HYDROCARBON AND ASSOCIATED PRODUCTS
VALUE CHAIN – IMPACT ON SOCIETY

Energy and Society, CH EN 6158
Alan Walker
May 29, 2014

Purpose

• Provide working knowledge of hydrocarbon price issues and products
• Working vocabulary of value chain
• Understand additional products that impact society
• Understand price impact on society
Outline

- Key Concepts and Terminology:
  - Sources and Uses from Energy Information Administration (EIA)
  - Petroleum Administration Defense Districts (PADD)
- Primary Products
- Price ranges
- Trading points
- Other products
Petroleum Administration Defense Districts (PADDs)

- Established by Executive Order during WWII, used for gasoline rationing
- Used for tracking an analysis of petroleum product movements throughout the nation

Primary Products

- Crude Oil
- Natural Gas
- Natural Gas Liquids

How prices are set

- Where product is traded
- Long term price history (25 years)
- Recent price history (5 years)
Crude Oil

- Commodity
- Major
  - Dubai
  - WTI
  - Brent
- Regional
  - Black Wax
  - Yellow Wax

Crude Oil as a Commodity

- Crude oil is composed of many different hydrocarbons
  - There is also a wide range of crude oils – heavy, light, sour, sweet
  - Regional variations
  - How is this all reconciled into global commodity pricing?

- Traded as a commodity around the world based on several indices or "baskets"
- Main examples include:
  - West Texas Intermediate (WTI – US)
  - Brent Blend
  - Dubai Crude
Long-term Crude Oil Prices

Dubai Crude

- Light (31 API), high sulfur (2% by mass)
- Used as bench price for Middle Eastern crude sold in the Asian markets
- Close link to Brent
Brent

- Light (37-42 API), sweet (0.37% sulfur) blend
- Brent – Acronym for field blends - Broom, Rannoch, Etive, Ness and Tarbert
  - Brent is a blend of approx. 15 crudes
- Historically, price is +/- $3 WTI
  - Price disconnect post September 2010

West Texas Intermediate (WTI)

- Light (39.6 avg. API), sweet crude (0.24% sulfur avg.)
- Major index traded on New York Mercantile Exchange (NYMEX)
  - Main trading hub in US is Cushing, OK
- Historically, has followed Brent pricing
  - Since Sept 2010, disconnect between Brent and WTI has grown
Where’s CH EN 6171?

Cushing, OK

- Nameplate storage capacity of 65,739 MBBL
  - 10-15% of total US crude storage capacity
- Delivery point for WTI
- Major Storage holders include:
  - Enbridge
  - Plains LP
  - Magellan
  - Blueknight
  - SemGroup
  - Enterprise
  - ConocoPhilips
  - Sunoco Logistics
WTI Pricing Trends, Last 5 Years

Bakken reaches 1MMBPD
Eagle Ford reaches 1MMBPD

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<tr>
<th>Date</th>
<th>WTI (USD)</th>
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<td>Nov 2012</td>
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<td>Mar 2014</td>
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<td>107.41</td>
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WTI Pricing

- In 2013, the WTI discount to Brent was over $20/bbl in February
- Declined to roughly $3/bbl in July
- Rose again to $12/bbl in December

Reasons

- US Crude export ban
- Declining Brent reserves
- Buildup of US crude inventory in Cushing with lack of capacity to move product to Gulf Coast
- All of these point to the same thing – Domestic oil boom
Crude Oil Marketing

- WTI, Brent, Dubai represent major benchmarks
  - Many other crude blends represent other regional products
  - Domestically, Louisiana Light Sweet (LLS), Alaskan North Slope (ANS), Bakken etc.
  - These are all indexed against major benchmarks like WTI

- **Spot Price** - The price for a one-time open market transaction for immediate delivery of a specific quantity of product at a specific location where the commodity is purchased "on the spot" at current market rates.

Where is oil this coming from, domestically?
Natural Gas

- Commodity: Mostly Methane
- NYMEX – primary
  - Henry Hub: Erath, Louisiana
  - Second most volatile commodity
- National Grid
- US Units: 1 MMCF = 1,000 MCF
  - 1,000 MMCF = 1 BCF = 1 MMMCF
  - 1 MCF = 1,000 SCF
  - 1 SCF ~ 1015 to 1030 BTU (Pipeline Quality)

  - 1 Decatherm = 1,000,000 BTU = 1 MMBTU = 10 Therm
  - 1 Therm = 100,000 BTU

Natural Gas Markets and Pricing

- Annual Base Load
  - Usually fixed or variable price
- Monthly Base Load
  - Fixed, variable, or indexed price
- Daily Spot
  - Usually fixed price
- Storage
  - Used to provide daily or inter-day flexibility
  - Usually inject during warm weather and withdraw during heating season

- Fixed price
- Index price
- Usually take or pay
- Additional cost for flexibility
Fixed Price

- Negotiated or RFP driven
- Fixed price by majors
- Most large independent or smaller use commodity traders
- Many large industrials use commodity traders
- Many small industrials use utility tariff schedules or commodity traders
- Derivatives: fixed-for-float swap is most common
  - Caps
  - Floors
  - Collars
  - Puts and calls
  - Commodity on commodity derivative

Monthly base load

- Can be based upon index or fixed price
- Index by region

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<tr>
<th>Location</th>
<th>Bidweek Avg to Date</th>
<th>Bidweek Vol to Date</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
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<td>$4.3357 37,000</td>
<td>$4.4025 5,000</td>
<td>$4.3146 30,000</td>
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<td>Kern River Gas Transmission Co. - on system delivery</td>
<td>$4.7744 30,600</td>
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<td>Kern River Gas Transmission Co. - on system receipt</td>
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<td>$4.5665 15,500</td>
<td>$4.6000 15,000</td>
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</table>

Source: Intercontinental Exchange, April 30, 2014
Daily Spot

- Most trades take place from around 7:00 to 10:00 am MT or scheduling deadline for the following day’s delivery
- May be extremely volatile

Source: Intercontinental Exchange (ICE) April 2014

WEST Day Ahead Indices

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<th>Wild Avg Index</th>
<th>Change($)</th>
<th>Change(%)</th>
<th>High</th>
<th>Low</th>
<th>Vol(WMB T)/</th>
<th>No. of Trades</th>
<th>No. of Companies</th>
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Source: Intercontinental Exchange (ICE) April 1, 2014
Natural Gas Liquids

- NGLs include:
  - Natural Gasoline
  - Isobutane
  - Normal butane
  - Propane
  - Ethane

How NGLs are Priced

- NGL Prices expressed in dollars per gallon

- Index based on prices set at:
  - Mont Belvieu, TX – Largest consuming region of NGLs in US
    - Strategically located on Gulf Coast – Market access
    - Significant storage capacity
  - Major driver of Mont Belvieu prices – Petrochemical Demand

- NGL prices higher than natural gas due to processing costs
NGL Price Trends

Trends in spot natural gas liquids prices in 2012
cents per gallon

Polar Vortex

- Indicates the volatility of NGL market, particularly in propane
- Propane prices at Conway, KS (second to Mont Belvieu in size of NGL hub)
  - June 2013 - $0.80/gal
  - Jan 2014 - $4.93/gal (nearly $210/bbl)
- Propane is a major heating fuel – cold temps combined with high agricultural use and exports created major shortage, high price volatility
Ethane Rejection

- Ethane must be processed, transported and fractionated
- Booming shale gas production has led to an oversupply of ethane
  - High BTU shale gas means we produce more ethane than petrochemical companies can use
- What happens to this over-supply?
  - Ethane Rejection – producers simply leave ethane in natural gas stream
  - At times, ethane is cheaper to burn than separate and sell

Other products that affect society

- Carbon dioxide
- Helium
- Sulfur
- Liquefied natural gas (LNG)
- Refinery products
Liquefied Natural Gas

- Limited use in the US to date, but highly promising as alternative transportation fuel
  - Truck
  - Rail

- Several large export terminals proposed along Gulf Coast and West Coast
  - Seen as a tool to ease domestic supply glut of natural gas
  - Major international energy source

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Global LNG Export Leaders

![Image: Global LNG Export Leaders]

Figure 3.3: Share of Global LNG Exports by Country, 1991-2012

Sources: Cedigaz, GGI/NL, Waterborne LNG Reports, US DOE, PFC Energy Global LNG Service
Global LNG Import Leaders

Japan and Korea are the world’s dominant LNG importers, consuming 52% of LNG supplied to the market in 2012.

<table>
<thead>
<tr>
<th>Country</th>
<th>Imports (%)</th>
<th>Change (2012 vs 2011)</th>
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<td>87.3</td>
<td>+8.6</td>
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<tr>
<td>South Korea</td>
<td>36.8</td>
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<tr>
<td>China</td>
<td>14.8</td>
<td>+1.9</td>
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<td>-3</td>
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<td>Other</td>
<td>7.1</td>
<td>+0.0</td>
</tr>
</tbody>
</table>

Figure 3.6: LNG Imports by Country: 2012 Imports & Incremental Change Relative to 2011 (in MTPA)

“Other” includes Canada, UAE, Greece, Thailand, Puerto Rico, Dominican Republic, Indonesia, and the Netherlands

Sources: Waterborne LNG, US DOE, PFC Energy Global LNG Service

Helium

- Prized for its inert properties:
  - Low boiling point
  - Low density
  - Low solubility
  - High thermal conductivity

- Used for silicon production, arc welding, tracer gases, cryogenics
Sulfur
- Byproduct of refining process
- H2S converted to elemental sulfur for air quality concerns
- Main use of elemental sulfur is sulfuric acid (62.7% of use - USGS)
- Production of phosphatic fertilizers
- Copper ore refining
- Also used in some refining/coal product production processes

Sulfur recovered from hydrocarbons ready to export, Vancouver