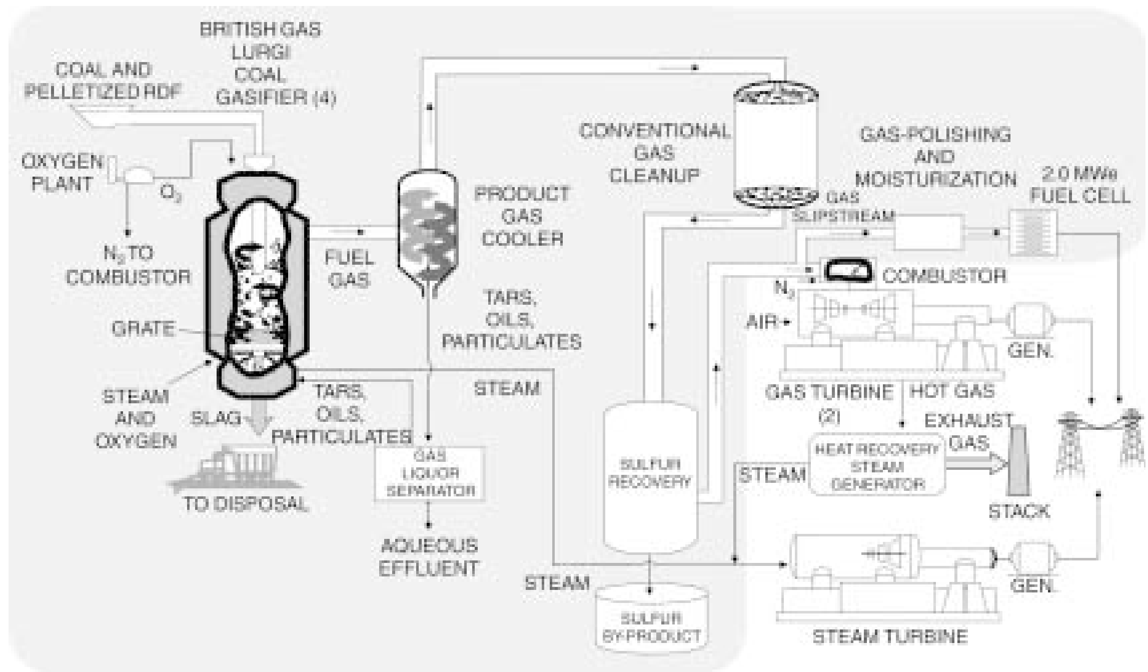
Advanced Electric Power Generation
Integrated Gasification Combined-Cycle

Kentucky Pioneer Energy IGCC Demonstration Project



Participant
Kentucky Pioneer Energy, LLC

Additional Team Members
Fuel Cell Energy, Inc. (formerly Energy Research Corporation)—molten carbonate fuel cell designer and supplier, and cofunder

Location
Trapp, Clark County, KY (East Kentucky Power Cooperative's Smith site)

Technology
Integrated gasification combined-cycle (IGCC) using a BG/L (formerly British Gas/Lurgi) slagging fixed-bed gasification system coupled with Fuel Cell Energy's molten carbonate fuel cell (MCFC)

Plant Capacity/Production
580 (gross); 540 MWe (net) IGCC; 2.0 MWe MCFC

Coal
High-sulfur Kentucky bituminous coal and pelletized refuse-derived fuel (RDF)

Project Funding

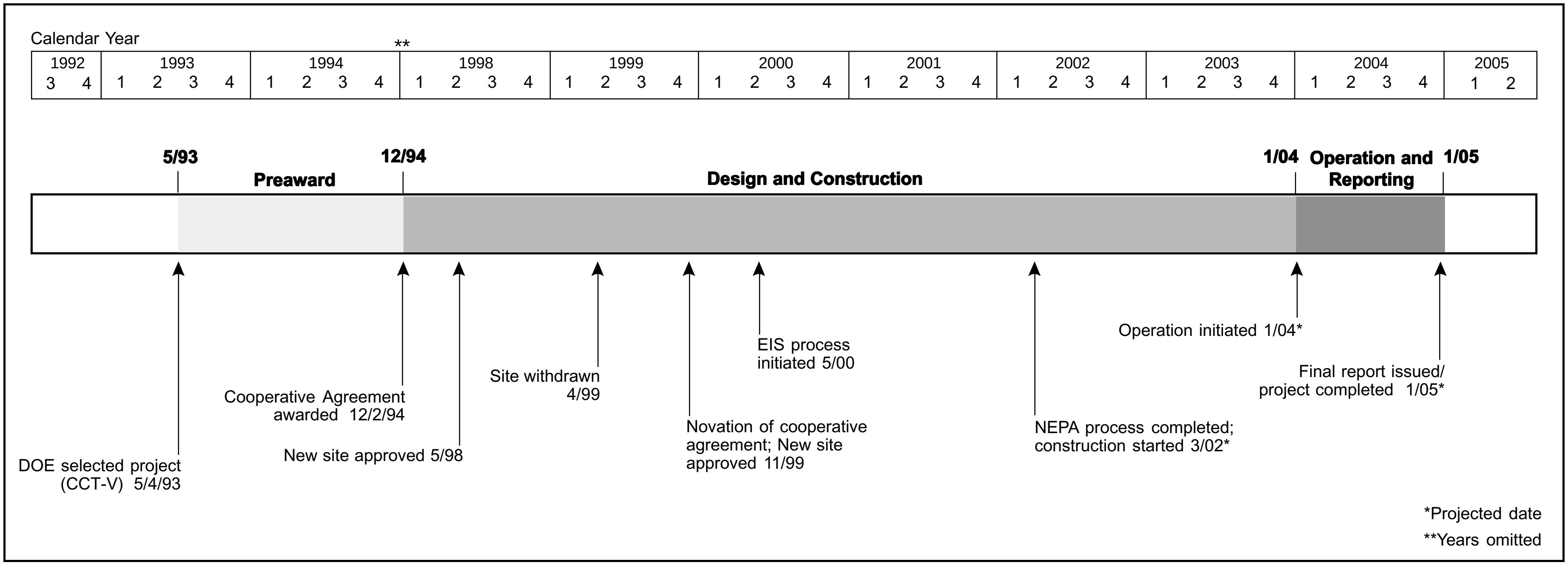
Total project cost	$431,932,714	100%
DOE	78,086,357	18
Participant	353,846,225	82

Project Objective
To demonstrate and assess the reliability, availability, and maintainability of a utility-scale IGCC system using a high-sulfur bituminous coal and municipal solid waste blend in an oxygen-blown, fixed-bed, slagging gasifier and the operability of a molten carbonate fuel cell fueled by coal gas.

Technology/Project Description
The four BG/L gasifiers are supplied with steam, oxygen, limestone flux, and a coal and pelletized RDF. During gasification, the oxygen and steam react with the coal and limestone flux to produce a coal-derived fuel gas rich in hydrogen and carbon monoxide. Raw fuel gas exiting the gasifier is washed and cooled. Hydrogen sulfide and other sulfur compounds are removed. Elemental sulfur is reclaimed and sold as a by-product. Tars, oils, and dust are recycled to the gasifier. The resulting clean, medium-Btu fuel gas fires two gas turbines. A small portion of the clean fuel gas is used for the MCFC.

The MCFC is composed of a molten carbonate electrolyte sandwiched between porous anode and cathode plates. Fuel (desulfurized, heated medium-Btu fuel gas) and steam are fed continuously into the anode; CO_2-enriched air is fed into the cathode. Chemical reactions produce direct electric current, which is converted to alternating current with an inverter.

Operation will commence on 100% coal with slowly increasing levels of RDF throughout the demonstration. This method will allow the development of a database of plant performance at various levels of RDF feed.



Project Status/Accomplishments

On May 8, 1998, DOE conditionally approved Ameren Services Company (merger of Union Electric Co. and Central Illinois Public Service Co.) as an equity partner and host site provider subject to completing specific business and teaming milestones. The new project site to be provided by Ameren was at its Venice Station Plant in Venice, Illinois. On April 30, 1999, Ameren Services Company withdrew from the project for economic and business reasons.

In May 1999, Global Energy USA Limited (Global), sole owner of Kentucky Pioneer Energy, LLC (KPE), expressed interest in acquiring the project and providing a host site at East Kentucky Power Cooperative's Smith Site in Clark County, Kentucky. Subsequently, Global negotiated all the necessary documents with DOE and Clean Energy Partners, L.P. (CEP) to acquire the project. In November 1999, the cooperative agreement was novated and the new site was approved.

The NEPA process was initiated with the public scoping meeting on May 4, 2000.

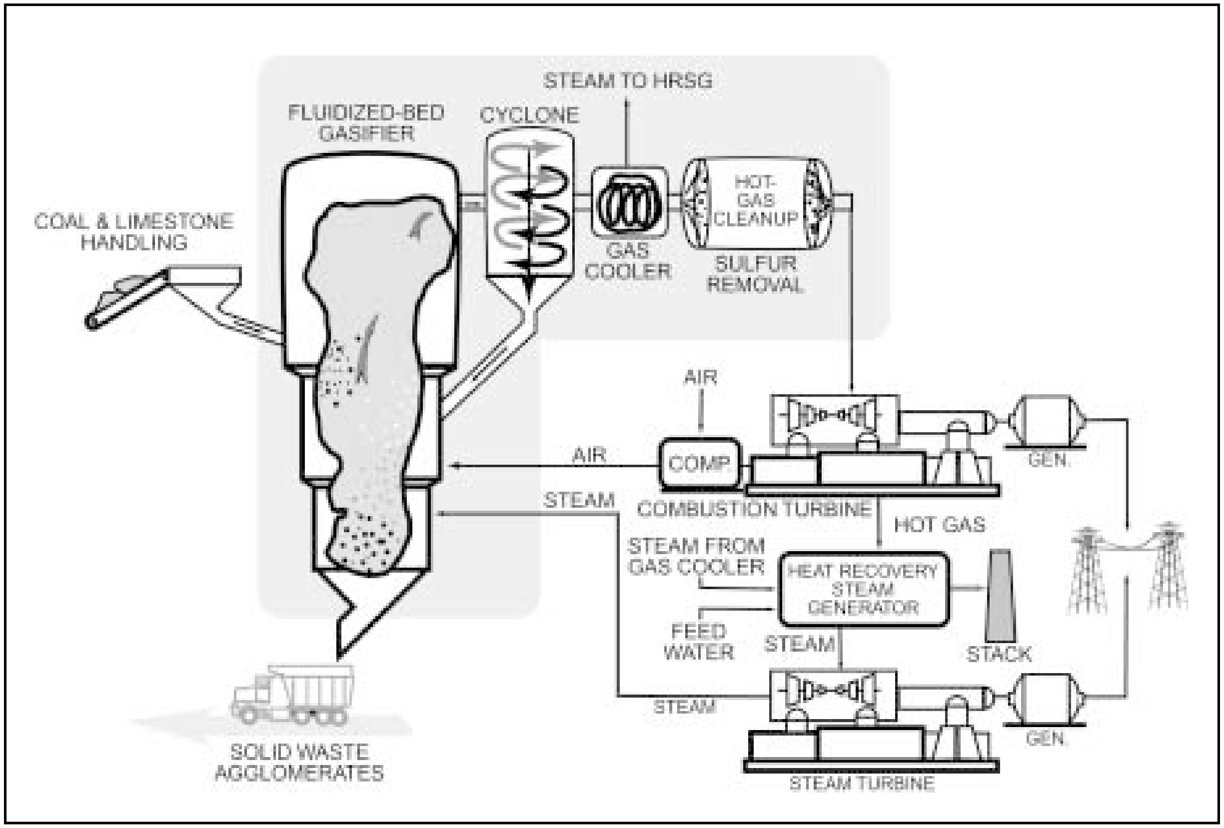
Commercial Applications

The IGCC system being demonstrated in this project is suitable for both repowering applications and new power plants. The technology is expected to be adaptable to a wide variety of potential market applications because of several factors. First, the BG/L gasification technology has successfully used a wide variety of U.S. coals. Also, the highly modular approach to system design makes the BG/L-based IGCC and MCFC competitive in a wide range of plant sizes. In addition, the high efficiency and excellent environmental performance of the system are competitive with or superior to other fossil-fuel-fired power generation technologies.

The heat rate of the IGCC demonstration facility is projected to be 8,560 Btu/kWh (40% efficiency) and the commercial embodiment of the system has a projected heat rate of 8,035 Btu/kWh (42.5% efficiency). The commercial version of the molten carbonate fuel cell fueled by a BGL gasifier is anticipated to have a heat rate of 7,379 Btu/kWh (46.2% efficiency). These efficiencies represent a greater than 20% reduction in emissions of CO_2 when compared with a conventional pulverized coal plant equipped with a scrubber. SO_2 emissions from the IGCC system are expected to be less than 0.1 lb/10^6 Btu (99% reduction); and NO_x emissions less than 0.15 lb/10^6 Btu (90% reduction).

Also, the slagging characteristic of the gasifier produces a nonleaching, glass-like slag that can be marketed as a usable by-product.

Piñon Pine IGCC Power Project



Participant
Sierra Pacific Power Company

Additional Team Members
Foster Wheeler USA Corporation—architect, engineer, and constructor
The M.W. Kellogg Company—technology supplier
Bechtel Corporation—start-up engineer

Location
Reno, Storey County, NV (Sierra Pacific Power Company's Tracy Station)

Technology
Integrated gasification combined-cycle (IGCC) using the KRW air-blown pressurized fluidized-bed coal gasification system

Plant Capacity/Production
107 MWe (gross), 99 MWe (net)

Coal
Southern Utah bituminous, 0.5–0.9% sulfur (design coal); Eastern bituminous, 2–3% sulfur (planned test)

Project Funding

Total project cost	$335,913,000	100%
DOE	167,956,500	50
Participant	167,956,500	50

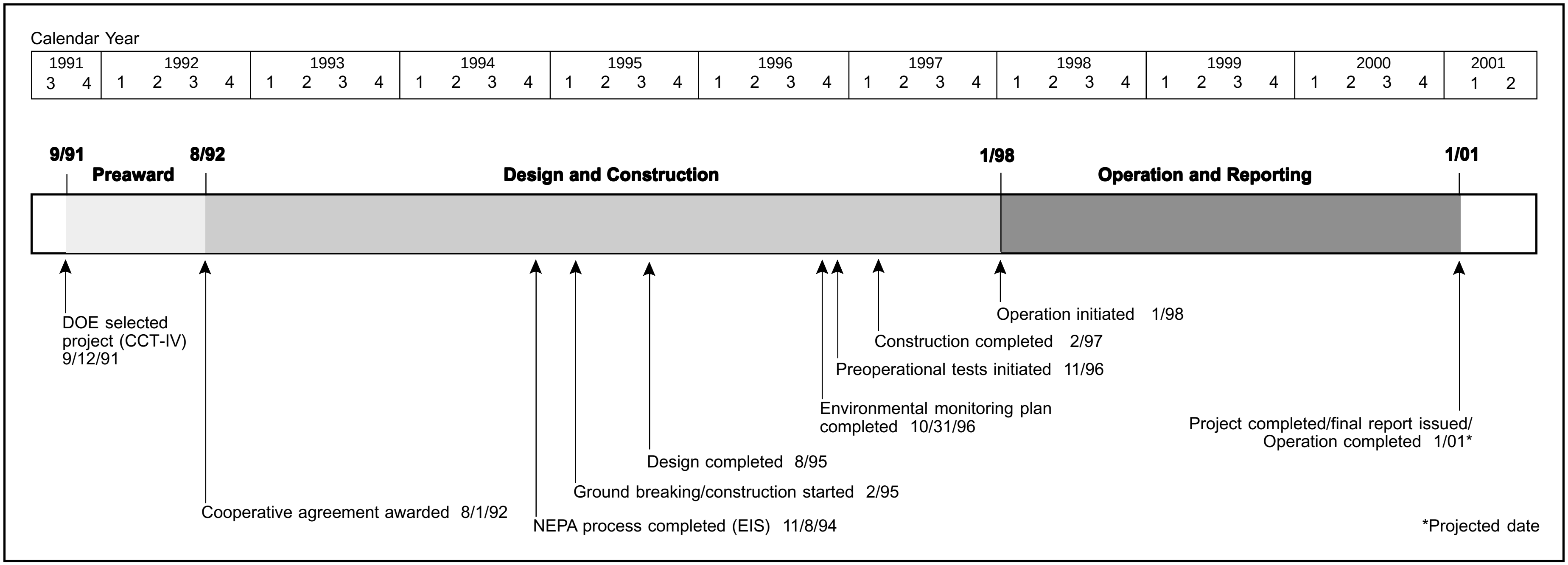
Project Objective
To demonstrate air-blown pressurized fluidized-bed IGCC technology incorporating hot gas cleanup (HGCU); to evaluate a low-Btu gas combustion turbine; and to assess long-term reliability, availability, maintainability, and environmental performance at a scale sufficient to determine commercial potential.

Technology/Project Description
Dried and crushed coal and limestone are introduced into a KRW air-blown pressurized fluidized-bed gasifier. Crushed limestone is used to capture a portion of the sulfur. The sulfur reacts with the limestone to form calcium sulfide which, after oxidation, exits as calcium sulfate along with the coal ash in the form of agglomerated particles suitable for landfill.

Low-Btu coal gas leaving the gasifier passes through cyclones, which return most of the entrained particulate matter to the gasifier. The gas, which leaves the gasifier at about 1,700 ºF, is cooled to about 1,100 ºF before entering the hot gas cleanup system. During cleanup, virtually all of the remaining particulates are removed by ceramic candle filters, and final traces of sulfur are removed by reaction with a metal oxide sorbent in a transport reactor.

The cleaned gas then enters the GE MS6001FA (Frame 6FA) combustion turbine, which is coupled to a 61-MWe (gross) generator. Exhaust gas from the combustion turbine is used to produce steam in a heat recovery steam generator (HRSG). Superheated high-pressure steam drives a condensing steam turbine-generator designed to produce about 46 MWe (gross).

The IGCC plant will remove 95+% of the sulfur in the coal. Due to the relatively low operating temperature of the gasifier and the injection of steam into the combustion fuel stream, the NO_x emissions are expected to be 70% less than a conventional coal-fired plant. The IGCC will produce 20% less CO_2 than conventional plants.



Project Status/Accomplishments

The system has initiated demonstration operations but continues to experience operational difficulties. The station began operation on natural gas in November 1996. Preoperational testing and shakedown of the coal gasification combined-cycle system continued through 1997 with syngas produced in January 1998. The plant was dedicated in April 1998.

The project continues to suffer from a number of design issues, many of which have been solved, but others remain. Problems have been attributed to the high degree of new technology, high scale-up factors on auxiliary components, and some design and engineering deficiencies. Nevertheless, Sierra Pacific is confident that no fatal flaws exist that will preclude successful demonstration and subsequent commercialization of the KRW gasification technology.

In the first quarter of 2000, Sierra Pacific began to make additional repairs and improvements so that sustained operation of the gasifier can be achieved. Improvements include increasing the diameter to the annulus section of the gasifier to address the problem of high temperatures of the limestone and ash leaving the gasifier. Also, the refractory in the gasifier grid area and 18 feet into the fluid bed region will be replaced with a single castable layer in a revised anchoring pattern, to provide improved resistance to low cycle fatigue of the refractory lining.

The project suffered a setback in August 2000 when char fines from the desulfurizer caught fire in the filter vessel during a start-up attempt, breaking candles, and melting filter holders. It will take six to eight months to make repairs, which have been delayed until the sale of the plant is complete. The final terms and conditions of the sale will not be known until mid-year 2001.

Commercial Applications

The Piñon Pine IGCC system concept is suitable for new power generation, repowering needs, and cogeneration applications. The net heat rate for a proposed greenfield plant using this technology is projected to be 7,800 Btu/kWh (43.7% efficiency), representing a 20% increase in thermal efficiency compared with a conventional pulverized coal plant with a scrubber and a comparable reduction in CO_2 emissions. The compactness of an IGCC system reduces space requirements per unit of energy generated relative to other coal-based power generation systems. The advantages provided by phased modular construction reduce the financial risk associated with new capacity additions. Further, this project is the only project demonstrating HGCU, which is important not only to IGCC technology, but also to pressurized fluidized-bed combustion.

With the exception of the recently awarded Kentucky Pioneer Energy IGCC Demonstration Project, the KRW IGCC technology is capable of gasifying all types of coals, including high-sulfur, high-ash, low-rank, and high-swelling coals, as well as biowaste or refuse-derived waste, with minimal environmental impact. There are no significant process waste streams that require remediation. The only solid waste from the plant is a mixture of ash and calcium sulfate, a nonhazardous waste.

Tampa Electric Integrated Gasification Combined-Cycle Project

Participant
Tampa Electric Company

Additional Team Members
Texaco Development Corporation—gasification technology supplier
General Electric Corporation—combined-cycle technology supplier
Air Products and Chemicals, Inc.—air separation unit supplier
Monsanto Enviro-Chem Systems, Inc.—sulfuric acid plant supplier
TECO Power Services Corporation—project manager and marketer
Bechtel Power Corporation—architect and engineer

Location
Mulberry, Polk County, FL (Tampa Electric Company's Polk Power Station, Unit No. 1)

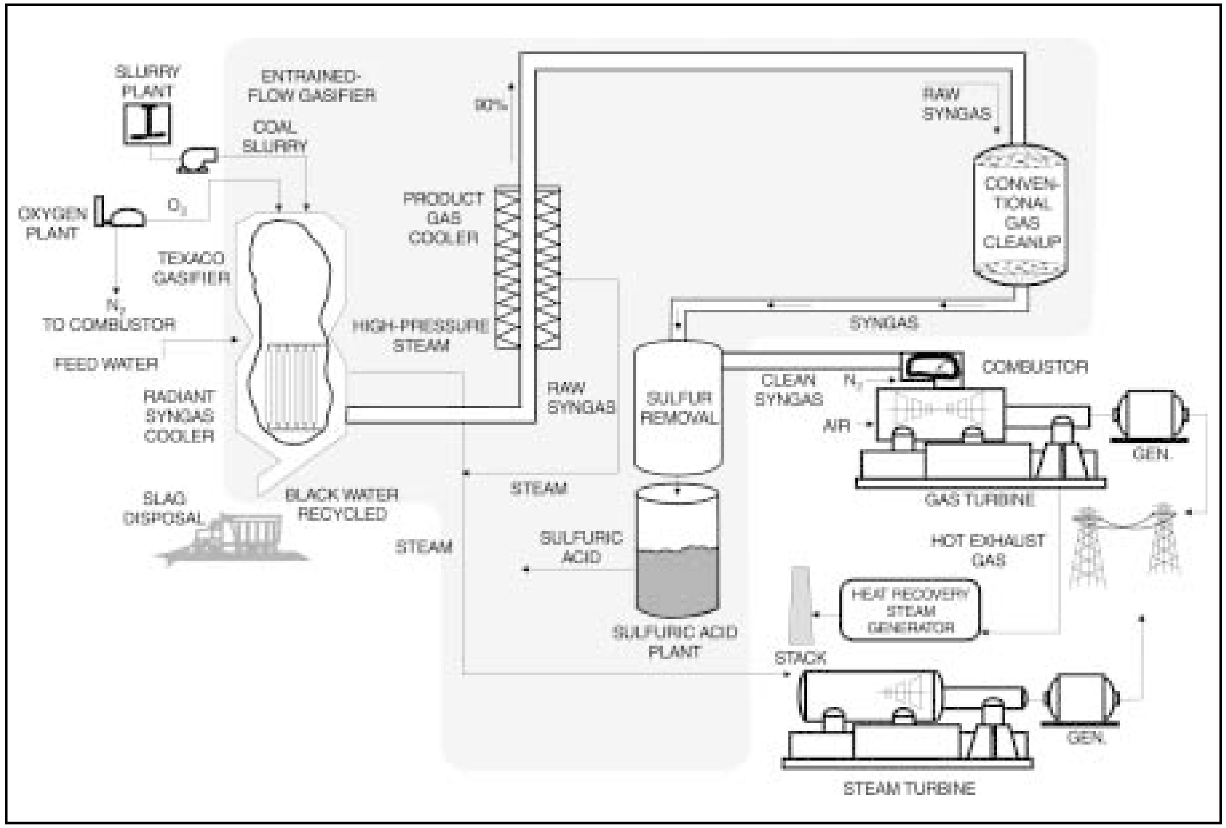
Technology
Advanced integrated gasification combined-cycle (IGCC) system using Texaco's pressurized, oxygen-blown entrained-flow gasifier technology

Plant Capacity/Production
316 MWe (gross), 250 MWe (net)

Coal
Illinois #6, Pittsburgh #8, Kentucky #11, and Kentucky #9; 2.5-3.5% sulfur

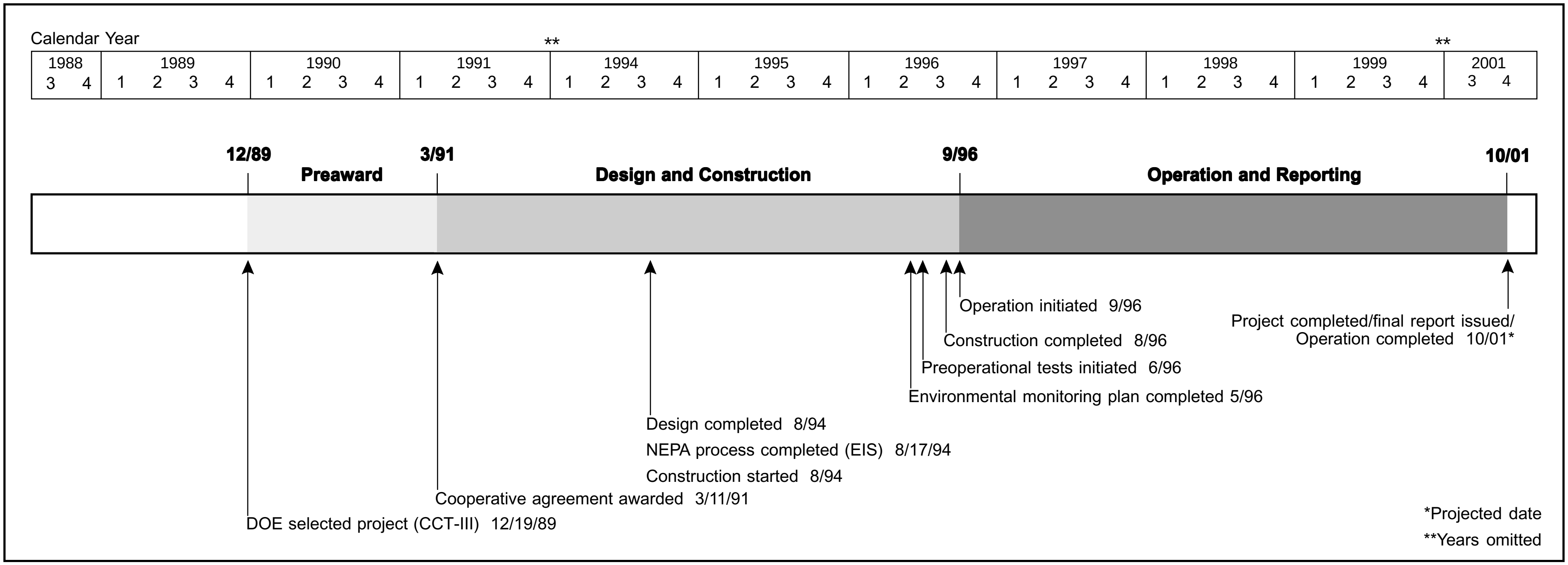
Project Funding

Total project cost	$303,288,446	100%
DOE	150,894,223	49
Participant	152,394,223	51



Project Objective
To demonstrate IGCC technology in a greenfield commercial electric utility application at the 250-MWe size using an entrained-flow, oxygen-blown, gasifier with full heat recovery, conventional cold-gas cleanup, and an advanced gas turbine with nitrogen injection for power augmentation and NO_x control.

Technology/Project Description
Coal/water slurry and oxygen are reacted at high temperature and pressure to produce a medium-Btu syngas in a Texaco gasifier. Molten ash flows out of the bottom of the gasifier into a water-filled sump where it forms a solid slag. The syngas moves from the gasifier to a high temperature heat-recovery unit, which cools the syngas while generating high pressure steam. The cooled gases flow to a water wash for particulate removal. Next, a COS hydrolysis reactor converts one of the sulfur species in the gas to a form that is more easily removed. The syngas is then further cooled before entering a conventional amine sulfur removal system. The amine system keeps SO_2 emissions below 0.15 lb/10^6 Btu (97% capture). The cleaned gases are then reheated and routed to a combined-cycle system for power generation. A GE MS 7001FA gas turbine generates 192 MWe. Thermal NO_x is controlled to below 0.27 lb/ 10^6 Btu by injecting nitrogen. A steam turbine uses steam produced by cooling the syngas and superheated with the gas turbine exhaust gases in the HRSG to produce an additional 124 MWe. The plant heat rate is 9,350 Btu/kWh (HHV).



Project Status/Accomplishments

Since Polk Power Station's first gasifier run in July 1996, the gasifier has operated over 21,000 hours. The station generated more than 6 million MWh of electricity from syngas it produced through March 2000. During one six-month period, the gasifier had an 83.5% on-stream factor and the combined-cycle availability was 94%.

Several modifications to the original design and procedures were required to achieve the recent high availability, including: (1) removing or modifying some of the heat exchangers in the high-temperature heat recovery system and making compensating adjustments in the balance of the system to resolve ash plugging problems, (2) additional solid particle erosion protection for the combustion turbine to protect the machine from ash, (3) implementing hot restart procedures to reduce gasifier restart time by 18 hours, (4) adding a duplicate fines handling system to deal with increased fines loading resulting from lower than expected carbon conversion, (5) revising operating procedures to deal with high shell temperatures in the dome of the radiant syngas cooler, and (6) making various piping changes to correct for erosion and corrosion in the process and coal/water slurry systems. A COS hydrolysis unit was installed in 1999 to further reduce SO_2 emissions, enabling the station to meet recent, more stringent emissions restrictions.

In March and April 2000, Tampa Electric tested several coal/petroleum coke blends. Preliminary test results from 60/40 and 40/60 blends of Pittsburgh #8 and petroleum coke (petcoke) looked promising. Both tests were successful and provide data that show continued operation on a blend of coal/petcoke is possible. One further test is planned using a 20/80 blend.

Commercial Applications

The project was presented the 1997 Powerplant Award by *Power* magazine. In 1996 the project received the Association of Builders and Contractors award for construction quality. Several awards were presented for using an innovative siting process: 1993 Ecological Society of America Corporate Award, 1993 Timer Powers Conflict Resolution Award from the State of Florida, and the 1991 Florida Audubon Society Corporate Award.

As a result of the Polk Power Station demonstration, Texaco-based IGCC can be considered commercially and environmentally suitable for electric power generation utilizing a wide variety of feedstocks. Sulfur capture for the project is greater than 98%, while NO_x emissions reductions are 90% those of a conventional pulverized coal-fired power plant. The integration and control approaches utilized at Polk can also be applied in IGCC projects using different gasification technologies.

TECO Energy is not only actively working with Texaco to commercialize the technology in the United States, but has been contacted by European power producers to discuss possible technical assistance on using the gasifier technology.

Wabash River Coal Gasification Repowering Project

Project completed.

Participant
Wabash River Coal Gasification Repowering Project Joint Venture (a joint venture of Dynegy and PSI Energy, Inc.)

Additional Team Members
PSI Energy, Inc.—host
Dynegy (formerly Destec Energy, Inc., a subsidiary of Natural Gas Clearinghouse)—engineer and gas plant operator

Location
West Terre Haute, Vigo County, IN (PSI Energy's Wabash River Generating Station, Unit No. 1)

Technology
Integrated gasification combined-cycle (IGCC) using Global Energy's two-stage pressurized, oxygen-blown, entrained-flow gasification system—E-Gas Technology™

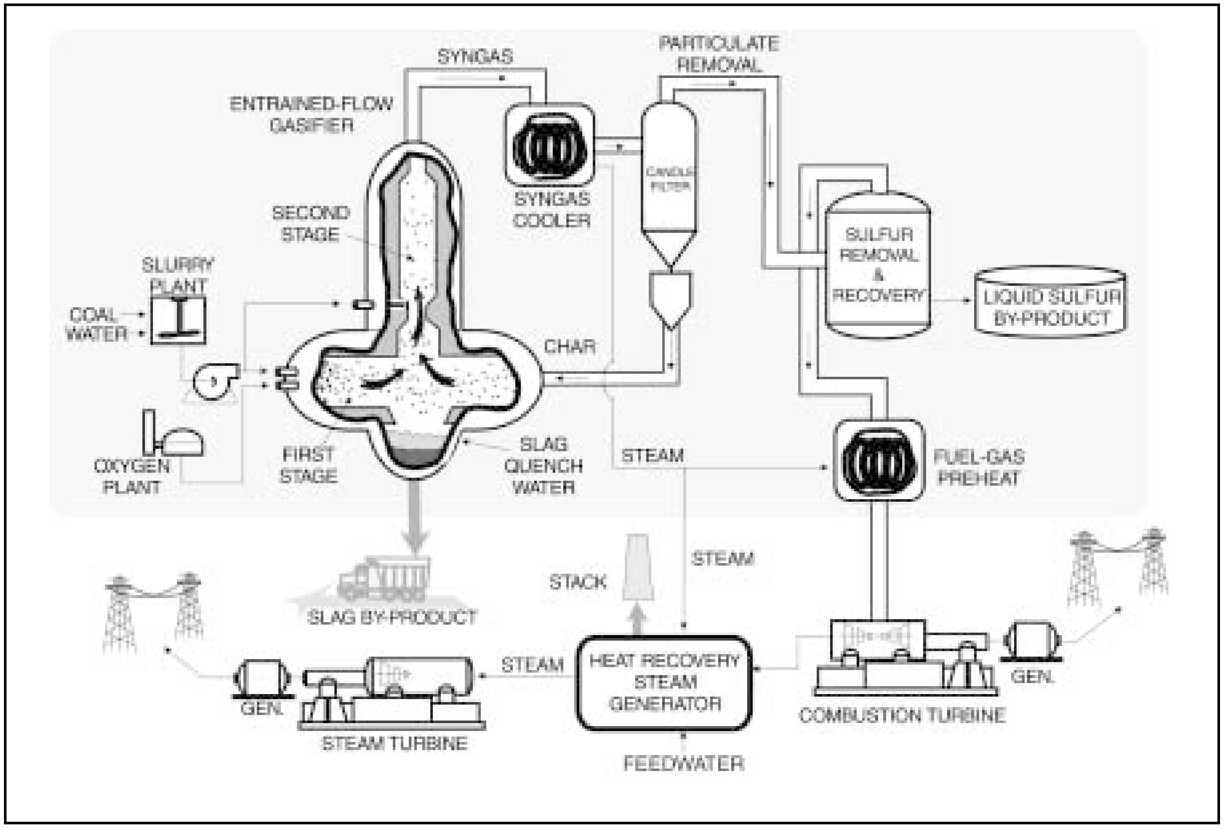
Plant Capacity/Production
296 MWe (gross), 262 MWe (net)

Coal
Illinois Basin bituminous

Project Funding

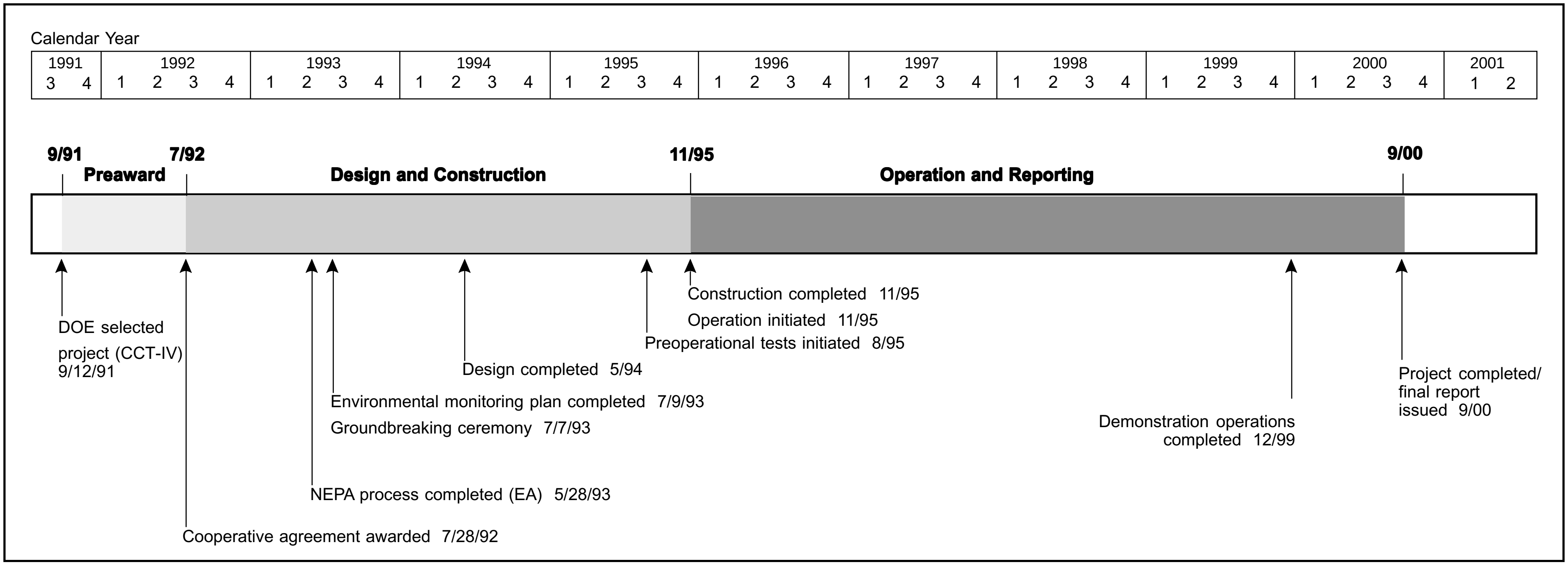
Total project cost	$438,200,000	100%
DOE	219,100,000	50
Participant	219,100,000	50

Project Objective
To demonstrate utility repowering with a two-stage pressurized, oxygen-blown, entrained-flow IGCC system, including advancements in the technology relevant to the use of high-sulfur bituminous coal; and to assess long-term reliability, availability, and maintainability of the system at a fully commercial scale.



Technology/Project Description
The Destec process features an oxygen-blown, continuous-slagging, two-stage, entrained flow gasifier. Coal is slurried, combined with 95% pure oxygen, and injected into the first stage of the gasifier, which operates at 2,600 °F/400 psig. In the first stage, the coal slurry undergoes a partial oxidation reaction at temperatures high enough to bring the coal's ash above its melting point. The fluid ash falls through a tap hole at the bottom of the first stage into a water quench, forming an inert vitreous slag. The syngas flows to the second stage, where additional coal slurry is injected. This coal is pyrolyzed in an endothermic reaction with the hot syngas to enhance syngas heating value and improve efficiency.

The syngas then flows to the syngas cooler, essentially a fire tube steam generator, to produce high-pressure saturated steam. After cooling in the syngas cooler, particulates are removed in a hot/dry filter and recycled to the gasifier. The syngas is further cooled in a series of heat exchangers. The syngas is water-scrubbed to remove chlorides and passed through a catalyst that hydrolyzes carbonyl sulfide into hydrogen sulfide. Hydrogen sulfide is removed in the acid gas removal system using MDEA-based absorber/stripper columns. A Claus unit is used to produce elemental sulfur as a salable by-product. The "sweet" gas is then moisturized, preheated, and piped to the power block. The power block consists of a single 192-MWe GE MS 7001FA (Frame 7 FA) gas turbine, a Foster Wheeler single-drum heat recovery steam generator with reheat, and a 1952-vintage Westinghouse reheat steam turbine.



Results Summary

Environmental

- The SO_2 capture efficiency was greater than 99%, keeping SO_2 emissions consistently below 0.1 lb/10^6 Btu and reaching as low as 0.03 lb/10^6 Btu; and SO_2 was transformed into 99.99% pure sulfur, a highly valued by-product.
- The NO_x emissions were controlled by steam injection down to 0.15 lb/10^6 Btu.
- Coal ash was converted to a low-carbon vitreous slag, impervious to leaching and valued as an aggregate in construction or as grit for abrasives and roofing materials; and trace metals from petroleum coke were also encased in an inert vitreous slag.

Operational Performance

- The first year problems encountered included:
  - Ash deposition at the fire tube boiler inlet, which was corrected by a change to the flow path geometry;
  - Particulate breakthrough in the hot gas filter, which was largely solved by changing to improved metallic candle filters.
  - Chloride and metals poisoning of the COS catalyst, which was eliminated by installation of a wet chloride scrubber and a COS catalyst less prone to poisoning.
- The second year identified cracking in the gas turbine combustion liners and tube leaks in the heat recovery steam generator (HRSG). Resolution involved replacement of the gas turbine fuel nozzles and liners and modifications to the HRSG to allow for more tube expansion.
- The third year was essentially trouble free and the IGCC unit underwent fuel flexibility tests, which showed that the unit operated trouble free, without modification, on a second coal feedstock, a blend of two different Illinois #6 coals, and petroleum coke.
- Overall thermal performance actually improved during petroleum coke operation.
- In the fourth year, the gas turbine incurred damage to rows 14 through 17 of the compressor causing a 3-month outage. But over the four years of operation, availability of the gasification plant steadily improved reaching 79.1% in 1999.

Economic Performance

- Overall cost of the gasification and power generation facilities was $417 million, including engineering and environmental studies, equipment procurement, construction, pre-operations management, and startup.
- Preliminary estimates for a future dual-train facility are $1,200/kW. Costs could fall to under $1,000/kW for a greenfield plant with advances in turbine technology.

Project Summary

The Wabash River Coal Gasification Repowering Project repowered a 1950s vintage pulverized coal-fired plant, transforming the plant from a nominally 33% efficient, 90-MWe unit into a nominally 40% efficient, 262-MWe (net) unit. Cinergy, PSI's parent company, dispatches power from the project, with a demonstrated heat rate of 8,910 Btu/kWh (HHV), second only to their hydroelectric facilities on the basis of environmental emissions and efficiency.

Beyond the integration of an advanced gasification system, a number of other advanced features contributed to the high energy efficiency. These included: (1) hot/dry particulate removal to enable gas cleanup without heat loss, (2) integration of the gasifier high-temperature heat recovery steam generator with the gas turbine-connected HRSG to ensure optimum steam conditions for the steam turbine, (3) use of a carbonyl sulfide (COS) hydrolysis process to enable high-percentage sulfur removal, (4) recycle of slag fines for additional carbon recovery, (5) use of 95% pure oxygen to lower power requirements for the oxygen plant, and (6) fuel gas moisturization to reduce steam injection requirements for NO_x control.

Over the four-year demonstration period starting in November 1995, the facility operated approximately 15,000 hours and processed approximately 1.5 million tons of coal to produce about 23 x 10^{12} Btu of syngas. For several of the months, syngas production exceeded one trillion Btu. By the beginning of the final year of operation under the demonstration, the 262-MWe IGCC unit had captured over 100 million pounds equivalent of SO_2.

Operational Performance

The first year of operation was plagued by problems primarily with: (1) ash deposition at the inlet to the fire tube boiler, (2) particulate breakthrough in the hot gas filter system, and (3) chloride and metals poisoning of the COS catalyst. A modification to the hot gas path flow geometry corrected the ash deposition problem. Replacement of the ceramic candle filters with metallic candles proved to be largely successful. A follow-on metallic candle filter development effort ensued using a hot gas slipstream, which resulted in improved candle filter metallurgy, blinding rates, and cleaning techniques. The combined effort all but eliminated downtime associated with the filter system by the close of 1998. Installation of a wet chloride scrubber eliminated the chloride problem by September 1996 and use of an alternate COS catalyst less prone to trace metal poisoning provided the final cure for the COS system by October 1997.

The second year of operation identified cracking problems with the gas turbine combustion liners and tube leaks in the HRSG. Replacement of the fuel nozzles and liners solved the cracking problem. Resolution of the HRSG problem required modification to the tube support and HRSG roof/penthouse floor to allow for more expansion.

By the third year, downtime was reduced to nuisance items such as instrumentation-induced trips in the oxygen plant and high-maintenance items such as replacement of high-pressure slurry burners every 40–50 days. In the third year, the IGCC unit underwent fuel flexibility tests. The unit operated effectively, without modification or incident, on a second coal feedstock, a blend of two different Illinois #6 coals, and petroleum coke (petcoke). These tests added to the fuel flexibility portfolio of the gasifier, which had previously processed both lignite and subbituminous coals during its earlier development. The overall thermal performance of the IGCC unit actually improved during petcoke operation. The unit processed over 18,000 tons of high-sulfur petcoke and produced 350,000 x 10^6 Btu of syngas. There was a negligible amount of tar production and no problems were encountered in removing the dry char particulate despite a higher dust loading. Exhibit 5-44 provides a summary of the thermal performance of the unit on both coal and petcoke. Exhibit 5-45 compares the coal and petcoke fuel characteristics and Exhibit 5-46 compares the syngas products.

The fourth year of operation was marred by a 3-month outage due to damage incurred to rows 14 through 17 of the gas turbine air compressor. However, over the four years of operation, availability of the gasification plant steadily improved, reaching 79.1% in 1999.

Environmental Performance

The IGCC unit operates with an SO_2 capture efficiency greater than 99%. As a result, SO_2 emissions are consistently below 0.1 lb/10^6 Btu of coal input, reaching as low as 0.03 lb/10^6 Btu. Moreover, the process transforms the SO_2 pollutant into 99.99% pure sulfur, a highly valued by-product, rather than a solid waste.

Steam injection controls NO_x emissions down to 0.15 lb/10^6 Btu. This is the emission limit being sought under the EPA SIP call related to ozone nonattainment areas. Also, particulate emissions are below detection limits.

The ash component of the coal results in a low-carbon vitreous slag, impervious to leaching and valued as an aggregate in construction or as grit for abrasives and roofing materials. Also, the trace metal constituents in the petcoke were effectively captured in the slag produced.

Economic Performance

The economic performance of the IGCC unit will be forthcoming in the Final Technical Report currently in preparation. Some preliminary information presented here was drawn from technical papers prepared over the course of the demonstration.

The overall combined cost of the gasification and power generation facilities was $417 million at completion. This cost includes engineering and environmental studies, equipment procurement, construction, pre-operations management (including operator training), and startup. Escalation during the project is included. Startup includes the costs of construction and operations, excluding coal and power, up to the date of commercial operation in December 1995. Soft costs such as legal and financing fees and interest during construction are not included.

Project participants project future costs of $1,200/kW for dual-train repowered facilities, and greenfield costs under $1,000/kW, with advances in turbine technology.

Commercial Applications

At the end of the demonstration in December 1999, Global Energy, Inc. purchased Dynegy's gasification assets and technology. Global Energy plans to market the technology under the name "E-Gas Technology™." The project is continuing to operate as Wabash River Energy, Ltd., a subsidiary of Global Energy.

The immediate future for E-Gas Technology™ appears to lie with both foreign and domestic applications where low-cost feedstocks such as petcoke can be used and co-production options are afforded such as bundled production of steam, fuels/chemicals, and electricity. Integration or association with refinery operations are examples.

In the longer term, the technology has application to the repowering of the 95,000 MWe of existing U.S. coal-fired boilers over 30 years old, and new foreign and domestic coal-fired capacity additions. Over time, the economics and performance of the technology will continue to improve, coal and gas price differentials will increase, and displacement of petroleum in chemicals and fuels production will increase in importance.

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References

- Steven L. Douglas. "Wabash River in Its Fourth Year of Commercial Operation." *7th Clean Coal Technology Conference: Volume II Technical Papers.* June 1999.

Exhibit 5-44
Wabash Thermal Performance Summary

	Design	Actual	
	Coal	Coal	Petcoke
Nominal Throughput, tons/day	2,550	2,450	2,000
Syngas Capacity, 10^6 Btu/hr	1,780	1,690	1,690
Combustion Turbine, MW	192	192	192
Steam Turbine, MW	105	96	96
Auxiliary Power, MW	35	36	36
Net Generation, MW	262	261	261
Plant Efficiency, % (HHV)	37.8	39.7	40.2
Sulfur Removal Efficiency, %	>98	>99	>99

Exhibit 5-45
Wabash Fuel Analysis

	Typical Coal	Petcoke
Moisture, % by wt.	15.2	7.0
Ash, % by wt.	12.0	0.3
Volatile, % by wt.	32.8	12.4
Fixed Carbon, % by wt.	39.9	80.4
Sulfur, % by wt.	1.9	5.2
Heating Value, as Rec'd, Btu/lb	10,536	14,282

Exhibit 5-46
Wabash Product Syngas Analysis

	Typical Coal	Petcoke
Nitrogen, % by vol.	1.9	1.9
Argon, % by vol.	0.6	0.6
Carbon Dioxide, % by vol.	15.8	15.4
Carbon Monoxide, % by vol.	45.3	48.6
Hydrogen, % by vol.	34.4	33.2
Methane, % by vol.	1.9	0.5
Total Sulfur, ppmv	68	69
Higher Heating Value, Btu/scf	277	268