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Thank you Mr. Chairman and Members of the Committee. I appreciate this opportunity to provide testimony on the Department of Energy's advanced clean coal technologies and the program for carbon capture and storage.

The economic prosperity of the United States over the past century has been built upon an abundance of fossil fuels in North America. We have approximately a 250-year supply of coal available in the United States, at our current consumption rates. Coal-fired power plants supply over half of our electricity today; the continued use of this secure domestic resource is critically dependent on the development of cost-effective technology options to meet our environmental goals, including the reduction of carbon dioxide (CO_2) emissions.

Carbon capture and storage (CCS) technologies offer a great opportunity to reduce these potential emissions. Fortunately, the United States and Canada are blessed with an abundance of potential geologic storage capacity. At the current rate of energy production and use, we could potentially store all of the associated CO_2 emissions in North America that are produced over the next 175 to 500 years, according to the geologic storage capacity estimates recently made by DOE's Regional Carbon Sequestration Partnerships. These results were recently published in the "*Carbon Sequestration Atlas of the United States and Canada*" that is available on our website at http://www.netl.doe.gov/publications/carbon_seq/refshelf.html.

The two greatest challenges facing technology development for clean power production integrated with CCS are reducing the cost of carbon capture and proving the safety and efficiency of long-term geologic storage of CO_2. DOE supports a robust RD&D program specifically designed to address these challenges. The Office of Fossil Energy's core Coal Technology Program includes the development of advanced technologies for pre-combustion (or gasification), post-combustion, and oxy-combustion – multiple pathways to produce power and capture CO_2 – as well as a robust program for carbon sequestration to prove the viability of long-term geologic and terrestrial storage. DOE's Office of Science also supports basic research in areas such as combustion chemistry, fundamentally new materials, and modeling of combustion reactions that underpin the development of potential future clean coal technologies, and basic research towards improving our scientific understanding of the behavior of CO_2 at potential geological sites.

The 2012 goal of the Coal Technology Program is to show that we can develop advanced technology to capture and store at least 90 percent of the potential CO_2 emissions from coal-fired power plants, with less than a 10 percent increase in the cost of electricity. This is an ambitious and significant goal, considering that commercially available technology to do this today will add from 30 to 70 percent to the cost of electricity.

Based on the Energy Information Administration's 2007 new capacity forecast, 145 gigawatts of new coal-based capacity will be required in the United States by 2030, while still maintaining most of the 300 gigawatts of generating capacity in the existing coal fleet. We have a fast-approaching opportunity to introduce a "new breed" of power plant – one that is highly efficient, capable of producing multiple products, and is virtually pollution-free ("near-zero" emissions, including carbon). In addition to technology for new plants, we are also likely to need technology that will permit efficient, cost-effective capture of CO_2 emissions from the existing fleet. DOE's R&D program is aimed at providing the scientific and technological foundation for carbon capture and storage for both new and existing coal-fueled power plants.

Gasification is a pre-combustion pathway to convert coal or other carbon-containing feedstocks into synthesis gas, a mixture composed primarily of carbon monoxide and hydrogen, which can be used as a fuel to generate electricity or steam, or as a basic raw material to produce hydrogen, high-value chemicals, and liquid transportation fuels. We are developing advanced gasification technology to meet the most stringent environmental regulations in any state and facilitate the efficient capture of CO_2 for subsequent sequestration – a pathway to "near-zero-emission" coal-based energy.

The portfolio of gasification projects that we are developing in partnership with industry covers a broad range of approaches. I'd like to highlight some of the important recent developments.

The Power Systems Development Facility (PSDF) in Wilsonville, Alabama, operated by the Southern Company for DOE, provides a pilot-scale test platform for evaluating components critical to the evolution of gasification technology. The "transport gasifier" under development at the PSDF is proving to be very promising in terms of efficiency and cost, especially for gasifying low-rank, high-moisture western coals. Data from this facility is providing the design basis for scaling technology components to full-size in support of near-zero-emission coal systems.

The Stamet dry-feed coal pump is another promising gasification sub-system that we have been sponsoring. It allows coal to be "pumped" directly into a high-pressure gasifier, thus avoiding the need for coal drying and a complex and costly lock hopper feeding system – or, alternatively, a slurry feeding system that is inefficient when used to feed high-moisture western coals. We have tested the system successfully at the PSDF, and in recent tests at Stamet's facilities in California where operation was successfully demonstrated at conditions typical of high-pressure gasifiers.

Another major program objective is the development of ion transport membrane (ITM) technology, an alternative to conventional cryogenic methods for oxygen production that promises capital cost reductions of $130 per kilowatt, and efficiency improvements of about 1 percent when integrated into oxygen-based gasification systems. This year we will test the robustness of the membranes under various process conditions and upsets in a 5-ton-per-day unit that is operating at Air Products and Chemicals, Inc.'s, Sparrows Point industrial gas facility located near Baltimore, Maryland. The information generated from this small unit will be used to design and test a 150-ton-per-day facility that will pave the way for a full-scale commercial unit in the Department's FutureGen Project, discussed further below.

Finally, we have been successfully testing the Research Triangle Institute's (RTI's) warm gas sulfur cleanup system at Eastman Chemical's Kingsport, Tennessee, chemical complex where a small syngas slipstream is taken from commercial coal gasifiers and processed in a transport desulfurization unit. Since last fall – in over 2,000 hours of operation – the unit has performed exceptionally well, achieving extremely low sulfur levels compared to existing commercial technologies. This new technology offers potential for capital cost reductions of $250 per kilowatt and efficiency improvements of 3 to 4 percent. We are currently in negotiations with RTI to scale up this technology for testing at a commercial Integrated Gasification Combined Cycle (IGCC) facility.

The **Advanced Turbine Program** is leveraging the knowledge gained from previous turbine R&D activities to make unprecedented gains in state-of-the-art turbine designs. Potential pathways to advanced turbine designs for high-hydrogen fuels include increasing turbine inlet temperatures, developing advanced combustor designs, increasing compression ratios, and integrating air separation and CO_2 compression.

For near-zero-emission power plants, a new generation of turbine technology is needed that is capable of operating on hydrogen fuels, without compromising operational performance, while achieving ultra-low NO_x emissions.

A primary goal of the Advanced Turbines Program is to show by 2012 that we can operate on hydrogen fuel, increase efficiency by 2 to 3 percentage points over baseline, and reduce NO_x emissions to 2 parts per million (ppm). At the same time, we hope to reduce capital cost when compared to today's turbines in existing IGCC plants. We are working with two of the turbine original equipment manufacturers, General Electric and Siemens Westinghouse, to meet these goals.

To facilitate the development of near-zero-emission coal-based power systems, the Advanced Turbines Program is also funding R&D on oxygen-fired (oxy-fuel) turbines and combustors that provide high efficiency through the use of ultra-high-temperature power cycles. Bringing such oxy-fuel combustors and turbines to commercial viability will require development and integrated testing of the combustor, turbine components, advanced cooling technology, and materials.

To reduce the costs associated with sequestering CO_2, the Advanced Turbines Program is investigating novel approaches for CO_2 compression, including development of the Ramgen shock-wave compression technology. Successful development will reduce the substantial power requirements and costs associated with compression for any zero-emission approach.

The Office of Fossil Energy has been developing high-temperature **Solid Oxide Fuel Cells** for a variety of applications under the Solid State Energy Conversion Alliance (SECA) program. These high-temperature fuel cells offer several significant advantages to coal-based near-zero-emission power systems. Recognizing the strategic importance of being able to operate on domestic fuel resources, namely, coal, we are refocusing the program to coal-based power generation applications.

First, electrochemical power generation is highly efficient and can result in large savings by reducing the size and cost of the up-front gasification and clean-up parts of the plant, as well as by reducing the amount of CO_2 that has to be sequestered.

Second, solid oxide technology can directly utilize carbon monoxide and methane produced in gasification without the need to shift the composition of the syngas to pure hydrogen, which incurs cost and efficiency penalties.

Third, solid oxide fuel cells have built-in carbon separation capability if the anode (fuel side) and cathode (oxidant side) streams are not mixed. We expect that fuel cells will provide over a 10 percentage point increase in efficiency in near-zero-emission systems, with capital costs comparable to or lower than current gas turbine/steam turbine systems.

DOE's **Carbon Sequestration Program** leverages basic and applied research with field verification to assess the technical and economic viability of CCS as a greenhouse gas mitigation option. The Program encompasses two main elements: Core R&D and Validation and Deployment. The Core R&D element focuses on technology solutions, including low-cost, low-energy intensive capture technologies, 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.

The key challenges the program is addressing are to demonstrate the ability to store CO_2 in underground geologic formations with long-term stability (permanence), to develop the ability to monitor and verify the fate of CO_2, and to gain public and regulatory acceptance. DOE's seven Regional Carbon Sequestration Partnerships are engaged in an effort to develop and validate CCS technology in different geologies across the Nation.

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 sequestration. The Partnerships are evaluating numerous CCS approaches to assess which approaches are best suited for specific geologies, and are developing the framework needed to validate and potentially deploy the most promising technologies.

The Regional Partnership initiative is using a three-phased approach.

Characterization, the first 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.

Validation, the 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 storage 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.

Deployment, the third phase, involves large-volume injection tests. This phase was initiated this fiscal year and will demonstrate CO_2 injection and storage at a scale necessary to demonstrate potential future commercial deployment. 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 (CCPI). The Department expects to issue a CCPI solicitation for carbon capture technologies at commercial scale in 2007.

DOE also recognizes the importance of the existing fleet of coal-fired power plants in meeting energy demand and possible future carbon constraints. Research is being pursued to develop technologies that dramatically lower the cost of capturing CO_2 from power plant stack emissions. This research, supported by the Office of Fossil Energy, is exploring a wide range of approaches that includes membranes, ionic liquids, metal organic frameworks, improved CO_2 sorbents, advanced combustor concepts, advanced scrubbing, and oxy-combustion. Additionally, advanced research is being pursued on high-temperature materials, advanced sensors & controls, and advanced visualization software. These developments could provide significant efficiency improvements and cost reductions for both existing and future power plants, based on pulverized coal combustion.

The FutureGen Project is an industry/government partnership to design, build, and operate a gasification-based, nearly emission-free, coal-fired electricity production plant. The 275-megawatt plant will be the cleanest fossil-fuel-fired power plant in the world. With respect to sequestration technologies, FutureGen will test, and ideally demonstrate the large-scale, permanent sequestration of the captured CO_2 in a deep saline formation. FutureGen is scheduled to operate from 2012 to 2016, followed by a CO_2 monitoring phase. The data and experience derived from this important endeavor will then be available to facilitate the design of the next generation of near-zero-emission plants.

By working in partnership with other Federal agencies, utilities, coal companies, research organizations, academia, and non-government organizations, we hope to make near-zero-emission coal technology a cost-effective and safe option to help meet our future power needs.

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