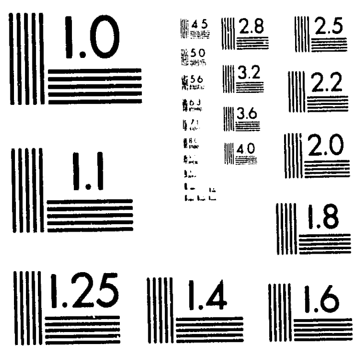
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A Utility's Perspective of the Market for IGCC

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A Utility's Perspective of the Market for IGCC

by

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DOE/Coal-Fired Power Systems 93
Advances in IGCC and PFBC Contractors Review Meeting
Morgantown, West Virginia

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INTRODUCTION

I would like to discuss our utility's view of the Market for Integration Gasification Combined Cycle (IGCC) power plants and share with you some of the experiences we have had with our Integrated Gasification Combined Cycle Power Plant Project, Polk Unit #1.

We have found that not only is the technology different from what most U. S. utilities are accustomed to, but also that the non-technical issues or business issues, such as contracting, project management and contract administration also have different requirements. During this conference you will hear many presentations on the status of the technical issues associated with IGCC technology. Therefore, I will focus my remarks on the non-technical or business issues that are vital to the successful commercialization of this technology.

We believe these business issues must be successfully addressed by both the utilities and the technology suppliers in order for integrated gasification combined cycle power plants (IGCC) to achieve commercial success.

In order to understand some of the issues we have experienced, it will be helpful to understand how our project is configured and our current status.

PARTICIPANTS

Tampa Electric Company (TEC) is an investor-owned electric utility, headquartered in Tampa, Florida. It is the principal, wholly owned subsidiary of TECO Energy, Inc., an energy related holding company heavily involved in coal mining, transportation, and utilization. TEC has about 3200MW of generating capacity, of which 97% is coal-fired. TEC serves about 470,000 Customers in an area of about 2,000 square miles in west-central Florida, primarily in and around Tampa, Florida.

TEC owns five generating stations; two are coal-fired (2852MW) two are oil-fired (253MW), and one is natural gas-fired (11MW). TEC also has four combustion turbines with about 160MW of generating capacity, used for start-up and peaking.

TECO Power Services (TPS) is a subsidiary of TECO Energy, Inc., and an affiliate of TEC. This company was formed in the late 1980's to take advantage of the opportunities in the non-utility generation market. TPS currently owns, and operates a 295MW natural gas-fired combined cycle power plant in Hardee County, Florida. Seminole Electric Cooperative and Tampa Electric Company are purchasing the output of this plant under a twenty year power sales agreement.

TPS is responsible for the overall project management for the DOE portion of this IGCC project. TPS will also concentrate on commercialization of this IGCC technology, as part of the Cooperative Agreement with the U. S. Department of Energy.

Tampa Electric Company has begun engineering for its new Polk Power Station Unit #1. This will be the first unit at a new site and will use, Integrated Gasification Combined Cycle (IGCC) Technology. The unit will utilize oxygen-blown entrained-flow coal gasification, along with combined cycle technology, to provide nominal 260MW (net) generation.

The project is partially funded by the U.S. Department of Energy (DOE) under Round III of its Clean Coal Technology Program. Use of a new hot gas clean-up system (HGCU) will highlight this demonstration of IGCC technology on a commercial scale.

OBJECTIVES

The main objective of any power plant is to provide electric power for the utility's Customers. This unit is an integral part of Tampa Electric's generation expansion plan. That plan requires 260MW of capacity to be in service in the summer of 1996. TEC's objective is to build a coal-based generating unit providing reliable, low cost electric power. Using IGCC technology will meet those requirements.

Demonstration of the oxygen-blown entrained-flow IGCC technology is expected to show that such a plant can achieve significant reductions of SO_2 and NO_x emissions when compared to existing and future conventional coal-fired power plants. In addition, this project is expected to demonstrate the technical feasibility of a commercial scale IGCC unit using hot gas clean-up technology.

The Polk Power Station Unit #1 IGCC Project will be constructed in two phases. TEC's operation needs called for 150MW of peaking capacity in mid-1995, becoming part of 260MW of capacity in mid-1996. The first phase will be the installation of an advanced CT, scheduled for commercial operation in July 1995. This CT will fire No. 2 oil during its first year while in peaking service. During that year, TEC will complete installation of the gasification and combined cycle facilities which will be in commercial operation in July 1996. This phased approach will satisfy TEC's generation expansion plan.

Part of this DOE CCT project will be to test and demonstrate a new hot gas clean-up (HGCU) technology. With the exception of the HGCU, only commercially available equipment will be used for this project. The approach supported by DOE is the highly integrated arrangement of these commercially available pieces of hardware or systems, in a new arrangement which is intended to optimize cycle performance, cost, and marketability at a commercially acceptable size of nominally 260MW (net). Use of the HGCU will provide additional system efficiencies by demonstrating the technical improvements realized from cleaning syngas at a temperature of about 1000°F rather than utilizing more traditional Cold Gas Clean-up (CGCU) methods: cooling the gas to about 100°F before the sulfur removal is attempted. This low temperature process has the disadvantage of the irreversible cooling losses and associated reheating before admitting the syngas to the CT.

TECHNICAL DESCRIPTION

This unit will utilize commercially available coal gasification (CG) technology as provided by Texaco in their licensed oxygen-blown entrained-flow gasifier. A general flow diagram of the entire process is shown in Figure 1. In this arrangement, coal is ground to specification and slurried in water to the desired concentration (60-70% solids) in rod mills. The unit will be designed to utilize about 2300 tons per day of coal (dry basis). This coal slurry and an oxidant (95% pure oxygen) are then mixed in the gasifier burner where the coal partially combusts in an oxygen deficient environment, at a temperature in excess of 2500°F. This produces syngas with a heat content of about 250 BTU/SCF (LHV). The oxygen will be produced from an Air Separation Unit (ASU). The gasifier is expected to achieve greater than 95% carbon conversion in a single pass. It is currently planned for the gasifier to be a single vessel feeding into one radiant syngas cooler where the temperature will be reduced from about 2500°F to about 1300°F.

After the radiant cooler, the gas will then be split into two (2) parallel convective coolers, where the temperature will be cooled further to about 900°F. One stream will go to the 50% capacity HGCU system and the other stream to the traditional CGCU system with 100% capacity. This flow arrangement was selected to provide assurance to TEC that the IGCC capacity would not be restricted due to the demonstration of the HGCU system.

The CGCU system will be a traditional amine scrubber type, with conventional sulfur recovery. Sulfur removed in the HGCU and CGCU systems will be recovered in the form of sulfuric acid and elemental sulfur respectively. Both of these products have a ready market in the phosphate industry in the central Florida area. It is expected that the annual production of 14,000 tons of elemental sulfur or 45,000 tons of sulfuric acid produced by this 260MW (net) IGCC unit will have minimal impact on the price and availability of these products in the phosphate industry.

Most of the ungasified coal exits the bottom of the gasifier/radiant syngas cooler into the slag lockhopper where it is mixed with water. These solids generally consist of slag and uncombusted coal products. As they exit the slag lockhopper, these non-leachable products are readily saleable for blasting grit, roofing tiles, and construction building products. TEC has been marketing slag from its existing units for such uses for over 25 years.

The water in the slag lockhoppers requires treatment before it can be either discharged or reused. All of the water from the gasification process will be cleaned and reused, thereby creating no requirement for discharging process water from the gasification system.

The Air Separation Unit (ASU) will use ambient air to produce oxygen for use in the gasification system and sulfur recovery unit, and nitrogen which will be sent to the advanced CT. The addition of nitrogen in the CT combustion chamber has dual benefits. First, since syngas has a substantially lower heating value than natural gas, a higher fuel mass flow is needed to maintain heat input. This additional mass flow has the advantage of producing higher CT power output. Second, the nitrogen acts to control potential NO_x emissions by reducing the combustor flame temperature which, in turn, reduces the formation of thermal NO_x in the fuel combustion process.

The ASU will be sized to produce about 2100 tons per day of 95% pure oxygen and 6300 tons per day of nitrogen. The ASU may be designed and constructed as a turnkey project.

The Hot Gas Clean-Up (HGCU) system is being developed by General Electric Environmental Services, Inc (GEESI). This process is undergoing pilot plant testing at GE's laboratory facilities in Schenectady, NY. The advantage of the HGCU over the CGCU is the ability to use the syngas from the gasification system. Instead of having to cool the gas prior to sulfur removal, the HGCU will accept gas at 900–1000°F. The successful demonstration of this technology will provide for higher efficiency IGCC systems.

One specific issue in the HGCU system for our project is the metal oxide sorbent being demonstrated. It is anticipated that the sorbent material used will be zinc titanate. This is a more robust material and more amenable to the oxygen-blown entrained-gasifier syngas than zinc ferrite, which is usually considered for air-blown gasifiers.

A regeneration system will produce a concentrated (about 13%) SO_2 stream. This will feed a sulfuric acid plant, for production of a saleable acid by-product.

The feasibility of two (2) other support processes will be investigated for potential improvements to this process. In addition to the high efficiency primary cyclone being provided upstream of the HGCU system, a high temperature barrier filter will be considered for possible installation downstream of the HGCU to protect the combustion turbine.

Use of sodium bicarbonate, $NaHC0_3$, will also be investigated for possible injection upstream of the barrier filter for removal of chloride and fluoride species on the barrier filter media by forming stable solids NaCl and NaF which would be disposed of with other plant solid byproduct streams.

The key components of the combined cycle are the advanced combustion turbine (CT), heat recovery steam generator (HRSG), steam turbine (ST), and generators.

GE is currently optimizing arrangements for increasing fuel inlet temperatures and also for lowering the pressure drop across the fuel inlet control valving. This has a compounding positive effect on cycle efficiency by also allowing a lower pressure in the ASU, requiring less air and nitrogen compressor parasitic power.

The HRSG is installed in the combustion turbine exhaust to complete the traditional combined cycle arrangement and provide steam to the 130MW steam turbine.

No auxiliary firing is proposed within the HRSG system. Hot exhaust from the CT will be channeled through the HRSG to recover the CT exhaust heat energy. The HRSG high pressure steam production will be augmented by high pressure steam production from the coal gasification plant. All high pressure steam will be superheated in the HRSG before delivery to the high pressure ST.

The ST will be designed as a double flow reheat turbine with low pressure crossover extraction. The ST and associated generator will be designed specifically for highly efficient combined cycle operation with nominal turbine inlet throttle steam conditions of approximately 1,450 psig and 1,000°F with 1,000°F reheat inlet temperature.

The operation of the combined cycle power plant will be coordinated and integrated with the operation of the CG process plant. The initial start-up of the power plant will be carried out on low-sulfur No. 2 fuel oil. Transfer to syngas will occur upon establishment of fuel production from the CG plant.

Under normal operation, syngas and nitrogen from the ASU will be provided to the CT. The syngas/nitrogen mix at the CT combustion chamber will be regulated by the CT control system to control the NO_x emission levels from the unit.

Cold reheat steam from the high pressure turbine exhaust and HRSG intermediate pressure steam will be combined before reheating in the HRSG and subsequent admission to the intermediate pressure ST. Some intermediate pressure steam will also be supplied from the HRSG to the sulfur recovery unit.

The heart of the overall project will be the integration of the various pieces of hardware and systems. Maximum usage of heat and process flow streams can usually increase overall cycle effectiveness and efficiency. In our arrangement, benefits are derived from using the experience of other IGCC projects, such as Cool Water, to optimize the flows from different subsystems. For example, low pressure steam from the HRSG will be produced to supply heat to the CG facilities for process use. The HRSG will also receive steam energy from the CG syngas coolers to supplement the steam cycle power output. Additional low energy integration will occur between the HRSG and the CG plant. Low pressure steam will be provided by the HRSG to the CG facilities for process use. Some low level waste heat in the CG facilities will be used for condensate heating for the HRSG. Condensate from the ST condenser will be returned to the HRSG/integral dearator by way of the gasifier, where some condensate preheating occurs.

Probably the most novel integration concept in this project is our intended use of the ASU. This system provides oxygen to the gasifier in the traditional arrangement, while simultaneously using what is traditionally excess or wasted nitrogen to increase power output and improve cycle efficiency and also lower NO_x formation.

The primary source of emissions from the IGCC unit is combustion of syngas in the advanced CT (GE 7F). The exhaust gas from the CT will be emitted to the atmosphere via the HRSG stack. Emissions from the HRSG stack are primarily NO_x and SO_2 with lesser quantities of CO, VOC, particulate matter (PM). Table 1 presents the estimated maximum hourly emission rates for this source. The emission control capabilities of the HGCU system are yet to be fully demonstrated. Therefore, some emission estimates are higher compared to estimated emissions from the CGCU system. After the completion of the 2-year demonstration period, the lower emission rates from the CGCU system must be achieved to meet permit requirements.

It is expected that at least 96 percent of the sulfur present in the coal will be removed by the CGCU and HGCU systems.

The advanced CT in the IGCC unit will use nitrogen addition to control NO_x emissions during syngas firing. Nitrogen acts as a diluent to lower peak flame temperatures and reduce NO_x formation without the water consumption and treatment/disposal requirements associated with water or steam injection NO_x control methods. Maximum nitrogen diluent will be injected to minimize NO_x exhaust concentrations consistent with safe and stable operation of the CT. Water injection will be employed to control NO_x emissions when backup distillate fuel oil is used and during the first year of the 7F CT operation when the unit is operated in the simple cycle mode.

Part of our the Cooperative Agreement with the DOE is a the two-year demonstration phase. During this period it is planned that about four to six different types of coals will be tested in the operating IGCC power plant. The results of these tests will compare this unit's efficiency, operability, and costs, and report on each of these test coals specified against the design basis coal. These results should provide a menu of operating parameters and costs which can be used by utilities in the future as they make their selection on methods for satisfying their generation needs, in compliance with environmental regulations.

Table 2 presents key project milestones. To date, contracts are in place with Texaco Development Corporation for the gasification license, GE for the combined cycle system, and GEESI for the HGCU system, Air Products for the ASU, MAN GHH for the radiant syngas cooler, Steinmuller for the convective syngas coolers, and Bechtel Power Corp. for the detailed engineering.

During the next nine months, preliminary engineering and the final process arrangements will be complete. National Environmental Policy Act (NEPA) activities are expected to be finalized by early 1994, allowing for the start of construction.

This will lead to the commercial operation of the CT in July 1995 and the IGCC unit in July 1996.

BUSINESS ISSUES
ECONOMIC JUSTIFICATION

The first business issue any utility has to deal with in implementing a new generating addition is the issue of economic justification. The three basic driving forces in the economic justification of any technology are its fuel cost relative to other technologies, its capital cost, and its efficiency.

I believe, in the short-term U. S. market, that IGCC's primary competition is natural gas-fired combined cycle technology. I believe that in order for IGCC to compete on a commercial basis, that natural gas prices have to rise relative to coal prices, and that the capital cost of the technology must come down. While this statement may seem to be somewhat obvious, it raises two interesting points.

The first is that while the relative pricing of natural gas and coal is not generally within the technology supplier's control, the capital cost is. The reduction of capital cost represents a major challenge for the technology suppliers in order for this technology to become commercialized.

The second point is that the improvements being achieved with IGCC efficiencies probably won't help it outperform the effects of natural gas pricing. This is due to the fact that the combined cycle portion of the IGCC technology is experiencing the most significant improvements in efficiency. While certain improvements in coal gasification and integration are being made, they potentially will be overshadowed by improvements in combustion turbine/combined cycle technology. Combustion Turbine/Combined Cycle improvements will apply to natural gas-fired units as well as IGCC units. Therefore, I believe the relative efficiencies of these technologies will continue to closely track.

I do see, however, a significant advantage for IGCC technology compared to conventional pulverized coal-fired units. As IGCC efficiencies continue to improve, combined with their environmentally superior performance, I believe that IGCC will be the "technology of choice" for utilities that install new coal-fired generation.

We have achieved economic justification of our project by virtue of the DOE's funding of $120 million awarded in Round III of their Clean Coal Technology Program. This program provides the bridge between current technology economics and those of the future. And Tampa Electric is pleased to be taking a leadership position in furthering the IGCC knowledge base.

SITING

The next major issue that a utility must address after a technology decision has been made is that of siting. Siting of coal-fired generation is a major issue that must be addressed in order to commercialize IGCC or any other coal-based technology. Successful siting is a primary responsibility of the utility. For the Polk Power Station, we employed a proactive approach with local environmentalists and the local communities.

By late 1989, we had formed an independent citizen's task force made up of 17 people representing environmentalists, educators, economists and community leaders, to help guide that search.

Some of the various groups who had members on the task force were: The National Audubon Society, Florida Audubon Society, 1,000 Friends of Florida, Sierra Club, The Hillsborough Environmental Coalition, and others. We made sure that at least half of the group was comprised of environmentalists. We knew that protecting the environment would be the number one priority in selecting the plant's technology and site.

The task force conducted a year-long study of more than 35 sites in six counties, with the assistance of a professional environmental consulting firm.

The task force ultimately decided—after much debate—that it was, in their minds, better to recommend sites that had already been touched by industry.

In their final analysis, they recommended three former phosphate tracts in southwest Polk County. They believed it was best, from both an environmental and economic standpoint, to place previously mined phosphate land back into productive use.

With that recommendation in hand, we began negotiations with the land owners. And that is how we came to select the site we have today.

The plant site is a 4,300-acre tract about 11 miles west of Fort Meade, and 11 miles south of Mulberry in Polk County, Florida.

This proactive approach to siting has been very successful for us. We have established strong support for our project and are maintaining a high level of interaction with the community so that we can maintain that support.

In 1991 we began a periodic newsletter to key Polk County residents and last year we held a series of personal community meetings with the residents nearest the site—presenting slide shows, displaying exhibits and answering questions.

We also were on hand for the Department of Energy's "Scoping Meeting" held last summer. Public support for the project was quite evident as more residents came to speak in favor of the plant than those who came to speak out against the plant.

This process of open and regular communications with our Customers and the media demonstrates that, even in today's environmental climate, we can successfully site and build coal-fired generation.

In a recent survey, three out of four of our Customers agreed that we need to build this facility.

And two out of three think we made the right decision to use coal.

Many of you know that these results are virtually the opposite of current national trends in public opinion. We will continue with our communications-based approach to this project, just as we have with all of our operations within Tampa Electric.

CONTRACTING

After successfully siting the plant, the next phase is to contract for the engineering, technology, and equipment that will be used in the IGCC facility. We have found this area to be significantly different than traditional utility plant contracting.

The first significant difference we experienced was the requirement to purchase a technology use license. Suppliers of coal gasification technology usually supply that technology via a "license." That is, they supply the proprietary information necessary to implement their technology but do not generally supply the actual gasification system equipment. In a traditional plant, utilities are used to buying equipment such as a boiler. When you buy a boiler, you get the design, technology, and the equipment from the boiler supplier. With a typical gasification license, you get permission to use the technology in conjunction with equipment supplied by vendors other than the owner of the gasification technology.

A primary area of concern here is the guarantees. The licensor of the technology will usually provide process guarantees. The equipment suppliers provide equipment guarantees. This causes a split in responsibilities that most utilities try to avoid. Innovative approaches in structuring these contracts are essential to eliminate any "gaps" in performance guarantees.

Licenses also have very strict confidentiality provisions. The long-term administration of confidentiality provisions is something most utilities are not required to deal with routinely and require special management attention. The utility industry has traditionally been very open about technology issues. Forums such as EEI serve as a traditional vehicle for exchange of technical information between utilities. This interchange for coal gasification technology must be managed in a different way. While certainly achievable, this represents another change in the way in which utilities must conduct their business.

In addition to confidentiality, the issue of technology rights and ownership must also be addressed. Technology rights and ownership have been very important issues in our contracting activities to date. Technology rights in this context refers to both patented technology as well as unpatented technology "know how." The companies supplying this technology have spent hundreds of millions of dollars to develop the technology to its current stage of development. Naturally, they wish to preserve their exclusive right to profit from marketing of those developments. Utilities want to insure they have the ability to use and profit from any improvements in the technology that may be subsequently developed. In addition, IPP's may want to reconfigure and repackage several systems in order to create a competitive advantage in the IPP marketplace. All of these positions are reasonable. However, we have found that it takes a great deal of effort to structure agreements which adequately protect all parties. The legal aspect of these intellectual property rights becomes central to successfully structuring these functional contracts for this technology.

Another unique situation we have experienced that can provide a positive benefit to utilities is that of vendors who would like to be owners. When a utility buys a boiler, the boiler vendor usually doesn't want to own the boiler and sell the utility steam over the fence. However, most gasification technology suppliers are receptive to the approach of owning and operating the gasification system. And if your gasification plant is oxygen-blown, the air separation unit vendors are also interested in this approach. This provides some new alternatives and a great deal of flexibility in how utilities manage the allocation of dollars between capital and expense. This approach also provides the utility flexibility in allocating or managing certain elements of the overall project risk.

These issues are all issues Tampa Electric has been faced with so far. I'm sure that as we move forward, we will continue to encounter business issues that require flexibility and cooperation by both Tampa Electric and the technology suppliers. In order to achieve successful commercialization of coal gasification power plants, both the technical and business issues must be addressed. I am confident that Tampa Electric's Polk Power Station IGCC Project will demonstrate the viability of this technology in a commercial environment. The business issues I've discussed today are significant but not insurmountable.

To successfully function in this environment, both technology suppliers and utilities must be flexible in their approach to the business. If gasification suppliers want to provide their systems to the utility industry, they must be willing to change from their traditional contracting approach. If utilities are going to own and operate IGCC units, they must also adapt the traditional utility approach of doing business to the specific requirements of this technology. In our experience, our technology suppliers have been responsive to our needs, cooperative, and open-minded in their approach to our project. We could not have come as far as we have without an open-minded approach on both sides.

Both suppliers and utilities must accept the challenge of recognizing that it can't be "business as usual" when implementing this new and exciting technology. Flexibility and ingenuity will be key to the successful commercialization of coal gasification power plants.

REFERENCES

Hester, J.C. 1991. *Air-Blown IGCC Project.* Eleventh Annual Gasification and Gas STream Clean-up System Contractors Review Meeting.

Jenkins, S.D. 1992. *Status of Tampa Electric Company IGCC Project.* First Annual Clean Coal Technology Conference, September 1992.

Pless, D.E. 1992. *How and Why Tampa Electric Selected IGCC For Its Next Generating Capacity Addition.* American Power Conference, April 1992.

Black, C.R. 1992. *A Utility's Perspective on the Commercialization of Gasification Power Plants.* EPRI/Coal Gasification Power Plants Conference, October 1992.

Table 1. Maximum Emissions from the IGCC Unit's CT (All Values lb/hr)

Constituent	Post-Demonstration*	Demonstration†	No.2 Fuel Oil
Particulate Matter	72	72	27
SO_2	518	518	92
NO_x	223	664	311
CO	98	99	99
VOC	3	3	32

*Maximum emissions after the 2-year demonstration period, based on emissions achievable with CGCU. Utilization of HGCU to be based on ability to achieve maximum post-demonstration emission rates.

†Maximum emissions during the 2-year demonstration period, based on up to 50 percent utilization of HGCU. Maximum post-demonstration emission rates to be achieved thereafter

Table 2. Major Project Milestones

Date	Activity
January 1992	Need for Power Certification received from State of Florida
February 1992	Texaco, Inc. awarded contract for preliminary engineering/process development
March 1992	Novated Cooperative Agreement signed
April 1992	Volume of Environmental Information submitted to DOE
April 1992	Letters of Intent initiated with Texaco and General Electric
July 1992	Site Certification Application submitted to Florida Department of Environmental Regulation
August 1992	DOE Scoping Meeting
September 1992	Request bids for detailed engineering
May 1993	Certification hearing before State of Florida
Fall 1993	Receive permits
January 1994	Start construction
July 1995	Commercial operation of CT
July 1996	Commercial operation of IGCC

Polk Power Station Unit No. 1

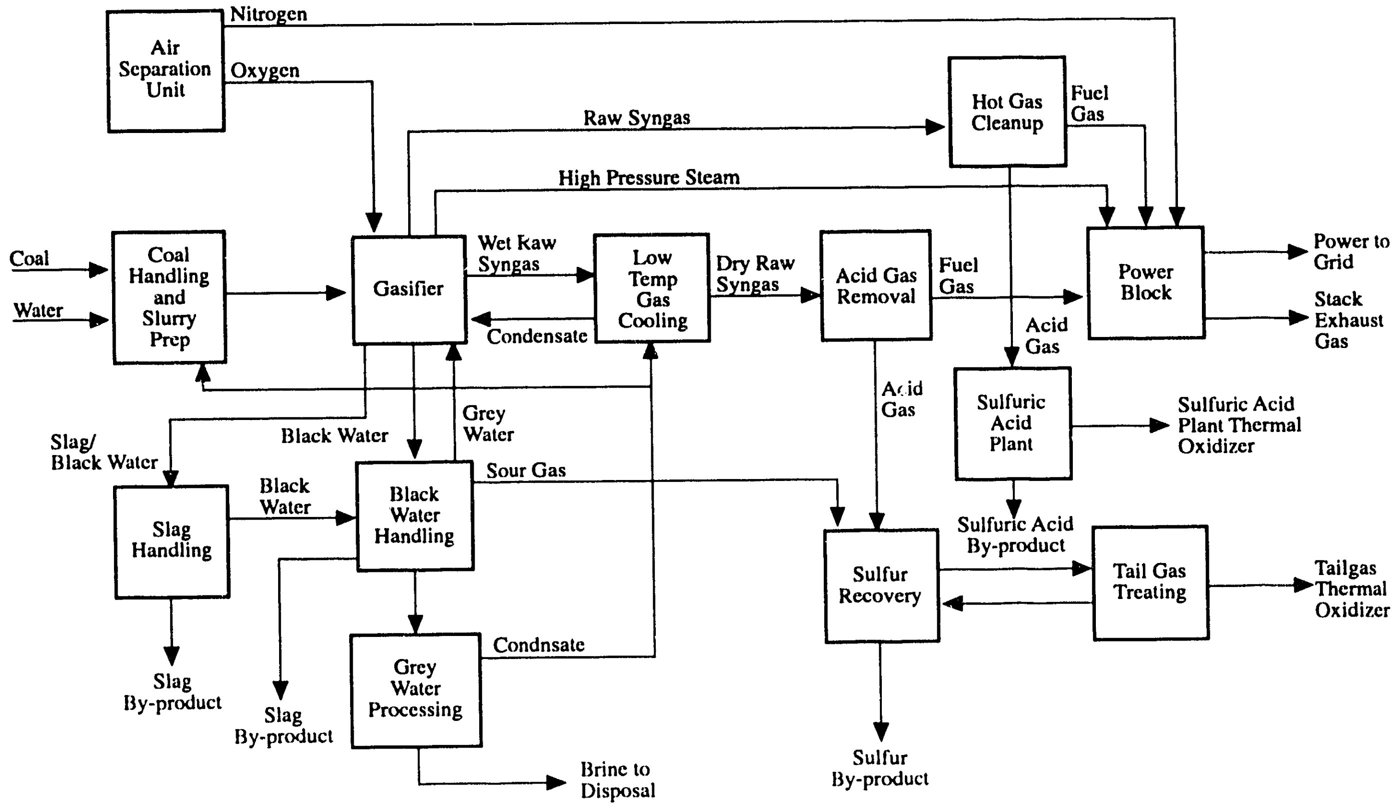

Figure 1. Generalized Flow Diagram of IGCC System

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