COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
U.S. HOUSE OF REPRESENTATIVES

Prospects for Advanced Coal Technologies: Efficient Energy Production, Carbon Capture and Sequestration

Tuesday, May 15, 2007
1:00 p.m. to 3:00 p.m.
2325 Rayburn House Office Building

Purpose

On Tuesday, May 15, 2007 the Subcommittee on Energy and Environment of the Committee on Science and Technology will hold a hearing to receive testimony on the advancement of coal technologies and carbon capture and sequestration strategies which will help to reduce the emissions of greenhouse gases, in particular, carbon dioxide.

The Department of Energy has a number of ongoing research and development programs designed to demonstrate advanced technologies that reduce coal power's carbon emissions. In addition, some industry leaders also have begun to invest in advanced coal technologies. The Committee will hear testimony from five witnesses who will speak to the current research, development, demonstration and ultimate commercial application of technologies that enable our power plants to operate more efficiently, reduce emissions, and capture carbon for long-term storage. They will discuss the technical and economical challenges we face to limit carbon emissions and safely manage the captured carbon on a large scale.

Witnesses

Mr. Carol O. Bauer, Director of the National Energy Technology Laboratory (NETL), a national laboratory owned and operated by the Department of Energy. In his current position as Director of NETL, he oversees the implementation of major science and technology development programs to resolve the environmental, supply and reliability constraints of producing and using fossil resources, including advanced coal-fueled power generation, carbon sequestration, and environmental control for the existing fleet of fossil steam plants.

Dr. Robert J. Finley, Director Energy and Earth Resources Center for Illinois State Geological Survey with specialization in fossil energy resources. He is currently heading a regional carbon sequestration partnership in the Illinois Basin aimed at addressing concerns with geological carbon management.

Mr. Michael Rencheck, Senior Vice President for Engineering Projects and Field Services at American Electric Power headquartered in Columbus, Ohio. He is responsible for engineering, regional maintenance and shop service organizations, projects and construction, and new generation development. He will discuss ongoing projects at AEP and can talk to plant efficiencies and retrofitting facilities to capture carbon.

Mr. Stu Dalton, Director, Generation at the Electric Power Research Institute. His current research activities cover a wide variety of generation options with special focus on emerging generation, coal-based generation, emission controls and CO2 capture and storage. He also helped to create the EPRI *Coal Fleet for Tomorrow* program.

Mr. Gardiner Hill, Director of Technology in Alternative Energy Technology, responsible for BP group wide aspects of CO2 Capture and Storage technology development, demonstration and deployment. He also is the BP manager responsible for the BP/Ford/Princeton Carbon Mitigation Initiative at Princeton University as well as the BP manager responsible for the BP/Harvard partnership on the Energy Technology Innovation Project. He posses 20 years of technical and managerial experience which is directly relevant to technology, business and project management.

Background

Approximately 50% of the electricity generated in the United States is from coal. According to DOE's Energy Information Administration (EIA) carbon dioxide emissions in the United States and its territories were 6,008.6 million metric tons (MMT) in 2005. In the United States, most CO2 is emitted as a result of the combustion of fossil fuels. In particular, the electric power sector accounts for 40% of the CO_2 emissions in the U.S, according to EIA.

If we are going to implement policies to reduce greenhouse gas emissions associated with the use of coal, what technologies are currently available, what technologies need to be developed or improved, and what technical challenges must we overcome to meet that goal? There are two primary approaches to reducing emissions associated with coal-fired power production: increasing the efficiency of coal-fired plants (through replacement with new plants or retrofitting existing plants) and through installation of carbon capture technology and transporting CO_2 to a permanent storage facility.

CO_2 Capture

Retrofitting existing coal-fired power plants to capture carbon is a critical component of any strategy to reduce our emissions of greenhouse gases. Carbon capture applications may be installed in new energy plants or retrofitted to existing plants. Some outstanding issues with retrofitting existing plants include site constraints such as availability of land for the capture equipment and the need for a long remaining plant life to justify the large expense of installing the capture equipment. Another potential barrier to retrofitting is the loss in efficiency that can occur due to the energy required to operate the carbon-capture equipment.

The first step in carbon capture and sequestration is to produce a concentrated stream of CO_2 for capture. Currently, there are three main approaches to capture CO_2 from large-scale industrial facilities or power plants: 1) post-combustion capture, 2) pre-combustion capture, and 3) oxy-fuel combustion capture.

Post-combustion capture process, although not required, involves extracting CO_2 from the flue gas following combustion of fossil fuels. There are commercially available technologies that use chemical solvents to absorb the carbon.

Pre-combustion capture separates CO_2 from the fuel by combining it with air and/or steam to produce hydrogen for combustion and CO_2 for storage. The most commonly discussed type of pre-combustion capture technology is the gasification method. Gasification is a method of taking low-value feedstocks such as coal, biomass or petroleum coke and transforming them through a chemical process to make high value products such as chemicals or electricity. Integrated Gasification Combined Cycle (IGCC) -- often discussed as a major breakthrough to improve the environmental performance of coal-based electric power generation – is a form of gasification that uses syngas created from the gasification process as the feedstock to power a combined-cycle turbine used to produce electricity. IGCC has the ability to produce a relatively pure stream of CO_2 arguably making it better suited for carbon capture than a pulverized coal plant.

Oxy-fuel combustion capture uses oxygen instead of air for combustion and produces a flue gas that is mostly CO_2 and water which are easily separated. This technique is considered developmental and has not been widely applied for power production, mainly because the temperatures that result from the combustion of pure oxygen are far too high for typical power plant materials.

CO_2 Sequestration

Geologic sequestration of CO_2 is considered the most feasible and widely studied method of storage. There are three main types of geologic formations: 1) oil and gas reservoirs, 2) deep saline reservoirs, and 3) unmineable coal seams.

When CO_2 is injected below 800 meters in a typical reservoir, the pressure induces CO_2 to behave like a relatively dense liquid. This state is known as “supercritical.” With each of the three methods listed above, CO_2 would be injected into reservoirs that hold, or previously held liquids or gases. In addition, injecting CO_2 into deep geological formations uses existing technologies that have been primarily developed by and used for the oil and gas industry. For these reasons, geologic sequestration appears to be a promising carbon storage strategy.

Pumping CO_2 into oil and gas reservoirs to boost production, a process known as enhanced oil recovery (EOR) is practiced by the petroleum industry today. Using EOR for long-term CO_2 storage is beneficial because sequestration costs can be partially offset by revenues from oil and gas production. However, the primary purpose of CO_2 for EOR was not intended to serve the need for long-term sequestration of CO_2 and the degree to which injected CO_2 remains in the reservoir in many areas utilizing EOR is unknown.

Depleted or abandoned oil and gas fields are potential candidates for CO_2 storage because the oil and gas originally trapped did not escape for millions of years demonstrating the structural integrity of these reservoirs. Because of their value as sources of oil and gas, these reservoirs have been mapped and studied and computer models have often been developed to understand how hydrocarbons move in the reservoir. These models could be applied to predict the potential movement of CO_2 within these reservoirs.

Still, there are concerns with using oil and gas reservoirs for CO_2 storage that stem from the stability of the reservoir post-production and the degree of certainty that leakage could be prevented.

A noteworthy project is the Weyburn Project in south-central Canada which uses CO_2 produced from a coal gasification plant in North Dakota for EOR. According to CRS, comprehensive monitoring is being conducted at Weyburn.

Deep saline formations are sedimentary basins saturated with saline or briny water that is unfit for human consumption or agricultural use. As with oil and gas, deep saline reservoirs can be found onshore and offshore. There are advantages of using saline reservoirs for CO_2 sequestration: they are more widespread in the U.S. than oil and gas reservoirs and potentially have the largest reservoir capacity of the three types of geologic formations being considered for carbon sequestration.

The first commercial-scale operation for sequestering CO_2 in a deep saline reservoir is the Sleipner Project in the North Sea. While deep saline reservoirs have huge potential capacity to store CO_2, there is concern about maintaining the integrity of the reservoir because of chemical reactions following CO_2 injection. CO_2 can acidify the fluids in the reservoir, dissolving minerals such as calcium carbonate, and possibly weakening the reliability of the storage site. Increased permeability could allow the CO_2 to create new pathways that lead to contamination of aquifers used for drinking water.

Many coal seams are unmineable with current technology because the coal beds are not thick enough, the beds are too deep, or the structural integrity of the coal bed is inadequate for mining. Because coal beds are highly permeable they tend to trap gases, such as methane, that bind themselves to the coal. CO_2 binds even more tightly to coal than methane, thus making it possible to store the unwanted CO_2 and increase the recovery of the valuable coalbed methane.

Efficient Energy Production and Retrofitting existing Coal-fired Power Plants

EIA projections show that a 2% increase in coal efficiency would exceed all additional renewable power generation through the EIA forecast period (2030).

Raising the efficiency of power plants is part of the debate on how best to reduce carbon dioxide emissions. Adopting advanced power generating systems could help plant efficiency for coal-fired power plants. For example, the Department of Energy's National Energy Technology Laboratory (NETL) is developing technologies to ensure existing and future coal power systems are more efficient and burn more cleanly. Their work includes gasification, advanced combustion, and turbine and heat engine technologies. Coal power plants operate at approximately a 33% efficiency level and NETL is striving to develop technologies for a central power plant that is capable of 60% efficiency with near zero emissions by 2020.

In addition to designing new plants to be more efficient, NETL and others are working on technologies that can be utilized to improve the efficiency of existing coal-fired power plants. In the short term, options such as converting from sub-critical to super-critical steam cycle and combining coal with biomass to fuel plants both offer opportunities to lower CO_2 emissions from existing coal plants.

If you have questions or need additional information, please do not hesitate to contact Michelle Dallafior with the Science and Technology Subcommittee on Energy and Environment at 226-2179.