Goals

To understand

- What “NGL’s” are
- Size and characteristics of the NGL markets
- Market Fundamentals (USA):
  - Supply
  - Demand
  - Logistics costs
  - Physical basis calculations/impact on gas value
NGL Supply – U.S. Overview

- Almost 100% of the ethane production in the U.S. and Canada is sourced from natural gas processing plants.
- 60% of global NGL is produced from natural gas (U.S. is app. 75%).
NGL Supply – NGL’s from Natural Gas Shale Gas Basins

Now account for 20+% of total U.S. gas production and potential 15+ years of reserves
Definitions – NGL’s

What is NGL?

- **NGL** – **Natural Gas Liquid**
- Typically refers to ethane, propane, butanes, and natural “gasoline” (pentanes)
- NGL’s are hydrocarbons removed (condensed) as a liquid from a hydrocarbon stream that is typically in a vapor phase (i.e. natural gas)
- They are kept in a liquid state for storage, shipping and consumption
Difference between “NGL & LPG”

Natural Gases

Methane (C$_1$H$_4$)
Ethane (C$_2$H$_6$)
Propane (C$_3$H$_8$)
Butane (C$_4$H$_{10}$)
Isobutane (C$_4$H$_{10}$)

Pentanes (C$_5$H$_{12}$)
Naphtha
Natural Gasoline
Condensate

Non-hydrocarbon gases such as: CO$_2$, H$_2$O, H$_2$S, N$_2$ etc.

Dry Gas or ”Natural Gas”
LPG
NGL

Heavier fractions

Definitions - NGL Types

“Purity Products”

“Purity” means that most (at least 90%) of the liquid stream contains one type of molecule

- Ethane
- Propane
- Iso-butane
- Normal butane
Definition of Terms
Ethane

- Simplest molecule containing more than 1 carbon atom (C_2H_6)
- Foundation of many compounds in the petrochemical industry
- Abbreviated as “C_2”
- Vaporizes at -126°F (-88°C)
Definition of Terms
Propane

- Abbreviation – $C_3$
- Chemical composition
  - $C_3H8$
  - Boiling point -44°F (-42°C)
Definition of Terms

Normal Butane

- Abbreviation – NC₄
- Chemical composition
  - C₄H₁₀
    - Boiling point 32°F (0°C)
Definition of Terms
Iso-Butane

- Abbreviation – IC₄
  - Boiling point 11°F (-12°C)
  - Also known as methylpropane

- Chemical composition
  - Is an ‘isomer’ of normal butane – different arrangement of the hydrogen molecules makes it behave differently; weighs less than NC₄
  - “Isom” (Isomerization) units convert normal butane to iso-butane when demand for IC₄ is high
Definition of Terms

“Mixed” Products

“Mixed” means that the product stream contains at least 2 different types of molecules.

Products sold as mixes:

- Ethane – propane mix (E/P)
- Natural gasoline (C₅+)

MIDSTREAM ENERGY GROUP
Definition of Terms

E/P Mix

- A blend of ethane and propane meeting the individual specifications for each
- Used only for ethylene production
- “Typical” blend quoted in market reports is 80% ethane/20% propane
  - Some chemical companies require custom blends
  - Price quoted as “ethane in E/P” for the 80% portion and the purity propane price for the 20% propane portion
Definition of Terms
Natural Gasoline

Abbreviation – C_{5+}
(the “+” means it’s a mix of pentanes plus heavier molecules such as C_{6-9} in smaller amounts)

Usually few molecules heavier than C_{10}

Markets

- Gasoline blending
- Ethylene production
- Solvent production (specialty application)
- Ethanol (denaturant)
- Diluent for use in syncrude operations
NGL Market Characteristics
NGL Supply/Demand Overview
How Big Is This Market?

- **Global supply – NGL:**
  - 11.8 million BPD:
    - 1.79 million BPD ethane
    - 7.77 million BPD propane and butanes (aka “LPG”)
    - 2.23 million BPD gas plant condensate/C₅+

- **Sources**
  - Natural gas processing – 60%
  - Crude oil refining – 40%

- Relative to crude oil and refined products, market size is small
  - Global crude oil and gas liquids supply is 89-91 million BPD
  - NGL/LPG is 13% of this

- NGL’s are getting more attention now:
  - NGL’s are a growing source of revenue for gas producers
  - NGL production in the U.S. is 1/3 of our total crude and NGL supply
NGL Markets Overview
USA

### NGL Supply Sources

- **Gas Processing & Fractionation**
  - 74%
  - 2,249 M BPD

- **Crude Oil Refining**
  - 20%
  - 620 M BPD

- **Overland & Waterborne Imports**
  - 6%
  - 177M BPD

### NGLs Produced

- **Ethane**
  - 42%

- **Propane**
  - 28%

- **Normal Butane**
  - 8%

- **Iso-Butane**
  - 9%

- **Natural Gasoline**
  - 13%

- **Ethane**
  - 5%

- **Propane**
  - 53%

- **Butanes**
  - 10%

- **Natural Gasoline**
  - 13%

- **Ethane**
  - 58%

- **Propane**
  - 23%

- **Normal Butane**
  - 5%

- **Iso-Butane**
  - 2%

- **Natural Gasoline**
  - 12%

- **Propane**
  - 60%

- **N-Butane**
  - 11%

- **Natural Gasoline**
  - 29%

(Please note: Natural Gasoline is typically used as a diluent in the production of hydrocarbons.

### NGL Demand

- **Petrochemicals**
  - 54%
  - 1,619 M BPD

- **Motor Gasoline Components**
  - 17%
  - 335 M BPD

- **Space Heating & Other Fuel Uses**
  - 19%
  - 567 M BPD

- **Exports**
  - 7%

- **Inventory Changes**
  - 3%

1. Percent of bbls from this source
2. Refinery naphtha exported to chemical plants
3. Canada exports app. 2/3 of its propane to the US

Source: EIA, Waterborne LPG Report, Hodson Report, MEG Analysis

(12 Month Averages – March 2011 to Feb 2012)
In a low gas price environment, NGL value is a key component of cash flow for gas producers.

NGL volume available for extraction depends on:
- Amount of gas available to processing plants
- How much NGL is contained in the gas that is produced

NGL volume actually extracted depends on:
- Process technology employed for NGL extraction
- NGL prices at the plant, net of transportation to market
- Economics of recovering ethane
- Processing contract terms
NGL’s from Natural Gas Forecasting Gas Supply When Gas Prices Are Low

Factors affecting gas volume forecasts:
- The producer’s price hedge positions
- Impact of slowing production rates on the total amount of gas that can be recovered
- “Take or pay” comments to service providers, such as pipelines, gas plants, NGL service companies
- Expiration of lease agreements – keep drilling or lose the lease
- Drilling contracts – keep drilling or lose the rigs
- NGL value impact on overall gas revenue – higher values may support continued drilling
NGL’s from Natural Gas
“Dry Gas” = Lower NGL Revenue, Lower Returns

Fees to move NGL’s to market can make a big difference in wellhead value

<15% Rate of Return

Source: Credit Suisse
Top NGL Producers in the U.S. Midstream Companies Are Primary Suppliers

Only 4 of these companies are also top gas producers; the others are midstream companies.

Source: DCP Midstream
NGL’s from Gas - Processing Economics
Gas Plant Profitability Metric – “Frac Spreads”

- The gas plant equivalent of a refinery “crack spread”
- Measure of gross profitability for gas plants
- Calculated as the difference between the revenue from sales of NGL’s contained in a gas stream as liquid and their value if left in the gas pipeline and sold at gas prices
NGL’s from Gas - Processing Economics
NGL Yields – “Gallons Per Mcf”

Need to know how much of the gas stream is NGL and what type NGL it is
“Theoretical” NGL yield is 100% of what the sample shows is there
The acronym for the “Gallons Per Mcf” of NGL’s in a gas stream is “GPM”
NGL Composition Trend
Higher Ethane Content per Barrel

US Composite NGL Barrel Composition by Component

<table>
<thead>
<tr>
<th>Component</th>
<th>2009 Average</th>
<th>Dec 2011 Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethane</td>
<td>768 M BPD</td>
<td>1,005 M BPD</td>
</tr>
<tr>
<td>Propane</td>
<td>547 M BPD</td>
<td>669 M BPD</td>
</tr>
<tr>
<td>Butane/C5+</td>
<td>595 M BPD</td>
<td>677 M BPD</td>
</tr>
<tr>
<td>Total</td>
<td>1,910 M BPD</td>
<td>2,351 M BPD</td>
</tr>
</tbody>
</table>

Volumes are rising – but C4+ volume share of the NGL Barrel has fallen by 2%

Source: EIA, MEG Analysis
NGL’s from Gas - Processing Economics
Gas Quality – Example “GPM” for Various Basins

<table>
<thead>
<tr>
<th>Rich Plays</th>
<th>NGL (GPM) Content*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avalon/Bone Springs**</td>
<td>4.0 to 5.0</td>
</tr>
<tr>
<td>Bakken**</td>
<td>4.0 to 9.0</td>
</tr>
<tr>
<td>Barnett</td>
<td>2.5 to 3.5</td>
</tr>
<tr>
<td>Cana-Woodford</td>
<td>4.0 to 6.0</td>
</tr>
<tr>
<td>Eagle Ford***</td>
<td>4.0 to 9.0</td>
</tr>
<tr>
<td>Granite Wash</td>
<td>4.0 to 6.0</td>
</tr>
<tr>
<td>Green River**</td>
<td>3.0 to 5.0</td>
</tr>
<tr>
<td>Niobrara**</td>
<td>4.0 to 9.0</td>
</tr>
<tr>
<td>Piceance-Uinta</td>
<td>2.5 to 3.5</td>
</tr>
<tr>
<td>Green River</td>
<td>2.5 to 3.5</td>
</tr>
<tr>
<td>Marcellus (Rich)</td>
<td>4.0 to 9.0</td>
</tr>
</tbody>
</table>

* gpm – gallons of NGLs per 1000 cu. ft.
** Oil Shale Plays
*** Both an Oil and Gas Shale Play
NGL’s from Gas – Yield Estimates Impact of Gas Plant Technology

Plant technology determines the limit of the NGL’s that can actually be recovered from the gas:

- **“Lean oil” plant NGL recoveries**
  - Least efficient for ethane, propane
  - 99% butanes and C5+, 65-75% propane, only 15-30% ethane

- **Refrigeration plants (use propane to “chill” the gas to remove more NGL)**
  - More efficient
  - 100% propane, butanes, and C5+, up to 80-85% ethane

- **Cryogenic (turbo expander) technology**
  - Most efficient and most expensive to build
  - 100% propane, butanes and C5+, up to 85-90% ethane
Gas liquids are expensive to handle, store, and transport compared to refined products

- Require high pressure and/or low temperature to maintain liquid state for shipment and handling
- Highly flammable – vapor “crawls” instead of rising; is heavier than air
- Needs special trucks, ships and storage (thick steel, insulated tanks, or underground caverns for large volumes)
NGL Logistics – Realized Pricing Estimates “Netback” Market Concept & the “T &F” Fee

- NGL values basis different locations consist of the commodity component and a location component.
- The commodity component is the value for the product itself, but:
  - NGL prices are only published at a few locations where large volumes are traded (hubs).
  - These traded prices must be adjusted by a location differential to get the value at the plant tailgate.
- Realized pricing at the plant = Hub value - the Fractionation cost – Transportation Cost.
- This is known as a “T&F” adjustment.
NGL Logistics
Impact of Location on Realized Prices

Ethane Recovery:
- Must consider the cost of getting to market when making ethane recovery decisions:

Jan 2010 – April 2012 Average Ethane Frac Spread:
- At Opal with estimated “T&F” included = $ .59/Mmbtu
- At Conway w/o fee deductions = $2.50/Mmbtu
NGL Logistics Costs
“T&F” Cost Snapshot – Field to Hubs

Estimated ranges for transportation & fractionation of mixed NGL’s – new build economics
## NGL’s from Gas - Processing Economics

### NGL Revenue Calculation – Plant Income

<table>
<thead>
<tr>
<th>NGL Component</th>
<th>Volume</th>
<th>Actual Yield</th>
<th>Transport Fee</th>
<th>Fractionation Fee</th>
<th>At Market Location</th>
<th>Gross NGL Revenue</th>
<th>Plant’s “Netback” NGL Revenue</th>
</tr>
</thead>
</table>

\[
\text{Component Revenue} = \text{NGL Component Volume Actual Yield} \times \text{At Market Location} = \text{Gross NGL Revenue} - \text{Transport Fee} - \text{Fractionation Fee} = \text{Plant’s “Netback” NGL Revenue}
\]
NGL’s from Gas - Processing Economics
NGL Revenue Calculation & Producer Income

Plant NGL Netback Revenue

$ $ $

= $

Plant Processing Fee(s)

= $$

Producer NGL Revenue Share

Producer NGL Revenue Share

+ Producer Gas Sales

= $$$

Producer Total Gas Stream Revenue
Pipeline Expansions Underway All Heading to Mont Belvieu


Source: Oil & Gas Journal, May 7, 2012 *In development/construction
Ethane Markets

Ethane for Ethylene Production:

% of Feedstock Market

Total Ethylene Feedstock Market

- Total feedstock demand still 191M BPD less than 2004
- Ethane produces more ethylene with fewer pounds of feedstock
Ethane for Ethylene - Outlook

- Expansions under way will add 60-80M BPD demand to the Gulf Coast area by 2013.
- New units planned for 2016-7 could add 200M BPD more.
- But meantime, supply growth is outpacing demand.

Ethane demand increasing:
- Peak 950M BPD 2010
- Peak 1.015 million BPD Nov 2011
- Forecast 1.2 million BPD by 2015
Ethane Frac Spreads $/Mmbtu
Current Trends 2010-2012

Prices & spreads peaked in Nov 2011; record demand Dec 2011
Ethylene plant turnarounds began Jan 2012 – will prices move up when they’re over?
Conway showing price pressure due to oversupply; can’t get the excess barrels south
Ethane Prices
How Low Can They Go?

Ethane – the alternate market is natural gas
- Price Forecast – start with the base price of gas at the plant tailgate, plus cost to recover it as NGL, plus transportation and fractionation cost (T&F), plus a margin

Example – assume gas price of $2.00/MMBTU
- Gas value is 13.18 CPG (BTU equivalent in CPG)
- Transportation and fractionation of 13.8 CPG
- Plant NGL extraction cost of 2.00 CPG (incremental expense)

Would need a minimum of 34 CPG at the hub to justify recovery for this plant (13.18 + 13.8 + 2.00 + 5.00) to earn a 5 CPG margin as a return
Propane Demand Trends
Demand Declining in Traditional Markets

- Little change in total US balance 2008-2011
- Refinery supply & imports are falling
- Apparent demand in traditional markets is declining
- Increase in gas plant supply is going to export & chemicals
Propane Prices Reflect Supply Imbalance

Seeing price pressure:

Propane Price as % of WTI
Propane – Heading Offshore Already

Rising Inventories and Exports:

Terminal Capacity Booked through 2013
Prices will settle at levels that encourage buying for winter

Source: EIA
Gas plant supply of NC4 is flat in spite of increase in overall NGL volumes; possibly converting some to IC4, leaving some in C5+

2011 net refinery balance is surplus of between 60 M BPD mixed butane

Refinery demand includes direct blending and refinery isomerization feedstock

Swing market is ethylene feedstock

Source: EIA, MEG Analysis
Butane Supply Exceeding Domestic Demand

Also switching from imports to exports:

Supply/Demand – Iso Butane 2009-2011

- Big increase in supply – up 17% Dec 2011 vs. Dec 2010
- Refinery demand meeting the challenge so far
- Propylene oxide production uses IC4 as well

Source: EIA, MEG Analysis
Supply/Demand – C5+ 2009-2011

- Gas plant supply up 10+% Dec 2011 vs. Dec 2010
- Imports rising – trans-shipments going to Canadian market
- Refinery blending market is stable
- High crude prices and strong diluent market limit chemical demand

Source: EIA, MEG Analysis
NGL Markets – Butane/Pentane
“Death Watch” for C4 and C5+ Summer Blending?

Key concerns for NGL markets will be proposed reductions in RVP and sulfur content.

Ultimate impact depends on:
- How much RVP is reduced and where
- Sulfur limits
- Changes in product flows resulting from closure of East Coast refineries
- Whether WTI moves back toward parity with coastal crudes and pressures Mid-Continent refineries
NGL Market View Summary

- Current bottlenecks in the logistics systems will be resolved when new pipeline, fractionation, and terminal capacity is in operation – 18-24 months
- Basis spreads between regions will settle at levels closer to the cost of new capacity but will stabilize at higher levels than in the past
- Propane supply will seek export markets near term; on purpose propylene production should help balance markets in 2-3 years
- Limited growth in motor gasoline demand, uncertainty around future fuels regulations is driving assumptions that increased butane supply will have to be moved offshore, or consumed in “on purpose” butadiene plants
  - The surplus is likely to be mixed refinery butane – treating, storage, and expanded logistics needed to handle this in the open market
- Demand for C5+ in ethylene cracking & gasoline blending not forecast to increase
  - Diluent market capability to handle increased volumes may depend on a crude export outlet other than the U.S.; prices already falling as supply grows in Upper Plains region
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