Global LPG: Opportunities and Challenges in an Evolving Market

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Dr. Walt Hart, Vice President, NGLs
+1 832 679 7240
Walt.Hart@ihsmarkit.com
Agenda

1) A few observations about the global LPG market
2) Economy and energy context
3) Global LPG production, consumption & trade
4) LPG as a petrochemical feedstock
5) LPG demand drivers
6) LPG pricing
7) Parting thoughts
LPG is a supply driven market, and most global LPG supply growth comes from only a few regions

Global LPG production by major source

Bio-LPG is unlikely to become an important contributor
Probably the most striking dynamic in the global LPG markets is the ascendancy of the US to be the world’s largest LPG exporter.
The dramatic increases in US exports have resulted in major changes in global LPG trade flows – incremental US exports have to move to Asia.
Economic expansion is still expected in 2019, although growth is slowing globally; the risk of recession increases in 2020 but is not forecasted.
Long term crude oil: US shale oil plays to plateau by the late 20s, with global demand peaking around 2030
Lower oil prices have reduced US investment but the effect on oil and gas production will lag; most near-term supply could be produced below $50/bbl

Monthly US crude oil production

Markers show annual average production for each year

Economy and Energy Context
US natural gas production is constrained by domestic and LNG demand – demand that is not met by associated gas will be met by non-associated gas.
The rapid rise in US NGL production is driven by development of the major shale gas and tight oil plays; supply from refining is relatively small and flat.

Specification ethane production has a major demand component.
US LPG supply greatly exceeds domestic demand and the balance must be exported
Propane production growth should slow in the next decade as US shale development matures and global oil demand growth slows.
Refineries make up a larger proportion of global butane production than for propane production, reducing the influence of slower US shale growth.
For propane, premium demand falls short of supply, allowing chemical feedstock markets to grow.
For butane, residential / commercial demand in Asia should largely keep pace with increased global supply.
The US has become the largest exporter of propane; most imports are into Asia
The Middle East remains the dominant exporter of butane; Asian butane imports have increased dramatically.
Waterborne LPG exports have become increasingly rich in propane, even as many growing Asian residential / commercial markets require butane-rich LPG.

Global waterborne LPG trade by source

Global Waterborne LPG Exports by Grade

Source: IHS Markit
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Source: IHS Markit
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Despite having fewer types of commercial scale applications, propane consumption as a petrochemical feedstock is much higher than for butane.
Chinese PDH propane demand growth slowed down in 2018 but is set to resume in 2019.
LPG has become increasingly important to the olefin equation as crackers shift to ethane from naphtha – less propylene from crackers means more on-purpose propylene

Global Ethylene production by feed type (KTA ethylene by feed)

- Naphtha 42%
- Ethane 38%
- LPG 14%
- Other 6%

2017 (inner)
Production = 153 MMTA

2022 (outer)
Production = 186 MMTA

Global Propylene production by source

- Steam Crackers
- FCC Splitters
- Dehydro
- Metathesis
- Other

Source: IHS Markit

Label percentages are for 2017

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Price sensitive demand for LPG is becoming more flexible in Asia

Price sensitive LPG cracking by region

Source: IHS Markit, Global Trade Atlas

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Global LPG demand growth will continue to be led by Asia
More than half of the top 10 total LPG demand countries are in Asia

Total Global LPG Demand Ranked by 2017 Data

- United States
- China
- India
- Japan
- Saudi Arabia
- S Korea
- Mexico
- Brazil
- Indonesia
- Rest of World
Residential / commercial LPG demand is growing steadily but chemicals demand clears the market
Together, India and China represent ~37% of global residential / commercial LPG demand
Northeast Asia LPG Demand: It’s not all Chinese PDHs…

LPG demand in Northeast Asia by end use

- Chemical
- Engine Fuel
- Industrial
- Residential and Commercial
- Other (Production)

LPG demand in Northeast Asia – Impact of China

- NE Asia ex China
- China Ethylene
- China PDH/BDH
- Other China
- China Res/Com/Ind
- Production
LPG Tariffs: About 3.5 million tons of propane were exported to China from the US in 2017 – now down to nil

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<th>Chinese Waterborne Propane Imports by Source Region</th>
<th>US Waterborne Propane Exports by Destination</th>
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<tr>
<td>Million tons propane per month</td>
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- **Africa**
- **Middle East**
- **Europe**
- **Other**
- **United States**
- **Americas ex US**
- **Australia**
- **Japan**
- **Brazil**
- **Dominican Republic**
- **Indonesia**
- **South Korea**
- **Netherlands**
- **Mexico**
- **China**
- **Other**
- **Undetermined**

US tariffs announced January and March 2018; Chinese retaliatory tariffs announced April 2018
The trade pattern from the United States to Asia has already shifted, with Chinese LPG prices now at a premium over the rest of Northeast Asia.
Industrial sectors helped buoy LPG demand in China during 2015/16 owing to LPG’s favorability against LNG, but the economics have since shifted.
South Asia* LPG Demand: Growth is driven by India’s residential / commercial market

LPG demand in South Asia by end use

LPG demand in South Asia is mostly from India

*Excludes the Middle East & SE Asia
Southeast Asia LPG Demand: Increasing petrochemical growth adds to residential / commercial demand
The residential/commercial sector drives demand growth in many Asian markets; new markets are emerging but some large markets have slowing growth rates.

Many growing markets are relatively butane rich.
The greatest potential to replace biomass* with LPG is in Africa and Asia

Residential & commercial use of biofuels and waste in 2016; ~757 million tons oil equivalent

- OECD Americas 3%
- NonOECD Americas 4%
- China 11%
- Non-OECD Asia Excluding China 35%
- Africa 39%
- OECD Europe 6%
- NonOECD Europe/Eurasia 2%
- OECD Asia Oceania 0%
- Middle East 0%

*Includes charcoal
Source: IEA
The greatest potential to replace kerosene* with LPG is in Asia and the Middle East

Residential & commercial use of kerosene in 2016; ~32 million tons oil equivalent

- OECD Asia Oceania: 41%
- China: 4%
- OECD Americas: 3%
- NonOECD Americas: 1%
- OECD Europe: 9%
- NonOECD Europe/ Eurasia: 0%
- Middle East: 15%
- non-OECD Asia Excluding China: 20%

Source: IEA “other kerosene”
The greatest potential to replace res / com coal* with LPG is in China

About a third of res/com coal is used in commercial applications

Residential & commercial use of coal in 2016;
~107 million tons oil equivalent

- China: 65%
- OECD Europe: 15%
- NonOECD Europe/ Eurasia: 6%
- OECD Asia Oceania: 1%
- Middle East: 0%
- Non-OECD Asia Excluding China: 8%
- NonOECD Americas: 0%
- OECD Americas: 0%
- Africa: 5%

Source: IEA *includes peat and coal byproducts

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Where will the next wave of res/com LPG demand arise?

**LPG market development versus GDP per capita in selected countries**

- **Subsidized markets**
  - Morocco
  - Egypt
  - Indonesia

- **High potential?**
  - India
  - Bangladesh
  - Nigeria
  - Malaysia
  - Thailand
  - Vietnam
  - Ukraine

- **Maturing: parts of Asia, Latin America**
  - China
  - Brazil

- **Natural gas displacement: E Eur**
  - South Africa
  - Ghana
  - Kenya
  - Germany

Source: IHS Markit, IEA

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IHSM LPG Price Forecasting Mechanism

1. Cash cost vs naphtha and winter fuel competition
2. Contract freight differentials to NE Asia
3. Freight differentials to NE Asia*
4. Freight differential from US
5. Freight differentials from various regions*

* Adjusted for winter heating demand spike
LPG should be a favored steam cracker feedstock in Northeast Asia while US LPG exports continue to grow.

Japan butane feedstock economics

Japan propane feedstock economics

Source: IHS Energy, IHS Chemical, Argus © 2018 IHS Markit

Constant $/metric ton

Favorable

Unfavorable

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Source: IHS Energy, IHS Chemical, Argus
Waterborne LPG freight has seen a recent increase as utilization of excess capacity grows.
We expect a gradual rise in VLGC freight rates assuming no surge in construction of VLGCs

Waterborne freight costs to Japan

- Arab Gulf to Japan: 75,000 cbm
- Australia to Japan: 75,000 cbm
- USGC to Japan: 75,000 cbm
- USGC to Japan: 75,000 cbm (via Panama Canal)

Source: IHS Energy

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The spot arbitrage will occasionally close but most LPG coming to Asia from the Middle East and the US is on contract
LPG prices at Mont Belvieu reflect Northeast Asia LPG prices and freight
In the US, LPG will be competitive as a feedstock vs. ethane while LPG production grows and logistical constraints for ethane persist.

**USGC Ethylene Variable Cash Costs**

- **Purity Ethane**
- **Propane**
- **Lt Naphtha**
- **Butane**

Source: IHS Markit, OPIS

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Propane prices should strengthen as US export growth slows
Global butane balances will be tighter than for propane, such that differentials of US butane to other international benchmarks will likely be smaller than for propane.
US prices have mostly been in line with other international benchmarks since US LPG export terminal capacity was sufficiently expanded.
Parting Thoughts – Some Things to Watch…

• **Crude oil** has long been a driver for LPG production and pricing; US oil and LPG production are sensitive to the current high levels of volatility and risk in the global crude oil markets

• **US shale oil** plays will eventually mature, and strategic planners should prepare for the impact on global LPG markets, and particularly on propane

• Increased **ethane feedstock** use may reduce the amount of LPG needed for ethylene production, but will increase the amount of LPG needed for propylene and butylenes via dehydrogenation

• It won’t hurt to have **Mont Belvieu prices** factored into Asia regional pricing formulas, but it is less important now that US prices are more closely following other international benchmarks

• **Tariffs** have reshuffled Asian propane importers, but what happens when the Chinese need to buy more propane for new PDH units, or if the tariffs go away following a trade deal?

• 3 of the world’s 4 most populous countries have had major **res/com demand** surges in the past ten years, and 2 of those have slowed their growth already – how will that demand be replaced?

• LPG for **power generation** and **bunker fuel** are hot topics; watch for any new large projects
Thank You!

Dr. Walt Hart
Walt.Hart@ihsmarkit.com
+1 832 679 7240

IHS Markit Customer Care
CustomerCare@ihsmarkit.com
Americas: +1 800 IHS CARE (+1 800 447 2273)
Europe, Middle East, and Africa: +44 (0) 1344 328 300
Asia and the Pacific Rim: +604 291 3600

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