PROJECT
facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Clean Coal Power Initiative (CCPI)

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PARTNER

Excelsior Energy, Inc.
Minnetonka, MN

LOCATION

Taconite
Itasca County, MN

Hoyt Lakes
St. Louis County, MN

MESABA ENERGY PROJECT

The objective of the selected-not-yet-awarded Mesaba Energy Project (Mesaba) is to design, construct and operationally demonstrate a utility-scale next-generation Integrated Gasification Combined Cycle (IGCC) electric power generating facility. Mesaba will demonstrate the ConocoPhillips E-Gas™ carbonaceous solids gasification technology and will have a planned installed capacity of up to 600 MWe (net). Mesaba will demonstrate technological advances by drawing upon the DOE-funded studies of potential performance and technological upgrades and nearly 1600 design and operational lessons learned from the substantially smaller-scale Wabash River Coal Gasification Repowering Project, located in Terre Haute, Indiana—a previous U.S. Department of Energy (DOE) clean coal technology project.

E-Gas™ features a slurry-fed, oxygen-blown, continuous-slagging, two-stage entrained-flow gasifier to convert carbonaceous feedstock—coal, petroleum coke, lignite or other solids containing substantial amounts of carbon—to hydrogen-rich synthesis gas (syngas) and a vitrified inert slag. The feedstock is slurried with water, combined with oxygen, and injected into the first stage of the gasifier. The feedstock undergoes a partial oxidation reaction at temperatures sufficient to drive off volatile matter and bring the ash content above its melting point. The molten ash falls through a tap hole in the bottom of the first stage into a water quench, forming an inert vitreous slag. The resultant raw hot syngas flows upward into the second stage, where it is quenched with more feedstock slurry. This second stream is volatilized in an endothermic reaction with the syngas stream to enhance the syngas heating value and improve efficiency by converting that portion of the feedstock to additional syngas.

The raw syngas exiting the gasifier flows to the fire-tube syngas cooler, which cools the syngas and generates high-pressure saturated steam. After cooling, entrained particulate matter is removed and recycled to the first stage of the gasifier, consolidating the solids in one stream as a slag exiting the first stage of the gasifier. The two-stage gasifier, coupled with the unique application of the fire-tube syngas cooler design, minimizes the size and temperature requirements for the high temperature heat recovery system, which improves cost-effectiveness and yields high conversion efficiencies.

The syngas is further cooled in a series of heat exchangers. The syngas is water-scrubbed to remove chlorides and passed through a series of reactions to remove and convert sulfur to its elemental form as a commercially marketable by-product. The desulfurized hydrogen-rich "sweet gas" is then heated, moisturized, and piped to the power block as fuel for the advanced combustion gas turbine-generator set(s) for electricity production. Hot exhaust from the combustion gas turbine is recovered and used to operate a Heat Recovery Steam Generator (HRSG). The high pressure steam from the syngas loop is combined with the steam produced by the HRSG and fed to a steam turbine-generator set to produce additional electricity. This combined cycle significantly improves efficiency by extracting a greater portion of the total available energy through combusting a clean fuel and making use of what would otherwise be waste process heat—effectively increasing the amount of electricity delivered to the electric utility grid that can be generated from each ton of coal. IGCC does this while achieving significantly lower emissions than conventional coal-based electric power generating technologies.