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Overview of Carbon Dioxide Capture

RTI International

Electricity generation is the largest source of carbon dioxide emissions, and the overwhelming majority of those emissions come from the existing fleet of conventional pulverized-coal power plants. Regulation of CO_2 emissions will affect the cost of electricity generation, which will affect operating costs for manufacturing, commercial establishments, residences, government, and electric vehicles.

Coal is, and will remain, the largest single fuel used to generate electricity in the United States, and probably the world. Coal accounts for half of electricity generation in the U.S. today, and is projected to increase to 60% by 2030, even with expanded use of other fuels, including renewables.

For pollutants such as acid-forming sulfur dioxide and nitrogen oxides and toxic metals such as mercury, technology has significantly decreased emissions in the U.S., even while use of coal has increased.

For CO_2 emissions management, multiple approaches will be needed to affordably address both energy demand/supply and environmental objectives. Technology for capture and sequestration will be one of those approaches, as will technologies to increase efficiency and reduce carbon intensity (e.g., use of natural gas), and increased use of other fuels (e.g., renewables, nuclear).

To achieve environmental objectives, emissions from existing coal-fired power plants must be reduced, in any case.

For existing coal-fired power plants, one option is to retire existing plants and replace them with new plants with higher efficiency and integrated CO_2 capture. Is this option realistic? Another approach is to develop affordable technologies for post-combustion CO_2 capture at existing coal-fired power plants.

The current technology for post-combustion CO_2 capture is scrubbing with amine solvents. This technology has been extensively used in natural gas industry, but has not been commercially used for coal plants. There are, moreover, a number of challenges associated with its use with coal plants, including toxicity of amines, degradation of solvent with flue gas contaminants, and corrosion of equipment. New post-combustion technologies are emerging from the laboratory, supported by R&D funds from the Department of Energy, with cost-sharing from the private sector. RTI International, for example, has developed a "dry carbonate" process, which recently was field-tested at EPA's Multi-pollutant Control Facility in Research Triangle Park, NC. The process achieved at least 90% capture in a series of tests, and is heading for pilot-scale demonstration within a year. If this technology proves to be commercially viable at a reasonable cost, it would be ready for early adoption in the marketplace in approximately the year 2016.

Pre-combustion capture, at new gasification-based (IGCC) power plants, depends upon improved technology for cleaning the synthetic gas. Demonstration of this technology (also developed by

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RTI International with DOE and industry funding) is planned at Tampa Electric Company's Polk Station next year.

Another technology, oxy-fuel combustion, in which coal is combusted with oxygen rather than air, has been tested at pilot scale in the U.S., Germany and Australia. Several technical challenges remain to be solved through further development.

The U.S. Department of Energy is beginning CO_2 injection demonstration projects to explore the sequestration/storage aspect of CCS through its Regional Partnership program. Large-scale capture demonstration projects are still being defined. Storage demos may begin operating as soon as 2010.

The first "pioneer" facilities for retrofit of capture to existing power plants may begin operating in 2016, with pioneer greenfield facilities beginning operations a few years later. Early adopters at both existing power plants and new Greenfield facilities will follow, beginning operations after the year 2020.

To support advancement of cost-effective CO_2 capture, R&D needs to focus on post-combustion capture for existing power plants, pre-combustion capture and enabling technologies for new power plants (IGCC), and developing technology for power plants of the 250 MW to 1000 MW scale.

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