North America Oil & Gas
Exploration & Production

Energy (Oil & Gas) Market Dynamics:
Investments, Trading and Price Interactions

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Bob Brackett is the Senior Research Analyst covering North American Oil & Gas Exploration & Production. He is currently recognized as All-American #1 by Institutional Investor (for the 5th year in a row). Previously, Bob was Director of E&P Planning and also Director of Corporate Strategy for Hess Corporation. Before Hess, Bob was an Engagement Manager with McKinsey & Company's Petroleum Practice, serving the majority of the world’s largest oil companies across five continents and 30 countries throughout the petroleum value chain. Bob began his career with ExxonMobil, spending eight years in positions in Exploration, Business Development, Development and Research. As a NASA Space Grant Fellow, Bob received his PhD in Earth & Planetary Sciences from Washington University – St. Louis. He received his MBA from Rice University in Houston. He also holds a BS in Geophysics and a BA in Astronomy from the University of Texas.
Key points

Why US oil supply response matters so much
   Global supply (outside of 3 countries) isn’t growing

How do E&Ps think about funding
   Cash in ~ cash out (except when greedy or scared)

How E&Ps won the shale war

Our forecast of US supply
   Oil price, reinvestment rate, inflation, and well efficiencies drive result

Why the “predator prey” model is so important
   Lotka-Volterra equation

Midstream the current investment gating factor

Natural gas falls prey to oil market and lack of demand
Remember – oil supply isn’t growing if we strip out US, Saudi Arabia, and Iraq
Remember – oil supply isn’t growing if we strip out US, Saudi Arabia, and Iraq (and Saudi Arabia and Iraq follow different ‘feedback’ rules)
Shale Era Business Model: Cash In ~ Cash Out (except when greedy or scared...)

E&P Sector CFO compared to “organic” capex (capital spent drilling & completing existing acreage) i.e., productive capex

Source: Company Data, Bernstein estimates, Bloomberg
Price → cash flow → capital plan updates → rig count → production

EIA Weekly Production Estimates and Actual Monthly Data (with rig count and WTI)

Source: HPDI, EIA; Baker Hughes, Bernstein analysis and estimates
Lion’s share of CFO goes to capex to create a quarterly wedge...
How E&Ps won the shale war...

...same way we won the revolutionary war...with help

Cumulative Cash flow statement, 1Q 2015 to 4Q 2016

Source: Corporate reports, Bloomberg, L.P., Bernstein analysis
Our forecast of US liquids volumes
Our forecast of US liquids growth...oil price, reinvestment rate, inflation, and well efficiencies drive result.
Impact of oil price

Shale Production Sensitivity to Oil Price

- Base
- $40
- $50
- $60
- $70
- $80

Years:
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018E
- 2019E
- 2020E
- 2021E
- 2022E

Oil Price:
- $40
- $50
- $60
- $70
- $80

Values:
- 0
- 2000
- 4000
- 6000
- 8000
- 10000
- 12000
- 14000
- 16000

Legend:
- Base
- $40
- $50
- $60
- $70
- $80
Impact of reinvestment rate

Shale Production Sensitivity to Reinvestment of CFO

Legend: 88%, 50%, 60%, 70%, 80%, 90%, 100%
What drove productivity...the Permian example

Productivity has increased in the Delaware largely due to rapid sand/ft increase (and lateral length)

Productivity increases in the Midland were more dominated by other effects (as lateral length and sand count already high years ago)

Source: DiDestop, FracFocus, Bernstein analysis and estimates

Due to Lateral Length
From 4,433' to 5,715'

Due to Sand Per Foot
From 785 lb/ft to 2,331

Due to Other Effects

2014
2017

Due to Lateral Length
From 6,798' to 8,492'

Due to Sand Per Foot
From 1,124 lb/ft to 1,877

Due to Other Effects

2014
2017

y = 45.938ln(x) - 184.58
R² = 0.6759

y = 21.444ln(x) - 38.577
R² = 0.2344

1st 12 months cumulative oil (kbo)

12-mo cumulative production (kboe)

Sand (lb/ft)
Lotka-Volterra (1st order nonlinear differential equations describing biologic systems)
Shale is not a thermostat – it induces waves (and needs culling!)

"equilibrium price" is not a static equilibrium
Midstream investment (not upstream) is gating factor for now

The Midland – WTI differential currently sits around -$15/bbl and is expected to remain wide until pipelines come online in 2019

Historic and Futures prices for key oil prices ($/bbl)

Black line below shows takeaway…the Permian would 'like' to grow faster than takeaway next year (but can't). The red area shows 'the lost barrels' which peak at 0.5 mln bopd…the green line is our forecast with constraints (note that constraints involve both volume and also pricing – higher differentials)

In our model, Permian gas doesn't fill pipes right away, but by 2021 needs more pipes
Permian wells keep getting better....this brings an astounding amount of gas byproduct

Permian Basin Oil Production (kbopd)

Permian gas production outlook, bcf/d

Capped because of pipeline constraints

Source: EIA; HPDI, Bernstein estimates
Future gas demand driven by U.S. energy chessboard

Estimated U.S. Energy Consumption in 2017: 97.7 Quads

Source: Lawrence Livermore National Laboratory

(2 QBTU ~ 1 MBOEPD)
Natural gas supply / demand balance 2016-2020

Supply Outlook to 2020: This healthy growth means that in addition to "free" associated gas, Haynesville and Marcellus growth are needed at the margin

Natural Gas Demand Outlook to 2020: healthy growth, but led by LNG exports, Mexico exports, and ethane crackers

Natural Gas Supply Outlook 2021-25: Associated gas can meet almost all of this supply, with minimal growth required from the Marcellus

Natural Gas Demand Outlook 2021-25: demand profile slows as fewer LNG terminals are expected to be sanctioned & Mexico's gasification will be complete
Exports need LNG and Mexico...LNG waiting and Mexico full

A wave of LNG FIDs in the US (and Australia) occurred from 2012-15, but they dried up after. It takes 4 years from FID to startup.

By 2021 gas will be as fully saturated into power demand as can be expected

This is due to the oversupply that we see in the LNG market from 2019-22...but by 2023 we will need more

Parity at the forward curve...but our deck suggests HH linked cheaper...

By 2021 gas will be as fully saturated into power demand as can be expected

Mexican forecast suggests rising imports to 2020...then falling

Parity at the forward curve...but our deck suggests HH linked cheaper...

54mtpa of new projects need to be sanctioned by 2020 to meet long-term market demand in 2025

Source: EIA; HPDI, Bernstein estimates. *CC-3 not yet officially FID-ed but Cheniere says will happen this year
Next ethane cracker wave likely smaller than the one going on now

<table>
<thead>
<tr>
<th>Company</th>
<th>City</th>
<th>Startup Date</th>
<th>Capacity</th>
<th>MTA</th>
<th>kbd ethane</th>
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<tr>
<td>Oxy/Mexichem JV</td>
<td>Ingleside</td>
<td>3/1/2017</td>
<td>550</td>
<td>32</td>
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<td>Dow</td>
<td>Freeport</td>
<td>3/1/2018</td>
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<td>Indorama Ventures PCL</td>
<td>Lake Charles</td>
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<td>ExxonMobil</td>
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<td>Chevron Phillips</td>
<td>Cedar Bayou</td>
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<td>Point Comfort</td>
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<td>Shin-Etsu</td>
<td>Plaquemine</td>
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<td>Lake Charles</td>
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<td>LACC LLC</td>
<td>Lake Charles</td>
<td>7/1/2020</td>
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<td>58</td>
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<tr>
<td>Exports</td>
<td>Enterprise/ETP</td>
<td>7/1/2018</td>
<td></td>
<td>200</td>
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<td><strong>BY 2020 total</strong></td>
<td></td>
<td></td>
<td><strong>9,770</strong></td>
<td><strong>767</strong></td>
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<tr>
<td>Dow</td>
<td>Freeport</td>
<td>1/1/2021</td>
<td>500</td>
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<td>Shell Chemical</td>
<td>Monaca</td>
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<td>1,500</td>
<td>87</td>
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<tr>
<td><strong>Total</strong></td>
<td>Port Arthur</td>
<td>1/1/2023</td>
<td>1,000</td>
<td>58</td>
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<td><strong>Exxon/SABIC</strong></td>
<td>San Patricio</td>
<td>6/1/2023</td>
<td>1,800</td>
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<td><strong>Post 2020 total</strong></td>
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<td></td>
<td><strong>4,800</strong></td>
<td><strong>174</strong></td>
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Source: EIA; SENER, Bernstein analysis
Comparing historical and projected gas prices

Source: Rystad, Bloomberg, Factset, Bernstein estimates.
Comparing historical and projected gas prices

Gas Marginal Cost Curve

- Cash Cost
- Rystad (Base)
- Henry Hub
- Marginal Cost
- Forward Curve
- Bernstein Forecast

Source: Rystad, Bloomberg, FactSet, Bernstein estimates.
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