2.0 Project Description

The proposed Great Bend Integrated Gasification Combined Cycle (IGCC) facility represents a first-of-a-kind commercial scale-up of technology that has been successfully demonstrated in other projects. The following describes the proposed IGCC process and associated material handling systems for the proposed facility.

2.1 Site Location and Description

The proposed Great Bend IGCC facility will be located in the Great Bend area of Meigs County, Ohio. The Great Bend site is located along the Ohio River near the town of Ravenswood, West Virginia. The location of the proposed facility is illustrated in Appendix A.

2.2 IGCC Process Description

In general, the IGCC process involves thermally converting coal into a synthetic gas (syngas), which, after cleanup, is utilized to generate electricity in a combined cycle process. The facility will be configured with two gasifiers producing syngas for two combustion turbines whose exhaust heat is used to produce steam feeding a common steam turbine. Nominally, the net output from the facility is 629 MW. The syngas cleanup systems remove particulates, sulfur compounds (H_2S and COS), mercury, and other compounds. Other systems include a sulfur recovery system that produces an elemental sulfur by-product from the sulfur compounds removed from the syngas. Slag produced by the gasifier may be utilized as a by-product offsite or placed in a landfill. Additional support systems include the air separation unit, flare, thermal oxidizer, and cooling tower, along with auxiliary processes, such as the auxiliary boiler, emergency generator, and emergency fire water pump. Plot plans of the proposed facility are in Appendix B. Appendix C contains block flow diagrams. Artist renderings of the proposed facility are located in Appendix D. The following describes the IGCC process in more detail.

Air Separation Unit

The Air Separation Unit (ASU) uses cryogenic distillation to separate ambient air into oxygen and nitrogen streams that are used by various systems in the IGCC process. Oxygen produced by the ASU is fed to each gasifier for use in the thermal conversion of coal to syngas. Oxygen from the ASU is also utilized by the Sulfur Recovery Units. Nitrogen produced by the ASU is injected into the combustion zone of the combustion turbines to increase mass flow in the combustion turbines and act as a diluent for reducing the formation of thermal NO_x. Nitrogen is also used to blanket and purge inert systems.

Gasification System

Two separate refractory-lined gasifiers operating under high temperatures and pressures are used to thermally convert coal to syngas in a reducing atmosphere (an atmosphere with insufficient oxygen content for complete combustion of the fuel). Oxygen (from the ASU) and a coal slurry are fed to each gasifier where they react under high temperature (approximately 2,500°F) to produce a syngas consisting primarily of hydrogen (H_2), carbon monoxide (CO), and carbon dioxide (CO_2). The syngas also contains small amounts of hydrogen sulfide (H_2S), carbonyl sulfide (COS), fine particles, methane, argon, ammonia, nitrogen, and other compounds. Ash that is present in the coal liquefies at gasifier temperatures and, when cooled, forms a by-product referred to as slag. The slag exits the gasifier separately from the syngas and is removed from the process by the slag handling system. Small amounts of fine particulate exit the gasifier in the raw syngas and are removed by the downstream cleanup systems. During startup operations, natural gas is consumed in the gasifiers for preheating prior to syngas production. Preheating emissions are exhausted to atmosphere from a preheat vent downstream of each gasifier.

Syngas Treatment System

The syngas exiting the gasifier must be cooled and cleaned prior to being used as a fuel in the combustion turbines. A first step in this process is a water scrubber that utilizes water trays to wash and cool the syngas. The water scrubber removes the fine solids, as well as ammonia, chlorides, and other trace components that are water soluble. Solids removed by the scrubber are processed and either recycled with water to the coal slurry preparation system for reinjection into the gasifiers or sent to the slag handling system. Various flash tanks are used to concentrate the fine particles and treat the process water. The resulting gas streams from these flash tanks may contain ammonia and sulfur compounds, and are routed to the sulfur recovery units or can be routed to the flare or thermal oxidizer control equipment. Following the water scrubber, the syngas flows through a low temperature gas cooling system, which includes heat exchangers that improve heat rate and lower the syngas temperature to accommodate the operation of the acid gas removal system.

The acid gas removal (AGR) system is designed to remove greater than 99% of the total sulfur from the raw syngas. Primary sulfur compounds in the syngas are hydrogen sulfide (H_2S) and carbonyl sulfide (COS). Because COS is not readily captured by the AGR, a hydrolysis unit is utilized upstream of the AGR to react COS with water vapor in the presence of a catalyst to form H_2S and CO_2. Cleaned syngas exits the AGR system to a saturator that adds moisture to the syngas. The moisture from the saturator adds mass to the syngas for increased combustion turbine output and provides for lower combustion flame temperatures to reduce thermal NO_x emissions. The H_2S rich solvent is sent to a stripper that recycles the solvent and produces gas streams containing primarily H_2S and CO_2. The acid gas is primarily sent to the sulfur recovery system, but may also be used for varying process purposes.

An activated carbon bed system is also included in the cleanup process and is expected to remove greater than 90% of the mercury from the raw syngas. This mercury removal system is located downstream of the COS hydrolysis unit and upstream of the AGR system.

A flare is a control device used to support the sulfur recovery process and integrated systems, including the AGR, primarily during short-term periods of startup, shutdown, and malfunction operations. A continuous natural gas pilot is in service on the flare during unit operations. The flare provides for the safe destruction of gas streams from several points in the IGCC process during startup, shutdown, and malfunction operations. Operating procedures are designed to minimize the duration and frequency of flaring events. Additionally, the process includes a low pressure absorber that is integrated with the AGR system, which is designed to reduce potential sulfur compounds in gas streams to the flare during startup, shutdown, and malfunction operations.

Sulfur Recovery System

Acid gas from the AGR and ammonia acid gas from various systems are processed by the sulfur recovery unit (SRU) that utilizes the Claus process to convert H_2S into an elemental sulfur by-product for offsite use or, if necessary, for placement in the landfill. The Claus process uses a series of catalytic stages where a portion of the H_2S is oxidized to SO_2, which then reacts with the remaining H_2S to form elemental sulfur.

Two key sections comprise the sulfur recovery unit: a thermal section and a catalytic section. The thermal section contains a reaction furnace where oxygen from the ASU oxidizes a portion of the H_2S into SO_2. The SO_2 then reacts with the remaining H_2S in the gas stream to form molten sulfur. Downstream of the reaction furnace, the remaining gas stream goes through a series of reheating and catalytic reactions to convert additional H_2S to molten sulfur. The molten sulfur exits the SRU as a liquid and is stored in a sulfur pit prior to being handled as a by-product. Vapors from the sulfur pit storage are controlled by the thermal oxidizer. Natural gas is used for preheating the sulfur recovery unit and may periodically be used to provide supplemental heat during operation.

Tail gas exiting the SRU contains SO_2 and H_2S. The SRU tail gas is transported to the tail gas treatment unit (TGTU) that hydrogenates SO_2 to H_2S prior to recycling the tail gas back to the process. Hydrogen for this process is provided by an ancillary stream of clean syngas.

Associated with the operation of the sulfur recovery process is the integral use of a flare and thermal oxidizer as control devices to provide for the safe and efficient destruction of combustible gas streams. These control devices are primarily utilized intermittently during short-term periods of startup, shutdown, and malfunction operations. A continuous natural gas pilot will be in service on both controls. The thermal oxidizer also controls emissions from various systems during normal operations, including the sulfur pit vent.

Power Generation System

The combined cycle block is comprised of two combustion turbines, two heat recovery steam generators (HRSG), and a common steam turbine. Each combustion turbine is a GE 7FB model turbine having a nominal gross capacity of 232 MW. The exhaust from each combustion turbine passes through a dedicated HRSG that supplies steam to a common steam turbine generator with a nominal gross capacity of 320 MW. The nominal gross output from the facility is 784 MW, while the nominal net output is 629 MW.

The combustion turbines are designed to operate on either syngas or natural gas. Natural gas will primarily be used during startup and shutdown operations to support the introduction and removal of syngas to the combustion turbines, but may also be used by the combustion turbines during normal operation when syngas in unavailable and combined cycle generation is economic. Thermal NO_x formation from the combustion of syngas in the combustion

turbines will be minimized by the use of steam saturation and diluent nitrogen to reduce the combustor flame temperature.

The steam turbine condenser, ASU, and other process loads are cooled by a wet evaporative mechanical draft cooling tower. The cooling tower will be designed with a high efficiency drift elimination system to minimize potential particulate emissions.

Ancillary Support Systems

Several other systems support the operations of the IGCC unit. A natural gas auxiliary boiler is available to provide supplemental steam to the power block and other processes during startup and shutdown operations. A diesel generator and diesel fire pump are available to support emergency operations.

2.3 Material Handling Process Description

Material handling systems associated with the proposed Great Bend IGCC facility are designed to transport and store coal, along with slag and sulfur by-products. Key components of the coal handling system include a barge unloader, conveyors, storage piles, a crusher station, and various transfer stations. Both the slag and sulfur by-product handling systems are being designed with the option to transfer these materials offsite location for beneficial reuse or to a landfill at the facility. Appendix C contains a flow diagram of the material handling system. The following describes the material handling system in more detail.

Coal Handling System:

The coal handling system is designed to unload, store, and handle coal in a manner that will minimize potential emissions. Fugitive dust mitigation measures incorporated throughout the coal handling system include the use of conveyor enclosures, enclosed transfer points, and optimal transfer chute designs. Other minimization steps include the use of dust suppression and forced air dust collection systems.

Coal deliveries will be by barge. The barge unloader is designed to transfer coal to a conveyor system that then transports the coal to storage piles. A portion of the conveying system to the coal storage piles is designed to accommodate coal received from the proposed barge unloader, as well as from a future barge unloader should a second unit be developed.

An underground reclaim system is designed to recover coal from the storage piles. Reclaimed coal passes through a crushing station prior to being conveyed to the coal slurry preparation building. The coal preparation system utilizes water to prepare a coal slurry that is supplied to each gasifier for the production of syngas.

Slag By-Product Handling System:

The gasification process produces a slag by-product that can be beneficially reused or placed in the landfill. The slag by-product is handled as a wet material with a high moisture content, which is conveyed to a temporary stockpile from where it is transported by truck offsite or to the landfill. Potential fugitive particulate emissions from this system are only related to truck traffic associated with transportation of slag by-product.

Sulfur By-Product Handling System:

Sulfur by-product produced by the IGCC process will be liquid molten sulfur, and will be transported by truck to an offsite facility for beneficial reuse. The landfill associated with the proposed facility is being designed to accommodate the future placement of a solid sulfur by-product. However, provisions to produce a solid sulfur by-product for placement in the landfill are not included in the current design of the sulfur recover system. Potential fugitive particulate emissions from this system are only related to truck traffic associated with transporting the molten sulfur offsite. Future truck traffic associated with potential transportation of a sulfur by-product to the landfill was also considered.