PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

04/2008

Evaluation of Carbon Dioxide Capture/Utilization/Disposal Options

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Background

Concerns over possible global climate changes due to increasing atmospheric concentrations of greenhouse gases such as carbon dioxide (CO_2), have placed a strong emphasis on the development of high-efficiency, coal-based energy systems, as well as on processes for recovering and sequestering CO_2 that is produced. One approach is oxycombustion with flue gas recycle to maintain a normal temperature profile in the furnace. Oxycombustion with flue gas recycle is an emerging technology that has the potential to allow for control of CO_2 emissions at a lower cost than a conventional air-fired pulverized coal (PC) power plant.

Description

The U.S. Department of Energy is investigating the feasibility of retrofitting boilers using this concept as a strategy for CO_2 recovery from conventional PC power plants. This approach was conceived nearly 20 years ago at Argonne National Laboratory (ANL) as a low-cost CO_2 source for enhanced oil recovery (EOR). A CO_2/oxygen (O_2) molar ratio of about three is necessary to preserve the heat-transfer performance and gas-path temperatures, allowing this system to be applied as a retrofit.

The principal contribution of this project is to develop engineering evaluations for the capture and recovery of CO_2 from PC-fired power plants that are retrofitted for flue gas recirculation. The full energy cycle will be considered, including mining, coal transportation and preparation, the PC-fired boiler with power generation, particulate removal and flue gas recirculation, facility water use, pipeline CO_2 conditioning, and CO_2 pipeline transport. ANL will also identify existing power plants that may be retrofit candidates, and will consider the effects of different coals on CO_2 capture as well as on the accessibility of sequestration options. In addition, the cost of retrofitting the existing fleet of domestic PC boilers with oxycombustion will be assessed by incorporating the AMIGA (All-Modular Industry Growth Assessment) macroeconomic model.

The project will provide the U.S. power industry with a low-cost retrofit system that could remain in service during future upgrades at power plants. The captured CO_2 can be used for EOR or otherwise sequestered. In general, the project addresses both design and full energy-cycle issues pertaining to existing coal-fired power plants.

PARTNERS

Argonne National Laboratory

PERIOD OF PERFORMANCE

10/01/1997 to 12/31/2010

COST

Total Project Value
$2,464,000

DOE/Non-DOE Share
$2,464,000 / $0

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Primary Project Goal

The goal of the project is to conduct comparative engineering assessments of technologies for the recovery, transportation, and utilization/disposal of CO_2 produced in high-efficiency, coal-based, energy systems. Coordinated evaluations will address CO_2 transportation, CO_2 use, and options for long-term sequestration. Commercially-available CO_2 capture technologies will provide performance and economic baselines for comparing innovative CO_2 recovery technologies across the full energy cycle.

Objectives

- Develop engineering evaluations for the recovery of CO_2 from PC-fired power plants retrofitted for flue gas recirculation and reconcile and extend these studies across the full energy-cycle.
- Identify existing power plants that may be retrofit candidates, considering the effects of different coals and the accessibility of a sequestration zone.
- Conduct analyses of an oxycombustion retrofit at large PC-fired power plants with AMIGA, regarding least-cost investment and ranking, as well as dispatch order and energy use in the economy.

Benefits

PC plants are the most common type of power plant; therefore, a system that can be retrofitted to PC-fired boilers and enable CO_2 recovery will have broad applicability. Flue gas recirculation eliminates the need for nitrogen (N_2)/CO_2 separation and sulfur separation, permitting more economical CO_2 recovery than competing amine-based systems. Technical and economic analyses will build on current accomplishments to develop a lower cost CO_2 capture technology.

Accomplishments

- A full energy cycle was evaluated based on simulation of an O_2-blown PC boiler with CO_2 recovery and flue gas recirculation that includes details of stream compositions for the whole system.
- Process design and economics for 300–900 MW PC-fired boilers burning low-, medium-, and high-sulfur coals have shown that oxycombustion is economical and could be an approach to lower the costs of eventually repowering a site with an integrated gasification combined cycle (IGCC) system.
- A draft report discussing the economics of oxycombustion and flue gas recirculation for low-, medium-, and high-sulfur coals was completed.
- A CO_2 pipeline network for the PJM region was postulated so that logistics and costs of CO_2 transport from oxycombustion power plants could be scoped out on a regional basis. This effort was then extended to the Illinois Basin, examining the logistics for an oxycombustion retrofit at a specific power plant on the edge of the Illinois Basin.
- Updated models to better define the performance and impacts of a high CO_2, low N2 flue gas.