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. Gasification plants can readily capture carbon dioxide, the leading greenhouse gas, much more easily and efficiently than coal-fired power plants. In many instances, this carbon dioxide can be sold, creating additional value from the gasification process.

Carbon dioxide captured during the gasification process can be used to help recover oil from otherwise depleted oil fields. The Dakota Gasification plant in Beulah, North Dakota, captures its carbon dioxide while making substitute natural gas and sells it for enhanced oil recovery. Since 2000, this plant has captured and sent the carbon dioxide via pipeline to EnCana's Weyburn oil fields in Saskatchewan, Canada, where it is used for enhanced oil recovery. More than five million tons of carbon dioxide have been sequestered.

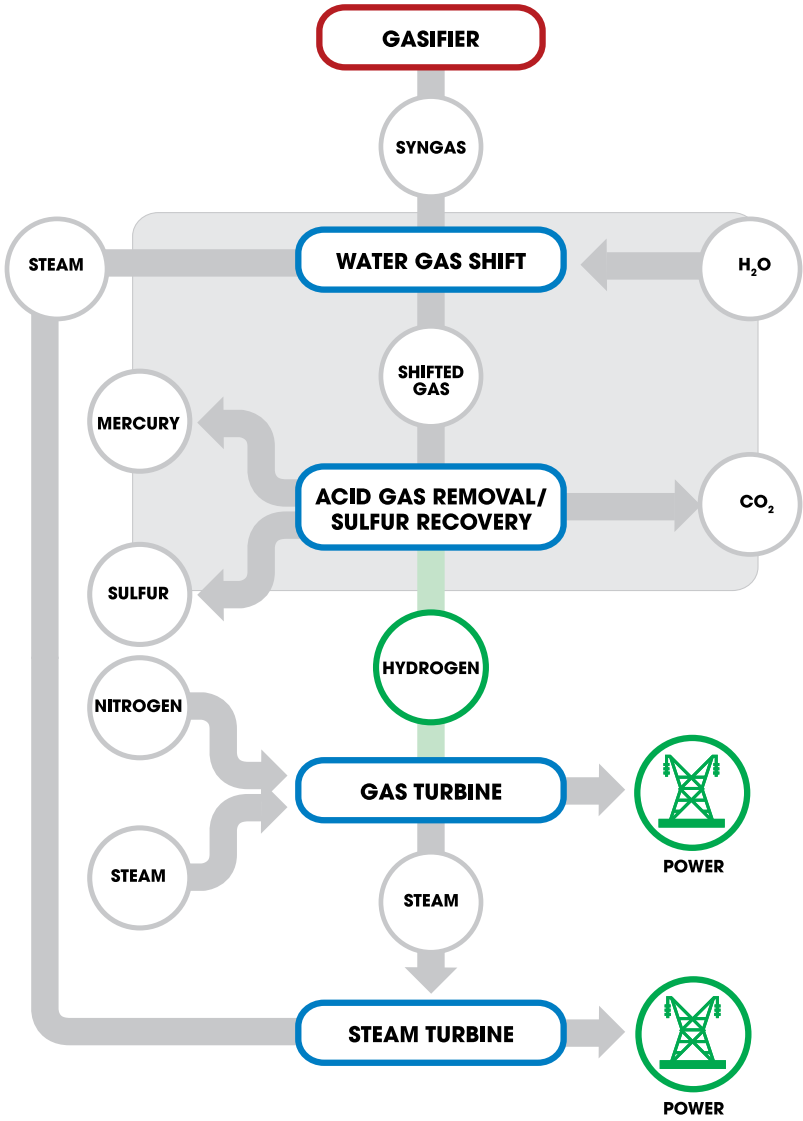
CARBON DIOXIDE

In a gasification system, carbon dioxide can be captured using commercially available technologies before it would otherwise be vented to the atmosphere. One process, called the water-gas shift reaction, is illustrated on the next page.

Converting the carbon monoxide to carbon dioxide and capturing it prior to combustion is more economical than removing carbon dioxide after combustion, effectively "de-carbonizing" or, at least, reducing the carbon in the syngas.

Gasification plants manufacturing ammonia, hydrogen, fuels, or chemical products routinely capture carbon dioxide as part of the manufacturing process.

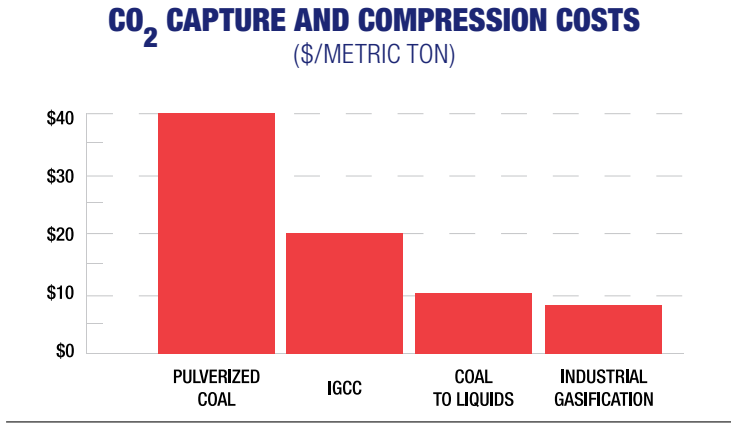
CO_2 REMOVAL FLOW



According to the Environmental Protection Agency, the higher thermodynamic efficiency of the IGCC cycle minimizes carbon dioxide emissions relative to other technologies. IGCC plants offer today's least-cost alternative for capturing carbon dioxide from a coal-based power plant. In addition, IGCC will experience a lower energy penalty than other technologies if carbon dioxide capture is required. While carbon dioxide capture and sequestration will increase the cost of all forms of power generation, an IGCC plant can capture and compress carbon dioxide at one-half the cost of a traditional pulverized coal plant. Other gasification-based options, including the production of motor fuels, chemicals, fertilizers or hydrogen, have even lower carbon dioxide capture and compression costs. This will provide a significant economic and environmental benefit in a carbon-constrained world.

AIR EMISSIONS

Gasification can achieve greater air emission reductions at lower cost than other coal-based power generation, such as supercritical pulverized coal. Coal-based IGCC offers the lowest emissions of sulfur dioxide nitrogen oxides and particulate matter (PM) of any coal-based power production technology. In fact, a coal IGCC plant is able to achieve low air-emissions rates that approach those of a natural gas combined cycle (NGCC) power plant. In addition, mercury emissions can be removed from an IGCC plant at one-tenth the cost of removal from a coal combustion plant. Technology exists today to remove more than 90% of the volatile mercury from the syngas in a coal-based gasification-based plant.



Source: MIT and Eastman Gasification Services

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 melt and 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% of the sulfur can be removed using commercially proven technologies and converted into marketable elemental sulfur or sulfuric acid.

WATER USE

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

THE ECONOMIC BENEFITS OF GASIFICATION

While a gasification plant is capital intensive (like any manufacturing unit), its operating costs can be lower than many other manufacturing processes or coal combustion plants. Because a gasification plant can use low-cost feedstocks, such as petcoke or high-sulfur coal, converting them into high-value products, it increases the use of available energy in the feedstocks while reducing disposal costs. Ongoing research, development, and demonstration investment efforts show potential to substantially decrease current gasification costs even further, driving the economic attractiveness of gasification.

In addition, gasification has a number of other significant economic benefits.

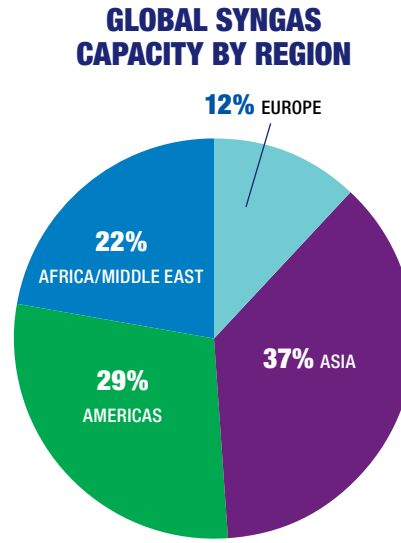
- The principal gasification byproducts (sulfur, sulfuric acid, and slag) are marketable.
- Gasification can produce a number of high-value products at the same time (polygeneration), helping a facility offset its capital and operating costs and diversify its risks.
- Gasification offers wide feedstock flexibility. A gasification plant can be designed to vary the mix of the solid feedstocks or run on natural gas or liquid feedstocks when desirable.
- Gasification units require less emission control equipment because they generate fewer emissions, further reducing the plant's operating costs.
- Investment in gasification injects capital into the economy (by building large-scale plants using domestic labor and suppliers), and creates domestic jobs (construction to build, well-paid jobs to run) that cannot be outsourced to overseas workers.

THE GASIFICATION MARKET OUTLOOK

The forecast for growth of gasification capacity focuses on two areas: large-scale industrial and power generation plants and the smaller scale biomass and waste to energy area.

INDUSTRIAL AND POWER GENERATION GASIFICATION

Worldwide industrial and power generation gasification capacity is projected to grow 70% by 2015, with 81% 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: the Chinese have focused on gasification as part of their overall energy strategy. Since 2004, 35 new large-scale gasification plants have been licensed or built in China.



By contrast, no new large-scale gasification plants have started in the United States since 2002. The industrial and power 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, U.S. industrial and power gasification capacity is expected to grow.

A number of factors will contribute to this expansion:

- Volatile oil and natural gas prices will make low-cost and abundant domestic resources with stable prices increasingly attractive as feedstocks.
- Gasification processes will be able to comply with more stringent environmental regulations because their emission profiles are already substantially less than more conventional technologies.
- There is a growing consensus that carbon dioxide management will be required in power generation and energy production. Since the gasification process allows carbon dioxide to be captured in a cost-effective and efficient manner, it will be an increasingly attractive choice for the continued use of fossil fuels.

BIOMASS AND WASTE-TO-ENERGY GASIFICATION

The greatest area of growth in terms of the **number** of plants in the U.S. is likely to be in the biomass and waste-to-energy gasification areas. Because they are smaller in scale, these plants are easier to finance, easier to permit and take less time to construct. In addition, municipal and state restrictions on land-fills and incineration and a growing recognition that these materials contain valuable sources of energy are driving the demand for these plants.

A number of factors will contribute to the growing interest in biomass and waste gasification:

- Restrictions on landfill space
- Efforts to reduce costs associated with waste management
- Growing recognition that biomass and waste contain unused energy that can be captured and converted into energy and valuable products
- Ability to use non-food biomass materials and convert them into valuable energy products

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