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Carbon Capture and Sequestration Legislation, Bills S. 699, S. 757

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Thank you Chairman Bingaman, Ranking Member Barrasso, and members of the Committee; I appreciate the opportunity to discuss the Department of Energy's activities to promote the development of carbon capture and storage (CCS) technologies.

My testimony will provide an overview of the Department of Energy's (DOE) research efforts in developing CCS technologies. The Administration is still reviewing S. 699 and S. 757 and does not have a position on either bill at this time.

Interagency Task Force on Carbon Capture and Storage

Before I discuss the Department's Clean Coal Research Program, I will briefly review the conclusions from the Interagency Task Force on CCS. In August 2010, the final report from the Task Force was issued summarizing the Administration's efforts to develop and deploy CCS technologies, and proposed a plan to overcome the barriers to the widespread, cost-effective deployment of CCS within ten years, with a goal of bringing five to ten commercial

demonstration projects online by 2016. This report is the collective work of 14 executive departments and federal agencies, which were tasked with developing a comprehensive and coordinated Federal strategy to speed the commercial development and deployment of clean coal technologies. The task force concluded that while there are no insurmountable technological, legal, institutional, regulatory or other barriers that prevent CCS from playing a role in reducing GHG emissions, early CCS projects face economic challenges related to climate policy uncertainty, first-of-a-kind technology risks, and the current high cost of CCS relative to other technologies.

Clean Coal Research Program

DOE continues to play a leadership role in the development of clean coal technologies with a focus on CCS. The Clean Coal Research Program – administered by DOE's Office of Fossil Energy and implemented by the National Energy Technology Laboratory – is designed to enhance our energy security and reduce environmental concerns over the future use of coal by developing a portfolio of revolutionary clean coal technologies. The Program is well positioned to help overcome the technical challenges associated with the development of clean coal technologies.

The Clean Coal Program, in partnership with the private sector, is focused on maximizing efficiency and environmental performance, while minimizing the costs of these new

technologies. In recent years, the Program has been restructured to focus on clean coal technologies with CCS. The Program pursues the following two major strategies:

1) capturing and storing greenhouse gases; and
2) improving the efficiency of fossil energy systems.

The first strategy aims to eliminate concerns over emissions of greenhouse gases from fossil fueled energy systems. The second strategy seeks to improve the fuel-to-energy efficiencies of these systems, thus reducing pollutant emissions, water usage, and carbon emissions on a per unit of energy basis. Collectively, these two strategies comprise the Clean Coal Program's approach to ensure that current and future fossil energy plants will have options to meet all emerging requirements for a safe and secure energy future.

Core Research and Development Activities

The Clean Coal Program is addressing the key technical challenges that confront the development and deployment of clean coal technologies through research on cost-effective capture technologies; monitoring, verification, and accounting technologies to ensure permanent storage; permitting issues; and development of advanced energy systems. The Program is also actively engaged in interagency efforts to address liability issues, public outreach, and infrastructure needs. As an example, today's commercially available CCS technologies would 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 integrated gasification combined cycle plant.[1] The Program is aggressively pursuing developments to reduce these costs to less than a 35 percent increase in the cost of electricity for pulverized coal energy plants and less than a 10 percent increase in the cost of electricity for new gasification-based energy plants.

Research is focused on developing technology options that dramatically lower the cost of capturing carbon dioxide (CO_2) from fossil fueled energy plants. This research can be categorized into three technical 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 to a process where a hydrocarbon fuel is gasified to form a 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. Collectively, research in each of these technical pathways is exploring a wide range of approaches such as 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. Coupling these developments with other advances in efficiency improvements and cost reduction from developments in gasification, turbines, and fuel cells, will help provide a technology base for commercial deployment of fossil energy systems integrated with CCS.

[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.

The Department is the primary supporter of the National Carbon Capture Center (NCCC), which is a joint partnership between DOE and industry. The NCCC is a one of a kind, world class facility which offers an opportunity to validate capture technologies on actual gas from a coal fired power plant or gasification facility. Because of the ability to operate under a wide range of process conditions, research at the NCCC can effectively evaluate technologies at various levels of maturity for many different applications.

Regional Carbon Sequestration Partnerships

The Regional Carbon Sequestration Partnerships were created by the DOE in 2003 through a competitive solicitation. The Partnerships were designed to address a range of issues associated with geologic storage of CO_2. The Clean Coal Program has been performing CCS field tests focused on injection, monitoring, verification, accounting and other aspects of geologic storage for many years, and the seven Regional Carbon Sequestration Partnerships are critical to this effort. These Partnerships are comprised of state agencies, universities, and private companies. They represent more than 400 unique organizations in 43 States, and four Canadian Provinces. Geographic differences in fossil fuel use and potential storage sites across the United States dictate the use of regional approaches in addressing CCS, so each Partnership is focused on a specific region of the United States and Canada that hold similar characteristics relating to CCS opportunities.

Together, the Partnerships form a network of capability, knowledge, and infrastructure that will help enable geologic storage technology to play a role in the clean energy economy. They represent regions encompassing 97 percent of coal-fired CO_2 emissions, 97 percent of industrial CO_2 emissions, 96 percent of the total land mass, and essentially all the geologic storage sites that can potentially be available for geologic carbon storage.

Regional Partnerships are drilling wells and injecting small quantities of CO_2 to validate the potential of key storage locations throughout the country. To date, the Regional Partnerships have injected over 1 million tons of CO_2 at 18 small scale injection projects throughout the United States and Canada. These tests have helped to validate storage at a small scale and understand the fate of CO_2 in different depositional systems containing saline water, oil, and natural gas. Several large scale projects are also underway that will inject several million tons of CO_2 over the life of the projects. One of these projects has safely and securely injected over 2 million metric tons of CO_2. Several more large-scale field tests will begin later this year.

Over the course of these initiatives, DOE and the Partnerships are addressing key infrastructure issues related to permitting, pore space ownership, site access, liability, public outreach, and education. We are also jointly developing Best Practice Manuals on topics such as site characterization, site construction, operations, monitoring, mitigation, closure, and long-term stewardship. These manuals will serve as guidelines for a future geologic sequestration industry in their regions, and help transfer the lessons learned from DOE's Program to all regional stakeholders. Finally, DOE and the Partnerships continue to work closely with the

Environmental Protection Agency (EPA) and other federal and state agencies in developing CCS regulatory strategies, which will provide additional certainty for future CCS deployments.

Demonstrations at Commercial-Scale

The success of the Clean Coal Program will ultimately be judged by the extent to which emerging technologies get deployed in domestic and international marketplaces. Both technical and financial challenges associated with the deployment of new "high risk" coal 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, address component integration issues, and gain the early learning commercial experience necessary to reduce risk and secure private financing and investment for future plants.

The Department is implementing large-scale projects through the Regional Partnerships, the Clean Coal Power Initiative (CCPI), and FutureGen. Phase III of the Partnerships 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 are addressing the liability, regulatory, permitting, and infrastructure needs of these projects. As described previously in this statement, the Partnerships have brought an enormous amount of capability and experience together to work on the challenges of these large projects.

The CCPI is a cost-shared partnership between the government and industry to develop and demonstrate advanced coal-based power generation technologies at the commercial scale. CCPI demonstrations address the reliability and affordability of the Nation's electricity supply from

coal-based generation. By enabling advanced technologies to overcome technical risks involved with scale-up and bringing them to the point of commercial readiness, CCPI accelerates the development of both advanced coal generation technologies and the integration of CCS with both new and existing generation technologies. The CCPI also facilitates the movement of technologies into the market place that are emerging from the core research and development activities. The CCPI program received an additional $800 million from the 2009 American Recovery and Reinvestment Act (Recovery Act) which, in combination with base funding, was used to fund four active CCPI projects, two pre-combustion and two post-combustion projects. In addition, a CCPI round II project has been modified to demonstrate CCS at a new integrated gasification combined cycle power plant. We are working closely with the project developers to comply with NEPA, air and water regulatory requirements, and complete initial Front End Engineering & Design (FEED) studies for the facilities. All five of these projects are on track to be operational between 2013 and 2015.

The FutureGen Project intends to conduct novel large-scale testing to accelerate the deployment of a set of advanced oxy-combustion power production technologies integrated with CCS. This project will be the first advanced repowering oxy-combustion project to store CO_2 in a deep saline geologic formation. On August 5, 2010, Secretary of Energy Steven Chu announced an award of $1 billion in Recovery Act funding to the FutureGen Alliance, Ameren Energy Resources, Babcock & Wilcox, and Air Liquide Process and Construction, Inc., to build FutureGen 2.0, a clean coal repowering program and carbon dioxide storage network. On February 28, 2011, the FutureGen Alliance selected Morgan County, Illinois, as the preferred location for the FutureGen 2.0 CO_2 storage site, visitor center, research, and training facilities.

In addition to the CCPI and FutureGen 2.0 projects, the Recovery Act has also helped fund more than 80 additional projects which includes three large scale Industrial CCS demonstrations, ten geologic site characterizations, forty-three university research training projects, seven CCS research training centers, six Industrial CCS projects focused CO_2 reuse, and 14 projects focused on accelerated component development in the core research program.[2]

Conclusion

CCS and related clean coal technologies can play a critical role in mitigating CO_2 emissions under many potential future carbon stabilization scenarios. Nevertheless, challenges remain to achieving cost-effective commercial deployment of CCS. The Department's research programs are a vital step to advancing the readiness of clean coal technologies for future commercial deployment. I thank this Committee and its members for allowing me the opportunity to provide an overview of DOE's research efforts in developing CCS technologies and I look forward to your questions. The Administration is still reviewing S. 699 and S. 757 and does not have a position on either bill at this time.

[2] Details about all of the Fossil Energy projects funded by the Recovery Act can be found here: http://www.fossil.energy.gov/recovery/index.html.