The Impacts of Synfuels (GTL, CTL, BTL, OTL) On World Petroleum Supply

Courtesy: Royal Dutch Shell's Bintulu SMDS facility

Zeus Expertise in LNG

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Core: proprietary databanks of world projects, markets, pricing, spending commitments, technologies, customers

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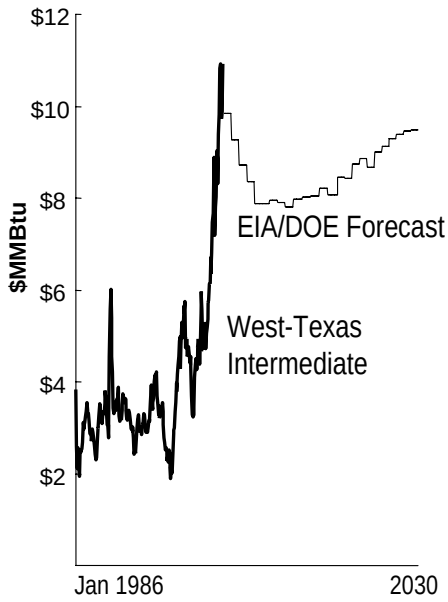
Today's Discussion

Daniel Henderson and David Harris
with coal-gasification reactor.
Courtesy: Csiro Energy Technology

- Drivers/challenges to synfuels development
- A review of synfuel conversion routes
  - Gas-to-liquids (GTL)
  - Coal-to-liquids (CTL)
  - Biomass-to-liquids (BTL)
  - Oil-Sands-to-liquids (OTL)
- Conclusions

Drivers to synfuels development



- High sustainable oil/gas prices and need for clean diesel
- Strong global demand for liquid fuel supply
- Large reserves of non-petroleum hydrocarbons for syngas conversion
- Geopolitical uncertainty of oil supply
- Expanding government initiatives
  - EPACT 2005 incentives ($5.4B for cost sharing; grants; Investment tax credits (ITC); loan guarantees
- Many proposed projects
- Will this be enough to tip synfuel technology into commercialization?

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Crude prices likely to trade $50/bbl for foreseeable future

Major OPEC exporters willing to sustain and support crude prices certainly in the $40/bbl to $50/bbl range

Synfuels can meet concerns about security and supply diversity; can deliver real emissions reductions today

Synfuels derived from derived from natural gas, coal and biomass can also reduce petroleum dependency, ensure security of energy supply and improve air quality

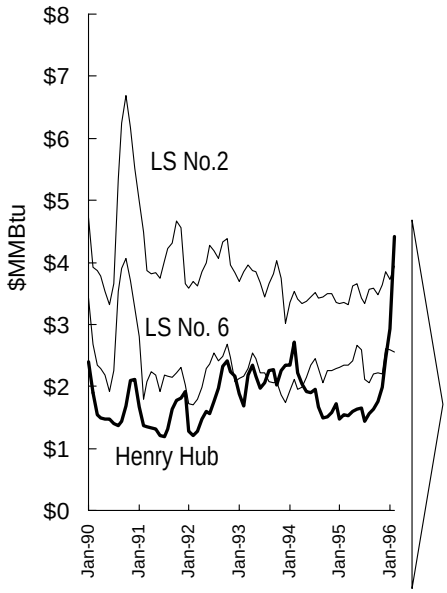
Potential US CTL producers wait for budget to see if EPACT2005 incentives are funded to get first plants built

Drivers to synfuels development

- Europe:
  - Key driver: environmental regulations for diesel
  - Significant demand in UK, Germany and Scandinavian countries
  - Diesel supply cannot meet demand
  - Refineries are long gasoline, short diesel
- Asia:
  - Key driver: environmental regulations in Japan, China and Australia
  - New and ongoing refinery upgrades will increase diesel supply but will not meet increasing demand
- US:
  - Key driver: environmental regulations for diesel
  - Diesel demand will likely be met by US production
  - Some GTL imports may supplement supply particularly on the West Coast

Source: John J. Waycuilis, Marathon Oil Company

Challenges to synfuels development



- Skepticism
- Economics
  - EPC crisis escalating capex costs for plant construction
- Vacillating public/govt support:
  - lower gasoline prices; mild winter, crisis averted

Déjà vu?
From mid-'90 to mid-'93 and again in '94 and '95, NG traded well below LS No.6, prompting major legislation and investment in NGVs. These initiatives faded in the late '90s as NG climbed above LS No. 2 prices.

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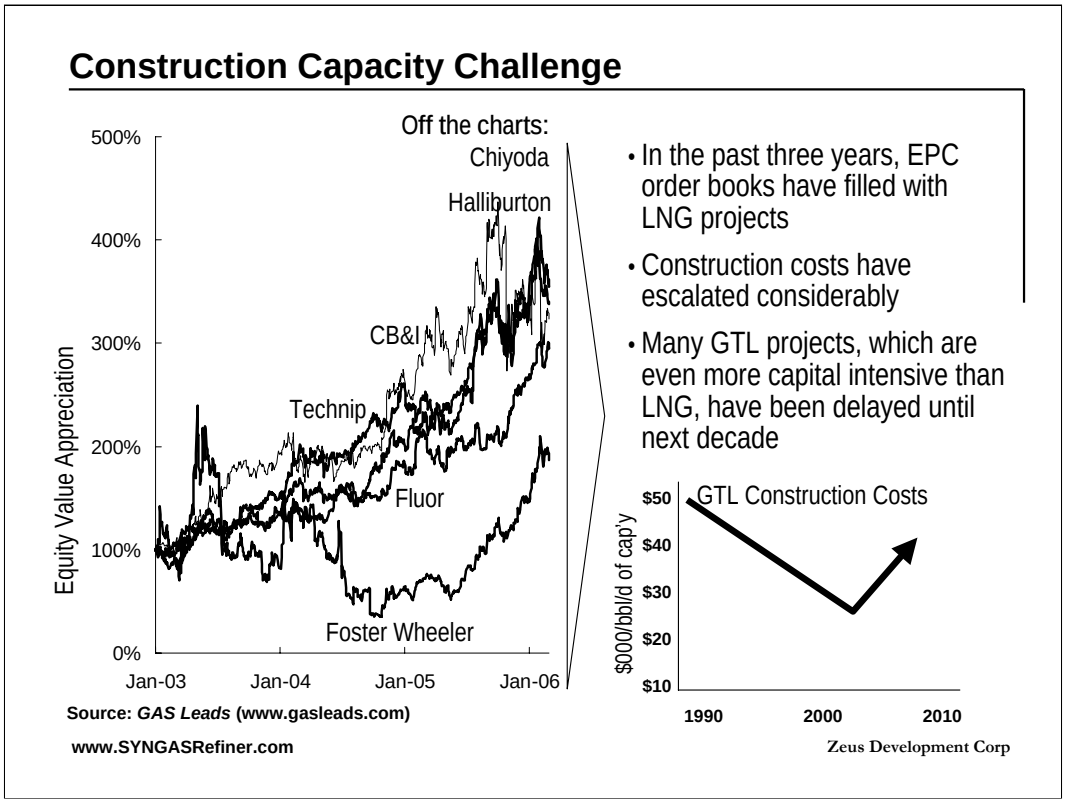
A global shortage of raw materials, contractors, labor and other items has pushed up the capex cost of synfuels plants

GTL most commercially advanced, but plant capex up to $40K/b/d to $60K/b/d of product produced after almost hitting the $20K/b/d goal; Shell Pearl GTL: $7B

Sasol building FT design reactor to achieve significantly higher productivity in terms of gas throughput and product conversion rates over current generation designs

Goal is next-generation reactor to lower capital cost of GTL process and improve operational efficiency



Capital investment to install new GTL plants comparable to large S. African operations ranged from $27Kb/d to $50K/b/d of liquid fuel produced

34,000-b/d Sasol/QP plant at Qatar was estimated to cost between $20K/b/d and $25K/b/d

BP's compact reformer was hoped to reduce costs to $20K/b/d, and with further improvements, to $17K/b/d – or low enough to compete with LNG projects

At around $11K/b/d, GTL projects could compete with new crude-oil refineries; that cost up to near $15K/b/d.

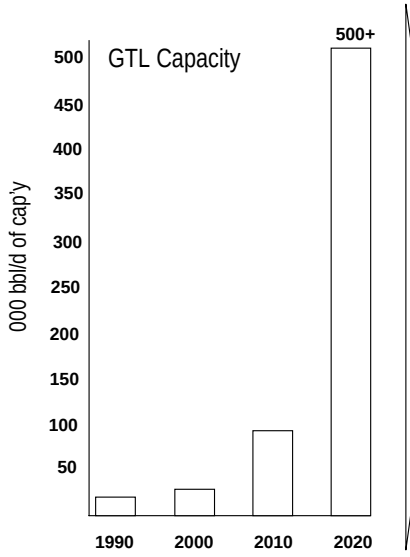
Gas to Liquids

	GTL	Refinery
Natural Gas (@ $1.00/MMBtu)	$10.00	
Crude Oil (@ $20/Bbl)		$20.00
Operating Costs	4.00	2.50
Cash Costs	14.00	22.50
Capital Recovery, Taxes	14.00	6.50
Total Cost to Produce	$28.00	$29.00

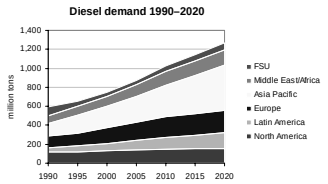
Source: ConocoPhillips

- Oil & Gas companies view synfuel economics favorably
  - ConocoPhillips sees GTL competitive with North Sea oil
- World proved gas reserves: 6,400 Tcf and growing 0.2%/yr
  - R/P ratio: 67
- 45% of world gas reserves located in nations with R/P ratios >200 yrs
- Ample gas reserves for GTL

Gas to Liquids



- Until Oryx, GTL projects were primarily demonstration oriented
  - Mossel Bay & Bintulu were the largest
- At 34,000 BPD, Oryx purported to be first commercial-scale plant
- Pearl GTL (Shell) & ExxonMobil to add ~300,000 BPD of capacity next decade
- More to follow
- By 2020, still less than 3% world diesel production



~7 barrels/ton of oil

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Coal to Liquids

China CTL plants move ahead

- Cheap feedstock: ~$5/bbl
- Labor and other direct cost: ~$15/bbl

US CTL plant activity somewhat stalled

- Developers seeking financing
- Reduce capex/opex
- Optimum logistics between cheap low-rank feedstocks and markets

Sasol estimates CTL plant ranges from $60Kb/d to $80K/b/d for 50K-b/d and 80K-b/d plant, respectively

- China's Shenhua and Ningxia CTL plants could cost between $5B to $7B, up from $6B, and consume 15MM to 19MM tpy of coal.
- Sasol in talks with two US firms and is busy improving its processes to offset rising costs
- DKRW is seeking financing for its $2.75B Medicine Bow, WY plant using GE gasifier and Rentech FT reactor
- US CTL plant costs from $1.2 billion to $3 billion with MT small plant at $1.5B up to $8B for larger plants.

China CTL plants move ahead with cheap feedstock most materials; feedstock costs would be about $5/bbl and other at $10/ton, labor and country has contracted direct operating costs would be about $15/bbl

US CTL plant activity somewhat stalled from enthusiasm last fall over EPACT2005 as developers seek financing, try to lower capex/opex and get close proximity to cheap low-rank feedstocks and markets

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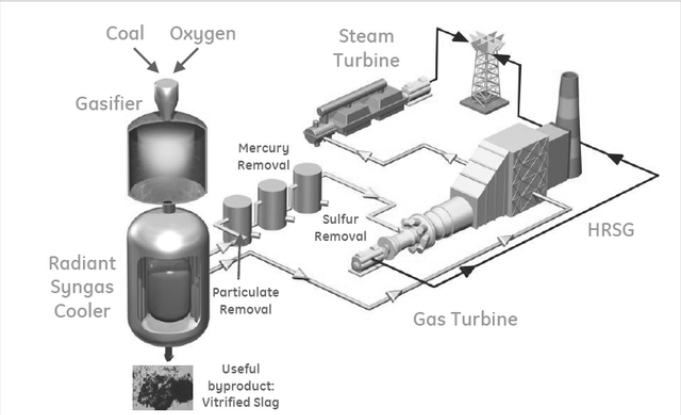
GE gasifier used on ERORA Group's Taylorville Energy Center, IL; received $5MM in public-private financing

US CTL plant costs from $1.2 billion to $3 billion with MT small plant at $1.5B up to $8B for larger plants.

Coal to Liquids

Planned U.S. Gasification
AEP, OH
Baard Generation, OH
Cash Creek, KY
Clean Coal Power, IL
DKRW, WY
Duke/Cinergy, IN
Energy Northwest, WA
Erora Group, IL
Excelsior Energy, MN
First Energy/Consol, OH
FPL, FL
Leucadia National, LA
Madison Power, IL
Mohave Station, CA
Mountain Energy, ID
Orlando Util/Southern, FL
Otter Creek, MT
Power Holdings, IL
Rentech, WY
Royster Clark/Rentech, IL
Southeast Idaho Energy, ID
Steelhead Energy, IL
Synfuel, OK
XCEL Energy, CO



GE gasifier used on ERORA Group's Taylorville Energy Center, IL received $5MM in public-private financing.
Diagram courtesy of GE

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US CTL plant cost depends on location, coal type, CO2 capture, CO2 pipelines to oilfields, coalmine supply

UCG in non-mined seams uses injection/production wells to convert coal in situ into product gas for chemical processes and power gen; UCG-IGCC plant generates at lower cost with CO2 emissions reduced to level 55% less than supercritical coal plant and 25% less than NGCC

Chinchilla project is targeting a 24,000-b/d diesel plant based on UCG syngas supply

UCG technology demonstrated exceptional environmental performance.

Compared to GTL: UCG-CTL is cheaper by eliminating steam reforming step that is 50% of GTL cost; but there is gasification cost and gas cleanup.

No coal handling, no reactor, no ash handling, no CO2 issues, it is at least 60% cheaper than CTL.

Capex cost of $40K b/d maybe fair estimate for UCG-based CTL.

Opex be much less than GTL or conventional CTL with no fuel purchase; use coal in ground vs. $1.50/MMbtu for coal for CTL and $6/MMbtu for gas for GTL.

Biomass to Liquids: Slow Advancements

BTL needs R&D

European governments view favorably.

BTL offers 90% reduction in greenhouse emissions

Five tons biomass = one ton BTL. In ideal location, one hectare generates four tons BTL

Small plant needs 12,000 acres.

European BTL production costs

2007: ~$3.35/gal

2020: ~$2.43/gal ($80/bbl COE price)

Capital cost of a commercial-size BTL plant ~$140,000/bbl in 2004 dollars

- Uncertain whether gasification, other processing steps can achieve cost reductions to become competitive
- BTL catalyst costs are high like other FT processes
- BTL could be used only as fuel extender
- Adding coal to biomass feedstock overcomes some challenges
- European gasifiers operate with mixed coal/biomass feeds
- Global Energy's German gasifier has co-produced power and methanol using a mixture of coal and a range of different biomass feedstocks since 2001.

Biomass to Liquids

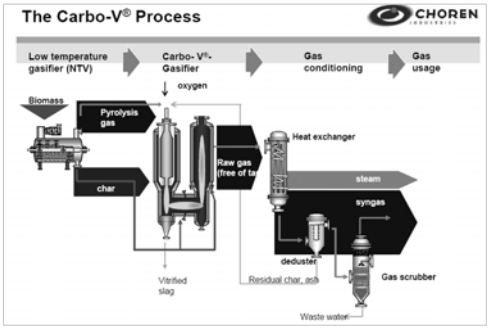


Diagram & photo courtesy of CHOREN

- First commercial-scale 4,000-b/d BTL plant is planned by CHOREN Industries in Freiberg, Germany and will begin operation after 2008 followed by four additional facilities
- About 2/3 of a BTL plant's capital cost is related to biomass handling and gasification
- BTL front-end technology is new and evolving and has parallels with cellulose ethanol technology
- Torrefaction will greatly help the need for eliminate huge staging areas and reduce transportation costs to move feedstocks to a central point.
- Main challenge is the high cost of removing oxygen

BTL or CTL plant ha 60% higher capex than GTL plant. ECN directs BTL development towards use of existing large-scale coal entrained flow gasifiers as only way to benefit from economy of scale/use existing technologies.

In initial phase, coal/biomass co-gasification is best option and is possible up to at least 10% w/o plant modifications. For higher biomass shares, biomass pre-treatment required

ECN aims at using torrefaction as a process to convert all kinds of biomass into a product that has properties similar to coal

Oil Sands to Liquids

Gasification technology is being used commercially to gasify either petroleum coke or heavy oils at numerous petrochemical and refining sites worldwide

Gasification is being applied to oilsands industry providing environmentally sound way of using bitumen-derived petcoke or bottoms to displace natural gas-based hydrogen, heat or power production

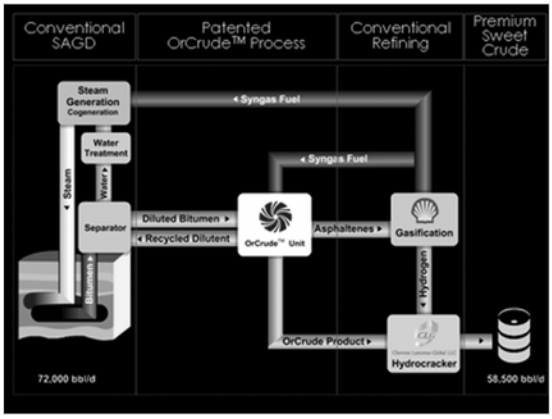
GE is providing gasifiers for US CTL projects but Shell gasifier being used on OPTI Canada/Nexen Long Lake project in northeastern Alberta

- OPTI Canada/Nexen Long Lake Economics
  - Many companies in the Canadian oilsands industry are talking about installing gasifiers in the future but this joint venture is building the first gasification facility that is planned to be operational next year
  - The need to economically extract synthetic crude oil (SCO) from Canadian tar sands has never been greater as private and state-owned producers such as China and India scramble to increase crude supply
  - The Long Lake project using a proprietary process will provide high quality SCO from the oilsands with a major operating cost advantage

Oil Sands to Liquids: OPTI Canada/Nexen Long Lake

Phase 1 under construction, Jan 2006, *Source: OPTI Canada Inc.*

Gasifier Unit, Jan 2006, *Source: OPTI Canada Inc.*



Source: OPTI Canada Inc.

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OPTI/Canada plans 120,000 b/d of SCO capacity by 2015; first phase under construction on $3.8B project with first steam late 2006 and the upgrader starting in mid-2007

About 1 mcf of natural gas is needed to produce bbl of bitumen using SAGD and 0.5 mcf needed for upgrading; average of 3kg of H2 required to produce one bbl of SCO at an estimated cost of $7/kg

Dependency on natural gas is a critical issue for in-situ oilsands producers and this project is designed to supply most of the fuel to dramatically reduce input costs.

Oilsands processing results in heavy sour crude subject to wide heavy-light differentials and diluent required to move the product to market if heavy crude not upgraded

The OPTI Canada process cycles bottom part of bbl to extinction rather than turning 15% of bbl into petcoke that has to be buried and uses that bbl as fuel

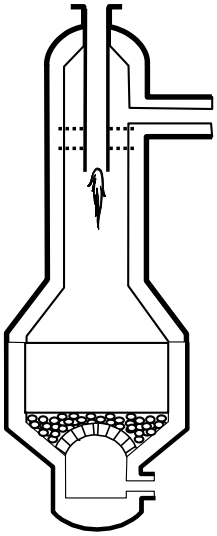
Liquid asphaltenes are fed into gasifier and converted to syngas with remaining fuel stream coming off gasifier after taking out H2 is equal to 100 MMcfd of gas; this stream used to fuel SAGD boiliers and cogeneration facility.

Heavy ends or bottoms sent from distillation columns to the gasifiers; reactor towers for two of the four trains being constructed.

Gasifier is specifically designed to have four trains with each one 33% of total capacity so one train down for regular maintenance to ensure higher reliability and high run time for plant.

An ASU will provide oxygen to gasifiers and hydrogen plant removes hydrogen from syngas; soot off back-end gasifier treated in wet-oxidation plant to reduce volume and waste and concentrate metals into filter cake.

Conclusions



- Economics have never been better for conversion of non-petroleum feedstocks to liquid fuels
- Principle challenge is building facilities in a construction-constrained market
- Between 5.0 and 10.0 mil BPD will come from synfuels by 2020
  - Oil sands is currently moving faster than any other of the synfuel technologies
    - 4.0 mil. BPD (17% of diesel cap'y) by 2020
  - OTL will improve economics of GTL, CTL and BTL
  - GTL will supply between 0.5 & 1.0 mil. BPD
  - CTL will supply between 0.5 & 2.0 mil. BPD
  - BTL is too hard to predict.

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Chevron acquires leases for 75,000 acres developing Ells River project that could potentially produce 100,000 bbl

EOM, CoP and Devon are also planning projects

Total acquired oilsands firm Deer Creek Energy

China's Sinopec Group bought 40% stake in Synenco Energy's Northern Lights project; CNOOC invested in Calgary-based MEG Energy in April 2005

India's ONGC has been discussing possibilities of investing in oilsands projects but hat not identified technology but is continuing search

Syngas International's gasification technology and another company's oilsands extraction technology played an integral part in "revolutionary" new extraction method; lab test showed an increased yield of up to 15%