PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Clean Coal Power Initiative (CCPI 2)

11/2007

Mesaba Energy Project

Project Description

The objective of the Mesaba Energy Project (Mesaba), awarded effective June 1, 2006, is to define, develop, design, construct and operationally demonstrate a commercial utility-scale next-generation Integrated Gasification Combined Cycle (IGCC) electric power generating facility having a nameplate capacity of 606 MWe (net). Mesaba will deploy substantial technology advancements in gasification, air separation and other plant systems and the integration thereof. It will also incorporate over 1,600 design and operational lessons learned from the successful but smaller-scale 262 MWe (net) Wabash River Coal Gasification Repowering Project, located in Terre Haute, Indiana—a previous U.S. Department of Energy (DOE) clean coal technology project.

The heart of the multiple-train gasification island is the advanced full-slurry quench, oxygen-blown, continuous-slagging, two-stage entrained-flow ConocoPhillips E-Gas™ gasifier that converts carbonaceous feedstock—coal, petroleum coke, lignite or other high-carbon solids—to hydrogen-rich synthesis gas (syngas) and a "glassy" vitrified inert slag resembling coarse sand. The feedstock is slurried with water and injected along with oxygen into the first stage of the gasifier. The feedstock undergoes a partial oxidation reaction to form syngas while the high temperature and pressure ensures complete conversion and traps inorganic ash and metals as molten slag. Slag falls through a tap hole in the bottom of the first-stage into a water quench and becomes a by-product for use by the construction industry. The raw hot syngas from the horizontal first-stage flows upward into the vertical second-stage gasifier where it is quenched with more slurry injected without additional oxygen. This second slurry stream is volatilized in an endothermic reaction with the syngas to increase the energy content of the gas. This unique two-stage gasifier increases efficiencies and provides feedstock mixing not available with other technologies.

The raw syngas exiting the second-stage gasifier is cooled in a unique heat recovery system to produce high-pressure saturated steam in a fire-tube boiler. This high-quality steam is supplied to the combined cycle power island Heat Recovery Steam Generator (HRSG). After cooling, particulate matter entrained in the syngas is removed, recycled and consolidated to the first-stage gasifier using a simple dry system more efficient than wet-scrubbing systems.

Chlorides, mercury and sulfur contaminants are then removed from the syngas in a series of chemical process steps. Sulfur is recovered in its elemental form for sale in agricultural and other markets. The E-Gas™ process recycles all unconverted gases to the second-stage gasifier to maximize sulfur recovery.

The desulfurized hydrogen-rich "sweet gas" is then heated, moisturized, and piped to the advanced combustion gas turbine-generator sets for electricity production. An advanced air separations configuration will also be deployed that provides combustion turbine air integration. Combustion turbine hot exhaust is supplied to the HRSG to superheat additional steam which is added to the steam provided by the fire-tube boiler. This steam is fed to the steam turbine-generator set to produce additional electricity. Spent steam and condensate is returned to the HRSG for superheating.

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ADDITIONAL TEAM MEMBERS

Fluor Enterprises
Aliso Viejo, CA

ConocoPhillips
Houston, TX

Siemens
Orlando, FL

LOCATION

Taconite
Itasca County, MN

Hoyt Lakes
St. Louis County, MN

ESTIMATED PROJECT DURATION

81 months

COST

Total Estimated Cost
$2,155,680,783

DOE/Non-DOE Share
$36,000,000 / $2,119,680,783

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

The E-Gas™ process captures approximately 80 percent of the chemical energy in the feedstock. The heat recovery system recovers an additional 15 percent of the feedstock energy in the form of steam, for a total feedstock conversion to useful energy of about 95 percent. The process is also amenable to future upgrading for removal of greenhouse gases like carbon dioxide.

Benefits

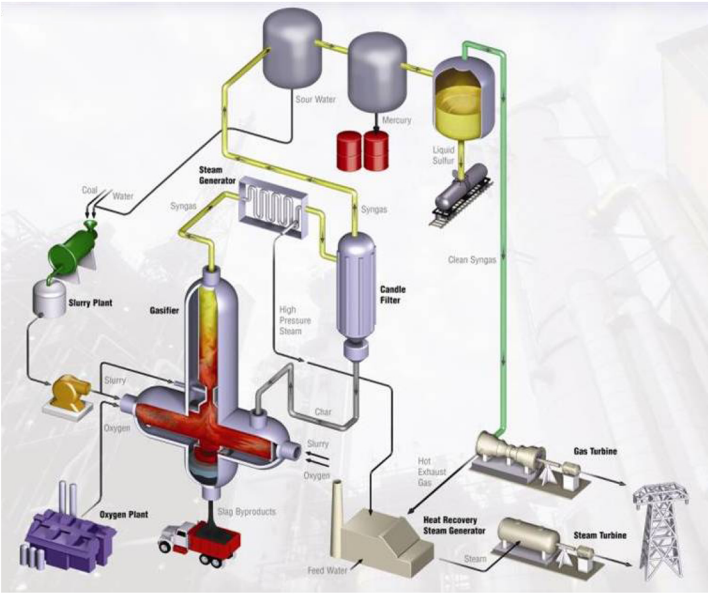
As compared to traditional coal-based electric power generating facilities and previous generation IGCC, Mesaba will demonstrate significant performance, efficiency and emissions improvements—making the project plant one of the most sophisticated and cleanest coal-based electric power generating facilities in the world when it enters service in about 2012.

The overarching project objective is to demonstrate the commercial development, engineering and standard replicable design configuration necessary to construct a large feedstock-flexible IGCC reference plant and establish a sound installed cost basis for future commercialization. Specific technical goals include:

a) Gasifier system operational availability of 90 percent or better;

b) The flexibility to gasify bituminous and sub-bituminous coals or a blend of sub-bituminous coal and petroleum coke;

c) 8,600 Btu/kilowatt-hour design heat rate (bituminous coal – feedstock adjusted); and,

d) Criteria pollutant and mercury emission levels equal to or below that of the lowest rates for utility-scale, coal-based generation and carbon dioxide emissions 15-20 percent lower than the current average for U.S. coal-based power plants fueled by similar feedstocks.

The Mesaba Energy Project is within the portfolio of the U.S. DOE Clean Coal Power Initiative (CCPI), the capstone of the National Coal RD&D Program managed by the U.S. DOE Office of Fossil Energy (FE). CCPI is an industry/government cost-share partnership to demonstrate clean coal technologies at sufficient scale to ensure proof-of-operation prior to commercialization. Technologies emerging from the program will help meet the challenging environmental objectives for America embodied in the Clear Skies Initiative, Global Climate Change Initiative, FutureGen, and the Hydrogen Initiative. CCPI provides an important platform responding to the National Energy Policy (NEP) priorities to increase domestic energy supply, protect the environment, ensure a comprehensive energy delivery system, and enhance national energy security.