

Coal Gasification: Power over Pollution

Using integrated gasification combined-cycle technology from Siemens, the Texas Clean Energy Project, which is scheduled to begin operating by 2014, will feature a coal-based power plant boasting fewer emissions than the cleanest natural gas power plant in existence. Don Hodel and Earl Gjelde of Summit Power explain why they regard coal gasification as a viable technology.

By Rachel Walker

In the rugged, desolate landscape near Odessa, Texas, USA, the future of coal-based power production is rising out of the stark Permian Basin. Summit Power's Texas Clean Energy Project (TCEP), a 400-MW integrated gasification combined-cycle (IGCC) plant, stands to transform coal – currently one of the most egregious greenhouse gas polluters – into the most benign commercial combustion power source available.

"This is the number one priority gasification project for the US government," says Don Hodel, Summit Power's Chairman and Senior Vice President for Strategy and Policy. "Everyone in the industry is watching this closely. There is avid interest worldwide in this because it is going to provide a great step forward." Using proven technology, the Texas project will integrate gasification, power production and chemical production under one roof for the first time in history. If successful, the US\$2.1 billion plant will demonstrate that coal can be used to produce

power while emitting minimal carbon dioxide and other pollutants, thanks to breakthrough gasification technology that allows for an unprecedented 90 percent carbon capture rate. The TCEP, expected to begin operating in 2014, will also produce fertilizer and sequestered carbon dioxide as revenue-generating by-products.

Worldwide, industry experts are watching Texas with sharp eyes, understanding that the results of the Texas Clean Energy Project stand to transform how the world uses coal as a power-producing feedstock.

Innovative Technology

Unlike traditional coal-fired power plants, Summit's Texas plant will not burn coal just for steam to produce power. Instead, the plant has awarded Siemens a front-end engineering design (FEED) contract to supply gasification island technology to break coal into its molecular compounds, creating synthetic gas (syngas) to run the power plant, and to produce other valuable by-products.

"There is avid global interest because TCEP will provide a great step forward."

Don Hodel, Chairman, Summit Power

Photos: Johannes Krömer



Breakthrough technology: Donald Hodel (left) and Earl Gjeld have high hopes for the integrated gasification combined-cycle (IGCC) plant.

Specifically, the plant will use two Siemens SFG-500 gasifiers, which are oxygen-blown, entrained flow systems. These operate on nearly pure oxygen (95–99 percent) as the gasification agent.

Once the coal is gasified, the technology downstream of the gasifiers sequesters the CO₂ and scrubs the syngas of other elements like mercury and sulfur. This process will prevent approximately 3 million tons of CO₂ from being emitted each year, for a 90 percent carbon capture rate. The carbon capture occurs after gasification, when the syngas (containing carbon and hydrogen) is being cleaned of sulfur. The CO₂ is subsequently compressed and sold for use for enhanced oil recovery (EOR).

One ton of compressed CO₂ produces 2.5 to 3 barrels of domestic oil. The clean syngas is then routed into the

combined-cycle power block, which includes a Siemens SGT6-5000F gas turbine and a heat recovery steam generator unit, which will reroute the steam to a Siemens SST-900RH steam turbine. The plant will also rely on Siemens air-cooled generators and SPPA-T3000 controls, large compressors and many electrical components. Additional syngas will be used to produce urea for fertilizer.

“All of the components are proven – they’re all there. And this will be the first time they are combined in such a fashion,” says Earl Gjeld, Chief Executive Officer of Summit. This advanced polygeneration plant is feasible in part because of the exceptional quality equipment provided by Siemens, says Hodel. The Siemens gasification equipment can operate on any carbon-based feedstock, from high-end coal and oil to low-grade

Donald Hodel is Chairman and Senior Vice President for Strategy and Policy at Summit Power. Hodel’s extensive experience in the energy industry began at the Bonneville Power Administration, where he served as Administrator (Chief Executive Officer) from 1972 to 1977. Mr. Hodel served in the federal government as the Under Secretary of the US Department of the Interior (1981–1982), Secretary of the US Department of Energy (1982–1985), and Secretary of the US Department of the Interior (1985–1988). He has served on the boards of directors of several publicly traded and privately held companies, numerous public foundations and institutes.

Earl Gjeld is Chief Executive Officer of Summit Power. Gjeld began his career at the Bonneville Power Administration, where he was the Deputy Administrator (Chief Operating Officer). He later served in the federal government as Under Secretary and Chief Operating Officer of the US Department of the Interior (1985–1989), and the Chief of Staff and Chief Operating Officer for the US Department of Energy (1982 to 1985). Gjeld has served on the boards of directors of the US Energy Association and US World Energy Congress, AMEN Properties and the National Wilderness Institute.

Summit Power Group, Inc. was founded in 1989 to develop electric power projects for would-be project owners on a success fee basis. Summit specializes in sustainable energy projects – high-efficiency natural gas-fired, wind power, solar power and coal gasification projects with 90 percent or better carbon capture.

supplies. Further, the combustion turbine can efficiently use the highly volatile hydrogen-rich syngas, which results from the high carbon capture rate.

While other gasifiers may have more commercial experience in the West, Hodel says the Siemens systems are “the simplest, most reliable, require the least downtime for maintenance, and handle the widest range of fuels – from low-end to high-grade. In addition, Siemens has the only proven high-hydrogen-fueled efficient combustion turbine that we’re aware of.” Summit has also contracted Siemens to provide long-term operation and maintenance of the TCEP, which assures investors of the plant’s viability, Gjeld explains. The two companies have worked together for more than 20 years. “Siemens is providing a crucial service with the long-term opera-

tion and maintenance contracts,” he says. “They are basically saying, ‘We will provide the technology and we will stand behind it.’ This is critical to all the parties on this project; indeed to its very success.”

The Plant of the Future

The capability to reduce carbon dioxide pollution drastically and simultaneously create revenue-producing by-products will set a new standard for future power plants, says Jason Lewis, TCEP Project Manager for the US Department of Energy (DOE). “Once built, the Texas Clean Energy Project will demonstrate very low or near-zero emissions from a coal-based, power-related, polygenerational facility,” says Lewis. “Once such a project is demonstrated, it will be really difficult to permit a plant that does not meet these standards.” Under the DOE’s Clean Coal

Power Initiative (CCPI), the project will demonstrate the commercial integration of large-scale IGCC capture and storage technology.

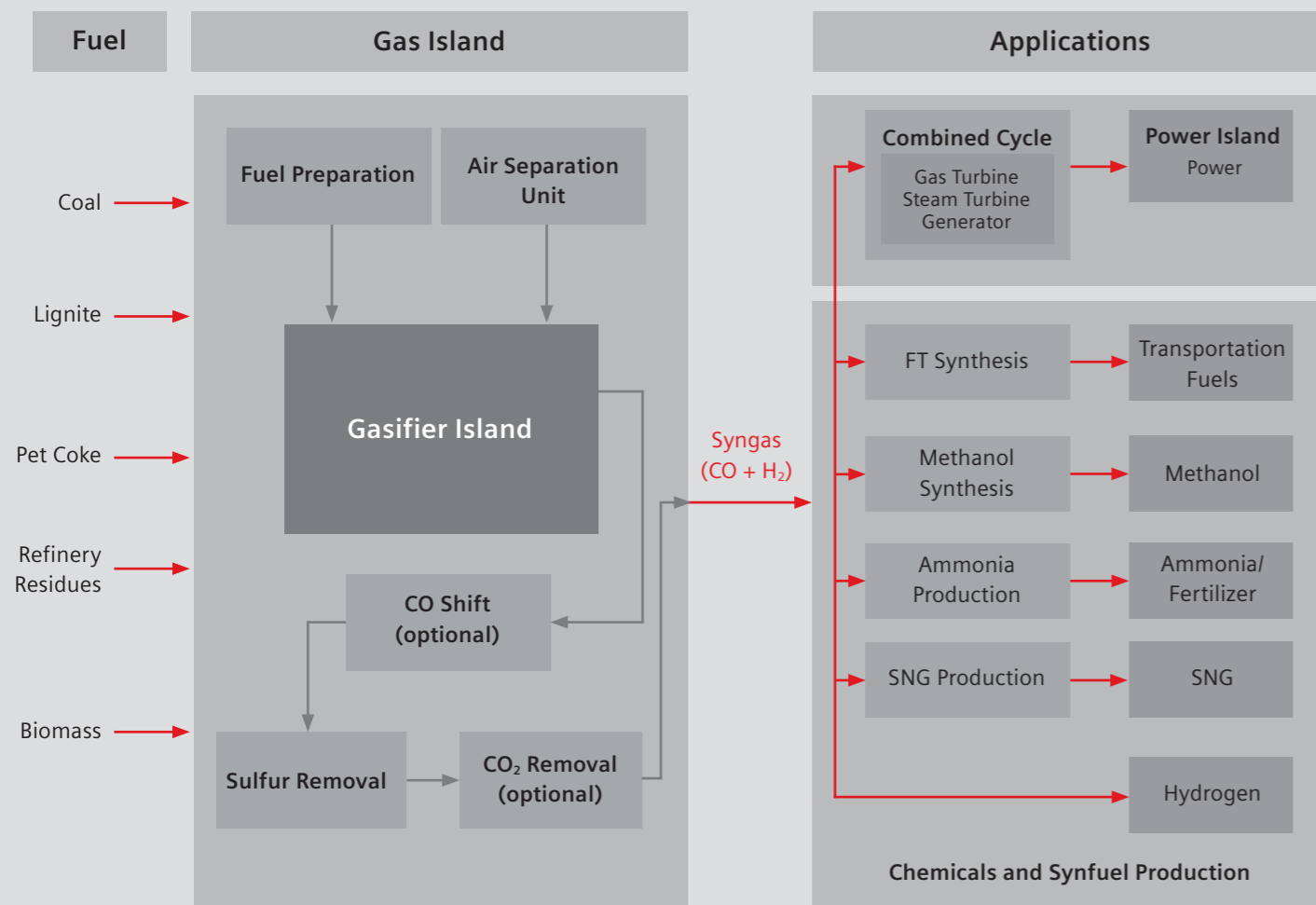
Because this is the first plant of its kind, building and operating it carries a greater risk and higher costs than conventional power plants. Summit anticipates spending US\$2.1 billion in total project costs, and the company has received US\$450 million from the US Department of Energy as part of its Clean Coal Power Initiative (CCPI). The project has also been awarded US\$313 million in investment credits. In addition, the company will be able to sell all of its commodities – power, urea, carbon dioxide, argon, sulfuric acid and inert slag – at market rates, as a result of the help with tax incentives and initial subsidies.

Lewis of the DOE says federal assistance will jump-start the market for this technology and for similar plants in the future. That, ultimately, will drive down costs. “The power industry tends to be conservative and slow to adopt new advanced technology,” says Lewis. “Once the first plant is shown to be viable, the second plant would not necessarily involve federal assistance, and the third plant would involve efficiency improvements and optimizations to further reduce costs.” Secondary to providing power to the American public, the DOE supports this project to “accelerate that natural progression and cause a material change in the marketplace,” says Lewis.

Addressing Environmental Concerns

Critics of gasification have argued that its significant water consumption and potential watershed pollution negate the benefits of emissions reduction. Most of the water in the TCEP system will be recycled through the plant, and Gjeld and Hodel say they’ve taken steps to reduce the plant’s water consumption. Rather than use water to condense the steam, they’ve invested in an expansive air-cooling system. Further, the plant uses a “zero discharge” system. Additionally, by

IGCC Demystified



An integrated gasification combined-cycle (IGCC) plant is a combined-cycle power plant where the typical fuel (natural gas) is replaced by synthetic gas produced via gasification of a solid or liquid feedstock such as coal or petroleum residuals. Today's IGCC technology improves plant efficiencies and uses less fuel to generate the rated power, resulting in better economics and reduced emissions.

Rather than burn coal directly, an IGCC plant breaks it down into its chemical constituents in three primary steps. First, the fuel, or feedstock, is combined with almost pure oxygen (95 to 99 percent) and steam under high temperatures (up to 2,500 °F) and pressure in a gasifier. The oxygen is derived from an air separation unit (ASU), which produces oxygen (O₂) from ambient air. The ASU also coproduces nitrogen, which can be used for diluting the syngas before it is used as a fuel. The coal molecules break apart and initiate chemical reactions that produce carbon monoxide (CO), hydrogen (H₂) and other gaseous compounds.

The carbon monoxide is passed over a catalyst with water, which stimulates a chemical reaction, converting the carbon monoxide into carbon dioxide (CO₂). That CO₂ is isolated and removed, essentially "capturing" carbon that would otherwise be emitted into the atmosphere in a traditional coal-burning power plant. The resulting gas, called synthetic gas, or syngas, consists mostly of hydrogen and is used to produce power or other coproducts.

The syngas is also cleaned to remove contaminants such as sulfur, mercury and particulates. The clean high-hydrogen syngas is routed to the power island, where a combined-cycle system has two types of turbines: combustion and steam. The combustion turbine is fueled by syngas and drives an electric generator. The exhaust heat is recovered, and is used to boil water and create steam for a steam turbine generator.

Syngas can also be used to produce commercial by-products, including transportation fuels, methanol, ammonia/fertilizer, hydrogen and substitute natural gas (SNG). This ability to produce multiple commodities is known as polygeneration.

"All of the components are proven – they're all there. And this will be the first time they are combined in such a fashion."

Earl Gjelde, Chief Executive Officer, Summit Power

recycling the wastewater, they expect to have no water discharge – and therefore no watershed pollution. Environmental groups also argue that "clean coal" is an oxymoron and say that the majority of captured CO₂ could still seep into the atmosphere during the enhanced oil recovery (EOR) operations. While that is possible, Lewis of the DOE says using CO₂ for EOR is an established practice, and studies have shown that the CO₂ remains in the oil fields. Further, his agency will apply strong oversight and will issue fines if the sequestration proves faulty, he says.

America has an estimated 200 to 500 years of coal reserves, making this country "the Saudi Arabia of coal," says Hodel. With extensive reserves worldwide and a growing need for energy in both developed and developing countries, coal is a logical, affordable power source, he explains. Yet he concedes it has also been legitimately castigated for its contribution to greenhouse gas emissions. "About ten years ago, we realized it was going to get harder and harder to build a traditional coal plant," he says. "There was strong resistance, and we knew that was just going to get stronger." Summit pursued the Texas IGCC plant because it made environmental, strategic and economic sense. And although greenhouse gas emissions

are not currently regulated, industry experts expect they soon will be. By building a coal-fueled plant with lower emissions than the cleanest natural gas plant, they aim to be ahead of the curve.

While this precedent-setting investment could prove lucrative, both Gjelde and Hodel insist their motivation is in part out of public service. Providing affordable, reliable energy with available coal resources and capturing 90 percent of the carbon emissions represents the realization of their mission. "We are putting together a project that is good for the country," says Hodel. "This plant will show that we can use our enormous domestic coal reserves in an environmentally sustainable way. It will be the cleanest fossil fuel power available."

Rachel Walker writes about science and technology from Boulder, CO, USA. Her work has appeared in the New York Times, Women's Health and Men's Journal, as well as notable regional magazines and newspapers. She is currently cowriting a book about molecular medicine and was a Ted Scripps Fellow in environmental journalism at the University of Colorado.

Further Information

www.summitpower.com/projects
www.siemens.com/energy

Glossary

- **Gasification:** The process of creating gas by breaking a material such as coal down into its molecular elements by combining it with oxygen and water at high temperatures.
- **Polygeneration:** The ability to generate or produce multiple products. The Texas Clean Energy Project will sell power, carbon dioxide and fertilizer, making it a polygeneration plant.
- **Carbon Capture:** The process of removing carbon dioxide from the fuel or the flue gas and thus preventing its emission into the atmosphere. In Texas, the plant will have precombustion carbon capture, which means the carbon will be removed from the feedstock following gasification and prior to combustion for power production.
- **Syngas:** Synthetic gas that is the result of the gasification of a carbon-based feedstock.
- **Combined-Cycle:** A combined-cycle energy plant operates a gas-fired turbine and utilizes the waste heat for a steam-powered turbine.