Polypropylene Industry Briefing

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A Global Advisor to the Energy & Chemicals Industry with Proven Track Record

Our People
- Over 150 consultants worldwide in Energy & Chemicals Advisory
- Expertise covering strategic, commercial, operational and technical aspects with deep energy and chemicals sector knowledge
- Nexant’s consultants are typically Chemical Engineers, Economists and MBA graduates who have significant prior experience working at energy & chemical producers

Proven Track Record
- Advising clients in the energy & chemicals industry for 50 years
- Completed over 2,000 client assignments including market assessments, technology evaluations, valuations / appraisals and due diligence

Global Footprint
- Strong international presence provides valuable insights through our consultants’ local market knowledge and our vast network of sector specialists

HMC's Customer Seminar
Nexant’s consulting services cover the entire energy value chain

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<td>– Wind</td>
<td>Other syngas derivatives</td>
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<td>– Clean Coal</td>
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GAS | BASE PETROCHEMICALS & POLYMERS |

Petroleum Refining | Olefins |
| Storage & Distribution | Aromatics |
| Biofuels | Polyolefins |
| Oxygenates | Vinils |
| Coal to Liquids | Styrenics |
| Gas to Liquids | Polyessters |
| Base Oils | Polyamides |
| Lubricants | Acrylates |

DOWNSTREAM OIL | INTERMEDIATE & SPECIALITY CHEMICALS |

Ammonia | Surfactants |
| Urea | Oleochemicals |
| Melamine | Engineering & Speciality Polymers |
| Ammonium Nitrates | Coatings, Adhesives, Sealants & Elastomers (CASE) |
| Phosphate & NPK Fertilizers | Polyurethanes |
| Methanol | Resins |
| Formaldehyde | Biochemicals |
| Acetyls | Speciality & Fine Chemicals |
Agenda

Petrochemicals recent performance
Investment Landscape
South East Developments
What a difference a year makes

Brent Crude Oil Price Decline, mth average

Source: Nexant
What does low oil mean for the petrochemicals sector?

**Brent Crude Oil Prices – US$/bbl**

**Issues for Global Chemicals:**

- Investment slowdown in Middle East and in other geographies. Partly associated with Middle East sponsors.
- Shifts in industry competitiveness. Naphtha cracking has become more competitive.
- Feedstock alternatives have become less attractive e.g. coal, bio etc.
- Pricing correction across the value chain due to falling cost base. However margins have improved for some products
- Demand upside for some geographies – increased disposable income?
Shale gas advantage has been eroded as naphtha cracking competitiveness improves with lower oil prices.

Petrochemicals Return on Capital Employed Index

- Sharp decline in crude oil
- Shale gas advantage
- Economic crisis
- Chemicals up-cycle

- ROCE - Naphtha
- ROCE - US Shale
- Brent oil price

Index (1984 Q1=100) vs Brent oil price ($/bbl)
Demand growth for polyolefins has varied over time yet the trend remains link to economic growth

Polymer consumption growth is driven by economic growth, or in more developed countries, by industrial production indices and consumer trends.

Estimated global PP demand CAGRs for 2000-2015 / 2015-2020 are 4.6% and 4.4% percent respectively.

Estimated global GDP growth for 2000-2015 / 2015-2020 is 2.9% / 3.2%.

Short-term global GDP forecasts (through 2020) have recently been reduced by almost 0.5% due to ongoing low oil prices, uncertainty about China, and other economic factors.
China is by far the largest polyolefins market and the gap is continuing to widen

Polyolefins per Capita Consumption, 2000-2020

Polymer demand is driven by industrial production and consumer trends, varying by country maturity
Investment Landscape
A number of new petrochemical projects are expected to be delayed due to the impact of low oil prices

Regional Petrochemical Feedstock Sources and Trends

US Shale Reserves
- Increased oil & gas production, resulting in lower energy prices.
- Increased production of co-produced ethane and other NGLs.
- Improved competitive position, resulting in reinvestment in commodity products.

China Coal Reserves
- Increase focus on coal to chemicals and PDH (via propane imports).
- Investment in new refinery capacity with a focus on refinery/petchem integration.
- Variable competitive position depending on feedstock. Access to markets is key.

Middle East Oil and Gas Reserves
- Further utilisation of ethane and other available NGLs.
- Investment in new refinery with a focus on refinery/petchem integration.
- Declining competitive position off-set by mixed feeds, integration scale, and higher value products.
CTO/MTO and PDH processes are increasingly becoming important sources of incremental global propylene supply. This trend has been due to higher growth in propylene demand than refinery and cracker investments, and also prompted by trends towards using a lighter feedstock slate for global ethylene production.

Globally, incremental propylene capacity from cracker and refinery developments is forecast to remain insufficient to balance propylene demand growth.

Firm CTO projects are limited to China and supported by the local availability of low-cost mine-mouth coal.

PDH investments are taking place in North America, Middle East and Asia. Propane exports from the US and the Middle East are also supporting PDH projects in Asia.
New refinery investments heavily concentrated in China and India

Global Refinery Capacity Changes 2014-2017

Bubble size – scale of total capacity additions
More than 20 CTO/MTO projects are under various stages of development in China

CTO/CTP Operating Plants in China

- First phase CTO project concentrated in the western regions exploiting lower cost coal reserves.
- East coast developments are focused on methanol imports for new MTO projects.
- Higher cost projects may not succeed.

CTO/CTP Capacity

- 2012
- 2013
- 2014
- 2015
- 2016

Ethylene
Propylene
PP additions highly concentrated in China, strong emphasis around new refinery and on-purpose propylene

Regional Polypropylene Incremental Capacity Additions (million tons)

Over the next five years, polypropylene capacity will increase by almost 20 million tons
Global polypropylene demand was estimated at 60 million tons in 2015, following growth of 4.4% from 2014.

Global Polypropylene Demand by End Use, 2015-e
(Global demand 60 million tons)

- Injection Moulding: 39%
- Fibre: 29%
- Film: 19%
- Others: 5%
- Other Extrusion: 8%

Regional Polypropylene Demand, 2015-e
(Global demand 60 million tons)

- Asia (ex China): 23%
- China: 33%
- Middle East: 7%
- Africa: 3%
- Western Europe: 12%
- South America: 5%
- CEE: 5%
- North America: 12%

Film applications are expected to have the highest growth rate, but almost all applications are forecast to have good growth.
Polypropylene volume growth set to remain highly dependent on China

Incremental PP Consumption Growth, million tons

Global Polypropylene Demand and capacity, million tons
The Middle East will continue to be the dominant export region, while China will remain the largest importer.

- With its low-cost production base, the Middle East is the dominant net export region, and this is not expected to change.

- North America, Western Europe, and Asia (ex China) are also net exporters:
  - Despite its low-cost propane position and large additions of PDH capacity, very little polypropylene capacity has been announced in North America.

- Despite large capacity additions, China continues to be the largest net importer, although this position will decline slightly.
South (East) Asia Developments
Economically, South East Asian is a major market with half a billion people registering U$2.4 trillion GDP in 2014

GDP of six major countries, 2014
(Total GDP 2.4 trillion dollars)

Population of six major countries, 2014
(Total Population 560 million people)
Although in relative term, not as big as China – the GDP is 5 times smaller, half slower growth and half GDP per capita consumption

The region’s fragmented market is illustrated by the highly varied GDP per capita

- Singapore is 5 times per capita larger than Malaysia (second largest per capita market) and Malaysia is 5 times larger than Vietnam (the smallest market in the analysis).
For the past decade, SEA PP markets have grown about as fast as GDP.

**SEA Polypropylene Demand and Economic Growth**

*Polypropylene growth ~ 1.1 – 1.2 times GDP growth on average*
High growth opportunities still exist in specific markets

Asia Polypropylene Demand Growth

- Consumption growth in polymers is associated with the substitution of traditional materials, infrastructure development and population demographics (income, urbanisation etc.)

Polypropylene consumption by major countries (total demand 4.4 million tons)

- Indonesia 32%
- Vietnam 21%
- Thailand 29%
- Malaysia 10%
- Philippines 7%
- Singapore 1%
Major Projects are progressing in India, however elsewhere project delays are occurring.

**Reliance Refinery & Cracker**
- Jamnagar, Gujarat
- Reliance Industries
- C2/C3: 1400/200 kta, no new PP only expansion
- Status: Under Construction, Start-up 2016

**ONGC Petro Additions Limited (OPaL)**
- Dahej, Gujarat
- ONGC, Gail, GSPC
- C2/C3: 1100/400 kta, PP 340 kta
- Status: Under Construction, Start-up 2016

**Indonesia integrated Refinery/petchem Projects**
- Balongan
- Pertamina/Partners
- C3: 500-2000 kta, derivatives not announced yet
- Status: Under Evaluation

**PETRONAS RAPID Refinery & Cracker**
- Pengerang, Malaysia
- Petronas/Partners
- C2/C3: 1300/1300 kta, PP 900 kta (Spheripol)
- Status: Planning: Start-up >2021

**South Korea**
- Hyosung 200 kta, 2017
- S-Oil 400 kta, 2018

IRPC, Thailand 140 + 160 kta (late 2017)

South Korea
- Hyosung 200 kta, 2017
- S-Oil 400 kta, 2018
Overview of major refinery/petrochemical investments in Vietnam

- **Nghi Son Refining & Petrochemical**
  - Located at Thanh Hoa Province
  - PetroVietnam/Idemitsu/Mitsui/Kuwait Petroleum
  - C3/PP: 370/370 kta
  - Status: Start-up 2017/Q4

- **Binh Son Refining & Petrochemical**
  - Located at Dung Quat economic zone
  - PetroVietnam
  - C3/PP: 150/150 kta
  - Status: Operational since 2010

- **Long Son Petrochemical**
  - Located at Ba Ria - Vung Tau
  - PetroVietnam/SCG – (QP exit 2015)
  - C2/C3: 1000/500 kta
  - Status: Start-up 2020-21

- **Vung Ro Refining & Petrochemical**
  - Located at Phu Yen Province
  - PetroVietnam/Technostar/Telloil
  - C3/PP: 900/900 kta
  - Status: Not Firm
Despite regional expansions, many markets are expected to rely on imports.

**Polypropylene Potential Market Deficits (million tons)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Demand in 2025</th>
<th>Capacity in 2020</th>
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<tbody>
<tr>
<td>Indonesia</td>
<td>1.2 mta</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.6 mta</td>
<td></td>
</tr>
<tr>
<td>Other Asia</td>
<td></td>
<td>1.3 mta</td>
</tr>
<tr>
<td>Philippines</td>
<td></td>
<td></td>
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<tr>
<td>Oceania</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>2.7 mta</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>1 mta</td>
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*May 2016*
Olefin pricing dynamics show a reversal of previous trends

Incremental Supply & Demand Changes, million tons

- **Propylene**
  - 10-15: 15, 19
  - 15-20: 23, 29

- **Ethylene**
  - 10-15: 20, 17
  - 15-20: 30, 41

Ethylene and Propylene Pricing Ratio Dynamics

- Initial price premiums on propylene reversed due to market oversupply
- Increase in merchant propylene sales reflected in quoted pricing – more liquidity versus ethylene market
- Future pricing corrections expected longer-term due to a combination of C3 cost structure, value chain integration and polymer substitution.
Olefin price trends are reflected in downstream polymer markets

**HDPE & PP Pricing Trends (US$/ton, CFR SEA)**

- HDPE
- PP
- HDPE/PP Ratio

**HDPE & PP Price Spreads (US$/ton, CFR SEA)**

- HDPE - PP spread
Summary of Polypropylene Market Developments

Demand Outlook:
Demand fundamentals are expected to remain strong in the outlook
- Global polypropylene demand was estimated at 60 million tons in 2015, an increase of 4.4% compared with 2014
- Global growth driver is Asia – China is forecast to account for 65% of Asia’s incremental demand over the next five years
  - On-going low oil prices, uncertainty about China, and other economic factors have reduced short-term global GDP forecasts and polymer demand growth forecasts

Supply Developments and Net Trade:
New capacity additions slowed in recent years, but will reach unprecedented levels in the next few years
- Total polypropylene production increased from 44 million tons to 73 million tons per year from 2005 to 2015
- Developments in the Middle East and Asia will contribute to capacity expansions up to 2020
- Global capacity additions planned for 2016 and 2017 will exceed the amount of demand growth
- Low oil prices have caused some longer term projects to be delayed or cancelled
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