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A Closer Look at IGCC Coal Generation

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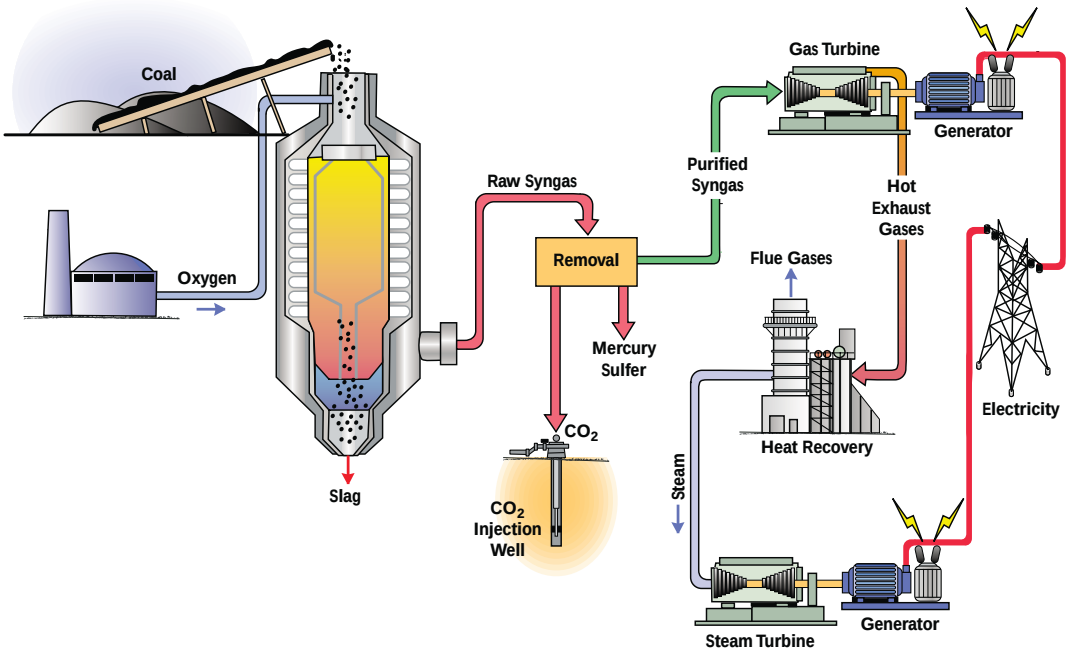
Modern society is hooked on electricity. So much so that world electricity usage is expected to grow by close to 3% per year between now and 2025. This means that by 2025 annual usage will have doubled from 13 billion MWh in 2000 to 26 billion MWh. For at least the foreseeable future, consuming electricity and burning coal go hand-in-hand. Approximately 40% of the world's electricity is currently generated from coal and this percentage is expected to stay steady as electricity usage grows[1]. And when you consider that the three countries with the largest forecast electric usage in absolute terms – China, the U.S., and India – also rank third, first, and fourth respectively in world coal reserves, it's easy to conclude that coal will continue to be a critical fuel for electric generation.

While coal may be low-cost and readily available, when it's used as fuel for electric generation it has significant environmental impacts. These include emissions of sulfur dioxide, nitrogen oxide, mercury, particulates, and carbon dioxide. While current technology appears capable of controlling sulfur dioxide, nitrogen oxide, mercury, and particulates emissions at cost levels that utilities, regulators and customers have found acceptable, carbon dioxide emissions present a thornier problem. The world's scientific community and even most politicians generally agree that man's consumption of fossil fuels is resulting in raised concentrations of greenhouse gasses. This in turn is increasing the earth's average temperature resulting in potentially severe environmental and societal consequences. The two human activities that release the most greenhouse gasses into the atmosphere are coal-fired electric generation and driving automobiles. So how can we continue to consume more and more electricity without exacerbating the global warming problem? One solution may be to change the base technology used to generate electricity from coal. Many within the industry now believe that IGCC (Integrated Gasification Combined-Cycle) technology combined with carbon sequestration[2] may offer mankind its best opportunity to reduce greenhouse gas emissions. Read on to learn what IGCC is, why it looks attractive, the current status of its development, the primary challenges that must be addressed to make it viable, and what the future may hold.

IGCC Technology



[1]All usage data in this newsletter is from the Energy Information Administration (EIA) *International Energy Outlook 2005*.
[2]Carbon sequestration is the injection of carbon into underground formations so that it is removed from the earth's atmosphere.

What is IGCC?

The current standard for creating electricity from coal uses a technology called supercritical pulverized coal (SCPC). With this process, the coal is crushed and then burned at high pressures and temperatures to heat a boiler. The boiler creates steam which is then passed through a turbine to drive a generator and create electricity. As mentioned above, pulverized coal units are a significant contributor to greenhouse gas emissions. IGCC uses a very different process to create electricity from coal. In IGCC units, the coal is transformed under high pressure and heat to a synthetic gas called syngas, which can be used to fuel a combined-cycle gas turbine. In units using combined-cycle technology (which is used in today's state-of-the-art natural gas power plants), gas powers a gas turbine (similar to a jet engine) in the first cycle. And then in the second cycle, the waste heat from the process is used to create steam which powers a steam turbine and generator to create additional electricity [see illustration on page 1]. The addition of the second cycle makes this technology more fuel efficient.

Why Use IGCC?

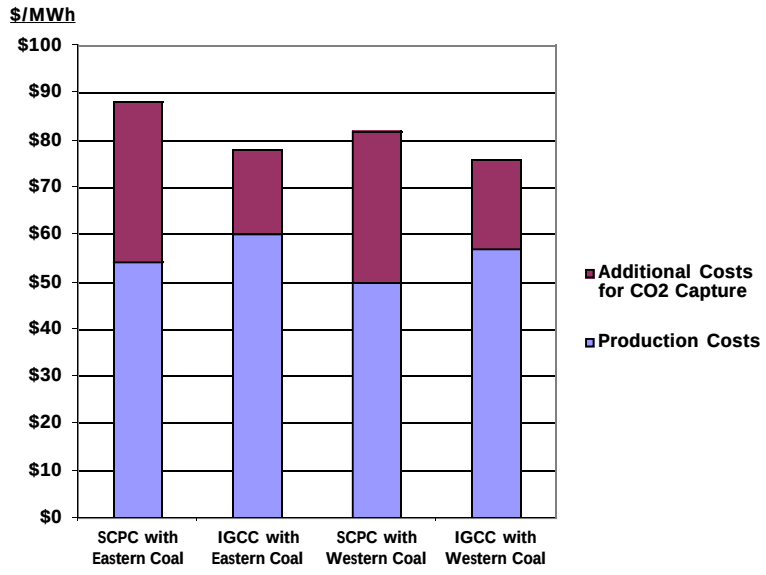
The primary benefit of the IGCC process is that it can increase unit efficiency from 33-35% for a pulverized coal unit to 43-45%, thus reducing greenhouse gas emissions per MWh generated simply by virtue of requiring less fuel to create a unit of electricity. Perhaps even more enticing, the removal of carbon dioxide during the gasification process is easier and cheaper than technologies that have been developed to remove carbon in traditional coal units. This raises the possibility that IGCC units could significantly reduce greenhouse gas emissions in two ways – first through increased efficiency and second through removal of carbon prior to combustion. After removal, the carbon dioxide is pumped into stable underground formations. In some cases, this may be a benefit to other industries such as oil extraction; in others this may simply be a disposal cost borne by the electric generator in return for reduced emissions.

In most of the developed world outside of the U.S., carbon emissions are already regulated and the benefits of carbon reduction can be quantified. In the U.S., most industry insiders expect that carbon emissions will soon be regulated by the federal government. In the meantime, a number of states in the Northeast and the West Coast are moving ahead with state level regulation. IGCC technology offers the hope that we can continue to grow coal as a fuel for electric generation while at the same time addressing the global warming issue.

Where Does IGCC Stand Today?

IGCC is generally considered a new and developing technology. Two full-scale coal-fired IGCC units are currently operational in the U.S. – one in Florida and one in Indiana. Additional coal-fired units can be found in Japan, the Netherlands and Spain. And other units fueled by refinery waste gases have operational histories in Japan and Europe. But most in the industry feel that additional units are needed to prove that the technology is commercially viable over a long period of time, especially using the varied types of coal that exist across the U.S. While a number of utilities in the U.S. are planning to build conventional coal units in the next few years, we are also beginning to see development of IGCC projects. At least 150 coal units are planned or under development in the U.S and approximately 15% of these are IGCC units[3]. Many state

IGCC and SCPC Cost Comparison[4]



[3]*Public Utilities Fortnightly*, December 2005, p. 34.

[4]Data from Integrated Combined Cycle Gasification Draft Report, Docket 9300-GF-176, Wisconsin Department of Natural Resources and the Public Services Commission of Wisconsin, Executive Summary p. II.

public utilities commissions have also begun to require utilities to evaluate IGCC technology in their long-term planning process.

What Are Barriers to Rapid IGCC Penetration?
So why aren't we seeing a rush to build IGCC units? There are two major reasons – limited operating experience and cost. More than 400 supercritical pulverized coal units are in operation worldwide. This operating history gives power plant builders assurance that the technology is mature and that unexpected operational problems will be limited. With only five coal-fired IGCC units with operating history, and none with history using western U.S. coal, utility planners and regulators are leery of potential problems. Contractors such as GE and Bechtel have indicated they are prepared to support IGCC projects with performance guarantees. But even so, many project sponsors will wait for others to prove the technology before investing large sums.

As for cost, IGCC technology currently costs more up-front and then also costs more to run – at least as long as there are no costs attributed to the emission of carbon. A recent study by the State of Wisconsin[5] indicated that levelized life-cycle costs for supercritical pulverized coal units are $50 to $53/MWh and $57 to $60/MWh for IGCC units. While there is hope that future advances in construction costs, operating reliability, and plant heating efficiencies may reduce the cost of IGCC relative to pulverized coal, utilities and regulators need to make decisions based on today's numbers. And using standard regulatory thinking, they will probably choose the lowest cost generating solution so as to keep customers rates as low as possible.

The relative cost of technologies changes, however, when the costs of carbon capture are taken into account. With carbon capture costs added, the cost of pulverized coal units rises to $82 to $88/MWh while the cost of IGCC units ranges from $75 to $78/MWh. Perhaps the biggest barrier then is not actual cost, but the lack of carbon emissions regulation in the U.S.

What the Future May Hold
Many industry insiders are bullish on the future of IGCC. There is strong pressure from environmental groups and regulators to invest in IGCC and many utility generation planners believe that the current wave of pulverized coal units may be the last. Indeed, it is possible that future carbon mitigation costs will result in a wave of stranded costs associated with today's coal generating units.

In the meantime, IGCC must prove itself. Big names in the industry are working to help make that happen. On the technology side, companies such as Bechtel, GE, Shell, Siemens, and ConocoPhillips are all actively marketing IGCC technology. Meanwhile, generation owners such as AEP, Cinergy, Erora Group, Excelsior Energy, Southern Company, Illinois Steelhead Energy, and Xcel Energy are all at some stage of planning or developing coal-fired IGCC projects. Perhaps furthest along is AEP, who has received some cost-recovery approvals from regulators in Ohio. In fact, AEP has three active proposals and expects to bring the first online in 2010. Also in the early stages of design and site selection process is the U.S. Department of Energy (DOE) sponsored FutureGen project which will build a government-financed 275 MW zero emission IGCC unit with carbon sequestration. The unit is planned to be operational in 2011 and Illinois, Montana, Texas, and Wyoming are preparing site bids. Similar efforts, both private and government-sponsored are active in European and Asian countries. Over the next five years, we should get a much clearer picture as to whether IGCC can bridge the attractiveness of coal with the environmental imperatives to limit emissions from electric generation.

[5]IBID.