the ENERGY lab

PROJECT FACTS

Carbon Capture and Gasification Technologies

The U.S. Department of Energy National Carbon Capture Center at the Power Systems Development Facility

Background

In cooperation with Southern Company Services, the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) established the National Carbon Capture Center (NCCC) at the Power Systems Development Facility (PSDF) in Wilsonville, Alabama. The center will bolster national efforts to reduce greenhouse gas emissions by developing cost-effective technologies to capture the carbon dioxide (CO_2) produced by fossil-fueled power plants.

The PSDF is a unique test facility. It is large enough to provide commercially relevant data, yet small enough to be cost-effective and adaptable to testing a variety of emerging technology developments. The facility is a test-bed capable of evaluating advanced technologies at multiple scales, thus allowing results to be scaled directly to commercial application. This capability gives the PSDF the flexibility to develop and demonstrate a wide range of advanced power generation technologies that are critical to developing highly efficient power plants that capture CO_2.

The PSDF was launched in late 1990 with the signing of an agreement between DOE and Southern Company Services. Since completion of the facility in 1996, it has been a center of national efforts to develop coal-based power generation technologies that are reliable, environmentally acceptable, and cost effective. Many of the technologies developed at the facility are now commercially available or are ready for commercialization, including a design for an integrated gasification combined cycle power plant to be built in Kemper County, Mississippi, that will showcase a transport gasifier technology that was developed at the PSDF. Building on this success, the PSDF is now narrowing its focus. The new NCCC at the PSDF will concentrate on developing cost-effective, commercially viable carbon capture

CONTACTS

Pete Rozelle
U.S. Department of Energy
Office of Fossil Energy
301- 903-2338
peter.rozelle@hq.doe.gov

Jenny Tennant
National Energy Technology Laboratory
304-285-4830
jenny.tennant@ netl.doe.gov

John Litynski
National Energy Technology Laboratory
412-386-4922
john.litynski@ netl.doe.gov

Shailesh D. Vora
National Energy Technology Laboratory
412-386-7515
shailesh.vora@netl.doe.gov

Morgan Mosser
National Energy Technology Laboratory
304-285-4723
morgan.mosser@netl.doe.gov

Roxann Laird
Southern Company Services, Inc.
205-670-5863
rfleonar@southernco.com

PARTNERS

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Fairbanks, AK • Morgantown, WV • Pittsburgh, PA • Sugar Land, TX

Website: www.netl.doe.gov

Customer Service: 1-800-553-7681

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U.S. DEPARTMENT OF ENERGY

PERFORMANCE PERIOD

10/01/2008 to 09/30/2013

COST

Total Project Value
$251,454,148

DOE/Non-DOE Share
$201,163,318 / $50,290,830

AWARD NUMBER

DE-NT0000749

technology for coal-fueled power plants through scale-up and continued technology development by DOE and/or third party technology developers.

Project Description

DOE/NETL and Southern Company Services have entered into a five-year cooperative agreement to establish and manage the NCCC at the PSDF. During this period, the NCCC and supporting industrial participants will:

- Modify the PSDF to increase the facility's ability to test, evaluate, and develop emerging CO_2 capture systems for fossil-fueled power plants. The NCCC will include multiple slip-stream capabilities of variable throughput to accommodate the evaluation of a wide-range of capture technologies, including evaluation of pre-combustion CO_2 capture, post-combustion CO_2 capture, and oxy-combustion processes.

- Test and develop CO_2 capture technologies that provide improved efficiency and cost effectiveness over those currently deemed commercially available. In addition to individual component testing, components of the CO_2 capture process will be integrated and optimized to provide data needed for scale-up.

- Test, develop, and optimize components to enable the deployment of carbon capture with minimal increase in the cost of electricity. These components include gas contaminant cleanup, gas separations, coal/biomass gasification or combustion technologies, fuel cell technology, materials, sensor technology, and others.

- Test and evaluate the transport gasifier with CO_2 capture using a variety of fuels including coal/biomass mixtures to characterize the performance of the different technology units, their integration, and balance-of-plant processes.

Scope

The NCCC will support national efforts to reduce greenhouse gas emissions by collaborating with technology developers in accelerating their CO_2 capture technology development for application to coal-fueled power plants. The NCCC offers a flexible test facility which provides commercially representative flue gas and syngas, and the necessary infrastructure in which developers' technologies are installed and tested to generate data for performance verification under industrially realistic operating conditions. Testing and developing new CO_2 capture technologies in commercially representative conditions is critical before the technologies can be deployed at full scale. The NCCC can provide such a setting by delivering coal-derived flue gas and syngas over a wide range of process conditions. The NCCC at the PSDF will provide the necessary personnel, materials, and facilities needed to conduct this research. The applied Research and Development (R&D) carried out at the NCCC on components or small pilot-scale systems can help bridge the gaps between fundamental R&D and large-scale commercial demonstration and provides for a seamless transition for promising technologies to migrate from laboratory to commercial applications.

Goals

- The NCCC will become a cornerstone for U.S. leadership in advanced CO_2 capture technology development.
- The NCCC will demonstrate integrated coal-based energy technology for plants that offer clean coal technology, including carbon capture.
- Technologies developed at the NCCC will be scaled directly to commercial-sized equipment and integrated with commercial projects, including those under DOE's Clean Coal Power Initiative.
- The NCCC will lead the way to lower-cost CO_2 capture technologies and enable affordable, reliable, and clean coal-based power generation for years to come.

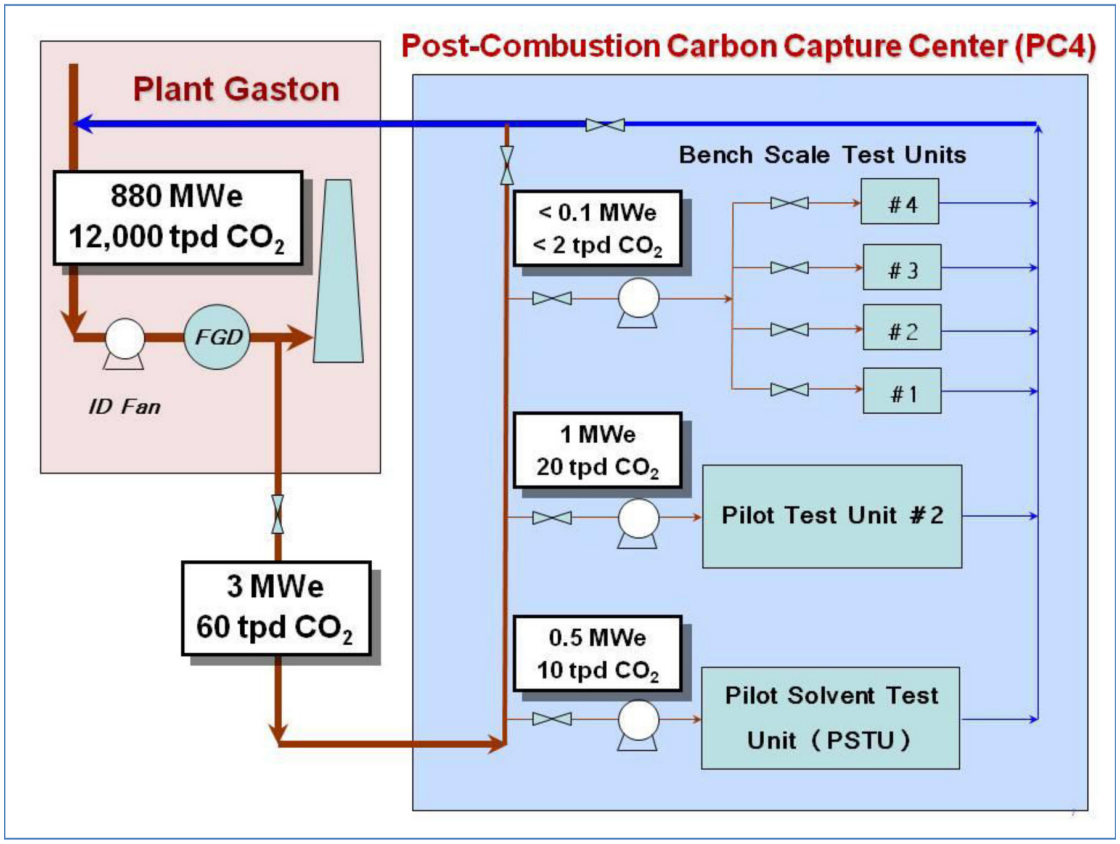

Figure 1. Diagram of the Post-Combustion Carbon Capture Center Test Facility.

Accomplishments

- DOE and NCCC jointly developed and instituted a Technology Screening Process (TSP) as an evaluation tool to assess and prioritize technologies for testing. The current TSP inventory contains more than 300 candidate technologies and is updated annually to ensure inclusiveness of the list.
- A preliminary screening study was conducted with favorable results for oxy-combustion CO_2 capture using the pressurized transport reactor. Detailed system studies, modeling, and additional economic analysis are in progress to further evaluate commercial feasibility of this technology.

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- A pilot solvent test unit (PSTU) for testing developers' next generation of CO_2 absorption solvents has been designed, constructed, and commissioned. This is one of three major areas included in the Post-Combustion Carbon Capture Center (PC4) test facility, Figure 1, which is being built to accommodate tests of a wide-range of capture technologies from flue gas. Testing of advanced solvents in the PSTU, CO_2-selective membranes, and CO_2 sorbents will begin in late 2011.

- The Syngas Conditioning Unit (SCU) in the pre-combustion CO_2 capture area has been modified to improve the gas analyzer capability, increase the electrical and instrumentation infrastructure, upgrade the temperature control systems, and increase the syngas flow for membrane testing.

- Five test campaign runs have been carried out in support of CO_2 capture technology testing. Reliable syngas produced with either Powder River Basin (PRB) sub-bituminous coal, lignite coal, or coal/biomass co-feed was delivered to the SCU at various quality and conditions. A number of advanced CO_2 absorbing chemical and physical solvents, various hydrogen- and CO_2-selective membranes, Water Gas Shift (WGS) catalysts, high temperature mercury capture sorbents, and solid oxide fuel cells were tested. Performance data generated have been used to validate laboratory data under ideal conditions and allow for engineering design for scale up.

- WGS catalyst tests have been conducted which reveal that steam-to-carbon monoxide (CO) ratios can be reduced, which in turn increases the net power output of an Integrated Gasification Combined Cycle (IGCC) plant and reduces the cost of electricity with CO_2 capture. Results have been supplied to catalyst suppliers and findings are being implemented at a commercial IGCC plant now under construction. The impact at one plant translates to an operational savings of over $200 million over the life of the plant.