FUTURE OF CCS TECHNOLOGY ADOPTION AT EXISTING PC PLANTS

primary project goals

Argonne National Laboratory (ANL) is constructing scenarios that affect carbon capture and storage (CCS) adoption as combinations of cases for the following dimensions: electricity demand, nuclear growth, renewable energy growth, higher or lower gas price factors, and alternative policies.

technical goals

- Extension of ANL's previous work in project FWP49539, "Evaluation of CO_2 Capture/ Utilization/Disposal Options."
- Simulate oxy-combustion and amine-based processes using ASPEN.
- Expand the scenario analyses to focus on the value of coal-based CCS for existing pulverized coal (PC) plants and for other technologies, such as coal-to-liquids with CCS.
- ANL will examine pathways that expedite CCS adoption, such as accelerated research and development (R&D) and carbon dioxide (CO_2) utilization for enhanced oil recovery (EOR).
- ANL will examine opportunities for R&D related to shale gas, such as developing CCS specifically for natural gas combined cycle (NGCC) units.

technical content

In a previous project (FWP49539), ANL conducted engineering assessments and economic evaluations on retrofitting PC boilers with oxy-combustion, and then eventually repowering the site with integrated gasification combined cycle (IGCC). The engineering assessment for oxy-combustion was conducted with the ASPEN process model and the economic evaluations with the AMIGA macroeconomic model. The assessment investigated the entire life cycle of the plant, which included the mining of the coal, coal transportation, coal preparation, power generation, environmental controls, water use, pipeline CO_2 conditioning, and pipeline transport of CO_2 for sequestration.

ANL also conducted ASPEN modeling for 18 different oxy-combustion and air-fired cases. Three different power production ratings (150 MW, 300 MW, and 450 MW) were investigated. The model included a selective catalytic reduction (SCR) system and a flue gas desulfurization (FGD) system for flue gas cleanup.

technology maturity:
Systems Analysis and Macroeconomic Modeling

project focus:
Analysis of CCS Technology Adoption

participant:
Argonne National Laboratory

project number:
FWP49806
continued from FWP49539

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None

performance period:
2/1/11 – 3/31/14

The analysis in the current project will demonstrate and, to the extent possible, quantify the role and benefit of R&D related to the utilization and environmental control of fossil fuels. The impacts of R&D will be shown by comparing model results such as deployment rates, emissions reductions, and electricity costs across various scenarios. The scenarios will capture a number of CO_2 control regimes, R&D programs, and economic conditions in order to fully understand the role that R&D plays in each. With widespread deployment of CCS under a CO_2 reduction target, R&D that lowers cost of CO_2 capture and increases efficiency will be shown to have a high economic payoff.

Other topics to be analyzed with the ANL model are as follows: the value of coal-based CCS in high natural gas price scenarios; opportunities and obstacles for R&D, on NGCC with CCS, including cost and performance parameters; the conditions under which CO_2-EOR enables faster deployment of CCS systems; the market opportunity for coal and biomass to liquid fuels and power co-production with CCS; and impacts on PC units, especially those retrofitted with CCS, from cycling due to intermittent grid generation from renewables.

technology advantages

The ANL model is especially designed to analyze the issues and scenarios described above.

R&D challenges

Capturing the impacts and costs of high intermittent renewable generation as it affects dispatchable coal generators, especially those that have adopted CCS.

results to date/accomplishments

- Ran Electricity Supply and Investment Model (ESIM) for high, mid, and low gas supply scenarios to identify retirement of existing PC power plants which do not retrofit with CCS and to identify the retrofit with CCS of other current PC plants.
- Modeled predicted increased CO_2 capture and decreased CO_2 emissions for the scenarios.
- Simulated the benefit of higher utilization (i.e., capacity factor) for PC plants that retrofit CCS because of rising up the loading order (i.e., dispatch order).
- Analyzed the value of coal-based CCS in high natural gas price scenarios.
- Analyzed opportunities and obstacles for R&D, specifically regarding CCS, including cost and performance parameters.
- Analyzed market opportunity for coal and biomass to liquid fuels and power co-production with CCS.
- Analyzed impacts on PC units, especially those retrofitted with CCS, from cycling due to intermittent grid generation from renewables.
- Concluded funding for R&D for CCS, nuclear, and biochemical technologies can help meet CO_2 reduction goals.
- Concluded credits for reducing CO_2 or small price on emitting CO_2 will provide incentive to operate units with CCS at higher utilization than units without capture.
- Concluded electricity prices can be moderated for consumers and businesses if revenue from a modest price on CO_2 is recycled back to help fund investments in advanced generation capacity.

next steps

This project ended on March 31, 2014.

available reports/technical papers/presentations

Hanson, D. and Schmalzer, D, "An Adoption Scenario for Carbon Capture in Pulverized Coal Power Plants in the USA," Greenhouse Gases Science and Technology (3:p.303-308), 2013.

Hanson, D. "Future of CCS Technology Adoption at Existing PC Plants," presented at CO_2 Capture Technology Meeting, Pittsburgh, PA, July 2013. *http://www.netl.doe.gov/File Library/events/2013/CO_2 capture/D-Hanson-ANL-Future-of-CCS.pdf*.

Hanson, D., and Schmalzer, D., "CCS Adoption Under Alternative Market Conditions," presented at U.S. Association for Energy Economics Conference, Austin, TX, November 2012.

Hanson, D., "Economics and Adoption of CO_2 Capture for Existing PC Plants in a Power System Context," Eleventh Annual Conference on Carbon Capture, Utilization & Sequestration, Pittsburgh PA, May 2012.

Hanson, D., "Future of CCS Technology Adoption at Existing PC Plants," presented at CO_2 Capture Technology Meeting, Pittsburgh, PA, July 2012.

Hanson, D.; Marano, J.; and Fout, T., "Economic Analysis of Existing Coal Plant Retrofits with CCS," Energy, Utility, & Environmental Conference, Phoenix AZ, January 2012.

Hanson, D., "A Market Scenario Approach to Managing Existing Power Plant Assets," 13th Annual Electric Power Conference and Exhibition, Rosemont, IL, May 2011.

Hanson, D., and Doctor, R., "Future of CCS Technology Adoption at Existing PC Plants," presented at CO_2 Capture Technology Meeting, Pittsburgh, Pennsylvania, August 2011.

"ANNUAL REPORT 2009: Evaluation of CO_2 Capture and Sequestration Using Oxyfuels with AMIGA Economic Modeling," November 23, 2009.

Doctor, R.; Hanson, D. A.; and Molburg, J. C., "Evaluation of CO_2 Capture and Sequestration Using Oxyfuels with AMIGA Economic Modeling," presented at 2009 NETL Capture Technology Meeting, March 2009.