3. INTEGRATED GASIFICATION COMBINED CYCLE RESOURCE UPDATE

Emerging clean coal technology continues to gain attention as a potential means to add new coal-based generating resources while offering reduced emissions compared to a new conventional coal plant. These emerging technologies also offer the potential to more economically capture carbon dioxide (CO_2) for beneficial reuse or geologic sequestration than conventional coal technology. Recent developments in the power supply industry related to Integrated Gasification Combined Cycle (IGCC) technology have created a groundswell of interest in this clean coal technology. In addition, incentives for IGCC and other clean coal technologies included in the Energy Policy Act of 2005 have the potential to reduce the cost differential between IGCC and other generation sources.

Within its 2004 IRP, PacifiCorp considered IGCC as a resource option in numerous candidate resource portfolios and included the best information available at that time on expected cost and performance. However, based on cost projections for IGCC as compared to other resource alternatives, such as conventional coal generation, the resulting Preferred Portfolio did not include IGCC.

Recognizing the potential of IGCC, PacifiCorp has continued to explore IGCC technology since the 2004 IRP was filed through discussions with suppliers and completion of a preliminary engineering study of the expected costs of an IGCC plant located at the Hunter site. The study results indicate that IGCC remains more costly than conventional pulverized coal, though the estimated cost gap has narrowed since the 2004 IRP. The results of PacifiCorp's preliminary IGCC study are presented below, along with discussions on EPACT2005 investment incentives, state IGCC policy developments, and the technical and regulatory challenges faced by emerging technology such as IGCC.

TECHNICAL UPDATE

PacifiCorp contracted with Parsons E&C in late 2004 to perform a preliminary engineering study of the expected cost of installing an IGCC plant on the Hunter site. This study represents Parsons' conceptual level analysis of the expected cost and performance of the two commercial gasifier options available at that time, GE-Texaco and ConocoPhillips E-Gas. The study is not equivalent to a Feasibility Study, which would develop the most reliable engineering and cost information necessary to make a decision regarding selection of the best IGCC technology. The study used Utah coal with an identical quality to the coal used in previous Hunter pulverized coal technology studies. This coal is a Utah bituminous low-sulfur coal with an average heat content of 11,500 Btu/lb (HHV).

The Parsons study developed a conceptual engineering, procurement and construction (EPC) price estimate for an IGCC plant. PacifiCorp then adjusted these costs to include other site-specific costs as derived from previous Hunter 4 studies of the cost of a new pulverized coal unit. These adjusted cost estimates included allowances for additional coal handling, construction management, water, spare parts, PacifiCorp personnel, and financing charges. Based on these adders the projected cost to install a 519 MW gasification system on the Hunter site was expected to be approximately $1,957/kW in 2005 dollars. This compares to the subcritical

pulverized coal boiler estimate of $1,687/kW and the supercritical boiler cost estimate of $1,735/kW used in the 2004 IRP.

This IGCC estimate does not include provisions for future inclusion of carbon capture equipment. The additional costs of making an IGCC facility "carbon capture ready" consist of providing space for the installation of future CO_2 separation process steps and providing larger equipment sizing to accommodate these future additions. Larger equipment sizing is necessary to enable the plant to produce the same electricity output as a plant without carbon capture equipment installed. While equipment to capture carbon can be added to an IGCC facility in the future without these up-front provisions, the overall cost of such a facility is expected to be lower with the initial planning of these additions. Including these costs would increase the initial IGCC cost estimate to $2,153/kW.

An IGCC facility at the Hunter site would have a projected design heat rate of 8,405 Btu/kWh HHV. Converting this design heat rate to an average annual heat rate yields a value of 8,657 Btu/kWh. A coal-based design that uses a supercritical boiler would have an estimated annual average heat rate of 9,129 Btu/kWh. Operation and maintenance (O&M) estimates for an IGCC were also developed for comparison with those for a pulverized coal unit. A supercritical unit would be expected to have a fixed O&M cost of $33.77/kW-yr with a variable O&M cost of $0.99/MWh, while the IGCC would be expected to have a fixed O&M cost of $62.01/kW-yr with a variable O&M cost of $0.27/MWh. Overall, this results in an O&M cost for IGCC of about 1.5 times the expected cost of supercritical pulverized coal technology.

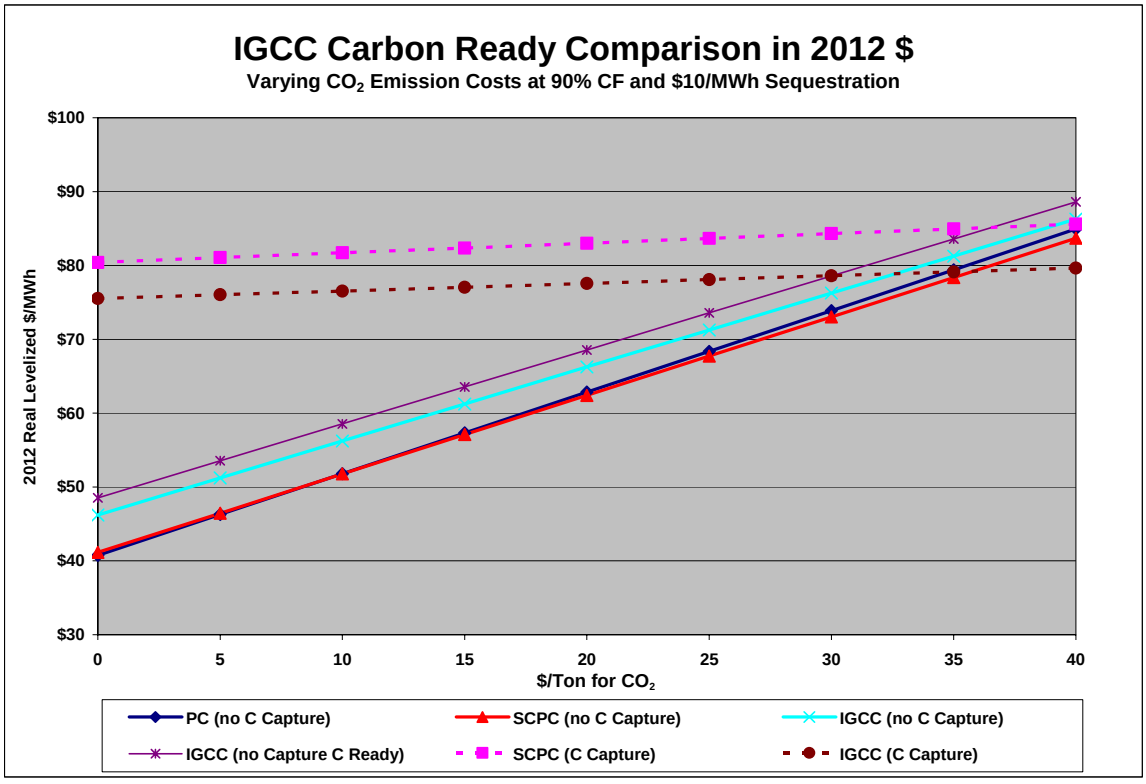
Based on the above results, the Total Resource Cost in 2005 dollars (as calculated for the IRP) to produce power from a supercritical pulverized coal boiler is estimated at approximately $39.35/MWh. By comparison, the Total Resource Cost of power for an IGCC plant, without carbon capture provisions, is estimated at about $43.90/MWh (11.6 percent higher) and $46.00/MWh (16.9 percent higher) if carbon-capture provisions (but not carbon separation or sequestration) are included in the initial project.

The cost differential between the technologies is particularly important since the consistent, primary policy direction of the states in which PacifiCorp operates is to procure resources with the lowest reasonable cost. For example, in the recently-passed Utah Energy Resource Procurement Act, although the Utah Public Service Commission may take into consideration factors such as long- and short-term impacts, risks, reliability, financial impacts on the utility, or other factors determined relevant by the commission when deciding whether to approve a resource, "lowest reasonable cost" is the first criterion listed.

Figure 3.1 illustrates the Total Resource Cost in 2012 dollars of different generation technologies under different assumptions of potential future carbon-related costs. The graph illustrates that if a CO_2 allowance cost of approximately $35 per ton is imposed, IGCC (with carbon capture and sequestration) becomes "least cost" under an assumed cost for sequestration of $10/MWh. It is important to note that accurate cost estimates for CO_2 sequestration do not exist and that the $10/MWh figure reflects a carbon sequestration research program goal established by the Department of Energy.[5]

[5] Carbon Sequestration Technology Roadmap and Project Plan 2005, U.S. Department of Energy, National Energy Technology Laboratory, May 2005.

Figure 3.1 – Real Levelized Cost for IGCC Technologies by CO_2 Allowance Cost Level



The Parson study also developed emissions performance estimates for IGCC technology. The study results and PacifiCorp's experience lead to the following estimates (Table 3.1) for IGCC emissions performance as compared to subcritical and supercritical pulverized coal.

Table 3.1 – IGCC and Conventional Pulverized Coal Emissions Comparison

Emissions	Utah PC/SCPC [a]	Utah IGCC	Percentage Reduction for IGCC
SO_2 (lb/MMBtu)	0.059	0.016	73%
NOx (lb/MMBtu)	0.072	0.011	85%
Mercury (lb/Trillion Btu)	0.600	0.470	22%
CO_2 – PC (lb/kWh)	1.870	1.725	8% [b]
CO_2 – SCPC (lb/kWh)	1.825	1.725	5% [b]

[a] Subcritical (PC) and supercritical (SCPC) pulverized coal have similar SO_2, NOx, and mercury emissions. CO_2 emissions vary among the technologies and are listed separately.
[b] CO_2 reductions based on IGCC without carbon capture or sequestration

It is important to note that new conventional coal plants, required to be equipped with Best Available Control Technology (BACT), also have very low emissions on a tons-per-year basis. Therefore, the emissions performance of IGCC reflects improvement on an already substantially reduced emissions profile as compared to emissions from a coal plant that is not equipped with BACT controls. With the improved emissions performance of new conventional coal plants, the potential for IGCC to offer more economic CO_2 capture as compared to conventional coal plants

represents the most compelling environmental reason to employ the technology for power generation.

PacifiCorp's next steps for IGCC analysis will include an update of the Parsons (now WorleyParsons) study to investigate the cost of an IGCC plant using Powder River Basin (PRB) and Jim Bridger coals. Current engineering understanding suggests that gasifier systems for lower rank coals would most efficiently use a dry coal feed instead of the slurry feed systems of GE and E-Gas. Additionally, PRB coals would most likely be used at plant sites at greater elevation than the Hunter site and this effect should also be studied.

If the conceptual level studies indicate that IGCC merits further consideration, feasibility studies would be necessary to further refine the estimated cost and performance characteristics of the competing commercial offerings. Feasibility studies would be undertaken by the commercial vendors and would take a minimum of between 4 to 6 months to complete. Each vendor feasibility study would cost approximately $300,000 to $500,000. These studies would focus on technology comparisons and indicative pricing in order to determine which commercial vendor offers the most attractive technology and price for PacifiCorp's specific sites and coals.

Whereas detailed engineering design and construction cost estimates for conventional coal plants can be obtained through studies that cost approximately $500,000 to $1 million, a similar level of detail for an IGCC plant currently requires a Front End Engineering Design (FEED) study to be conducted. Due to the developmental nature of IGCC, such a study would currently cost between $10-$15 million dollars and require 10 to 14 months to complete. The expected end result would be a firm money EPC cost estimate suitable for contract execution. Due to its high cost, a FEED study would only be undertaken after a decision to move ahead with a specific IGCC project was reached.

EFFECTS OF ENERGY POLICY ACT INCENTIVES

The Energy Policy Act of 2005 contains Investment Tax Credit (ITC) provisions and loan guarantees for qualifying IGCC facilities. Since PacifiCorp currently holds a relatively strong credit rating, loan guarantees provide little incentive. The ITC, although only applicable to the gasifier portion of the IGCC plant, therefore is the key economic subsidy available.

The exact impact of the investment tax credits is difficult to assess due to uncertainty regarding the availability of the credits (other projects further along could exhaust the available pool of $800 million of tax credits) and PacifiCorp's tax position. Oregon's passage of Senate Bill 408 creates additional uncertainty about how to incorporate these tax incentives into an evaluation. However, as an example, if an IGCC project at the Hunter site could take full advantage of the ITC, the estimated cost of energy for IGCC in 2012 could be reduced by approximately $3.00/MWh—about half the currently estimated price differential between carbon capture-ready IGCC and supercritical boilers.

IGCC STATE POLICY DEVELOPMENTS

Some power providers have announced their interest in developing IGCC facilities and have begun preliminary activities towards that end. Companies with projects that have been publicly

announced with a reported substantial level of commitment include American Electric Power (through its subsidiaries Ohio Power and Columbus Southern Power), Excelsior Energy, Steelhead Energy, and Cinergy (through its subsidiary Public Service of Indiana) in partnership with Vectren Corporation.

As detailed above, IGCC remains a higher-cost option than either subcritical or supercritical pulverized coal generation. The cost gap is even greater for IGCC that is configured to accommodate future CO_2 separation processes and greater still when adding the estimated costs of carbon separation and sequestration operations. This cost gap presents a challenge for the technology that is difficult to overcome in a "least-cost/least-risk" planning framework—even one that includes a methodology that assumes a future cost for CO_2 emissions. The projects that are advancing at this time appear to be doing so for reasons related to public policy support for the technology that deviates from the least cost/risk-balanced requirement as currently applied in PacifiCorp's planning process.

In the case of American Electric Power (AEP), which is considering a 600 MW IGCC plant, the technology offers the state of Ohio the opportunity for local economic development through the ability to use high-sulfur eastern coal. Through a probabilistic analysis, AEP made a case to its regulators that IGCC may be least-cost compared to pulverized coal when considering a range of possible carbon regulatory regimes. AEP is seeking assured cost recovery for the project and accelerated cost recovery of engineering and financing costs.[6] AEP has indicated that cost recovery must be assured before it will proceed with construction. The Ohio PUC is expected to rule on the application by the end of the year and AEP has initiated a FEED study with GE-Bechtel.

The development of Excelsior Energy's Mesaba Energy Project, a 531 MW IGCC plant scheduled to come online in 2011, has been furthered by legislation (MS 216B.1693-1694) passed in Minnesota in 2003 that provides significant support for the project. This support includes tax incentives, streamlined development, and regulatory benefits that incorporate an exemption from certificate-of-need proceedings and the right to a long-term power purchase agreement from Xcel Energy. In addition, $10 million in renewable development funds have been provided by the State and the project is receiving $36 million in Federal grant money through the Department of Energy's Clean Coal Power Initiative.

Steelhead Energy's Southern Illinois Clean Energy Center is a combined 615 MW power and 86 MMSCFD synthetic natural gas plant scheduled to come on line 2010. The first phase of a two part FEED study was launched in April 2005 and was completed in October. The development of the project has been supported by $5 million in funding from the State of Illinois to perform the first phase of the FEED study. Additionally, the project benefits from legislation passed in Illinois this summer (SB 90) that sets a price for synthesis gas produced from a coal gasification facility using Illinois coal and permits gas utilities to enter into 20-year supply contracts with any synthesis gas producer. The legislation declares those synthesis gas contracts to be prudent and recoverable subject to certain price constraints. Additional Illinois legislation (SB 1814) passed

[6] Application and Direct Testimony of Bruce H. Braine on behalf of Columbus Southern Power Company and Ohio Power Company before the Public Utilities Commission of Ohio, Case No. 05-376-EL-UNC, March 18, 2005 and May 5, 2005, respectively.

concurrently with SB 90 provides economic incentives, including tax exemptions and credits, and low-cost financing for innovative coal gasification projects.

Cinergy and Vectren Corporation have been working on Feasibility Studies for a 600 MW IGCC plant in Southwestern Indiana. This project benefits from legislation passed in Indiana this year (HB 1245) that establishes an investment tax credit for an IGCC facility that primarily serves Indiana customers. In addition to providing needed power, the project is viewed as an economic development opportunity that will encourage the use of Indiana coal. Cinergy recently announced their intention to proceed with a FEED study with GE-Bechtel.

Other states are encouraging the development of IGCC through legislation that provides incentives for the technology. West Virginia passed legislation (HB 2813) earlier this year that allows power companies to file for PSC certificates of public convenience and necessity for new plants concurrently with applications for other required permits and licenses. The legislation was designed to speed up the regulatory process for approving new power plants in the hope of luring AEP's proposed IGCC facility.

In each of these examples above the proposed IGCC project would use eastern bituminous coals. Interest in eastern bituminous coal arises, in part, because Clean Air Act requirements since 1990 have encouraged the use of low-sulfur western coals even in eastern plants with a resulting chilling effect on the coal extraction industry in the mid-west and east. The status of IGCC development for eastern coals is also more advanced than applications for western coals and substantial engineering and design work on the gasifier and coal feed must be completed for IGCC applications on western coals. This potentially introduces additional technology risk. The Energy Policy Act provision for a western coal facility demonstrates the less advanced state of development for IGCC using western fuels. Additionally, for each of the projects referenced above, there has been no final commitment to build a facility. This commitment typically is not considered until after the completion of a FEED study.

CHALLENGES TO IGCC DEVELOPMENT

While IGCC has gained much attention, there are many issues that remain to be resolved before a definitive cost, risk and technology comparison can be made to conventional coal-fired generation. Additionally, the least-cost/least-risk regulatory framework presents challenges for near-term development of the technology. A few of these issues and challenges to development are listed below:

- A very dynamic environment exists around IGCC and many claims about the technology's cost and performance are being made that cannot be verified until FEED studies are completed and the first reference plants are in operation. FEED studies typically take 10–14 months. For example, AEP's FEED study will take 12 months, cost millions of dollars, and will not be completed before late 2006.

- A number of consortia have publicly stated that they are prepared to provide performance guarantees or "wraps" covering the entire IGCC generating island. However, at the present time no final, signed contracts have been entered into for the construction of IGCC plants, so the precise terms of those wraps are yet to be made available. Thus, it is

difficult to assess the risk posed by this newer technology. The information presented above includes an inherent assumption that such wraps are available and/or the technology performs as advertised.

- Because of the developing nature of IGCC technology, considerable up-front engineering must be performed through a FEED study to develop detailed cost and performance estimates necessary to make a final decision to proceed and award an EPC or other contract. As indicated, a FEED study necessary to develop an EPC price costs around 10-15 million dollars which, absent cost-recovery assurances, a utility may be unable to justify without knowing if those costs are recoverable.

- As discussed earlier, perhaps the most compelling environmental reason to pursue IGCC is its potential to economically capture CO_2. Within the current planning framework, the following information is needed to determine if IGCC is the clear choice as compared to other generation resources:
  - valid and accurate cost estimates for future CO_2 sequestration (which currently do not exist), and
  - sufficient estimates of the probability, timing, and stringency of potential future carbon constraints.

  Without this information, it is difficult to assess the currently estimated additional costs of IGCC on a risk-adjusted basis to determine if the technology is least-cost/least-risk as required by the current regulatory framework.

- Schemes for commercial-scale carbon sequestration are unproven, and a regulatory framework has yet to be developed for certifying and indemnifying permanent sequestration.

In order for IGCC technology to advance in the near term, cost recovery schemes must be developed that will provide an assured future cash flow to pay for the required engineering design studies and, ultimately, demonstration of the technology. This will reduce the risk that must be shouldered by the utility compared to the risk borne when it chooses a proven technology. Alternatively, there must be clear and consistent policy direction from states and regulators that emerging technology such as IGCC, despite its higher cost and uncertainty about its performance, is preferred over conventional coal generation technology due to its environmental attributes and/or potential to economically capture CO_2.

CONCLUSION

As indicated, announced IGCC projects appear to be advancing as a result of state policy decisions that support IGCC technology even though it may not be least cost. These state policy decisions are intended to advance state-specific energy and environmental goals as well as economic development interests. These incentives have been necessary because IGCC is more expensive than conventional coal generation and remains unproven at the scale proposed for these commercial power production applications. This presents technology risk, financing difficulties, and other attendant risks within current regulatory frameworks. Significantly, for PacifiCorp and its customers, additional technical challenges remain to be addressed for the application of IGCC using western coals.

PacifiCorp recognizes the significant potential of IGCC to help mitigate fuel price risk and reduce carbon risk while also offering reduced emissions of criteria pollutants. In light of this, PacifiCorp will continue its efforts to closely follow the technology development and available commercial offerings. Additionally, PacifiCorp will initiate a preliminary engineering study of an IGCC facility located at the Jim Bridger site using PRB coal. This study will provide updated information about the cost, performance, and viability of IGCC application at the Jim Bridger site.

However, until IGCC technology is more fully developed and becomes more cost competitive, as documented by a publicly available detailed FEED or actual commercial installation, the absence of consistent state policy and cost recovery direction among PacifiCorp's states in favor of emerging clean coal technology, such as IGCC, will likely retard its development. In the interim, the integrated resource planning process must follow currently established standards and guidelines set forth by the states and, as a result, will continue to prefer a least-cost/least-risk portfolio based on established commercial technologies. At present, based on information currently available, PacifiCorp's planned portfolio incorporates conventional coal-fired generation.