the Act, these Recovery Act funds will help fund activities targeted at expanding and accelerating the commercial deployment of CCS technology to provide a key thrust to the advanced coal program to accelerate, by many years, the advances needed for future plants with CCS.

The Joint Explanatory Statement of the Recovery Act identifies the following major initiatives that will complement and accelerate efforts in the advanced coal program:

Maintain Fossil Energy R&D Program: $1 billion to be used to conduct fossil energy research and development.

Additional Funds for the CCPI Round 3 FOA: $800 million to be used to augment funding for the CCPI Round 3 competition.

New CCS Initiative for Industrial Applications: $1.52 billion to be used for a competitive solicitation for a range of industrial carbon capture and energy efficiency improvement projects, including a small allocation for innovative concepts for beneficial CO2 reuse.

Expand Geologic Site Characterization: $50 million to be used for site characterization activities in geologic formations. DOE expects to require projects to complement and build upon the existing characterization base created by the Regional Partnerships, looking at broadening the range and extent of geologic basins that have been studied to date.

Initiate a Geologic Sequestration Training and Research Grant Program: $20 million for geologic sequestration training and research grants. This program will emphasize advancing educational opportunities across a broad range of colleges and universities.

INTERNATIONAL COLLABORATIONS

Recognizing that climate change is a global issue that requires a global response, the DOE plays an active leadership role in an international initiative known as the Carbon Sequestration Leadership Forum (CSLF).

The CSLF is a voluntary climate initiative of developed and developing nations that, collectively, account for 75 percent of all manmade carbon dioxide emissions. It is currently comprised of 22 members, including 21 countries and the European Commission.

Formed in 2003, the CSLF marshals intellectual, technical, and financial resources from all parts of the world to support atmospheric stabilization, the long-term goal of the United Nations Framework Convention on Climate Change. Members are dedicated to collaboration and information sharing in developing, demonstrating, and fostering the worldwide deployment of multiple technologies for the capture and long-term geologic storage of carbon dioxide at low costs. Additionally, the CSLF is committed to establishing a companion foundation promoting legislative, regulatory, administrative, and institutional practices that will ensure safe, verifiable long-term storage.

In addition to the CSLF, the Office of Fossil Energy is currently cooperating with numerous countries through bilateral agreements and multilateral activities to identify areas of collaboration in promoting and developing clean fossil energy technologies internationally.

These activities include:

The U.S.-China Fossil Energy Protocol, a bilateral agreement on energy technology cooperation that has the goals of reducing the impact of China's growing demands on global hydrocarbon markets and improving environmental performance; providing commercial opportunities for U.S. business; and acquiring unique information of scientific or technical interest to DOE.

US-India Energy Dialogue: Coal Working Group: The Office of Fossil Energy and India's Ministry of Coal jointly chair the Coal Working Group initiative to exchange information on policies, programs, and technologies to promote the efficient and environmentally responsible production and use of coal.

Global Gas Flaring Reduction Partnership: DOE is working with the World Bank and others to support national governments and the petroleum industry in their efforts to reduce flaring and venting of gas associated with the extraction of crude oil. Gas flaring wastes a valuable clean energy resource and emits carbon dioxide, a greenhouse gas.

Asia Pacific Economic Cooperation: APEC's Energy Working Group seeks to maximize the energy sector's contribution to the region's economic and social well being, while mitigating the environmental effects of energy supply and use. The Office of Fossil Energy provides expertise in LNG and methane hydrate technologies to the Energy Working Group.

The International Energy Agency (IEA): The Office of Fossil Energy is involved in many aspects of the IEA, including emergency preparedness and clean coal technology transfer.

Increasingly, the IEA focuses on resolving energy and environmental challenges, particularly relating to climate change.

The Office of Fossil Energy participates in the IEA Working Party on Fossil Fuels, a highly effective method to create international support for Fossil Energy programs and objectives such as IGCC and carbon sequestration. The primary objective for the next three years will be to develop and implement activities to promote clean fossil energy technologies internationally. The Office of Fossil Energy is currently working on the implementation of the recommendations to the G-8 on Near Term Opportunities for Carbon Capture and Storage.

IEA Clean Coal Center: The IEA Clean Coal Centre is a collaborative project established in 1975 involving member countries of the IEA. The service is governed by representatives of member countries, the European Commission, and industrial sponsors. The IEA Clean Coal Centre program of work contains studies of considerable significance for all countries involved in the use or supply of coal.

IEA Greenhouse Gas Program (IEAGHG): The IEAGHG is a collaborative research programme founded in 1991. The members include 17 countries, the European Commission and 17 multi-national industrial sponsors. Its aim is to provide members with definitive information on the role that technology can play in reducing greenhouse gas emissions. It is principally focused on CCS; how mitigation options compare; how CCS can be done safely, legally, and cost-effectively; and what needs to be done to introduce CCS and be confident it will be successful.

World Energy Council: World Energy Council (WEC) is an organization of more than 100 countries headquartered in London covering all aspects of energy including fossil, nuclear, hydro and renewables. DOE participates through the WEC Committee on Cleaner Fossil Fuel

Systems Committee, chaired by the Fossil Energy's Office of Clean Energy Collaboration. Committee members include 26 countries and seven multilateral organizations striving to promote knowledge worldwide on the research, development, demonstration, and deployment of cleaner fossil fuels to meet global energy needs; promote the clean and efficient use of fossil fuels, with a concentration on carbon capture and storage.

Additionally, numerous international projects are supported through DOE's core advanced coal program. U.S. technological advances and expertise in CCS are being shared in initiatives such as the Australian Otway Basin project; the European Union funded CO_2SINK project in Germany; the Algerian In Salah industrial-scale CO_2 storage project; the Ordos Basin Assessment in China; the North Sea Sleipner Project; and the IEA GHG Weyburn-Midale CO_2 Monitoring and Storage Project, Zama Acid Gas Project, and the Fort Nelson Project, all in Canada.

CONCLUSIONS

Today, nearly three out of every four coal-burning power plants in this country are equipped with technologies that can trace their roots back to the Department's advanced coal technology program. These efforts helped accelerate production of cost-effective compliance options to address legacy environmental issues associated with coal use. Advanced CCS technologies will undoubtedly play a key role in mitigating CO_2 emissions under potential future carbon stabilization scenarios. DOE's Program is helping make the enabling technologies available. The United States must continue to show leadership in technology development and future deployment to bring economic rewards and new business opportunities both here and abroad.

I applaud the efforts of this Committee and its Members for taking a leadership role in addressing these timely and significant issues.