Gasification Technologies Council

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INTRODUCTION

Mr. Chairman and members of the subcommittee, my name is James Childress. I am the Executive Director of the Gasification Technologies Council (GTC). The GTC has more than seventy companies that own and operate plants, or provide the technologies, processes, services and equipment essential to their operation. Gasification plants in which our members are involved account for more than 95% of world capacity.

In my testimony today I would like to address issues associated with gasification's readiness to compress and capture CO_2 and public policy steps that could be taken to accelerate commercialization of sequestration of CO_2 from IGCC power plants and gasification-based manufacturing facilities. Also, with opposition to coal-based power plants threatening to put severe price and supply pressures on natural gas, gasification technologies can help the United States meet its energy needs in environmentally and economically sound ways.

THE TECHNOLOGY

Gasification is a proven and efficient manufacturing process that converts hydrocarbons such as coal, wastes, or biomass into a clean synthesis gas (syngas), which can be used to produce chemicals, plastics, fertilizers, fuels, and electricity. Gasification ***is not*** a combustion process.

Gasification has been used commercially on a global scale for more than 50 years by the chemical, refining, and fertilizer industries and for more than 35 years by the electric power industry. There are more than 420 gasifiers currently in use in some 140 facilities worldwide. Nineteen plants are operating in the United States.

GROWTH IN THE INDUSTRY

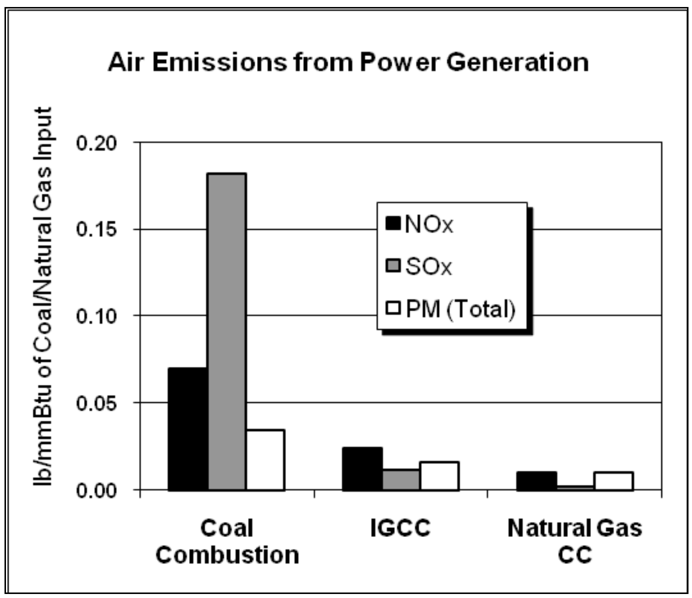
Worldwide gasification capacity is projected to grow 70 percent by 2015, with some 80 percent of the growth occurring in Asia. China is expected to achieve the most rapid growth as it moves aggressively to displace use of oil and gas in its chemicals and fertilizer industries. There are also seven coal-to-substitute natural gas projects in development in China. In addition, there are twelve proposed gasification-based IGCC power plants under evaluation by the Chinese government.

Since 2004, 29 new gasification plants have been licensed and/or built in China. In contrast, no new gasification plants have started up in the United States since 2002. In the U.S., plans have been announced for some 45-50 new gasification-based projects in twenty-five states.   However, whether these plants will actually be constructed depends on a number of factors, perhaps the most important of which is the lack of a clear regulatory framework addressing carbon capture and sequestration.

POWER GENERATION – IGCC

An Integrated Gasification Combined Cycle (IGCC) power plant combines the gasification plant with a “combined cycle” power plant. Clean syngas is combusted in high efficiency gas turbines to produce electricity. The excess heat from the gasification reaction is captured, converted into steam and sent to a steam turbine to produce additional electricity. IGCC offers both significant environmental benefits and the lowest-option for carbon capture of any coal-based power generation method.

Compared to traditional combustion-based technologies producing electricity from coal, an IGCC shows marked reductions in all criteria air pollutants, higher efficiency, and lower water use and solid waste generation. Air emissions from an IGCC approach those of a natural gas combined cycle (NGCC) plant. (Source: IL DEP, GE Energy)

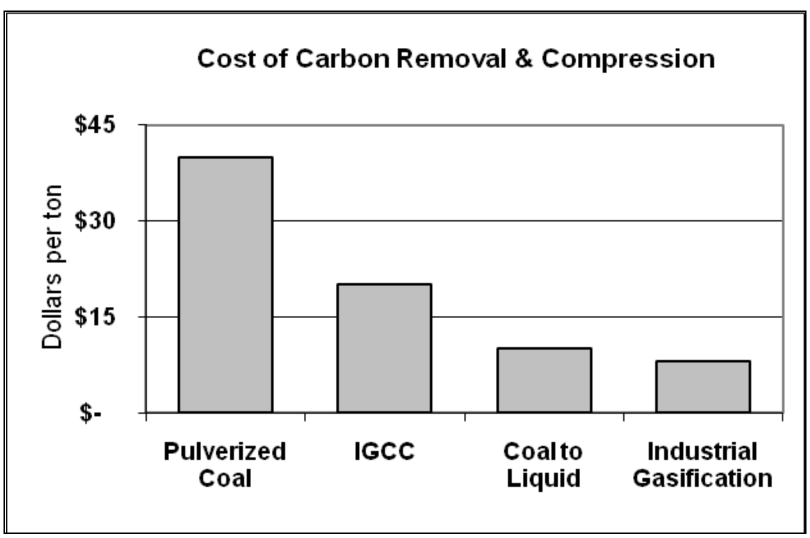


Commercial technology exists today to remove more than 95% of the mercury from a gasification-based plant at one-tenth the cost of removal for a coal combustion plant.

CARBON CAPTURE

More than 80 percent of global gasification capacity is already capturing CO_2 . What are commonly called "industrial gasification" facilities, chemical, plastics, fertilizer, fuels and hydrogen plants routinely capture the CO_2 as part of their manufacturing process. However, because of lack of economic incentives or regulatory requirements, the CO_2 is not sequestered.

Gasification also provides the least cost path toward capturing CO_2 emissions associated with power generation from coal, heavy petroleum residues such as petcoke and other fossil fuels. This is because the syngas being treated in an IGCC power plant is under pressure and is approximately one percent of the volume of post-combustion exhaust gas that must be cleansed in a conventional coal-fired plant. This results in lower capital and operating costs for the IGCC as well as reduced parasitic energy requirements. Costs of carbon capture and pressurization for industrial gasification facilities are even lower, because the equipment and processes necessary for removing CO_2 from the gas stream are part of the manufacturing process. (Source: Eastman Chemical, MIT)



CONSEQUENCES OF A MORATORIUM ON COAL-BASED POWER GENERATION, INCLUDING IGCC

Despite the strong environmental benefits of IGCC, coal-based IGCC plants are facing the same opposition and delay encountered by combustion-based plants. Much of this is due to demands that IGCC plants incorporate carbon capture and sequestration in their initial operations.

A prime example occurred in Florida last year when the Tampa Electric Polk Unit 6 IGCC was indefinitely postponed when the state announced greenhouse gas reductions goals, but without the necessary regulatory structure and certainty to implement those reductions. The Tampa utility has been successfully running its first IGCC at the Polk plant since the mid-1990's and expectations were that the new unit would provide valuable experience leading to increased investor and owner confidence in IGCC technology.

Since the postponement, Tampa Electric has announced that the additional capacity the new IGCC would have provided will now be met by natural gas powered generation. This scenario is typical of coal cancellations in the U.S. Despite calls for efficiency and renewables as alternatives to coal, the power generation fuel of choice is natural gas. This demand for natural gas based power generation is accelerating because of its low emissions and higher capacity factor.

The Energy Information Administration estimates that by 2020 the use of coal for power will increase while the use of natural gas will decline. (Source: US EIA)

U.S. Fuel Demand for Power Generation (Quads)

	2007	**2020**
Coal	20.68	23.67
Natural Gas	6.77	5.92
Renewables	3.65	5.64

The EIA forecast is clearly unrealistic – coal use will not rise under the current circumstances and gas certainly will not decline. Industry analysts have indicated that incremental natural gas demand of 3 quads will be needed to meet the expected coal shortfall, even while U.S. natural gas production has been essentially flat.

One analysis of the consequences of a de facto coal plant moratorium lays out the following scenario:

- Incremental natural gas demand will have to come from marginal gas supplies.
- North American gas fields look to be maxed out at current demand levels.
- Marginal supplies will probably need to be purchased from the global liquefied natural gas (LNG) market.
- Therefore, US gas prices will be determined by much higher European and Asian prices, will be oil indexed to attract spot cargoes.

The price impacts of this rise in natural gas demand for power generation will be severe for industries such as chemicals, plastics and fertilizers that rely on natural gas as a feedstock, manufacturers that use gas as a fuel, and homeowners, already faced with skyrocketing oil and gasoline prices.

Industrial gasification offers one element of a solution – through plants gasifying coal or petroleum coke to produce chemicals, fertilizers or substitute natural gas (SNG), but the public policy and political climate is not reassuring. We propose the outline of a way forward.

CONCLUSIONS & RECOMMENDATIONS

There is the need for a sustained, long term carbon capture and sequestration initiative involving government and industry. The initiative should provide assurances to industry, the investment community and regulators that CCS via gasification is a viable option for capturing and sequestering CO_2 emissions from power generation and manufacturing. The elements of the initiative should include

:

- Demonstration at a commercial scale of multiple IGCC power plants with CCS using a variety of coals;
- Incentives that recognize and reward the ability of industrial gasification to offer large scale, near term opportunities for CCS at lower costs; and
- A uniform national policy framework addressing regulation of CO_2 emissions and CCS, including incentives and liability indemnification for early adopters.

Gasification: Background Information

What is Gasification?

Gasification is a manufacturing process that converts carbon-containing materials, such as coal, petroleum coke (“petcoke”), biomass, or various wastes to a “synthesis gas” or “syngas” which can then be used to produce valuable products, such as, electric power, chemicals, fertilizers, substitute natural gas, hydrogen, steam, and transportation fuels.

Gasification Is Not Combustion

Gasification is a *partial* oxidation (reaction) process which produces syngas comprised primarily of hydrogen (H_2) and carbon monoxide (CO). It is <u>not</u> a *complete* oxidation (combustion) process, which produces primarily thermal energy (heat) and residual solid waste (slag), criteria air pollutants (NOx and SO_2), and carbon dioxide (CO_2).

How Does Gasification Work?

Feedstocks

Gasification enables the capture — in an environmentally beneficial manner — of the remaining “value” present in a variety of low-grade hydrocarbon materials (“feedstocks”) that would otherwise have minimal or even negative economic value.

Gasifiers can be designed to run on a single material or a blend of feedstocks:

- **Solids:** All types of coal and petroleum coke (a low value byproduct of refining) and biomass, such as wood waste, agricultural waste, and household waste.
- **Liquids**: Liquid refinery residuals (including asphalts, bitumen, and other oil sands residues) and liquid wastes from chemical plants and refineries.
- **Gas**: Natural gas or refinery/chemical off-gas.

Gasifier

The core of the gasification system is the gasifier, a pressurized vessel where the feed material contacts with oxygen (or air) and steam at high temperatures. There are several basic gasifier designs, distinguished by the use of wet or dry feed, the use of air or oxygen, the reactor’s flow direction (up-flow, down-flow, or circulating), and the gas cooling process. Currently, gasifiers are capable of handling up to 3,000 tons/day of feedstock throughput and this will increase in the near future.

After being ground into very small particles — or fed directly (if a gas or liquid) — the feedstock is injected into the gasifier along with a controlled amount of air or oxygen and steam. Temperatures in a gasifier range from 1,400-2,800 degrees Fahrenheit. The heat and pressure inside the gasifier break apart the chemical bonds of the feedstock forming syngas.

The syngas consists primarily of hydrogen and carbon monoxide and, depending upon the specific gasification technology, smaller quantities of methane, carbon dioxide, hydrogen sulfide, and water vapor. Syngas can be combusted to produce electric power and steam or used as a building block for a variety of chemicals and fuels. Syngas generally has a heating value of 250-300 Btu/scf, compared to natural gas at approximately 1,000 BTU/scf.

Typically, 70 to 85 percent of the carbon in the feedstock is converted into the syngas. The ratio of carbon monoxide to hydrogen depends in part upon the hydrogen and carbon content of the feedstock and the type of gasifier used.

Oxygen Plant

Most gasification systems use almost pure oxygen (as opposed to air) to help facilitate the reaction in the gasifier. This oxygen (95 to 99 percent purity) is generated by using proven cryogenic technology. The oxygen is then fed into the gasifier through separate co-feed ports in the feed injector.

Gas Clean-Up

The raw syngas produced in the gasifier contains trace levels of impurities that must be removed prior to its ultimate use. After the gas is cooled, the trace minerals, particulates, sulfur, mercury, and unconverted carbon are removed to very low levels using commercially-proven cleaning processes common to the chemical and refining industries.

Carbon Dioxide

Carbon dioxide (CO_2) can also be removed at the gas cleanup stage using a number of commercial technologies. In fact, CO_2 is routinely removed with a commercially proven technology in ammonia and hydrogen manufacturing plants. Ammonia plants already capture roughly equivalent to 90 percent of the CO_2 and methanol plants capture approximately 70 percent.

Byproducts

Most solid and liquid feed gasifiers produce a glassy-like byproduct, which is non-hazardous and can be used in roadbed construction or in roofing materials. Also, in most gasification plants, more than 99 percent of the sulfur is removed and recovered either as elemental sulfur or sulfuric acid. Finally, for feeds (such as coal) containing mercury, more than 95 percent of the mercury can be removed from the syngas using relatively small and commercially available activated carbon beds.

Which Industries Use Gasification?

Gasification has been used in the chemical, refining, and fertilizer industries for more than 50 years and by the electric power industry for more than 35 years. Currently, there are more than 140 gasification plants — with more than 420 gasifiers — operating worldwide. Nineteen of those gasification plants are located in the United States.

The use of gasification is expanding. For example, there are several gasification projects under development to provide steam and hydrogen for synthetic crude upgrading in the oil sands industry in Canada. In addition, the paper industry is exploring how gasification can be used to make their operations more efficient and reduce waste streams.

Gasification Applications and Products

Hydrogen and carbon monoxide, the major components of syngas, are the basic building blocks of a number of other products, such as chemicals and fertilizers. In addition, a gasification plant can be designed to produce more than one product at a time (co-production or "polygeneration"), such as the production of electricity, steam, and chemicals (e.g. methanol or ammonia). This polygeneration flexibility allows a facility to increase its efficiency and improve the economics of its operations.

Chemicals and Fertilizers

Modern gasification has been used in the chemical industry since the 1950s. Typically, the chemical industry uses gasification to produce methanol as well as chemicals — such as ammonia and urea — which form the foundation of nitrogen-based fertilizers. The majority of the operating gasification plants worldwide are designed to produce chemicals and fertilizers. And, as natural gas and oil prices continue to increase, the chemical industry is developing additional coal gasification plants to generate these basic chemical building blocks.

Eastman Chemical Company helped advance the use of coal gasification technology for chemicals production. Eastman's coal-to-chemicals plant in Kingsport, Tennessee, converts Appalachian coals to methanol and acetyl chemicals. The plant began operating in 1983 and has gasified approximately 10 million tons of coal with a 98 to 99 percent on-stream availability rate.

Hydrogen for Oil Refining

Hydrogen, one of the two major components of syngas, is used to strip impurities from gasoline, diesel fuel, and jet fuel, thereby producing the clean fuels required by state and federal clean air regulations. Hydrogen is also used to upgrade heavy crude oil. Historically, refineries have utilized natural gas to produce this hydrogen. Now, with the increasing price of natural gas, refineries are looking to alternative feedstocks to produce the needed hydrogen. Refineries can gasify low value residuals, such as petroleum coke, asphalts, tars, and some oily wastes from the refining process to generate both the required hydrogen and the power and steam needed to run the refinery.

Transportation Fuels

Gasification is the foundation for converting coal and other solid fuels and natural gas into transportation fuels, such as gasoline, ultra-clean diesel fuel, jet fuel, naphtha, and synthetic oils. Two basic paths are employed in converting coal to motor fuels via gasification. In the first, the syngas undergoes an additional process, the Fischer-Tropsch

(FT) reaction, to convert it to a liquid petroleum product. The FT process, with coal as a feedstock, was invented in the 1920s, used by Germany during World War II, and has been utilized in South Africa for decades. Today, it is also used in Malaysia and the Middle East with natural gas as the feedstock.

In the second process, so-called Methanol to Gasoline (MTG), the syngas is first converted to methanol (a commercially used process) and the methanol is converted to gasoline by reacting it over a bed of catalysts. A commercial MTG plant successfully operated in the 1980's and early 1990's in New Zealand and one is under development in China.

Transportation Fuels from Oil Sands

The "oil sands" in Alberta, Canada are estimated to contain as much recoverable oil (in the form of bitumen) as the vast oil fields in Saudi Arabia. However, to convert this raw material to saleable products requires mining the oil sands and refining the resulting bitumen to transportation fuels. The mining process involves massive amounts of steam to separate the bitumen from the sands and the refining process demands large quantities of hydrogen to upgrade the "crude oil" to finished products. (Wastes from the upgrading process include petcoke, deasphalted bottoms, vacuum residuals, and asphalt/asphaltenes — all of which contain unused energy.)

Traditionally, oil sand operators have utilized natural gas to produce the steam and hydrogen needed for the mining, upgrading, and refining processes. However, a number of operators will soon gasify petcoke to supply the necessary steam and hydrogen. Not only will gasification displace expensive natural gas as a feedstock, it will enable the extraction of useable energy from what is otherwise a waste product (the petcoke). In addition, black water from the mining and refining processes can be recycled to the gasifiers using a wet feed system, reducing fresh water usage and waste water management costs. (This is not inconsequential since traditional oil sand operations consume large volumes of water.)

Substitute Natural Gas

Gasification can also be used to create substitute natural gas (SNG) from coal. Using a "methanation" reaction, the coal-based syngas — chiefly carbon monoxide (CO) and hydrogen (H_2) — can be profitably converted to methane (CH_4). Nearly chemically identical to conventional natural gas, the resulting SNG can be used to generate electricity, produce chemicals/fertilizers, or heat homes and businesses. SNG will enhance domestic fuel security by displacing imported natural gas that is likely to be supplied in the form of Liquefied Natural Gas (LNG).

Power Generation with Gasification

As stated above, coal can be used as a feedstock to produce electricity from gasification. This particular coal-to-power technology allows the continued use of coal without the high level of air emissions associated with conventional coal-burning technologies. This occurs because in gasification power plants the pollutants in the syngas are removed *before* the syngas is combusted in the turbines. In contrast, conventional coal combustion technologies capture the pollutants *after* the exhaust gas has passed through the boiler or steam generator — generally using an expensive "bag house" and/or "scrubber."

IGCC Power Plants

An Integrated Gasification Combined Cycle (IGCC) power plant combines the gasification block with a "combined cycle" power block (consisting of one or more gas turbines and a steam turbine). Clean syngas is combusted in high efficiency gas turbines to produce electricity. The excess heat from the gasification reaction is then captured, converted into steam and sent to a steam turbine to produce additional electricity. The gas turbines can be operated on a backup fuel such as natural gas during periods of scheduled gasifier maintenance or can co-fire the backup fuel to compensate for any shortfall in syngas production.

Gas Turbines

In IGCC— where power generation is the focus — the clean syngas is combusted (burned) in high efficiency gas turbines to generate electricity with very low emissions. The turbines used in these plants are derivatives of proven, natural gas combined-cycle turbines that have been specially adapted for use with syngas. For IGCC plants that include carbon capture, the gas turbines must be able to operate on syngas with higher levels of hydrogen. Although modern state-of-the-art gas turbines are commercially ready for this "higher hydrogen" syngas, work is on-going in the United States to develop the next generation of even more efficient gas turbines ready for carbon capture-based IGCC.

Heat Recovery Steam Generator

Hot gas from each gas turbine in an IGCC plant will "exhaust" into a heat recovery steam generator (HRSG). The HRSG captures heat in the hot exhaust from the gas turbines and uses it to generate additional steam that is used to make more power in the steam turbine portion of the combined-cycle unit.

Steam Turbines

In most IGCC plant designs, steam recovered from the gasification process is superheated in the HRSG to increase overall efficiency output of the steam turbines, hence the name Integrated Gasification Combined Cycle. This IGCC combination, which includes a gasification plant, two types of turbine generators (gas and steam), and the HRSG is clean and efficient — producing NOx levels less than 0.06lb per MMBtu (coal input basis) and combined cycle efficiencies exceeding 65 percent when process stream integrated from the gasification plant is included.

Another example of the "integrated" design in the fully integrated IGCC is the IGCC gas turbine that can provide a portion of the compressed air to the oxygen plant. This reduces the capital cost of the compressors while also decreasing the amount of power required to operate the oxygen plant. Additionally, gas turbines use nitrogen from the oxygen plant to reduce combustion NOx as well as increase power output.

Existing IGCC Power Plants
Fourteen gasification based power plants are operating around the world with one more under construction. Total capacity for these fifteen plants is 4.1 gigawatts of electricity. Numerous additional projects are planned.

In the U.S. two coal-based IGCC's have been in operation for more than a decade. The 262 MW Wabash River Coal Gasification Repowering Project (Wabash) in Indiana began commercial operation in November 1995 and helped pioneer the use of coal gasification for power in the United States. Since 1995, this facility has gasified over 1.7 million tons of bituminous coal and over 2.0 million tons of petcoke.

Tampa Electric Company also helped pioneer the use of coal gasification technology for power generation in the United States. Tampa's 250 MW Polk Power Station near Lakeland, Florida, began operating in 1996 and serves 75,000 households. The Polk plant uses high sulfur Illinois and other coals, but also blends Power River Basin coal and petcoke in order to reduce fuel costs. The Polk Power station markets the slag from the gasifier for use in manufacturing roofing and concrete blocks. Sulfuric acid, another by-product, goes into fertilizer production

What are the Environmental Benefits of Gasification?

Besides fuel and product flexibility, gasification-based systems offer significant environmental advantages over competing technologies, particularly coal-to-electricity combustion systems. This advantage occurs because the net volume of syngas being treated pre-combustion in an IGCC power plant is 1/100 (or less) than the volume of post-combustion exhaust gas that must be cleansed in a conventional coal-fired plant.

Air Emissions
Gasification can achieve greater air emission reductions at lower cost than other technologies, such as supercritical pulverized coal. In fact, coal IGCC offers the lowest emissions of sulfur dioxide (SOx) nitrogen oxides (NOx) and particulate matter (PM) of any coal-based power production technology. In addition, mercury emissions can be removed from an IGCC plant at one-tenth the cost of removal for a coal combustion plant. Technology exists today to remove more than 95% of the mercury from a gasification based plant.

Solids Generation
During gasification, virtually all of the carbon in the feedstock is converted to syngas. The mineral material in the feedstock separates from the gaseous products, and the ash and other inert materials fall to the bottom of the gasifier as a non-leachable, glass-like solid or other marketable material. This material can be used for many construction and building applications. In addition, more than 99 percent of the sulfur can be removed using commercially proven technologies and converted into marketable elemental sulfur or sulfuric acid. (See chart).

Water Usage
Gasification uses approximately 14 to 24 percent less water to produce electric power from coal compared to other coal-based technologies and water losses during operation are about 32 to 36 percent less than other coal-based technologies. This is a major issue in many countries — such as the United States — where water supplies have already reached critical levels.

Sustainability
Gasification can help move industrial and electric power facilities towards sustainability. It can reduce the environmental footprint from low-value waste materials by utilizing them as feedstock; rather than disposing of them. By extracting the useable energy from materials that would otherwise be treated as a waste and enabling reuse of waste waters, a facility can both reduce its environmental footprint and improve its operating margins.

Carbon Dioxide
In a gasification system, CO_2 can be captured using commercially available capture technologies before it would otherwise be vented to the atmosphere. One commercially available removal technology that is used as part of carbon capture, called the water-gas shift reaction, is illustrated below:

Converting the CO to CO_2 prior to combustion is much simpler and more economical than doing so after combustion, effectively "de-carbonizing," or at least reducing the carbon in the syngas.

Plants manufacturing ammonia, hydrogen, fuels, or chemical products with a gasification system routinely capture CO_2 as part of the manufacturing process. The Dakota Gasification plant in Beulah, North Dakota, captures the CO_2 while making substitute natural gas. Since 2000, this plant has sent captured CO_2 via pipeline to EnCana's Weyburn oil fields in Saskatchewan, Canada, where it is used for enhanced oil recovery. To date, more than five million tons of CO_2 has been sequestered.

According to the Environmental Protection Agency the higher thermodynamic efficiency of the IGCC cycle minimizes CO_2 emissions relative to other technologies.4/ IGCC plants offer today's least-cost alternative for capturing CO_2 from a coal-based power plant. In addition, IGCC will experience less of an energy penalty that other technologies if carbon capture is added. While CO_2 capture and sequestration will increase the cost of all forms of power generation, the U.S. Department of Energy estimates that the cost of CO_2 capture for a power plant concluded that the CO_2 capture cost is 10 percent more expensive for a conventional coal plant as for an IGCC power generation facility.5/

What are the Economic Benefits of Gasification?

Gasification can compete effectively in high-price energy environments. While a gasification plant is capital intensive (like any manufacturing unit), its operating costs are potentially lower than many other manufacturing processes or coal combustion plants because a gasification plant can use low-cost feedstocks, such as petcoke. Due to continued research and development efforts the cost of these units will continue to decrease.

There are a number of significant economic benefits with gasification. Inherent in the technology is its ability to convert low-value feedstocks to high-value products, thereby increasing the use of available energy in the feedstocks while reducing disposal costs. The ability to produce a number of high- value products at the same time (polygeneration) helps a facility offset its capital and operating costs. In addition, the principal gasification byproducts (sulfur and slag) are readily marketable.

Gasification offers wide fuel flexibility. A gasification plant can vary the mix of the solid feedstocks or run on natural gas or liquid feedstocks when desirable. This technology enables an industrial facility to replace its high-priced natural gas feed with lower priced feedstocks, such as coal or petcoke — thus reducing its operating costs.

For example, a refinery using gasification to manufacture hydrogen and steam can replace its natural gas feedstock with waste materials that may otherwise have to be disposed of (such as petcoke). The ability to use lower value fuels enables a refinery to reduce both its fuel and disposal costs while producing the large quantities of hydrogen that are needed for cleaner transportation fuels.

In addition, gasification units require less pollution control equipment because they generate fewer emissions; further reducing the plant's operating costs.

What is the Gasification Market Outlook?

Worldwide gasification capacity is projected to grow 70 percent by 2015, with 81 percent of the growth occurring in Asia. The prime movers behind this expected growth are the chemical, fertilizer, and coal-to-liquids industries in China, oil sands in Canada, polygeneration (hydrogen and power or chemicals) in the United States, and refining in Europe. China is expected to achieve the most rapid growth in gasification worldwide. There are seven coal-to-substitute natural gas gasification plants under development and twelve proposed IGCC plants in China. Since 2004, 29 new gasification plants have been licensed and/or built in China. In contrast, no new gasification plants have started up in the United States since 2002.

The gasification industry in the United States faces a number of challenges, including, rising construction costs and uncertainty about policy incentives and regulations. Despite these challenges, gasification is expected to grow significantly in this country.

A number of factors will contribute to a growing interest in gasification, including volatile oil and natural gas prices, more stringent environmental regulations, and a growing consensus that CO_2 management should be required in power generation and energy production. All of these factors contribute to a growing interest in gasification worldwide.

Energy Security

America is at a critical juncture in meeting its electric generating needs. Natural gas prices are volatile and while new natural gas supplies are being developed, those supplies are generally located outside the country. In addition, there is increasing concern about the need to diversify U.S. fuel requirements. Gasification is a technology that can help address some of these energy security concerns. Gasification can generate electricity and produce substitute natural gas and transportation fuels using major domestic resources such as coal or petroleum coke, thus reducing U.S. dependence on both foreign oil and foreign natural gas.

Bioprocessing

In addition to using the traditional feedstocks of coal and petroleum coke, gasifiers can utilize biomass, such as yard and crop waste, “energy crops”,(such as switch grass), and waste and residual pulp/paper plant materials as feed. Municipalities as well as the paper and agricultural industries are looking for ways to reduce the disposal costs associated with these wastes and for technologies to produce electricity and other valuable products from these waste materials. While still in its infancy, biomass gasification shows a great deal of promise.

A Link to the Future

Gasification is a “link” technology to a hydrogen economy. Because gasification converts feedstocks such as coal directly into hydrogen, it can become a competitive route to producing the large quantifies of hydrogen that will be needed for fuel cells and cleaner fuels. By contrast, other technologies must first create the electricity needed to separate the hydrogen from water using electricity or expensive natural gas.

CONCLUSIONS AND RECOMMENDATIONS

Gasification is the cleanest, most flexible way of using fossil fuels. Currently, over 80 percent of the installed worldwide gasification capacity is capturing CO2. Gasification also provides the lowest cost option for capturing CO2 from a fossil-fuel based power plant.

While there are strong advantages to gasification, it also faces a number of challenges, particularly for coal-to–power applications. The following are needed to help with the widespread deployment of this technology:

- Demonstration on a **commercial scale** of multiple IGCC power plants with CCS
- Policies that recognize and reward the ability of "industrial gasification" (involved in the manufacture of products and fuels) to offer large scale, near term opportunities for CCS at lower costs; and
- A uniform national policy framework addressing carbon dioxide including incentives and liability indemnification for early adopters.