# CTL and SNG Production: Issues and Opportunities

Arie Geertsema
Range Fuels, Inc., Broomfield, CO

GTC Workshop March 14, 2007, Denver, CO

# Structure

- Background and Terminology
- CTL - Characteristics and Status
- SNG - Characteristics and Status
- Economics
- Commercial Hurdles
- The Path Forward

# Coal Conversion

- Combustion to produce steam/power
- Gasification to produce syngas ($H_2$ with CO)
  - Syngas to fuels (indirect liquefaction) - **CTL**
  - Syngas to chemicals, including methanol
  - Syngas to hydrogen
  - Syngas to synthetic natural gas - **SNG**
- Direct coal liquefaction (Not covered here: not commercial)
- Co-production (“polygeneration”)

*Note: Gas to Liquids (GTL) same as second part of Coal to Liquids (CTL)*

# CTL and SNG

- CTL

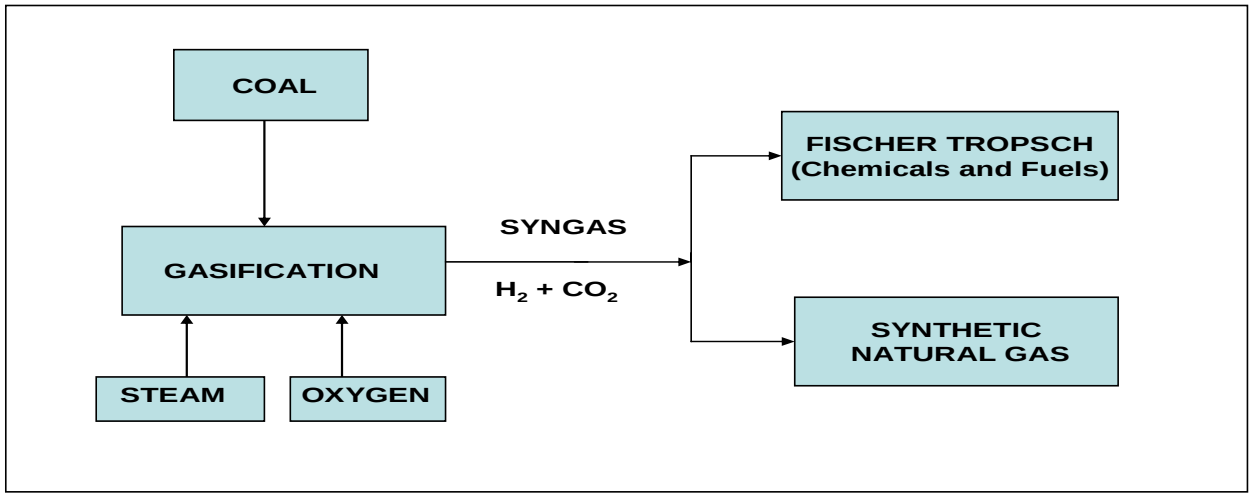
  Coal to syngas ($CO + H_2$) and then syngas to liquids (fuels and/or chemicals)

  Second step called Fischer-Tropsch (FT) Synthesis

- SNG

  Substitute Natural Gas or Synthetic Natural Gas: Coal to syngas and then syngas to methane (natural gas)

# CTL and SNG




Both require oxygen and steam to produce syngas

CTL produces a much wider range of products
- gases/liquids/waxes

SNG produces primarily methane (natural gas)

# Status of CTL

## Commercial

Only in South Africa by Sasol

## Projects under consideration

Numerous studies at different stages of planning: many only early conceptual

## More significant proposals

Sasol: China - Engineering in progress

WMPI (USA, PA) 5,000 bbl/d in pre-financing stage

Several Rentech proposals

# FT (Liquids Synthesis)

Technologies differ:

- Catalysts and reactor types
- Product spectra
- Temperatures
- Stages of development
- Experience range from small pilot scale to large commercial scale

But: Proven technologies not readily accessible

# Sasol CTL

- FT invented 1920's
- South Africa saw opportunity in late 1920's
- Developed pre WW II Germany
- Commercialized in South Africa 1955 and again late 70's/early 80's
- Other natural gas based ventures built and more in progress

# Sasol

- Fuel products marketed at import parity $ prices; Chemicals marketed competitively internationally
- Government: loan guarantees and floor price
- All government support repaid in a short period – no net cost to taxpayer, no current special treatment
- Extensive expansions into chemicals and related products ongoing – highly profitable
- “Sasol Four” (Mafutha) in pre-feasibility phase

# Sasol Secunda Plants ~ 1985

Initial capacity: 2 x 50,000 bbl/d, Then 40% of SA's fuel needs, now 28%; Cost $6bn; Site 13 $km^2$ (~3,200 acres)
Two plants built sequentially with $500m saving

Construction work force 28,700 from 39 nationalities

250 million man-hours. Now 160,000 bbl/d

# FT Diesel Fuels

- Primary product zero S, minimal aromatics
- Predominantly straight chain (high cetane number >70)
- Fuels fully compatible with existing fuels
- Suitable for aviation
- Emissions from diesel engines greatly superior to even CARB diesel performance
- Excellent blending stocks

# FT Fuels

- Sasol experience of 50 years - >200 products; cumulatively >1.5 billion barrels of fuel
- Primary international need now diesel fuel

  (Note: USA 4.3% higher now than ’04)
- Large scale tests were/are done
  - Shell, Sasol and Syntroleum products - VW- Berlin, Bus London, California trucks, Daimler-Chrysler and others
  - Jet fuels
  - Superior emissions performance

# Sasol Qatar Oryx Project (GTL)

- Commissioned 2007 at 34,000 bbl/d
- Two reactors 60 m high, 10 m diameter; @2,200 tons
- Project expansion to add 66,000 bbl/d fuels and 8,500 bbl/d lubricants

# SNG

- Technology well understood but commercially only applied in a few cases
- Economics “evasive”
- Reaction (methanation)

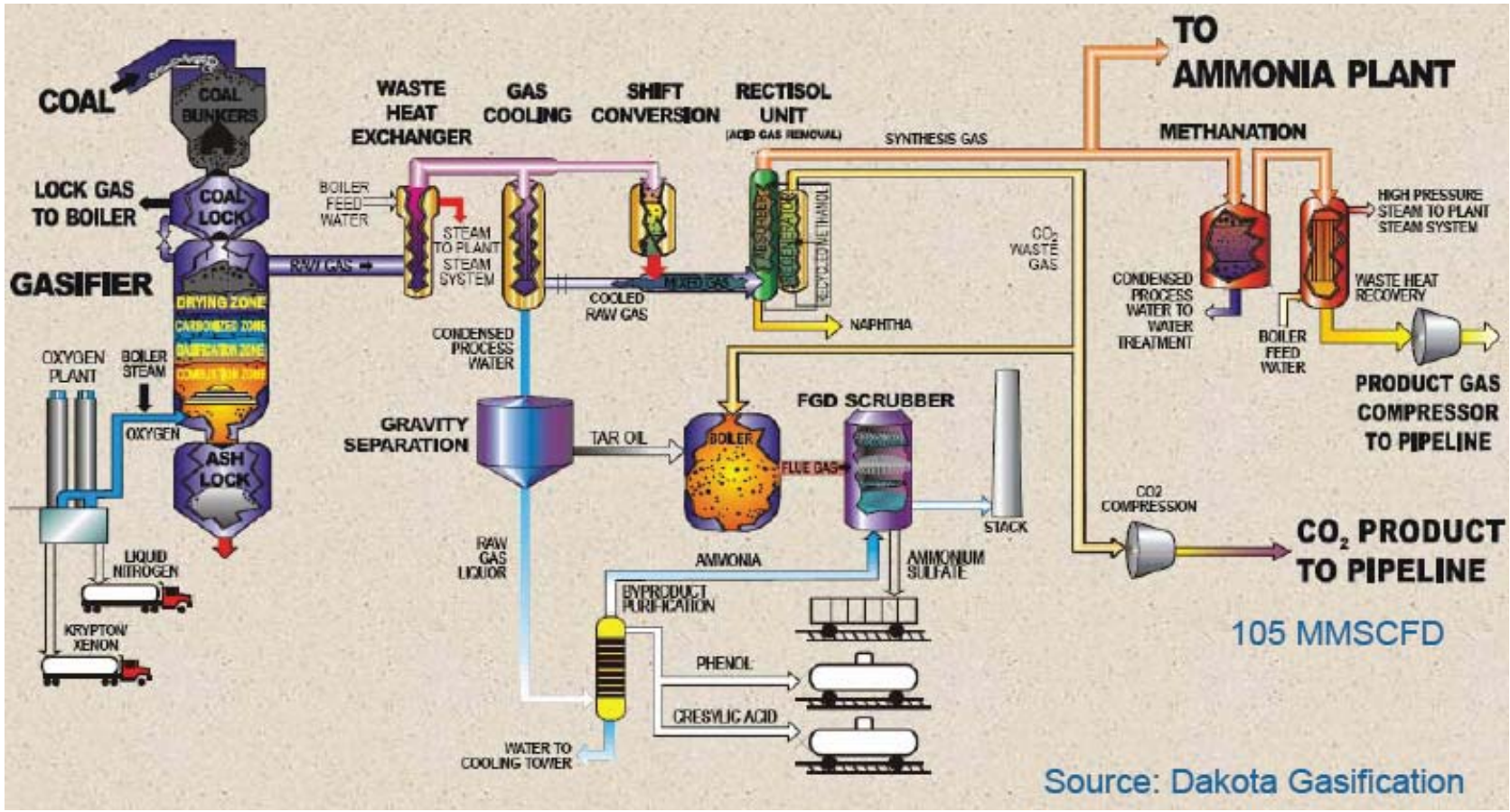
$$CO + 3H_2 \rightarrow CH_4 + H_2O$$

- Gas very clean
- Potential co-products from gasification

# Great Plains SNG Plant ND

**6 m ton per year lignite and 160 million scf/d SNG per day. Reliability >98.7% since 1984; sell various chemicals and sequester up to ~5,000 t/d $CO_2$ in EOR in Canada**

# Great Plains SNG Plant



# Economic Drivers

- Strategic considerations - more self-sufficiency and greater flexibility in supply/demand
- High crude prices
- Increasing cost of alternative ways to meet environmental performance specs of fuels
- Environmental opportunities – $CO_2$ sequestration capable and environmentally superior fuels
- Progress with gasification for IGCC

# Economics

- Distinguish between actual (real) costs and paper studies
- Real costs hard to get by and very site and configuration specific - what is in/what is out?
- Usually no incentives for operating companies to provide data
- Escalation and scale factors can mislead
- Pre-investment for additional options - caution
- Lego-block estimates can be deceptive
- Plant integration, utilities and infrastructure integration critical

# Economics

**Operating costs: Location specific**

- Infrastructure available in and outside of plant
- Site/town development, accessibility, roads, water
- Local labor and skills – construction and continuous operation
- Coal availability and cost
- Marketing (CTL and SNG)
- Manufacturing/workshop capabilities and capacities
- Financing structure and potential liabilities
- Insurance regime and options
- Fiscal regime

# Economics

**Operating costs: Products**

- Product spectrum - market driven: defines choice of reactors/processes
- Extent of product work-up/refining
- Specialized products: marketing lag and risks for market penetration
- Take-off contracts
- Realizing expected fuel quality premiums
- Impact on capital costs

# Economics: Process Factors

Some inter-dependent elements:

- Syngas production ($H_2$/CO), P, purity
- Syngas conversion system
- Product work-up: aqueous and hydrocarbons
- Process integration: steam, fuel gas etc
- Start-up
- Catalyst replacement and/or make-up
- Turn-down ratio
- Instrumentation and control
- Scale critical for work-up economics

# Economics: CTL Costs

CTL capital investment (Sasol 2006)

- For 50,000 to 80,000 bbl/d (2 to 3 million tons/yr) green field cost $60,000 to $80,000 per daily barrel

  (Note 1: GTL ~$30,000/dbbl

  Note 2: 2007 above roughly 50% higher)

Operating costs (~2004)

- About $5/bbl for coal at $10/ton
- Cash plant costs (catalysts labor etc) ~ $10/bbl

Owner's costs depend on financing packet and commercial conditions

CTL yields: About 2 barrel/ton of coal, depending on coal, i.e. for 80,000 bbl/d about 15 million t/year coal

# Some Hurdles to Commercialization

Hurdles are not insurmountable: has been done, can be done and can make money

- Little generic design data available – site and project specifics determine economics
- High capital investment for economy of scale
- General economic uncertainty and perceived high risk for high capital layout
- More plants required to give comfort to investors and financiers (“I’ll build the next plant”)

# More Hurdles

- Large companies reluctant to lead initiatives for commercial deployment - Potential owner-operators scarce
- Uncertainties and scepticism about products
- Perceived risks
- Environmental claims doubted – $CO_2$ issues
- CTL and SNG: Coal perceptions, but coal can be clean

# Looking Forward

- CTL and SNG made big strides in technology and cost reductions, e.g. new large FT reactors
- Chemicals may be attractive - needs large scale for economy of scale - fuels (CTL and SNG) to provide base capacity
- Co-production ("polygeneration") can improve viability but beware of added complexity
- Technologies available, but further development will improve the economic viability
- Energy Policy Act of 2005 and subsequent bills provide valuable incentives

# Looking Forward - 2

- Focus on costs to come down – new/novel gasification to beat limitations of conventional gasification
- Bring down capital and operating costs with smart engineering and operations: Learn by doing
- CTL now becoming increasingly feasible – with high oil prices even more so
- Potential carbon constraints are to be factored in
- Convince financial skeptics by excellent performance

# Conclusions

- CTL and SNG proven with superior product properties and environmental performance
- Expected crude oil prices and trends support coal conversion technologies
- Some replacement of imported crude strategically essential - including for chemical industries
- For meaningful strategic oil replacement, the target should be at least 1 million bbl/d
- Requires a national will and strategy
- The bold could get the rewards
- Do it again and start now