

Coal Gasification

Delivering energy-efficient, reliable technologies, proven logistics and constructability in challenging locations to meet cost and schedule



KBR

TECHNOLOGY



Southern Company and KBR are working together in conjunction with the U.S. Department of Energy (DOE) to develop the necessary experimental information required to commercialize TRIG™— a clean coal technology that KBR has tested on a semi-commercial scale since 1996.

Managing Energy Needs in a Greener World

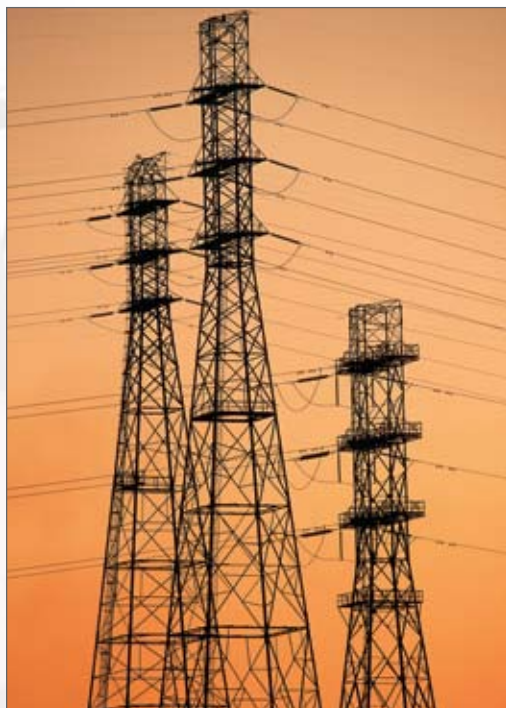
Recent escalation in natural gas prices along with the desire to reduce emissions and improve the efficiency of existing and new power and chemical plants has caused the industry to refocus its attention to coal gasification. Companies that need clean energy from stranded or alternative resources fast rely on their EPC contractor to answer:

- Is the project timeline realistic and feasible to predict revenue streams?
- How will you confidently balance logistics, safety and sustainability?
- Which issues are likely to impede delivering clean, reliable, cost-effective energy?

Understanding project needs and offering innovative solutions that reduce risk in coal gasification is a differentiator that KBR brings to every project. With over 60 years of commercial operating experience based on our fluidized catalytic cracking (FCC) technology, KBR's Transport Reactor Integrated Gasifier (TRIG™) economically taps coal's potential while mitigating its harmful effects enhancing environmental performance and reliability.

Choosing Energy-Efficient Technology

Project teams at KBR conduct preliminary studies and select energy-efficient technology for your downstream needs. With so much pressure to “go green” and drive revenue at the same time, companies require technology that delivers efficiency gains and future savings while eliminating air pollutants and potential greenhouse gases. Using “clean coal technology” like KBR's TRIG, companies can benefit from a new generation of energy processes that sharply diminish air emissions and other pollutants from coal-burning power plants. While we have a number of proprietary technologies that outperform competitive solutions in reliability and cost-effectiveness, we are neutral when it comes to offering expertise in coal gasification technology when TRIG is not the preferred solution.



Under the Energy Department's Clean Coal Power Initiative, the IGCC plant will turn coal into gas for generating electricity, while significantly reducing emissions of sulfur dioxide, nitrogen oxides and mercury.



For power generation, TRIG uses a cost-efficient air-blown design; however, it operates equally well for chemical and fuel production in an oxygen-blown configuration. In either situation, TRIG easily handles low rank, high-moisture, and/or high-ash coals found in more than 60 percent of worldwide coal reserves.

Making Environmental Compliance Affordable

Now more than ever, conventional coal-fired power plants face the risk of considerable capital costs and long-term operating expenses to meet ever-tightening emissions regulations. Operators can bypass these high cost by removing pollutants more cost effectively with integrated gasification combined cycle (IGCC) facilities that use KBR's TRIG. Proven for producing power and chemicals, KBR's TRIG is a superior coal gasification technology that processes transportation fuels from coals with less environmental impact. For example, KBR along with Southern Company scaled up a 50 tonne per day (tpd) facility into a full-commercial plant making 600 megawatts of power per day minimizing the environment impact of NO_x, SO₂ and particulate matter.

Meeting the Growing Energy Demand

TRIG offers advantages over other existing technologies. Most existing coal gasification technologies perform best on bituminous coals and petroleum refinery waste products. These gasifiers require oxygen from an air separation plant, which is expensive to operate. Also, these gasifiers operate at higher temperatures that melt ash embedded in coal, which with the air separation plant and the higher operating temperatures can lower overall plant availability. Additionally, TRIG is more flexible than other gasifiers and operates in air-blown or oxygen-blown mode.

TRIG is more efficient than other oxygen-blown gasifiers when used to make syngas. In contrast, TRIG for IGCC applications offers a simpler, more robust method of air-blown configuration for eliminating coals' harmful effects while contributing to a cleaner environment and increasing reliability. For example, to help meet the skyrocketing demand for energy the Power Systems Development Facility (PSDF) near Wilsonville, Alabama boasts near-term practical applications of TRIG.



Identifying what product slates generate the most revenue and whether your project makes economic sense is our first and foremost goal.



Low-rank coals have less energy per pound but account for over half of the worldwide reserves. Unlike other gasifiers, KBR's TRIG delivers power commercially at a cost lower than that of the most advanced coal-fired plants.

Making Safety First

Organizations that want to mitigate risk must choose an EPC company like KBR that takes proactive measures, rewards safety performance, records lost time incidents (LTI) and minimize environmental and social impact. While some contractors track lagging indicators (post-incident), KBR tracks leading indicators (pre-incident) and implements best practices to create an injury free work environment. Achieving project success means continuously improving safety records and removing health and environmental hazards that could stall production. Further proof of our pledge to put safety first includes holding regular safety meetings, promoting a safety-first culture and achieving 5,584,891 hours at In Salah gas development project without any recordables.

Averting risk during concept, feasibility, front-end engineering and design (FEED), detailed design, construction and commissioning is an area in which KBR is well equipped

Overcoming Logistical Risks

Operating in remote areas, our teams deliver logistics that include erecting virtual towns in isolated areas where no infrastructure exists. This construction effort requires moving oversized equipment and building roads, railroads, bridges and camps to accommodate thousands of workers. From conducting site surveys to coordinating with the Army Corps of Engineers in the US and governmental infrastructure groups abroad, KBR has extensive experience identifying load

lengths and capacities as well as width limits. Solving logistics like upgrading load capacities of roads, bridges and railways is an area where KBR has a great deal of expertise. Besides transportation, challenges and the logistics involved with locating and training local workforces between 5,000 – 8,000 persons, we often build year-round in extremely adverse conditions and temperatures using specialized concrete and other construction materials especially designed for extreme climates.



KBR is transforming coal into clean energy for power generation, hydrogen for refining and captured CO₂ for enhanced oil recovery (EOR) in mature fields.



KBR's TRIG offers a simpler, more robust method for generating energy from coal than other available alternatives. It is unique among coal gasification technologies in that it is cost-effective when handling low rank coal, as well as coals with high moisture or high ash content.

Meeting Cost and Schedule

Risking a massive coal gasification project with an inexperienced EPC contractor could cost you your reputation. The fact is, much of the criteria affecting your ability to achieve monthly objectives depends on having the right systems in place and a strong EPC team aligned with your vision and focused on your goals. At KBR, we will assemble the right team to meet your production targets and local requirements. That's the reason Southern Company repeatedly turns to KBR for engineering expertise when executing coal gasification projects.



Understanding client needs and offering innovative solutions that reduce risk in coal gasification projects across the globe is a differentiator that KBR brings to every project.

Managing Execution Risks

Safeguarding your multi-billion dollar project is always a priority with KBR. With fast-tracked timetables, environmental compliance and tight capital budgets, effective project management and controls will take you seamlessly from an initial idea to cost effective energy. This is why we take great strides to determine whether it makes

sense to build your plant elsewhere or build it onsite. Building off-site requires a company that has significant modular design and construction experience, and KBR has both. Over the years, we have built thousands of facilities both on and off-site, taking an active role in the success of each from concept to commissioning and beyond.

Maximizing Jobsite Opportunities

As a global service provider, we maximize employment opportunities for indigenous communities and provide extensive training for local workers. In-depth understanding of cultural issues allows KBR to work seamlessly with a wide array of local governments and communities worldwide. In this way, we are able to provide a sustainable workforce of local professionals who optimize plant processes with little to no assistance from corporate headquarters.



The IGCC plant at Southern Company will use state-of-the-art emission controls, showcasing the cleanest, most efficient coal-fired power technology in the world, including the transport gasifier technology that KBR along with Southern Company and the DOE developed at the PSDF near Wilsonville, Ala.

Generating Successful Outcomes

Deploying tools, systems and procedures globally combined with our advanced project management software allows for borderless work sharing and increases the success of your project. Ensuring that standards and project requirements are aligned with your vision, our experts communicate and monitor progress using business execution tools such as IPMS, project portals, 3D conceptual engineering, project dashboards, geographic information systems and object engineering. Over the years, our extensive project management tools have allowed KBR to communicate work progress while applying our proprietary process technologies to hundreds of projects with major energy companies.

TRIG produces more power and offers lower capital, operation and maintenance costs than oxygen-blown gasification

Demonstrating TRIG Near Wilsonville, Alabama, USA

The PSDF is an engineering-scale demonstration of TRIG and includes a high-temperature, high-pressure syngas dust filtration system and other critical subsystems. Rather than burning coal directly to make electricity, gasification first breaks coal down into chemical components. Gases that result from this chemical breakdown fuel power plants using integrated gasification combined cycle technology. By further developing TRIG, KBR in conjunction with Southern Company has enabled the technology to work even more effectively with sub-bituminous and other low-rank coals. For example, TRIG is adapted from KBR's proven technology that turns low-rank coal into a viable fuel for modern gas turbine power generations.



The operational experience gained by Southern Company and KBR at the demonstration unit at PSDF in Wilsonville, Alabama, is the basis of a planned, full-scale, commercial implementation of TRIG.



Overseeing rigorous process simulation, modeling, feasibility studies, process optimization and early production design and procurement support has granted KBR a reputation of solving "first of its kind" challenges.

Turning Coal into Substitute Natural Gas (SNG)

In our new Coal to SNG process, TRIG is integrated with a conventional methanation scheme to make pipeline-quality SNG from low rank coal such as Powder River Basin (PRB) coal and lignite. PRB is the single largest mined coal in USA, and KBR routinely uses it for baseline tests at the TRIG demonstration unit in Wilsonville, Alabama. Study results conclude KBR's Coal to SNG process is suited for a wide range of feedstocks, particularly low rank coal that are inexpensive and abundant. The process scheme offers a technically robust and energy efficient design, with several advantages over comparable gasification processes. To date, our teams are currently investigating the economics of building mine-mouth 150 million standard cubic foot per day SNG facilities using KBR's TRIG gasification technology at various western US locations.

Deriving Greater Environmental Benefits

Gasification plants are able to capture and compress carbon dioxide for storage at a much lower cost because they inherently remove carbon dioxide from gas streams as a part of the manufacturing process. With environmental concerns over greenhouse gases, operators of gasification plants are entering into agreements to sell carbon dioxide for enhanced oil recovery. Injecting CO₂ thousands of meters underground is a practice KBR has world-class experience in after designing and constructing one of the world's largest CO₂ capture and storage project at the In Salah gas development plant in Algeria.



BP turned to KBR and its joint venture for full EPC services, infrastructure and construction management for the largest dry gas project in Algeria – In Salah.



Financing Large-Scale Coal Gasification Projects

Backing a project means more to KBR than just making it sustainable. Besides serving as your technology partner, KBR can also be your business partner. In some cases, KBR's Ventures group can help secure financing, facilitate equity and debt investments and participate in managing assets as an equity partner. Investing in energy and chemical plant projects is a routine practice in our Ventures group, which holds a vested interest in executing projects at optimal cost and operational efficiency. Egypt Basic Industries Corporation (EBIC) is a prime example of how KBR served as the EPC, technology and business partner for this 2000 million TPD plant using our ammonia technology—KAAP™—in its largest commercial application.

Designing efficient facilities that deliver clean, secure, affordable and reliable energy is how KBR operates on a daily basis



Sustaining operations abroad is key to KBR and that's why we chose to train the entire team of Egyptian locals in a similar size facility in Trinidad so they could learn first-hand from experienced engineers.

Enhance Efficiency. Boost Reliability. Go Green Economically.

Having the capability to produce electricity, hydrogen, chemicals or various combinations while eliminating virtually all air pollutants and potentially greenhouse gas emissions makes coal gasification one of the most promising technologies for future-minded energy companies. With KBR's TRIG, energy companies can transform even low-rank coals into clean energy while boosting environmental performance and reliability.

To learn more, visit coalgasification.kbr.com or email coalgasification@kbr.com

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