Petrochemical Market Outlook

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Petrochemical Outlook

- Petrochemical Basics
- Economy & Energy
- Impact On Regional Cost Positions
- Capacity Additions, Demand, and Trade
- Conclusion
Energy → Feedstocks → Petrochemicals

Crude Oil

Refinery

Naphtha
Gas Oil

Ethane
Propane
Butanes
Field Condensates

Gas Separation Unit

Natural Gas

Ethylene Unit

Ethylene
Propylene

Methane/Hydrogen

Crude C₄

• Butadiene
• Mixed Butylenes

Pygas

• Benzene
• Toluene/Xylene
• Heavy Aromatics
• C₅-C₆ Non Aromatics

Fuel Oil

Olefins Flow Diagram

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Propylene Has Multiple Sources

- Gas Oil
  - Refinery FCC Unit
  - Alkylation Unit
    - High Octane Alkylate Gasoline
  - Isobutane
    - Refinery Grade 60% purity
    - Purification Splitter
      - Cumene, Oligomers, Isopropanol
      - Polymer Grade (99.5%)
      - Chemical Grade (93%)

- Propane
  - Chemical
    - Cracker
      - On Purpose
    - Propane Dehydrogenation (PDH)
      - On Purpose
    - Ethylene/Butylene
      - Metathesis

- Naphtha/NGL
  - Non-Chemical
    - Refinery Grade 60% purity

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2007 World Light Olefins Supply Profile

Ethylene
- Ethane: 29%
- Propane: 8%
- Butane: 4%
- Gas Oil: 5%
- Naphtha: 52%
- Others: 2%

Total: 115 Million Metric Tons

Propylene
- Stm. Crackers: 64%
- Others: 6%
- FCC/Splitters: 30%

Total: 69 Million Metric Tons

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2007 World Light Olefins Demand Profile

Ethylene
- PE 59%
- EDC 12%
- Ethylene Oxide 14%
- Others 8%
- EBZ 7%

114 Million Metric Tons

Propylene
- PP 66%
- Others 3%
- Propylene Oxide 8%
- Acrylic Acid 4%
- Oxo Alc. 7%
- Acrylonitrile 8%
- Cumene 4%

69 Million Metric Tons

October 2007
North America
2007 Ethylene Supply/Demand

Production by Feedstock

- Ethane: 53%
- Naphtha: 17%
- Propane: 17%
- Butane: 4%
- Gas Oil: 4%
- Others: 5%

Demand by End-Use

- PE: 59%
- EDC: 12%
- Ethylene Oxide: 13%
- EBZ: 5%
- Others: 11%

Domestic Demand = 31 Million Metric Tons

October 2007
North America
2007 PG/CG Propylene Supply/Demand

Production by Source
- Stm. Crackers: 48%
- FCC/Splitters: 49%
- Others: 3%

Demand by End-Use
- PP: 58%
- Propylene Oxide: 12%
- Acrylic Acid: 6%
- Oxo Alc.: 7%
- Acrylonitrile: 10%
- Cumene: 1%
- Others: 6%

Domestic Demand = 15 Million Metric Tons

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Future Propylene Supply In North America

Future supply to meet continued growth in North America propylene demand will come from:

- Capacity creep on existing units
- Increased operating rates at on-purpose metathesis units.
- Debottlenecks, and increased feed flexibility at refinery’s and steam crackers
- Canadian tar sands production
Economy and Energy Impact on Regional Ethylene Economics
Positive economic factors still outweigh growing negatives. Balance is at risk of tipping...

**Positive Factors**
- Monetary Policy
- Fiscal Policies
- Corporate Profits
- Oil $ Re-Investment
- High Productivity
- Consumer Spending
- "China"
- Emerging Countries

**The Risks**
- High Energy Prices
- Over-zealous Lending
- Government Deficits
- Consumer Indebtedness
- Credit Crunch
- Currency Disparity
- Rising Inflation
- Geopolitical Instability

2007-2010
3.0% – 3.3%
Global GDP Growth

*October 2007*
World Ethylene GDP Elasticity

Average Elasticity '90 to '99 = 1.96
Average Elasticity '00 to '05 = 1.25
Average Elasticity '06 to '11 = 1.33
Historically natural gas in North America traded at well below equivalent fuel value for crude oil, but by the start of this decade the two fuel sources converged. The longer term forecast shows gas becoming slightly favored on a BTU basis.
Higher “worry premiums” regarding perceived threats or real constraints to international crude oil supplies favor gas based petchem units.

Exports from Canada and U.S. to Europe and Asia are possible as long as this advantage prevails. In the longer term, cost parity and severe surpluses could limit export opportunities – but for now…

Export Markets Are Very Attractive
2006 Global Ethylene Cost Curve

Dollars Per Metric Ton

Cumulative Capacity (Million Metric Tons)

Market Based Feedstock Units

Advantaged Feedstock Units

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Global Ethylene Cash Costs By Site
Ethylene Production Basis

<table>
<thead>
<tr>
<th>Region</th>
<th>2003</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>USGC Natural Gas, $/MM Btu</td>
<td>5.45</td>
<td>6.97</td>
</tr>
<tr>
<td>Brent Crude Oil, $/Bbl ($/MM Btu)</td>
<td>29 (~5)</td>
<td>66 (~11)</td>
</tr>
</tbody>
</table>

Dollars Per Ton

CUMULATIVE ETHYLENE CAPACITY (million tons)

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Basic Chemicals & Plastics Capacity Distribution
1990 vs. 2015

- Americas: 37% (1990) vs. 23% (2015)
- Middle East: 3% (1990) vs. 15% (2015)
- Asia & India: 22% (1990) vs. 41% (2015)
- Europe: 37% (1990) vs. 19% (2015)

Basic Chemicals & Plastics Global Capacity Increase

- Annual Percentage Capacity Gain:
  - 1990: 8%
  - 1995: 7%
  - 2000: 6%
  - 2005: 5%
  - 2010: 4%
  - 2015: 3%

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CMAI
# Global Ethylene Capacity Growth

( -000- Metric Tons )

<table>
<thead>
<tr>
<th>Major Region</th>
<th>2006 Capacity</th>
<th>2011 Capacity</th>
<th>'06 to '11 Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East / Africa</td>
<td>14,843</td>
<td>34,146</td>
<td>19,303</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>35,225</td>
<td>49,687</td>
<td>14,462</td>
</tr>
<tr>
<td>America's</td>
<td>40,293</td>
<td>41,315</td>
<td>1,022</td>
</tr>
<tr>
<td>Europe</td>
<td>30,860</td>
<td>31,735</td>
<td>875</td>
</tr>
<tr>
<td>World Total</td>
<td>121,221</td>
<td>156,883</td>
<td>35,662</td>
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</tbody>
</table>
Regional Ethylene Capacity Additions

Million Metric Tons

0 2 4 6 8 10 12

North America
West Europe
Southeast Asia
Northeast Asia
Others

Annual Demand Change*  

* Two-year rolling average

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Revolutionary shift in new capacity emphasis is altering value chain patterns...

Global Basic Chemicals and Plastics

Percent of World Total being added by New Gulf & China

Then Emphasis Shifts

China Leverages its Coal-to-Chemicals Capabilities for Vinlys and Methanol

“New Gulf”

China
Ethylene Investments In The Americas

- **Western Canada** limited by ethane availability. Olefins supply based on oil sands development under study.
- **U.S. Gulf Coast** priority shifts to feed flexibility, energy efficiency and domestic market focus.
- **Mexico** looking to leverage upstream and downstream integration.
- **Trinidad and Venezuela** offer “advantaged feedstock” based investments.
- **Brazil** driven by upstream and downstream integration, focused on MERCOSUR.
A strong and resilient global economy continues to drive demand growth for light olefins.

- Ethylene demand growth forecast at ~4% per year
  - Strongest Growth in PE and EO/EG
- Propylene demand growth forecast at ~5% per year
  - Strongest growth in PP and Cumene
United States
Ethylene Demand Forecast

Total Demand Growth = -0.4% AAGR 2007-12

Million Metric Tons

02 03 04 05 06 07 08 09 10 11 12

PE 2.6 / -0.7 *
Ethylene Oxide 0.0 / -1.6 *
EBZ 0.2 / -2.3 *
Others -0.5 / 0.4 *
Capacity 0.1 / -0.2 *

*%AAGR 02-07 / %AAGR 07-12

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North America
Monthly Ethylene Net Equivalent Trade

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Net Exports

Net Imports

Ethylene  Vinyls  Styrenics  Polyethylene  Glycol  Alpha Olefins  Vinyl Acetate  Others

Others - consists of Acetaldehyde and Ethylene Propylene Rubber
North America Ethylene Net Equivalent Trade

Million Metric Tons

02 03 04 05 06 07 08 09 10 11 12

Net Exports

Ethylene Polyethylene Vinils Styrenics Glycol Others Others Net Trade

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Olefins Derivative Trade Dominated By The Middle East

- By 2009, ethylene net trade is dominated by the Middle East Region
- North America net trade moderates
- Asia imports, mainly China, remain the largest
The Olefins Business Cycle Continues…

U.S. Integrated Olefins/Polyolefins Cash Margins

Dollars Per Metric Ton

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Our vision of the next five years...

- Global Demand Remains Robust
- New Capacity somewhat delayed but market impact unavoidable
- North America loses many “export opportunities” while imports of finished goods accelerate
- By late 2008, evident markets are softening – *emotional then physical*
- Consolidations and closures occur; recovery signs appear by 2012
THANK YOU!
Contact any CMAI location to assist in your petrochemicals market analysis

CHEMICAL MARKET ASSOCIATES, INC.

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