Jenkins Report and Jenkins Exhibit 1

INTEGRATED GASIFICATION COMBINED CYCLE TECHNOLOGY IS NOT COMMERCIALLY AVAILABLE OR TECHNICALLY FEASIBLE FOR MEETING THE REQUIREMENTS OF BASIN ELECTRIC POWER COOPERATIVE'S DRY FORK STATION

STEPHEN D. JENKINS
CH2M HILL, INC.

Table of Contents

INTEGRATED GASIFICATION COMBINED CYCLE TECHNOLOGY IS NOT COMMERCIALLY AVAILABLE OR TECHNICALLY FEASIBLE FOR MEETING THE REQUIREMENTS OF BASIN ELECTRIC POWER COOPERATIVE'S DRY FORK STATION

STEPHEN D. JENKINS
CH2M HILL, INC.

SUMMARY OF FINDINGS

Main Findings of This Report

The three main points that I want to convey to the reader of this report are as follows:

1. Integrated Gasification Combined Cycle (IGCC) and Pulverized Coal (PC) are two very different power generation technologies, incorporating very different processes. While PC burns coal in a boiler to make steam for a steam turbine generator, IGCC uses a chemical process that converts the coal to a synthetic gas, which then becomes the fuel used in a gas turbine generator. Substituting IGCC technology for PC technology at Dry Fork Station would be completely redefining the source of power generation technology.

2. IGCC technology is neither commercially available nor technically feasible for meeting the project requirements for Dry Fork Station, as those terms are defined in the New Source Review (NSR) Manual, which provides the guidance for developing the Best Available Control Technology (BACT) evaluation process. IGCC technology suppliers do not commercially offer a 385 megawatt (MW) net IGCC power plant for use with Powder River Basin subbituminous coal, operating at high elevation, and with the ability to provide 95% availability.

3. Even if Basin Electric Power Cooperative were able to purchase IGCC technology for use at Dry Fork Station, it still would not be BACT. The BACT analysis clearly shows that PC technology is BACT for the Dry Fork Station project.

Purpose of the Report and Discussion of Findings

Basin Electric Power Cooperative (BEPC) requested that Integrated Gasification Combined Cycle (IGCC) power generation technology be evaluated for its potential use at the new Dry Fork Station, in lieu of the proven Pulverized Coal (PC) power generation technology that it has selected. Based on my 33 years of experience in the electric power industry, specializing in the permitting, design, construction and operation of PC and IGCC plants, my opinion is that IGCC is not a viable choice and would not meet the critical project requirements for Dry Fork Station. BEPC has selected PC, which is the only power generation technology that can meet the critical project requirements.

While PC is proven at hundreds of installations worldwide, IGCC s still a developing technology that is being demonstrated at only five coal-based units, only two of which are in the U.S. IGCC is not able to meet the critical requirements for Dry Fork Station:

- Providing baseload capacity with high reliability and availability;
- Utilizing commercially available and proven technology; and
- Generating electricity at a reasonable cost.

Baseload capacity is what electric utilities call the generating units that run "24/7", the backbone of the U.S. generating fleet that provides the "base" needs of the customers. These large, efficient power generating units are operated at full load, and are backed up by other, smaller, less efficient units (sometimes called "peakers") that can start up quickly to handle increases in customers needs on cold winter mornings and hot summer days. Together, the baseload units and peakers must follow and satisfy the customers' needs, and do it with high availability.

Why is high availability important? High availability is important for baseload units – they must be available to generate power when called on 24/7 to meet the daily base requirements of the customers. When the availability of a baseload PC unit falls below this level, other baseload units must be called on to pick up the requirements of the customers. This is usually done using smaller, less efficient baseload power generating units, meaning that low availability can directly result in higher cost electricity. Further, smaller and less efficient PC units typically have higher emissions per unit of energy generated. Low availability on a baseload unit then leads to higher overall generating system emissions.

Due to increases in power consumption by BEPC's customers, new baseload capacity is needed. That is the basic business purpose of the new Dry Fork Station, to keep the backbone of power generation strong and meet the needs of BEPC's customers. BEPC selected PC power generation technology to meet this challenge, since it is proven worldwide at doing just that. Other than normal outages for maintenance and repair, PC plants typically operate over 90% of the year. That is called 90% availability. BEPC's existing PC units, such as those at Laramie River Station, have a history of doing just that. The Dry Fork Station is being designed for 95% availability.

BEPC did not select IGCC technology, partly because IGCC cannot yet provide baseload capacity with 95% availability. The five IGCC demonstration plants worldwide have a poor availability record. While they were designed to provide 85% availability, none of them has met that design goal, even after as long as 14 years of operation. None achieves 80% on a consistent basis, and one has rarely reached 60% availability. Even though IGCC technology is not commercially available or technically feasible for the Dry Fork Station, using IGCC would subject BEPC's customers to higher cost electricity, very likely with higher emissions from the other units that would have to pick up generation when the IGCC unit was not operating.

In order to provide 95% availability, BEPC selected the technology that is commercially available and proven to meet the critical requirements for the Dry Fork Station site. PC technology has been proven worldwide for decades, and is commercially available from a number of suppliers. PC technology can be designed for a wide range of site conditions, at sea level or high elevations, and at generating capacities up to over 1,100 MW. Dry Fork Station is being designed to generate 385 MW to match the baseload needs of BEPC's customers.

IGCC technologies are being demonstrated at these five plants at the 250-300 MW size. Based on these demonstrations, the IGCC technology suppliers are commercially offering IGCC technology for full-scale operations, at the size that they call the IGCC "reference plant". It is a standard size of about 600-630 MW (net), based on using eastern bituminous coal, designed for a site at or near sea level. No one has ever built an IGCC plant to use subbituminous coal at a site at high elevation like the Dry Fork Station site. High elevation has significant impacts on IGCC plant performance, reducing the plant's net output by about 13%. These are some of the reasons that IGCC suppliers don't make (or commercially offer) a 385 MW (net) size IGCC unit designed for using subbituminous coal for operation at the high elevation of the Dry Fork Station site.

BEPC and its customers must depend on proven technology that achieves 95% availability. They cannot afford to experiment with developing technologies like IGCC. Dry Fork Station cannot be a technology demonstration or a research & development project that goes on for years to try and see if IGCC can be made to work. The power generation technology for Dry Fork Station must be commercially available and proven to be able to operate efficiently and with 95% availability. PC technology meets that requirement; IGCC does not.

The power generation technology for Dry Fork Station must be able to generate electricity at a reasonable cost. Not only is the capital cost of an IGCC plant much higher (at least 25% more) than a PC plant, its operating and maintenance costs are much higher (about 25-30% more) than a PC plant. Overall, the electricity that an IGCC plant generates is about 20-25% higher in cost than a PC plant. PC technology meets the need for generating electricity at a reasonable cost; IGCC does not.

Conclusion

Unlike IGCC, PC technology is commercially proven and available, and can utilize Powder River Basin subbituminous coal, operate at 4,560 feet elevation, provide the required 95% availability, and generate electricity at a reasonable cost. In selecting PC technology, BEPC has made the only power generation choice for Dry Fork Station.

BASIS FOR EXPERT OPINION

Basin Electric Power Cooperative (BEPC) requested an expert opinion regarding the selection of the best power generation technology to meet the critical project requirements of its new Dry Fork Station. BEPC requested that this opinion compare pulverized coal (PC) technology, which BEPC has selected for Dry Fork Station, with Integrated Gasification Combined Cycle (IGCC), another coal-based power generation technology.

I was requested to make this expert opinion based on my direct, professional experience with both of these technologies. I have 33 years of experience in the power industry, with primary experience in the permitting, design and operation of large PC power plants, emission control systems for PC power plants, and IGCC power plants. I am employed by CH2M HILL, Inc., an international engineering and environmental consulting firm, as Vice President, Gasification Services. Prior to joining CH2M HILL, I was the Gasification Technology Leader for URS Corporation, another international engineering and environmental consulting firm.

Before joining URS Corporation, I worked for Tampa Electric Company over a 25-year period. I worked in a number of areas in the company, including power plant operations, power plant engineering, fuels, environmental permitting, finance, governmental affairs and regulatory affairs. Of most importance to the subject of this report, I served as the Deputy Project Manager for the Polk Power Station IGCC project, one of only two operating coal-based IGCC power plants in the United States. This is where I gained my hands-on experience with IGCC technology.

Since working at the Polk Power Station IGCC plant, I have been directly involved in the permitting of more IGCC and gasification plants than anyone else in the U.S. and was the lead author of the industry's first IGCC Permitting Guidelines Manual, developed for the Electric Power Research Institute's CoalFleet for Tomorrow® Program. In addition to my work at the Polk Power Station IGCC facility, my other IGCC and coal gasification plant experience includes:

- AEP Great Bend (629 MW) – IGCC Technology Lead for air permit application
- AEP Mountaineer (629 MW)– IGCC Technology Lead for air permit application
- Carson Hydrogen Power Project (500 MW) - IGCC Technology Lead for air, water, and waste permitting strategies
- Confidential Client (620 MW) - IGCC Technology Lead for air, water and waste permitting strategies for the conversion of a gas-fired combined cycle unit in Pennsylvania to IGCC technology
- Energy Northwest, Pacific Mountain Energy Center (600 MW) - IGCC Technology Lead for air permit application and state siting documentation
- Excelsior Energy, Mesaba Energy Project (1,212 MW) – IGCC Technical Lead and DOE Liaison for all local, state and federal permitting
- Global Energy, Inc. – Kentucky Pioneer Project (540 MW) – IGCC Technology Lead for air permit application
- Global Energy, Inc. – Lima Energy Project (540 MW) - IGCC Technology Lead for air permit application
- REH – Southeast Idaho Energy – Gasification system air permitting consulting
- Texaco Power & Gasification - Bellefonte IGCC Project (1,600 MW) - IGCC Technology Lead for development of Supplemental Environmental Impact Statement

As part of my career in IGCC and gasification, I have written numerous technical papers and articles, made many presentations, and testified as an expert witness on IGCC and gasification technology. I have provided "Gasification 101" and "IGCC 101" technical presentations to environmental and economic regulatory agencies in the United States and Canada. This includes presentations as part of the Gasification Technologies Council's Regulatory Workshops, and special presentations provided at the request of federal and state agencies, such as those I prepared for the U.S. Environmental Protection Agency (EPA), the Colorado Public Utilities Commission and the Texas Commission on Environmental Quality. Together, I have given my presentations on IGCC technology to over 60 local, state and federal agencies, including the Office of the Governor of Wyoming and the Wyoming Department of Environmental Quality.

I am a proponent of IGCC technology. I believe that IGCC technology has the potential to provide clean, efficient, reliable electricity, and I am involved in many facets of promoting IGCC plant development. I look forward to the wide deployment of IGCC technology, so that this technology can be proven at full scale, and then further developed at larger, more efficient and more cost-effective sizes.

I am also very aware of the limitations of IGCC technology. The recent history of this technology has shown that it has significant limitations in performance, especially with respect to efficiency, availability and cost effectiveness. IGCC technology does not fit everywhere. Specifically, it does not meet the critical project requirements for the Dry Fork Station, which are shown below:

- Providing baseload capacity with 95% availability;
- Utilizing commercially available and proven technology; and
- Generating electricity at a reasonable cost.

As prior power generation technology evaluations prepared by CH2M HILL for BEPC have shown, only PC technology meets all of these critical project requirements. In 2005, CH2M HILL prepared a technical report that compared power generation technologies for use at Dry Fork Station (Exhibit 1). The report included a hypothetical Best Available Control Technology (BACT) analysis that compared the potential changes in emissions if IGCC were to be used in place of PC technology, and the "cost effectiveness" of any potential emission reductions in terms of "$/ton removed", as is commonly determined in the industry as part of a BACT analysis. In that report, CH2M HILL concluded that PC was the most cost-effective and Best Available Control Technology for use at Dry Fork Station. The report also concluded that IGCC technology was not applicable for use at Dry Fork Station, was not cost effective for emission reductions, and did not meet the critical project requirements.

In 2007, CH2M HILL updated that report (Exhibit 2). I contributed to the detailed assessments of PC and IGCC technology as part of the "hypothetical" BACT analysis. That

BACT analysis was, and still is, considered to be hypothetical, since the purpose of a BACT analysis is to select an emission control technology for a proposed power generation technology. PC and IGCC are both power generation technologies, not emission control technologies. However, we developed the hypothetical BACT analyses to determine what the additional costs might be for any incremental reductions that IGCC might be able to achieve. Such a hypothetical BACT analysis would not be required by the U.S. Environmental Protection Agency as part of the air permitting for a new coal-based power plant, and was not required by the Wyoming Department of Environmental Quality as part of the air permitting for the Dry Fork Station project.

As part of providing my expert opinion, it was important to provide further updates to the calculations, given the recent, significant increases in capital costs for industrial facilities, especially with respect to power plants. Further, IGCC technology has suffered from even greater increases in costs. Our updated assessment confirms the conclusions of our prior reports, in that IGCC would not meet the critical project requirements, and it is not a power generation choice for Dry Fork Station. PC technology remains the only choice of power generation technology for Dry Fork Station.

OVERVIEW OF A HYPOTHETICAL BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

As part of developing this report, I have evaluated the differences between PC and IGCC as separate and unique power generation technologies and each one's ability (or lack of ability) to meet the critical project requirements for Dry Fork Station. As part of the air permit application for Dry Fork Station, BEPC provided the required BACT analysis and properly selected the applicable emission control technologies for the PC technology chosen for Dry Fork Station.

While PC and IGCC are power generation technologies, and not emission control technologies, it is possible to evaluate IGCC as part of a "hypothetical" BACT analysis to determine if it would even be technically feasible to substitute IGCC for PC, what the potential emission reductions, if any, might be if substituted for PC, and if those emission reductions would be cost-effective compared to PC. This analysis is considered to be hypothetical, since the U.S. Environmental Protection Agency (EPA) would not require such an evaluation as part of the BACT analysis for a PC power plant. The BACT process is used for selecting emission control technologies; it is not meant for choosing, changing, or redefining the actual source - the power generation technology.

Following are the very important conclusions that result from the requirements of the BACT analysis and the specific definitions provided in the NSR Manual, which provides the guidelines for conducting the BACT analysis:

1. Substituting PC power generation technology with IGCC technology would require a significant and fundamental redefinition of the design of the source of power generation technology. IGCC technology is not something one designs into or adds onto a PC power plant. They are two completely different technologies for generating electricity.

2. As the terms "commercially available" and "technically feasible" are defined and used in the NSR Manual, which provides the guidance for conducting a BACT analysis, IGCC technology is not commercially available or technically feasible for the Dry Fork Station project. IGCC technology suppliers do not make (or commercially offer) a 385 MW (net) IGCC power plant designed to use Powder River Basin subbituminous coal as the feedstock for an IGCC power plant located at a site at an elevation of 4,560 feet and to provide 95% availability. No IGCC power plant has ever been designed or built to generate 385 MW (net) using subbituminous coal, at an elevation of over 4,000 feet. Dry Fork Station must use a commercially proven power generation technology that provides 95% availability, and this project cannot serve as a technology demonstration or a research and development project.

3. Even if IGCC was substituted for the PC technology selected for Dry Fork Station, it still would not be BACT. IGCC is not cost effective compared to PC technology.

THE HYPOTHETICAL BACT ANALYSIS

The NSR Manual

The NSR Manual was developed by the U.S. EPA to provide the guidance for a BACT analysis. The manual is used for selecting emission control systems for a wide range of industrial sources, including power generation technologies. The NSR Manual uses a five step, top down methodology for evaluating add-on emission controls. This methodology is well defined, and provides for a defensible selection or elimination of emission control technologies. The manual uses specific terms which may be defined differently in each step of the process. Therefore, it is important that the definitions be fully understood in order to assess the specific emission control technology appropriately in each step of the process.

The specific terms are listed below, with reference to the page numbers where they occur in the NSR Manual:

- Available (Pages B.5, 17, 18 and 20)
- Practical potential (Page B.5)
- Technically feasible or infeasible (Pages B.7, 17, 19, 20 and 21)
- Applied to full scale development (Page B.11)
- Demonstrated (Pages B.11 and 17)
- Applicable (Pages B.17 and 18)

As part of this hypothetical analysis, it is important to first determine whether IGCC meets each (or any) of these definitions.

1. Is IGCC an available control technology?

Page B.5 - IGCC is not "available" because it does not to have the practical potential for application at the Dry Fork Station. As noted above, IGCC technology has never been designed or operated using Powder River Basin subbituminous coal at high elevation. Since the IGCC suppliers do not make or commercially offer a 385 MW (net) IGCC power plant (either for eastern bituminous coal or subbituminous coal), and for use at high elevation, BEPC would not be able to even buy such a plant for application to the Dry Fork Station.

Page B.17 - IGCC is not "available" since it cannot be "obtained by the applicant through commercial channels". As noted above, the IGCC suppliers do not make or commercially offer a 385 MW (net) IGCC power plant. When BEPC sent out a Request for Proposals to study the feasibility of installing IGCC technology at Dry Fork Station, they only received three proposals. None of them offered any guarantees or warranties, even though specific guarantees and warranties were requested to be included in the proposals. Without such guarantees or warranties, they could not be considered as real commercial offerings.

Page B.18 – IGCC cannot be considered to be "available" since it has not yet "reached the licensing and commercial sales stage of development" for the needs of Dry Fork Station – a 385 MW (net) power plant with 95% availability, based on using Powder River Basin subbituminous coal, located at a site at an elevation of 4,560 feet, generating electricity at a reasonable cost, and using a commercially proven technology.

Page B.20 – IGCC cannot be considered to have "commercial availability" for the Dry Fork Station project, since no vendor guarantees were offered, even though specific guarantees and warranties were requested to be included in the proposals.

2. Does IGCC have a <u>practical potential</u> to be applied to Dry Fork Station?

Page B.5 – IGCC has no practical potential to be applied at Dry Fork Station. What would be required for Dry Fork Station is not commercially available, and such a configuration has never been designed or operated anywhere. Further, IGCC cannot meet the 95% availability requirement. It would not be practical for IGCC to be installed at Dry Fork Station.

3. Is IGCC <u>technically feasible or infeasible</u>?

Page B.7 – IGCC would not be technically feasible since there would be significant difficulties in designing the plant, and in actually making the plant work, based on physical limitations and engineering principles related to the size of the unit and the impacts of high elevation.

Page B.17 – IGCC is not technically feasible since it has not "been installed and operated successfully on the type of source under review". As noted above, IGCC technology has never been installed and operated successfully using subbituminous coal at high elevation. Further, based on the poor operating history and efficiencies of the longer operating IGCC demonstration plants, IGCC has not even been installed and operated successfully using eastern bituminous coal at or near sea level.

Page B.19 – IGCC is technically infeasible due to its "commercial unavailability" to meet the size, site conditions, elevation and critical project requirements of Dry Fork Station. This is not an issue of cost. As noted above, a request for proposals for an IGCC plant designed for the Dry Fork Station resulted in proposals that could not meet commercial requirements for guarantees and warranties.

Page B.20 – The technical infeasibility of IGCC technology for the Dry Fork Station site has been clearly described above. The "unresolvable technical difficulties would preclude the successful development" of an IGCC plant that needs to be designed at the 385 MW (net) size, using subbituminous coal, located at an elevation of 4,560 feet, with a requirement for baseload operation with 95% availability.

Page B.21 – IGCC is not technically feasible since all of the information noted above clearly shows that "source-specific factors exist and are documented to justify the technical infeasibility" of IGCC technology at Dry Fork Station.

4. Has IGCC been <u>applied for full scale development</u>?

Page B.11 – IGCC technology has not yet been applied for full-scale development. IGCC has only been demonstrated at small scale, at the 250-300 MW (net) size. IGCC technology suppliers are now commercially offering the full-scale IGCC reference plant described above, at the 600 -630 MW (net) size. It will be five to six years before full-scale plants have been constructed and started up.

5. Is IGCC demonstrated?

Page B.11 – IGCC has not been successfully demonstrated in practice on full scale operations. It has only been demonstrated at small scale, as noted above, and even those demonstrations cannot be considered to be successful since the plants have not met their design goals.

Page B.17 – IGCC is not yet demonstrated since it has not "operated successfully on the type of source under review", meaning a 385 MW (net) IGCC plant using Powder River Basin subbituminous coal, located on a site at an elevation of 4,560 feet, and providing baseload electrical generating capacity with 95% availability.

6. Is IGCC applicable?

Page B.17 – IGCC is not applicable since it cannot "reasonably be installed and operated on the source type under consideration", meaning a 385 MW (net) power plant designed to use subbituminous coal, operate on a site located at an elevation of 4,560 feet, and provide baseload capacity with 95% availability using a commercially available and proven power generation technology.

STEP 1 OF THE BACT ANALYSIS

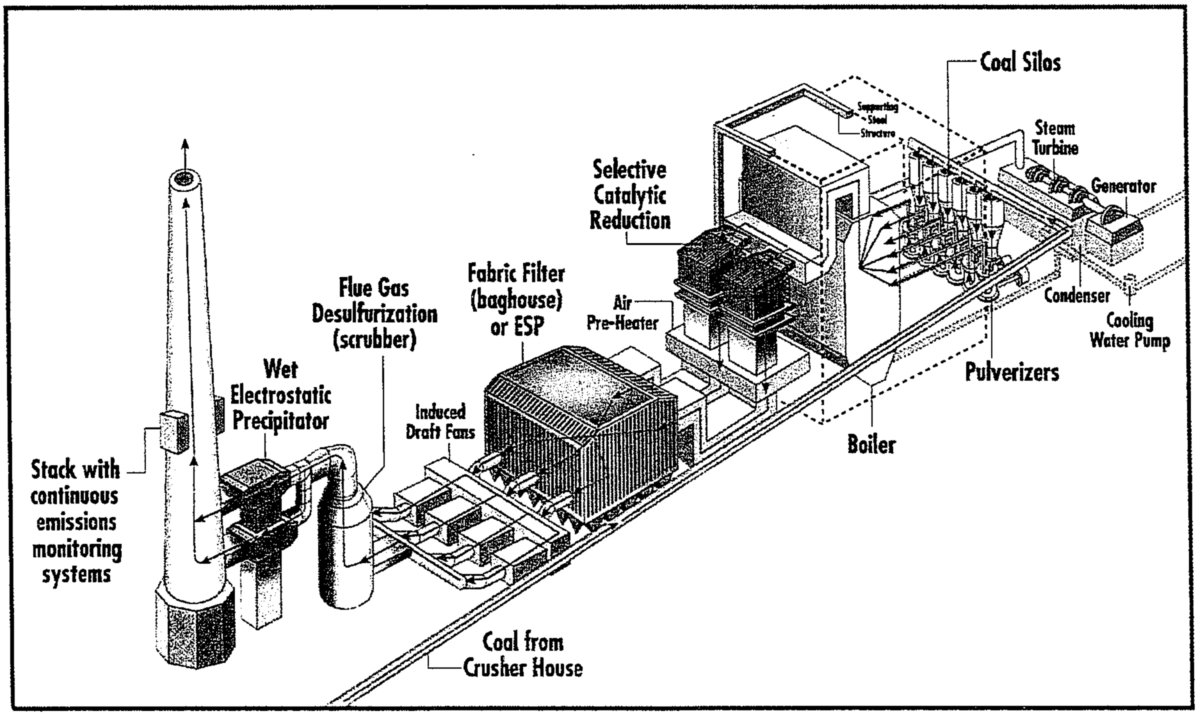
1. Would the use of IGCC technology instead of PC technology constitute a redefinition or redesign of the proposed PC technology?

The purpose of a BACT analysis is to evaluate various emission control technologies that can be applied to the power generation source that has been selected for a specific project. The purpose of the BACT analysis is not to evaluate or select the actual source of power generation technology. The power generation technology is selected prior to performing the BACT analysis, using project-specific and site-specific parameters. For this project, BEPC selected PC technology to meet its critical project requirements, and it has evaluated and selected specific emission control technologies for use with that PC technology.

Changing from PC technology to IGCC technology would be a significant and fundamental redefinition of the design of the source for Dry Fork Station. In order for the reader to fully understand this, it is important to understand the differences between PC and IGCC technologies. Following is a basic description of these two unique power generation technologies.

WHAT IS PC TECHNOLOGY?

PC technology, which is proven at hundreds of installations world-wide at large commercial scale, involves the combustion of coal to produce steam, which is then used to drive a steam turbine generator to generate electricity. After exiting the steam turbine, the steam is condensed to water, and then pumped back to the boiler to be turned into steam again. The figure below shows the major systems in a PC power plant.



Source: Florida Power & Light

The use of steam produced in a boiler and used to drive a steam turbine-generator is called the Rankine thermodynamic cycle. With PC technology, the coal is first crushed and pulverized to a fine powder, then blown into the boiler with air. The combustion of coal occurs in a range of 2,500-3,000 °F, producing exhaust gases made up primarily of carbon dioxide ("CO_2"), nitrogen and water. It is important to clarify that in a PC boiler, the coal is the fuel. Some of the nitrogen in the coal, as well as the nitrogen in the air, is converted to oxides of nitrogen (NOx). Ash in the coal is converted either to fly ash, which exits with the exhaust gases, or bottom ash, which is extracted from the bottom of the boiler's furnace.

The flue gases from the coal combustion process then leave the boiler and pass through emission control systems. Typically, the first emission control system is the selective catalytic reduction ("SCR") system, for NOx reduction. The flue gas then enters the air preheater, which transfers heat from the flue gases to the incoming combustion air, increasing the overall plant efficiency. Following that, the flue gases pass through a fabric filter (baghouse) or electrostatic precipitator, where more than 99% of the fly ash is removed. The flue gases then flow into the flue gas desulfurization ("FGD") system, where sulfur dioxide ("SO_2") is absorbed. If a dry FGD system is used (as with the Dry Fork Station configuration), the baghouse follows it, so that the fly ash and the SO_2 reaction byproducts can be removed in one step. From there, the cooled, clean flue gases exit through the stack.

WHAT IS IGCC TECHNOLOGY?

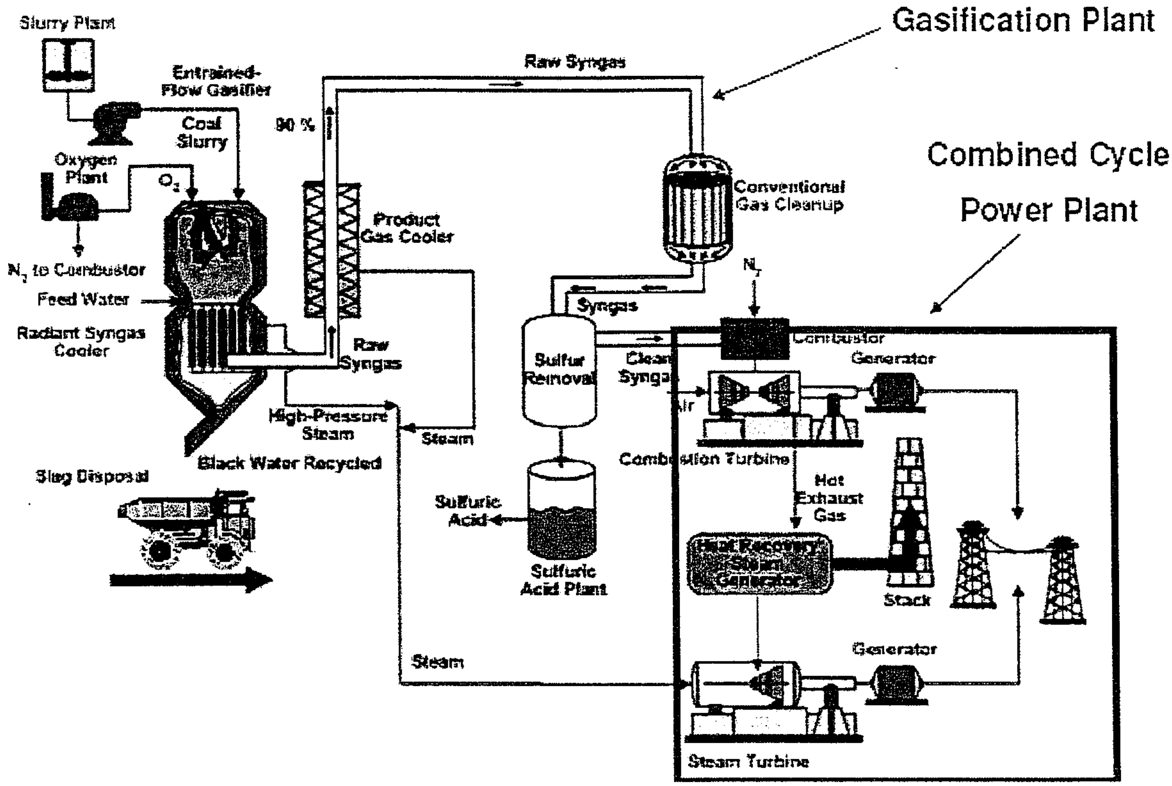
IGCC is a developing technology for generating electricity using a synthetic gas produced from coal. It is considered a developing technology, since there are only five demonstration-sized, coal-based IGCC plants worldwide, versus hundreds of commercial-scale PC plants as noted above. IGCC uses coal very differently from PC technology. As noted above, coal is the fuel for a PC boiler – it is actually burned with a flame. However, in an IGCC plant, the coal is not a fuel, and the coal itself is not burned. In an IGCC plant, the coal is simply a feedstock for a chemical process that creates a synthetic gas.

IGCC is a combination of coal gasification technology from the chemical industry and combined cycle technology from the power industry. Understanding each of these two technologies and how they are integrated into one facility for generating electricity is important.

Coal gasification is a process whereby carbon-based materials, like coal, are converted at high temperature and high pressure, and with a limited amount of air or oxygen, into a synthetic gas, called "syngas". This syngas is composed primarily of carbon monoxide and hydrogen, which are combustible gases, although they are also used in the chemicals industry as basic building blocks for a wide range of chemicals and fuels. The syngas can be combusted for use in generating electricity. Coal gasification is very different from the combustion that occurs in a boiler. PC boilers require excess air to ensure that the coal is completely combusted, while gasification operates in an oxygen-starved environment, so that complete combustion is precluded. Gasification has been in use worldwide for over 200 years, initially for converting coal to town gas for use in heating and lighting, and later for the production of chemicals and transportation fuels. Coal gasification itself is not a method for generating electricity, but is a chemical process used to produce the syngas.

Combined cycle power generation technology uses a combination of two unique methods of power generation. The first is the Brayton thermodynamic cycle, where gas turbines combust natural gas or diesel oil as the primary fuel. The gas turbine operates like a jet engine, and rotates at a high rate of speed. It is connected on the same shaft to a generator, so that the mechanical energy is converted to electrical energy. The exhaust gases leave the gas turbine at a temperature over 1,000°F. This hot exhaust gas flows through a boiler, called a heat recovery steam generator ("HRSG"), which uses the hot exhaust gas to produce steam. This steam is piped to a steam turbine generator to generate additional electricity. By capturing the energy in the exhaust gas, the output and efficiency of the overall power plant are increased substantially.

An IGCC facility combines coal gasification technology from the chemical industry with combined cycle power generation technology from the power industry. The figure below shows how this combination of coal gasification and combined cycle technologies is integrated into the power generation technology we call IGCC.



Source: U.S. Department of Energy

Air, steam, oxygen, nitrogen and other streams are integrated between the gasification and combined cycle "islands"; hence, the name Integrated Gasification Combined Cycle, or IGCC. The integration part of IGCC provides a great challenge in the design and during operation. It involves combining coal gasification and power generation technologies, as well as additional systems that are required to monitor and control the overall process.

Conclusion

As noted above, PC and IGCC are two very different power generation technologies, incorporating very different processes. While PC combusts coal in a boiler to make steam, IGCC converts coal to a synthetic gas, which is then used in a gas turbine.

Other than the coal handling and storage equipment and a main station transformer for connecting the plant to the electrical grid, almost everything else in between the "coal in" and "power out" points is completely different for these two power generation technologies and there are few pieces of equipment or systems that are similar or interchangeable.

On that basis, changing from PC technology to IGCC technology would require a significant and fundamental redefinition of the design of the PC power generation technology that has been selected for Dry Fork Station.

2. Would the use of IGCC technology satisfy the critical project requirements for the Dry Fork project?

IGCC would not meet the critical project requirements for Dry Fork Station, which are:

- Providing baseload capacity with 95% availability;
- Utilizing commercially available and proven technology; and
- Generating electricity at a reasonable cost.

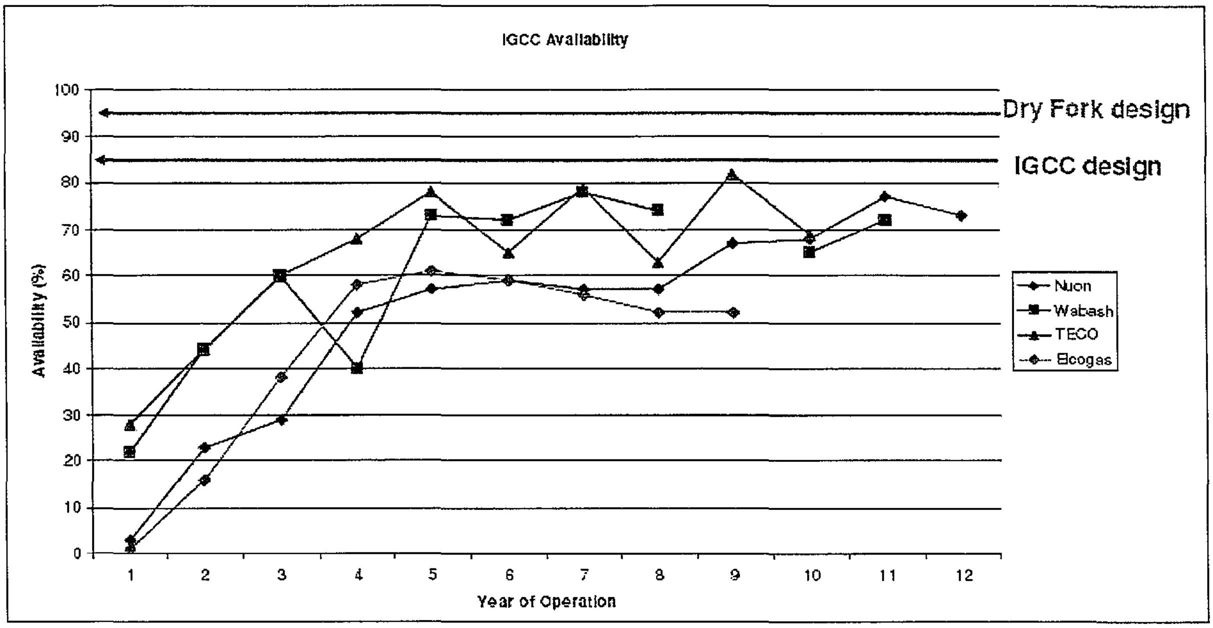
PC technology was selected as the power generation technology for the Dry Fork Station project because it meets all of the critical project requirements. PC technology is proven worldwide in hundreds of installations. Using IGCC technology would not satisfy the basic business purpose and objectives of the Dry Fork Station project. An assessment of the ability of IGCC to meet each of the critical project requirements is provided below.

a. Can IGCC technology provide the 95% availability required for the Dry Fork Station project?

IGCC has only been demonstrated at relatively small-scale operations, and at only five coal-based plants worldwide, the oldest of which has been in operation about 14 years. Two are in the United States, one is in the Netherlands, one is in Spain, and the most recent demonstration plant started up last fall in Japan. All five are referred to as "demonstration" plants, as each was built to demonstrate the first application of a specific IGCC technology at a nominal 250-300 MW size, using one gasifier train with a power block composed of one gas turbine, one HRSG and one steam turbine.

None of these plants has been able to provide even close to 95% availability. As the figure below shows, none of the four initial IGCC demonstration plants has achieved even 80% operational availability on a consistent basis. One has barely been able to achieve 60%

availability. These IGCC demonstration plants have not been able to meet their individual project-specific goals of 85% availability. Based on that performance, and the fact that the IGCC reference plant designs (for the plants to be started up in 2011-2014) are expected to provide only as high as 86% availability, IGCC would not be able to meet the 95% availability requirement for Dry Fork Station.



Source: Electric Power Research Institute

Tampa Electric's Polk Power Station Unit #1 IGCC facility was designed to meet an 85% availability goal in the second year of operation[1]. As the graph shows, the availability in the second year was only 45%, and it has never achieved 85% availability in its more than 11 years of operation. It barely meets 80% availability on a consistent basis. Even with the thousands of lessons learned at Polk Power Station Unit #1, Tampa Electric noted in the application to the State of Florida for its proposed new Polk Power Station Unit #6 (now cancelled), that it would only achieve 86% availability[2]. Even at 86% availability, IGCC technology would not be able to meet the critical project requirements for Dry Fork Station.

This is in comparison to PC technology, which has been successfully demonstrated in service at hundreds of full scale units for decades. PC technology has achieved over 90%

[1] "Final Public Design Report", Tampa Electric Company, July 1996.

[2] "Testimony and Exhibits of Michael R. Rivers", Tampa Electric's Petition to Determine the Need for Polk Power Plant Unit 6, July 2007.

operational availability on a consistent basis. BEPC's own PC units, such as the three units at the Laramie River Station, have achieved an average availability of greater than 90% over the past six years.

IGCC is not yet able to provide baseload capacity with high reliability and availability.

b. Is IGCC technology a commercially available and proven technology?

IGCC technology is not a commercially available and proven technology for the project requirements for the Dry Fork Station. It is not commercially available at the 385 MW (net) size needed for Dry Fork Station. As noted previously, IGCC technology suppliers are now offering their technologies for use in commercial power plants. These commercial offerings are based on the use of a two-gasifier train configuration, with each gasifier designed to produce sufficient syngas to fully load a modern "FB" class gas turbine. The gas turbine is then matched with a steam turbine generator designed to utilize the steam produced in the HRSGs and in the syngas coolers (if used) in the gasification island. The commercial IGCC offerings are based on the plant being designed for bituminous coal, and operating at or near sea level. This "IGCC reference plant" is typically sized to generate approximately 600-630 MW (net) at these conditions.

While many of the components of an IGCC plant have been proven in commercial service, the operating history of the demonstration plants has clearly shown that IGCC is not yet a proven technology for full-scale, baseload power generation. It is still a developing technology.

One of the performance expectations of IGCC was that it would be much more efficient than PC technology. That has not been the case, and IGCC has been unsuccessful in meeting that performance expectation. For example, Tampa Electric Company's Polk Power Station IGCC Unit #1 was designed for a heat rate of 8,500 Btu/kWh, which is an efficiency of 40%. Tampa Electric has reported that the plant's normal operating heat is 9,600 Btu/kWh, or an efficiency of only 35.5%. On an annual basis, the startups and shutdowns increase the heat rate to as high as 10,140 Btu/kWh, or an efficiency of only 33.6%.

It will be another six to seven years before the proposed "full scale" IGCC reference plants will have been constructed, have been started up, have gone through initial operation, and have been in stable operation for at least one to two years. Only at that time will it be possible to determine whether IGCC technology has been successfully demonstrated on full scale operations. For now, IGCC is not proven on full-scale operations.

c. Can IGCC technology generate electricity at a reasonable cost?

As discussed above, IGCC is not even commercially available at the 385 MW (net) size needed for Dry Fork Station. Even if BEPC could buy IGCC technology at that size, and designed to meet the critical project requirements for Dry Fork Station, it would cost BEPC's customers much more than for PC technology. Over the past several years, the industry has seen a significant escalation in the capital cost of power plants. This is highlighted in a recent report by Cambridge Energy Research Associates (CERA), providing the increases in power plants costs since 2000[3].

Increases in power plant capital costs, along with fuel and O&M costs, directly impact the cost of electricity. Industry data has been consistent in showing that IGCC is significantly higher in capital cost than PC technology.

As an example, GE Energy noted that IGCC technology costs 20-25% more than PC technology[4], and that they expected to be able to cut that premium in half. That has not occurred. IGCC capital costs have continued to escalate. Some of the most up-to-date IGCC cost data have been provided by Duke Energy Indiana for its proposed 795 MW gross/630 MW net Edwardsport IGCC project. In 2007, Duke Energy had reported the cost of this IGCC plant (a GE energy IGCC plant designed for eastern bituminous coal) to be $1.985 billion[5]. In April, 2008, Duke Energy notified the Indiana Utility Regulatory Commission that the cost estimate had increased another $365 million[6], or 18%, to $2.35 billion, or $3,730/kW. Such increases in capital cost will continue to have an impact on the cost of

---

[3] http://www.cera.com/aspx/cda/public1/news/pressReleases/pressReleaseDetails.aspx?CID=9505

[4] "GE's Gasification Developments", Ed Lowe, GE Energy. October, 2005.

[5] "Edwardsport Integrated Gasification Combined Cycle Power Station – Front End Engineering and Design Study Report", filed with the Indiana Utility Regulatory Commission, April, 2007.

[6] "Petitioner's Case-in-Chief Testimony and Exhibits of James L. Turner", filed by Duke Energy Indiana with the Indiana Utility Regulatory Commission, May 16, 2008.

electricity from IGCC power plants. Duke Energy is also building its 800 MW (net) Cliffside PC unit in North Carolina. The cost of that unit is estimated to be $1.8 billion, plus another $600 million in interest during construction, for a total of $2.4 billion[7]. This would be $3,000/kW. On that basis, Duke Energy's IGCC plant will be 24% higher in capital cost than its PC plant.

The U.S. Department of Energy (DOE) published its most recent (2007) detailed technical and economic cost data in a report titled "Cost and Performance Baseline for Fossil Energy Plants". The report provides the cost of electricity generated by various power generation technologies. For PC and IGCC, the costs are based on the use of bituminous coal:

	IGCC	PC
Cost of Electricity, c/kWh	7.80	6.40

IGCC costs are based on GE Energy technology

This DOE report shows that the cost of the same electricity from IGCC would be 22% higher than from a PC unit. Another example of the higher cost of electricity from IGCC plants is for the proposed Mesaba IGCC project in Minnesota. As part of the administrative hearings for this case before the Minnesota Public Utilities Commission, the Administrative Law Judges assigned to the case found that the cost of the electricity from this plant would be 32% higher than that from a proposed nearby PC plant[8].

Based on these recent cost estimates, <u>IGCC is not able to generate electricity at a reasonable cost</u>.

Conclusion

While PC technology meets all of the project requirements, IGCC does not. Based on this evaluation, IGCC technology does not satisfy the critical project requirements for a

---

[7] "February 2008 Advanced Clean Coal Cliffside Unit 6 Cost Estimate, Docket No. E-7, Sub 790", letter from counsel to Duke Energy Carolinas to the North Carolina Utilities Commission, February 29, 2008.

[8] "Findings of Fact, Conclusions of Law, and Recommendation", MPUC Docket No. E-6472/M-05-11993 and OAH Docket 12-2500-17260-2. April, 2007.

commercially proven power generation technology that can provide reasonably-priced electricity with 95% availability for the Dry Fork Station project.

3. Has IGCC technology been successfully demonstrated on full scale commercial operations?

According to the NSR Manual, an "available" technology is one that has been "successfully demonstrated in practice on full scale operations". As noted above, IGCC demonstration plants have not been successful in achieving either availability or efficiency design goals. Further, IGCC technology only exists at the demonstration size. It will be several years before the full-scale IGCC plants will be in operation.

IGCC cannot be considered as "available" based on this definition in the NSR Manual, because it has not been successfully demonstrated on full-scale operations. It is still a developing technology, and is not yet considered to be proven at full scale. That conclusion is further confirmed by the construction of another IGCC technology demonstration plant, such as the Nakoso plant in Japan, which only recently began operation.

STEP 2 OF THE BACT ANALYSIS

Step 2 is for determining the technical feasibility of emission control options that were identified in Step 1. Although IGCC has been eliminated from further consideration in Step 1 of the BACT analysis, it will be evaluated under Step 2 of this hypothetical BACT analysis. According to the NSR Manual, an emission control option that has been demonstrated is considered to be technically feasible. Emission control options that have not been demonstrated are assumed to be technically feasible if they are commercially available and can reasonably be installed and operated on the source.

1. Has IGCC technology been installed and operated successfully on projects like the Dry Fork Project?

IGCC technology has never been installed or operated successfully on any projects like the Dry Fork Station project. The Dry Fork Station project presents a technical challenge to IGCC technology, in that the design coal is subbituminous coal from the Powder River Basin, the plant will be located at an elevation of 4,560 feet, and with a requirement for 95%

availability. The GE Energy (then Texaco) technology used at Tampa Electric Company's Polk Power Station was designed for eastern bituminous coal. It presently uses blends of bituminous coal and pet coke. The ConocoPhillips (then Destec) technology used at the Wabash River Plant was designed for local bituminous Indiana coals. In order to lower generation costs, it presently uses up to 100% pet coke as the feedstock.

Another key design feature of all of the IGCC demonstration projects is that they were designed to operate at sea level or low elevation. There are no IGCC plants operating at high elevation. Throughout the western U.S., there are many PC plants that have been successfully built and operated with subbituminous coal at high elevation, as there are minimal elevation impacts on PC technology. However, IGCC technology has technical limitations due to high elevation.

At high elevations, such as at the Dry Fork Station site, the impacts of high elevation would be substantial, resulting in a reduction in net plant output of 13% (see calculations later in this report). At higher elevations, where the air is less dense, gas turbines are unable to compress sufficient amounts of air through their combustion systems. The impact of this restriction is that the amount of syngas that can be combusted (with the lower amount of air available) is reduced, and gas turbine power output is reduced. Since less syngas is used, the coal throughput is also reduced. Since less coal is used, the amount of oxygen required is also reduced, and the capacity of the air separation unit is reduced. Since commercial gasifiers and gas turbines are designed and rated at sea level conditions, the plant's output would be reduced to a point where more than 10% of the plant equipments capacity would go unused. This means that the millions of dollars spent for such equipment would have to be spread over the lesser amount of power generated at the plant, making electricity from an IGCC power plant even more expensive than from a PC plant.

Conclusion

For these reasons, no IGCC plants have been built at high elevation. More specifically, no IGCC plants have been installed or successfully operated at the conditions of the Dry Fork Station.

2. Is IGCC technology commercially available for the Dry Fork Project?

IGCC technology is not commercially available for the 385 MW (net) size and for meeting the critical project requirements for the Dry Fork Station. IGCC technology is commercially offered as a standard "reference plant", based primarily on the use of eastern bituminous coal, at sea level or low elevation. For example, GE Energy, a leader in the IGCC industry, does not offer its IGCC technology for use with subbituminous coal, so that it would not be considered for this project at all.

However, IGCC technology is not commercially available at the 385 MW (net) size needed for the Dry Fork Station. IGCC technology suppliers have demonstrated (although not successfully demonstrated, as history shows) their technologies at the 250-300 MW (net) size, using a configuration with one gasifier, one gas turbine, one HRSG and one steam turbine. This one gasifier train configuration was designed only for demonstration purposes, and is not offered commercially.

Today, IGCC technology suppliers are commercially offering an IGCC "reference plant" that uses two 50%-sized gasifiers to produce sufficient syngas to fully load two FB-class gas turbines, with two HRSGs and a steam turbine rated to use the steam from the HRSGs and syngas coolers in the gasification block for power generation. This reference plant configuration would generate 770-795 MW (gross) and 600-630 MW (net), using eastern bituminous coal as the feedstock, and operating at sea level.

The IGCC reference plant's approximate output is as follows:

Gas turbine gross output:	464 MW
Steam turbine gross output:	+ 320 MW
Total gross output:	**784 MW**
Internal load:	-150 MW
Net plant output	**630 MW**

This is the basis of the reference plant that is commercially available from several IGCC technology suppliers. This would not meet the critical project requirements for Dry Fork Station. These IGCC technology suppliers do not commercially offer the "one gasifier train" demonstration plant design, as that was only for demonstration plant purposes. What is commercially offered is the two gasifier configuration described above. The gas turbines are manufactured and commercially offered in a fixed size. In order to fully load these gas turbines, the gasification technology manufacturers have designed their gasifiers to a matching size. The overall implication of this is that IGCC power plants are commercially offered to generate about 630 MW net. Not 250 MW net, as in the demonstration plants, and not 385 MW net as with the project requirements for the Dry Fork Station. The 385 MW net size of IGCC plant is not commercially offered.

Conclusion

Therefore, IGCC technology is not commercially available for application at Dry Fork Station.

3. Is IGCC technology demonstrated to be applicable to projects like Dry Fork – can it be reasonably installed and operated at Dry Fork Station?

IGCC technology has not been demonstrated to be applicable to projects like Dry Fork Station. It cannot be reasonably installed and operated at the site conditions and to meet the critical project requirements for Dry Fork Station. This issue deals primarily with whether IGCC can be installed and operated at Dry Fork Station, using subbituminous coal at high elevation, and meeting 95% availability. Even though a 385 MW net size IGCC plant is not commercially available, this report evaluates whether such a plant could be reasonably operated at the Dry Fork Station site.

In a recent detailed study by ConocoPhillips (an IGCC technology supplier) and WorleyParsons (an engineering company)[9], the impacts of elevation were determined for an IGCC plant at sea level and one at over 4,000 feet altitude. The study was based on the commercial IGCC reference plant described above. In the table below, the column "Impact of Elevation" provides the results of the study. The base values for the IGCC plant at sea level are from a study performed by ConocoPhillips in 2006[10]. The values at the 4,000- foot level (similar to the Dry Fork Station site) are calculated from the per cent reduction values presented in the study.

---

[9] "CO_2 Capture: Impacts on IGCC Plant Performance in a High Elevation Application using Western Sub-bituminous Coal", Satish Gadde and Jay White (WorleyParsons) and Ron Herbanek and Jayesh Shah (ConocoPhillips), October, 2007.

[10] "E-Gas Applications for Sub-Bituminous Coal", Ron Herbanek and Thomas A. Lynch, ConocoPhillips, October, 2005.

Gross plant output, MW	IGCC plant at sea level	Impact of 4,000 foot elevation	IGCC plant at 4,000'
Gas turbine	464	-9%	422
Steam turbine	314	-16%	263
Total gross output, MW	778	-12%	685
Total aux loads and losses, MW	134	-8%	123
Net power output, MW	644	-13%	561

This study shows that high elevation does have a significant impact on IGCC technology and its performance. The reference plant (for this study, the reference plant was sized at 644 MW) would experience a reduction in power output to only 561 MW. This is an overall reduction in plant output of 83 MW, or 13%. This shows that there would be a significant performance impact on an IGCC plant due to the high elevation of the Dry Fork site. While some components of the gasification island would be smaller, since less coal would be gasified, some portions of the IGCC plant would remain at the same size. The gas turbines are a standard factory size, and would operate at below their maximum rated output due to the less dense air. The steam turbine, which would be 16% smaller as shown in the table above, could be manufactured at a size closer to that lower capacity.

Conclusion

It would not be reasonable or cost effective to select a power generation technology that would suffer such a performance impact. Since the 385 MW net size is not commercially available, IGCC technology could not be installed at the Dry Fork Station. Due to the significant impacts on performance, IGCC technology could not be reasonably operated at the Dry Fork Station site.

4. Has IGCC technology reached the licensing and commercial sales stage of development for a project with the needs and attributes of Dry Fork Station?

Conclusion

As noted above, IGCC technology is not commercially available at the 385 MW (net) size, for use with subbituminous coal, at the high elevation of the Dry Fork Station site. It is not yet developed to the stage where it would meet the Dry Fork Station project requirements for generating baseload capacity with 95% availability, and using a commercially proven technology.

STEP 4 OF THE BACT ANALYSIS

Step 4 of the BACT analysis is used to evaluate the energy, environmental, and economic impacts of each of the emission control technologies that have "survived" the prior assessment steps. While IGCC technology has been eliminated in the steps shown above, it is still valuable to show that IGCC is not a cost effective technology for reducing emissions, compared to the PC technology that has been selected for Dry Fork Station.

1. What is the incremental cost-effectiveness of IGCC technology, compared with PC technology, in reducing emissions--what is the cost per ton of additional pollutants removed?

Conclusion

Using the most current and reliable capital, O&M and fuel costs, as well as environmental performance that is applicable to PC and IGCC plants, the cost effectiveness values have been calculated (as shown later in this report), for changing from PC to IGCC technology (even though IGCC technology was eliminated from each of the BACT steps as shown above). The value for the overall incremental reductions in emissions is $26,400/ton, which is far above any cost effective values used to make alternate selections for emission control systems.

ASSESSMENT OF THE CLEAN AIR TASK FORCE REPORT

In April, 2008, Mr. Mike Fowler of the Clean Air Task Force submitted his report "Expert Report on Integrated Gasification Combined Cycle and Pulverized Coal Combustion in the Best Available Control Technology Analysis for the Dry Fork Station Power Plant". His report was prepared on behalf of the Powder River Basin Resources Council, in support of their contention that IGCC technology should be selected as BACT for the Dry Fork Station project. The report makes conclusions that IGCC is cost-effective, commercially available at