Natural Gas Utilization via Small-Scale Methanol Technologies

Natural Gas Utilization Conference
October 14, 2014

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Outline

- About ADI Analytics

- Gas Utilization and Low Oil Prices

- Small-Scale Methanol Technologies
ADI Analytics is a boutique consulting firm serving energy and chemical companies with passion, rigor, and expertise.

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<th>Markets</th>
<th>Technology</th>
<th>Operations</th>
<th>Functions</th>
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<td>Oil &amp; Gas</td>
<td>Exploration</td>
<td>Production</td>
<td>Refining</td>
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<td>Power &amp; Mining</td>
<td>Coal</td>
<td>Generation</td>
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<td>Chemical &amp; Industrial</td>
<td>Plastics</td>
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Fortune 500 and mid-sized companies, start-ups, investors, and governments have hired us to shape decisions globally.
Outline

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- Small-Scale Methanol Technologies
North American demand for gas is being driven by power.

Residential Natural Gas Demand
(Billion Cubic Feet Per Day)

-1.1%

13.7 13.1 13.4 13.9 13.3 13.2 12.0 12.9 13.4 13.1 13.1 12.9 11.4 13.5

2000 01 02 03 04 05 06 07 08 09 10 11 12 13

Commercial Natural Gas Demand
(Billion Cubic Feet Per Day)

-0.6%

8.7 8.3 8.6 8.7 8.6 8.2 7.8 8.3 8.6 8.5 8.6 7.9 9.0

2000 01 02 03 04 05 06 07 08 09 10 11 12 13

Industrial Natural Gas Demand
(Billion Cubic Feet Per Day)

-1.5%

22.3 20.1 20.6 19.6 19.9 18.1 17.9 18.2 18.3 16.9 18.7 19.2 19.8 20.4

2000 01 02 03 04 05 06 07 08 09 10 11 12 13

Natural Gas Demand for Power
(Billion Cubic Feet Per Day)

4.1%

14.3 14.6 15.5 14.1 15.0 16.1 17.0 18.7 18.3 18.8 20.2 20.8 25.0 22.3

2000 01 02 03 04 05 06 07 08 09 10 11 12 13

Source: EIA Annual Energy Outlook, 2013
Oil prices have fallen ~20% in the past four months.

Brent and WTI have fallen 21% and 17%, respectively.
... Posing a significant and material threat to various natural gas utilization projects

Gas Monetization IRRs Vs. Oil/Gas Price Ratio
(U.S. Gulf Coast, 35% Taxes, No Debt)

Lower oil prices depress gas monetization returns by 5-10 points

Oil / Gas Price Ratio, barrel / MM Btu basis
The payback for line-haul LNG truck fleets is 2-3 years based on current commodity prices and typical mileage

Fuel price differential and payback
(Annual mileage fixed at 125K)

Annual mileage and payback
(Fuel price differential fixed at $1.10)

Base Case Model Assumptions:
1. Diesel price $4/gal growing at 2% annually, LNG at $2.9/DGE growing at 0.5%
2. Truck fuel economy of 6.5 mpg diesel; 10% fuel economy penalty for NG engine
3. LNG truck upcharge of $35,000 for 11.9 L spark ignited NG engine & fuel system
4. 10 truck fleet, annual truck mileage of 125,000
5. Expiring fiscal and tax incentives not included
Outline

- About ADI Analytics
- Gas Utilization and Low Oil Prices

  - Small-Scale Methanol Technologies
Key messages

1. Natural gas conversion to methanol is a significant opportunity given current commodity prices and that large-scale conversion is a mature process.
Natural gas conversion to methanol in large-scale plants is a mature and widely-used process around the world.

Natural Gas Conversion Processes

- Natural Gas
  - Oxygen
  - Syngas
    - Fischer Tropsch
      - Diesel
      - Naphtha
      - Jet Fuel
    - Methanol
      - Gasoline
      - DME
      - Olefins
    - Hydrogen
      - Ammonia
      - Refineries
      - Fuel Cells

Transportation fuels

Chemicals
Conversion of natural gas to methanol could be attractive in North America since methanol prices track oil prices.

Methanol, Oil, and Natural Gas Prices

Oil / Gas Price ($/boe)

Methanol Price ($/ton)

Source: Methanex; EIA
Key messages

1. Natural gas conversion to methanol is a significant opportunity given current commodity prices and that large-scale conversion is a mature process.

2. Companies are responding with several large-scale methanol plant announcements in North America many of which will export all their product to Asia.
This robust growth outlook coupled with low natural gas prices are driving new methanol projects in North America

### List of Methanol Plant Announcements

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Start-up</th>
<th>Cost, $B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Emission Energy Plants</td>
<td>La Place, LA</td>
<td>2106</td>
<td>1.00</td>
</tr>
<tr>
<td>Celanese Corp.</td>
<td>Clear Lake, TX</td>
<td>2015</td>
<td>0.79</td>
</tr>
<tr>
<td>Valero Energy Corp.</td>
<td>St. Charles, LA</td>
<td>2016</td>
<td>0.70</td>
</tr>
<tr>
<td>Methanex Corp.</td>
<td>Geismar, LA</td>
<td>2014/15</td>
<td>1.10</td>
</tr>
<tr>
<td>LyondellBasell</td>
<td>Channelview, TX</td>
<td>2014</td>
<td>0.45</td>
</tr>
<tr>
<td>G2X Energy</td>
<td>Pampa, TX</td>
<td>2014</td>
<td>0.04</td>
</tr>
<tr>
<td>NW Innovations</td>
<td>Kalama, WA / Westward, OR</td>
<td>2018</td>
<td>2.00</td>
</tr>
</tbody>
</table>

### List of MTG and DME Plant Announcements

<table>
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<tr>
<th>Company</th>
<th>Location</th>
<th>Start-up</th>
<th>Cost, $B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emberclear Corp. (MTG)</td>
<td>Natchez, MS</td>
<td>2019</td>
<td>2.80</td>
</tr>
<tr>
<td>G2X Energy (MTG)</td>
<td>Lakes Charles, LA</td>
<td>2017</td>
<td>1.30</td>
</tr>
<tr>
<td>OCI Partners LP (MTG)</td>
<td>Beaumont, TX</td>
<td>2016</td>
<td>1.00</td>
</tr>
<tr>
<td>Sundrop Fuels Inc. (MTG)</td>
<td>Colorado</td>
<td>2014</td>
<td>0.58</td>
</tr>
<tr>
<td>Marcellus GTL LLC (MTG)</td>
<td>Allegheny/Blair Townships, PA</td>
<td>2015</td>
<td>0.25</td>
</tr>
<tr>
<td>SoCalGas Co. (DME)</td>
<td>Southern California</td>
<td>2014</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Source: Fuel Magazine, Hart Energy
## Key messages

1. Natural gas conversion to methanol is a significant opportunity given current commodity prices and that large-scale conversion is a mature process.

2. Companies are responding with several large-scale methanol plant announcements in North America many of which will export all their product to Asia.

3. Small-scale methanol plants have higher capital costs but can be economically viable in the Marcellus if they can source natural gas at attractive prices.
In recent years, methanol plants have grown in size enabling economies of scale and low capital costs.

Estimated Capital Costs for Planned Methanol Plants in U.S.
(U.S. Dollar Per Ton Per Year of Capacity)

- Average: $532
In comparison, small-scale units will have higher capex per ton of production but could benefit from cheap feedstock gas.

**Capital Cost for Small-Scale Methanol Plants**  
(U.S. Dollar Per Ton Per Year of Capacity)

**Natural Gas Feed Cost**  
(U.S. Dollar Per Million Btu)

<table>
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<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
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**Other assumptions**

- Capacity, tons per day: 50
- Gas per ton of methanol, MM Btu: 36
- Plant life, years: 20
- Interest rate, percent: 15%
- Operational cost, percent of capex: 10%
In sum, methanol from small-scale plants could be produced at a cost significantly lower than current or historical pricing.

Cash Cost of Methanol from Small-Scale Plants
(U.S. Dollar Per Ton)

Assumes a discount rate of 15%; actual returns will be higher at current pricing.

Natural Gas Cost, $ / MM Btu
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4. Investors will have to address technology risk associated with small-scale methanol plants and lower regional demand.
Few companies are developing small-scale methanol technology which needs to be demonstrated commercially

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<th>Company</th>
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</table>
| Maverick Synfuels     | - Offers small-scale, skid-mounted, modular, 10-30 tons/day methanol plants using commercial steam methane reforming and methanol synthesis catalysts  
                        - Claims a novel engineering design with small footprint and short delivery time  
                        - Process tested at a pilot / demonstration scale but not commercialized yet  
                        - Announced JV for a plant in Canada and partnership with a fabricator for plants |
| R3 Sciences           | - Developing a homogeneous catalyst-based 3-30 tons/day methanol plants  
                        - Claims process operates at a lower temperature and pressure with higher syngas conversion per pass and selectivity to methanol leading to lower capex  
                        - Plans to transition process through pilot / demonstration scales in 2014-15 with a commercial unit targeted by the end of 2015 |
| Oberon Fuels          | - Developed proprietary skid-mounted, small-scale production units to convert methane and carbon dioxide to DME and methanol at 10-30 ton/day capacity  
                        - Focusing development and commercialization effort on DME than methanol |
| GasTechno GTL         | - Developing direct conversion process for gas to methanol and other products  
                        - Process tested at pilot-scale and now targeting demonstration scale  
                        - Claims ability to handle rich gas streams with limited pre-treatment and …  
                        - … A wide range of scales from 1 to ~450 tons per day of products  
                        - Company estimates capital costs of $400-$1,350 for 17-55 tpd plants |
Finally, regional methanol demand is low although new NGL crackers could change this going forward.

U.S. Methanol Demand by Region
(Million Tons Per Year)

Source: U.S. Census data on chemicals; ADI Analytics
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