Increasing Power Plant Efficiency — Lignite Fuel Enhancement

CCPI-1

Clean Coal Fuels

Upgrading ■
Conversion □

Participant
Great River Energy (GRE)

Additional Team Members
Electric Power Research Institute — collaborator

Lehigh University — collaborator

Barr Engineering — lignite handling

Falkirk Mining Company — lignite coal supplier

Location
Underwood, McLean County, ND (GRE's Coal Creek Station)

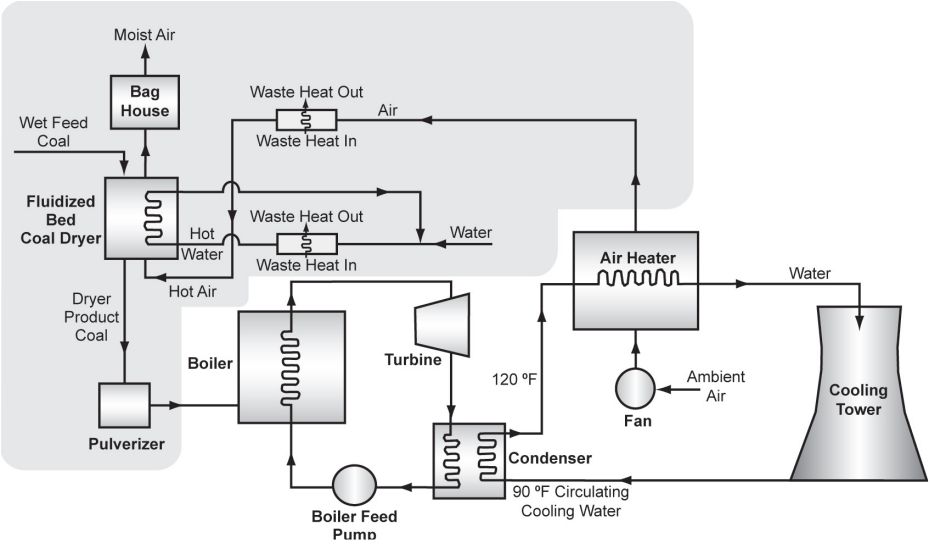
Technology
GRE's waste-heat dryer for low-rank coals

Project Capacity/ Production
546 MW

Coal
Lignite

Project Funding

Total	$31,512,215	100%
DOE	13,518,737	43
Participant	17,993,478	57



Objectives

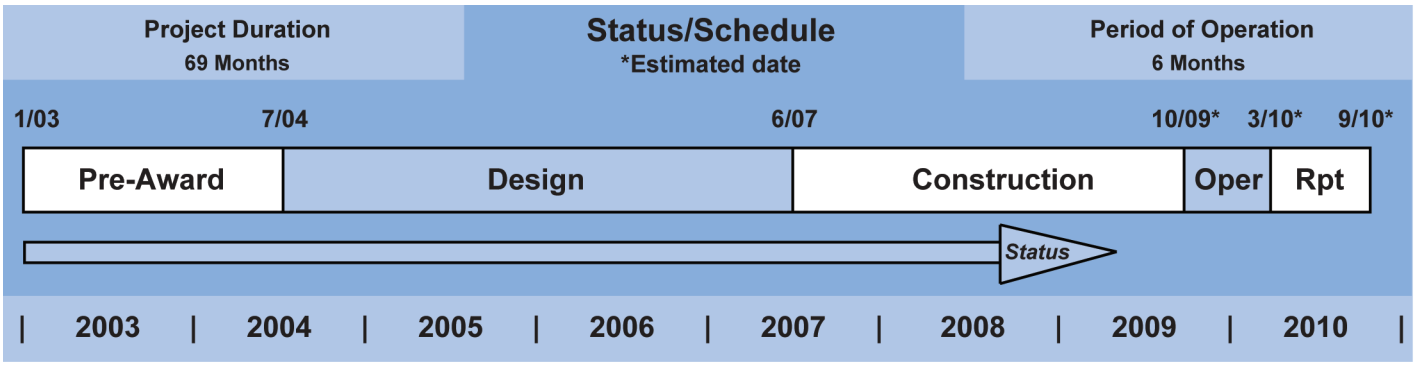
To demonstrate a 25 percent reduction in lignite moisture content (e.g., from 40 percent moisture to 30 percent moisture in this application) using plant waste heat; and to optimize and assess plant operation on dried coal to quantify benefits.

Technology/Project Description

The project demonstrates Great River Energy's (GRE) waste-heat dryer for low-rank coals on a 546-MW tangentially fired boiler at the Coal Creek Station using North Dakota lignite that has approximately 40 percent moisture content. In phase 1 of a two-phased effort, GRE is to build and operate a prototype dryer module capable of producing one-fourth of the dry lignite requirement for the plant. In phase 2, which follows successful operation of the first dryer, GRE will build full-scale dryers to provide sufficient dryer capacity to fully fuel the 546-MW unit, and optimize plant operation on dried lignite and evaluate performance. The full boiler dryer system uses plant cooling water and flue gas as the major heating medium. Water drawn from the cooling tower captures heat from the steam condenser in the boiler circuit, raising the temperature to about 120 °F. The heated water is routed to an air heater before returning to the plant cooling water circuit. Ambient air is heated in the air heater to about 105 °F and subsequently used as the fluidizing media in the fluidized-bed dryer to provide heat along with hot water. In practice, a two-stage dryer is used to enhance heat transfer.

Benefits

This technology uses heat (that would otherwise be lost out the stack) to upgrade the low-rank coal feedstock, thereby enhancing plant efficiency and performance. The high moisture content in low-rank coals significantly increases plant heat rates and reduces efficiency by requiring application of heat generated during combustion to vaporize large amounts of water in coal. This heat of vaporization represents a heat loss because it does not contribute to power generation. Moreover, high moisture content coals can contribute to corrosion of ductwork, and place an energy penalty on fans that move the vaporized water and pulverizers



that process the moisture in the coal. GRE's upgrading process improves plant economics and reduces plant heat loss (decreases heat rate), increases efficiency, and thereby reduces emissions of carbon dioxide (CO_2), mercury, nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (PM) per unit of energy produced. This technology has potential application to more than 100 gigawatts of domestic coal-fired capacity that currently uses low-rank coals.

Status/Accomplishments

The National Environmental Policy Act (NEPA) requirement was met with an Environmental Assessment (EA) and issuance of a Finding of No Significant Impact (FONSI) on January 16, 2004. A cooperative agreement was awarded July 9, 2004.

Following installation and startup, around-the-clock operations of the prototype dryer and data collection began in March 2006. The moisture of the processed lignite coal was reduced from about 38.5 percent to 29.5 percent. The prototype dryer test results indicated that in addition to reducing the emissions of SO_x, NO_x, and CO_2, there is also potential for mercury reduction. When the heavy components of lignite fallout in the first stage of the dryer, some material that is concentrated in mercury is also removed. Also, reducing moisture in coal increases mercury oxidation and facilitates additional capture in the flue gas desulfurization unit.

In September 2006, GRE initiated design activities for full-scale dryers (135 tons/hr), which will have improved reliability and flexibility with regard to management of the higher density fraction from the first stage, heat input, pressure drop, moisture reduction, and coal throughput. GRE is installing four dryers on unit 2 as part of the project, and because of the success of the prototype, GRE is installing four more dryers on unit 1 with its own funds. Thus, the entire Coal Creek Station is being retrofitted with lignite coal dryers.

GRE completed design of the integrated full-scale dryer system in December 2007. Fabrication and on-site assembly was finished in May 2008. By December 2008, major dryer internals, such as water coils, air sparger, fire protection system, and explosion protection system were completed for Unit 2 dryers. Remaining construction activities include enclosure of the buildings, auxiliary equipment, and modifications to the coal handling system. GRE plans to complete construction of the dryer system and begin testing in fall 2009.

Based on the success of the prototype dryer, the entire Coal Creek Station is being retrofitted with lignite coal dryers.

The coal dryer technology has generated significant domestic and international interest. GRE has performed pilot-scale tests to determine specific coal drying characteristics for utilities interested in the technology.

Project team members are performing a preliminary engineering effort to evaluate the feasibility and benefits of using the coal dryer technology for lignite coal from Saskatchewan province in Canada. A proposal was submitted to investigate the possible benefits for Turkish lignite coals.

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