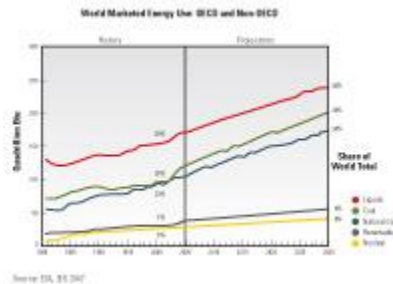


# KBR

## Coal Gasification

### Market Situation

Clean coal technology using gasification is a promising alternative to meet the global energy demand. Information from the Energy Information Administration indicates that since 2004 the use of coal as a global energy source has caught up with the use of Natural Gas, and would even surpass it by 2030.



World Marketed Energy Use by Fuel Type [Click to Enlarge](#)

Most existing coal gasification technologies perform best on high rank (bituminous) coal and petroleum refinery waste products but are inefficient, less reliable and expensive to operate when processing low rank coal. These low grade coal reserves including low rank and high ash coal remain underutilized as a global energy sources despite being available in abundance.

The KBR's Transport Gasifier (also known as TRIG™) was particularly developed with these low rank coals in mind. Our proprietary TRIG™ technology offers a simple and reliable method for processing low grade coal such as lignite coal, sub-bituminous coal and high ash coal in a cost-effective and efficient way. The TRIG™ gasifier un-locks the true potential of low rank coal by efficiently converting it to high quality synthesis gas for a wide variety of industrial and energy applications.

### Commercial Applications

Gasifier Comparison

Gasifier Type	Energy Eff.	Availability	OPCA	Capital Investment	Flex and Life
Slagging - Entrained Flow	High	Medium	High	Medium	Low/High
Non-Slagging - Fixed/Moving Bed	Low	High	Medium	Low	High
KBR TRIG™ (Non-Slagging)	Medium	High	Low	High	Low/High

Legend: High (Red), Medium (Half Red), Low (White)

TRIG™ Combines Benefits, Suited for Low Rank, Low Cost Coal [Click to Enlarge](#)

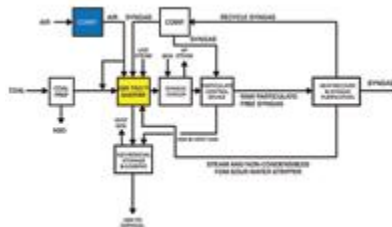
As a Coal Gasification Licensor, KBR offers the industry our innovation through TRIG™ – Transport Integrated Gasification – an advanced gasification process technology that offers a robust solution for monetizing inexpensive, low grade feedstock such as lignite coal, sub-bituminous coal, and high ash coal. These coal reserves might otherwise remain uneconomical global energy sources due to high moisture and ash contents. With KBR's TRIG™ gasification technology, coal energy suppliers can now convert low rank coal into clean coal energy for power generation, hydrogen for refining, and synthesis gas for ammonia, methanol and production of coal to liquid fuels.



TRIG™ Provides Clean Syngas for a Wide Range of Energy & Fuels Applications [Click to Enlarge](#)

TRIG™ gasification allows tapping vast coal reserves in stranded coal mines in a cost effective, efficient and environmentally friendly way. KBR's TRIG™ gasifier is a proven circulating fluidized bed technology derived from our fluid catalytic cracking (FCC) process. With our coal gasification technology licenses, operators can expect superior environmental and economic benefits in processing low grade coal and gasification of waste to energy. TRIG™ offers a superior method for producing clean coal energy with reduced emissions. Unlike other gasifiers, TRIG™ process technology was developed for both IGCC (Integrated Gasification Combined Cycle) power generation and chemicals/ fuels production.

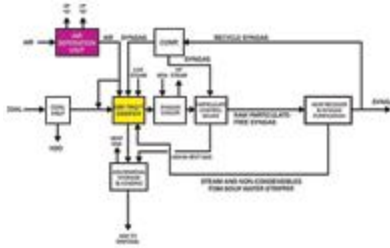
### Flexible Operation – Air-blown or Oxygen-blown Design:



Block Flow Diagram of Air-blown TRIG™ for IGCC/Power Applications [Click to Enlarge](#)

For power generation, the system will be configured using a cost-efficient air-blown design that eliminates oxygen plant; however, it operates equally well in the oxygen-blown mode for chemicals and fuels production and polygeneration applications. In either configuration, TRIG™ easily handles the high moisture, high ash coals that account for more than half the worldwide coal reserves. TRIG™ gasifier was developed by Powerful Partners™ KBR and Southern Company, two respected leaders in the global energy industry along with support from the U.S. Department of Energy (DOE) to generate reliable and economical clean coal energy.

### Chemicals/ Fuels Production:



Block Flow Diagram of Oxygen-blown TRIG™ for Chemicals & Fuels Applications [Click to Enlarge](#)

Besides offering a superior gasifier, KBR has developed proprietary process schemes to convert syngas to ammonia, methanol, substitute natural gas (SNG), and Fischer-Tropsch derived transportation fuels. These novel and efficient schemes minimize plant energy consumption, water use and emissions while increasing the output of valuable products. Added benefits of integrated solutions to operators include helping to increase profitability and improving project economics.

For more information on TRIG™ gasification applications, please visit our [Coal Gasification Publications](#).

## Values & Benefits

### TRIG™ Value Added Features

- Lower feedstock cost - low rank coal, including lignite
- Lower energy consumption
- Lower water requirement - no black water
- High quality syngas
- High reliability design
- Lower capital and operation cost

### High Efficiency

TRIG™ technology features a compact, refractory-lined circulating fluidized bed gasifier, which produces high-quality, tar-free syngas at high gasification efficiencies.

### High Reliability

TRIG™ is a non-slugging gasifier that operates at moderate temperatures and below the melting point of ash. This provides more reliable operation while using less oxidant and energy. In particular, our gasifier's proprietary ash removal system eliminates the technical difficulties associated with slag handling faced by conventional slugging gasifiers. Unlike other commercial gasifiers which operate at much higher severity and would therefore require sparing, TRIG™ requires no spares.

### Lower Capital and Operating Cost

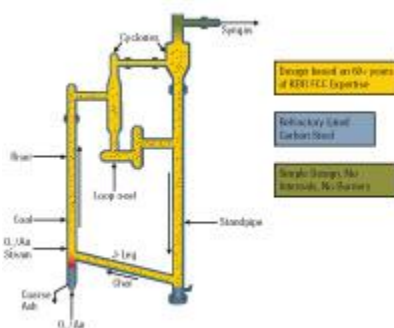
TRIG™ features a low-cost, proprietary refractory with extended life. Reduced refractory replacement is expected due to low temperature operation and superior refractory design. This is a significant improvement over competition

resulting in a projected higher gasifier availability and lower maintenance cost. Additionally, TRIG™ design offers economies-of-scale advantages by providing a single gasifier with a large capacity. Combined with the gasifier's high reliability design, operators can expect significant savings in both operating and capital costs.

## Lower Energy Use and Reduced Emissions

TRIG™ system incorporates high temperature syngas cooling and uses a downstream particulate filter. These elements result in high process efficiencies while eliminating water scrubbing and significantly reducing plant water consumption and effluent discharge. Other unique aspects of TRIG™ process can be found in KBR proprietary heat integration and optimized syngas processing schemes, which directly result in reduced auxiliary energy consumption.

## Technology Information



[Click to Enlarge](#)

The TRIG™ system utilizes Transport Gasification, an advanced circulating fluidized bed gasifier that is designed to operate at high solids circulation rates and gas velocities, resulting in higher throughput, carbon conversion and efficiency. Since the gasifier uses a dry feed and does not melt the ash in the feedstock, it is particularly well-suited for lower-cost fuels such as sub-bituminous coal, lignite coal or other coals with high ash or moisture content. TRIG™ is based on KBR's fluid catalytic cracking technology, which has been used for decades in petroleum refineries.

---