DOE Office of Petroleum Reserves – Strategic Unconventional Fuels

Fact Sheet: Coal to F-T Liquids Technology

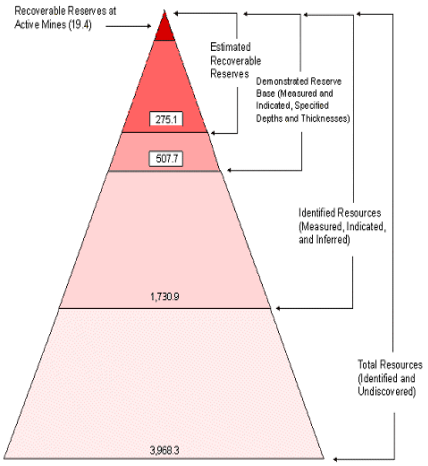
Background

- Coal-to-liquids (CTL) conversion could help increase domestic fuels production.
- America's massive coal resources could meet current U.S. coal demand, plus requirements for CTL, for another 200 years or longer.[1]

Coal Resources and Requirements

- U.S. coal reserves exceed 493 billion short tons. About 45% is bituminous coal, and 55% is lower rank sub-bituminous and lignite.[2] Less than one billion tons are anthracite.
- One third is surface mineable and two thirds would require underground mining.

Figure 1 - Delineation of U.S. Coal Resources and Reserves - 2003 (Billion Short Tons)



- U.S. annual coal production reached 1.13 billion short tons in 2005, of which 90 percent was used for power generation[2].

- However, the National Coal Council estimates that with major investment and effort, domestic coal production could be doubled to exceed 2.4 billion tons by 2025.[3]
- A 32,000 Bbl/d CTL plant using bituminous coal would consume approximately 16,000 tons of coal per day or 6 million tons of coal per year. The same size plant using lignite would require twice that volume.[4]
- An 80,000 Bbl/d plant would consume about 39,500 tons per day or 14.5 million tons/year of high quality bituminous coal.[4]

Table 1 - U.S. Top Coal Reserve States (EIA 2005)

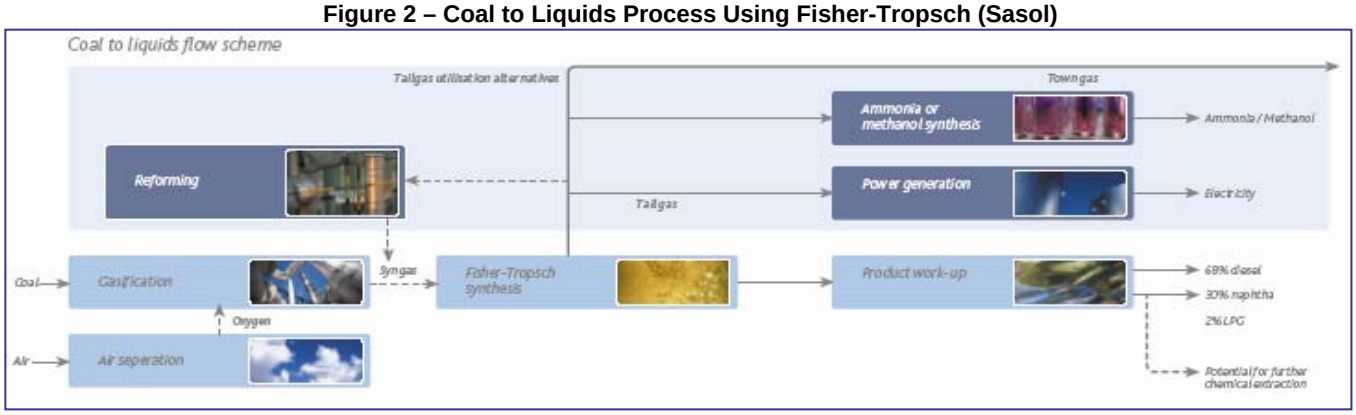
Rank	State	Demonstrated Coal Reserves (Billion Short Tons)
1	Montana	119.33
2	Illinois	104.6
3	Wyoming	64.8
4	West Virginia	33.5
5	Kentucky	30.5
6	Pennsylvania	27.8
7	Ohio	23.4
8	Texas	12.5
9	Colorado	16.4
10	Indiana	9.6

- An industry producing 2.5 million barrels/day would require thirty-three 80,000 Bbl/d plants and consume approximately 475 million tons of bituminous coal or 960 million tons of lignite per year.[5]
- An actual U.S. industry development profile would likely include more plants ranging in size from 10,000 to 30,000 Bbl/d than 50,000 to 80,000 Bbl/d.
- The Sasol Coal to Liquids plants in South Africa currently produce about 150,000 barrels of oil equivalent (BOE) per day.[5]

Indirect CTL Technology

- Coal can be gasified, using a variety of coal gasification processes, to create synthetic gas.
- Synthesis gas can be converted – through proven Fischer-Tropsch (FT) processes – to clean, high quality liquid fuels, including, primarily ultra-clean diesel and jet fuels.
- Depending on coal quality and process technology, FT processes can also yield quantities of naphtha and ammonia. The process can also be used to make methanol. (Figure 2)
- Integrated Gasification Combined Cycle (IGCC) technology can be incorporated in F-T plant design (and vice versa) to generate significant quantities of electricity for plant use or sale into the power grid.
- Although each of the component technologies is deemed proven, no integrated gasification, F-T

Figure 2 – Coal to Liquids Process Using Fisher-Tropsch (Sasol)



synthesis and power generation plant has yet been demonstrated in the United States.

Indirect CTL Economics

- Coal Gasification, IGCC, and F-T Liquids plants are very capital intensive.[3]
- U.S. projects may be initiated at design capacities of about 10,000 to 30,000 Bbl/day, expanding over time to outputs of up to 80,000 Bbls / day.[3]
- Smaller plants will be more expensive on a barrel of capacity basis. Scully Capital estimates capital costs for a 32,000 Bbl/d CTL plant of between $81,000 and $92,000 / stream day barrel of output.[6] This is consistent with estimates that range from $100,000 per daily barrel for a 10,000 BPD plant to $70,000 for 80,000 BPD commercial plants [3]
- Taking credit for the value of CO_2, sold power, naphtha, and other products, and any premium for the high quality fuel, F-T liquids could compete with oil at a crude oil price of $41 to $61/ Bbl depending on plant size, coal type (bituminous v. lignite), and financial asumptions.[6]

Environmental Considerations

- Underground and surface coal mining can have significant environmental impacts. These impacts have been substantially reduced since the Surface Mining Act, adoption of more stringent Federal and state regulation, and development of best management practices that will be applied in future coal mining and reclamation operations.
- Coal gasification and F-T synthesis generates significant quantities of carbon dioxide, (1.8 x petroleum refining), albeit in a concentrated form that can be captured, compressed, and sequestered.
- Depending on plant proximity to candidate fields, volumes of captured CO_2 may be injected into oil reservoirs to increase oil recovery or into coal seams to enhance coal bed methane production.
- IGCC power generation technology, combined with capture and storage of CO_2, could make integrated gasification power generation and liquid fuels production more environmentally desirable than traditional coal-fired power plants and oil refining.
- The F-T process produces superior quality diesel fuel that has virtually no sulfur, very low aromatic content and a high cetane number.[4] The naphtha produced is well suited for conversion to other fuels and/or chemicals in a refinery.

References

[1] BP World Statistical Survey of Energy Resources, 2005.

[2] U.S. EIA, Table 15. Recoverable Coal Reserves …" http://www.eia.doe.gov/cneaf/coal/page/acr/table15.html

[3] National Coal Council, "Coal: America's Energy Future, Volume II; A Technical Overview" March 2006 p. 59.

[4] Scully Capital "The Business Case for Coal Gasification with Co-Production " November 8, 2006.

[5] Sasol Synfuels International,Inc. "Unlocking the Potential Wealth of Coal". September 2005.

[6] Dr. David Gray, Mitretek "Presentation to National Academies Workshop on Peak Oil" Washington, D.C. - 2005.