Perceived as risky and expensive, how real are the issues affecting credit quality of power plants employing cutting edge IGCC technology? By Gregory Remec, director, project finance, at Fitch Ratings

Credit Quality

Natural gas-fired power plants comprise the vast majority of recently constructed capacity in the United States, but the high price and price volatility of natural gas have developers considering alternative technologies.

Integrated gasification combined cycle (IGCC) is an advanced power plant technology behind an increasing number of recently announced power projects. Fuelled by coal but with lower emissions than traditional coal-fired power plants, IGCC facilities integrate coal gasification processes with gas turbine power generation technology.

The separate systems comprising an IGCC facility are proven technologies, but their integration for power generation is a relatively recent accomplishment, with a small number of successful commercial projects completed worldwide. IGCC projects offer strategic value in fuel flexibility and marketable co-products, but the technology is perceived as risky and expensive. To date no IGCC facilities have been project financed in the United States.

An evolving technology

Gasification is a proven process utilized extensively in chemical and refining facilities to produce synthesis gas (or syngas) from a wide variety of carbon-based feedstock, including coal, petroleum coke, asphalt, petroleum residuals, biomass wastes, and other carbon-rich materials. Syngas, which is composed of primarily carbon monoxide and hydrogen, can be used to produce multiple chemical products, liquid fuels, and synthetic natural gas. In the case of IGCC, syngas fuels a gas turbine for power generation.

Coal was gasified in the 1800s to produce “town gas,” a fuel for lighting of residences, streets and businesses in the United States and Europe before electricity became widely available.

The first patent for a gasifier was awarded in Germany to Lurgi GmbH in 1887. Coal gasification became widespread during the 1930s and 1940s to produce syngas for municipal and industrial applications. Gasification technology was further developed during World War II to convert coal-derived syngas into liquid transportation fuels.

Following the war, natural gas supplanted syngas for many uses, but other applications continued to drive the development of coal gasification technology. Beginning in the 1950s, gasification became prevalent in chemical processing plants and refineries to convert coal and residual heavy oils into hydrogen, used for the production of ammonia, fertilizers and other chemical processes. South Africa used gasification technology extensively to produce motor fuels from coal, due to a lack of petroleum from international sanctions imposed during apartheid.

Partly in response to the oil crisis of the early 1970s, the US Department of Energy (DOE) began funding studies to evaluate the use of coal syngas to fuel power generation equipment. These early studies led to eventual funding of IGCC demonstration projects in the United States. In 1984, Southern California Edison’s 100 megawatt (MW) Cool Water IGCC plant became operational, and in 1987 Dow Chemical’s 160MW Louisiana Gasification Technology project was built. By the mid-1990s, several IGCC plants were constructed in Europe, located at refineries and fuelled by various refinery-based fuels.

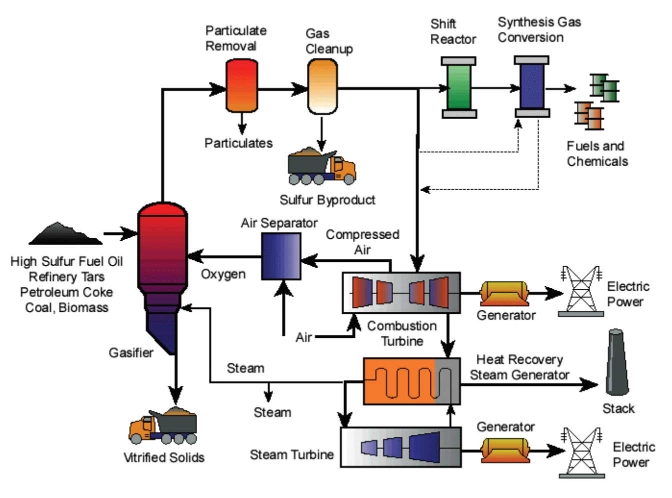
Two commercial-scale IGCC demonstration facilities constructed in the 1990s with US DOE funding support are still operating in the United States: the 250MW Polk Power Station in Florida, owned by Tampa Electric Company, and the 262MW Wabash River Generating Station in Indiana, now jointly owned by Wabash Valley Power Association, Global Energy Inc., and PSI Energy Inc.

Process overview

IGCC facilities merge two primary systems, a fuel gasification system and a combined cycle power generation system. These two systems are integrated by virtue of their shared use of compressed air, heat and steam. A gasifier converts coal or other carbon-based feedstock into syngas by applying heat under pressure in the presence of steam and a carefully controlled amount of air or oxygen. Particulates, sulphur and other contaminants are removed from the syngas, which is then used as fuel for the combined cycle power generation system. Additional equipment and processes can be used to convert the syngas into a variety of other co-products including hydrogen, transportation fuels, fertilizer, chemicals and synthetic natural gas.

Similar to natural gas-fuelled power plants, “combined cycle” refers to the combination of a combustion turbine cycle and a steam turbine cycle. The syngas fuels a combustion turbine and generator to produce electricity.

Chart 1: IGCC process diagram



Source: US Department of Energy and Gasification Technologies Council

Compressed air from the combustion turbine is utilized by the gasifier and the air separation unit. Heat from the turbine exhaust boils water in the heat recovery steam generator. The steam produced is both exported to the gasifier and used to drive a steam turbine and generator to produce electricity.

Potential Advantages

IGCC technology offers potentially superior environmental performance relative to pulverized coal power plants, stemming from the ability to remove pollutant-forming impurities from syngas prior to combustion. Treating syngas fuel is generally more efficient than treating the diluted and higher volumes of post-combustion exhaust gases, as in pulverized coal power plants.

Existing IGCC facilities are cleaner than coal-fired power plants operating today, and comparable to state-of-the-art supercritical pulverized coal facilities. Emissions levels for future IGCC facilities may significantly improve as the technology progresses. However, IGCC facilities are not as clean as natural gas-fired power plants, and may need additional emissions control equipment to meet potentially more stringent regulations in the future.

Sulphur dioxide is controlled in IGCC facilities by removing sulphur from the syngas prior to combustion. Sulphur in the coal or other feedstock forms hydrogen sulphide during the gasification process, and is readily captured from the syngas by processes developed for the chemical manufacturing industries. The reducing environment of a gasifier greatly decreases combustion byproducts such as nitrogen oxides. Nitrogen typically emerges from the gasifier as ammonia, which can be readily scrubbed from the syngas. Pulverized coal plants typically utilize more capital-intensive flue gas treatment systems such as scrubbers to remove sulphur dioxide, and selective catalytic reduction systems to control nitrogen oxides.

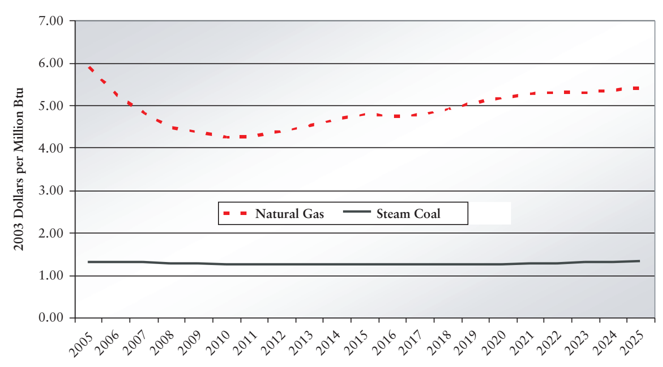
Carbon dioxide is a greenhouse gas currently not regulated in the United States but may be in the future. IGCC facilities emit approximately 20% less carbon dioxide per unit of electricity generated than conventional coal-fired plants, but approximately 40% more than a natural gas combined cycle plant. IGCC technology is expected to allow carbon dioxide to be captured prior to syngas combustion, which is less difficult and less costly than it is for pulverized coal and natural gas power plants that must remove carbon dioxide from post-combustion exhaust gases. However, carbon dioxide capture and sequestration techniques have not been commercialized and are still considered unproven.

Particulate emissions are greatly reduced in IGCC facilities relative to conventional coal-fired power plants. Minerals and other impurities in the fuel that are not gasified form environmentally inert slag or bottom ash and are removed from the gasifier. Results vary across different gasifier designs, but typically only a small fraction of impurities contained in the fuel exit the gasifier as fly ash, which must be removed downstream. IGCC facilities reportedly produce about one-half the amount of solid waste produced by conventional coal plants, which may reduce potential disposal costs.

IGCC facilities may have a potential advantage over other combustion-based power plants for controlling mercury emissions. Mercury emissions are not presently regulated but may be in the future. Mercury removal from natural gas and syngas has been commercially employed for many years, with 90% – 95% removal efficiency reported. Mercury removal costs for an IGCC facility are estimated to be about one-tenth the cost of flue gas-based mercury control.

Fuel cost and fuel flexibility are other potential advantages of IGCC facilities. Prices and price volatility for coal have been considerably lower historically than for natural gas, and US DOE forecasts predict the price differential to be maintained in the future.

Electric power generation average fuel prices



Source: US Department of Energy 2005 Annual Energy Outlook

Depending on the design, IGCC facilities may utilize a wider range of coals than pulverized coal plants, although designs for lower rank fuels typically incur higher capital costs due to the increased size of fuel handling and gasifier equipment. IGCC facilities may be able to switch fuel suppliers in response to changes in market prices more easily than pulverized coal plants. IGCC facilities can also use industrial fuels such as petroleum coke and petroleum residual products, and natural gas as a startup and/or backup fuel.

IGCC facilities are generally more efficient in converting coal to electricity than traditional coal-fired plants. Natural gas combined cycle plants are more efficient than any coal-fuelled technology, but total fuel expense is far greater at today's natural gas prices. The combined cycle configuration results in current IGCC design heat rates of approximately 8,500 British thermal units (Btu) per kilowatt hour (kWh), depending on the selected gasifier technology and fuel. Most coal-fired power plants are typically less efficient and have higher heat rates, although state-of-the-art supercritical pulverized coal plants are designed for efficiencies comparable to current IGCC facilities. Efficiencies for IGCC facilities in the future are expected to increase significantly as the technology improves.

Incremental equipment and processes may allow IGCC facilities to produce marketable co-products in addition to electricity. Sulphur can be extracted from the hydrogen sulphide captured as part of sulphur dioxide control, and can be marketed as elemental sulphur or sulphuric acid. Ammonia from the gasifier can be used to produce fertilizer and other marketable ammonia-based chemicals. IGCC technology offers an economic manner to capture hydrogen gas, as hydrogen is a principal component of syngas. Hydrogen also can be marketed for use in chemical processing, such as fertilizer manufacturing, or possibly as fuel for fuel cells and hydrogen-powered vehicles.

Additional equipment and processes can be used to convert the syngas into various clean transportation fuels or synthetic natural gas. The extent of cash flow benefits from co-product manufacturing and marketing will vary with IGCC project design, location, fuel, and market prices.

Published estimates for IGCC all-in busbar cost of electricity vary widely, but in general are expected to be approximately 10% higher than for supercritical pulverized coal plants.

Issues and concerns

A primary factor delaying commercial development of IGCC facilities is perceived low reliability. IGCC demonstration projects suffered low availability in early years of operation due to equipment and process problems, although performance has improved over time.

The Wabash River demonstration project's first year availability was reported to be 22% due to technical problems encountered in the startup phase, but eventually achieved annual availability levels of nearly 80%. Current IGCC designs are expected to have overall annual availability levels of approximately 85%. Adding redundant gasification equipment boosts the predicted availability to above 90%, but incurs a commensurately increased capital cost. Modern coal-fired power plants can attain annual availability levels in excess of 90%, and new natural gas combined cycle plants are designed for even higher availability levels.

The relatively high capital cost of IGCC facilities is another issue delaying deployment. There is considerable variability in IGCC cost estimates due to differences in design configuration, gasifier technology, fuel, redundancy and other project-specific variables.

However, there is general agreement that IGCC facilities are more expensive to build per kilowatt (kW) of capacity than supercritical pulverized coal and natural gas power plants. Published capital cost estimates for construction of new IGCC facilities range from approximately $1,200/kW to $1,600/kW for an approximately 550MW facility. In comparison, published capital cost estimates for construction of similarly sized supercritical pulverized coal power plants range from approximately $1,100/kW to $1,300/kW, and for natural gas combined cycle power plants the estimated range is approximately $500/kW to $600/kW.

Capital costs for IGCC facilities are expected to fall with increased competition, design standardization, technology improvements and economies of scale, but only over time as more IGCC facilities are built.

Non-fuel operating and maintenance (O&M) cost projections for IGCC facilities are comparable to those for supercritical coal facilities, but can be three to four times higher than for natural gas combined cycle plants. IGCC demonstration facilities reported high levels of O&M costs in the initial years of operation while technical challenges were resolved. New IGCC designs will incorporate the lessons learned from earlier projects and are expected to have O&M costs closer to projected levels.

Published estimates for IGCC all-in busbar cost of electricity vary widely, but in general are expected to be approximately 10% higher than for supercritical pulverized coal plants. Busbar cost for IGCC facilities is comparable to natural gas combined cycle power plants when natural gas prices reach approximately $4.50 to $5.00 per million British thermal units (MMBtu). Current Henry Hub natural gas prices are in excess of $10.00 per MMBtu, although the US DOE expects long-term gas prices for power producers to stabilize in the range of $4.50 to $5.00 per MMBtu. Fuel costs comprise more than half the total busbar cost for natural gas combined cycle power plants, while capital costs comprise approximately two-thirds of projected busbar cost for IGCC and advanced pulverized coal power plants.

Ratings considerations

Many drivers of credit quality for IGCC projects are generally similar to conventional power projects. However, due to the unique nature of IGCC technology and the limited operational history of commercial IGCC facilities, the relative importance of completion, operation and offtake risks and their mitigation is substantially increased. Increased risks will require stronger mitigants to offset the possibility of reduced cash flows.

Completion risk is the risk that a project is not completed on time, on budget and/or up to the required performance standards. Higher construction, completion and delay risks for IGCC projects suggest the need for:

- Fixed-price turnkey contracts for construction and commissioning of power projects, with achievable budgets and schedules based on a milestone approach.
- Longer construction schedules typical of newer technologies to provide a cushion in the event of unexpected delays, with performance and delay liquidated damages based on milestone attainment.
- Experienced, financially strong and capable contractors, with demonstrated ability and motivation to deliver on their obligations. The preference is for single (usually consortium) entities with responsibility for completion,

reducing the risks associated with coordinating multiple contracts and responsibilities across multiple parties.

- A qualified independent engineer with high familiarity of current and evolving IGCC technology aspects to opine on the reasonableness and achievability of the budget and schedule.
- Increased contingent funding and liquidity to ensure coverage of cost overruns commonly encountered with newer technology.
- Availability of skilled labour experienced in construction of facilities incorporating gasification and combined cycle technologies.
- Rigorous completion and acceptance testing and criteria, confirmed by the independent engineer. IGCC projects can be expected to have longer ramp-up periods with lower initial availabilities. Risk mitigation techniques can include longer periods between initial and final acceptance, multiple staged availability and performance tests, or other methods of ensuring the project is fully operational upon final acceptance.
- Longer warranty periods that begin to run after the project has met rigorous completion testing.

Operation risk is the risk that a project will perform at lower productivity or higher costs than projected. IGCC demonstration projects have had mixed success at achieving output and availability targets. Until IGCC technology establishes a track record of tested, accepted cost and performance characteristics, Fitch perceives the operation risk to provide greater uncertainty in IGCC projects than for more conventional technologies. Increased operation risks for IGCC projects suggest the need for:

- Experienced and financially strong O&M contractors to operate and maintain the project.
- Long-term O&M contracts with appropriately structured penalties and incentives, a longer ramp-up period and achievable performance standards. IGCC projects may be subject to additional risks in locating acceptable operators in the event replacements are necessary.
- Mitigating features to offset the higher likelihood of volatile operating expenses, such as higher operating reserves and/or liquidity facilities.
- Long-term supply contracts that ensure fuel availability in sufficient quantities at prices required for the project to operate as projected. The fuel flexibility and lower fuel price volatility of IGCC technology is favourable for project ratings.

Offtake risk is the risk that the demand for IGCC offtake is lower than expected or does not exist at the price it is offered, or the offtaker is unwilling or unable to honour its commitment to purchase the offtake. IGCC facilities will likely be single-user or few-user projects, and the ability of a project to generate cash flows is heavily dependent on the offtaker. Required elements given increased offtake risk include:

- Long-term power purchase contracts with investment grade offtakers for at least the term of the rated debt. The potentially higher cost of IGCC power places increased emphasis on the credit quality of the offtaker.
- Take-or-pay provisions in the purchase contracts to mitigate power market price risks, such as sustained periods of low natural gas prices that could make IGCC offtake uneconomical.
- Strong and enforceable termination provisions to guarantee debt repayment in the event the offtaker terminates the contract.
- Matching of revenues with expenses. Fixed-price purchase contracts could subject an IGCC project's cash flows to high volatility, particularly in the earlier years of operation when technical problems are more likely to reduce availability and production.
- Reasonable and attainable contracted availability and efficiency target levels, as confirmed by the independent engineer.
- Liberal allowances for maintenance outages, especially during ramp-up.
- Appropriately structured incentives and penalties, with risks borne by the responsible parties. Extended grace periods may be appropriate to allow for increased likelihood of equipment outages.

IGCC technology will be considered unproven until IGCC projects establish a track record of tested and accepted performance statistics. Fitch believes IGCC projects will be subject to increased levels of completion and operation risks, generally requiring stronger mitigation.

IGCC project debt should incorporate structural features to mitigate reductions in project cash flow. Structural mitigants include:

- Debt-service reserve accounts that may need to be higher in earlier years of operation to make debt-service payments during periods of reduced or interrupted revenues.
- Operating reserve accounts to mitigate the risk of a temporary shortage of funds in the event of extended outages.
- Major maintenance reserve accounts to ensure funds are available to pay for more frequent equipment overhauls.
- Dividends and subordinated debt payments contingent on meeting minimum debt-service coverage ratios or other performance standards.
- Certainty that all committed funding sources are in place prior to financial close, with contingent funding sources identified in the event a funding source fails to materialize. IGCC projects have relatively long construction periods and may rely on multiple sources of funding, including state and federal government support.

Conclusions

IGCC technology will be considered unproven until IGCC projects establish a track record of tested and accepted performance statistics. Fitch believes IGCC projects will be subject to increased levels of completion and operation risks, generally requiring stronger mitigation. Fitch expects IGCC projects will require increased offtake prices due to higher capital costs and reduced reliability, and thus project ratings will rely more heavily on contractual terms and offtaker credit quality. Favourably, IGCC technology offers flexibility to respond to changes in environmental regulations and fuel supply trends. This flexibility may add stability to cash flow and coverage ratios. ■