the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Slipstream Pilot Scale Demonstration of a Novel Amine-Based Post-Combustion Process Technology for CO_2 Capture from Coal-Fired Power Plant Flue Gas

Background

The mission of the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) Existing Plants, Emissions, & Capture (EPEC) Research & Development (R&D) Program is to develop innovative environmental control technologies to enable full use of the nation's vast coal reserves, while at the same time 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 is focused on advancing technological options for the existing fleet of coal-fired power plants in the event of carbon constraints.

Pulverized coal (PC) plants burn coal in air to produce steam and comprise 99 percent of all coal-fired power plants in the United States. CO_2 is exhausted in the flue gas at atmospheric pressure and a concentration of 10 to 15 percent by volume. Post-combustion separation and capture of CO_2 is a challenging application due to the low pressure and dilute concentration of CO_2 in the waste stream, trace impurities in the flue gas that affect removal processes, and the parasitic energy cost associated with the capture and compression of CO_2. Chemical solvents can be used to capture CO_2 from flue gas by absorbing it into a liquid carrier. Research has been ongoing to identify new, next generation solvents. Slipstream testing and validation of promising solvents along with innovative post-combustion capture processes can make significant progress toward increasing the energy efficiency and consequently reducing the cost of CO_2 recovery from coal-fired power plants.

Description

Linde LLC (Linde) and partners will design, build, and operate a 1 megawatt electric (MWe) equivalent pilot plant at a PC plant host site to further refine a post-combustion capture solvent technology developed by Linde and BASF incorporating BASF's novel amine-based process along with Linde's process and engineering innovations. This technology offers significant benefits compared to other solvent-based processes as it aims to reduce the regeneration energy requirements using novel solvents that are stable under coal-fired power plant feed gas conditions. BASF has developed the desired solvent based on the evaluation of a large number of candidates. Linde has evaluated a number of options for capital cost reduction in large engineered systems for solvent-based post-combustion capture technology.

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PARTNERS

BASF
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Linde Engineering Dresden GmbH
EPRI
Southern Company

PERFORMANCE PERIOD

Start Date	End Date
12/01/2011	11/30/2015

COST

Total Project Value
$18,490,456

DOE/Non-DOE Share
$14,792,365 / $3,698,091

AWARD NUMBER

FE0007453

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U.S. DEPARTMENT OF ENERGY

A techno-economic assessment will be performed for a conceptual 550 MWe coal-fired power plant incorporating the amine-based post-combustion CO_2 capture technology in development. Results from previous bench-scale and small pilot testing will be analyzed and design optimization studies will be performed to select the slipstream pilot plant design basis. The basic design will be completed with sufficiently detailed engineering to accurately estimate the cost of the slipstream pilot implementation. The techno-economic analysis and the slipstream pilot plant cost estimates will be used to confirm project feasibility and progression to the next stage.

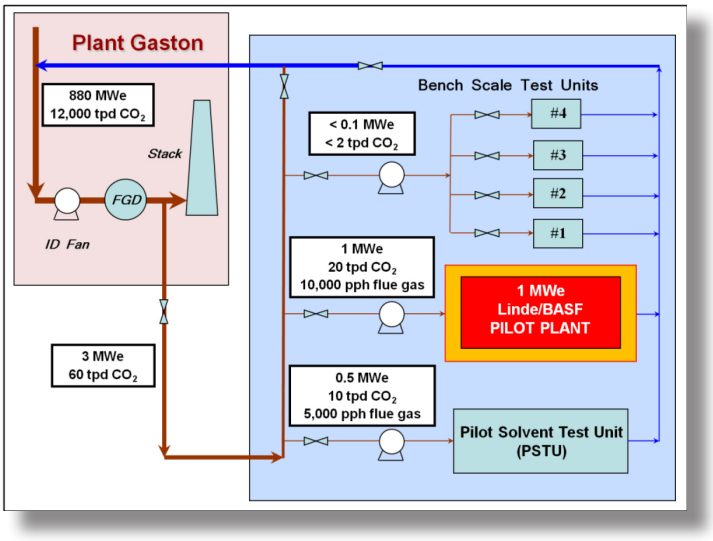
Based on completed detailed engineering studies and design development for the system, the pilot plant will be constructed, installed, and commissioned to operate on a slipstream of coal-fired flue gas. The National Carbon Capture Center (NCCC) in Wilsonville, Alabama, will be the host site for the slipstream pilot plant. Parametric testing will be conducted to confirm that the pilot plant meets the performance targets and to obtain appropriate design information. A detailed data analysis will be performed to assess and develop the design basis for scale-up. The pilot plant will be operated continuously under stable conditions to confirm the solvent stability and key material compatibility. The long-term test results will be used to update the techno-economic study and develop a commercialization plan for this technology.

Project Goal

The overall goal of the project is to conduct a pilot plant test of the Linde-BASF post-combustion capture technology—incorporating BASF's novel amine-based process—on a slipstream of flue gas at a coal-fired power plant host site to confirm that it can meet DOE performance targets.

Objectives

The project objectives are to (1) demonstrate the benefits of the novel, amine-based, post-combustion CO_2 capture process technology by performing a techno-economic analysis on a 550 MWe coal-fired power plant incorporating CO_2 capture; (2) design, build, and operate a 1 MWe equivalent slipstream pilot plant to treat flue gas from a coal-fired power plant; and (3) perform parametric and long-duration tests and complete data analysis and an updated techno-economic analysis to demonstrate that the technology meets performance and cost targets.



NCCC test facility with pilot plant integration.

Planned Activities

- Develop an overall model using a flowsheet simulator for a conceptual PC power plant incorporating post-combustion based CO_2 capture and compression.
- Select the solvent that achieves the best combination of performance targets for post-combustion CO_2 capture.
- Develop and optimize a basic design package for the 1 MWe-equivalent pilot plant.
- Utilize the basic design to complete a preliminary engineering evaluation of the pilot plant to enable specification of the equipment and modules and their pricing.
- Update detailed engineering design and complete the process safety review.
- Complete fabrication of the final equipment and module packages needed for the system.
- Complete pilot plant construction and commissioning.
- Perform pilot plant start-up and testing, including parametric testing and long-duration continuous operation.
- Generate final economic analysis and commercialization plan.

Accomplishments

- Project kick-off meeting conducted in November 2011.

Benefits

Establishing the capability of this novel, post-combustion CO_2 capture technology at the pilot plant scale can provide the first steps toward commercialization and achieve significant reductions in the cost of electricity (COE) of large-scale power plants, thereby working toward the achievement of the DOE goal of 90 percent CO_2 capture with less than 35 percent increase in COE.