3. KENTUCKY PIONEER IGCC DEMONSTRATION PROJECT DESCRIPTION AND ALTERNATIVES

3.1 Kentucky Pioneer IGCC Demonstration Project Facility

The Kentucky Pioneer Integrated Gasification Combined Cycle (IGCC) Demonstration Project facility would be located in Clark County, Kentucky (Figure 3.1-1) on a 121-hectare (300-acre) site within the 1,263-hectare (3,120-acre) J.K. Smith Site, owned by East Kentucky Power Cooperative (EKPC) (Figure 3.1-2). The project site is 34 kilometers (21 miles) southeast of the city of Lexington, 13 kilometers (8 miles) southeast of the city of Winchester, and 1.6 kilometers (1 mile) west of the community of Trapp, Kentucky.

The 121-hectare (300-acre) project site was previously disturbed by preliminary construction activities in the mid-1980s when EKPC began construction of the J.K. Smith coal-fired power station. EKPC had completed preliminary grading, primary foundations, fire protection piping, and rail spur access infrastructure installation before the project was canceled in the early 1990s when the projected demand for electricity in the area failed to materialize. The Kentucky Pioneer IGCC Demonstration Project would be built on the portion of the site that was previously cleared and graded. Figures 3.1-3 to 3.1-6 illustrate the current site conditions.

The site is reached by Kentucky Highway 89 and accessed through a gated perimeter fence and access road. The access road is approximately 1.6 kilometers (1 mile) long from Kentucky Highway 89 to the project site. Plant access by rail, which crosses the eastern side of the station, would be from a freight rail line owned by CSX Transportation, Inc. (Figure 3.1-7). An existing railroad loop about 5 kilometers (3.1 miles) long will be utilized for raw material delivery and product transportation around the 121-hectare (300-acre) project site (Figure 3.1-8).

To support the project, EKPC would construct a new 138 kilovolt (kV) electric transmission line. The proposed route for the line would extend northeasterly from the project site to the Spencer Road Terminal in Montgomery County, Kentucky, where it will interconnect with the existing local power grid. Figure 3.1-9 shows the location of the Spencer Road Terminal with respect to the proposed project site. This transmission line would provide additional capacity adequate to accommodate the addition of the Kentucky Pioneer IGCC Demonstration Project and is consistent with the master plan for transmission outlets required for existing and future generation at EKPC's J.K. Smith Site. However, the resulting margin of transmission capacity of the Kentucky Pioneer IGCC Demonstration Project plus the existing and planned EKPC CTs is small, thus triggering the need for future expansion of the local power grid. The impacts of potential future expansion of the grid are addressed in Section 5.14, Cumulative Impacts.

The proposed new transmission line would be approximately 27 kilometers (17 miles) in length, however the exact route for the line has yet to be determined. For this environmental impact statement (EIS), it is assumed the transmission line would be constructed in a similar fashion as other 138 kV electric transmission lines built by EKPC in the project area. The line would require a 30 to 45 meter (100 to 150 foot) wide right-of-way. The electrical conductors would be supported by double wood and/or steel, single and/or double pole structures. The average height of the support structures would be approximately 24 meters (80 feet) above ground and the average span between structures would be 122 to 305 meters (400 to 1,000 feet), depending upon the terrain (Figure 3.1-10).

As stated previously, the exact route of the transmission line is yet to be determined. The U.S. Department of Agriculture's Rural Utility Service (RUS) has approval authority for this capacity upgrade (Global Energy 2000b). Under RUS *National Environmental Policy Act* (NEPA) policies and procedures, transmission lines of less than 230 kV and less than 40.2 kilometers (25 miles) may be categorically excluded from the requirement to prepare an EIS under NEPA. Transmission lines in this category normally require an Environmental Report (ER) for the application to be approved (7 CFR 1794.22). EKPC would prepare the ER for this transmission line and RUS would determine if a categorical exclusion is appropriate.

The direct-line distance between the proposed station location and the Spencer Road Terminal is 24 kilometers (14.9 miles). The proposed 138 kV transmission line is 27 kilometers (17 miles) in length, therefore the proposed route can only deviate to either side of the direct line between the two locations by a maximum of 1.6 kilometers (1 mile). This establishes a 3.2-kilometer-wide (2-mile-wide) corridor between the proposed site location and the Spencer Road Terminal into which the route must fit. The terrain in this corridor is typified by gently rolling hills and land use is predominantly agricultural, with a few small areas of mixed woodland and agricultural land. There are very few residences along the proposed route as it runs through areas classified as rural. The geology in this area is similar to that found at the project location, as described in Section 4.6, Geology.

The proposed route may cross between approximately five and ten creeks and streams, as shown in Figure 3.1-9. Many of these streams are intermittent and ephemeral and would not be directly affected by construction of the transmission line. Cultural resources, such as historic sites and structures, may also be encountered along the route. The typical construction procedures that would be implemented would minimize impacts to these resources by avoiding the locations during route planning. Intermittent and Ephemeral streams are typically crossed during periods of no recorded flow. Impacts to streams would most likely be minor should a flow be present during construction, since the line would pass over the creek or stream.

As Figure 3.1-9 shows, there are seven locations along or near the area which would contain the transmission line route where federally-listed endangered species have been shown to occur. Six of these seven locations represent the presence of the endangered plant, Running buffalo clover (*Trifolium stoloniferum*), with the seventh, located to the northeast of the Spencer Road Terminal, representing the presence of the endangered mammal, the Indiana bat (*Myotis sodalis*). To prevent any impacts to these endangered species, the route would be established to avoid these locations. If construction were required near the location of the Indiana bat habitat, special procedures would be required. Any required tree removal could only occur during the bat's hibernation period, which occurs between November 15th and March 31st.

The transmission line would be constructed to support the power island combined cycle units regardless of approval of the Proposed Action. Therefore, it is considered a related action for both No Action Alternative 2 and the Proposed Action.

3.1.1 Kentucky Pioneer IGCC Demonstration Project Facility Description

The Kentucky Pioneer IGCC Demonstration Project facility would be located on a 121-hectare (300-acre) tract within the 1,263-hectare (3,120-acre) J.K. Smith Site. The facility would demonstrate the following three innovative technologies: (1) gasification of a blend of coal and refuse derived fuel (RDF) pellets; (2) the utilization of a synthesis gas (syngas) product as a clean fuel in combined cycle turbine generator sets; and (3) the operation of a high-temperature molten carbonate fuel cell on coal derived syngas. The project would be a commercial operation, and is expected to be active for at least 20 years.

The total cost of the Kentucky Pioneer IGCC Demonstration Project is currently estimated to be $432 million. Global Energy, Inc., has indicated that approximately 80 percent ($345.6 million) of the project cost is allocated for the construction and operation of the British Gas Lurgi (BGL) Process facility and high-temperature molten carbonate fuel cell demonstration portions of the project. The proposed Federal action is for DOE to provide, through a Cooperative Agreement with Kentucky Pioneer Energy, L.L.C. (KPE), a subsidiary of Global Energy, Inc., approximately $78 million (approximately 18 percent of overall $432 million project cost) in cost-shared funding support for the design, construction, and operation of the proposed demonstration facilities.

Figure 3.1.1-1 presents a conceptualized layout and process flow of the complete Kentucky Pioneer IGCC Demonstration Project facility. To facilitate discussion of the project, the layout has been divided into the following two parts: (1) the combined cycle units, or power island; (2) the BGL process and high-temperature molten carbonate fuel cell demonstration, or gasification island.

The estimated project cost of the power island would be $86.4 million. The primary power production area would consist of two General Electric 7FA combustion turbines coupled to a Heat Recovery Steam Generator. The General Electric 7FA combustion turbine is a heavy duty, industrial type machine with high efficiency and low nitrogen oxide (NO_x) and carbon monoxide (CO) emissions. F-Frame turbines are single-casing, single-shaft machines with a common rotor. The turbine sits on a horizontal axis with the cold end (compressor end) attached to the generator. The turbines have axial exhaust for improved efficiency. The F-Frame combustion turbine can attain 100 percent power load within 30 minutes and generate about 197 megawatts (MW). The Heat Recovery Steam Generator is coupled to the 7FA turbine and utilizes the hot exhaust to create steam. This steam then drives another turbine to create an additional 93 MW of electricity, thus improving the efficiency of the fuel source over conventional turbine generation methods. The two-unit facility is designed to generate 580 MW of gross electricity, of which approximately 40 MW would be used to operate the facility. Thus, it would produce a net power output of 540 MW. The turbines would be fired with natural gas under No Action Alternative 2 and with syngas fuel should the Proposed Action proceed. Under the Proposed Action, the turbines would operate on natural gas only if the gasifiers would be taken off line for maintenance. Natural gas is available as a fuel supply from an existing EKPC supply line and can alternatively be supplied, if necessary, from several nearby transmission pipelines (EIV 2000).

The Proposed Action is to provide cost-shared funding for the construction and operation of the power and gasification islands. The proposed project would consist of the following major facility components: (1) RDF pellet and coal receipt and storage sheds; (2) gasification plant; (3) sulfur removal and recovery facility; (4) air separation plant; (5) high-temperature molten carbonate fuel cell; and (6) two combined cycle power units. The production of syngas in the BGL process occurs in the gasification plant, sulfur removal and recovery facility, and air separation plant.

Under the Proposed Action, the combined cycle turbines would be fired with syngas. The syngas firing process consists of the following four steps: (1) generation of syngas from RDF pellets and coal reacting with steam and oxygen in a high temperature reducing atmosphere; (2) removal of contaminants, including particulates and sulfur in the sulfur removal and recovery facility; (3) clean syngas combustion in a gas turbine generator to produce electricity; and (4) recovery of residual heat in the hot exhaust gas produced by the gas turbine. The residual heat is used to generate steam in a heat recovery steam generator that produces additional electricity in a steam turbine, which is the combined cycle aspect of the plant. In addition, a slipstream of clean syngas will supply a 2 MW molten carbonate fuel cell demonstration.

Global Energy, Inc., will not begin detailed design of the proposed project, including layout and flow sheet information, until the project financing is finalized. However, Global Energy, Inc., has provided rough general estimates of quantities of materials required for the construction of the gasification island facilities. The estimates are as follows: steel - 160,000 tons; concrete - 145,000 tons; pipe - 140,000 tons; and wire - 100,000 tons. Figure 3.1.1-2 identifies a conceptual facility layout depicting the major process elements of the project.

3.1.2 Kentucky Pioneer IGCC Demonstration Project Process Description

The following subsections describe the facility and project processes. Figure 3.1.1-1 provides a process flow diagram for the Kentucky Pioneer IGCC Demonstration Project.

3.1.2.1 Raw Material Receipt, Storage, and Preparation

The primary raw materials used in the BGL gasification process would be high-sulfur coal and RDF pellets manufactured from municipal solid waste, limestone, and petroleum coke. The RDF pellets and high-sulfur coal would be received at the project facility by railcar from offsite. RDF pellets would be shipped in covered cars or closed containers. They would be unloaded in an enclosed concrete-floored environment containing electric feed conveying equipment in accordance with the required Kentucky Department of Environmental Protection Air Permit that Global Energy, Inc., would obtain. This equipment would move the material into the covered storage area, which would be enclosed and concrete contained. A single building or enclosure is envisioned for storage of both RDF pellets and coal. Dust control would be integral to the enclosed unloading and handling system and conform to air permit emission limits in the facility air permit. Receiving, storage and handling systems would be covered and weather protected to avoid precipitation and runoff management concerns.

The storage building would be sized to house approximately a 10-day supply of coal and RDF pellets (Global Energy 2000b). The building would be located within the 121-hectare (300-acre) project site. Limestone would also be received by railcar and stored in silos onsite. Each of the silos would have a storage capacity of 272 metric tons (300 tons). RDF pellets, coal, and limestone would be transported from the single building and silos to the gasifier by covered conveyers to ensure a high level of control of particulate emissions. During the demonstration period, the facility would use a co-feed of RDF pellets and high-sulfur coal at a 1:1 ratio. To operate the facility, approximately 745,022 metric tons per year (821,250 tons per year) each of RDF pellets and coal would be required (EIV 2000).

3.1.2.2 Continuous Gasification Process

This section describes the three stages comprising the continuous gasification process. The BGL gasification, sulfur removal and recovery, and air separation process would all occur concurrently during the gasification process; however, each stage occurs in a separate facility. This section describes each stage and facility separately to develop an understanding of the process and is not intended for use as a chronological sequence description of the gasification process.

BGL Gasification

The gasification process consists of four BGL gasifiers which are fixed-bed, oxygen-blown slagging gasifiers that operate at a pressure of approximately 350 pounds per square inch-gauge (psig) and have a temperature range of 1,760 degrees Celsius (ºC) (3,200 degrees Farenheit [ºF]) in the lower section of the reactor to approximately 482ºC (900ºF) in the upper section of the reactor. A syngas is produced from the high temperature and low oxygen environment in the reactor which causes the decomposition of the feed into its basic elements. The BGL gasification process is a pressurized, closed process that has no emissions or stack. However, in case of a malfunction, the gasifiers would be routed to an emergency flare. Petroleum coke would be used for the cold start-ups of the gasifiers. Approximately 54 metric tons (60 tons) of petroleum coke would be required for each of the four BGL gasifier units. Global Energy, Inc., has indicated that once initial start-up fills are complete, further quantities of petroleum coke would be put into the storage facility for future use, when necessary. Limestone is a required component of the gasification process, comprising approximately two to three percent of overall material feed. At the fuel feed rates proposed, approximately 127 metric tons (140 tons) of limestone would be required per day of operation.

The RDF pellets and coal enter the gasifiers through a lock hopper at the top of the gasifier and then descend through the gasifier by gravitational forces. As hot gases rise, the RDF pellets and coal are heated simultaneously causing moisture and volatile light hydrocarbons to leave the components and become a part of the syngas. As they descend, the components become carbonized. Oxygen and steam are injected near the bottom of the reactor and provide both the heat source for the chemical conversion process and the chemical element for formation of the syngas. The high temperatures at the bottom of the gasifier convert the inert ash content of the components into a molten slag. The slag is then removed from the bottom of the reactor through a lock hopper and water quench. The reducing atmosphere of the gasifier ensures chemical decomposition of feed materials into syngas components. The composition of syngas is 55 percent carbon monoxide (CO), 30 percent hydrogen (H_2), 10 percent carbon dioxide (CO_2), and 5 percent methane and ethane. Sulfur-cleaning processes discussed in the following section reduce the sulfur component of the syngas to a maximum of 40 parts per million (ppm) of hydrogen sulfide (H_2S).

The slag removed from the lock hopper and water quench is in the form of vitrified frit, an inert glassy silica matrix material. Frit is a synthetic aggregate suitable for road paving and concrete construction, which is a marketable co-product of the syngas process. Nearly all inert materials and metals present in the feed material become part of the frit due to the extremely high temperatures in the gasifier. The composition and manufacturing process of the RDF pellets are discussed in Section 3.2.2.

The vitrified frit would undergo leach testing to determine if it is considered hazardous material. Should the leach testing indicate that the frit was not hazardous, KPE would market the product for use in road paving and construction. If the frit is determined to be hazardous, KPE would have 90 days to manage the material. The frit would remain where it was staged while a decision is made if the hazardous characteristic could be removed. Any storage containers would be covered to prevent spills during this process. If the hazardous characteristic is removable, it would be disposed of in an approved hazardous waste facility and the frit would be marketed, otherwise, the frit would require disposal in an approved hazardous waste facility. Section 5.13, Waste Management, further discusses the management of the vitrified frit.

Steam is produced as the hot syngas leaves the top of the reactor, enters the cooling tower, and is cooled and purified by heat exchange. The cooling tower serves as a condenser for the steam turbine in the combined cycle system and as a process cooler. The conceptual process flow provided by Global Energy, Inc., assumes a circulation rate of 20,000 gallons per minute for the tower. Particulates and other impurities are removed in this initial gas processing stage. Light oils and water are condensed during cooling. The oils are returned to the gasifiers and injected near the bottom. These oils collect any small quantities of particulates that are carried over in this process. The re-injection of the oils ensures that the oils are completely converted to syngas components (EIV 2000).

Sulfur Removal and Recovery

The sulfur compounds are removed from the raw syngas in two steps, acid gas cleanup and sulfur recovery, which are described below. The acid-gas cleanup is generally accomplished by using a selective amine-type solvent. The sulfur recovery units use a process unit that employs a specific chemical reaction, called the Claus reaction, to generate elemental sulfur. The elemental sulfur in these compounds will be a co-product and sold commercially. The quantity of elemental sulfur generated would depend directly on the sulfur content of the coal used. The selection of a coal source will not be determined until after project financing is completed. A bounding scenario based on 50 percent coal feed and 4 percent sulfur in coal, which is the worst-case for sulfur production, equates to approximately 90.7 metric tons (89.3 long tons) per day of elemental sulfur. The 33,100 metric tons (32,600 long tons) would be a minor addition to annual domestic sulfur production, which was approximately 15.2 million metric tons (14.9 million long tons) in 1999. The majority of this, 13.1 million metric tons (12.9 million long tons), was produced by other energy companies in fuel refineries or natural gas exploration (ChemExpo 1999). The elemental sulfur produced by the Kentucky Pioneer IGCC Demonstration Project facility is similar to that produced by other energy companies, and is therefore readily marketable. The majority of the sulfur market, approximately 90 percent, is allocated to the development of sulfuric acid for fertilizer production (ChemExpo 1999). Liquid tankers are currently planned to transport the sulfur offsite; however, the choice of rail or truck transport will depend upon customer selection and their location.

The acid-gas clean-up process removes the sulfur compounds after the raw syngas has cooled. There are several technologies that can accomplish this process. Each process is based on the absorption of the sulfur into a selective amine-type solvent. The Kentucky Pioneer IGCC Demonstration Project facility would utilize an acid-gas clean-up process that is expected to achieve better than 99 percent sulfur removal, lowering the clean syngas sulfur to 40 ppm or less H_2S. The specific acid-gas clean-up process has not yet been determined for the Kentucky Pioneer IGCC Demonstration Project. For example, the acid-gas clean-up technology could include the Purisol technology developed by Lurgi and the Selexol™ process developed by UOP, L.L.C. (EIV 2000).

The acid-gas clean-up process consists of washing, absorption, stripping, and regeneration to remove sulfur and other contaminants from the syngas. The sulfur removal process absorbs sulfur compounds in a selective solvent. The removal of contaminants occurs in the absorber tower. The syngas will enter the bottom of the absorber and pass through a prewash section where naphtha, hydrogen cyanide, and other undesirable compounds are removed by washing with a portion of the solvent stream. The prewash solvent is circulated to a stripper and extractor where the contaminants are removed and recycled to the gasifier. The prewash syngas then enters the main wash section of the absorber in order to remove the H_2S. This section also contains carbonyl sulfide (COS) hydrolysis trays to convert COS to H_2S to allow its removal. The H_2S-free syngas then enters the final, upper portion of the absorber and is washed by demineralized water to remove any solvent vapors remaining in the desulfurized syngas. The water-saturated syngas is then routed to the gas turbines through the preheat/saturation area.

The H_2S absorbed by the solvent in the absorber or reabsorber is removed by indirect steam stripping in the hot regenerator. The stripped H_2S is sent to the Claus Sulfur Plant and then the regenerated solvent is circulated back to the absorbers. The gas stream containing primarily H_2S generated in the acid-gas clean-up process is sent to the Sulfur Recovery Unit where the sulfur compounds are converted to elemental sulfur using the Claus reaction. The gas stream first reacts with air in a combustion chamber to produce sulfur dioxide (SO_2). Next, the gas is cooled and sent through the Claus reactors where a highly active aluminum oxide catalyst induces conversion to elemental sulfur. In addition, the gas undergoes a reaction known as the Claus reaction in which the SO_2 produced in the first step reacts with H_2S to produce elemental sulfur and water.

The gas would then pass through a hydrogeneration unit to convert all reduced sulfur back to H_2S to allow cleanup of the small fraction of remaining sulfur. The Kentucky Pioneer IGCC Demonstration Project would recycle the tail gas back to the gas clean-up plant so that there are no SO_2 emissions from the sulfur recovery process.

The gasifiers could be shut down or placed on standby quickly if there is a problem during the acid-gas clean-up process or the sulfur removal process. The removal of oxygen injection and solid fuel addition rapidly removes heat and allows isolation of the reactor and avoidance or minimization of any flare or vent release of raw syngas. The gasifiers are routed to an emergency flare in case of malfunction (EIV 2000). The primary stream constituent to the flare is syngas diluted with water and nitrogen (N_2). As stated previously, purified syngas is predominantly CO and H_2, with small amounts CO_2, methane, ethane, and sulfur present. These constituents and modern flare design generally result in CO, CO_2 and water as flare combustion products. Sulfur dioxide would result from the combustion of the relatively minor sulfur content. Raw syngas, before purification, would contain these main constituents and some heavier hydrocarbon compounds. Regulatory requirements accept that flares are essential components of safe plant design and account for potential flare combustion considerations in permit and non-permit requirements.

Air Separation Process

The purpose of the air separation plant is to extract oxygen (O_2) and N_2 from the atmosphere for use in the gasification process. An on-site air separation unit would supply approximately 1,814.4 metric tons (2,000 tons) per day (TPD) of O_2 to the gasifiers. The air separation unit will also supply N_2 for the dilution of fuel gas before it is used in the gas turbines. The air separation unit uses electricity generated by the facility to satisfy its energy needs and has no direct emissions. The air separation plant would use either cryogenic or pressure swing processes to purify air from the atmosphere through a series of separation steps.

After sulfur removal, the purified syngas fuels the gas turbine portion of the combined cycle power generation plant. Nitrogen and steam are blended into the clean syngas to dilute it to the desired temperature and as a means for controlling NO_x emissions. This also provides higher mass flow of fuel to the turbines, resulting in more power generation.

In the event the gasifier would not be needed, it would be placed on standby or shutdown. The removal of O_2 injection and solid fuel addition rapidly removes heat and allows isolation of the reactor and avoidance or minimization of any flare or vent release of raw syngas (EIV 2000).

3.1.2.3 Fuel Cell Commercial Power Generation

Fuel cells are an emerging technology that are proving to be a viable source of electricity and would be part of this DOE demonstration project. The molten carbonate fuel cell would use a small slipstream of clean syngas to produce approximately 2 MW of electricity with only negligible pollutant emissions. The fuel cell produces electricity by means of a chemical membrane and electrolytic process as opposed to traditional combustion processes. The anode and cathode aspects of the fuel cell enable utilization of electrons liberated in the chemical reaction for electric power production. The electric power production process is similar to the production of electricity in a battery. The molten carbonate fuel cell produces higher fuel-to-electricity efficiencies of about 60 percent and operates at higher temperatures than other established fuel cell technologies. Thermal efficiencies of molten carbonate fuel cells are estimated to increase to as much as 85 percent when used in a co-generation application such as this project. The molten carbonate fuel cell is currently in the testing phase; however, the Kentucky Pioneer IGCC Demonstration Project would utilize this technology (EIV 2000).

The electric power is generated through a series of chemical reactions that take place between the anode and the cathode within the fuel cell. The hydrogen from the syngas is combined with oxygen, while using carbon dioxide as a catalyst, to create water vapor. The energy released from this reaction provides the electricity generated by the fuel cell. The other primary component of the syngas, CO, combines with the water vapor released by this reaction to create more hydrogen and CO_2. The byproducts generated by this reaction will supply more fuel and catalyst for the first reaction.

The emissions associated with the molten carbonate fuel cell would be minimal. The manufacturer, FuelCell Energy Corporation, stated that their emissions of NO_x are 2 ppm and SO_x emissions are at undetectable levels. Estimated emissions from the Kentucky Pioneer IGCC Demonstration Project facility, discussed in Section 5.7, Air Resources, indicate that the fuel cell would have comparatively lower emissions per megawatt. The estimated levels presented, 980 metric tons (1,078.38 tons) per year of NO_x, 717 metric tons (788.68 tons) per year of CO, and 448 metric tons (492.93 tons) per year of SO_x, show that emissions per megawatt for each pollutant would be approximately 1.8, 1.4, and 0.8 metric tons (2, 1.5, and 0.9 tons) per year, respectively. Emissions per megawatt for operation of the fuel cell would be nearly undetectable, compared to the emissions per megawatt for operation of the combined cycle turbine units. The trace emissions of NO_x and SO_x from the fuel cell ensures that emissions from the syngas used for fuel cell processes would be lower than they would be if the syngas were used for combined cycle turbine operation (EIV 2000). There are no liquid or solid wastes associated with fuel cell operation.

3.1.2.4 Supporting Project Facilities

The supporting project facilities would include administrative offices, railcar loading and unloading areas, on-site utilities, steam-generating units, air emissions control equipment, and wastewater treatment equipment. The existing water intake structure located in the Kentucky River would also be modified to accommodate the additional water requirements of the facility.

Though detailed design has not been initiated, Global Energy, Inc., has indicated that all of these supporting facilities, with the exception of the administrative offices and railcar loading and unloading areas, would be incorporated into the 12-acre main power island facility, and are included under both the No Action Alternative 2 and the Proposed Action. Administrative offices are housed in existing buildings owned by EKPC on the site and are leased by Global Energy, Inc. Rail loading and unloading areas required for the Proposed Action would be integrated into the balance of the plant for optimal layout of the site and utilization of the process area.

3.2 Fuel Source

The solid fuel source for the Kentucky Pioneer IGCC Demonstration Project would be high-sulfur coal and RDF pellets. RDF pellets would be procured from an RDF pellet manufacturer. The two fuel sources would be shipped by rail directly to on-site storage. At least 50 percent of the feed would consist of high-sulfur coal from the Kentucky region during the one-year demonstration period (Global Energy 2000b).

3.2.1 Coal

KPE intends to use high-sulfur coal as the coal fuel co-feed; it will be procured for direct delivery to the project site. Western Kentucky coal is generally considered the high-sulfur coal region; however, Eastern Kentucky may also provide high-sulfur coal supplies. Project economics would determine the supplier and the type of coal supplied (Global Energy 2000b). The facility would require approximately 2,268 metric tons (2,500 tons) per day of coal, which equates to about 25 railcars per day. Compared to coal-fired electric generation technologies, this project would require less coal consumption to generate 540 MW.

3.2.2 Refuse Derived Fuel Pellets

The RDF pellets would be a procured material from an existing manufacturer. RDF pellets vary in size and are typically extruded into a uniform dense shape that makes them well suited to transportation and storage. Typical sizes would be small cylinders in the 1.27 centimeter (0.5 inch) by 7.62 centimeter (3 inch) range, or 3.81 centimeter (1.5 inch) square by 10.16 centimeter (4 inch) long blocks. The bulk density of RDF pellets is approximately 640 kilograms per cubic meter (40 pounds per cubic foot). By comparison, the bulk density of bituminous coal is approximately 801 kilograms per cubic meter (50 pounds per cubic foot) and a 50-50 mix of coal and RDF by weight would be equivalent to a 44-56 mix of coal and RDF by volume (Global Energy 2000b).

The Kentucky Pioneer IGCC Demonstration Project facility will convert the RDF pellet and coal feed into a syngas fuel through a chemical process conducted in a low oxygen atmosphere. The syngas fuel will then be combusted to generate the electrical output from the plant. Though the RDF Pellets themselves will not be directly combusted, the facility would be regulated as a Municipal Waste Combustor under U.S. Environmental Protection Agency guidelines established by 40 *Code of Federal Regulations* (CFR) Part 60. Chapter 6, Regulations, of this EIS discusses the applicability of these guidelines to the Kentucky Pioneer IGCC Demonstration Project facility.

3.2.2.1 Pellet Manufacturers

Historically, the waste-to-energy industry has used RDF pellets as a means of assuring effective co-feeding at conventional power plants. A wide variety of RDF pellet manufacturers and RDF pellet products exist. RDF pellets from sewage sludge are also produced to facilitate effective use of the energy content of this material in a generally dry form (Global Energy 2000b). Global Energy, Inc. intends to obtain all RDF pellets from one supplier and is in the initial stages of contract negotiations with an RDF supplier located on the east coast of the United States.

3.2.2.2 Refuse Derived Fuel Pellet Production

RDF is manufactured in a process that includes controlled steps for the processing of municipal solid waste (MSW) or common household waste. Initially, sorting of the MSW removes obvious large objects, also known as white goods (e.g. refrigerators). These continue on to the landfill and amount to five to ten percent of the original weight of the MSW. Cans are then removed either magnetically, or for aluminum cans, by eddy current technology. Glass is removed by gravity. These are sent to recycling units and amount to a further five to ten percent of the original weight. Processing methods vary but most of the balance is then often tumbled in a long rotary drum that might be envisioned as a pressure cooker. With steam and air insertion rates used to control the temperature and moisture of the RDF product, a sterile “mulch type material” will result. Clumps of plastic are screened out for shredding or separate handling. The energy content of plastics is well suited in recycling energy in the gasification process. If shredded, the plastic component can be included in the RDF pellets. Otherwise, plastic material could be fed into the gasifier separately or simply recycled conventionally. Hammer mills and trundles are typically used to reduce the MSW to a small uniform size and homogeneous mixture. The sterile mulch is then formed into dense pellets by being forced through a mold at high pressures. The exact forming process is dependant upon handling considerations and the feed performance requirements of the gasification process. Being made with relatively low moisture content, RDF pellets are stable and durable. The process results in pellets with a relatively uniform size and shape and a generally uniform energy content. RDF pellets also have a relatively low ash content and good handling and storage life before use (Global Energy 2000b).

Different RDF pellet manufacturing processes may result in slightly different RDF pellet compositions. The variation in RDF pellet composition due to different manufacturing processes should not be an issue for this project however, as Global Energy, Inc., intends to supply all RDF pellets for this project from the same manufacturer. In the event other suppliers are used, there may be a slight change in the resulting waste streams from the gasifier unit but the resulting syngas makeup should remain the same.

3.2.2.3 Refuse Derived Fuel Transport

RDF pellets are a high density, stable product of uniform size. The pellets are amenable to bulk handling and shipping without undo fragmentation and loss. Large volume shipping would most likely use inter-modal rail (Global Energy 2000b). Should negotiations prove successful with the intended supplier, the RDF pellets would be shipped from a manufacturer on the east coast of the United States. The estimated transit distance is 1,609 to 1,931 rail kilometers (1,000 to 1,200 rail miles). The facility would require about 2,500 TPD of RDF, which equates to approximately 25 rail cars per day. For planning purposes, Global Energy, Inc., assumes unit train handling of the RDF pellets. One unit train consists of 100 rail cars. This results in approximately two unit trains of RDF pellets per week of operation and approximately 100 unit trains of RDF pellets for the complete one-year demonstration period of the project.

3.2.3 Synthesis Gas

Section 3.1.2 details the production of syngas in the Kentucky Pioneer IGCC Demonstration Project facility. Gasification technology is known to produce a very consistent syngas product, regardless of the variability of the feed. Though the RDF pellet composition is expected to be relatively constant, slight variations in the composition would have no effect on the composition of the syngas produced. The resulting syngas is expected to be 55 percent CO, 30 percent H_2, 10 percent CO_2, 5 percent methane and ethane, with a relatively small amount of sulfur in the form of H_2S.

3.3 Fuel Source Considered But Eliminated

The following fuel source was considered in the process of identifying the Proposed Action, but was found not to be a reasonable option because it poses significant disadvantages relative to the Proposed Action and no compensating advantages.

3.3.1 Briquette Facility

The *Notice of Intent to Prepare an Environmental Impact Statement for the Kentucky Pioneer Integrated Gasification Combined Cycle Demonstration Project, Trapp, KY,* published in the *Federal Register* on April 14, 2000, indicated that a fuel production facility would provide the project with fuel briquettes made from high-sulfur coal and solid renewable fuels such as MSW. The briquette facility would have been built at an off-site location and the briquettes would have been shipped by rail to on-site storage for use as a fuel source. Since the publication of the Notice of Intent, Global Energy, Inc., has determined that using briquettes produced from a mixture of coal and MSW is not a practical alternative. Rather, Global Energy, Inc., proposes co-feeding coal and commercially obtained RDF pellets.

In comparison with a briquette facility, co-feeding coal and RDF pellets would provide the following advantages to the Kentucky Pioneer IGCC Demonstration Project:

- RDF pellets reduce capital and operating costs.
- RDF pellets significantly reduce transportation costs.
- RDF pellets have undergone extensive processing and are generally more innocuous than raw MSW.

3.4 Alternatives Analyzed

Section 102.2(C) of NEPA requires that agencies evaluate the reasonable alternatives to the proposed action in an EIS. The purpose for agency action determines the range of reasonable alternatives. The goals of the proposed agency action establish the limits of reasonable alternatives. Congress established the Clean Coal Technology (CCT) Program with a specific purpose: to demonstrate the commercial viability of technologies that use coal in more environmentally benign ways than conventional coal technologies. Congress also directed DOE to pursue the goals of the legislation by means of partial funding (cost sharing) of projects owned and controlled by non-Federal government sponsors. This statutory requirement places DOE in a much more limited role than if the Federal Government owned and operated the project. In the latter situation, DOE would be responsible for a comprehensive review of reasonable alternatives for siting the project. However, in dealing with an applicant, the scope of alternatives is necessarily more restricted because the agency must focus on alternative ways to accomplish its purpose that reflect both the application before it and the functions the agency plays in the decision process. It is appropriate in such cases for DOE to give substantial consideration to the applicant's needs in establishing a project's reasonable alternatives.

The range of reasonable alternatives to be considered in the EIS for the proposed Kentucky Pioneer IGCC Demonstration Project was determined in accordance with the overall NEPA strategy. The EIS includes an analysis of the No Action Alternative, as required under NEPA. Global Energy, Inc., has stated that the site would be used to construct a natural gas fired combined cycle plant should DOE decide against providing cost-shared funding for the gasification technology demonstration and, therefore, two No Action Alternatives will be addressed. No Action Alternative 1 assumes that DOE decides against providing cost-shared funding for the project and that no plant is constructed as a result. No Action Alternative 2 assumes that DOE decides against providing cost-shared funding for the project and that Global Energy, Inc., constructs a natural gas fired combined cycle plant, the power island portion of the overall project without the gasification component, at the proposed project location. In addition, the EIS analyzes the Proposed Action, which includes engineering and design, permitting, fabrication and construction, testing, and demonstration of the gasification technology and fuel cell, and the operation of the power island on the generated syngas.

Because of DOE's limited role of providing cost-shared funding for the proposed Kentucky Pioneer IGCC Demonstration Project, the EIS does not evaluate alternative sites for the proposed project. Site selection was governed primarily by benefits that KPE could realize. KPE selected the proposed previously-disturbed project site because the costs would be much higher and the environmental impacts would likely be greater if an undisturbed area were chosen.

3.4.1 No Action Alternatives

The Council on Environmental Quality (CEQ) NEPA Regulations (40 CFR Parts 1500-1508) and the DOE NEPA Regulations (10 CFR 1021) require the analysis of a No Action Alternative. Under the No Action Alternative, DOE would not provide partial funding for the design, construction, and operation of the Kentucky Pioneer IGCC Demonstration Project. This EIS considers two actions should this occur.

3.4.1.1 No Action Alternative 1

No Action Alternative 1 assumes that DOE decides against providing cost-shared funding for the project and that no plant is constructed as a result. This will result in no change in environmental impacts since it assumes that no plant would be built. DOE believes this scenario is unlikely to occur but it is presented because it serves as an analytical baseline for comparison of the environmental effects of the project.

3.4.1.2 No Action Alternative 2

No Action Alternative 2 assumes that DOE decides against providing cost-shared funding for the project and Global Energy, Inc., constructs a natural gas-fired combined cycle plant, the power island portion of the overall project, at the proposed project location. This alternative includes all associated facilities required for the operation of the power island, including administrative offices, on-site utilities, steam-generating units, required air emissions control equipment, wastewater treatment equipment, and the modification of the existing water intake structure. Siting for the foundation of the two combined cycle generator units would be within the 4.8-hectare (12-acre) plant site. All water for the plant would be supplied from existing EKPC intake structures at the J.K. Smith Site. The EKPC transmission line described in Section 3.1 would be required to support this action. The changes in the environment resulting from the operation of the power island are presented in the appropriate sections of Chapter 5, Environmental Impacts, and provide a basis for comparison with the impacts of the Proposed Action.

3.4.2 Proposed Action

Under the Proposed Action, DOE would provide, through a Cooperative Agreement with KPE, financial assistance for the design, construction, and operation of the proposed Kentucky Pioneer IGCC Demonstration Project. All associated facilities for the power and gasification islands, including fuel storage, rail car unloading sites, and air emissions control equipment, for the gasification and fuel cell technologies will also be constructed under the Proposed Action together with two syngas-fired combined cycle electric generation units and the transmission line. The proposed facility would be designed for at least 20 years of commercial operation and the CCT Program demonstration would operate for at least the first year. The proposed project would cost $432 million, of which DOE's share would be approximately $78 million, or 18 percent.

The proposed project includes the design, construction, and operation of the BGL gasification technology and associated facilities to provide a fuel source for the two planned turbines. Under the Proposed Action, the turbines would be fired using the syngas product generated by the gasification technology. A high-temperature molten carbonate fuel cell would be connected to the facility and provide an additional 2 MW of electric power generation capacity while running off a small slipstream of syngas. The facility would demonstrate the following three innovative technologies: (1) gasification of RDF pellets and coal; (2) use of a syngas product as a clean fuel in combined cycle turbine generator sets; and (3) operation of a high-temperature molten carbonate fuel cell on coal and refuse derived syngas. This project would be the first commercial scale application of the BGL gasification technology in the United States. This project would also demonstrate the first commercial scale molten carbonate fuel cell operating on syngas. The demonstration would operate for at least the first year of the facility's 20-year commercial operational period. Data generated during the one-year demonstration would be used to determine if the coal and RDF pellet co-feed would continue after the first year of operation.

The purpose of the proposed project is to generate technical, environmental and financial data from the design, construction, and operation of the facilities at a scale large enough to allow the power industry to assess the potential of BGL gasification and fuel cell technologies for commercial application. If the project succeeds in generating this data, it would demonstrate that IGCC power plants, based on this technology, could be built cost effectively, with thermal efficiencies that would significantly reduce electric power costs over more conventional technologies.

3.5 Comparison of Alternatives

Table 3.5-1 reflects a comparison of alternatives at the project site under the two No Action Alternatives and the Proposed Action. This brief comparison of impacts is presented to aid decisionmakers and the public in understanding the environmental impacts of proceeding with the Kentucky Pioneer IGCC Demonstration Project.

The following discussion is based on the detailed information presented in Chapter 5, Environmental Impacts. The environmental impact analyses were designed to produce a credible projection of the potential environmental impacts, using conservative assumptions and analytical approaches. A detailed discussion of the level of conservatism and any uncertainties in these analyses is presented in Chapter 5. Impacts presented are for each alternative alone and are not cumulative; however, comparisons of impacts for the different alternatives are made at points within Table 3.5-1.