Petrochemicals Outlook: *Markets in Transition*

Paige Marie Morse
December 2017
Markets in Transition: 2018 Outlook

**Feedstocks:** Fundamental changes in cost and selection
- New sources and improving logistics

**Development:** Regional dynamics are a major factor
- Existing asset base must adapt

**Transition:** Dynamics in opposite directions
- Major petrochemicals not moving together
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Global and specialist local markets, offering exclusive prices and insight.

**Natural Gas/LNG**
Daily price info for international natural gas and LNG markets as well as analytical reports and fundamental data.

**LPG/NGL**
Assesses international LPG prices each day, including the key European indexes and benchmarks.

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Argus reports on international biofuel and biomass markets.

**Metals**
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- Governments
- International Agencies
- Trading Houses

We focus on not only providing the most accurate market data in the price reporting industry, but have passion for proving the best user experience for our customers as well.

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Argus continues to invest and grow

<table>
<thead>
<tr>
<th>Employees by region</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americas</td>
<td>193</td>
<td>225</td>
</tr>
<tr>
<td>Europe</td>
<td>305</td>
<td>364</td>
</tr>
<tr>
<td>CIS</td>
<td>113</td>
<td>118</td>
</tr>
<tr>
<td>Asia</td>
<td>119</td>
<td>136</td>
</tr>
<tr>
<td>Total</td>
<td>730</td>
<td>843</td>
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<table>
<thead>
<tr>
<th>Employees by function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Editorial</td>
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<tr>
<td>Marketing</td>
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<tr>
<td>Technology</td>
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<tr>
<td>Consulting</td>
</tr>
<tr>
<td>Product Development</td>
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<tr>
<td>Sales</td>
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<tr>
<td>Conferences</td>
</tr>
<tr>
<td>Bus Development</td>
</tr>
<tr>
<td>Corporate Services</td>
</tr>
</tbody>
</table>

# of employees: 843
# of journalist employees: 384

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Argus Petrochemical Services

- Full range of international petrochemical services, including key derivatives.
- A quality one stop shop for pricing, consulting and analysis thru the entire energy space.
- Mitigate risk with an in-depth understanding of current market and have confidence in the decisions made using our analysis.

Benzene
Methanol
Ethylene

Toluene and Xylenes
Chlor-alkali
Propylene

Fuels and Octane
C5 and Hydrocarbon Resins
Butadiene
Polymers

illuminating the markets

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Energy price evolution

**USGC - Monthly energy prices**

(barrel of oil equivalent), $/bl

- Natural gas
- Crude oil

[Graph showing monthly energy prices for natural gas and crude oil from January 2000 to January 2017.]
Shifting feedstock relationships

**USGC - Monthly LPG and related market prices**

(barrel of oil equivalent), $/bl
Propane has been getting cheaper vs Naphtha

- Propane/Naphtha ratio has dropped as NGL availability has grown in US
- LPG needed economic incentive to find outlet in petrochemicals

Argus Consulting
The Petrochemical Value Chain

Feedstock
- Crude Oil
- Natural Gas
  - Condensate
  - Butanes
  - Propane
  - Ethane
  - Methane
  - Steam Cracking

Primary Petrochemicals
- Naphtha
  - Aromatics
    - Xylene
    - Toluene
    - Benzene
  - Pygas
  - Olefins
    - Ethylene
    - Propylene
    - Butadiene
    - C5’s

Derivatives
- Synthetic Rubber
- Adhesives
- Polyethylene
- Polystyrene
- Polypropylene
- Methanol
- Ammonia

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Product Mix varies with Cracker Feedstock

Shift towards Ethane has critical impact on supply of other petrochemicals

Split of co-products per feedstock type for every ton of ethylene produced
— Argus Consulting
Global olefins prices

World ethylene prices

$/t

World PG propylene prices

$/t

illuminating the markets

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Europe moving to lighter feedslate

- Naphtha remains dominant feedstock for steam crackers
- Ethane investments yet to be fully realized

Source: Argus LPG Analytics
US Ethane exports: Wide-ranging destinations

There are 21 coastal naphtha crackers in Europe. If all converted 25 pc of their capacity to ethane, could consume 180 KBD of ethane

Exxon/Shell
Max 50 KBD

Ineos: 20 KBD;
Max 40 KBD

Ineos: 20 KBPD;
Max 40 KBPD

Rafnes

Mossmorran, UK
Grangemouth, UK
Wilton, UK

Borealis: 16 KBPD
Max 46 KBPD

Sunoco Logistics
50 KBPD
Early 2016

Marcus Hook, PA

Nova
Max 50 KBD
30 KBPD

Red Deer, Canada

Sarnia, Canada

Jamnagar, India
Reliance
75 KBPD 2017

Morgan’s Point, TX

Enterprise Export
200 KBPD capacity
90 pc contracted
On stream Q3 2016
US Propane exports: Changing market dynamic

US propane stocks and exports

Source: Argus LPG World

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LPG prices higher than expected in 2017

US Gulf coast NGL prices  

- Strong petrochemical demand from Asia
- Exports have created tighter local market
- Improved logistics may allow for lower inventory needs

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Global ethylene capacity growth

- **North America**: NGL driven
- **Western Europe**: Central and Eastern Europe
- **Africa and Middle East**: Slowing growth
- **Latin America**: NGL driven
- **Northeast Asia**: Coal driven
- **Southeast Asia**: -5,000 to 0

+15mn t 2011-2016
+36mn t 2016-2021

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US steam cracker capacity growth

- Cost advantage drives expansion in Ethylene, and Polyethylene

<table>
<thead>
<tr>
<th>Company</th>
<th>Site</th>
<th>New of Expansion Capacity ('000t)</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxychem/Mexichem</td>
<td>Ingleside, TX</td>
<td>500</td>
<td>Q1 2017</td>
</tr>
<tr>
<td>Westlake Chemical</td>
<td>Calvert City, KY</td>
<td>70</td>
<td>Q2 2017</td>
</tr>
<tr>
<td>LyondellBasell</td>
<td>Corpus Christi, TX</td>
<td>363</td>
<td>Q3 2017</td>
</tr>
<tr>
<td>Dow</td>
<td>Freeport, TX</td>
<td>1,500</td>
<td>Q3 2017</td>
</tr>
<tr>
<td>Chevron Phillips</td>
<td>Old Ocean, TX</td>
<td>1,500</td>
<td>Q1 2018</td>
</tr>
<tr>
<td>Chemical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExxonMobil</td>
<td>Baytown, TX</td>
<td>1,500</td>
<td>Q2 2018</td>
</tr>
<tr>
<td>Indorama</td>
<td>Lake Charles, LA</td>
<td>370</td>
<td>Q1 2018</td>
</tr>
<tr>
<td>Formosa Plastics</td>
<td>Point Comfort, TX</td>
<td>1,200</td>
<td>Q4 2018</td>
</tr>
<tr>
<td>Shintech</td>
<td>Plaquemine, LA</td>
<td>500</td>
<td>Q1 2019</td>
</tr>
<tr>
<td>Sasol</td>
<td>Lake Charles, LA</td>
<td>1,500</td>
<td>Q3 2019</td>
</tr>
<tr>
<td>Westlake/Lotte</td>
<td>Lake Charles, LA</td>
<td>1,000</td>
<td>Q3 2019</td>
</tr>
<tr>
<td>Total Petrochemicals</td>
<td>Port Arthur, TX</td>
<td>1,000</td>
<td>Q1 2021</td>
</tr>
<tr>
<td>Shell Chemical</td>
<td>Monaca, PA</td>
<td>1,600</td>
<td>Q3 2021</td>
</tr>
</tbody>
</table>

| Total supply additions | 12,603              | 2017-2021                       |
Most Expansion in China

- Improved margins boost capacity expansions
- Asian expansions 5mn t/yr 2017 and 3mn t/yr 2018-20
- China leads adding new CTO/MTO and steam crackers

*Prorated annual capacities presented*
• Most additions in high demand region (Asia)
• Also driven by feedstock advantage: coal in Asia; propane in NA
Propylene production by region – 2016 and 2021

- China favors on-purpose production as demand grows faster than coproduct routes
- US continues to rely on refineries, with growing PDH

On-purpose includes: Propane dehydrogenation (PDH), Coal-to-Olefins (CTO), Methanol-to-Olefins (MTO), and metathesis

Source: Argus 2017 Propylene Annual
On-purpose capacity by region in 2017

- On-purpose capacity grew fastest in past five years
- PDH capacity grew 24pc in past five years... Slowing to 11pc
- PDH now accounts for 15pc of Chinese capacity

Total Capacity: 26.3 mn t

— Argus Consulting
Chinese PDH operations

- 12 units operating since first in 2013
- Operations stabilizing before recent inspections
- Outages can create significant price volatility

Source: Argus Propylene and Derivatives
## PDH units: North American projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Capacity ('000 t/y)</th>
<th>Technology</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flint Hills Resources</td>
<td>Houston, TX</td>
<td>650</td>
<td>Lummus</td>
<td>Operating since 2010</td>
</tr>
<tr>
<td>Dow</td>
<td>Freeport, TX</td>
<td>750</td>
<td>UOP Oleflex</td>
<td>Operating Dec15</td>
</tr>
<tr>
<td>Enterprise</td>
<td>Mont Belvieu, TX</td>
<td>750</td>
<td>Lummus</td>
<td>start-up Fall 2017</td>
</tr>
<tr>
<td>Inter Pipeline</td>
<td>Alberta, Canada</td>
<td>2 x 500</td>
<td>UOP Oleflex</td>
<td>2021; + 500 PP</td>
</tr>
<tr>
<td>Pembina/PIC</td>
<td>Alberta, Canada</td>
<td>550</td>
<td>UOP Oleflex</td>
<td>2021; + 550 PP</td>
</tr>
<tr>
<td>Formosa Plastics</td>
<td>Point Comfort, TX</td>
<td>550</td>
<td>Uhde STAR</td>
<td>Unlikely before 2022</td>
</tr>
<tr>
<td>Rextac</td>
<td>Odessa, TX</td>
<td>NA</td>
<td>TBA</td>
<td>cancelled</td>
</tr>
<tr>
<td>C3 Petrochemicals</td>
<td>Chocolate Bayou, TX</td>
<td>2 x 500</td>
<td>UOP Oleflex</td>
<td>suspended</td>
</tr>
<tr>
<td>Sunoco Logistics</td>
<td>Pennsylvania</td>
<td>NA</td>
<td>TBA</td>
<td>Under evaluation</td>
</tr>
<tr>
<td>Dow</td>
<td>TBA</td>
<td>NA</td>
<td>TBA</td>
<td>Under evaluation</td>
</tr>
<tr>
<td>Lyondell</td>
<td>USGC</td>
<td>Up to 1mn t</td>
<td>TBA</td>
<td>PO planned; Possible PP</td>
</tr>
</tbody>
</table>
CTO units: Complex process

- Utilize domestic feedstock, but demanding multi-step process
  - Proceeds through syn gas, methanol intermediate, mixed products
- Most integrated to polymer for ease of shipment to market
- New environmental requirements may delay planned units

Source: Argus China Petroleum
Signposts: Emerging disruptions

• Growing feedstock trade helps to share competitiveness . . . enabling petrochemicals growth in many regions

• CTO developments important in China . . . but environmental concerns may impact growth

• Europe has been more resilient than expected . . . but Ethylene/PE deluge will be significant test

• Cost metrics are shifting with supply sources . . . challenging previous metrics for regional pricing
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