Wabash River Coal Gasification Repowering Project

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Contractor:
Wabash Coal Gasification Repowering Project
Joint Venture
2500 City West Blvd., Suite 150
Houston, Texas 77042

Contract Number:
DE-FC21-92MC29310

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CONTRACT INFORMATION

Contract Number: DE-FC21-92MC29310

Contractor: Wabash River Coal Gasification Repowering Project Joint Venture
2500 City West Blvd., Suite. 150
Houston, Texas 77042
(713) 735-4000

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Robert Fisackerly Destec Energy
R. Clay Spears Destec Energy

METC Project Manager: R. Daniel Brdar

Period of Performance: August 1, 1992 to September 30, 1998

Schedules and Milestones:

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OBJECTIVES

The Project’s sponsors, PSI Energy, Inc. and Destec Energy, Inc., will demonstrate, in a fully commercial setting, coal gasification repowering of an existing generating unit affected by the Clean Air Act Amendments ("CAAA"). The Project will also demonstrate important advancements in Destec’s coal gasification process for high sulfur bituminous coal.

Upon completion, the Project will not only represent the largest CGCC power plant in operation in the United States but will also emit
lower emissions than any other high sulfur coal fired power plant.

**BACKGROUND INFORMATION**

The Wabash River Coal Gasification Repowering Project (Project), a joint venture of Destec Energy, Inc. (Destec) of Houston, Texas and PSI Energy, Inc. (PSI) of Plainfield, Indiana, will develop, design, construct, own, and operate a coal gasification combined cycle (CGCC) power plant. Destec’s coal gasification technology will be used to repower one of the six units at PSI’s Wabash River Generating Station in West Terre Haute, Indiana. The CGCC power plant will produce a nominal 270 net MW of clean, energy efficient, capacity for PSI’s customers. In the repowered configuration, PSI and its customers may additionally benefit because of the role this Project plays in PSI’s compliance plan under the CAAA regulations. The Project will use locally mined, high sulfur coal.

The Destec Coal Gasification process was originally developed by the Dow Chemical Company during the 1970's in order to diversify it's fuel base. The technology being used at Wabash is an extension of the experience gained from that time through pilot plants and up to the Louisiana Gasification Technology, Inc. (LGTI) facility at Plaquemine, Louisiana which has been operating since April 1987.

**Project Team**

PSI will manage the construction of, own and operate the power generation facilities. Sargent & Lundy will provide engineering services to PSI. Destec will manage the construction of, own and operate the coal gasification and air separation facilities. Dow Engineering Company, engineer for Destec’s 160 MW coal gasification facility (LGTI) operating in Louisiana, will provide engineering services to Destec. Destec is in the process of transferring coal gasification engineering expertise from Dow to Destec Engineering Company and this Project is pivotal in this transition.

**Organizational Structure**

Two agreements establish the basis for the relationship between PSI and Destec. The Joint Venture Agreement established the Wabash River Coal Gasification Repowering Project Joint Venture in order to administer the Project under the DOE Cooperative Agreement. The Gasification Services Agreement includes the commercial and performance terms under which the Project will be developed and operated for a 25 year period. The major provisions of the Gasification Services Agreement are:

**PSI**
- to own and operate the power generation facility
- to build the power generation facility to an agreed common schedule
- to furnish Destec with a site, coal, power and services
- to pay a monthly fee to Destec for gasification services

**DESTEC**
- to own and operate the coal gasification facility
- to build gasification facility to agreed, common schedule
- to guarantee performance of the coal gasification facility
- to meet environmental conditions
- to deliver syngas and steam to the power generation facility

The structure of the Gasification Services Agreement allows the Power Generation Facility and the Coal Gasification Facility to be integrated for high efficiency.
PROJECT DESCRIPTION

Process

The Destec gasification process features an oxygen-blown, two-stage entrained flow gasifier. PSI will procure coal for the Project consistent with the design specification ranges of Destec's coal gasification facility. Destec's plant will be designed to accept coal with a maximum sulfur content of 5.9% (dry basis) and a minimum energy content of 13,500 BTU/pound (moisture and ash free basis). PSI and Destec will test at least two other coals for significant periods during the demonstration period.

In the Destec process, coal is ground with water to form a slurry (see Figure 1). It is then pumped into a gasification vessel where oxygen is added to form a hot raw gas through partial combustion. Most of the non-carbon material in the coal melts and flows out the bottom of the vessel forming slag - a black, glassy, non-leaching, sand-like material. Particulates, sulfur and other impurities are removed from the gas before combustion to make it acceptable fuel for the gas turbine.

The synthetic fuel gas (syngas) is piped to a General Electric MS 7001F high temperature combustion turbine generator. A heat recovery steam generator recovers gas turbine exhaust heat to produce high pressure steam. This steam and the steam generated in the gasification process supply an existing steam turbine-generator.

New enhancements, techniques and other improvements included in the Project are as follows:

- A novel application of integrated coal gasification combined cycle technology will be demonstrated at the Project for the first time ... repowering of an existing coal-fired power generating unit.
- The coal fuel for the Project will be high sulfur bituminous coal, thus demonstrating the environmental performance and energy efficiency of Destec's advanced two-stage coal gasification process. Previous Destec technology development has focused on lower rank, more reactive coals.
- The plant will be designed to outperform air emission standards established by the Clean Air Act Amendments for the year 2000.

Figure 1
Site

Early site feasibility studies resulted in locating the new coal gasification repowering facilities to the west of PSI’s existing Wabash River Generating Station (Figures 2 & 3). The location of these facilities minimizes the cost of alloy steam piping connecting the existing Unit 1 steam turbine and the new heat recovery steam generator. Existing facilities to be used by the Project include the railroad, coal unloading facilities, condenser and auxiliaries and the ash pond, in addition to the existing steam turbine generator end substation. No new construction will be required within the existing boiler and turbine buildings except for the steam piping interconnection.

New construction will take place in two areas. A 15 acre plot containing the gasification island, oxygen plant, water treatment and gas turbine-heat recovery steam generator block is on a hill overlooking the existing station. The new coal pile, wastewater and storm water ponds will be located nearby in an area previously used as an ash pond.

Facilities

Facilities for the Project include the following:
- Gasification (Destec Facilities)
- Slurry preparation
- Gasification and heat recovery
- Slag removal
- Gas cleanup
- Sulfur recovery
- Oxygen plant
- Control, administration & maintenance building

Power Generation (PSI Facilities)
- Combustion turbine
- Heat recovery steam generator
- Modifications to coal handling
- Oil storage tanks
- Piping additions
- Water treatment facilities
- Control room and buildings

Destec and PSI will independently design, procure equipment and construct their respective portions of the Project.

The total estimated installed cost for the Project is $407 million, of which Destec’s and PSI’s facilities are $285 million and $122 million, respectively. Funding from the Department of Energy’s Clean Coal program will contribute $198 million toward the capital cost and operating costs in the first three years operating costs.

Project Environmental Aspects

The plant will be designed to substantially outperform the standards established in the CAAA for the year 2000. The Destec technology to be employed will remove at least 98 percent of the sulfur in the coal. SO₂ emissions will be less than 0.20 pounds of SO₂ per million Btu’s of fuel. NOₓ emissions from both the gasification block and the power block are expected to be less than 0.7 lb/MWh. CO₂ will also be reduced, approximately 21 percent on a per kilowatt-hour basis by virtue of the increased system efficiency. Figure 4 compares emissions of current Wabash Unit 1 with expected emissions from the Project.

By providing an efficient, reliable and environmentally superior alternative to utilities for achieving compliance with the CAAA requirements, the Project will represent a significant demonstration of Clean Coal Technology.

The gasification process by-products, sulfur and slag, are also recyclable. Most of the non-carbon minerals in the coal are removed during the gasification process. Sulfur is removed as 99.7 percent pure
Figure 2 PLOT PLAN

Figure 3 ARTIST CONCEPTION
Other coal gasification process enhancements included in the Project to improve the efficiency and environmental characteristics of the system are as follows:

- **Hot/Dry Particulate Removal/Recycle** will be demonstrated at full commercial scale at the Project. Destec’s current plant, operating in Louisiana, has utilized a wet scrubber system to remove particulates from the raw syngas.
- **Syngas Recycle** will provide fuel and process flexibility while maintaining high efficiency.
- **A High Pressure Boiler** will cool the hot raw gas by producing steam at a pressure of 1,600 pounds per square inch absolute (psia). Destec's first unit is currently operating at a pressure of 650 psia in a much less corrosive environment than will be experienced at the Project.
- **The Carbonyl Sulfide (“COS”) Hydrolysis** system to be incorporated at the Project will be Destec's first application of this technology. This system is necessary to attain the high percent removal of sulfur at the Project.
- **The Slag Fines Recycle** system will recover most of the carbon present in the slag byproduct stream and recycle it back for enhanced carbon conversion. This also results in a high quality byproduct slag.
- **Fuel Gas Moisturization** will be accomplished at the Project by the use of low-level heat in a new concept different from that used before Destec. This concept will reduce steam injection required for NOx control.
- **Sour water,** produced by condensation as the syngas is cooled, will be processed differently from the method used at LGTI. This will allow more complete recycling of this stream, reducing waste water and increasing efficiency.
- **An advanced design oxygen plant producing 95 percent pure oxygen** will be used by the Project. This will increase the overall efficiency of the Project by lowering the power required for production of oxygen.

The power generation facilities included in the Project will incorporate the latest advancements in combined cycle system design while accommodating design constraints necessary to repower the exiting Unit One steam turbine.

- **The Project will incorporate an Advanced Gas Turbine** with new design compressor and turbine stages, higher firing temperatures and higher pressure ratios, specially modified for syngas combustion.
- **Integration between the heat recovery steam generator ("HRSG") and the gasification facility** has been optimized at the Project to yield high efficiency and lower operating costs.
- **Repowering of the Existing Steam Turbine** will involve upgrading the unit in order to accept increased steam flows generated by the HRSG. In this manner, the cycle efficiency will be maximized because more of the available energy in the cycle will be utilized.

The expected net plant heat rate for the entire new and repowered unit is 8974 Btu/KWh (HHV), representing approximately 20 percent improvement over the existing unit. This heat rate will be among the lowest of commercially operated coal-fired facilities in the United States. The combustion turbine generator will produce approximately 192 MW. Steam generated by the combustion turbine heat recovery steam generator and in the gasification island will supply the existing steam turbine to generate an additional 109 MW. Plant auxiliaries in the power generation and coal gasification areas and the oxygen plant will consume approximately 33 MW, for a nominal net power generation of 269 MW.
elemental sulfur, and can be sold as a raw material to make agricultural fertilizer. The remaining minerals leave the process chemically bound as slag which has been used as aggregate in asphalt roads and as structural fill in various types of construction applications.

FUTURE WORK

In the next nine months, the Project expects to clear the hurdles required to support the start of construction in the third quarter of 1993. The three primary external clearances needed are the receipt of a Certificate of Necessity from the Indiana Utility Regulatory Commission, receipt of the air emissions and water effluent permits from the Indiana Department of Environmental Management, and completion of the NEPA review. All of these areas are progressing well, and completion is expected no later than first quarter 1993. Both PSI Energy and Destec Energy have been involved in process design activities, equipment specification and selection, site layout and other engineering to support the start of construction.

The duration of on-site construction will be approximately two years, through the second quarter of 1995. Design, procurement and construction activities will confirm the current project schedule and capital cost estimates. Following plant start-up and commissioning activities, the integrated coal gasification and power generation facilities will be tested to demonstrate achievement of syngas production to support base load gas turbine operation, coal conversion efficiency, auxiliary power consumption, overall heat rate and environmental emission guarantees.

With the completion of these plant performance tests, operation as part of the PSI Energy’s electrical generation grid will start. The Project Participants have a twenty-five year contract. The first three years of operation are the DOE demonstration period. During this period, the Project will demonstrate its ability to fully operate in the utility environment, under both base load and dispatched conditions, and to match maintenance schedules to the normal utility requirements. Gasification plant availability.

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<tr>
<th>PROJECT EMISSIONS</th>
<th>SO₂</th>
<th>NOₓ</th>
<th>CO</th>
<th>PM</th>
<th>PM-10</th>
<th>VOC</th>
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<td>18</td>
<td>124</td>
<td>25</td>
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<td>12</td>
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<td>Power Block Tons/yr</td>
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<td>774</td>
<td>374</td>
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<td>TOTAL Tons/yr</td>
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<td>792</td>
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<td>Lb/MW hr</td>
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<td>0.47</td>
<td>0.07</td>
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<tr>
<td>Lb/MM Btu</td>
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<td>0.08</td>
<td>0.05</td>
<td>0.01</td>
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<tr>
<th>CURRENT UNIT NO. 1 BOILER EMISSIONS</th>
<th>Tons/yr</th>
<th>Lb/MW hr</th>
<th>Lb/MM Btu</th>
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<td>5.713</td>
<td>38.2</td>
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<td>Project: 268 MW at 90% capacity factor.</td>
<td>1,370</td>
<td>9.3</td>
<td>0.8</td>
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<td>Unit 1: 294,432 MW hr average annual actual gross generation for 1989 and 1990.</td>
<td>94</td>
<td>6.0</td>
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<td>(approx. 37.3% capacity factor for Unit 1)</td>
<td>126</td>
<td>0.85</td>
<td>0.07</td>
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<td>126</td>
<td>0.82</td>
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<td>5</td>
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Figure 4
and operating costs will be proven in this period, and data will be collected for operation with other coal sources. At the end of the three year demonstration period, the Participants will provide reports to the DOE which are expected to confirm the maturity of the coal gasification repowering technology for its application in other fully commercial repowering applications.