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Comprehensive Report to Congress Clean Coal Technology Program

Piñon Pine IGCC Power Project

A Project Proposed By:
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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 reduction 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 Sierra Pacific Power Company (SPPC) of Reno, Nevada. SPPC requested financial assistance from DOE for the design, construction, and operation of a nominal 800 ton-per-day (86-Megawatt gross), air-blown integrated gasification combined-cycle (IGCC) demonstration plant. The project, named the Piñon Pine IGCC Power Project, is to be located at SPPC'S Tracy Station, a power generation facility located on a rural 400-acre plot about 17 miles east of Reno (Figure 1) . The demonstration plant will produce electrical power for the utility grid. The project, including the demonstration phase, will last 96 months at a total cost of $269,993,100. DOE's share of the project cost will be 50 percent, or $134,996,550.

The objective of the proposed project is to demonstrate an advanced IGCC system based upon the air-blown, fluidized-bed KRW gasifier with in-bed desulfurization using limestone sorbent and an external fixed-bed zinc ferrite sulfur removal system. The integrated performance to be demonstrated will involve all of the process subsystems, including coal feeding; a pressurized air-blown, fluidized-bed gasifier; a hot gas conditioning system for removing sulfur compounds, particulate and other contaminants, resulting in exceptionally low atmospheric emissions; a highly efficient combustion turbine appropriately modified to utilize low-Btu coal gas as fuel; a heat recovery steam generation system; a steam cycle; IGCC control systems; and the required balance of plant systems. The base feedstock for the project is a low-sulfur bituminous coal from Utah.

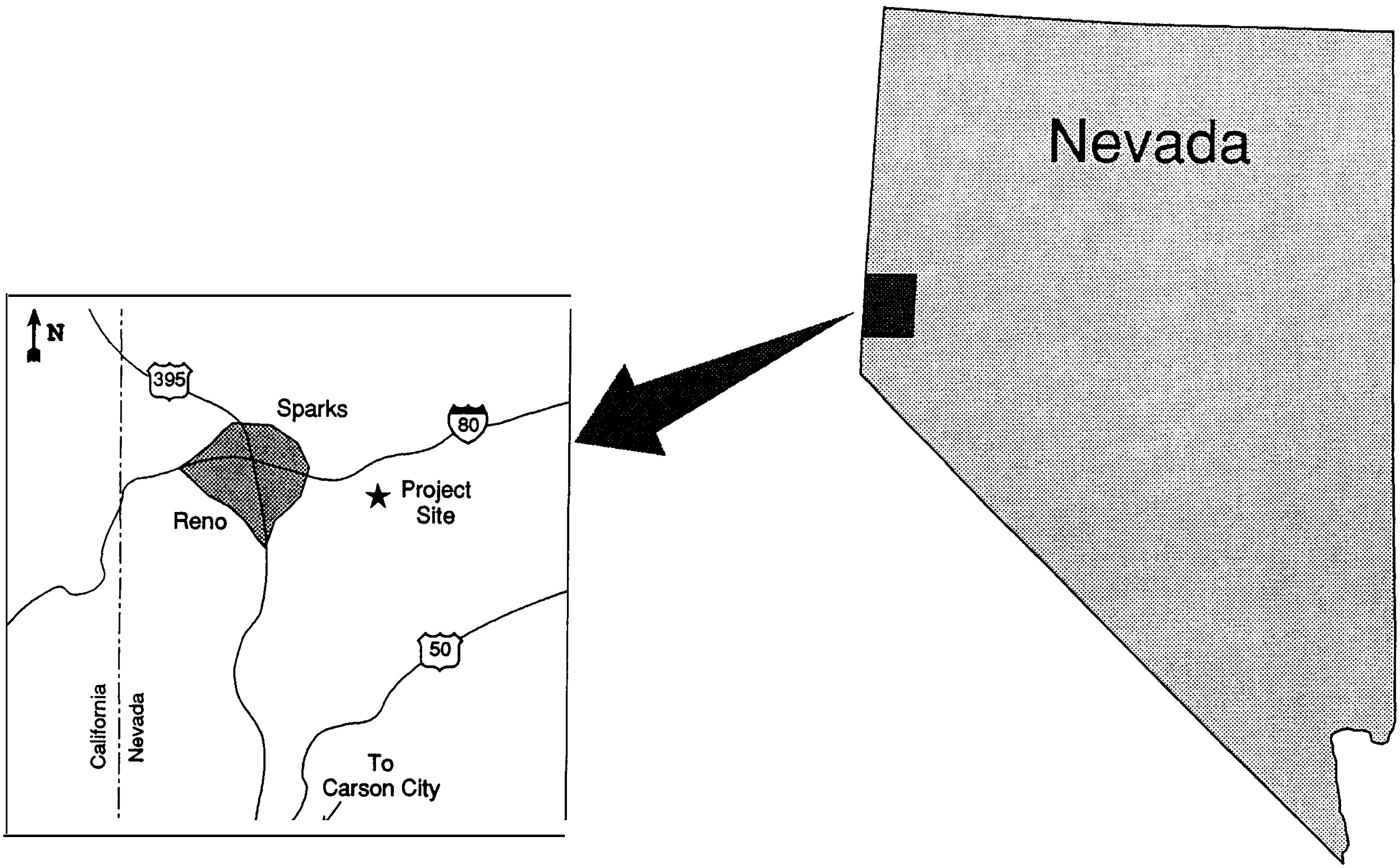

Figure 1. Location of P ñon Pine IGCC Power Project

If the project is as successful as anticipated, it will demonstrate that integrated coal gasification combined-cycle power plants based on this technology can be built at capital costs and thermal efficiencies which significantly reduce electric power costs over more conventional technologies. The project will also demonstrate the effectiveness of hot gas cleanup in achieving a negligible environmental impact with either its normal fuel of low-sulfur western bituminous or with high-sulfur eastern bituminous coal, which will also be tested during the demonstration.

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 $25.0 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 1990s. 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.

(9) 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 Piñon Pine IGCC Power Project provides for the design, construction and operation of an 86-Megawatt (MWe) gross integrated gasification combined-cycle (IGCC) demonstration plant (Figure 2). The plant, located near Reno, Nevada at SPPC'S Tracy Station, will demonstrate the integrated performance of a gasifier island based upon KRW'S pressurized, air-blown, fluidized-bed coal gasifier and coupled to a gas and steam power island. The key subsystems of the gasifier island include a pneumatic coal feed system, fed by lockhoppers, which introduces the coal into the gasifier; an air-blown KRW gasifier capable of producing low-Btu gas; and a hot gas conditioning system for removing sulfur compounds, particulate, and other contaminants as necessary to meet environmental and combustion turbine fuel requirements. The key subsystems of the power island include a versatile Westinghouse combustion turbine (56 MWe gross) capable of allowing the use of natural gas, coal gas or distillate fuels; a heat recovery steam generation (HRSG) system capable of superheating high pressure steam generated in the gasification and desulfurization sections; a steam turbine (30 MWe gross) ; all control systems; and required auxiliary systems. Emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) will be far below the limits set by current regulations.

The project activities include engineering and design, permitting, procurement, construction, start up, and demonstration. During the 42-month demonstration phase, the IGCC plant will be operated on several types of coal, thus enhancing future viability of the technology. This project will represent a critical step in the commercialization of fluidized-bed IGCC systems by demonstrating the performance of the pressurized, air-blown, fluidized-bed gasifier and by showing that key subsystems can be integrated into a power plant with high system efficiency, attractive system operating characteristics, and competitive capital and operating costs.

Successful demonstration of this project will encourage electric utilities and industrial power producers to construct similar

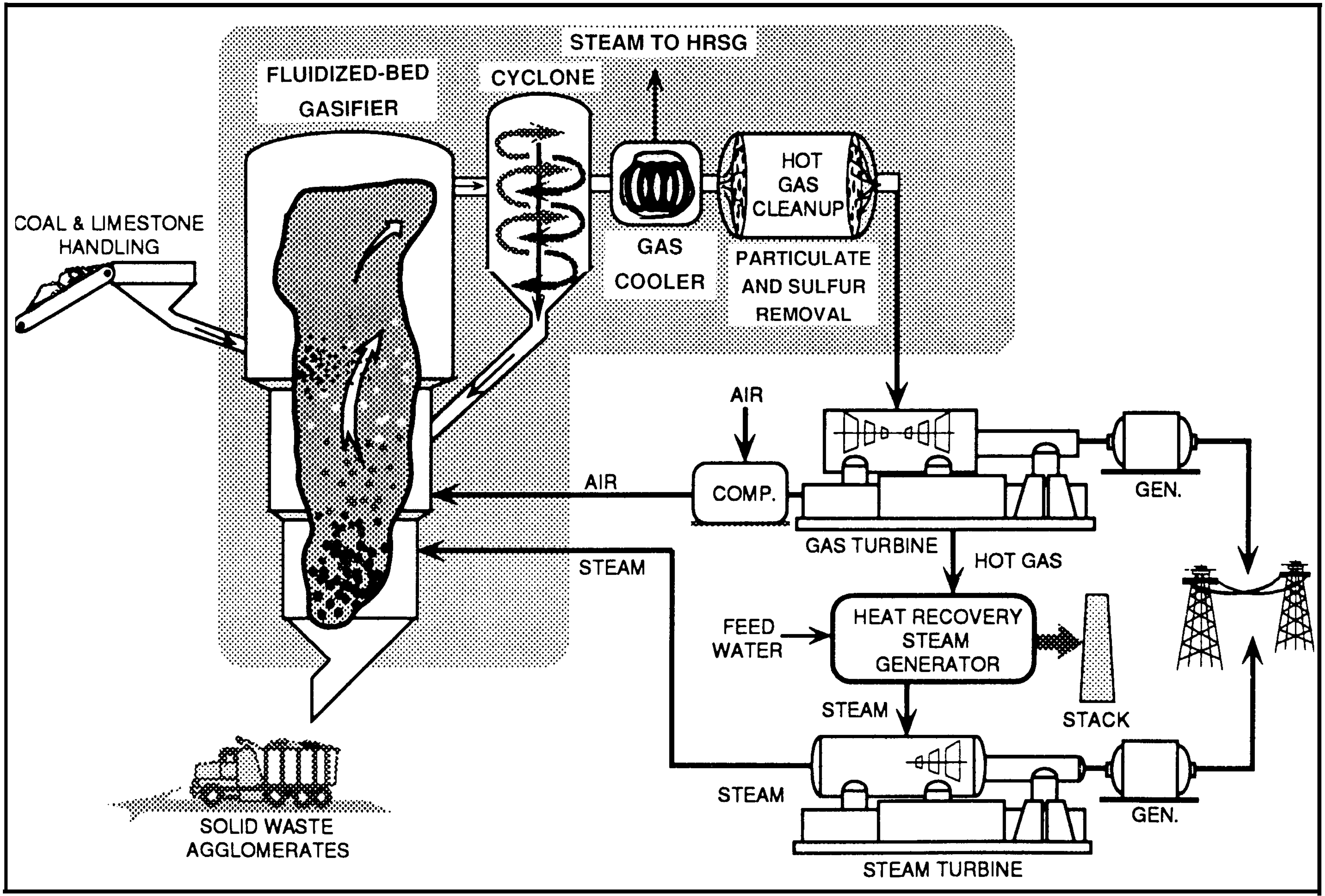

Figure 2. Piñon Pine IGCC Power Project Schematic

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size or larger units (by adding gasifier island modules) and will foster the eventual wide-scale deployment of fluidized-bed IGCC technology.

3.1.1 Project Summary

Title:	Piñon Pine IGCC Power Project
Proposer:	Sierra Pacific Power Company
Location:	Sierra Pacific Power Company's Tracy Station near Reno, Storey County, Nevada
Technology:	Integrated gasification combined cycle using the KRW pressurized, air-blown, fluidized-bed coal gasifier; hot gas cleanup; and an advanced combustion turbine
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
Type of Coal Used:	Western low-sulfur bituminous and eastern high-sulfur bituminous
Products:	Electric power
Project Size:	86-MWe (gross), 800 tons of coal per day
Project Start Date:	September 1992
Project End Date:	September 2000

3.1.2 Project Sponsorship and Cost

Project Sponsor:	Sierra Pacific Power Company
Co-Funder:	U s . Department of Energy
Estimated Project Cost:	$269,993,100
Cost Distribution:	Participant Share, 50 percent DOE Share, 50 percent

3.2 IGCC PROCESS

3.2.1 Overview of Process Development

The Piñon Pine IGCC is similar to, but improves upon, first generation IGCC technology in several aspects. The Participant believes its pressurized, air-blown fluidized-bed gasification technology will provide a higher thermal efficiency than a similar oxygen-blown system because it consumes less auxiliary power. Most of the sulfur pollutants are captured within the fluidized bed, before they can exit the gasifier. Additional impurities are removed through an advanced hot gas cleanup system, which operates with an effective, regenerative, sulfur sorbent (zinc ferrite) to remove sulfur compounds and ceramic filters to remove particulate. In addition, the inherent modular design of the system and simple process configuration are expected to yield significantly lower engineering and construction costs.

The Piñon Pine Project integrates a number of technologies fostered by the Department of Energy. Among these are the KRW Energy Systems fluidized-bed gasifier, in-bed desulfurization using limestone sorbent, and zinc ferrite sulfur removal from a hot gas stream. DOE and its predecessor agencies have supported development of this fluidized-bed gasification technology since 1972 when the design of a process development unit (PDU) was first initiated under contract with Westinghouse Electric Corporation. Construction of the PDU was completed in 1975 at Westinghouse's Waltz Mill Facility near Madison, Pennsylvania. From 1984 to 1988, the addition of dolomite and limestone to the gasifier bed for in-bed sulfur removal was successfully demonstrated at the PDU. These tests indicated that 85 to 90 percent sulfur removal efficiencies could be routinely achieved while using coal feedstocks containing 2 to 4.5 percent sulfur. In addition, the use of these sorbents in the gasifier was found to increase the product gas heating value while decreasing the production of ammonia, a major contributor to NO_x emissions.

It is important that a demonstration of the advanced IGCC technology include actual integration of the gasifier with a combined cycle power plant. This step is necessary in order to evaluate the adequacy of integrated control concepts and to measure actual performance of a complete power generation system on a utility grid. The modular concept of the proposed technology will provide information that is directly applicable to other commercial plants, since such plants will essentially incorporate one or more replicates of the demonstration project plant configuration.

3.2.2 Process Description

The two major components of the plant are the gasification island and the power island. In the gasification island, crushed and sized coal and limestone are metered via lockhoppers and fed pneumatically through a central feed tube in the bottom of the gasifier. The temperature of the bed is controlled by metering the air and steam into the gasifier's central jet. The coal/limestone bed is maintained in a fluidized state in the gasifier via gas recirculation. Combustion of char and gas occurs within the bed to provide the heat necessary for the endothermic reactions of devolatilization, gasification, calcination, and desulfurization. Ash and spent limestone are removed from the bottom of the bed.

The coal gas leaving the gasifier passes through a cyclone to remove the majority of the particulate matter, which is returned to the fluidized bed. The gas leaving the gasifier is cooled to about 1050°F before entering the hot gas cleanup section. A ceramic candle filter removes essentially all the remaining particulate material prior to the clean gas entering the sulfur sorbent bed. Here nearly all the remaining sulfur compounds are removed in a fixed bed of zinc ferrite sorbent. The zinc ferrite is subsequently regenerated with steam and air. This process sends the regenerator gas stream to the sulfator where the sulfur reacts with fresh limestone and air to form calcium sulfate, which exits the system along with the coal ash in a form suitable for landfill.

In the power island, the clean coal gas is sent to a Westinghouse CW251 B12 combustion turbine, which is coupled to an electric generator designed to produce approximately 56 MWe (gross). Special inlet vanes on the turbine will accommodate the extra mass flow produced by the low-Btu gas (low as 90 Btu per standard cubic foot). The heat recovery steam generator (HRSG) receives high pressure steam slightly above saturation and uses the exhaust gas from the combustion turbine to superheat the steam. The steam is heated to 900°F and 900 psig for expansion in a non-reheat steam turbine to produce approximately 30 MWe (gross). High pressure boiler feed water is circulated to the sulfator and the gasifier's product gas cooler. Steam is also produced at 50 psia for various auxiliary plant purposes.

3.3 GENERAL FEATURES OF PROJECT

3.3.1 Evaluation of Developmental Risk

Subsequent to selection and as a part of the fact finding process, DOE performed a detailed evaluation of the Piñon Pine IGCC Power 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 both within DOE and available under contract contributed to the evaluation. The data base for the evaluation included Participant-furnished documentation and fact-finding discussions with the Participant.

The project uses new technologies in the following systems: the gasifier, the ceramic filter, the hot gas cleanup unit, and the solid waste sulfator. Consequently, there is a higher risk associated with these process areas than if commercially available systems were used.

However, the project's overall technical risk is considered to be moderate. The degree of technical risk is mitigated by M.W. Kellogg's experience and expertise gained in the operation of the KRW Energy Systems process development unit at Waltz Mill, Pennsylvania, during the 1970s and 1980s. The Waltz Mill facility operated at coal throughputs of up to about 1 ton per hour and at pressures of up to 245 pounds per square inch (absolute). As a result of the operation of this facility, the KRW gasifier to be used in the Piñon Pine project was tested at the pilot plant scale for over 10 years. During this period, over 13,000 hours of operation were accumulated on the KRW process development unit, generating an extensive data base on a wide variety of feedstocks and operating conditions, including in-bed desulfurization with dolomite or limestone. This pilot-scale testing included operation with ceramic filters and external hot-gas desulfurization. The technical feasibility is discussed in more detail in Section 3.3.1.2.

The 96-month schedule allows sufficient time for the design, construction, and operation of the demonstration project. The project schedule is presented in Section 6.2. The first budget period is extended to allow for completion of a definitive cost estimate, the NEPA requirements, and Nevada's Utility Environmental Policy Act (UEPA) requirements. The planned 36-month design phase will provide sufficient time to complete the engineering and design of the project. Phase II, construction, begins 26 months before the completion of Phase I to allow for early procurement of long-lead time equipment, such as the gas turbine. Finally, the planned 42-month demonstration period will allow for demonstration of process performance, system availability, and reliability, in order to provide a technical, economic, and environmental evaluation of advanced coal gasification combined cycle power plants.

The overall cost estimate, evaluated during the fact finding process, was prepared by consolidating estimates prepared by the Participant and the two major subcontractors, Foster Wheeler and M.W. Kellogg. The Participant generated project management and coordination costs, as well as operating costs, by using historical in-house data for manpower requirements, fuel prices, maintenance costs, and required subcontracts. The engineering, design, and construction costs were developed using top-down factored estimating procedures. In-house data or phone quotes were used to price the major pieces of equipment. Factors were applied to the equipment costs to estimate the associated bulk material cost and labor installation cost, which included direct labor and indirect field costs.

The risk analysis program used by DOE to estimate the financial risk associated with this project indicated a low probability that the originally proposed project cost of $340,726,600 would be overrun. In fact, the fact-finding process identified several areas where the cost estimate could be reduced without significantly affecting the project risk. These cost reductions were negotiated into the final cooperative agreement.

DOE recognizes that demonstrating the commercial readiness of new technologies inherently carries a certain amount of risk. Careful assessment of the risks associated with this project, coupled with the potential benefits of the technology, lead DOE to conclude that those risks are acceptable and worth taking.

3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

IGCC systems offer significant potential environmental, economic, and efficiency benefits when compared to conventional pulverized coal-fired plants with flue gas scrubbers. Currently, there are five IGCC projects, either in the design phase, or in negotiation, under the Clean Coal Technology Program. Each of these projects is intended to demonstrate a different gasification technology integrated with a combined cycle power plant.

The Piñon Pine IGCC Project will demonstrate the KRW fluidized-bed gasification process, operating in the air-blown mode with in-bed desulfurization and hot gas cleanup technology. The other IGCC systems to be demonstrated include: the ABB Combustion Engineering air-blown, entrained-flow gasification system selected under CCT-2, the Tampa Electric CCT-3 project utilizing an oxygen-blown Texaco gasification system, the CCT-4 Wabash River IGCC Project using a Destec oxygen-blown, entrained-flow gasifier with cold gas cleanup, and the CCT-4 Toms Creek IGCC project utilizing Tampella’s air-blown, fluidized-bed gasification system. Although similar in many respects, each of these projects demonstrates a distinct technology with differing concepts relative to coal gasification, gas stream cleanup, system integration, and technology application. In addition, the Piñon Pine IGCC Project is unique in its use of western bituminous coal, the fixed-bed, external, hot gas desulfurization step, and the external combustion of the waste solids from the gasification system.

3.3.1.2 Technical Feasibility

As discussed in Section 3.3.1, DOE recognizes that technical uncertainties exist in the proposed project, especially with regard to scale up of the gasifier, performance of the hot gas cleanup system, and overall IGCC plant integration.

The data and models available for scale-up design have been developed through operation of the l-ton-per-hour Waltz Mill Process Development Unit. A large number of coals were tested at that facility, including coals with characteristics similar to the western bituminous coal used as a design basis for this project. In addition, a 3-meter diameter Cold Flow Scale-Up Facility was built and operated at Waltz Mill to augment the 1-ton-per-hour data. In addition to gasification tests, barrier filter tests on metal and ceramic candle filters were conducted. Zinc ferrite testing in both the bulk and polishing modes were also performed.

Western bituminous coal contains a moderate amount of ash which has satisfactory fusion temperature properties and presents no unusual challenge to the gasifier. Carbon conversion in the gasifier has been set at 90 percent with the balance of the carbon recovered as fuel in the sulfator/combustor system. The general characteristics of the design coal for this project appear to be compatible with all of the compliance requirements of applicable environmental standards.

Improvements have been made to the zinc ferrite system tested at Waltz Mill. A three-reactor system will be provided, with two reactors operating in series while the third sorbent bed is being regenerated. This arrangement will minimize sulfur escape from the system by reducing the opportunity for increased leakage as a batch of sorbent nears the end of its absorption cycle. The arrangement will also allow the reactor operating as the first of two in series to be regenerated more slowly, thus protecting the sulfator from a sudden flow of regeneration gas with high sulfur content as would occur with a two reactor system.

Although the various components and systems have been developed and tested, this project will represent the first fully integrated IGCC plant based on the KRW gasification technology. As such, some uncertainty exists with regard to the operation and control of the integrated facility. The project will maintain a high level of effort to address technical risks and uncertainties throughout the design, construction, and operation phases of the project. Control of the plant will be provided by the integration of the combustion turbine controls, steam generator and steam turbine generator controls, and the gasifier control into one control system. Such commercial state-of-the-art information and control systems have been applied to several commercial combustion turbine power plants.

Previous studies have indicated that the turbine lead--gasifier follow control mode has the capability of providing stable IGCC plant response over a wide range of anticipated operating conditions. This conclusion was supported by operational experience at the 100-MWe Cool Water Coal Gasification Plant during the 1980s. While this control mode has not yet been applied to a combined-cycle power plant with hot-gas cleanup, the major control characteristics of the gasifier and power islands are sufficiently similar to permit application of this control strategy. In addition, as a part of the design phase, an overall plant simulation model will be developed for initial and recurrent operator training and to aid in the proper control of the plant.

3.3.1.3 Resource Availability

All of the resources required for the project are available. The Participant owns the proposed site and has committed to its share of the project financing through each budget period. Essential infrastructure services are available, including water, natural gas, rail and highway access, electric service, and sanitary waste disposal.

3.3.2 Relationship Between Project Size and Projected Scale of Commercial Facility

The size of the Piñon Pine Power Project is based on providing a demonstration of a commercially realistic gasification unit which could be offered as it is embodied in the project or as a number of modules of the same general size. No significant scale-up of the gasification system is required for the demonstrated technology to become commercially attractive. All technical, economic, and environmental data from the project will be directly applicable to commercial projects.

For utilities and industries requiring small increments of power, 60 to 100 MWe, the demonstrated unit size would be essentially replicated. Units on the order of 150 to 500 MWe would be built by replication of modules, or by moderate, 2:1, scaling of the gasifier module. The economics of scale are essentially achieved in the steam turbine and other balance of plant systems. Gasification modules could be added according to growth projections, with the sizing of the balance of plant systems and site infrastructure based on the final desired power plant capacity.

3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

The Piñon Pine demonstration plant will provide utilities and other power generators with design, construction, and operating data on which to base future decisions regarding new power generation options. Verification of the commercial feasibility of the advanced IGCC technology is expected to be accomplished during the planned 42-month test program to begin in 1997. Once the demonstration program is completed, the plant will be operated commercially, thus serving as a prototype module which can be replicated for use by utilities and other power generators in the 2000's.

Following successful demonstration, the advanced IGCC technology will be offered in modular, low-cost, efficient power generating units. The technology offers several advantages which improve its marketability:

- It will be demonstrated at a commercial module size.
- It has higher efficiencies than conventional pulverized coal systems and most other competing technologies.
- It has installation flexibility in that the gasification portion of the system can be added to a natural gas-fired combined-cycle or combustion turbine in order to convert these systems to coal-fueled systems, or it can be used to repower existing pulverized coal power plants as well as oil- or natural gas-fired power plants. It can also be used in cogeneration applications.
- It is projected to have lower capital and operating costs than competing pulverized coal systems.
- It has the capability of using all U.S. coals and Of minimizing water usage.
- It has the environmental flexibility to meet current and future environmental constraints.
- The infrastructure needed to commercialize the advanced IGCC technology exists on a nationwide basis.
- The potential market for the technology is large and market penetration is likely to be high if the Participant's economic, efficiency, reliability, and environmental targets are met.
- It offers high process efficiency and reduced space requirements per unit of energy generated.

The project team of SPPC, Foster Wheeler USA Corporation, and The M. W. Kellogg Company will be in an excellent position to commercialize the technology to be demonstrated. The technology's advantages of modularity, rapid and staged on-line generation capability, high efficiency, environmental controllability, and reduced land and natural resource needs, will enhance the potential for the Piñon Pine IGCC Power technology to become a strong contender for widespread application for meeting future U.S. energy needs.

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, for which it was assumed that 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 from maximum commercialization of the IGCC technology into national and regional areas in 2010 are given in Table 1. Negative percentages indicate decreases in emissions or waste quantities in 2010. Conversely, positive values indicate increases in emissions or waste quantities as compared to the no-action alternative. These computer-derived results should be regarded as approximations of actual impacts.

Table 1. Projected Environmental Impacts in 2010, IGCC 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%	-10%	-16%

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

As shown in Table 1, commercialization of the IGCC 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 3.

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 IGCC technologies over the conventional coal-fired technologies.

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

On the national average, the IGCC 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 in some IGCC processes. For this particular technology, bottom ash and spent limestone from the gasification process will comprise the bulk of the solid waste. If a suitable market cannot be established, these solids will be 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

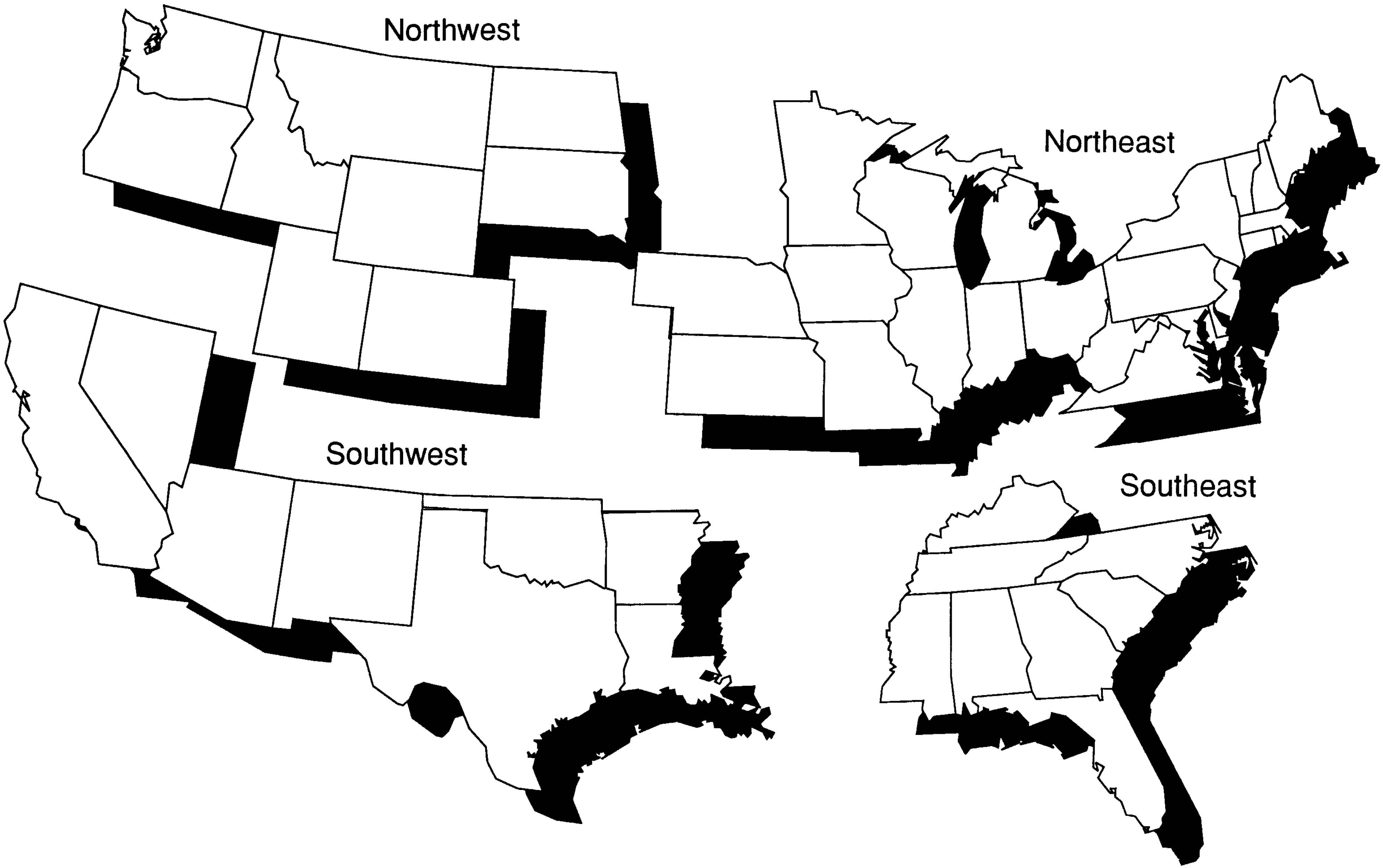

Figure 3. Quadrants for the Conterminous United States

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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) during Phase I of 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.

5.0 PROJECT MANAGEMENT

5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

As the signatory to the Cooperative Agreement, Sierra Pacific Power Company will be responsible for all aspects of the project. It will accomplish the project objectives by means of the organizational relationships shown in Figure 4. SPPC will manage the project through a Project Manager, who will be assisted by a team of technical and managerial personnel. The engineering, procurement, and construction of the plant has been contracted to the Foster Wheeler USA Corporation. The M. W. Kellogg Company will provide the gasification technology and will be responsible for the design of the gasification island.

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 Representative. The Project Manager will be the primary point of contact for the project and will be responsible for DOE management of the project.

5.2.2 Participant

SPPC, as the Participant, will be responsible for all aspects of the project, including design, permitting, construction, operation, data collection, and reporting. SPPC will utilize the services of Foster Wheeler USA Corporation for the engineering design, procurement, and construction of the power island, and The M. W. Kellogg Company for the gasification technology and the engineering design of the gasification island. SPPC will designate a full time Project Manager, who will be responsible for all technical and administrative activities to be performed

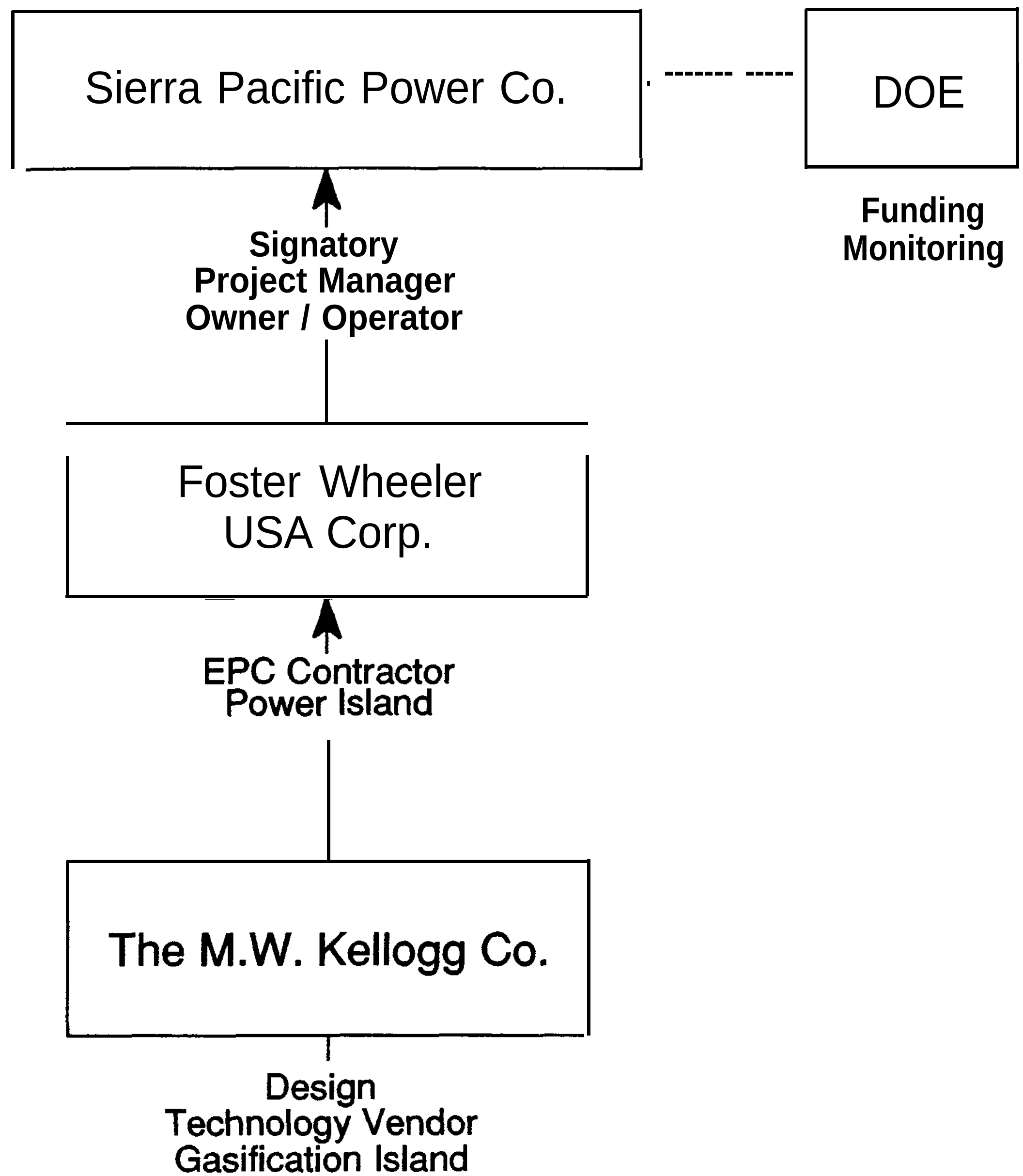

Figure 4. Piñon Pine IGCC Power Project Organization

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under the Cooperative Agreement. This Project Manager will be the primary point of contact for DOE interaction.

5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURES

SPPC will prepare and maintain a Project Management Plan that presents project procedures, controls, schedules, budgets, and other activities required to adequately manage the project. This document, which will be finalized shortly after execution of the Cooperative Agreement, will be used to implement and control project activities. Throughout the course of 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 that will generally provide for rights of access by DOE to all data generated or used in the course of or under the Cooperative Agreement by SPPC and its subcontractors. DOE will have unlimited rights to nonproprietary data first produced in the performance of the Cooperative Agreement and limited rights of access to proprietary data utilized in the course of the demonstration. DOE will have the right to have relevant proprietary information delivered to it 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 IGCC Technology as 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 IGCC 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

Design, construction, and operation of the Piñon Pine demonstration plant to demonstrate the pressurized, air-blown, fluidized-bed KRW IGCC technology incorporating hot gas cleanup is a vital step in widespread commercial application of this process. It is essential that a demonstration of the technology be conducted to produce long term reliability, availability, maintainability and environmental performance at a scale sufficient to illustrate commercial potential. Demonstration of the technology with commercially available and large scale equipment will provide valuable information for the private sector to use in making future commercialization decisions.

Throughout the U.S., particularly in the Midwest and East, there are numerous aging coal fired utility boilers without SO_z controls which are candidates for Repowering with pressurized air-blown, fluidized-bed IGCC technology. Repowering of these plants with IGCC systems will result in improved plant efficiencies, reduction of net emission rates of SO_z, NOx, and CO* , and the addition of capacity increments resulting from the gas turbine output in the combined-cycle operation. Space constraints at many generating sites further emphasize the benefits of the smaller space requirements associated with the IGCC . Because of the advantages discussed in Section 3.3.3, as power demand grows SPPC anticipates a large potential market for new power stations utilizing the Piñon Pine IGCC Power Project technology.

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 Cooperative Agreement are as shown below.

<u>Pre-award Cost</u>

DOE Share	$ 440,750	50.0%
Participant Share	440,750	50.0%
	$ 881,500	

<u>Phase I</u>

DOE Share	$ 12,389,150	50.0%
Participant Share	$ 12,389,150	50.0%
	$ 24,778,300	

Phase II

DOE Share	$ 83,523,650	50.0%
Participant Share	83,523,650	50.0%
	$167,047,300	100.0%

Phase III

DOE Share	$ 38,643,000	50.0%
Participant Share	38,643,000	50.0%
	$ 77,286,000	100.0%

Total Estimated Project Cost

DOE Share	$134,996,550	50.0%
Participant Share	$134,996,550	50.0%
	$269,993,100	100.0%

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.

TOTAL ESTIMATED PROJECT COST		$269,993,100
* Budget Period 1	DOE Share	$ 6,015,850
	Participant Share	$ 6,015,850
Budget Period 2	DOE Share	$ 90,337,700
	Participant Share	$ 90,337,700
Budget Period 3	DOE Share	$ 38,643,000
	Participant Share	$ 38,643,000

* Preaward costs are included in Budget Period 1.

6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 96 months to complete. The phases and their expected durations are as shown below:

Phase I:	Design and Permitting	36 months
Phase II:	Construction and Start-up	44 months
Phase III:	Operation and Data Collection	42 months

Phases I and II overlap by 26 months.

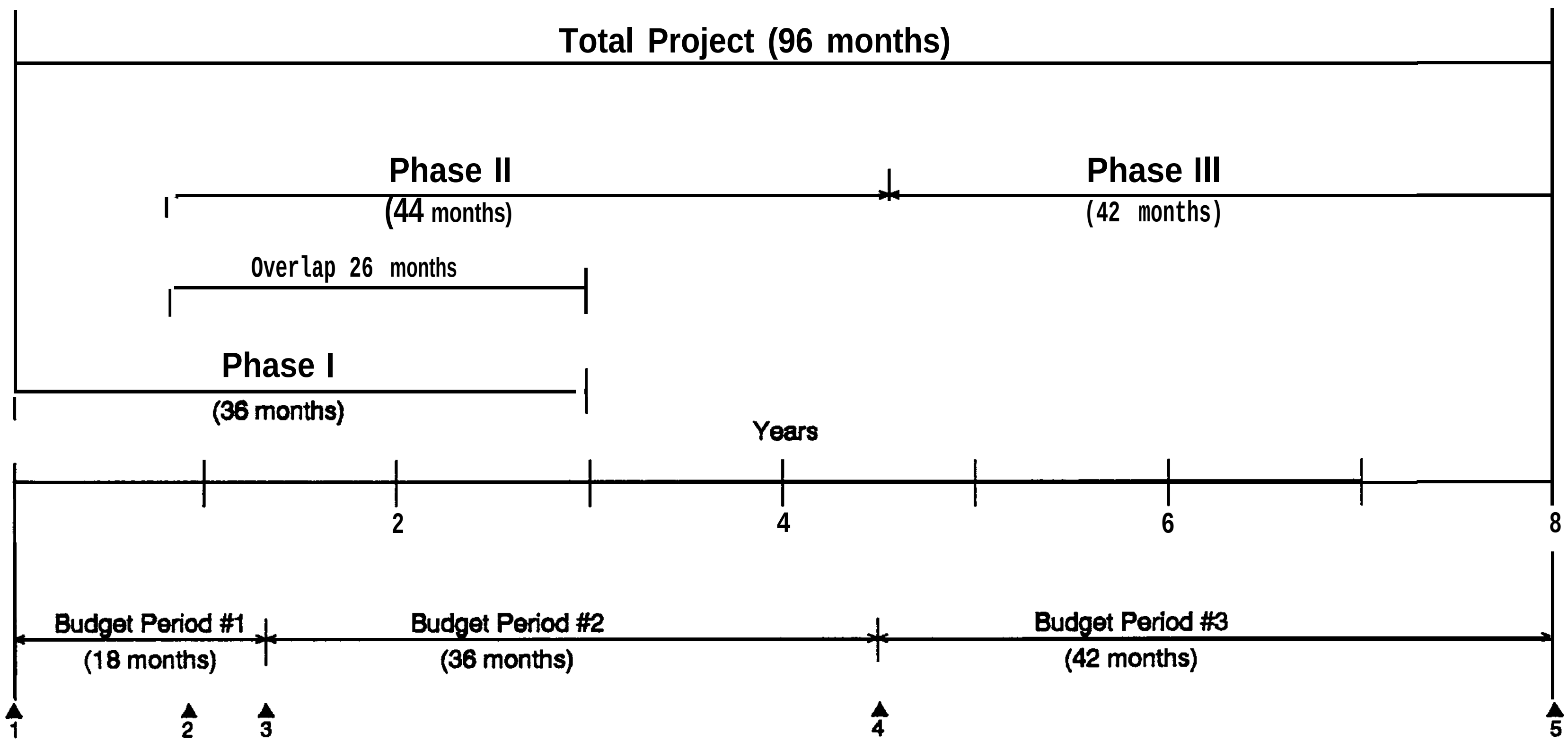
Budget periods are used to manage the financial risk of the project and to facilitate project decision making. The project is divided into three sequential budget periods as follows:

Budget Period 1 -- 18 months
Budget Period 2 -- 36 months
Budget Period 3 -- 42 months

A project schedule is shown in Figure 5. Construction is expected to be completed by March 1997, and the project is expected to be completed by September 2000.

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 pay the Government in accordance with the Repayment Agreement to be executed at the time of award of the Cooperative Agreement.



Milestone	Description
1	Project Starts / DOE signs
2	NEPA Completed
3	UEPA Completed, Definitive Estimate Complete
4	Construction /Startup Complete /Operation Begins
5	Testing Completed

Figure 5. Piñon Pine IGCC Power Project Schedule

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