GLOBAL CHEMICAL INDUSTRY UPDATE

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- Cost Curve Analytics
- Capital Cost Services
- Scenarios
- Special Studies

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- Chemical Company Analysis
- Regional or Country Analysis
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- Member Events

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- Transaction
- Legal Services
- Technology
- Renewables
- Specialties
- Training
The petrochemical value chain is extensive

- Oil, Gas Production
- Hydrocarbon Feed
- Monomer/Base Chemicals
- Derivatives & Intermediates
- Resins

Converters: Pellets to bags, film, bottles or fiber

Manufactured Goods

Retail

Consumers
Key Issues Being Discussed in the Global Chemical Industry

- Crude Oil Price Outlook
  - V-shape / U-shape / L-shape recovery

- Demand Growth & The Economy
  - Low Crude as a demand stimulus

- US NGL Supply
  - Ethane & Propane availability

- Need for infrastructure investment to support expanding regional trade

CEO Roundtable Discussions at AFPM, APIC, CPCIC, EPCA
Key Issues Being Discussed in the Global Chemical Industry

- Non-conventional & On-Purpose Production Technologies
- China, China, China
  - Shifting demand growth / slowing economy / currency / stock market
  - Coal-to-Chems / On-purpose / and Conventional Investments
  - Private Company Market Share
  - Adoption of Responsible Care Charter
- Lifting of Iran Sanctions Impact
- “Sustainability”, GHG Emissions, Carbon Tax, Bio-Based Chemicals

CEO Roundtable Discussions at AFPM, APIC, CPCIC, EPCA
When Energy Markets Move Chemical Markets Respond

- Rapid decline in crude oil pricing causes supply-chains to “pause” as buyers *anticipate lower prices*.
- Lower production costs combined with a pause in demand, can result in sudden price declines, which can serve to *stimulate demand*:
  - Higher GDP growth; lower use of recycle plastics; stimulate substitution
- Falling prices / lower margins force *re-assessment of capital spending* projects → slowing additions creating a pause/reversal of CAPEX inflation.
- Combination of these impacts can create *tight markets in the future*
After Falling From the Cliff, Crude Prices Continue Search of Bottom

**Assumptions**

- **Weak**: Pricing will continue given little decrease in US and OPEC production levels.
- **Demand growth is not sufficient to absorb crude supply on offer before 2H 2016.**
- **Strong US crude and product inventories, lift of export ban exacerbate downward pressure.**

**Price forecast risks**

- **Downside**: Strong US production continues amid prospects of price war with return of Iranian production to unsanctioned trading.
- **Upside**: Complicated geopolitical situation initiates price rally. Unexpected increase in demand.
Global Crude Oil Inventories Are High, and Are Creeping Higher

Recent US Gasoline and Diesel stocks are Close to 5 year High Levels

China has been adding storage capacity and increasing stored crude volume

Global crude inventory exceeded 60 days of global supply (>5500 Million Barrels)

Source: Energy Information Administration (EIA)

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Demand Can Be Stimulated By Macro-economic And Substitution Effects

- Basic chemicals and derivatives are the fundamental building blocks for many durable and non-durable consumer goods.
- Global economic growth drives the demand growth for basic chemicals.
- Low energy prices stimulate economic growth; this will translate into accelerated growth for basic chemicals.
- Lower relative prices spur growth where chemicals can substitute against other materials.
Accelerated Demand Growth Can Drive Global Utilization Rates Higher For Most Segments

- With the exception of methanol, expected improvement in global GDP drives demand growth higher than forecast capacity expansions.
- IHS base forecast for most segments sit at or below historical average; plastics is higher driven by substitution assumptions.
- Downside case would be problematic for all value chains except chlor-alkali (vinyls).
- Assuming GDP strengthens, implication is that for most value chains utilization rates will be rising.

Demand Growth Range vs. Capacity: 2016-2020

- Demand or Capacity Growth, %
- Capacity
- IHS Base
- High Elasticity, High GDP
- Low Elasticity, Low GDP
Global Base Chemicals Cumulative Demand Growth
2010 - 2020 = 224 Million Metric Tons

Million Metric Tons

<table>
<thead>
<tr>
<th></th>
<th>Total Growth MM Tons</th>
<th>AAGR: 2010/20 MM Tons/Yr</th>
<th>AAGR: 2010/20, %</th>
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<tbody>
<tr>
<td>Ethylene</td>
<td>61.6</td>
<td>5.6</td>
<td>3.5</td>
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<tr>
<td>Methanol</td>
<td>52.4</td>
<td>4.8</td>
<td>6.9</td>
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<tr>
<td>Propylene</td>
<td>47.8</td>
<td>4.3</td>
<td>4.2</td>
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<tr>
<td>Chlorine</td>
<td>28.1</td>
<td>2.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Paraxylene</td>
<td>19.4</td>
<td>1.8</td>
<td>4.5</td>
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<tr>
<td>Benzene</td>
<td>14.7</td>
<td>1.3</td>
<td>2.3</td>
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Capital Investment Peaks 2013-2015; Asia Slows Dramatically, N. America Accelerates, Middle East Is Steady

Global Chemical CAPEX, 2014 US $ Billions

- ROW
- Europe
- S. America
- N. America
- Asia Pacific
- Middle East
Global EBIT Will Pull Back Slightly In The Near-term Before Accelerating As Demand Growth Exceeds Supply

- Lower crude price in the US depress gas-based margins in the near-term, but recovery improves with energy and tighter markets; ethane price rise threatens ethylene/PE margins
- An assumption to a return of normal operations and pressure from trade, eases Europe off of current supply-constrained highs
- Asia shows improvement going forward as improving profits in methanol and C/A margins offset weakness in propylene
Key Drivers For Investments In New Capacity Will Vary By Region

- **North America (USA)**
  - Leverage low cost natural gas based chemicals into investments in ethylene, propylene and methanol based derivatives.
  - Invest to establish export channels to market that exceed historical norms.

- **Middle East (Saudi Arabia)**
  - Moderated investment pace, diversified feedslate to support downstream market development and continued industrial expansion well beyond ethylene chemistry.

- **North East Asia (China)**
  - Strong domestic investment focused on reducing import dependencies.
  - Leverage coal to chemicals technology near term.
Top 5 Countries Adding Base Chemical Capacity
231 Million Tons from 2010 to 2020

Top five will add nearly 75% of base chemical capacity. China will dominate new capacity, adding 45% of total.

Investment capital has shifted to North America, however, the vast majority of new investment continues to accelerate in Asia/Pacific, dominated by China.
• Become “global leader”, beyond size, have **core proprietary technologies**, competitive advantage, global brand, international scope & breadth

• Global leadership role responding to energy changes, changes in regional markets (Japan & Korea), **cutting edge of innovative solutions**

• Understand chemical value-chain, from well-head to consumers; understand China’s position at each stage of the value-chain and developments needed to be a leader

• **Address over-capacity issues**
  • Shut down inefficient capacity with significant environmental impact
  • Restructure portfolio to replace imports related to domestic product quality and performance
  • Focus on supply-chain optimization

• Focus on **strategic emerging industries** – build integrated clusters of innovative leading technology chemicals; including **specialty chemical clusters**.
Regional Trade Is Critical To Success In The Global Chemical Industry

- Trade is an essential element of basic chemical supply chains
- Low cost regions such as North America and the Middle East will export increasing volumes
- On-purpose technology will change propylene trade patterns
- Significant investment in ships, ports, and infrastructure is needed to support increasing trade volumes

5 Countries Adding 75% of Base Chemical Capacity: 2010 to 2020 (231 MM Metric Tons)
But Chemical Trade Continues To Globalize, Connecting Advantaged Feeds With Markets, Labor And Capital

- Trade will continue to grow, connecting resource-rich geographies with high growth markets.
- By 2020 global trade will have more than doubled from 2000 levels, representing about 50% of global production.
- Pressure on high-cost producers servicing markets targeted by advantaged capacity will intensify.
- Global supply-chain expertise and well crafted go-to-market strategies increase in importance.

Global: Total Trade & 2020 Exports, Base Chemicals & Plastics

Source: IHS
China Remains Central To Basic Chemical Trade

**US Ethylene Demand & Equivalent Trade**

<table>
<thead>
<tr>
<th>MM Metric Tons</th>
<th>% of Capacity</th>
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</thead>
<tbody>
<tr>
<td>60</td>
<td>75%</td>
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</table>

**China Ethylene Demand & Equivalent Trade**

<table>
<thead>
<tr>
<th>MM Metric Tons</th>
<th>%, Self-Sufficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>75%</td>
</tr>
</tbody>
</table>

**Net Equiv Exports**

**Domestic Demand**

**Net Exports, % of Cap.**

**Net Equi. Imports**

**Domestic Demand**

**Self-Sufficiency**
The Impact of Energy At The Extremes…

Summary of key trends

• Basic chemicals and derivatives markets adjust to “new energy” dynamics
• …lower energy and lower prices for plastics can represent a demand stimulus
• Pause in capital project approval combined with stronger demand growth can result in tight markets for certain value chains; higher margins
• Emerging changes in China market will continue to have a global impact in most value chains
• Lifting of sanctions on Iran likely to impact PE and methanol near term
• Expanding (or contracting) regional trade requires detailed understanding of logistics developments and solid go-to-market strategies
The Impact of Energy
At The Extremes…

Beyond 2020…

• Crude oil price trend in relation to NAM natural gas and China coal: impact on rate of demand growth and investment location decisions

• Availability of low-cost ethane and propane in North America to support continued investments; both domestic and international

• Developments in on-purpose technology for olefins versus traditional routes, including the use of methanol as a route to olefins.

• Impact of coal-to-chemicals and on-purpose propylene in China: private/provincial investment versus state-owned; self-sufficiency and surplus capacity impacting trade with China.
The ethylene value chain

Ethylene

Polyethylene (LDPE, HDPE, LLDPE)

Ethylene Oxide

Monoethylene Glycol (MEG)

Dichloride (EDC)

Ethylene Dichloride (EDC)

Vinyl Chloride Monomer (VCM)

Others

Film and Sheet – packaging (high clarity film markets), films
Extrusion Coating – coating paper, paperboard for packaging
Injection Molding – housewares, toys, molded furniture

Film – garbage bags, food packaging
Injection Molding – housewares, lids, caps
Sheet – geo membranes
Blow Molding – bottles, containers for household chemicals,
antifreeze, Injection Molding – smaller containers for pharmaceuticals, shampoo, cosmetics
Film and Sheet – packaging, liners, Pipe and Tubing

Antifreeze, Polyester (fiber and PET),
Household cleaning, Paint &
coatings, Industrial & Institutional
Cleaning, Personal Care, Lubricants,
Construction, Cosmetics, Paint,
Automotive, Consumer Electronics,
Textiles

Pipes & Fittings, Profiles &
Tubes, Films & Sheets, Wires &
Cables, Bottles

Appliance and Electrical/Electronics, Food Packaging/ Food,
Service
Ware, Medical Products, Furniture Components, Foam Board and
Sheathing, Building Insulation, Rigid Packaging, Automotive
Components, Refrigerator Components, Electrical Components,
Electronics/Electrical Appliances, Paper Coating, Nonwoven Binders
North America NGL Feedstock

- **North America natural gas** remains well supplied but “methane demand constrained” including LNG exports in the forecast.

- **North America NGL** balance shows there is sufficient ethane supply to handle current wave of new US ethylene crackers (10 million metric tons).

- **Ethane supply** for an additional 15 million metric tons of ethylene beyond 2020 is available at the “right price”.

- **Propane supply** will be long in the near term, making propane the likely competitive feedstock compared to ethane.

- **Ethane prices** will rise to reflect higher demand and support extraction of higher cost supply; propane parity / competitive ethylene derivative exports, provide a price ceiling.
Natural Gas Remains Advantaged; However, Ethane Economics Will Change

Crude Oil – Vs – Natural Gas & NGLs

Source: IHS

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US Ethane Demand To Increase faster than Supply
Exports (waterborne and pipe) and capacity additions (creep and greenfield)

Source: IHS

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# North America Ethylene Capacity Growth: 2014–2020

**Completed or Firm Projects (Thousand Metric Tons)**

## Ethylene Capacity Additions

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Total Additions</th>
<th>2014-2021</th>
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<tr>
<td>BASF/Total</td>
<td>Port Arthur, TX</td>
<td>128</td>
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<tr>
<td>ChevronPhillips</td>
<td>Cedar Bayou, TX</td>
<td>1500</td>
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<tr>
<td>Dow</td>
<td>Freeport, TX</td>
<td>1500</td>
<td></td>
</tr>
<tr>
<td>Dow</td>
<td>Plaquemine, LA</td>
<td>250</td>
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<tr>
<td>Eastman</td>
<td>Longview, TX</td>
<td>17</td>
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<tr>
<td>Equistar</td>
<td>Channelview I, TX</td>
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<tr>
<td>Equistar</td>
<td>Channelview II, TX</td>
<td>182</td>
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<td>Corpus Christi, TX</td>
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<tr>
<td>Equistar</td>
<td>La Porte, TX</td>
<td>385</td>
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<tr>
<td>ExxonMobil</td>
<td>Baytown, TX</td>
<td>1500</td>
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<tr>
<td>Flint Hills</td>
<td>Port Arthur, TX</td>
<td>100</td>
<td></td>
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<tr>
<td>Formosa</td>
<td>Point Comfort, TX</td>
<td>1150</td>
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<td>Indorama</td>
<td>Lake Charles, LA</td>
<td>370</td>
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<td>LACC LLC</td>
<td>Lake Charles, LA</td>
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<td>Oxy/Mexichem</td>
<td>Ingleside, TX</td>
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<td>Plaquemine, LA</td>
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<td>Sasol</td>
<td>Lake Charles, LA</td>
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<td>Westlake</td>
<td>Calvert City, KY</td>
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<td>Williams</td>
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<td>Braskem Idesa</td>
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<tr>
<td>Nova</td>
<td>Sarnia</td>
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*Firm:* 12869
Propylene Market View
North America PDH Propylene Capacity Additions Latest Update

### Propylene Capacity Additions
Projected North American Propylene (2014 - 2020) (Thousand Metric Tons per Year)

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Total Additions 2014-2021+</th>
<th>Technology</th>
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<tr>
<td>BASF</td>
<td>Freeport, TX</td>
<td>475</td>
<td>MTP</td>
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<tr>
<td>Dow</td>
<td>Freeport, TX</td>
<td>750</td>
<td>PDH</td>
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<tr>
<td>Enterprise</td>
<td>Mont Belvieu, TX</td>
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<td>PDH</td>
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<td>Ascend</td>
<td>Alvin, TX</td>
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<td>PDH</td>
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<td>Formosa</td>
<td>Point Comfort, TX</td>
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<td>PDH</td>
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<td>Williams</td>
<td>Redwater, Alberta</td>
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### Possible Propylene Capacity Additions
Other Announcements

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<tr>
<td>Flint Hills Resources</td>
<td>Houston, TX</td>
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<tr>
<td>Williams</td>
<td>Western Canada</td>
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<td>Dow</td>
<td>Freeport, TX</td>
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<tr>
<td>Sunoco</td>
<td>Marcus Hook, PA</td>
<td>600</td>
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<td><strong>Announced:</strong></td>
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Propylene Supply Diversification

From By-Product/Co-Product of Refining/Steam Crackers to On-Purpose

World: PG/CG Propylene Prod. by Feedstock

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Propylene Capacity Additions Overwhelm Demand Growth

Five years of excess capacity through end 2019

Global Propylene Capacity Additions vs. Demand Growth

Source: IHS

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Polyethylene

Key Issues

• Global demand growth healthy: ~1.3xGDP (2015-2020)
• Excess capacity growth concentrated in low cost / high demand regions of North America, Middles East, and China
• Low crude brings improved margins for naphtha-based producers; WEP capacity closures postponed; Asia capacity runs at higher rates
• South America projects postponed until conditions improve.
• North Americas joins Middle East as major global exporter: look for increasing competitive environment for domestic market
Polypropylene

Key Issues

• North America experiencing unprecedented margin acceleration due to tight supply/demand.

• Imports of resins and finished goods expected to continue to increase into North America with no new capacity on the horizon until 2019.

• New capacity in China and Middle East likely to continue downward pressure on prices in those regions.

• Chinese self sufficiency likely to redirect trade flows away from China and to other regions that are short resin like the Americas.
Questions?