Executive Panel Discussion

**Moderator:**
Dave Witte - IHS Markit

**Panelists:**
Walter Pinto - Lyondellbasell  
Tony Jones - Valero  
Ron Corn - CPChem  
Mike McAtee - BASF
Addressing strategic challenges with interconnected capabilities

Brought together to form the most comprehensive sources of data, analytics and insight for the Energy Upstream, Oil Markets, Midstream, Downstream & Chemical Markets
Agenda

The opportunity - outlook for shale oil, gas and petchems

The threat – analyzing capital build options through the supply chain

The challenge – panelists ideas to offset threats and capture opportunities
Chemicals are illustrative of the energy supply chain. Global chemical demand is concentrated in developing world with more than 50% of demand growth in China…
…But petroleum supply is concentrated elsewhere
Trade from advantaged hydrocarbon regions fills the demand gap – typically at the first value chain node with reasonable logistic costs and product market liquidity.

Volumes greater than 5,000 metric tons noted; intra-regional trade excluded.
Capital investments seek to maximize returns – preferably with a sustainable competitive advantage

**Investment “Drivers”**

✓ Secure an energy & feedstock advantage
✓ Leverage current technology and build world-scale for maximum capital efficiency
✓ Invest with proximity to local markets and/or access to trade routes
✓ Build to leverage an upstream and/or downstream integrated position

Braskem-Ideas Ethylene/PE Plant
Nanchital, Veracruz, Mexico
Start-Up: June 2016

Photo courtesy of Braskem IDESA
Combination of high crude prices and stable gas is attractive for those North America investments based on natural gas and natural gas liquids.
Global crude and condensate production requires ~20 MMb/d new supply by 2022

Global crude and condensate supply in 2022

- **Total crude and condensate production in 2016**: 82 MMb/d
- **Base declines to 2022**: Conventional, 10 MMb/d; Unconventional, 3 MMb/d
- **New capacity additions to 2022**: Unsanctioned, 5 MMb/d; Sanctioned, 7 MMb/d
- **Total crude and condensate production in 2022**: 88 MMb/d

Source: IHS Markit

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Nearly 1,300 Tcf North American gas supply at Henry Hub < $4/MMBtu

Source: IHS Markit

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Lots of feedstock unlocked by shale suggest another wave of US-based investment – but where?

**US Ethane Demand and Rejection**

- **Base Chemical**
- **Miscellaneous Fuel**
- **Exports**
- **Rejection**

**US Proven Gas Reserves**

Source: IHS Markit
For chemicals, plant builds either aligned with demand or hydrocarbon supply; lately total capital investment has trended down - except in the US. Will it continue?

Capital Spending in the Chemical Industry

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Plenty of value creation available for US investment, but high execution risk as delays and overruns destroy value

Impact of Project Underperformance on Base US Ethane Cracking NPV

At target CAPEX

10% overrun

NPV, Millions $

On Schedule 6 Months Delay

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Case study - Multiple models for investment exist to satisfy Chinese demand growth

<table>
<thead>
<tr>
<th>Option</th>
<th>Cash Cost</th>
<th>Capital</th>
<th>Market Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export ethane, build cracking in China</td>
<td>Highest</td>
<td>Lowest</td>
<td>Lowest</td>
</tr>
<tr>
<td>Build US methanol, export to MTO in China</td>
<td>Lowest</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td>Build ethane cracker in US, export product</td>
<td>Moderate</td>
<td>Highest</td>
<td>Highest</td>
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Low-cost Chinese and high US capital costs means Chinese investment beats US returns even after accounting for high feedstock shipping costs.
At expected ethane prices, cash costs favor naphtha at crude prices below $60/Bbl. Will crude to ethane spreads be low enough for Chinese ethane to beat naphtha?

**Equivalence Graph - Cash Cost For Ethylene**

- **Asian Ethylene vs Brent**
- **Ethylene vs Ethane**

**Forecast Ethane Delivered China**

- $500/ton = $10/MMBTU = 67 cpg
Conclusions

• Demand growth concentrated in developing world and dislocated from hydrocarbon supply

• Shale has unlocked huge amounts of competitive supply supporting investment growth in Energy and Chemicals

• Poor (relative) EPC performance eroding feedstock advantages

• New approaches to improve US EPC productivity are needed, or risk a shift of building to overseas
Our distinguished panel

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Senior Director, Global Projects and Engineering

Mike McAtee
Senior Vice President, Strategic Projects

Ron Corn
Senior Vice President, Petrochemicals

Tony Jones
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