North America Propylene Supply Study

A deep dive into eleven propylene trade areas in North America

August 2018
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Study scope</td>
<td>5</td>
</tr>
<tr>
<td>Deliverables</td>
<td>6</td>
</tr>
<tr>
<td>Table of contents</td>
<td>7</td>
</tr>
<tr>
<td>Methodology</td>
<td>12</td>
</tr>
<tr>
<td>Project Team</td>
<td>13</td>
</tr>
<tr>
<td>About IHS Markit</td>
<td>14</td>
</tr>
<tr>
<td>Contact information</td>
<td>16</td>
</tr>
</tbody>
</table>
Introduction

As the Shale Gale has shaped the petrochemicals global market, North America has responded by leveraging its new raw material advantage. However, in a world with lower crude oil expectations, the plan has not gone exactly as predicted and North America’s propylene market dynamics continued to evolve against a new outlook. As the factors influencing changes in the propylene market continue to develop, the North America Propylene Supply Study can provide insight to what are these changes likely to look like and key strategic issues that will direct the North American propylene market forward.

During recent years, increased natural gas production brought an excess of natural gas liquids such as ethane and propane. Ethane’s emergence as a cost advantaged feed for ethylene production has led to decline in propylene availability from steam cracking. At the same time, propane availability has driven both North American investment in on-purpose propylene production via PDH and expansion of propane export capability which has supported PDH investments in Asia.

In addition, propylene availability originating within refineries as a by-product of gasoline and alkylation of refinery grade propylene will be affected by future changes in refinery operations and fuel demand. Evolving propylene market dynamics are expected to influence infrastructure changes, derivative investments, and movement of propylene within the region and globally.

The North America Propylene Supply Study provides in-depth discussion of key strategic questions facing the propylene industry such as:

- How will North American PDH projects impact regional and global propylene markets?
- How will expanded export capability affect North American propylene supply?
- What changes are planned to pipeline infrastructure and how will they affect distribution?
- When, where, and what propylene derivative capacity will be added and how will it affect the global propylene derivative markets?
- What is the North American impact of significant investment in China’s propylene capacity?

The study will include in-depth analysis of eleven North America propylene trade areas (PTAs). For each PTA, IHS Markit will provide:

- Capacity by propylene grade and technology type
- Pipeline, rail, terminal capabilities
- Demand by propylene grade
- Inter-PTA and offshore trade flow snapshots
- Propylene net back prices
The propylene trade areas within North America are defined as follows:
Study Scope

This special report provides a detailed look at North America's propylene trade areas (PTAs) with coverage of the following topics:

**Strategic Issues**
- Shale Gas/Tight Oil Impact on Olefins
- On-Purpose Capacity
- Expansion of Propylene Export Capability
- Changes to Pipeline Infrastructure
- Propylene Derivative Additions
- Impact of Changes in the Refining Sector
- Massive Chinese Propylene Investment

**North America Producer Profiles**

**Prices**
- Mechanisms
- Energy Forecast through 2027
- Propylene Price Forecast through 2027

**Propylene Technology Review**
- Description of Major Technologies Including Process Flow Diagrams
- Economic Snapshots all Major Technologies for Propylene Production

**Supply-Demand**
- Discussion of Key Supply-Demand Trends
- Supply-Demand Balances 2000-27 for North America, Canada, Mexico, and U.S.

**Distribution**
- Definition of Propylene Trade Areas (PTA)
- Inter-PTA trade grids, PTA production and consumption, PTA supply and demand
- Polymer-Grade, Chemical-Grade, and Refinery-Grade propylene integration by PTA
- Steam Cracker and PDH Propylene Producers’ Capacity and Logistics Capabilities
- Refinery Propylene Producers’ Capacity and Logistics Capabilities
- Propylene Export Terminals

**Trade**
- Discussion of Propylene Trade
- Tables of Net Equivalent Trade, Imports, Exports
  - North America, Canada, Mexico, United States

**Appendices**
- Production Location Maps
- Capacity Tables
- PG/CG Integration Tables
- RGP Integration Tables
Deliverables

The final Report in narrative form (PDF) will be delivered via IHS Markit’s Connect platform with detailed market analysis and insight on topics listed in the study scope.

The study also includes:

- On-line access to Excel files containing propylene supply/demand tables and graphs, capacity tables, and trade grids as developed for the study

- An optional 2-hour Webinar presentation with IHS market expert Todd Dina and other members of the study team to review primary conclusions and strategic issues as developed within the study.
Table of Contents

Introduction
  Team Profiles and Content List

Explanatory Notes
  Study Preface
  Data Sources
  Supply/Demand Balances
  Derivatives
  Conversion Factors
  Incoterms – Shipping Terms
  Study Methodology
  Production
  Operating Rates
  Demand
  Trade
  Abbreviations in this Study

Executive Overview
  Global Outlook
    Supply and Demand
    Supply/Demand Snapshots
    Global Net Trade
    Forecast Market Conditions
  North America Overview
    Supply and Demand
    Trade
    Regional Dynamics
    Primary Conclusions

Strategic Issues
  The Effect of Shale and Tight Oil on Propylene Supply
    Background
    Decreased Propylene Co-Production
    Advantaged Feedstocks Promote On-Purpose Production
    Fluid Catalytic Cracking (FCC) Propylene Production Remains Flat
  Effect of Changes in Oil Fundamentals on Propylene Supply
    Background
    Fluidized Catalytic Cracking Propylene Output Flattens
    IMO 2020 Rolls In
    Gearing Up for Peak Oil Demand
    Splitters and Their Role
Alkylation of Refinery Grade Propylene
   Background
   Isobutane Availability
   Butylene Shortage
   Blending of Condensates
   Refinery Grade Propylene Alkylation Value
   Forecast on Projects

Propane Dehydrogenation in North America
   Background
   Need for On-Purpose Propylene Production
   Upcoming North American Propane Availability versus Consumption PDH Projects

Propylene Capacity Investment in China
   Background
   Propane Dehydrogenation (PDH)
   Coal to Olefins/Propylene (CTO/CTP)
   Methanol to Olefins (MTO)
   Impact on North America

Changes in Infrastructure
   Background
   Enterprise Export Terminal
   Enterprise Lou-Tex Pipeline
   Changes in Railcar Service Capability

Methane as a Feedstock Route
   Background
   Methane: The New Paradigm?
   BASF Project
   Forecast on Projects

**Competitive Analysis: Propylene Cost & Margin Economics**
   Competitive Cost & Margin Analytics Model Applications
   Propylene Feedstocks
   North America Propylene Competitive Cost Position
   Propylene Market Developments

**Merchant Market Size and Composition**
   Participants
   United States
   Canada
   Mexico
Profiles of Key Propylene Players in North America

Andeavor
BASF
BP
Braskem
Chevron
Chevron Phillips
CITGO
Deer Park Refining
Delek Group
DowDuPont
Eastman
Enterprise
ExxonMobil
Flint Hills Resources
Formosa Plastics Corporation, USA
Huntsman
Imperial Oil
Indelpro
Ineos
Inter Pipeline
Irving Oil
LyondellBasell (Equistar Houston Refining)
Marathon Petroleum
Motiva
Nova Chemical
PBF Energy (Chalmette, Toledo Refining, Paulsboro Refining)
Pembina
PEMEX
Philadelphia Energy
Phillips 66
Shell
Total
Valero
Westlake

Propylene Price Mechanisms

Price Definitions
Price Forecast Methodology
Energy
Propylene Price Boundaries
Propylene Price Forecast
Technology Review
Propylene Production and Consumption Technologies
Steam Cracking
Refinery FCC
Splitting
Alkylation
Polygas/Dimersol
Oil Sands Upgrading
Propane Dehydrogenation
Metathesis
Olefin Cracking & Interconversion
High Severity FCC
Methanol-to-Olefins/Propylene
Coal to Olefins

Production Economic Snapshots
Propylene Via Metathesis (C4C2 – Butylene Stream at Raffinate 2 Valuation)
Propylene Via Metathesis (C2 Dimerization)
Propylene Via Metathesis (C4C2 – Butylene Stream at Butane Valuation)
Propylene Alkylation (HF Acid Process)
Propylene Alkylation (Sulfuric Acid Process)
Propylene Polymer Gasoline
Propylene Splitter Purification
Propane Dehydrogenation (UOP Oleflex Process)
Propane Dehydrogenation (ABB Houdry CATOFIN Process)
Fluid Catalytic Converter (FCC)
FCC with ZSM-5 Additive

Supply and Demand in North America
United States
Canada
Mexico
Supply and Demand Tables by Country, 2007–2027

Propylene Distribution in North America (by PTA)
Definition of Propylene Trade Areas (PTAs)
Supply and Demand by Propylene Trade Area (PTA)
PTA 1: Louisiana Mississippi River Area
PTA 2: Rest of Louisiana and Eastern Texas
PTA 3: Texas Gulf Coast
PTA 4: Rest of Texas
PTA 5: Eastern United States
PTA 6: Mid-Continent United States
PTA 7: Mountain States of the United States
PTA 8: West Coast United States
PTA 9: Western Canada
PTA 10: Eastern Canada
PTA 11: Mexico
Supply and Demand Snapshot for PTAs 1–11, 2017, 2022, and 2027
Supply and Demand Tables for PTAs 1–11, 2007–27
Capacity Integration Table for PTAs 1–11, 2017

Propylene Trade in North America
Country-Level Trade, 2007–2027
  Polymer Grade Trade
  Chemical Grade Trade
  Refinery Grade Trade
Inter-PTA Trade
  Polymer Grade Trade
  Chemical Grade Trade
  Refinery Grade Trade
North America Net Equivalent Trade
  United States
  Canada
  Mexico
Inter-PTA Trade Maps for Total, PG, CG, and RG Propylene: 2017, 2022, 2027
Inter-PTA Trade Grids for Total, PG, CG, and RG Propylene: 2017, 2022, 2027
Propylene Terminals in North America
Steam Cracker Capacity and Logistics, 2017
Refinery FCC/Coker Capacity and Logistics, 2017

Appendix
Production Locations Maps
North America PG and CG Capacity by PTA, 2007–2027
North America RG Capacity by PTA, 2007–2027
North America FCC Capacity by PTA, 2007–2027
North America Coker Capacity by PTA, 2007–2027
North America PG, CG Capacity Integration by PTA, 2007–2027
North America RG Capacity Integration by PTA, 2007–2027
Methodology

IHS Markit has earned a reputation within the petrochemical industry for its ability to build upon its extensive models and databases and to provide meaningful forecasting and strategic planning services to its clients. Looking past the “numbers” has allowed IHS Markit to not only provide clients with short-term solutions, but to also become a valuable partner in longer-term strategic planning with an eye to the global petrochemical picture.

Over three decades in the business of petrochemical consulting, IHS Markit has developed the most comprehensive databases of supply/demand that are available to the industry, providing a solid base of information from which to build.
Project Team

**Pat McSpadden**
Managing Director, Chemical Consulting, IHS Markit
E Pat.McSpadden@ihsmarkit.com
T +12817523239

**Todd Dina**
Director Global Olefins, Service Leader North America Light Olefins and Director of Propylene Studies
E Todd.Dina@ihsmarkit.com
T +12817523238

**Steve Lewandowski**
Vice President, Olefins
E Steve.Lewandowski@ihsmarkit.com
T +12817523230

**Tracy Cui**
Principal Analyst, Global Olefins, IHS Markit
E Tracy.Cui@ihsmarkit.com
T +18326797286

**Jacob Marinelli**
Chemical Consulting
E Jacob.Marinelli@ihsmarkit.com
T +18326797284

**Amreen Ali**
Chemical Consulting
E Amreen.Ali@ihsmarkit.com
T +18326198590
About IHS Markit

IHS Markit is the leading source of information, insight and analytics in critical areas that shape today’s business landscape. Businesses and governments in more than 165 countries around the globe rely on the comprehensive content, expert independent analysis and flexible delivery methods of IHS Markit to make high-impact decisions and develop strategies with speed and confidence.

IHS Markit has been in business since 1959 and became a publicly traded company on the New York Stock Exchange in 2005. Headquartered in Englewood, Colorado, USA, IHS Markit is committed to sustainable, profitable growth and employs more than 8,000 people in 31 countries speaking 50 languages around the world.

IHS Markit serves businesses and all levels of governments worldwide ranging from 85% of Global Fortune 500 to small businesses. IHS Markit provides comprehensive content, software and expert analysis and forecasts to more customers in more than 180 countries worldwide.

Information, analytics, and expertise

IHS Markit offers must-have business information, advanced research and analytics, and deep expertise in core industry sectors, such as energy and natural resources, chemicals, electronics, and transportation. We focus on business-critical workflows that support our customers’ needs, including:

Strategy Planning & Analysis:
- Strategic Planning, Corporate Development, M&A, Investment Analysis, Risk Assessment
- Energy Technical: Exploration-Production, Geoscience, Engineering, Commercial Development
- Product Design: Engineering Design, Research and Development
- Supply Chain: Procurement, Logistics, Operations, Manufacturing
- Environmental Health, Safety & Sustainability: Sustainability, Regulatory, Environment Health and Safety

This interconnected information, expertise, and analytics across industries and workflows allows IHS Markit to provide best-in-class solutions that power growth and value for our customers.
About IHS Markit

IHS Markit (Nasdaq: INFO) is a world leader in critical information, analytics and solutions for the major industries and markets that drive economies worldwide. The company delivers next-generation information, analytics and solutions to customers in business, finance and government, improving their operational efficiency and providing deep insights that lead to well-informed, confident decisions. IHS Markit has more than 50,000 key business and government customers, including 85 percent of the Fortune Global 500 and the world’s leading financial institutions. Headquartered in London, IHS Markit is committed to sustainable, profitable growth.