"Naphtha Scenario & Petrochemicals Feedstocks - India; Outlook, Challenges and Imperatives"
Agenda

1. Petroleum Refining Scenario in India
2. Demand/Supply and Naphtha Scenario in India
3. Importance of Naphtha as Petchem feedstock in Indian Context
4. Naphtha Crackers and their Viability improvement
5. Challenges & Imperatives in Naphtha Utilisation
6. Future Scenario & Conclusions
Agenda

Petroleum Refining Scenario in India
Real GDP growth of emerging markets has slowed, holding back global growth
India – the growth engine

Strong growth at above 7%

GDP Growth, %

Source: IMF

Huge population size

in millions

Source: IMF

Young population - More than 70% are under 40

Source: Census of India 2011

Source: IMF
India: Refining capacity

Map of Refineries in India
(Capacity in MMTPA)

Capacity Share

- IOC/CPCL: 35%
- RIL: 26%
- BPC/NRL/BORL: 14%
- ONGC/MRPL: 7%
- HPC/HMEL: 10%
- ESSAR: 9%

Capacity (IOC): 69.3 MMTPA
Capacity (CPCL): 11.5 MMTPA
Group Capacity: 80.8 MMTPA
India Capacity: 230.1 MMTPA
India : Refining Capacity Growth

- As on January 1, 2016, India has a total refining capacity of 230.0 MMTPA.
- 17 out of the total 22 refineries in India belong to PSUs.

* Considering commissioning of Paradip Refinery in 2015-16
Indian Refineries: Capacity Utilization

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed Capacity, TMT</th>
<th>Crude T'put, TMT</th>
<th>Capacity Utilisation, %</th>
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<tbody>
<tr>
<td>2008-09</td>
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<td>105</td>
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<td>2009-10</td>
<td>178</td>
<td>161</td>
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<tr>
<td>2010-11</td>
<td>187</td>
<td>185</td>
<td>106</td>
</tr>
<tr>
<td>2011-12</td>
<td>196</td>
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<td>2012-13</td>
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<td>103</td>
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<td>2013-14</td>
<td>219</td>
<td>215</td>
<td>103</td>
</tr>
<tr>
<td>2014-15</td>
<td>222.5</td>
<td>215</td>
<td>104</td>
</tr>
<tr>
<td>2015-16</td>
<td>234</td>
<td>230</td>
<td>102</td>
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</table>

Expected Nos for 2015-16
India: Product Demand & Refining Capacity

- HSD export prospects will diminish with competition from
  - ME & US for Europe supply
  - Japan & Australia for Asia Pacific
- Gasoline export problem in view of
  - ME capacity addition
  - Lower Gasoline demand in US

Source: PPAC/ Draft XI Plan Demand Document
# India - Situational Analysis

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock Availability</td>
<td>Limited</td>
</tr>
<tr>
<td>Feedstock Cost</td>
<td>No relative advantage</td>
</tr>
<tr>
<td>Demand/Demand growth</td>
<td>High Demand Growth Potential</td>
</tr>
<tr>
<td>Technology Access</td>
<td>Low</td>
</tr>
<tr>
<td>Competitiveness</td>
<td>Low</td>
</tr>
<tr>
<td>Ease of doing business</td>
<td>Low</td>
</tr>
<tr>
<td>Political &amp; Economic Situation</td>
<td>Political situation is fundamentally stable</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Below average</td>
</tr>
<tr>
<td>Legal Framework</td>
<td>Complicated</td>
</tr>
</tbody>
</table>
Prospects and Development of the Asian Petchem Sector

**Promising India**
- Among the fastest growing Asian petrochemical markets
- Surplus Naphtha but high import dependency for petrochemicals mainly due to lack of olefins feedstock

**Japan and South Korea**
- Matured markets with little demand growth expected
- Expected to have less export availability as there would be little further capacity developments and capacities may be rationalised.

**Southeast Asia**
- More petrochemical capacity developments would take place in the developing region.
- Vital to focus on domestic demand
India is dependent on imports for many petrochemical products, with some requiring more than 50% of imports.
Agenda

Demand/Supply & Naphtha Scenario in India
Naphtha Consumption Profile - India

Prior to 2015
- Petrochemicals: 60%
- Fertilizer: 16%
- Power/Steel: 21%
- Others: 3%

Post 2015
- Petrochemicals: 56%
- Fertilizer: 22%
- Power/Steel: 20%
- Others: 2%

*Additional 1.2 MMT being used in Southern Urea Plants*
While crackers in NE Asia & SE Asia continue to remain reliant on Naphtha Imports, India will continue to have surplus Naphtha…

- Northeast and Southeast Asia are forecast to remain reliant on imports for naphtha supply through the period to 2025 and beyond.
- The two regions will be largely supplied by the Middle East, with Africa, as alternative source of naphtha, when African refining capacity increases.
- In 2014, the Middle East exported 24.6m tonnes and 8.4m tonnes of naphtha to Northeast Asia and Southeast Asia respectively.
- This presents an advantage to India in petrochemical investments compared with the two regions, given its current naphtha surplus and proximity to major supplier Middle East as well as emerging Africa.
Naphtha Surplus but will naphtha crackers be cost competitive?

**Advantages**

- C3-C6 based streams available
- Aromatics can be produced from Naphtha cracker Py- gas
- Py-gas is primarily used for gasoline blending in India.
- Toluene and higher aromatics can be extracted from py-gas stream from naphtha cracker, India is significantly short in these raw materials
- Styrene needs (100% imports currently) can be met through naphtha crackers
- Ability to target specialty products/niche grades for import substitution

**Concerns**

- Single site feedstock availability - pooling
- Competing in the C2 stream with ethane based producers
- Polypropylene already surplus in India – need to find new outlets/products.

Naphtha Demand Estimates for FY19 as per MOPNG

Source: PPAC
No substantial extra naphtha generation at Barauni, BGR and Haldia as the same is expected to be absorbed in MS pool.
## SURPLUS NAPHTHA AVAILABILITY (PSU)

<table>
<thead>
<tr>
<th>PSUs</th>
<th>Refinery</th>
<th>PROJECTED NAPHTHA AVAILABLE</th>
<th>2015-16</th>
<th>As per Future Plans</th>
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</tr>
<tr>
<td>HPCL</td>
<td>Mumbai Refinery</td>
<td>180*</td>
<td>NIL</td>
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<tr>
<td></td>
<td>Vizag Refinery</td>
<td>180*</td>
<td>839</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>BPCL</td>
<td>Mumbai Refinery</td>
<td>545</td>
<td>192</td>
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<tr>
<td></td>
<td>Kochi Refinery</td>
<td>359</td>
<td>50**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BORL</td>
<td>120</td>
<td>100</td>
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</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRPL</td>
<td></td>
<td></td>
<td>800-1000</td>
<td>800-1000</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>TOTAL</td>
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<td>2181</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* Currently majority naphtha from MR/VR gets consumed in domestic market

**Proposed to revamp/install new CCR

| TOTAL (including IOCL) | 3170 | 3382 |

All Fig in TMT

* Approx 3.7 MMTPA Additional Surplus Naphtha from Pvt Refiners

Inputs from HPCL, BPCL, MRPL
Surplus Naphtha though seemingly scattered, but largely concentrated in the West...

- **Demand includes petrochemical use, fertilizer sector and power sector**

Source: PPAC; ICIS Consulting Analysis

- India’s naphtha surpluses are in the South and West, while East India sees a deficit.
- However, there is insufficient feedstock supply for new crackers other than West India.
How has the industry changed?

- Shale revolution in the US and the rise of downstream industry in the Middle East have significantly changed the petrochemical landscape in the past decade. Both the US and the Middle East will remain as the key exporters through the period to 2025 and beyond.
- In Asia, matured markets like Japan and South Korea will remain key suppliers, though capacity rationalization will lead to declining exports.
- Continued development in China’s petrochemical industry and ongoing economy reform to focus on slower but more sustainable growth in the country are likely to bring about new changes.
- Meanwhile, signs are pointing towards a less import dependent China. In fact, China has turned a net exporter for some products.
- Market will get more competitive. Southeast Asia is to focus on domestic demand and be less reliant on exports in its business model.
- South Asia notably India demand potential remains and is not matched with existing & planned capacity in the pipeline
Agenda

Importance of Naphtha as Petchem Feedstock in Indian Context
Steam Cracking Around the World

The Heavier the Hydrocarbon Feed the more complicated the economics

North America: Shale Gas

Middle East: Ethane Refinery Integration Liquids

Russia/CIS: Ethane Refinery Integration Naphtha

Asia: Naphtha Heavy Liquids

Configuration is Important
India – Ethylene Capacity by Feedstock

- Naphtha: 63%
- Ethane: 18%
- Propane: 16%
- Others: 3%
India – Ethylene/Propylene Capacities

- **HPL (Naphtha Cracker)**
  - Ethylene: 750
  - Propylene: 350

- **BCPL (Gas Cracker)**
  - Ethylene: 230
  - Propylene: 60

- **GAIL (Gas Cracker)**
  - Ethylene: 800

- **IOCL (Naphtha Cracker)**
  - Ethylene: 857
  - Propylene: 640

- ** hmEL (FCC)**
  - Propylene: 450

- **GAIL (Gas Cracker)**
  - Ethylene: 800

- **OPAL (Mixed Feed Cracker)**
  - Ethylene: 1100
  - Propylene: 350

- **RIL, Nagothane, Vadodara, Gandhar, Hazira, Jamnagar (Cracker/FCC)**
  - Ethylene: 2954
  - Propylene: 2020

- **MRPL (FCC)**
  - Propylene: 450

- **IOCL (FCC)**
  - Propylene: 700

- **HPL (Naphtha Cracker)**
  - Ethylene: 750
  - Propylene: 350

- **Red – New/Proposed**

Source: IOCL Analysis
## India – Ethylene Capacities

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Location</th>
<th>Ethylene Capacity (KTA)</th>
<th>Feed Mix(%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas Authority of India Ltd</td>
<td>Pata, UP</td>
<td>850</td>
<td>Ethane: 55-75, Propane: 20-30, C4-C6: 5-6</td>
<td>Natural Gas</td>
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<tr>
<td>2</td>
<td>Haldia Petrochemicals Ltd</td>
<td>Haldia, WB</td>
<td>670</td>
<td>100</td>
<td>Naphtha Cracker</td>
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<tr>
<td>3</td>
<td>Indian Oil Corporation Ltd</td>
<td>Panipat, Har</td>
<td>857</td>
<td>100</td>
<td>Naphtha Cracker</td>
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<tr>
<td>4</td>
<td>Reliance Industries Ltd (IPCL)</td>
<td>Vadodara, Guj</td>
<td>180</td>
<td>100</td>
<td>Naphtha Cracker</td>
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<tr>
<td>5</td>
<td>Reliance Industries Ltd (IPCL)</td>
<td>Gandhar, Guj</td>
<td>420</td>
<td>Import Ethane</td>
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<tr>
<td>6</td>
<td>Reliance Industries Ltd (IPCL)</td>
<td>Nagothane, MH</td>
<td>530</td>
<td>Import Ethane</td>
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<tr>
<td>7</td>
<td>Reliance Industries Ltd</td>
<td>Hazira, Guj</td>
<td>860</td>
<td>Import Ethane, Naphtha</td>
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<tr>
<td>8</td>
<td>Brahmaputra Cracker &amp; Polymer Ltd (GAIL)</td>
<td>Dibrugarh, Asm</td>
<td>220</td>
<td>Natural Gas + Naphtha</td>
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<tr>
<td>9</td>
<td>Reliance Industries Ltd</td>
<td>Jamnagar, Guj</td>
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<td>ICGC, Syngas, Import Ethane,</td>
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<td>10</td>
<td>ONGC Petro Additions Ltd</td>
<td>Dahej, Guj</td>
<td>1100</td>
<td>Mixed Feed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>6887</td>
<td></td>
<td></td>
</tr>
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</table>
## India – Propylene Capacities

<table>
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<tr>
<th>No.</th>
<th>Name</th>
<th>Location</th>
<th>Propylene Capacity (KTA)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Haldia Petrochemicals Ltd</td>
<td>Haldia, WB</td>
<td>370</td>
<td>Naphtha Cracker</td>
</tr>
<tr>
<td>2</td>
<td>Indian Oil Corporation Ltd</td>
<td>Panipat, Haryana</td>
<td>640</td>
<td>Naphtha Cracker</td>
</tr>
<tr>
<td>3</td>
<td>Reliance Industries Ltd (IPCL)</td>
<td>Vadodara, Gujarat</td>
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<td>Naphtha Cracker + Gandhar - 30 KT</td>
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<tr>
<td>4</td>
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<td>Nagothane, MH</td>
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<tr>
<td>5</td>
<td>Reliance Industries Ltd</td>
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<td>Brahmaputra Cracker &amp; Polymer Ltd (GAIL)</td>
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<td>7</td>
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<td>FCC</td>
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<tr>
<td>8</td>
<td>ONGC Petro Additions Ltd</td>
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<td>Mixed Feed Cracker</td>
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<tr>
<td>9</td>
<td>Hindustan Mittal Energy Ltd</td>
<td>Bhatinda, Punjab</td>
<td>450</td>
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<tr>
<td>10</td>
<td>Mangalore Refinery Petrochemicals Ltd</td>
<td>Mangalore, Kar</td>
<td>450</td>
<td>FCC</td>
</tr>
</tbody>
</table>

**Total**: 5010
India Import Requirement Grows Despite New Capacity Build

Net Exports

Net Imports

08 09 10 11 12 13 14 15 16 17 18

Ethylene  Vinils  Styrenics  Polyethylene  Glycol  Others

Net Trade
Asia: A Paradigm Shift in Competitiveness

Ethylene - Cash Cost of Production

- U.S. Ethane
- NEA Naphtha
- MDE Ethane
- China CTO

$ Per MT

RATIONALE FOR REFINERY-PETROCHEMICAL INTEGRATION

- **Need for Petrochemical Integration:**
  - Limited growth in liquid fuel business
  - Substitution of liquid fuels by gas
  - Reduced Margins
  - Adding value to all molecules of refinery

- **Key driving factors for forward integration:**
  - Utilization of refinery streams
  - Generation of petrochemical building blocks, at competitive cost
  - Sharing of facilities/ utilities
  - Better response to market volatility

- **Refinery and Petrochemical business are inter-related**
  - Similar bases for technology
  - Assured feedstock availability
  - Absorption of return streams
  - Identical approaches for operation and maintenance.
Steam Cracker Feedstock Slate Becoming Lighter

- Global Cracker Feedstock is lightening, primary driven by Ethane/LPG gas cracking growth in North America
- Combined North America LPG/Ethane cracking would contribute 94% of NA C2 feedstock, up from 83% in 2010
- ME feedstock will remain more stable as LPG/Naphtha additions offset continued growth in ethane cracking
- Both NE & SE Asia, to remain heavily based on Naphtha cracking

Source: ICIS
Global Olefins Production Trends from Steam Crackers have changed dramatically

Source: IHS
The Indian Perspective

- Indian per capita polymer consumption @ 8kg/yr compared to global average consumption of >25kg/yr
  - Double digit yearly growth in plastic demand
  - 1 kg/yr increase corresponds to 1.2 MMTPA demand increase; size of a world class Ethylene complex

- Indian refining capacity @ 230 MMTPA (5th largest in the world); 2014 Ethylene production in India 4 MMTPA
  - Enormous opportunity to integrate with Refineries
  - 7MMTPA of excess Naphtha available as on date
  - Gasoline Growth, Resultant Maximization and India’s move to BS 6 (Euro 6) by 2020 could reduce Naphtha Availability

- Regional imbalance
  - Eastern India with 26% of national population takes 11% of demand
  - Northern India 31% of national population takes 21% of demand
  - Development of Northern and Eastern India in line with Western India
• In Worst case scenario, where capacities do not materialise or there are no new investments, India will see a deficit of up to 8 million tonnes and 3.5 million tonnes in ethylene and propylene respectively.

• Expect addition of around 4m tonnes ethylene and 2.6m tonnes propylene capacity to be invested by 2025.

• In other words, given India’s huge deficit in ethylene and increasingly for propylene it presents a case for development in upstream crackers
## India – Ethylene Derivatives – Gap Analysis

<table>
<thead>
<tr>
<th>Product</th>
<th>Demand/Supply Gap (kTa)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2020</td>
<td>2035</td>
<td>2020</td>
<td>2035</td>
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<tr>
<td></td>
<td>Prod Cap</td>
<td>Demand</td>
<td>Gap</td>
<td>Prod Cap</td>
<td>Demand</td>
<td>Gap</td>
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<tr>
<td>Polyethylene</td>
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<td>Total Ethylene Gap</td>
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<td></td>
<td>3200</td>
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<td>12800</td>
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*Based on Name Plate Production Capacity, Announced Expansions and Expected Growth*
## India – Propylene Derivatives – Gap Analysis

<table>
<thead>
<tr>
<th>Product</th>
<th>Demand/Supply Gap (kTa)</th>
<th>2020</th>
<th>2035</th>
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<tbody>
<tr>
<td></td>
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<td>Prod Cap</td>
<td>Demand</td>
</tr>
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<td>Propylene Oxide</td>
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<td>Phenol</td>
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<td>420</td>
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<td>Super Absorbent Polymer</td>
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<td>130</td>
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<td><strong>Total Propylene Gap</strong></td>
<td><strong>1450</strong></td>
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• Based on Name Plate Production Capacity, Announced Expansions and Expected Growth
### India – Feedstock Requirement Analysis

<table>
<thead>
<tr>
<th>Product</th>
<th>Requirement (kTa)</th>
<th>Feedstock Requirement (kTa)</th>
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<td></td>
<td>2020</td>
<td>Case 1</td>
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<tr>
<td>Ethylene</td>
<td>3200</td>
<td>Naphtha - 10300</td>
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<td>Propylene</td>
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Case 1 – Naphtha as Feedstock
Case 2 - Mix of Propane and Naphtha
Case 3 – Ethane Crackers & PDH
## India – Feedstock Requirement Analysis

<table>
<thead>
<tr>
<th>Product</th>
<th>Requirement (kTa)</th>
<th>Feedstock Requirement (kTa)</th>
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<tr>
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<td>12800</td>
<td>Naphtha – 47500</td>
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<td>Propylene</td>
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**Case 1** – Naphtha as Feedstock  
**Case 2** - Mix of Propane and Naphtha  
**Case 3** – Ethane Crackers & PDH
Agenda

Naphtha Crackers and their Viability Improvement
Naphtha Cracker Complex

Steam Cracker

- Hydrocarbon Feed
- Operations & Maintenance

Utilities

Waste

Ethylene

Co-Products
- Hydrogen
- Methane
- Propylene
- C4's
- PFO
- Etc..

Traditional focus

Co-products drive Economics
## Typical Product slate from Naphtha cracker

<table>
<thead>
<tr>
<th>Feedstocks</th>
<th>Ethane</th>
<th>Propane</th>
<th>Butane</th>
<th>Naphtha</th>
<th>Diesel Fuel</th>
<th>Vacuum Distillate</th>
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<tbody>
<tr>
<td><strong>Products</strong></td>
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<tr>
<td>Hydrogen</td>
<td>8.8</td>
<td>2.3</td>
<td>1.6</td>
<td>1.5</td>
<td>.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Methane</td>
<td>6.3</td>
<td>27.5</td>
<td>22</td>
<td>17.2</td>
<td>11.2</td>
<td>8.8</td>
</tr>
<tr>
<td>Ethylene</td>
<td>77.8</td>
<td>42.0</td>
<td>40</td>
<td>33.6</td>
<td>26</td>
<td>20.5</td>
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<tr>
<td>Propylene</td>
<td>2.8</td>
<td>16.8</td>
<td>17.3</td>
<td>15.6</td>
<td>16.1</td>
<td>14.0</td>
</tr>
<tr>
<td>Butadiene</td>
<td>1.9</td>
<td>3.0</td>
<td>3.5</td>
<td>4.2</td>
<td>4.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Other C4</td>
<td>0.7</td>
<td>1.3</td>
<td>6.8</td>
<td>4.5</td>
<td>4.8</td>
<td>6.3</td>
</tr>
<tr>
<td>Gasoline C5-200</td>
<td>1.7</td>
<td>6.6</td>
<td>7.3</td>
<td>18.7</td>
<td>18.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Includes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piperylene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Cyclopentadiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Isoprene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td></td>
<td></td>
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<td>3.1</td>
<td></td>
</tr>
<tr>
<td>Xylene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Styrene</td>
<td></td>
<td></td>
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<td>1.0</td>
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<tr>
<td>Other C9+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.0</td>
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<tr>
<td>Fuel Oil</td>
<td>-</td>
<td>0.5</td>
<td>1.5</td>
<td>4.7</td>
<td>18.1</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Source: Axens
## Utilization of Valuable Molecules of Naphtha cracker

<table>
<thead>
<tr>
<th>Naphtha Cracker Streams</th>
<th>Potential Molecules in streams</th>
<th>Value Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4</td>
<td>Butadiene</td>
<td>SBR, PBR, SBS, ABS etc</td>
</tr>
<tr>
<td></td>
<td>MTBE</td>
<td>MMA, PMMA, butyl Rubber, PIB etc</td>
</tr>
<tr>
<td></td>
<td>Isobutene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Butene-1</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>Dicyclopentadiene</td>
<td>HCR, Ink, adhesives etc</td>
</tr>
<tr>
<td></td>
<td>Piperlyene</td>
<td>HCR</td>
</tr>
<tr>
<td></td>
<td>Isoprene</td>
<td>IIR, SIS, etc</td>
</tr>
<tr>
<td>C6- C8</td>
<td>Benzene, Toluene &amp; Xylene</td>
<td>Various derivatives of Benzene</td>
</tr>
<tr>
<td>C-8</td>
<td>Styrene</td>
<td>SBR, SIS, ABS etc</td>
</tr>
<tr>
<td>C-9</td>
<td>Resin oil, di olefins</td>
<td>C9 based HCR</td>
</tr>
<tr>
<td>C-10</td>
<td>Naphthalene</td>
<td></td>
</tr>
<tr>
<td>C11- C12</td>
<td>Aromatic Solvents</td>
<td></td>
</tr>
</tbody>
</table>
## Typical reduction in ethylene Cash Cost

<table>
<thead>
<tr>
<th>Derivative Projects</th>
<th>Reduction in cash cost of ethylene</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Based on Butadiene (140KTA)</strong></td>
<td></td>
</tr>
<tr>
<td>- SBR (120 KTA)</td>
<td>12%</td>
</tr>
<tr>
<td>- SBR (+ 60 KTA)</td>
<td>(+) 6%</td>
</tr>
<tr>
<td>- SBS (35 KTA)</td>
<td>(+) 4%</td>
</tr>
<tr>
<td><strong>Extraction of Styrene from Py-gas (20 KTA)</strong></td>
<td>(+) 2%</td>
</tr>
<tr>
<td><strong>Based on C4’s (200 KTA)</strong> (Includes MMA, Butene-1, Maleic Anhydride/Butanediol)</td>
<td>(+) 20%</td>
</tr>
<tr>
<td><strong>Based on C5’s (90 KTA)</strong> (Includes Di cyclo pentadiene, Isoprene, Piperlyene)</td>
<td>(+) 15%</td>
</tr>
</tbody>
</table>

With implementation of all value added downstream derivatives, ethylene cash cost is likely to be reduced by ~60%.

*Source: in-house estimate*
Agenda

Challenges and Imperatives for Naphtha Utilisation
Challenges in Naphtha Utilisation

- Naphtha Quality for petrochemicals.

- Naphtha availability at a single location for world scale petrochemical Unit

- Naphtha Pooling at a single location:
  - Logistics cost
  - Inadequate infrastructure

- Price fluctuation impacts the profitability of Naphtha based petrochemicals

- Competition from gas/coal based petrochemicals.
Indian Industry is faced with following challenges:-

- **Feedstock Constraints**
  - Insufficient availability of natural gas to drive high petrochemicals growth
  - Non availability of indigenous Coal & its poor quality

- **High Energy Cost**
  - Refineries & Petrochemical industry dependent on its own CPP based on LNG or Naphtha or LSHS resulting in higher power/ utilities cost.

- **High feedstock prices** (non availability of advantage feed stock) are squeezing margins.
CHALLENGES FOR REFINERIES

- High Operating Cost – energy costs
- No plug & play system for utilities

- High Logistics Cost
  - Poor infrastructure for raw material/product movement at ports/roads etc.

- High Capital Cost

- Cost competition from:
  - Olefins from Middle East (NG based)
  - Olefins from China (Coal based)
Agenda

Future Scenario & Conclusions
Future Scenario

- Refinery-Petrochemicals integration is an essential driver for economic growth, as well as corporate profitability. Significant opportunity exists for refinery-petrochemical integration.

- One single refinery or even one PSU does not have sufficient Naphtha available to cater to a world scale Naphtha cracker plant. Therefore, option of pooling of feedstock by PSU refineries needs to be explored.

- Locate petrochemical plants within refinery site as brownfield expansion, for max integration synergy.

- Build world scale capacities, to exploit economies of scale – ethane imports

- Evaluate & utilize High severity FCC for basic petrochemical building blocks

- Consortium cracker approach may resolve the availability of building blocks issue for downstream units.
Feedstocks – What can India Do?

- **Mixed Feed Crackers**
- **Pool Naphtha from Existing and New Refining Sources for Cracker**
  - Taxation for Pooling – Stock Transfer.
  - Coastal Shipping
  - Rail Utilisation
- **Reverse SEZ Offshore**
  - Opportunity with the Opening up of Iran
  - Modification/Clarifications in Exim Norms/Tariffs
- **Import Naphtha from Middle East**
  - Surplus Naphtha Available in ME
  - Long Term Contracts
  - Port and Transportation Infrastructure
- **Import Ethane from US**
  - Surplus Ethane in US
  - Long Term Contracts
  - Port, Shipping and Pipeline Infrastructure
- **Import Condensate**
  - Higher Percentage of Oil Production now in Condensate form ~ 12%
  - Availability of Field Condensate on the rise in US and ME
  - Port, Shipping and Pipeline Infrastructure
  - Long Term Contracts
Initiatives Planned for Future Growth

- Reverse SEZ – Iran
- Examining opportunities for collaboration with petrochemical players for setting up gas/condensate based, cost competitive Petrochemicals Complexes
- Possibility of setting up petrochemical plant in India, on a coastal location, being explored by sourcing feedstocks from ME/USA – transportation remains a concern
- Objective – to enhance availability of low cost polymers in India
Conclusions

- Naphtha remains surplus in the medium term in South Asia
- Naphtha cracking is now very competitive
- India will be deficient of feed to match Petchem growth
- Conventional designs might miss economic opportunity
- Ability to be feed flexible helps in an uncertain market place.
- Import of Condensate and/or Naphtha and/or Ethane is a possibility
Thanks !!