Chemical Industry Outlook

VMA Market Outlook Workshop

August 14-15, 2014
The Langham
Boston, MA

Presented By IHS Chemical:

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Brought together to form the most comprehensive source for chemical market research and expertise in the world – **IHS Chemical**.
Consumers Pull Chemical Demand
Energy Drives Manufacturing Costs

Consumers → Retail → Consumer Goods

Retail → Petrochemicals

Energy → Petrochemicals

Petrochemicals → Derivatives
Agenda: Global Chemicals Outlook

• Strategic Trends In Base Chemicals
• Energy at the Extremes
• Final Discussion & Wrap-up
Basic Chemicals Global Capacity

2000

- Ethylene, 97,691
- Benzene, 42,327
- Chlorine, 53,144
- Methanol, 37,316
- Propylene, 59,623

290 Million Metric Tons

2020

- Ethylene, 201,808
- Benzene, 70,269
- Chlorine, 94,578
- Methanol, 131,536
- Propylene, 142,318

640 Million Metric Tons

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Changes In Energy & Demand Growth Incentives Show Varied Results

Basic Chemicals Capacity Growth, Million Metric Tons

- Benzene
- Chlorine
- Methanol
- Propylene
- Ethylene

- 00 to 10
- 10 to 20
Strategic Issues In Base Chemicals

- Incentives to build on-purpose threaten oversupply near term; demand trending towards GDP

- Crude oil to natural gas ratio is key to location of new capacity; and keep one eye on coal in China

- Understanding China is key; light olefins feedstock and fuels end-uses stimulate demand growth
Strategic Issues In Base Chemicals

- Electricity cost is the major factor; demand growth linked to construction materials

- Supply trends complicated by refining and chemicals; benzene trades while derivatives are local
Methanol Demand Growth Driven By Olefins & Fuel End-uses In China

GDP Elasticity Vs Global GDP

- Ethylene
- Propylene
- Methanol
- Benzene
- Chlorine
- Global GDP, %
Chemical Investments Seek A Sustainable Advantage

Energy & Feedstocks
...make up 60-70% of the costs of chemical production. Investments seek a competitive advantage in energy and feedstock costs.

Demand Growth
Proximity to demand growth essential without distinct cost or technology advantage. Trade access is also key.

Technology
Technology to enable competitive production costs, economies of scale, high performance products. First to market is important.
Three Regions (Countries) – One Strategy: Invest In “Advantaged” Capacity

North America, Middle East and China are making new capacity investments driven by low-cost feedstock positions.
Investment Drivers Vary By Region

- **North America (USA)**
  - Low-cost energy and feedstocks from shale oil & gas drive new investments
  - Stagnant domestic growth shifts focus to higher exports
  - Sustained low-cost position should stimulate domestic demand

- **Middle East (Saudi Arabia)**
  - Moderated investment pace, diversified feedslate
  - Downstream market development

- **North East Asia (China)**
  - Strong domestic investment focused on reducing import dependencies as domestic demand evolves
## Impact of shale gas on North America downstream chemical value chains

<table>
<thead>
<tr>
<th>Value Chains</th>
<th>Main Products</th>
<th>Investment 2000-2010 (Kta)</th>
<th>Investment 2010-2020 (Kta)</th>
<th>Downstream Derivatives</th>
<th>Quartile on Cost Competitiveness</th>
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<tbody>
<tr>
<td>C1</td>
<td>Methanol</td>
<td>-6,300</td>
<td>+17,200</td>
<td>Formaldehyde, Acetic Acid, VAM</td>
<td>Q1-Q2</td>
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<tr>
<td></td>
<td>Ammonia</td>
<td>-7,000</td>
<td>+9,700</td>
<td>Urea, Nitric Acid, Fertilizers</td>
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<tr>
<td>C2</td>
<td>Ethylene</td>
<td>+0.3</td>
<td>+13,800</td>
<td>PE</td>
<td>Q1-Q2</td>
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<tr>
<td>C3</td>
<td>Propylene</td>
<td>+1,831</td>
<td>+4,788</td>
<td>EO/EG</td>
<td>Q1-Q2</td>
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<td>C4</td>
<td>Butadiene</td>
<td>.91</td>
<td>+.32</td>
<td>PVC</td>
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<tr>
<td>C6-C9</td>
<td>Aromatics</td>
<td>Declining</td>
<td>Declining</td>
<td>PP</td>
<td>Q1-Q2</td>
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<td>Oxo Alcohols, Acrylics, PO, ACN</td>
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<td>Rubber, Dispersions</td>
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<td>Oxo Alcohols, Plasticizers</td>
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<td>B: cumene; ethylbenzene</td>
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<td>MX: PX; MX; OX</td>
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</tbody>
</table>
A Wave of Investment in China Seeking to Reduce Dependency on Imports

Capital Expenditure, Billion US Dollar

- C2 Cracker
- MEG
- MTO
- CTO/CTP
- PDH
- CTMEG

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Kingdom of Saudi Arabia Chemical Landscape Continues to Evolve

Emerging KSA Portfolio

### HISTORICAL

<table>
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<tr>
<th>Different Commodities</th>
<th>Commodities</th>
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<tbody>
<tr>
<td>Polyethylene</td>
<td>Ethylene Glycol</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>Styrene</td>
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<td>Polystyrene</td>
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### NEW

<table>
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<tr>
<th>Performance Polymers</th>
<th>Specialty Chemicals</th>
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<tr>
<td>ABS</td>
<td>MDI/TDI</td>
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<tr>
<td>Synthetic Rubber</td>
<td>Polyols</td>
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<tr>
<td>Polycarbonate</td>
<td>EO/PO</td>
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<tr>
<td>Polycetal Resins</td>
<td>Amines</td>
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<tr>
<td>Nylon 6</td>
<td>Glycol Ethers</td>
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<tr>
<td>C8 PE/Elastomers</td>
<td>Acrylate Monomers</td>
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<td>Epichlorohydrin</td>
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</tbody>
</table>

Source: Saudi Aramco
Trade Patterns Will Continue To Emerge

- Investment in low-cost regions will push trade volumes higher
- Logistics investments increasing to meet future demand
- Finished goods trade patterns are also shifting
2020 Exports & Total Trade
Basic Chemicals & Plastics

- Trade will continue to grow, connecting resource-rich geographies with high growth markets.
- Supply-chain expertise and well crafted go-to-market strategies will increase in importance.
- Intensifying pressure on high-cost producers servicing markets targeted by advantaged capacity.

% 2020 Production Exported

<table>
<thead>
<tr>
<th>Year</th>
<th>MEG</th>
<th>Methanol</th>
<th>Polyethylene</th>
<th>Xylenes</th>
<th>Styrene</th>
<th>Polystyrene</th>
<th>Polypropylene</th>
<th>Vinyls</th>
<th>PET</th>
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<td>00</td>
<td>60%</td>
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<tr>
<td>05</td>
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<td>10</td>
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<td>15</td>
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<tr>
<td>20</td>
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<tr>
<td>25</td>
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Supply Chain Intensity (SCI) Drives Future Decisions for Manufacturing

Off-shoring
Shift to low-cost locale distant from end market

Near-shoring
Shift to medium-cost locale co-regional or proximate to end market

On(re)-shoring
Return local supply & services to the domestic market

Low SCI
Small Impact of Delays
Low Shipping Cost vs. Value
High Labor Input
Quality Insensitive

Apparel – Glycol, Polyester, Nylon
Footwear - PU, EVA, SBS
Furniture – PU, (Outdoor - PP, HDPE)
Appliances – PP, ABS, Nylon, PU, PS, PC
Electronics – ABS, PC, PBT, POM, Nylon
Autos & Assemblies – PP, PU, PBR, Nylon, PC, ABS
Aerospace – Carbon Fiber, Epoxy, PEEK

High SCI
Complex
Rapid Life-cycle
High Shipping Cost vs Value
Quality Imperative
Strategic Trends

Key Takeaways

• Strategic Trends

  – **Demand growth trends** slightly above GDP for ethylene and propylene; methanol strong growth is driven by use as light olefin feedstock and use in fuel applications.
  
  – **Investments in ethylene, propylene and methanol**; will accelerate near term, driven by “supply-push” dynamics as U.S., China, and Middle East leverage competitive feedstock positions.
  
  – **Derivative trade** continues to grow, as low-cost centers supply high-demand growth regions.
  
  – **Downstream manufacturing** expected to grow in North America for products with a high “supply-chain intensity”, enabled by sustained low energy and renewed chemicals investments.
Energy at the Extremes
Extreme Energy Differentials Create Opportunities & Risks

Crude oil & US Feedstock Prices

Constant 2012 Dollars Per MMBtu

20 15 10 5 0 2000 2005 2010 2015 2020

WTI Crude
Brent Crude
USGC Light Naphtha
Butane
Propane

Henry Hub Gas

Ethane

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Global Profit on the Upswing; Down-Cycle Muted for Advantaged Regions

Basic Chemicals & Plastics EBIT Comparison

- Global Average
- West Europe
- Asia
- North America

85 88 91 94 97 00 03 06 09 12 15 18

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## Ethylene Capacity Additions


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<td>ChevronPhillips</td>
<td>Cedar Bayou, TX</td>
<td></td>
<td>150</td>
<td>1350</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,500</td>
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<tr>
<td>Dow</td>
<td>Freeport, and Plaquamine</td>
<td>220</td>
<td>600</td>
<td>900</td>
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<td>1,720</td>
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<td>Equistar</td>
<td>All Locations</td>
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<td>ExxonMobil</td>
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<td></td>
<td>750</td>
<td>750</td>
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<tr>
<td>FHR</td>
<td>PT Arthur</td>
<td>100</td>
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<td>Formosa</td>
<td>Point Comfort, TX</td>
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<td>Oxy/Mexichem</td>
<td>Ingleside, TX</td>
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<td>413</td>
<td>137</td>
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<td>Sasol</td>
<td>Lake Charles, LA</td>
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<td>387</td>
<td>1163</td>
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<td>Westlake</td>
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<td>94</td>
<td>122</td>
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<td>Williams</td>
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<td>750</td>
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<td>Braskem Idesa</td>
<td>Mexico</td>
<td>250</td>
<td>750</td>
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<tr>
<td>Nova</td>
<td>Sarnia</td>
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<td>168</td>
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<td>168</td>
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<td>795</td>
<td>935</td>
<td>1,113</td>
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<td>4,537</td>
<td>3,076</td>
<td>887</td>
<td>12,261</td>
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Energy and Hydrocarbon Feedstock Costs: Key Drivers in Chemicals Manufacturing

- Propylene
- Ethylene
- Butadiene
- Mixed Butylenes
- Methane/Hydrogen
- Benzene
- Toluene
- Xylene
- Naphtha
- Gas Oil
- Propane
- Ethane
- Butane
- Condensate
- Pygas
- Benzene Toluene/Xylene
- Heavy Aromatics
- C5/C6 Non Aromatics
- Methane/Hydrogen
- Butadiene
- Mixed Butylenes
- Propylene
- Ethylene
- Fuel Oil
- Methanol Synthesis
- Methanol
Energy

Key Takeaways

- **Energy at the Extremes**
  - *A sustained advantaged for NAM* natural gas and China coal versus crude oil will attract investment and shift the balance of capital investment and product trade.
  - Crude oil priced near $100/bbl, and NAM natural gas prices near $5/MMBtu, seems to be viable for a long period of time given supply/demand dynamics within these respective markets.
  - **Chemical industry profitability** greatly influenced by value-chain and regional availability and access to low-cost energy and feedstocks. Significant pressure builds on “crude-based” technologies and regions.
  - *On-purpose technology* justified to fill supply gaps created by energy market dynamics; supply constraint and margins resulting from divergence in energy.