PROJECT OPTIONS TO UTILIZE NATURAL GAS

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GAS ELECTRIC PARTNERSHIP

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PRESENTATION OVERVIEW

- Apache Background and Role of Gas Monetization
- Project Options for Natural Gas in North America
  - LNG Export Plants in North America: Why and Why Not
  - LNG for Domestic Fuels Market
    - Marine, Heavy Duty Trucking and Mining, Rail
    - E&P Operations: Fracking and Drilling
  - Conversions to Higher Value Product Streams
  - The Case for New Gas-Fired Power
APACHE’S GLOBAL ENERGY PORTFOLIO

- Canada
- Central
- Permian
- GC Onshore
- GOM Shelf
- Deepwater
- Argentina
- North Sea
- Egypt
- Australia
THE WORLD HAS CHANGED

Prices turned upside down

Natural Gas ($/MMBTU)

Crude Oil ($/BBL)

Henry Hub

Brent

WTI
MAINTAINING OUR PORTFOLIO BALANCE

Revenue: Increasingly liquids-driven

Production: Consistently ~50% Liquids over last 10 years
BENEFITING FROM RISING INTERNATIONAL GAS PRICES

Realized Gas Price

- North America
- International

Price per MCF

International Gas Revenue

Revenue in $MM

Periods: 1Q10, 2Q10, 3Q10, 4Q10, 1Q11, 2Q11, 3Q11, 4Q11, 1Q12
NORTH AMERICAN STRANDED GAS

- Double-edged sword of abundant natural gas
- Increasing barriers to liquid-rich assets
- Disconnect between energy content and valuation
- Upside potential for natural gas, sustainable volumes for a long time to come
- North America priorities for “economically stranded” gas:
  - Accelerate development of US and Canadian gas plays
  - APA produces 1 billion cubic feet of natural gas per day in North America
  - Achieve exposure to higher value downstream markets
    AND create demand for natural gas as alternative energy source

APA 2011 Production

APA 2011 Revenue
More unconventional plays mean:
- No more cheap oil
- Increasing ratios of associated gas
- Oil to Gas 6:1 ratio in pricing continues in the U.S. until other markets emerge
COST OF GAS SUPPLY

- Current U.S. shale gas volumes = Approx. 14 bcfd of gas at less than $5 per MCF.
- By comparison, U.S. 2012 gas consumption = 68 bcfd.
- Forecast for 2013 = 70 bcfd (3% growth)

Significant new supply available at breakeven < $5/MCF...new supply will keep prices depressed over the long-term
PROJECT OPTIONS FOR NATURAL GAS: ROLE OF LNG
LNG EXPORT POTENTIAL IN NORTH AMERICA

- Alaskan projects not shown.
- Also not shown: Existing Regas Terminals not currently considered for export
Trucking: New 12L natural gas, spark-ignited engine for trucking released by Cummins Westport this year. LNG tanks for these trucks come standard.

CNG use for fleet vehicles and public transport continues to rise.

E&P: Dual Fuel Engines available from CAT for fracking and drilling applications.

E&P: Drilling with natural gas can also be done with dedicated natural gas turbine gen sets or spark-ignited engines.

Rail: LNG Engine for Rail being developed with CNR. CNG engines already exist.
SAVINGS IN NATURAL GAS FOR DIESEL REPLACEMENT

- Diesel - volumetric energy content or heating value of Diesel #2 is approximately 129,500 British thermal units (Btu) of energy per gallon (34,210 Btu/liter).

- Natural gas volumetric energy content can range from 900 to 1,400 Btu per standard cubic foot, depending on gas composition.

- Comparison
  - If natural gas has an average 1,000 Btu, then it would take 129.5 Scf to equal the same energy content as a gallon of diesel, diesel gallon equivalent (DGE).
  - Gas volumes are typically measured in one-thousand standard cubic feet or Mcf

1 Mcf = 7.72 DGE

Energy Equivalency:
Natural gas = $3.5 /MMBTU
Diesel = $30.8 / MMBTU (at $4/gal)

Source: Encana Welcome Address, ANGA Drilling Summit, July 26, 2012
APA has converted 274 vehicles to CNG in its fleet. Goal is 80% of 1000 fleet vehicles converted by 2015.

CNG applications provide midstream opportunities to support CNG fueling station infrastructure and affect transportation fueling market.

Widespread view is that CNG fits well for fleet vehicle conversions. LNG for long-haul trucking provides pay-back in less than 2 years.

CNG stations within cities can also be served by LNG (stored and cryogenically pumped.)
CNG / LNG FUELS FOR DRILLING AND FRACKING

- Cost savings already proven by Encana, Noble, EQT to be $25k-200k per month for LNG use in drilling engines.
- Tests in drilling and frack fleets ongoing to explore all three sources of natural gas.
- CNG could require smaller transport distance and more trips given load limits on CNG trucks.
- Most desirable will be wellhead (field) gas with limited processing treatment – directly at site.

Source: Various presentations, ANGA Drilling Summit, July 26, 2012
FLOATING LNG

- Floating LNG will enable development of stranded offshore fields
- Can be delivered more quickly than land-based facilities with less environmental impact
- Shell Prelude project is under construction, will be world’s largest floating structure
- FLNG is space constrained at ¼ size of onshore LNG and ½ the capacity
- Early developers will utilize principle of “design one, build many” but site variations challenge this assumption
- Favorable economics are site dependent: Design for offloading LNG (tandem or side by side) and operational availability

SE Asia may be good area for F-LNG given lack of infrastructure and localized pockets with condensate/gas mix
FLOATING LNG – ENABLING TECHNOLOGY AND DESIGN CHOICES

Enabling Technologies:
- Offloading design: tandem or side-by-side
- Tilt and movement effects on AGRU and cryogenic heat exchanger
- Process capabilities for turndown, start-up
- Deep seawater intake – use turrets or risers

Design choices:
- Flexibility to handle variations in feed gas composition?
- “Generic F-LNG design is not possible”
- Threshold volumes of LPG’s and condensate processing? Improves economics
- Optimal size? 3.3-3.8 mmtpa per Shell Prelude and Statoil design (in FEED).
- Dual refrigerant and expander cycles are both validated and now applicable
PROJECT OPTIONS FOR NATURAL GAS: CONVERSION STREAMS FOR HIGHER VALUE PRODUCTS
COMPARISON OF REFORMING PROCESSES

Reforming to produce syngas

CO₂ + CO + H₂ + heat

Ammonia Path

Carbon Removal and Conversion

H₂

Reforming and Shift

Waste: CO₂

ASU, Add N₂

NH₃ + impurities

Cyrogenic clean-up

Methanol Path

Methanation

CH₄O

Waste: N₂ + H₂O

Polypropylene Plant

Polypropylene, Ethylene, Propylene, or gasoline

GTL Diesel Path

CO₂ removal

Waste: Heat, H₂O

Fischer-Tropsch Reaction

CₙH₂(2n+2), typ. Diesel and Naptha

Typically use Steam Methane Reformer or Auto-thermal Reformer. Technology gap for lower cost process = oxygen membranes

Natural Gas Feed

Steam {& O₂}
New exploration will increasingly find smaller pockets of gas rather than 50+ TCF discoveries

Two OEM’s presently developing “small scale” GTL plants for 1000 bbl/day (~10-15 MMSCFD)

These modular GTL plants are based on microchannel reactor technology with proprietary catalysts

Aiming for onshore applications which lend themselves to modular, small-scale units, or possibly offshore treatment of associated gas

Based on Fischer-Tropsch process with upstream syngas reformer to produce optimized blend of diesel, LPG and Naphtha

Source: Velocys
AMMONIA, METHANOL, PROPYLENE

- Established conversion technologies for natural gas fed processes. Relatively high energy consumption ~28 GJ/ton for ammonia and methanol, historically. Recent reformer and catalyst improvements have lowered this value.

- All streams require gas clean-up (dependent on upstream quality) and **syngas production through reforming**, with remaining synthesis stages dictated by end product.

### Product Streams’ Energy Consumption from Natural Gas

<table>
<thead>
<tr>
<th>Product</th>
<th>Yearly prod. (mil. t/y)</th>
<th>Energy consumpt. (GJ/t)</th>
<th>Thermal LHV Practical (%)</th>
<th>Efficiency Ideal (%)</th>
<th>CO₂ (t/t)</th>
<th>Main technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>124</td>
<td>29</td>
<td>65</td>
<td>89</td>
<td>16^a</td>
<td>Syngas/synthesis</td>
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<tr>
<td>Ethylene</td>
<td>75</td>
<td>15^b</td>
<td>62</td>
<td>93</td>
<td>0.65</td>
<td>Steam cracking C₂H₆</td>
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<tr>
<td>Propylene</td>
<td>53</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>Steam cracking C₃H₆</td>
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<tr>
<td>Methanol</td>
<td>32</td>
<td>28</td>
<td>72</td>
<td>84</td>
<td>0.28</td>
<td>Syngas/synthesis</td>
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<tr>
<td>Hydrogen</td>
<td>20</td>
<td>12.6</td>
<td>84^c</td>
<td>92</td>
<td>0.9</td>
<td>Steam reforming</td>
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<tr>
<td>Synfuels</td>
<td>18^d</td>
<td>67</td>
<td>60</td>
<td>78</td>
<td>1.18</td>
<td>Syngas/synthesis</td>
</tr>
</tbody>
</table>

- ^a incl. CO₂ converted into urea
- ^b data kindly provided by F. Dautzenberg, ABB Lummus, 2005
- ^c CH₄ used for reaction heat; no steam export
- ^d excl. 3 million tonnes per year under construction

Multiple FEED studies underway for North American plants and 12 identified potential new build fertilizer projects. Demand is mainly driven by U.S. fertilizer markets.

Ammonia pricing typically requires less than $3/MCF but new process improvements have pushed profitability curve towards $4/MCF gas.

Major licensors of ammonia technologies have focused on areas to advance process efficiency:
- Primary and secondary reforming
- Higher productivity catalysts
- Purification
- Integration of plant, use of waste heat

Recent process improvements may push production cost curve and allow higher gas prices.
METHANOL AND MTP PRODUCTION

- Market price increases for products with higher level of reforming and energy requirement.
- Methanol, ethylene and propylene pricing tracks with crude oil.
- Necessitates high oil to gas ratio to make gas to methanol profitable.
- Some EPC’s marketing concepts of going larger (< 3000 tpd) using a high pressure reformers and multiple product streams
  - Gain economies of scale if market can support off-take

<table>
<thead>
<tr>
<th>End Product</th>
<th>Current U.S. Prices ($/MMBTU)</th>
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<tbody>
<tr>
<td>Methanol</td>
<td>$16.6</td>
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<tr>
<td>Gasoline</td>
<td>$23.7</td>
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<td>Propylene</td>
<td>$26.5</td>
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<tr>
<td>Diesel <em>F-T process</em></td>
<td>$30</td>
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<tr>
<td>Acrylic Acid</td>
<td>$35</td>
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Increasing level of complexity and capex cost

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<tr>
<th>Month</th>
<th>WTI Crude Oil ($/MMBTU)</th>
<th>USG MeOH Spot Avg $/MMBTU Methanol</th>
<th>Henry Hub Gas ($/MMBTU)</th>
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<tr>
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PROJECT OPTIONS FOR NATURAL GAS: GAS-FIRED POWER
GAS-FIRED POWER IN NA – EXPECTED DEMAND INCREASE

U.S. EIA data shows average capacity factor increase from 42 to 52% from 2005 to 2010, for peak demand hours.

Natural Gas Electric Power Generation: Departure from April 2011 to April 2012 = 70 to 95 GWhr (35% increase)

* All graphs courtesy of U.S. EIA
New NGCC power will be mainly built in areas with highest coal to gas conversion.

- Approx. 60-90 GW in older coal power could be replaced by new gas-fired plant builds

Union of Concerned Scientists believes 59 GW of coal fired power plants are ripe for retirement, concentration in NE and SE U.S.
CASE FOR NEW GAS-FIRED POWER PLANTS IN SHORT TERM

Forecasts for Natural Gas Fired Power Demand (GW-hr)

*Average monthly demand shown, does not include higher than anticipated seasonal demand spike in summer months

<table>
<thead>
<tr>
<th>Year</th>
<th>Moderate Increase Scenario</th>
<th>Current Rate of CTG Switching Scenario</th>
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<tbody>
<tr>
<td>2013</td>
<td>114</td>
<td>128</td>
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<tr>
<td>2014</td>
<td>136.8</td>
<td>173</td>
</tr>
<tr>
<td>2015</td>
<td>164</td>
<td>234</td>
</tr>
</tbody>
</table>

- Diversion in gas fired electric power due to low cost gas in 2012 – provides estimate in expected future growth in gas demand.
- Demand quickly exceeds supply of gas-fired power by 2015, at current coal to gas (CTG) switching rate.

Exceeds US gas fired generation capacity (185 GW)!
SUMMARY

- All projects should be evaluated against their own economics, market pricing and gas monetization potential.
  - Capex vs gas flow rate can be used to evaluate monetization potential ($MM / MMCFD). LNG projects and power plants tend to have lowest capex per MMCFD.
  - Must also evaluate IRR, heavily depends on market pricing.
- Long term gas demand growth is the over-arching goal but commercial drivers will dictate project growth areas.
- Realistically, need project growth of 17-23 BCFD in North America to bring gas price into more healthy $5/MCF range.
QUESTIONS??

Thank you for your time.

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