

# Coal-to-Liquids Technology (CTL)



**Countries around the world explore CTL to address growing domestic demand and energy security.**

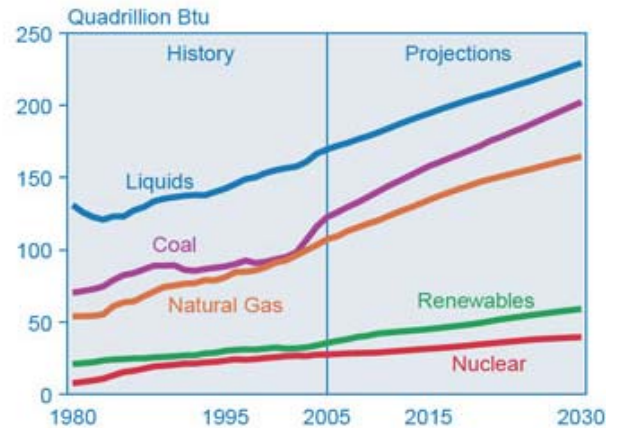
Interest in coal-to-liquids (CTL) technology is growing world-wide, the result of soaring oil prices and increasing geopolitical tensions. Countries that rely heavily on oil imports are refocusing attention and investment on home-grown options. The United States and China, the world's number one and two oil consumers, are leading the charge in CTL.

## A Fuel-Hungry World Looks for Alternatives

By 2030, world demand for liquid fuels in the transportation sector alone (excludes electrical, building or industrial uses) is expected to increase to 58% of all liquid fuel consumption. Much of this is due to booming demand for vehicle fuel in developing nations like China and India. By 2030, forecasts call for global vehicle ownership to double to about 1.5 billion vehicles.

**Table: World Marketed Energy Use by Fuel Type, 1980-2030, International Energy Outlook 2008**

Right now, 96% of the energy used in transport comes from petroleum. But with oil prices climbing and concerns about security and availability of supply increasing, countries are turning to alternatives such as ethanol, battery and CTL. The International Energy Outlook 2008 expects these unconventional liquids resources to become increasingly competitive.



## Why Coal?

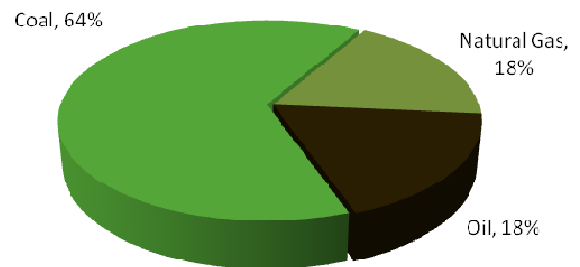
Coal-to-liquids technology (CTL) is not new. South Africa has been producing coal-derived fuel since 1955. Today, more than 30% of its gasoline and diesel needs are met by CTL operations.

**Table: International Energy Outlook 2008**

The appeal of CTL is the abundance of coal. Geologists estimate that of all the world's fossil fuel reserves, the vast majority (64%) is coal. At current rates of consumption, proven coal reserves are forecast to last 147 years, compared to about 40 years for oil reserves and 60-70 years for natural gas reserves.

The American National Mining Association estimates that the cost of converting coal to liquids is competitive when oil costs surpass \$35/barrel. With oil currently at over \$100/barrel, CTL is seen as a cost-effective and increasingly attractive alternative to importing oil.

**World Fossil Fuel Reserves**



## The Process

- › **Direct coal liquefaction** converts coal to a liquid by dissolving it in a solvent at high temperature and pressure to produce a variety of products. The process is highly efficient, but the liquid products require further refining to achieve high grade fuel characteristics. Direct coal liquefaction technology has been demonstrated in the U.S. and is being commercially deployed in China and other countries.

## Producing Liquid Fuels from Coal - Two Approaches

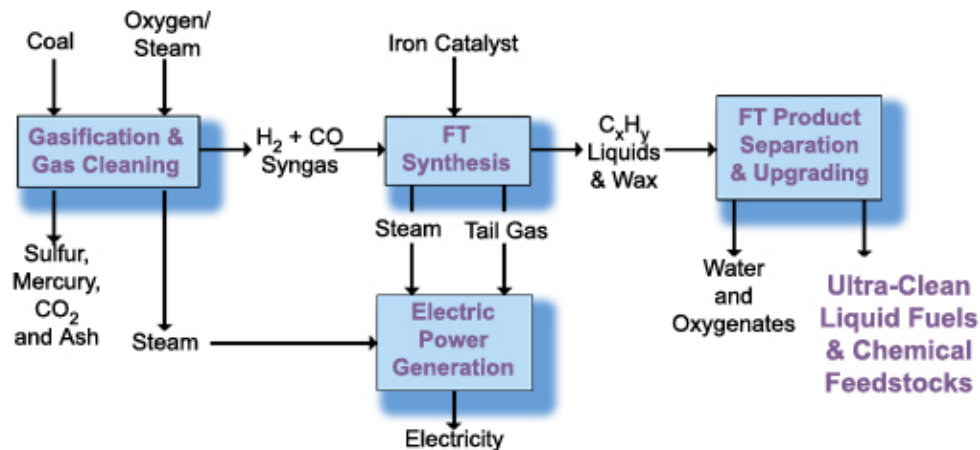


Chart: FutureCoalFuels.org

- ▶ **Indirect coal liquefaction** first gasifies the coal with steam to form a synthetic gas or “syngas” (mixture of hydrogen and carbon monoxide). The syngas is treated to remove impurities and unwanted compounds such as mercury and sulphur. This gas enters a second stage Fischer-Tropsch process, which converts the syngas into liquid fuels and other chemical products.

Diesel fuel produced by Fischer-Tropsch synthesis is virtually sulphur-free. It burns more completely and emissions are significantly lower than low-sulfur diesel, as tested by the U.S. Defense Department. Most of the CO<sub>2</sub> is already concentrated and ready for capture and possible sequestration or use in enhanced oil or gas recovery.

## Clean Coal

The residue from burning coal has been linked to both environmental and health issues. In response, the coal industry and government are investing in clean coal technologies to capture, reduce and eliminate emissions of greenhouse gases and other pollutants. Coal gasification, the initial stage of the liquefaction process, removes impurities from coal. CTL plants allow for extraction of impurities in the gas stream, such as heavy metals and mercury. Post-gasification treatment of syngas removes virtually all particulate matter and residual metals. The result is a near zero-sulphur fuel and lower NO<sub>x</sub> (nitrogen oxide) emissions. CTL can capture CO<sub>2</sub> through the Fischer-Tropsch processes. Captured CO<sub>2</sub> can be used in enhanced oil and coal bed methane recovery or for safe storage deep underground.

## Who's Interested in CTL?

- ▶ South Africa currently has the world's only commercial coal-to-liquids (CTL) operation, although China is ramping up production. More than 30% of South Africa's transport diesel and gasoline fuel needs are met by CTL.

- The USA, the world's largest oil consumer, has several CTL projects in development. In July 2008, plans for the nation's first coal gasification and liquefaction plant were unveiled in West Virginia, in August 2008 a major CTL project was announced on the Crow Reservation in Montana. The West Virginia plant could produce up to 100,000 barrels/day of gasoline; the Montana project about 50,000 barrels/day of diesel, jet fuel and naphtha.
- China, the world's second largest oil consumer, has plans for a number of CTL plants to produce gasoline, jet fuel and diesel fuels. In June 2008 the nation's first CTL plant, the \$2 billion Shenhua facility, launched trial production. The plant will eventually produce 50,000 barrels/day of diesel and gasoline fuels.
- In July 2008, Alter NRG Corp. announced plans to build a \$4.5 billion CTL plant in northern Alberta. It would produce approximately 40,000 barrels/day of diesel fuel and naphtha (hydrocarbon products).
- Monash Energy, a collaboration of Shell and Anglo American, is developing a CTL project in Australia's Latrobe Valley using latest low-emissions technologies. Germany, Indonesia & India are exploring CTL.

## Benefits of Coal-to-Liquids

- Various types of coal, including low-quality coal, can be used to produce a variety of fuels: diesel, gasoline, jet fuel and various naphtha (hydrocarbon) products.
- CTL fuels can be delivered using existing infrastructure, including pipelines and gas station pumps.
- CTL fuels can be used by current automobile and airplane engines without modification.
- Coal-derived fuels are sulphur-free, low in particulates and have low levels of nitrogen oxide.
- Through the use of carbon capture and storage over the full fuel cycle, carbon dioxide emissions can be significantly reduced by up to 20% compared to conventional oil products.



*Disclaimer: First Avenue Partners is pleased to bring you this overview of Coal-to-Liquids Technology. We encourage you to read it in conjunction with other resources widely available on the internet. Please note that this report is for information only and is not meant as a solicitation to buy or sell securities.*

*Sources: International Energy Outlook 2008; World Coal Institute, "Coal to Liquids"; BP Statistical Review of World Energy, June 2008; National Mining Association, Liquid Fuels from U.S. Coal; FutureCoalFuels.org*