Market drivers for the syngas industry

Richard Hands
Editor, *Nitrogen+Syngas*
BCInsight Ltd

Gasification and Technologies Conference, Colorado Springs, 16 October 2017
Syngas: the key step to some of the world’s most important chemicals
## Syngas market sizes

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Supply – Feedstock issues
Demand – Ammonia
– Methanol
– Hydrogen
– Others

Conclusions
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   – Feedstock issues

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Feedstocks for syngas production

- Natural gas - reforming, partial oxidation etc
- Naphtha reforming
- Gasification of solid/heavy feedstocks:
  - Coal
  - Heavy oils/residues
  - Biomass
  - Municipal waste
- Electrolysis of water – H₂ only
- Reforming of CO₂?
Advantages of methane

• Already a gas - avoids capital intensive front-end processing
  But still requires pre-treatment – sulphur as a catalyst poison etc.

• Available in large, concentrated quantities – economies of scale
  But faces increasing competition from other uses – LNG, power production.

• Has historically been the cheapest feedstock
  Originally developed from ‘stranded’, often associated gas resources, but these are now less common, and power and LNG have created regional and global gas markets and made gas more expensive, except where prices are government controlled.
Impact of feedstock prices

Source: PotashCorp
Historic feedstock costs
(inflation adjusted, 50 yrs)
The return of coal

• Gas became expensive or unavailable in key regions
  China, India, Vietnam, United States, even Australia, Indonesia.

• Gasification can use cheap coal, unsuitable for power generation
  e.g. bituminous coal in China, high ash coal in India.

• Energy security/independence issues, but...
  Heavy CO$_2$ penalty - becoming increasingly important.
  Capital expense drives huge project sizes to regain economies of scale, with
  knock-on effects on project finance requirements, construction challenges etc.
The return of natural gas

• New technology changes the economics of gas production
  The rise of ‘unconventional’ gas – coalbed methane, tight gas, and of course...

• Shale gas - places recoverable gas reserves back next to high areas of demand
  And also next to written-down syngas capacity.

• Energy security/independence issues
Gas prices are often not based on market factors

<table>
<thead>
<tr>
<th>Low cost locations</th>
<th>Medium cost locations</th>
<th>Higher cost locations</th>
</tr>
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<tbody>
<tr>
<td>Arab Gulf</td>
<td>Indonesia</td>
<td>EU spot</td>
</tr>
<tr>
<td>$1.20</td>
<td>$5.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>Trinidad</td>
<td>India</td>
<td>Ukraine</td>
</tr>
<tr>
<td>$2.00</td>
<td>$4.10</td>
<td>$5.20</td>
</tr>
<tr>
<td>Argentina</td>
<td>Egypt</td>
<td>Japan</td>
</tr>
<tr>
<td>$1.40</td>
<td>$3.80</td>
<td>$7.00</td>
</tr>
<tr>
<td>North Africa</td>
<td>Malaysia</td>
<td>China (E coast)</td>
</tr>
<tr>
<td>$1.00</td>
<td>$5.30</td>
<td>$7.00</td>
</tr>
<tr>
<td>Venezuela</td>
<td>Australia (W)</td>
<td>LNG E Asia</td>
</tr>
<tr>
<td>$0.20</td>
<td>$4.00</td>
<td>$8.00</td>
</tr>
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<td>Russia</td>
<td>Pakistan</td>
<td>LNG W Europe</td>
</tr>
<tr>
<td>$1.20</td>
<td>$3.00</td>
<td>$5.50</td>
</tr>
<tr>
<td>US</td>
<td></td>
<td>Australia (E)</td>
</tr>
<tr>
<td>$2.50</td>
<td></td>
<td>$8-13</td>
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(Average wholesale gas prices to industrial consumers, 2016, US dollars/MMBtu)

Red = controlled prices      Blue = market prices         *Italic = significant gas availability issues*

Source: International Gas Union
But gas markets are changing

Source: IGU
Low carbon syngas

• Biomass gasification
  More efficient than biofuels – uses all of the plant.
  Issues with energy density, gathering sufficient feedstock economically.
  Can exist with food production where waste biomass is used, e.g. paper mills.

• Alternative to waste incineration
  ‘Biogas’ also a possibility.

• Syngas derivatives to capture off-peak power from renewables

• New, modular plant designs are changing the economics of small-scale production
Feedstock market drivers

• Feedstock pricing has been the key to siting of syngas-based chemical capacity, with a desire for self-sufficiency an additional major factor in China and India.
• Gas pricing remains controlled in most parts of world, but availability now plays as big a part as pricing (esp. India, even parts of Middle East).
• In some areas the gas is available, but low controlled prices have discouraged exploration and development (e.g. Trinidad, Egypt).
• Carbon intensity is starting to matter more and more. No coal without CCS?
• Many small niche units now trialling other feedstocks – biomass, gasified waste, biogas, renewables.
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End uses for ammonia

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<tr>
<th>Application</th>
<th>Demand (%)</th>
<th>Fertilizer use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct application as a fertilizer</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Urea</td>
<td>56%</td>
<td>48%</td>
</tr>
<tr>
<td>Ammonium nitrate/CAN/UAN</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td>Mono/di-ammonium phosphate</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Ammonium bicarbonate</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Industrial uses (caprolactam etc)</td>
<td>10%</td>
<td>-</td>
</tr>
</tbody>
</table>

Ammonia that ends up as fertilizer: 74%
Fertilizer markets are mature

Nitrogen consumption, million tonnes N/year

Source: CF Industries
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## End uses for methanol

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<th>Fuel use (%)</th>
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<tr>
<td>Direct blending into gasoline</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>MTBE/TAME</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>Dimethyl ether (DME)</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Biodiesel esterification</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>28%</td>
<td>-</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Methanol to olefins (MTO/MTP)</td>
<td>9%</td>
<td>-</td>
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**Methanol that ends up as fuel:** 36%
Changing methanol market

- Virtually all incremental demand in past 10 years has come from China
- China has sought to monetise coal to displace imports of crude oil and various chemicals, including ammonia and methanol.
- Fuel uses have driven the boom so far – DME blending in LPG, methanol blending in gasoline.
- Methanol to olefins (MTO) now taking over as a massive growth area.
- Non-integrated MTO production has huge disruptive potential for methanol market.
- Ex-China, most other new plants worldwide are product of US shale gas boom or relaxation of Iran sanctions. Some are aimed at export to China.
Changing methanol market

Source: Methanex
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Markets for hydrogen

• Dominated by refining
  Hydrogen required for hydrocracking and hydrotreating of heavy, sour feeds.

• Regulation and changing feeds drive new investment
  Steadily reducing sulphur content of fuels, inc. maritime (once a sulphur sink).
  Increased use of heavy, sour feeds (eg Canadian oil sands bitumen).

• Almost all refinery hydrogen comes from natural gas (or off-gases)
  Most (85%) generated on-site, but US has a large (55%) merchant H2 market.

• Fuel cells, ‘hydrogen economy’
  Long term potential but many hurdles to cross.
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Other syngas derivatives

• Fischer-Tropsch liquids (XTL)
  - Several large-scale applications – South Africa (CTL, GTL), Malaysia (GTL), Qatar (GTL), China (CTL), Nigeria (GTL), but investment sporadic and expensive. GTL must compete with LNG as an investment choice for gas.
  - Low oil prices have killed interest. Only two large plants now under development; Turkmenistan, Uzbekistan. US project cancelled.
  - But - many small-scale developers looking to biomass, municipal waste, via microchannel reactors etc.

• Gasification to power (IGCC)
  - Some large-scale plants built 1990s/2000s as part of ‘clean coal’ demonstrations.
  - CO2 capture issues, high costs, cheap natural gas and push for renewables have all dampened enthusiasm.
  - Some potential for underground coal gasification (UCG) but faces environmental opposition.

• Synthetic/substitute natural gas (SNG)
  - Almost exclusively a Chinese phenomenon to monetise coal resources. Ambitious plans but serious questions about costs and environmental issues.
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Syngas market drivers

• Upstream factors
  - Feedstock pricing and availability are the key to project siting and profitability.
  - Gas remains the favoured option. Coal/coke mainly a factor where gas is not available and/or there is govt push for self-sufficiency.
  - Gas markets are evolving. LNG and unconventional gas are leading to slow spread of liberalisation of markets.
  - Low carbon options are becoming increasingly important – biomass, waste, renewables, with considerable investment now in small-scale generation.

• Downstream factors
  - Ammonia is a mature market. Outside of the minority technical/industrial sector, growth may be as low as 1% per year going forward. Chinese cap on fertilizer use.
  - Methanol is the fastest growing derivative. China’s push to substitute imported oil has led to increasing focus on fuel uses and methanol to olefins. Methanol could rival ammonia as largest derivative in 15 years.
  - Hydrogen is also growing, as refiners require additional desulphurisation and upgrading capacity. Longer term the ‘hydrogen economy’ will also become a factor.
  - Other uses are fairly niche. Low oil prices have reduced interest in GTL/CTL and low gas prices in IGCC. Growth in small-scale low carbon applications.
Thank you for your attention!