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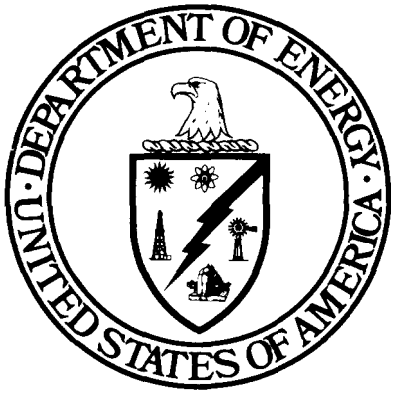
Comprehensive Report to Congress Clean Coal Technology Program

Wabash River Coal Gasification Repowering Project

A Project Proposed By:
Wabash River Coal Gasification Repowering Project Joint Venture



U.S. Department of Energy
Assistant Secretary For Fossil Energy
Office of Clean Coal Technology
Washington, D.C. 20585

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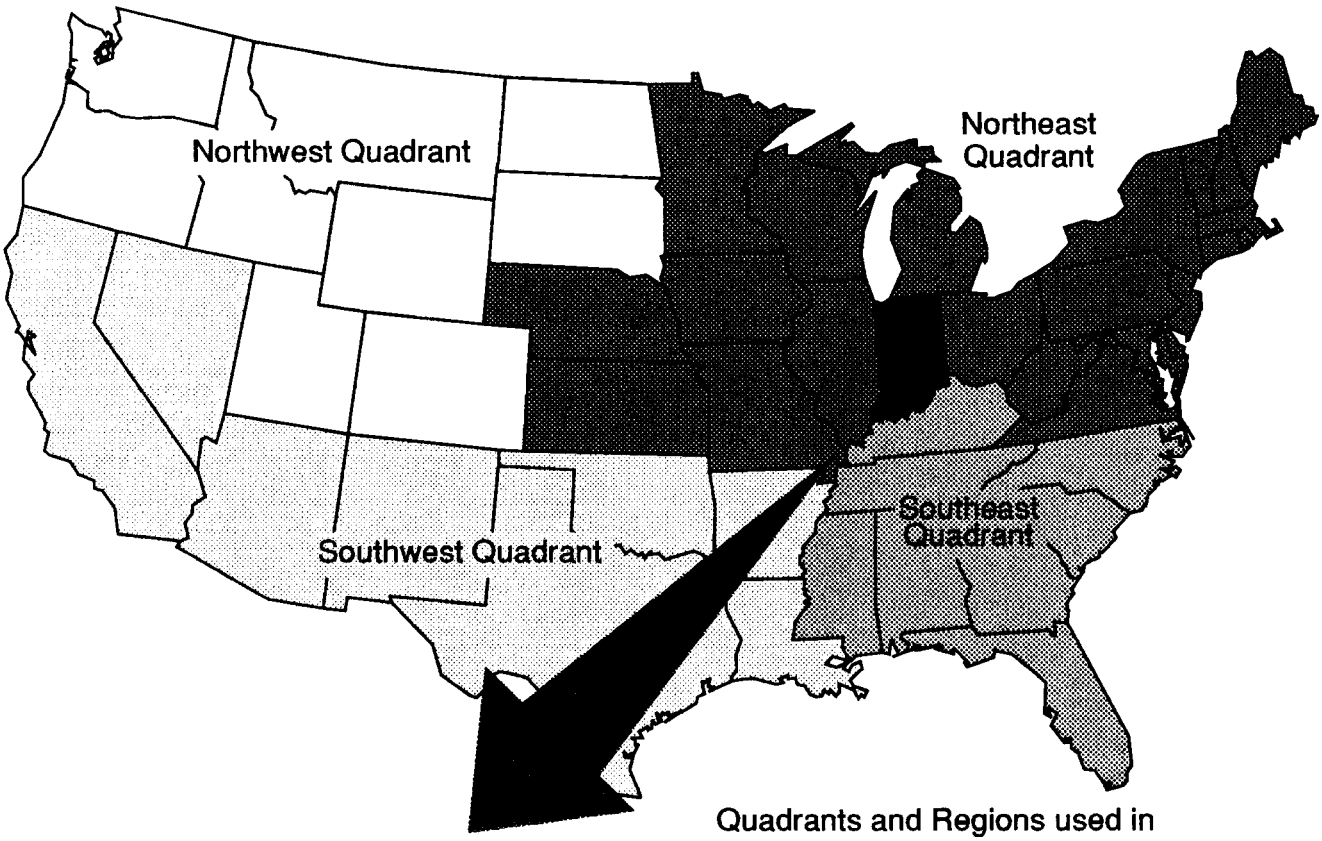
1.0 EXECUTIVE SUMMARY

Public Law 101-121 provided $600 million to conduct cost-shared Clean Coal Technology (CCT) projects to demonstrate technologies that are capable of replacing, retrofitting, or Repowering existing facilities. To that end, a Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in January 1991, soliciting proposals to demonstrate innovative energy efficient technologies that were capable of being commercialized in the 1990's. These technologies were to be capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or nitrogen oxides from existing facilities to minimize environmental impacts such as transboundary and interstate pollution and/or (2) providing for future energy needs in an environmentally acceptable manner.

In response to the PON, 33 proposals were received by DOE in May 1991. After evaluation, nine projects were selected for award. These projects involved both advanced pollution control technologies that can be "retrofitted" to existing facilities and "Repowering" technologies that not only reduce air pollution but also increase generating-plant capacity and extend the operating life of the facility.

One of the nine projects selected for funding is a project proposed by the Wabash River Coal Gasification Repowering Project Joint Venture, which will be referred to as the Participant. This proposer, a Joint Venture between PSI Energy Inc. (PSI), of Plainfield, Indiana and Destec Energy, Inc. (Destec), of Houston, Texas has requested financial assistance from DOE for the design, construction, and operation of a nominal 2544 ton-per-day (TPD) (265 MWe) two-stage, oxygen-blown, coal gasification combined-cycle (CGCC) Repowering demonstration project. The project, named the Wabash River Coal Gasification Repowering Project, is to be located at PSI's Wabash River Generating Station in West Terre Haute, Indiana. The project location and site are shown in Figures 1 and 2. The demonstration project will utilize advanced coal gasification technology in a commercial Repowering setting to repower an existing generating unit affected by the Clean Air Act Amendments of 1990. Emissions from the repowered generating unit will be reduced by greater than 90%, despite an increase in electrical generating capacity of over 150%. In addition, the unit will produce more energy from fewer tons of coal. The project, including the demonstration phase, will last 71 months at a total proposed cost of $396 million. DOE's share of the project cost will be 50% or $198 million.

The CGCC system will consist of Destec's oxygen-blown, entrained-flow, two-stage coal gasifier, which is capable of utilizing high sulfur bituminous coal; a gas conditioning system for removing sulfur compounds and particulate; systems or mechanical devices for improved coal feed; a combined-cycle power generation system



Quadrants and Regions used in
Programmatic Environmental Impact Analysis
(DOE / PEIA-0002)

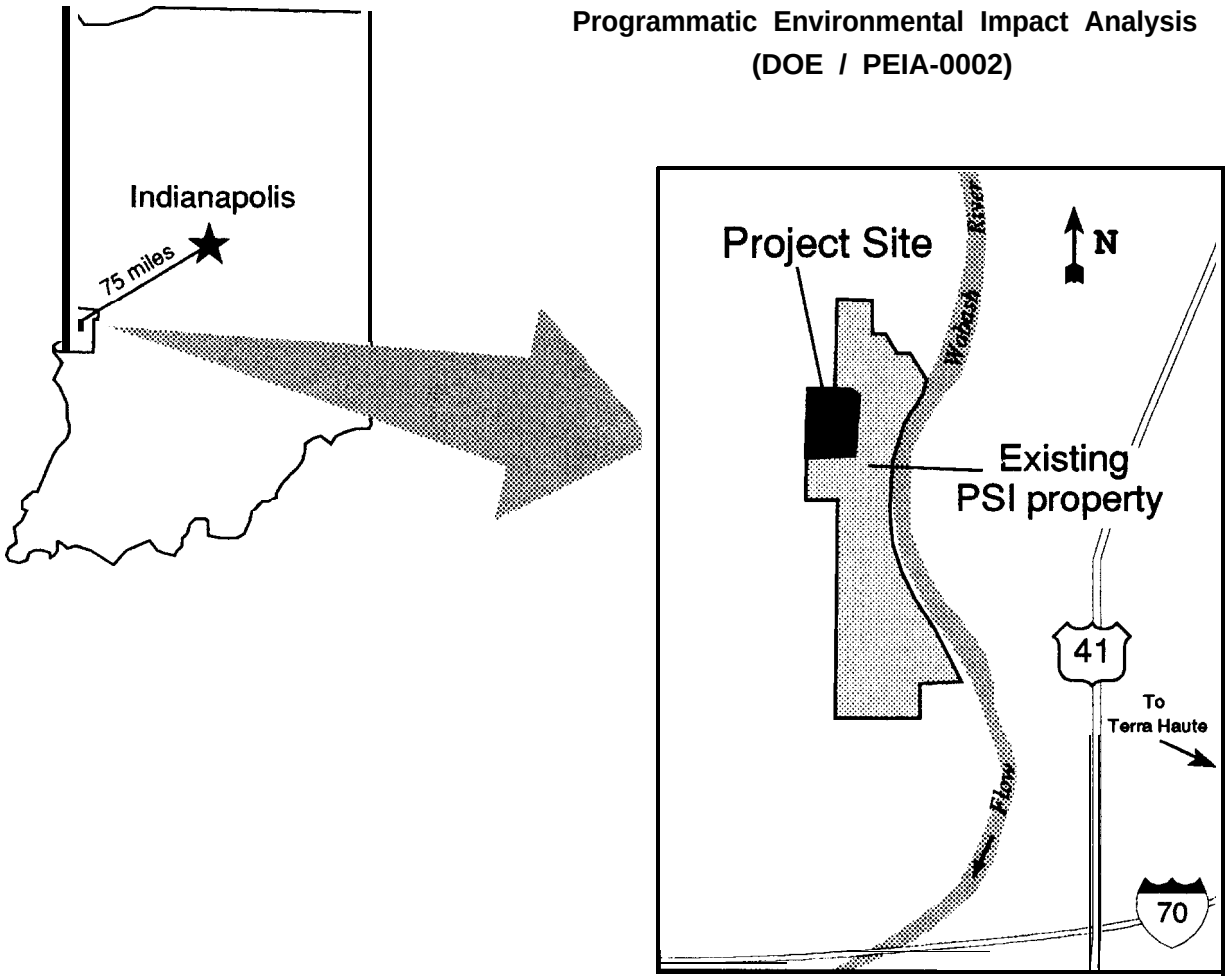


Figure 1. Project Location

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wherein the conditioned fuel gas is combusted in a combustion turbine generator; a heat recovery steam generator; a gas cleanup system; and all necessary coal handling equipment. An existing 99-MWe steam turbine and associated equipment will also be part of the CGCC system. The result of Repowering will be a CGCC power plant with low environmental emissions (SO_2 of less than 0.25 lbs/MMBtu and NO_x of less than 0.1 lb/MMBtu) and high net plant efficiency. The Repowering will increase unit output, providing a total CGCC capacity of a nominal 265 MWe. The project, which will be in a fully commercial setting, will demonstrate important technological advancements in processing high sulfur bituminous coal.

The potential market for Repowering with the demonstrated technology is large and includes many existing utility boilers currently fueled by coal, oil, or natural gas. In addition to a greater, more cost-effective reduction of SO_2 and NO_x emissions attainable by using the demonstrated technology, the net plant heat rate will be improved. This improvement is a direct result of the combined-cycle feature of the technology, which integrates a combustion topping cycle with a steam bottoming cycle. Therefore, this technology is suitable for Repowering applications and can be applied to any existing steam cycle located at plants with enough land area to accommodate coal handling and storage.

In addition to the Participant's joint venture members, PSI and Destec, the project team will include Sargent and Lundy, which will provide engineering services to PSI; Destec Engineering Inc., which will provide engineering services to Destec; and Destec Operating Company, which will provide operation services for the gasifier to Destec.

2.0 INTRODUCTION AND BACKGROUND

2.1 REQUIREMENT FOR A REPORT TO CONGRESS

On October 23, 1989, Congress made available funds for the fourth clean coal demonstration program (CCT-IV) in Public Law 101-121, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1990, and for Other Purposes" (the Act). Among other things, this Act appropriates funds for the design, construction, and operation of cost-shared, clean coal projects to demonstrate the feasibility of future commercial applications of such "... technologies capable of replacing, retrofitting, or Repowering existing facilities . . ." On November 5, 1990, Public Law 101-512 was signed into law, requiring that "a general request for proposals" for CCT-IV be issued by no later than February 1, 1991 and to make selection of projects for negotiations no later than eight months after the date of the general request for proposals. "

Public Law 101-121 appropriates a total of $600 million for executing CCT-IV. Of this total, $7.2 million are required to be reprogrammed for the Small Business and Innovative Research Program (SBIR) and $25 million are designated for Program Direction Funds for costs incurred by DOE in implementing the CCT-IV program. The remaining, $567.8 million was available for award under the PON.

The purpose of this Comprehensive Report is to comply with Public Law 101-512 which directs the Department to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-IV Program.

2.2 EVALUATION AND SELECTION PROCESS

DOE issued a draft PON for public comment on November 20, 1990, receiving a total of 19 responses from the public. The final PON was issued on January 15, 1991, and took into consideration the public comments on the draft PON. DOE received 33 proposals in response to the CCT-IV solicitation by the deadline, May 17, 1991.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-IV solicitation was to obtain "proposals to conduct cost-shared Clean Coal Technology projects to demonstrate innovative, energy efficient technologies that are capable of being commercialized in the 1990's. These technologies must be capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen from existing facilities to minimize environmental impacts such as transboundary and interstate pollution and/or (2) providing for future energy needs in an environmentally acceptable manner."

2.2.2 Qualification Review

The PON established seven Qualification Criteria and provided that, "In order to be considered in the Preliminary Evaluation Phase, a proposal must successfully pass Qualification." The Qualification Criteria were as follows:

(a) The proposed demonstration project or facility must be located in the United States.

(b) The proposed demonstration project must be designed for and operated with coal(s) from mines located in the United States.

(c) The proposer must agree to provide a cost share of at least 50 percent of total allowable project cost, with at least 50 percent in each of the three project phases.

(d) The proposer must have access to, and use of, the proposed site and any proposed alternate site(s) for the duration of the project.

(e) The proposed project team must be identified and firmly committed to fulfilling its proposed role in the project.

(f) The proposer agrees that, if selected, it will submit a "Repayment Plan" consistent with PON Section 7.7.

(g) The proposal must be signed by a responsible official of the proposing organization authorized to contractually bind the organization to the performance of the Cooperative Agreement in its entirety.

2.2.3 Preliminary Evaluation

The PON provided that a Preliminary Evaluation would be performed on all proposals that successfully passed the Qualification Review. In order to be considered in the Comprehensive Evaluation phase, a proposal must be consistent with the stated objectives of the PON, and must contain sufficient finance, management, technical, cost, and other information to permit the Comprehensive Evaluation described in the solicitation to be performed.

2.2.4 Comprehensive Evaluation

The Technical Evaluation Criteria were divided into two major categories: (1) the Demonstration Project Factors were used to assess the technical feasibility and likelihood of success of the project, and (2) the Commercialization Factors were used to assess the potential of the proposed technology to reduce emissions from existing facilities, as well as to meet future energy needs through the environmentally acceptable use of coal, and the cost effectiveness of the proposed technology in comparison to existing technologies.

The Cost and Finance Evaluation criteria were used to determine the business performance potential and commitment of the proposer.

The PON provided that the Cost Estimate would be evaluated to determine the reasonableness of the proposed cost. Proposers were advised that this determination "will be of minimal importance to the selection," and that a detailed cost estimate would be requested after selection. Proposers were cautioned that if the total project cost estimated after selection is greater than the amount specified in the proposal, DOE would be under no obligation to provide more funding than has been requested in the proposer's Cost Sharing Plan.

2.2.5 Program Policy Factors

The PON advised proposers that the following program factors could be used by the Source Selection Official to select a range of projects that would best serve program objectives:

(a) The desirability of selecting projects that collectively represent a diversity of methods, technical approaches, and applications.

(b) The desirability of selecting projects in this solicitation that contribute to near term reductions in transboundary transport of pollutants by producing an aggregate net reduction in emissions of sulfur dioxide and/or the oxides of nitrogen.

(c) The desirability of selecting projects that collectively utilize a broad range of U.S. coals and are in locations which represent a diversity of EHSS, regulatory, and climatic conditions.

(d) The desirability of selecting projects in this solicitation that achieve a balance between (1) reducing emissions and transboundary pollution and (2) providing for future energy needs by the environmentally acceptable use of coal or coal-based fuels.

(e) The desirability of selecting projects that provide strategic and energy security benefits for remote, import-dependent sites, or that provide multiple fuel resource options for regions which are considerably dependent on one fuel form for total energy requirements.

The word “collectively” as used in the foregoing program policy factors, was defined to include projects selected in this solicitation and prior clean coal solicitations, as well as other ongoing demonstrations in the United States.

2.2.6 Other Considerations

The PON provided that in making selections, DOE would consider giving preference to projects located in states for which the rate-making bodies of those states treat the Clean Coal Technologies the same as pollution control projects or technologies. This consideration could be used as a tie breaker if, after application of the evaluation criteria and the program policy factors, two projects receive identical evaluation scores and remain essentially equal in value. This consideration would not be applied if, in doing so, the regional geographic distribution of the projects selected would be altered significantly.

2.2.7 National Environmental Policy Act (NEPA) Compliance

As part of the evaluation and selection process, the Clean Coal Technology Program developed a procedure for compliance with the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality NEPA regulations (40 CFR Parts 1500-1508), and the DOE guidelines for compliance with NEPA (52 FR 47662, December 15, 1987). DOE final NEPA regulations replacing the DOE guidelines were published in the Federal Register on April 24, 1992. This procedure included the publication and consideration of a publicly available Final Programmatic Environmental Impact Statement (DOE/EIS-0146) issued in November 1989, and the preparation of confidential preelection project-specific environmental reviews for internal DOE use. DOE also prepares publicly available site-specific documents for each selected demonstration project as appropriate under NEPA.

2.2.8 Selection

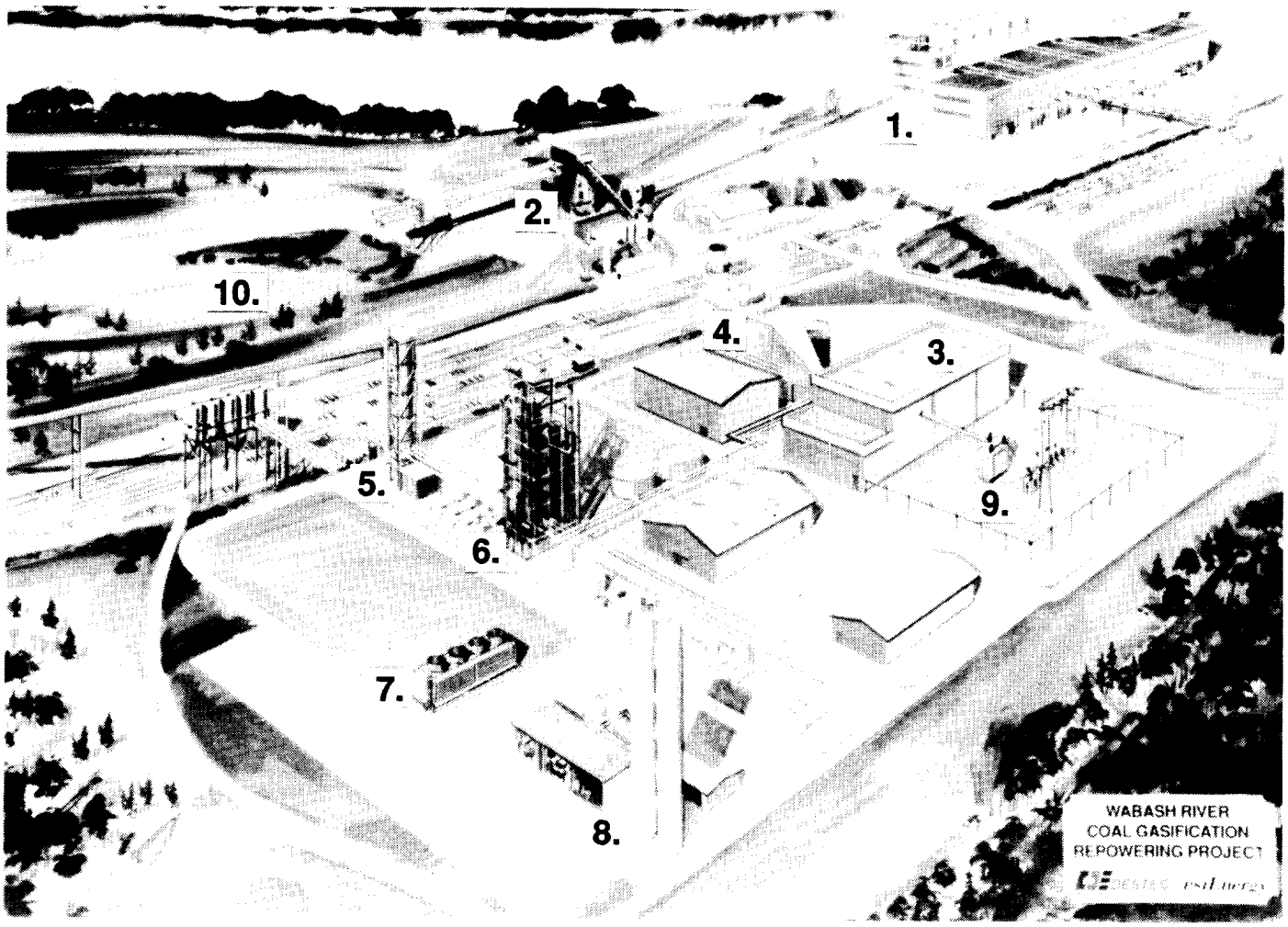
After considering the evaluation criteria, the program policy factors, and the NEPA strategy as stated in the PON, the Source Selection Official selected 9 projects as best furthering the objectives of the CCT-IV PON. These selections were announced on September 12, 1991 during a press conference.

3.0 TECHNICAL FEATURES

3.1 PROJECT DESCRIPTION

The Wabash River Coal Gasification Repowering Project will demonstrate the commercial application of a CGCC system by the Repowering of an existing reheat steam turbine at PSI's Wabash River Generating Station in West Terre Haute, Indiana. An artist's conception of the plant is shown in Figure 3. The CGCC system will consist of Destec's oxygen-blown, two-stage, entrained-flow coal gasifier which is capable of utilizing high sulfur bituminous coal; a gas conditioning system for removing sulfur compounds and particulate; systems or mechanical devices for improved coal feed; a combined-cycle power generation system, wherein the conditioned synthetic fuel gas is combusted in a combustion turbine generator; a gas cleanup system; a heat recovery steam generator; all necessary coal handling equipment; and an existing plant steam turbine and associated equipment.

The demonstration will result in a combined cycle power plant with low emissions and high net plant efficiency. The net plant heat rate for the new, repowered unit will be 8740 Btu/kWh, representing a 21% improvement over the existiing unit while cutting SO_2 by greater than 90% and NO_x emissions by greater than 85%. As a comparison, the typical heat rate for a conventional pulverized coal-fired unit with stack gas scrubbing is about 10,500 Btu/kWh. The total output from the CGCC repowered system



1. **Existing Wabash Station**
2. **Existing coal transfer tower**
3. **Gas turbine building**
4. **Heat recovery steam generator stack**
5. **Coal receiving silo**
6. **Gasifier**
7. **Cooling towers**
8. **Oxygen plant**
9. **New substation**
10. **Existing coal pile**

Figure 3. Artist Conception of Project

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will be a nominal 265 MWe. A schematic of the proposed project is presented in Figure 4.

The project activities consist of design and engineering, permitting, procurement, construction and start-up, operation and data collection. The operation phase of the project will be 36 months. During the operation period, it will be demonstrated that the CGCC system is ready for commercialization for either a Repowering application or a grass roots power plant. PSI Energy Inc., Indiana's largest electric utility, will provide the site for the Repowering project. The host plant, Wabash River Generating Station, presently has six generating units at the station. Unit 1 will be repowered for this project. This unit is a nominal 100-MWe Westinghouse reheat steam turbine which was put into service in 1953; it will be rated at 105 MWe in the Repowering configuration. Currently, Unit 1 is in service and prior to this project, plans were to operate it until 2005, to meet system peaks and to provide capacity during other unit maintenance outages. The demonstration project will add an additional 166 MWe of effective generating capacity for PSI.

The demonstration project will help form the basis for a new generation of 21st century power plants. The technology, which relies on gasified coal, will produce as much as 25% more electricity from a given amount of coal than today's conventional coal-burning methods. In addition to its high efficiency, the technology offers U.S. utilities a cost effective compliance option for the Clean Air Act Amendments. The extremely low emissions of the plant and its environmentally safe, saleable by-products make this an effective compliance strategy for utilities. DOE predicts that advanced coal technologies such as this CGCC technology will capture a major portion of the power producing market because of its high efficiency, environmental soundness, and cost competitiveness.

3.1.1 Project Summary

Title:	**Wabash River Coal Gasification Repowering Project**
Proposer:	**Wabash River Coal Gasification Repowering Project Joint Venture**
Location:	**Wabash River Generating Station of PSI Energy, Inc., West Terre Haute, Indiana**
Technology:	**Coal gasification combined cycle comprised of Destec's oxygen-blown, entrained-flow, two-stage pressurized gasifier, an advanced combustion turbine, and a heat recovery steam generator**

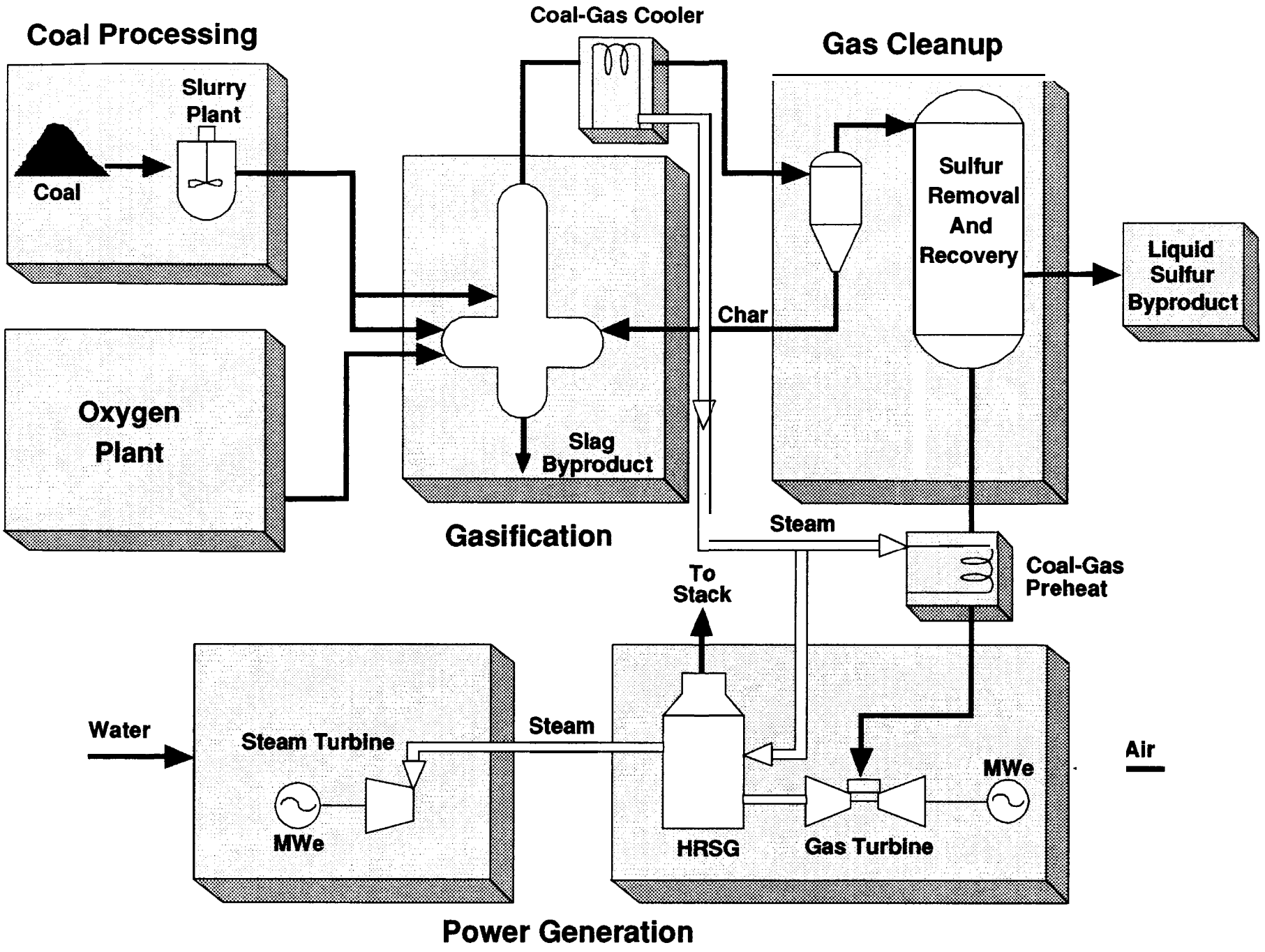

Figure 4. Wabash River CGCC Repowering Project Schematic

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Applications :	**Utility and industrial electric power generation, cogeneration, Repowering of steam turbines and gas-fired combined cycles, and Repowering of conventional pulverized coal power plants and oil- or natural gas-fired power plants**
Coals Utilized:	**High sulfur bituminous**
Product:	**Electricity**
Project Size:	**265 MWe**
Project Starting Date:	**August 1992**
Project Ending Date:	**June 1998**

3.1.2 Project Sponsorship and Cost

Project Sponsor:	**The Wabash River Coal Gasification Repowering Project Joint Venture**	
Project Co-Funders:	**The Joint Venture Partners: Destec Energy, Inc. and PSI Energy Inc., and the U.S. DOE**	
Estimated Project Cost:	**$396,000,000**	
Cost Distribution:	**Participant Share**	**$198,000,000**
	DOE Share	**$198,000,000**

3.2 CGCC PROCESS

3.2.1 Overview of Process Development

The Wabash River CGCC Repowering Project will use the Destec coal gasification process. This two-stage gasification process utilizes a second stage gasification step to recover heat as chemical energy and thus upgrade the quality of medium Btu syngas generated by the first stage slagging gasifier. The gasification technology provides excellent environmental performance and high thermal efficiency.

Research was begun in the mid-1970's by the Dow Chemical Company (Dow) aimed at developing a coal gasification process that could efficiently and economically utilize the lignite reserves that Dow had acquired in northwestern Louisiana. After obtaining fundamental design data through research efforts at bench scale, a 12 TPD air-blown, coal gasification prototype plant was constructed and began operations in 1979. It was later converted

to an oxygen-blown system to improve reliability and was operated through 1983. It was in this facility that the geometry of the Dow two-stage gasifier was first tested. The prototype plant, although strong in on-stream reliability, remained deficient in energy efficiency. It was shutdown and a new plant, called "Prototype Two" was designed, constructed, and operated. It was initially operated for one year (1983) using air as the oxidant. The plant was then converted to oxygen feed and was operated from 1984 through late-1985 in this mode. The Prototype Two plant had a design basis of 800 TPD using air or 1600 TPD using oxygen.

During the operation of the Prototype Two plant, sufficient data were obtained to scale the process up to a commercial scale coal gasification plant. The first commercial plant, operated by Louisiana Gasification Technology, Inc. (LGTI), now a wholly-owned subsidiary of Destec Energy, Inc., started up in 1987, as a 2,200-TPD, 161-MWe plant utilizing low rank, highly-reactive coal. In May 1989, Dow formed Destec Energy, Inc., to apply the expertise Dow had developed in combined-cycle cogeneration facilities and syngas production in the growing independent power market. LGTI is now into its fourth year of operation and has processed more than 1.8 million tons of low sulfur sub-bituminous coal. This syngas facility is operated by Destec as part of its continuing drive to link gas turbines to solid fuels and to provide synthetic fuel gas for the Dow Plaquemine Chemical facility. Test runs with bituminous coal have been performed at LGTI and these provide the design basis for the proposed Clean Coal Technology project. Although not part of the proposed project, Destec intends to continue component and process development at the LGTI facility to support technology enhancements related to such areas as materials development testing and combustion turbine technology, that are to be demonstrated in the Wabash River CGCC Repowering Project.

3.2.2 Process Description

The Destec coal gasification process is an oxygen-blown, entrained-flow process which produces a medium Btu syngas and is well suited for utility power generation. The two major components of the Wabash River CGCC demonstration project are the gasification island and the power island (Figure 4) . In the gasification island, coal is ground with water to form a slurry. It is then pumped into a gasification vessel where oxygen is added to form a hot, raw gas through partial combustion of the coal. 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. The hot, raw gas is cooled in a heat exchanger to generate high pressure steam. Particulate, sulfur and other impurities are removed from the gas before combustion to make it acceptable fuel for the gas turbine in the power island.

In the gasification process, approximately 2500 TPD of coal are gasified at full load. Precrushed coal from the rod mill feed hopper enters an open circuit feed hopper where coal slurry is produced by wet grinding. The coal slurry process is designed to maximize solids concentration in the coal feed to the gasifier. High solids concentration produces high efficiency in the first stage gasifier and improved conversion in the second stage. Recycled water is fed into the rod mill inlet along with the coal to produce the desired slurry solids. The Destec gasification process consists of two stages--an entrained flow slagging first stage and an entrained flow non-slagging second stage. The slagging section, or first stage, is a horizontal refractory lined vessel in which coal slurry and oxygen are combined in a partial combustion atmosphere at an elevated temperature (exceeding 2000 degrees Fahrenheit) and pressure (400 psia) to produce a high temperature syngas. The coal is almost totally gasified in this environment to syngas. All coal ash can flow out of the taphole in the bottom of the gasifier into a water-filled quench tank. Water quenching turns the ash into slag which is continuously removed from the bottom of the gasifier, crushed, dewatered and stored for later disposition.

The raw syngas generated in the first stage flows up from the horizontal section into the non-slagging second stage of the gasifier. This non-slagging section is a vertical, refractory–lined vessel in which additional coal slurry is reacted with the hot synthetic gas stream exiting the first stage. This additional slurry and some recycled cooled syngas serve to create and quench additional syngas. The cooled syngas leaves the reactor and moves to a high temperature heat recovery unit which further cools the syngas. The cooled syngas then flows to a dry particulate removal section where particles are separated from it and recycled to the gasifier. The syngas is further cooled through a series of heat exchangers prior to hydrogen sulfide removal. As the gas cools, sour water containing ammonia, carbon dioxide, and other dissolved gases is collected and treated in a sour water treatment unit for recycle to the slurry preparation plant to make more coal slurry. The hydrogen sulfide is removed from the sour syngas by an acid gas removal (AGR) system which removes over 98% of the sulfur in the syngas. The sweet syngas is then reheated before being sent to the power plant.

The cleaned syngas is routed to a combined cycle system for electric power production. The major components of the system include the combustion turbine, heat recovery steam generator, steam turbine, demineralizer, and power delivery system. The syngas is piped to a combustion turbine generator which produces approximately 198 MWe of electricity. A heat recovery steam generator uses heat from the gas turbine exhaust to produce high pressure steam. This steam and the steam generated in the gasification process supply an existing steam turbine generator to produce an additional 104 MWe. Plant auxiliaries in the power

generation and coal gasification areas consume approximately 37 MWe for nominal net power generation of 265 MWe.

3.3 GENERAL FEATURES OF PROJECT

3.3.1 Evaluation of Developmental Risk

Subsequent to selection and as part of the fact-finding process, DOE performed a detailed evaluation of the CGCC project and determined it to be reasonable and appropriate. The evaluation focused on the project's technical, schedule, and cost risks. A team of experts from within DOE and available under contract contributed to the evaluation. The data base for the evaluation included Participant-furnished documentation and DOE fact-finding discussion with the Participant.

The degree of technical risk associated with this project is mitigated by Destec's experience and expertise in the design, construction, and operation of gasification and power generating systems. Destec currently operates LGTI where coal feed systems, the two-stage oxygen-blown gasifier, syngas heat exchanger, conventional gas cleanup and power generating equipment have operated successfully and reliably on over 1.8 million tons of low sulfur sub-bituminous coal. Approximately 1200 tons of high sulfur bituminous coal, gasified over 8 days, have been tested in critical sections of LGTI to provide design data for high sulfur bituminous coal. Technology and design advances include: scale-up from the 160-MWe equivalent at the LGTI facility to a 265-MWe CGCC, processing of high sulfur coal, and use of a dry particulate removal and recycle system. These technical advances are considered to be of low to moderate risk. Some additional risks are inherent with the CGCC technology until it becomes fully commercial at this size. These risks include integration of the power island with the gasification island, both to use syngas as a fuel and to optimize system configuration for maximum performance and reliability at minimum cost.

The 71-month schedule allows sufficient time for the detailed design, construction, start-up and operation of the demonstration project. The schedule presented in Section 6.2 shows a rather short detailed design and permitting period. This reflects the high degree of completion already achieved by the Participant in these areas. A 12-month overlap of Phase I and Phase II anticipates timely completion of the NEPA process. Both NEPA completion and permitting activities should be facilitated by the project being Repowering at an existing site. The Phase II schedule has allotted sufficient time for component and integrated system evaluation at full load prior to moving into the operation phase. Finally, the planned demonstration period will allow for demonstration of the process performance, system availability and reliability.

The cost estimate, evaluated during the fact-finding process, was based to a large extent upon vendor bids and budget quotations. Where quotations were not available, costs were estimated by consultants using an extensive data base of similar, commercially available equipment and applying appropriate scaling factors. Major systems were estimated on an installed-cost basis which included not only equipment items, but also related bulk materials and all subcontractors' costs. A financial risk analysis program was used by DOE to evaluate the risk in the estimate. This analysis indicated that there was a very low risk that the proposed cost would be exceeded.

DOE recognizes that demonstrating the commercial readiness of new technologies inherently carries a certain amount of risk. Careful assessment of the risks associated with the project and the potential benefits of the technology leads DOE to conclude that those risks are acceptable and worth taking. Provisions to manage risks will be made in the design of the system as well as in the operating procedures for the system demonstration.

3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

The CGCC coal conversion method to be demonstrated in this project is similar to the technology currently being successfully operated at Destec's LGTI facility. The technology enhancements to be demonstrated are described in section 3.3.1.2. The primary differences are the project scale, the plant integration in a commercial Repowering setting, and the use of high sulfur bituminous coal.

The LGTI facility is comprised of equipment capable of generating 160 MWe as compared to the proposed CGCC demonstration of 265 MWe. The larger scale increases the technology attractiveness to potential users. The technology enhancements to be demonstrated in the proposed CGCC Repowering project offer significant improvements over the plant system being operated at LGTI. These improvements will result in higher thermal efficiency (lower heat rate) , lower capital costs, lower product cost, increased safety and flexibility of coal usage.

The integration of the plant will be the first time that Destec's gasification technology will be demonstrated in a commercial Repowering setting and utility application. The LGTI facility operates in a non-integrated manner supplying fuel gas to the gas turbine (as a substitute for natural gas when the gasifier is operating) located at a distance away from the gasifier (referred to as over the fence) and supplying steam for use at a chemical plant complex; whereas, in the CGCC demonstration, the gasifier, gas turbine, and repowered steam generator are integrated to maximize system efficiency.

The project will demonstrate the environmental performance and energy efficiency of the CGCC system with an abundant U.S. solid fuel. While a low-sulfur (less than 0.5%) sub-bituminous coal with a heating value of 8,800 Btu/lb is converted to fuel gas at LGTI , the CGCC demonstration plant will utilize a high-sulfur (4.5 to 4.9% sulfur) bituminous coal of about 12,000 Btu/lb. This capability will offer an excellent option for competitively meeting future and potentially more stringent environmental emission constraints.

Another similar project is the 100-MWe Cool Water Coal Gasification Plant located near Daggett, California, which started operation in June 1984. This 1OOO-TPD facility was the first commercial integrated coal gasification combined-cycle power plant in the world. In its five-year demonstration period, Cool Water with its Texaco based coal gasification process operated reliably, safely and cleanly to produce 2.7 billion kWh of electric power. Texaco's entrained-flow, oxygen-blown, single stage coal gasification process is coupled with a "radiant" fuel gas heat recovery system to produce a medium-Btu fuel gas. The primary difference in Destec's gasification process is its two-stage gasifier coupled with a "fire-tube" fuel gas heat recovery system. As compared to the Cool Water Plant, the Wabash River Coal Gasification Repowering Project has a greater power generating capacity (265 MWe) and will be operated in a fully commercial Repowering setting for 20 years, subject to successful demonstration of performance and reliability. With the generating capacity proposed for Repowering of the Wabash River Station, significant improvements in thermal efficiency and capital cost are projected over what was demonstrated by the Cool Water Plant.

In addition to Texaco's oxygen-blown coal gasification technology, other established and emerging coal gasification technologies are also under consideration for combined-cycle electric power generation for the 1990 to 2005 period. The primary candidates include: an oxygen-blown, entrained-flow system being offered by Shell; an air-blown, entrained-flow system offered by ABB Combustion Engineering; air-blown, fluidized-bed systems owned by Kellogg, Tampella, and Winkler; a dry-bottom fixed-bed system owned by Lurgi; and a slagging fixed-bed system owned by British Gas/Lurgi.

3.3.1.2 Technical Feasibility

As discussed in Section 3.3.1, DOE recognizes that technical uncertainties exist in the proposed project, primarily in the performance of the gasifier on high sulfur bituminous coal, in the operation of the dry particulate removal and recycle system, and in overall CGCC plant integration. Overall, the proposed process is technically acceptable and the project is technically

sound. The following discussion outlines the new enhancements and techniques included in the project.

- The integrated coal gasification combined cycle technology will be integrated with a gas turbine and an existing steam turbine to repower an existing coal fired power generating unit.

- High sulfur bituminous coal will be processed in Destec's two stage gasifier to demonstrate what is projected to be excellent environmental performance and high efficiency. Previous operating experience has focused on lower rank, more reactive coals.

- A dry particulate removal and recycle system will be operated at a fully commercial scale. Previous operating experience has been with a wet scrubber to remove particulate from the raw syngas.

- The product gas cooler will cool the hot raw gas, which will contain high concentrations of corrosive sulfur compounds associated with the high sulfur coal. The gas will be cooled by producing steam at a pressure of 1600 psia. Previous experience is at a pressure of 650 psia in a much less corrosive environment than will be experienced in the project.

- Syngas recycle, to provide fuel and process flexibility while maintaining high efficiency in related processes, will be demonstrated for the first time.

- A carbon sulfide hydrolysis system will be incorporated in the project to attain a very high percentage removal of sulfur. This is the first time that this technology will be applied to a CGCC plant.

- A slag fines recycle system will be incorporated which recovers most of the carbon present in the slag byproduct stream and recycle it back for enhanced carbon conversion. This enhancement is added to improve the quality and marketability of the slag by-product.

- Fuel gas moisturization will be accomplished by a system which uses low-level heat in a new concept. This concept will reduce steam injection required for NOX control.

- A novel sour water system will be used to allow more complete recycle of the sour water condensation. This will reduce waste water effluent and improve plant efficiency.

3.3.1.3 Resource Availability

The Joint Venture partners have arranged to provide the Participant share of the project financing as presented in Section 6.1. The Participant share will come from both partners.

The project will be located at PSI's existing Wabash River Generating Station. Peabody Coal Company has donated land to PSI Energy for the gasification facility. Essential infrastructure services are available including water, natural gas, highway access, electric service, solid waste and sanitary waste disposal.

Resources for lifetime operation of the project (including manpower, land, coal, limestone, water, and transportation) are available in the region. PSI currently employs 208 people at the Wabash River Generating Station. It is expected that 90 percent of the labor requirements will be filled with the regionally available labor force.

3.3.2 Relationship between Project Size and Projected Scale-up of Commercial Facility

The CGCC technology to be demonstrated in the project will have a high potential for market penetration. The project will demonstrate a commercial-size unit with a nominal 265-MWe capacity in a Repowering setting, using an oxygen-blown, entrained-flow gasifier, a combustion turbine, and a steam turbine. This configuration is compatible with all commercially available advanced gas turbines and thus resolves the issue of scale-up. The project is based at a utility and will be operated in a manner similar to other utility generating units. The project will accommodate most U.S. coals and enable testing of various types of coal. This project, operating at commercial size, will demonstrate the superior thermal efficiency and environmental compliance of the coal gasification technology in both Repowering and new capacity applications.

3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

The Destec coal gasification technology has been developed for combined-cycle power and steam generation. This technology has been demonstrated on low sulfur coal at a smaller scale and has proven successful in generating clean, reliable power. A demonstration plant such as that in the planned project is an essential next step in commercializing the technology for utility and industrial power generation applications.

The project is expected to begin operation in 1995. Verification of the commercial feasibility of the technology will be accomplished with a 36-month demonstration test program, after

which the project will continue to be a part of PSI's commercial plant. System reliability, economics, and environmental performance will be established so that commercialization can be successfully achieved.

During and following successful demonstration, the CGCC technology will be offered to other utility and industrial users. The technology offers several advantages that will contribute to its marketability:

- It will demonstrate improved thermal efficiency for the repowered unit.
- The modularity of the gasifier technology will permit a range of units to be considered for Repowering, or various sizes of new units to be considered for a utility expansion plan.
- A relatively short construction schedule will offer flexibility to utilities to meet load requirements.
- Fuel flexibility will allow utilities to make greater choices in fuel supplies to meet new environmental regulations .
- Environmental flexibility will allow users to meet current and future environmental constraints.
- The potential market for the technology is large and market penetration is likely to be high if the proposer's economic, efficiency, reliability and environmental performance targets are met.

Destec, as the owner of the coal gasification technology and operator of a power generation plant which utilizes the technology, has the professional credibility to commercialize this technology. In parallel with the demonstration project, Destec intends to continue to improve its CGCC technology through development efforts at its LGTI facility, and continue to proactively market the technology directly to power and steam generating customers. Destec plans to commercialize the technology initially by building, owning, and operating coal gasification facilities. In this mode, Destec can provide services to a utility or other generators who can depend on Destec's commercial based expertise.

4.0 ENVIRONMENTAL CONSIDERATIONS

The overall strategy for compliance with NEPA, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a pre-selection, project-specific environmental analysis; and a post-selection, site-specific

environmental analysis. To satisfy the first element, DOE issued the final PEIS to the public in November 1989 (DOE/EIS-0146). In the PEIS, results derived from the Regional Emissions Database and Evaluation System (REDES) were used to estimate the environmental impacts that might occur by the year 2010 if each technology were to reach full commercialization and capture 100 percent of its applicable market. The environmental impacts were compared to the no-action alternative, which assumed continued use of conventional coal technologies through 2010, with new plants using conventional flue gas desulfurization to meet New Source Performance Standards (NSPS).

Projected environmental impacts in 2010 from maximum commercialization of the CGCC technology are presented in Table 1 for the entire nation as well as regional areas. Negative percentages indicate decreases in emissions or waste quantities in 2010 as compared to the no–action alternative. Conversely, positive values indicate increases in emissions or waste quantities. These computer-derived results should be regarded as approximations of actual impacts.

Table 1. Projected Environmental Impacts in 2010, CGCC Technology (Percent Change over No-Action Alternative)

Region	Sulfur Dioxides	Nitrogen Oxides	Carbon Dioxide	Solid Wastes
National	-37%	-17%	-6%	-5%
Northeast	-40%	-19%	-4%	-7%
Southeast	-46%	-25%	-4%	+10%
Northwest	-7%	-6%	-3%	+34%
Southwest	-36%	-14%	-l0%	-16%

Source: Programmatic Environmental Impact Statement (DOE/EIS-0146), November 1989.

As shown in Table 1, commercialization of the CGCC technology would provide sulfur dioxide, nitrogen oxides, and carbon dioxide reductions, with the largest reductions occurring in the Southeast quadrant, closely followed by the Northeast and Southwest. The Northwest quadrant would be least affected by emissions reductions and shows an increase in solid waste production. The quadrants used in the REDES study are depicted in Figure 1.

Total suspended particulate (TSP) emissions would be minimally affected, since the use of conventional pollution control

equipment would at least meet NSPS. Therefore, minimal changes from the baseline emissions would be expected.

Carbon dioxide emissions would also be reduced. These reductions would be contributed primarily by the improved efficiencies of CGCC technologies over the conventional coal fired technologies.

Water consumption for CGCC is not expected to be significantly different than that for the no-action alternative. Advanced CGCC facilities are expected to consume less water than other coal conversion technologies because of novel process design approaches for CGCC technologies.

On the national average, the CGCC technology is anticipated to generate less solid waste on a dry basis than conventional coal-fired technology with wet flue gas desulfurization. The slag, fly ash, and bottom ash produced by the gasification processes are non-hazardous wastes acceptable for landfill disposal; and the sulfur, which comprises about 20% of the solid waste, is recoverable as a saleable by-product. For this particular technology, dewatered slag from the gasification process and waste from the sulfur removal process will comprise the bulk of the solid waste. If a suitable market cannot be established, products of these waste streams will be combined and disposed of in landfills.

The second element of DOE's NEPA strategy for the CCT program involved preparation of a pre-selection environmental review based on project-specific environmental data and analyses that offerors supplied as part of their proposals. The review summarized the strengths and weaknesses of each proposal against the environmental evaluation criteria. It included, to the extent possible, a discussion of alternative sites and processes reasonably available to the offeror, practical mitigating measures such as the options for controlling discharges and for management of solid and liquid wastes, impacts of each proposed demonstration on the local environment, and a list of required permits. Finally, the risks and impacts of each proposed project were assessed. This analysis was provided for the Source Selection Official's use before the selection of proposals.

As the final element of the NEPA strategy, the Participant will submit to the DOE the environmental information specified in Appendix J of the PON. This detailed site- and project-specific information will be used as the basis for the site-specific NEPA documents to be prepared by DOE. These documents, which will be in full compliance with NEPA and the CEQ and the DOE regulations for NEPA compliance, will be completed and must be approved before federal funds can be provided for detailed design, construction, and operation.

In addition to the NEPA requirements outlined above, the Participant must prepare and submit an Environmental Monitoring Plan (EMP) for the project, following the guidelines provided in Appendix N of the PON. The purpose of the EMP is to ensure that sufficient technology, project, and site environmental data are collected to provide health, safety, and environmental information for use in subsequent commercial applications of the technology.

The Participant, in a draft Environmental Information Volume, describes positive impacts to the environment which include overall reductions in sulfur dioxide and nitrous oxide emissions. The project's average SO_z emissions are projected to be less than 0.25 lb/mtu. This emission rate represents a greater than 90% decrease in SO for the plant. The average $NO_=$ emissions will be approximately 0.088 lb/MMBtu, a greater than 85% decrease in the current emissions from the unit. The Repowering project will produce about a 20% improvement in the overall coal-to-electricity efficiency compared to the current operation of the unit. Therefore, CO_z emissions per unit of useful energy produced will be lowered by a similar percentage relative to continued operation of the unit in its current configuration.

5.0 PROJECT MANAGEMENT

5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

The CGCC Demonstration Project organization is depicted in Figure 5. The Wabash River Coal Gasification Repowering Project Joint Venture will serve as the Participant for this project and, along with the Joint Venture partners, will be the signatory to this Cooperative Agreement. The Joint Venture partners, through the Joint Venture Agreement management committee, will be responsible for the performance of all engineering, design, construction, operation, financial, legal, public affairs, and other administrative and management functions required to execute the project. In addition to the Joint Venture partners, the project team consists of the Destec Engineering Inc., Destec Operating Company and Sargent and Lundy.

Destec Engineering Inc., under agreements with Destec Energy, will design and construct the syngas and all related facilities. Destec Operating Company will provide operations and maintenance of the syngas facility. Sargent and Lundy will perform the engineering and design for the combined-cycle Repowering portion of the project for PSI.

DOE will monitor all aspects of the project, including the overall progress and direction of design, construction? start-up, and operation to ensure that all project goals are met. This monitoring will include DOE participation at critical review points .

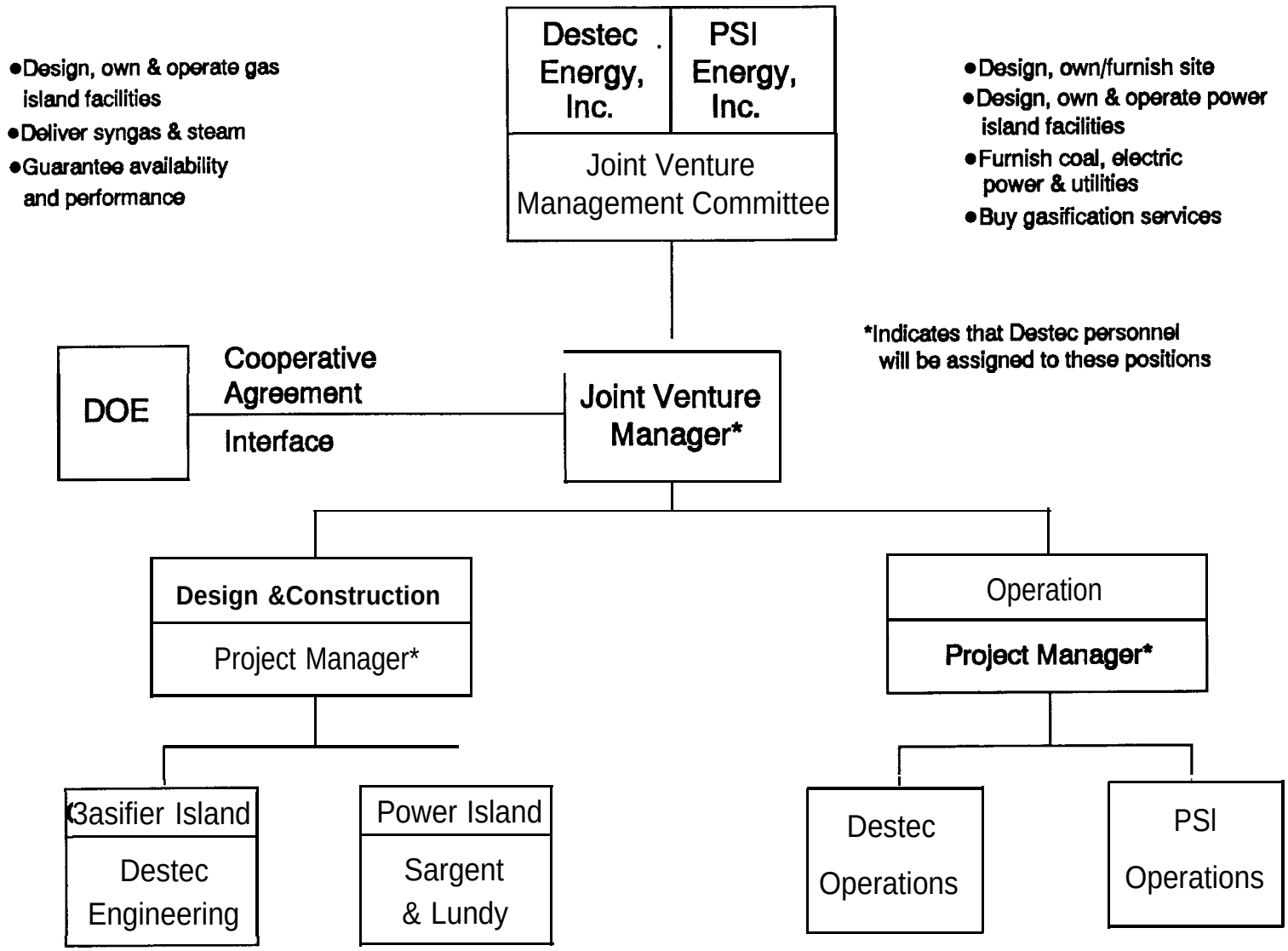

Figure 5. Project Organization

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5.2 IDENTIFICATION OF RESPECTIVE ROLES AND RESPONSIBILITIES

5.2.1 DOE

DOE will be responsible for monitoring all aspects of the project and for granting or denying approvals required by the Cooperative Agreement. A DOE Project Manager will be designated by the DOE Contracting Officer to act as a Contracting Officer's Technical Representative (COTR) . The COTR will be the primary point of contact for the project and will be responsible for the DOE management of the project.

5.2.2 Participant

The Joint Venture, as the Participant, will be responsible for all aspects of the project, including design, permitting, construction, operation, data collection and reporting. The Participant under the Joint Venture Agreement will appoint an employee of Destec to be the Project Manager. This person will have the authority to legally bind the Joint Venture and will be responsible to the Joint Venture Management committee. The Project Manager will have the responsibility for the implementation of the project and be the primary point of contact for DOE interaction.

5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURES

The Participant will prepare and maintain a Project Management Plan which presents the project procedures, controls, schedules, budgets, baseline design information, and other activities required to adequately manage the project. This document will be prepared shortly after execution of the Cooperative Agreement and will be used to implement and control project activities. Throughout the project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared and delivered to DOE.

5.4 KEY AGREEMENTS IMPACTING DATA RIGHTS, PATENT WAIVERS, AND INFORMATION REPORTING

With respect to data rights, DOE has negotiated terms and conditions which will generally provide for rights of access by DOE to all data generated or utilized in the course of or under the Cooperative Agreement by the Participant and its subcontractors. DOE will have limited rights to proprietary and clean coal protected data and unlimited rights to other contract data. DOE will have the right to review relevant proprietary information under suitable conditions of confidentiality.

With regard to patents, data and other intellectual property, the Participant has made a contractual commitment to exercise its best efforts to commercialize the CGCC Technology demonstrated in

this project. To effect commercialization, the Participant has also made a contractual commitment to flow down their commercialization obligation in all contracts with suppliers of the technology to be demonstrated under this Cooperative Agreement.

The Participant has requested for itself and on behalf of its subcontractors who will participate in the demonstration program, a waiver of patent rights in any subject invention, i.e., any invention or discovery by any of them which is conceived or first actually reduced to practice in the course of or under the Cooperative Agreement. Favorable action is anticipated to be given to the Participant's Patent Waiver request considering the level of cost sharing, the commitment by its principal subcontractor to commercialization of the CGCC Technology, and agreement by the Participant to repay up to the Government's contribution in accordance with the DOE guidelines. Any grant of a patent waiver will reserve to the Government a nonexclusive, nontransferable, and irrevocable paid-up license to practice or to have practiced any waived subject invention for or on behalf of the United States.

5.5 PROCEDURES FOR COMMERCIALIZATION OF TECHNOLOGY

The CGCC Demonstration Project will be used as a stepping stone to move the CGCC technology to readiness for widespread commercial application by the late-1990's. Following demonstration of plant reliability and performance, the Joint Venture partners plan to continue plant operation on a commercial basis for a 20-year operating period. Destec plans to use this demonstration as the basis for its commercialization strategy for CGCC technology. The data generated in this project will enable U s . utilities to have a proven technology for repowering older coal fired plant to comply with the Clean Air Act Amendments. The demonstration project will also enable financial lenders to make informed lending decisions with regard to future technology applications.

Throughout the U.S., particularly in the Midwest and East, there are more than 95,000 MWe of existing coal-fired utility boilers which will be over 30 years old in the year 1996. These aging boilers primarily are without air pollution controls and are candidates for Repowering with CGCC technology. Repowering of these plants with CGCC systems will result in improved plant efficiencies and reductions in net emission rates of $S0_2$, NO_x and CO_2. The modularity of the gasifier technology will permit a range of units to be considered for Repowering and the relatively short construction schedule for the CGCC technology will allow utilities greater flexibility in designing strategies to meet their load requirements.

6.0 PROJECT COST AND EVENT SCHEDULING

6.1 PROJECT BASELINE COSTS

The estimated cost and the cost sharing for the work to be performed under the project phases of the Cooperative Agreement are as shown below.

Pre-Award

DOE Share	$ 3,107,559	50%
Participant Share	$ 3,107,559	50%
	$ 6,215,118	100%

Phase I

DOE Share	$ 12,002,960	50%
Participant Share	$ 12,002,960	50%
	$ 24,005,920	100%

Phase II

DOE Share	$130,588,914	50%
Participant Share	$130,588,914	50%
	$261,177,828	100%

Phase III

DOE Share	$ 52,300,567	50%
Participant Share	$ 52,300,567	50%
	$104,601,134	100%

Total Estimated Project Cost

DOE Share	$198,000,000	50%
Participant Share	$198,000,000	50%
	$396,000,000	100%

Sequential budget period costs, dependent upon scheduling of activities in the project phases, shall be shared by DOE and the Participant as shown below. At the beginning of each budget period, DOE intends to obligate sufficient funds to pay its share of the expenses for that period.

Budget Period 1 *	DOE Share	$ 43,175,801
	Participant Share	$ 43,175,801
Budget Period 2	DOE Share	$102,523,632
	Participant Share	$102,523,632
Budget Period 3	DOE Share	$ 52,300,567
	Participant Share	$ 52,300,567

* Pre-award costs are included in Budget Period 1.

6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 71 months to complete. The phases and their expected durations are as shown below:

Phase I:	Design and Permitting	17 months
Phase II:	procurement, Construction, and Start-Up	30 months
Phase III:	Operation and Data Collection	36 months

Phases I and II overlap by 12 months.

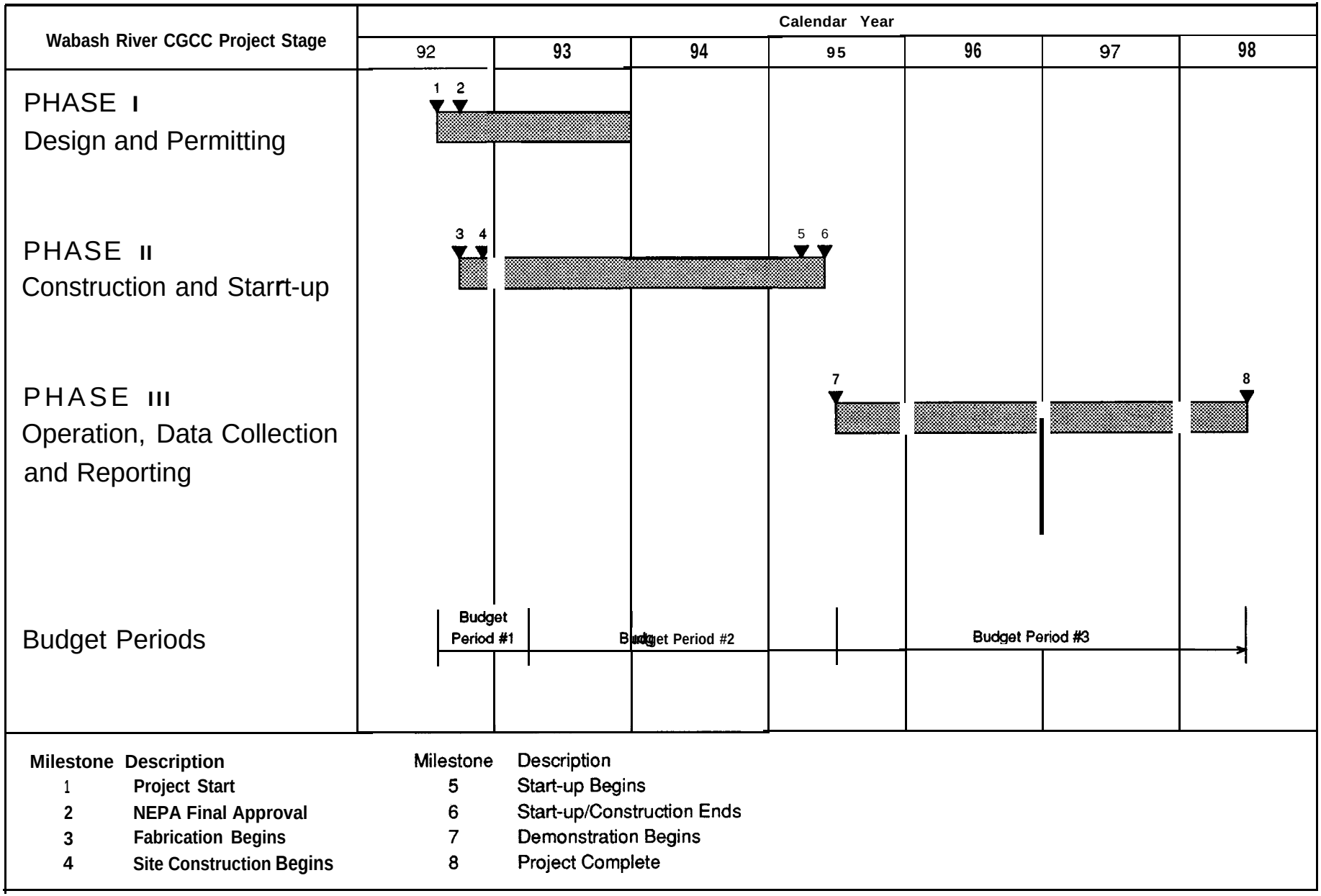
Budget periods are used to manage the financial risk of the project and to facilitate project decision making. The project is divided into three sequential budget periods as follows:

Budget Period 1 -- 9 months
Budget Period 2 -- 26 months
Budget Period 3 -- 36 months

A project schedule is shown in Figure 6. Construction is expected to be completed by June 1995 and the demonstration tests are expected to be completed by June 1998.

6.3 REPAYMENT AGREEMENT

Based on DOE's recoupment policy as stated in Section 7.7 of the PON, DOE is to recover an amount up to the Government's contribution to the project. The Participant has agreed to repay the Government in accordance with the Repayment Agreement to be executed at the time of award of the Cooperative Agreement.



Milestone	Description	Milestone	Description
1	Project Start	5	Start-up Begins
2	NEPA Final Approval	6	Start-up/Construction Ends
3	Fabrication Begins	7	Demonstration Begins
4	Site Construction Begins	8	Project Complete

Figure 6. Wabash River CGCC Project Schedule

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