the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Evaluation of Carbon Dioxide Capture/Utilization/Disposal Options

Background

The mission of the U.S. Department of Energy's (DOE) Existing Plants, Emissions & Capture (EPEC) Research and Development (R&D) Program is to develop innovative environmental control technologies to enable full use of the nation's vast coal reserves, while allowing the current fleet of coal-fired power plants to comply with existing and emerging environmental regulations. The EPEC R&D Program portfolio of post- and oxy-combustion carbon dioxide (CO_2) emissions control technologies and CO_2 compression and reuse is focused on advancing technological options for the existing fleet of coal-fired power plants in the event of carbon constraints.

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 oxy-combustion with flue gas recycle to maintain a normal temperature profile in the furnace. Oxy-combustion 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

DOE 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, 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 oxy-combustion will be assessed by incorporating the All-Modular Industry Growth Assessment (AMIGA) macroeconomic model.

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PERFORMANCE PERIOD

Start Date	End Date
10/01/97	12/31/10

COST

Total Project Value
$2,494,000

DOE/Non-DOE Share
$2,494,000 / $0

PARTNERS

Argonne National Laboratory

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U.S. DEPARTMENT OF ENERGY

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.

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

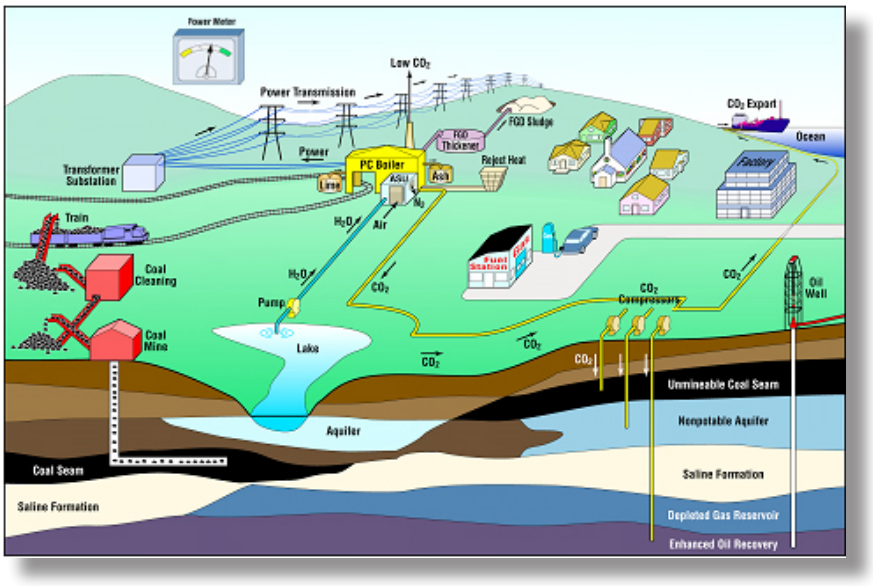
- Develop engineering evaluations for the recovery of CO_2 from PC-fired power plants retrofitted for flue gas recirculation, and reconcile and extend these studies across the full energy-cycle.
- Identify existing power plants that may be retrofit candidates, considering the effects of different coals and the accessibility of a sequestration zone.
- Conduct analyses of an oxy-combustion 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 oxy-combustion 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 oxy-combustion 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 oxy-combustion power plants could be scoped out on a regional basis. This effort was then extended to the Illinois Basin, examining the logistics for an oxy-combustion retrofit at a specific power plant on the edge of the Illinois Basin.
- Models were updated to better define the performance and impacts of a high CO_2, low N_2 flue gas.
- AMIGA studies enhanced with Aspen Plus® were performed to evaluate unit level performance, considering both investment and energy ranking, and dispatch order and energy in the economy.



Full Energy Cycle.