Global Petrochemical Market Outlook:
Will Expansion Activity in North America Continue?

Presented to:

VMA MARKET OUTLOOK WORKSHOP
OMNI Parker House, Boston, MA

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- Coal
- Power and Renewables
- Regional Gas, Power and Coal Markets

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- Climate Strategy
- Curated Content
- Integrated Energy Events & CERAWeek
CHEMICALS ENABLE MODERN LIVING

**Chemical industry value chain**

- **Natural resources**
  - Oil
  - Gas
  - Coal
  - Minerals
  - Renewables

- **Base chemicals**
  - Olefins
  - Aromatics
  - Chlor-alkali
  - Syn-gas
  - Ag-chems

- **Chemical intermediates**
  - Commodities
  - Differentiated commodities
  - Technical specialties

- **Formulated products / performance materials**
  - Polymers & plastics
  - Engineering resins
  - Synthetic fibers
  - Paints and coatings
  - Adhesives/sealants
  - Water treatment
  - Flame retardants...

**Customers**

- Transportation
- Consumer products
- Packaging
- Construction
- Recreation
- Industrial
- Medical
- Pharmaceutical
- Personal care
- Textiles
- Electronics
- Aerospace
- Business equipment
Petrochemical Market Outlook

As global demand grows, North America will continue to attract new investments

- Energy markets will see natural gas in North America significantly advantaged versus crude oil
- Global economy will grow at 2.5-3.0% leading to annual demand growth of:
  - Ethylene ~ 5.5 to 6 million tons
  - Propylene ~ 4 to 4.5 million tons
  - Methanol ~ 3.5 to 4 million tons
- North America will remain an attractive region for base chemical and derivatives capital investments
- Investments continue in China and Middle East at a more moderate pace
Energy fundamentals impact chemical industry investment decisions, short term demand growth

- **Energy trends** impact regional competitiveness, industry profitability, and ultimately drive investment decisions in the global petrochemical industry

- Advantaged investments in North America, Middle East and China see **lower margins in low crude oil** market

- IHS Markit Vice Chairman Daniel Yergin observes that there are two major forces currently operating on the **global oil market**, *rebalancing and recalibration*.

- The **North American natural gas** market is becoming more **integrated, complex, and globally connected**, subject to demand uncertainties in a currently oversupplied world market.

- **Crude oil (energy) “at the extremes”** impacts demand for chemicals and plastics. At the extremes, energy trends will both destroy and stimulate demand
Combination of high crude prices and stable gas is attractive for North America chemical investments, based on natural gas and natural gas liquids.

Global crude oil vs. USGC natural gas

- USGC Natural Gas
- Brent Crude

Source: IHS Markit
Demand growth for chemicals & plastics directly linked to global economic growth

• Basic chemicals and plastics represent the key building blocks for durable and non-durable consumer goods
• Multiple years of positive economic growth results in acceleration of base chemical demand growth
• Aligning capacity additions with demand growth is the balance producers are seeking
• Economic contractions/stimulus causing supply-chains to respond rapidly (inventor de-stock / re-stock).
Economic growth in advanced countries and emerging markets are key drivers to petrochemical demand

### Real GDP, Annual % Change

<table>
<thead>
<tr>
<th>Year</th>
<th>World</th>
<th>Advanced countries</th>
<th>Emerging markets</th>
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<td>2014</td>
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</tr>
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<td>2016</td>
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<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
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### Annual % Change in GDP

<table>
<thead>
<tr>
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<tr>
<td>World</td>
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<td>2.8</td>
<td>2.5</td>
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<td>1.6</td>
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<td>2.3</td>
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<tr>
<td>Canada</td>
<td>2.6</td>
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<td>1.4</td>
<td>2.7</td>
<td>2.3</td>
<td>2.3</td>
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<td>1.9</td>
<td>1.7</td>
<td>2.0</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>UK</td>
<td>3.1</td>
<td>2.2</td>
<td>1.8</td>
<td>1.4</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>China</td>
<td>7.3</td>
<td>6.9</td>
<td>6.7</td>
<td>6.6</td>
<td>6.3</td>
<td>6.1</td>
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<tr>
<td>Japan</td>
<td>0.2</td>
<td>1.2</td>
<td>1.0</td>
<td>1.3</td>
<td>1.0</td>
<td>0.7</td>
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<tr>
<td>India</td>
<td>6.9</td>
<td>7.7</td>
<td>7.0</td>
<td>7.3</td>
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<td>-3.6</td>
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<td>1.7</td>
<td>3.5</td>
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<td>Russia</td>
<td>0.8</td>
<td>-2.8</td>
<td>-0.2</td>
<td>1.5</td>
<td>2.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2017 IHS Markit
Chemical demand growth (vs GDP) has been decelerating over time; forecast to continue

### Average global GDP elasticity, by market & time period

- **1990-1999**: Ethylene, Benzene
- **2000-2007**: Propylene, Chlorine
- **2011-2016**: Methanol
- **2017-2025**: Paraxylene

**Source**: IHS Markit
Ethylene and propylene continue pattern of accelerating demand growth / strong capacity growth is needed

Demand growth: past / present / forecast (million metric tons)

Source: IHS Markit

Nameplate capacity growth: past / present / forecast (million metric tons)

Source: IHS Markit
Growth in base chemicals dominated by ethylene, propylene and methanol; new capacity dominated by APAC

Source: IHS Markit
Other unknowns impact strategic investment decisions

- Energy risk in an OPEC / shale regime
- Demand risk given China’s economic and industrial pivot
- Unpredictable capital and project EPC performance
- Climate policy post Paris Accords
- Disruptive technologies (e.g. Siluria)
- Country risk with geo-political unrest
- Market access risk under protectionist backlash
Capital investments in chemicals are seeking a sustainable competitive advantage

Chemical Investment “Drivers”

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

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

Photo courtesy of Braskem IDESA
Beyond energy and economic growth, there are many other factors to consider:

**Additional Investment Considerations:**

- Crude oil/energy price trends
- Global economic growth
- Geo-political considerations
- Govt. fiscal policy / currency strength
- Global energy markets
- State of industry profit cycle
- China structural changes
- Non-conventional technology
- Sustainability
- Levels of integration
- Regional CAPEX differentials
- Logistics investments
- Evolving Consumer Products
470 MM metric tons of production in 2016

What are the best locations for future investments?
Market uncertainty results in slowdown in new capacity additions; 2019 forecast to decline to 2012 levels
Driven by a number of major initiatives, China investment in base chemicals has accelerated since 2000 and will continue into the 2020’s

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

**Total base chemical capacity for select countries**

- United States
- Canada
- Mexico
- Saudi Arabia
- Iran
- South Korea
- Singapore
- India
- China

Source: IHS Markit

Base Chemical Capacity = ethylene, propylene, methanol, benzene, paraxylene, chlorine
Beyond China and the United States, since the early 90’s some countries have continued to invest in base chemicals while others have seen investments stall

- Saudi Arabia, Iran; leveraging low cost hydrocarbons to drive industrial development
- S.Korea, Singapore, India are driven by strong demand growth in APAC
- Mexico and Canada linked to strong demand via NAFTA, but limited by energy developments
Market uncertainty causing delayed project approvals, results in falling capital spending across global chemical markets by early 2020's.
Ammonia, along with ethylene, propylene (and related derivatives) make up the vast majority of new capital spending in the next wave of investments.
North America Low Cost Brings Back Base Chemical & Associated Derivative Investments

North America - Base Chemical Total Capacity

Source: IHS Markit

© 2017 IHS Markit
North America ethylene capacity growth including firm and announced projects

### Firm Projects: 2017 - 2022

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Timing</th>
<th>Total Growth -000- metric tons</th>
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</thead>
<tbody>
<tr>
<td>Dow</td>
<td>Plaquemine, LA</td>
<td>1H-17</td>
<td>250</td>
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<tr>
<td>Equistar</td>
<td>Corpus Christi, TX</td>
<td>1H-17</td>
<td>401</td>
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<tr>
<td>Oxy/Mexichem</td>
<td>Ingleside, TX</td>
<td>1H-17</td>
<td>550</td>
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<tr>
<td>ChevronPhillips</td>
<td>Cedar Bayou, TX</td>
<td>2H-17</td>
<td>1,500</td>
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<tr>
<td>Dow</td>
<td>Freeport, TX</td>
<td>2H-17</td>
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</tr>
<tr>
<td>ExxonMobil</td>
<td>Baytown, TX</td>
<td>1H-18</td>
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<tr>
<td>Indorama</td>
<td>Lake Charles, LA</td>
<td>2H-18</td>
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<tr>
<td>Formosa</td>
<td>Point Comfort, TX</td>
<td>2H-18</td>
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<tr>
<td>Shin-Etsu</td>
<td>Plaquemine, LA</td>
<td>1H-19</td>
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<td>Sasol</td>
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<td>LACC</td>
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<td>Shell</td>
<td>Monaca, PA</td>
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<td><strong>Total additions</strong></td>
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### Announced Projects: 2022+

<table>
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<tr>
<th>Company</th>
<th>Location</th>
<th>Total Growth -000- metric tons</th>
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</thead>
<tbody>
<tr>
<td>Ascent / Braskem</td>
<td>West Virginia</td>
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<tr>
<td>Badlands NGL 1</td>
<td>North Dakota</td>
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<tr>
<td>Badlands NGL 2</td>
<td>“Shangri-La”</td>
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<td>ChevronPhillips 2</td>
<td>Cedar Bayou, TX</td>
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<tr>
<td>Formosa</td>
<td>St James Parish, LA</td>
<td>1,000</td>
</tr>
<tr>
<td>Formosa</td>
<td>LA</td>
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<tr>
<td>Hanwha</td>
<td>TBA</td>
<td>1,000</td>
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<tr>
<td>Indorama</td>
<td>LA or TX</td>
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<tr>
<td>PTTCG/Marubeni</td>
<td>Shadyside, OH</td>
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<tr>
<td><strong>Total additions</strong></td>
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<td><strong>10,500</strong></td>
</tr>
</tbody>
</table>
Chemical industry earnings forecasts to decline with new waves of capacity in the near term; Chlor-alkali market showing good recovery by 2020

Global Cash Earnings Trends by Chemical Value-Chain

Source: IHS Markit © 2017 IHS Markit
Lower earnings in Americas and Middle East are offset by stronger earnings in Asia and Europe where new capacity discussions are also underway.
Final Thoughts As You Plan Your Next Move In The Chemical Sector

- Energy markets will see natural gas in North America advantaged versus crude oil (BTU basis)
- Two major forces in the global oil market, rebalancing and (cost) recalibration will play out in the near term
- Global economic fundamentals remain solid; uncertainty indicators have declined; US is strong; Europe is brighter; China remains resilient.
- Capital spending slowdown will create tight market conditions in olefins and chlor-alkali by end of the decade
- North America will remain an attractive region for petrochemical and related investments; investors to include both domestic and foreign companies
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