KEMPER COUNTY ENERGY FACILITY:
DEMONSTRATION OF A COAL-BASED TRANSPORT GASIFIER

NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

PARTNERS
Mississippi Power Company

PROJECT DURATION
Start Date - 11/17/2008
End Date - 04/30/2020[1]

COST
Total Project Value
$2,014,812,860[2]
DOE/Non-DOE Share
$406,903,360 / $1,607,909,500

PROJECT NUMBER
FC26-06NT42391

[1] This is the period of performance recognized under the DOE Financial Assistance Award.

[2] This is the value established for the portion of the total project costs recognized under the DOE Financial Assistance Award for cost-sharing purposes. It is not necessarily equal to the actual total project cost burden of the Performer.

KEMPER COUNTY ENERGY FACILITY

BACKGROUND

The U.S. Department of Energy (DOE) Office of Fossil Energy, through the National Energy Technology Laboratory, is charged with implementing the DOE Clean Coal Power Initiative (CCPI). The intent behind the CCPI is to leverage public and private investment to secure low-cost energy production and protect the environment. The goal of this program is to demonstrate a new generation of innovative coal-utilization technologies in a series of projects carried out across the country. These demonstrations are conducted on a commercial scale to prove the technical feasibility of the technologies and to provide technical and financial information for future applications. The U.S. Department of Energy awarded Southern Company Services a cooperative agreement under the CCPI Round 2 Program to provide direct financial support for the development and deployment of the Transport Integrated Gasification (TRIG™) technology that is being utilized by the project.

PROJECT DESCRIPTION

The Kemper County Project (Kemper County Energy Facility) is a lignite-fueled integrated gasification combined cycle (IGCC) facility that was constructed in Kemper County, Mississippi. The plant design incorporates the air-blown TRIG™ technology jointly developed by Southern Company, KBR, and DOE at the Power Systems Development Facility in Wilsonville, Alabama. Mississippi Power Company, a Southern Company subsidiary, owns and operates the plant. Lignite reserves near the plant site owned by Mississippi Power Company and developed and mined by Liberty Fuels (a subsidiary of North American Coal Corporation) supply the feedstock for the IGCC plant. The plant has a peak net output capability of 582 megawatts electrical (MWe) when using syngas in the combustion turbine coupled with natural gas firing in the heat recovery steam generator duct burners. During syngas-only operations, the plant achieves a net generating capacity of 524 MWe. The facility employs advanced emissions control equipment to produce marketable byproducts of anhydrous ammonia, sulfuric acid, and carbon dioxide (CO_2). Over 65 percent of the CO_2 is captured, making the Kemper County Energy Facility's carbon emissions comparable to a natural gas-fired combined cycle power plant. The estimated 3 million tonnes of CO_2 per year captured from the Kemper County Energy Facility gasification process is transported via a 61 mile pipeline for use in enhanced oil recovery operations at depleted oil production fields in Mississippi.

GOALS/OBJECTIVES

The primary objective of this project is to demonstrate the operation of a commercial-scale, air-blown transport gasifier technology and integrate it with a combined-cycle island. Other objectives of the project include (1) operating an advanced syngas cleanup system that includes sulfur removal and recovery; high temperature, high-pressure particulate filtration; and ammonia recovery and mercury removal; (2) demonstrating high availability, high thermal efficiency, low cost, and low emissions of the IGCC in commercial operating mode; and (3) operating an integrated CO_2 capture and compression system with the intent to capture and geologically sequester 65 percent of the CO_2 via enhanced oil recovery.

HIGHLIGHTS & ACCOMPLISHMENTS

Many performance goals were achieved during plant commissioning and the initial phases of operation. With 224 days of gasifier operation, the Kemper County coal gasification facility demonstrated the operation of the complex lignite coal-to-energy process per design. Kemper is the largest IGCC project in the world and the first to use lignite as fuel, capture and sell CO_2, and produce multiple byproducts from initial startup. The Kemper Project features the largest fluidized bed coal dryers in the world, the largest high-pressure dust filtration system by a factor of three, the largest two Selexol units, and the largest two CO_2 compressors. In terms of coal feed and thermal input capacity, each of the two Kemper gasifiers is the largest in the world (by a factor of nearly two in IGCC application). The following list incorporates some of the most significant achievements at the Kemper facility:

- Maintaining an excellent plant safety record both during construction and operation. The recordable incident rate (RIR) during construction was 0.42, less than one-sixth the industry average, while the plant has maintained an excellent operational RIR of 0.16 to date.
- Stable and automatic operation of the integrated fuel delivery, gasification, syngas conversion, and syngas cleanup systems with the gas turbine firing 100 percent syngas.
- Syngas production rates up to 100 percent of design flow rate with downstream syngas conversion and cleanup that resulted in nearly total scrubbing of polluting components such as halides, ammonia, and hydrogen sulfide.
- Coal feed rates at full design from an innovative coal feed system. Such high coal feed rates and thermal inputs to a single gasifier are nearly twice that of any other IGCC project in the world.
- Water-gas shift reactors operated at steam-to-CO ratio of 1.7, much below the industry standard, allowing a substantial savings in syngas humidification costs.

- Syngas production availabilities up to 38 percent, a value consistent with typical first year gasification processes, including 31 days of continuous gasifier operation.
- Gasifier particulate separation cyclone efficiencies exceeding 99.99 percent at the highest solids circulation rates in the world.
- Gasifier availability was over 90 percent once coal feed began.
- First IGCC plant to generate superheated steam from the syngas coolers for power generation.
- First facility to use coal-derived syngas from an air-blown gasifier to activate the sour water-gas shift catalyst.
- First Selexol units to process syngas produced from air-blown gasification, experiencing no difficulty in operation while achieving excellent performance.
- Combustion turbine loads of up to 73 percent when using syngas alone; the maximum loads achieved were near the established upper load limit and were progressively increased by Siemens as commissioning progressed.
- Per design, 65 percent CO_2 capture equaling the carbon footprint of natural gas combined cycle, plus pipeline CO_2 transportation for enhanced oil production.
- Production of on-spec sulfuric acid and anhydrous ammonia.
- Proven ease of start, shutdown, and restart of both gasifier and integrated processes.

PROJECT STATUS

On June 28, 2017, Southern Company and Mississippi Power Company announced they were suspending start-up and operations activities involving the lignite gasification portion of the Kemper County energy facility. The combined cycle plant will continue to operate using natural gas pending the Mississippi Public Service Commission's decision on future operations. Changes to the project economics were primarily driven by the dramatic decrease (>70 percent) in the long-term price forecast for natural gas since the project was approved in 2010. The updated long-term natural gas price forecast for 2017 indicated a 25–30 percent reduction in sustained natural gas commodity price as compared to the 2016 forecast.

The Kemper Project featured many first-of-a-kind systems as well as other unique and innovative technologies. The scale-up of the core TRIG technology has been successfully demonstrated with the ability to operate at 100 percent of coal feed design and produce a syngas suitable for power generation in the combustion turbines. As a result, the commissioning process and extended operation have provided valuable information that will apply to future IGCC and other coal-based endeavors. Design, construction, startup, operations, and performance best practices and lessons learned from the Kemper IGCC project are extensive. The accumulated information is being documented and will be available in forthcoming DOE reports to ensure that the technology is ready to serve energy needs where fuel costs and carbon capture credits make it economically competitive.

Aerial View of Kemper Energy Facility (April 2016)

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