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BEFORE THE

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COMMITTEE ON NATURAL RESOURCES

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Mr. Chairman, Members of the Committee, it's a pleasure for me to appear before you today to discuss DOE's development of carbon sequestration technologies to mitigate climate change.

The economic prosperity of the United States over the past century has been built upon our abundance of fossil fuels in North America. The use of fossil fuels results in the release of emissions that can impact the environment, including the emission of carbon dioxide (CO_2) from power plants that contribute to global climate change.

Economic growth in the United States and the projected growth of United States and world energy demands provide an incentive for the development of technologies that permit the use of fossil fuels, such as coal, to continue to serve as a strategic resource to meet our future energy needs. Carbon capture and storage (CCS) technologies promise great opportunities to reduce the potential environmental impacts of CO_2 emissions from fossil fuel power plants. By capturing CO_2 before it is emitted to the atmosphere, and then storing it in deep underground geologic formations, fossil fuels can be used with dramatically reduced potential for impact on

climate change and, depending on cost, potentially without constraining economic growth. This is a challenging issue to address, since the technologies to capture CO_2, and field projects required to demonstrate the efficacy of long-term storage, need to be developed and demonstrated at appropriate scales.

CCS and Climate Change Mitigation

DOE has been working on three technology areas that could mitigate greenhouse gas emissions. These areas include (1) reducing carbon intensity by switching to renewable or low-carbon fuels, (2) improving efficiency both on the supply and demand sides, and (3) developing and deploying CCS technologies. Wide-scale adoption of these technological solutions could substantially reduce atmospheric CO_2 releases. The Office of Fossil Energy has been supporting research, development, and demonstration (RD&D) of CCS technologies for the past 10 years. The DOE Office of Science also supports basic research towards improving our scientific understanding of the behavior of CO_2 at potential geological sites and research towards the development of methods for enhanced terrestrial sequestration in plants and soils.

CCS has the technical potential to mitigate up to 55 percent of future U.S. CO_2 emissions, as reported in the special report of the International Panel on Climate Change (IPCC) on Carbon Dioxide Capture and Storage. For CCS to have a significant impact on reducing the contribution of CO_2 into the atmosphere, however, it would require that several hundred to several thousand CCS facilities be constructed around the world using different geologic formations. This would be a significant undertaking but one that is achievable with the appropriate policy and technology developments. As greenhouse gas emissions are a global problem, carbon sequestration technology could also be very important for China, which also has very substantial coal

resources, and is projected to overtake the United States to become the world's largest emitter of greenhouse gases in 2007 or 2008.

Importance of CCS to the United States

Fossil fuels will continue to play an important role in the Nation's future energy strategy. In a scenario of a carbon-constrained world, there is a strong need and also a strong incentive to develop technologies to mitigate the release of CO_2 into the atmosphere while still continuing to permit the use of coal – currently our Nation's most abundant fuel source.

CCS is a very promising technology that could allow the continued viability of fossil fuels as an energy source. CCS – the capture, transportation to an injection site, and long-term storage in a variety of suitable geologic formations – is one of the pathways that the Department of Energy is pursuing to reduce atmospheric CO_2 emissions.

DOE Carbon Sequestration Program

DOE is taking a leadership role in the development of CCS technologies through its Sequestration Program. The Department is developing both the core and supporting technologies through which CCS could potentially become an effective and economically viable option for reducing CO_2 emissions. The Carbon Sequestration Program works in concert with other programs within the Office of Fossil Energy that are developing the complementary technologies that are integral to coal-fueled power generation with carbon capture: Advanced Integrated Gasification Combined Cycle, Advanced Turbines, Fuels, Fuel Cells, and Advanced Research. Successful research and development (R&D) could enable carbon control

technologies to overcome technical and economic barriers in order to achieve cost-effective CO_2 capture and enable widespread deployment of these technologies.

The DOE Carbon Sequestration Program (Program) leverages applied basic research with field verification to assess the technical and economic viability of CCS as a greenhouse gas mitigation option. Successful carbon sequestration technology development and deployment could provide the means by which fossil fuels can continue to be used in a future carbon-constrained world.

The Program encompasses two main elements: *Core R&D* and *Validation and Deployment*. The Core R&D element focuses on technology solutions that can be validated and deployed in the field. Lessons learned from field tests are fed back to the Core R&D element to guide future R&D. Through its Integrated Gasification Combined Cycle, Fuels, Sequestration, and Advanced Research programs, DOE is investigating a wide variety of separation techniques, including gas phase separation, absorption, and adsorption, as well as hybrid processes, such as adsorption/membrane systems. Current 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. The program is also investigating the development of alternative combustion technologies such as Oxycombustion and chemical looping. The ultimate goal is to drive down the energy penalty associated with capture so that coal power plants achieve 90 percent carbon capture at a cost of less than a 10 percent increase in the cost of electricity compared to a power plant without CCS.

The other key components to DOE's Sequestration Program include having the ability to store CO_2 in underground formations with long-term stability (permanence), the ability for monitoring and verifying the fate of CO_2, and public acceptance. These key attributes are being

pursued by DOE's seven Regional Carbon Sequestration Partnerships. The Partnerships are engaged in an effort to develop and validate the technology to implement DOE's CO_2 Sequestration Program in different geologies of the Nation. Conducting geographically diverse tests provides information on how to apply CCS to storage sites with different geologic characteristics.

Collectively, the seven Partnerships represent regions encompassing 97 percent of coal-fired CO_2 emissions, 97 percent of industrial CO_2 emissions, 97 percent of the total land mass, and essentially all of the geologic storage sites in the United States potentially available for CCS. The Partnerships are evaluating numerous CCS approaches to assess which approaches are best suited for specific geologies of the country, and are developing the framework needed to validate and potentially deploy the most promising CCS technologies.

The Regional Partnership initiative is using a three-phased approach. The first phase, the Characterization Phase, was initiated in 2003 and focused on characterizing regional opportunities for CCS, and identifying regional CO_2 sources and storage formations. The Characterization Phase was completed in 2005 and led to the current Validation Phase. This second phase focuses on field tests to validate the efficacy of CCS technologies in a variety of geologic storage sites throughout the United States. Using the extensive data and information gathered during the Characterization Phase, the seven Partnerships identified the most promising opportunities for CCS in their regions and are performing widespread, multiple geologic field tests. In addition, the Partnerships are verifying regional CO_2 storage capacities, satisfying project permitting requirements, and conducting public outreach and education activities.

The third phase, or Deployment Phase, involves large-volume injection tests. This phase is scheduled to begin in fiscal year 2008, and will demonstrate CO_2 capture, transportation,

injection, and storage at a scale equivalent to potential future commercial deployments. Given the opportunities provided by the FY 2007 Operations Plan, DOE will initiate these activities in 2007. The geologic structures to be tested during these large-volume storage tests will serve as potential candidate sites for the future deployment of technologies demonstrated in the FutureGen Project as well as the Clean Coal Power Initiative, which will complete a solicitation for carbon capture technologies at commercial scale in 2008.

Geologic Storage Potential

In the recent assessment completed by DOE's Regional Carbon Sequestration Partnerships, titled the *Carbon Sequestration Atlas of the United States and Canada*, DOE worked with the United States Geological Survey (USGS), the Office of Surface Mining, the United States Forrest Service, and a number of oil and gas experts. The Atlas identifies hundreds of years of storage potential in deep saline formations, depleted oil and gas reservoirs, and unmineable coal seams. Over 3,500 billion tons of potential storage capacity exists throughout these regions and represents a potential significant resource for CCS. The geological sequestration experts from the Partnerships, the National Carbon Sequestration Database and Geographical Information System – or NATCARB – and the National Energy Technology Laboratory (NETL) created a methodology to determine the capacity for CO_2 storage in the United States and Canada, and an Atlas from data generated by the Partnerships and other databases, including the USGS.

The information collected during the second phase (the Validation Phase) will be used to update the capacity estimates throughout the United States, and revise and issue an updated version of the Atlas in 2009. DOE expects to continue the effort to characterize additional

geologic formations after 2009 during the third phase (the Deployment Phase) of the program. In addition, the data collected during the Validation phase field tests and Deployment phase large volume CCS tests will be used to validate the capacity estimates presented in the Atlas. Future work on the Atlas will seek more active involvement with expert organizations like the USGS. Their expertise will complement and strengthen existing DOE efforts. More active involvement of USGS also would improve future versions of the Atlas and allow more detailed assessment of Federal lands.

Regulatory Compliance

DOE has been working with the Environmental Protection Agency (EPA) on its permitting structure for the DOE Regional Carbon Sequestration Partnerships field tests. DOE worked closely with EPA on the development of an Underground Injection Control Class V permitting guidance document that will guide the EPA Regions and State regulators when issuing permits for the RD&D injection projects. DOE and EPA meet regularly to review the status of field projects, to share technical information, and to identify areas of future collaboration.

Closing Remarks

CO_2 storage can play an important role in reducing carbon dioxide emissions. At the same time, it will increase the Nation's ability to use its domestic energy resources to meet our energy needs and increase economic prosperity throughout the United States.

Mr. Chairman, and members of the Committee, this completes my prepared statement. I would be happy to take any questions you may have at this time.