Oil and Gas Development Scenarios in Texas

ERCOT LTSA Workshop
May 16, 2017
Oil/Gas Market Fundamentals – Typical Cycles

- Higher prices discourage demand
- Lower prices encourage demand

Supply Excess
- Price Decreases
- Drilling Activity Decreases

Supply Shortfall
- Drilling Activity Increases
- Price Increases

Supply Excess
- Price Increases
- Drilling Activity Decreases

Higher prices discourage demand

Lower prices encourage demand

Source: Michelle Foss based on Tom Bates, Lime Rock

• Oil supply shortfall “fell short” because:
  - Iran, Iraq, Libya, ongoing projects
  - OPEC/Saudi policy
  - U.S. unconventional producers are nimble

• Demand growth might remain lackluster:
  - slower economic growth in China+
  - energy efficiency & conservation
  - alternative fuels
  - environmental factors
Crude oil is a global commodity...

Certainly global, but is it a “commodity”?
U.S. natural gas is not global but more of a commodity...

Will U.S. LNG exports “integrate” U.S. and world gas markets?
• When gas is “cheap” relative to oil:
  • LNG, GTL, CNG becomes attractive
  • Globally, natural gas is traded (pipelines or LNG) is priced linked to oil

• 2 large GTL facilities planned for LA cancelled
• Limited switching from diesel to LNG/CNG in transportation
• LNG exports “less” attractive...
Challenges Facing U.S. LNG Exports

- "Low" demand growth (China, India, Japan, and others):
  - Coal, nuclear, renewables have priority - energy security
  - Not enough gas infrastructure (especially storage)
  - Low gas market readiness
  - Sluggish economic growth
  - Japanese energy policy: nuclear, renewables, efficiency

- "Surging" global LNG supply ➔ excess supply until the early 2020s
  - Unsubscribed U.S. liquefaction capacity
  - Parts of contracted volumes not tied to specific destinations

U.S. Oil and Gas Production Proved Resilient

The rig count does not mean the same as before:
- Cluster drilling: more wells per rig
- Infill drilling:
  - less production per well but also lower cost
  - in areas with proven high productivity
- Focusing on best acreage

D&C and operating costs decreased significantly since 2014
- Sustainable?

Source: Baker Hughes rig and EIA production data.
Upstream Costs: Efficiency? Technology? Oil Price?

What percentage of these reductions are temporary?

http://www.ihs.com/info/cera/ihsindexes/index.aspx
TX: Rig Count (hence, production) Rebounding Fast

- Drilling is much more responsive to the oil price rather than the natural gas price
- 442 rigs in TX in early May 2017 versus 173 in May 2016 and 949 in August 2008

Source: Baker Hughes rig and EIA price data.
An oil (primarily, Permian) story!

- Oil and natural gas prices decoupled since the late 2000s
- Oil price recovered some after OPEC announcement in late 2016
- Gas price is still low ➔ gas-directed drilling remains anemic
- NGL prices traditionally linked to oil price; but today they are discounted, especially ethane ➔ “industrial renaissance”

Source: Baker Hughes rig data.
**Summary of TX**

**Barnett:** >20K wells 1995-now; peak drilling of 2,900+ in 2008 (100+ rigs); today only 5-6 rigs; gas core in Tarrant, Wise, Denton & Johnson; oil/liquids drilling in Montague, Cooke & Wise after 2010; ~8,000 mi\(^2\); BEG scenarios of 10K to 20K more wells through ~2040

**Haynesville (TX):** >1,000 wells 2008-now (including Bossier); peak of ~190 in 2011 (~30 rigs); today 37-38 (mostly in LA); San Augustine, Shelby, Nacogdoches, Harrison, Panola, Rusk (~2,000 mi\(^2\) in TX); BEG scenarios for all Haynesville of 5K to 10K more wells through ~2045

**Eagle Ford:** >10K wells 2008-now; peak of ~3,500 in 2013 (250+ rigs); hit low of 29 in May 2016; today ~80; Gonzalez, DeWitt, Karnes, Atascosa, McMullen, LaSalle, Dimmit, Webb; ~20,000 mi\(^2\); mostly focused on oil and condensate windows; gas window largely undeveloped but can be developed in the future with the right price environment

**Permian:** 4-5K per year 2011-14; peak of 560+ rigs in Oct14; hit low of 130 May 2016; today ~350; largest (~60,000 mi\(^2\) in TX) most complex (multiple formations); conventional and unconventional mixed; oil, gas & liquids; long history of drilling; activity to remain strong for years (as long as oil price remains “attractive”)

**Midstream:** pipelines for crude, liquids and natural gas; processing; fractionation. Long-distance pipelines to Gulf Coast from Permian, Marcellus and Cushing; gas export pipelines to Mexico.

**Corpus Christi LNG:** FID on 2 trains (4.5 MTPA each) in May 2015, production expected in 2018.

**Freeport LNG (3 trains, 13.2 MTPA):** construction started Nov14; first shipment from the first train in late 2018; trains 2 and 3 estimated in 2019

**Downstream:** 22 projects 2017-22, $29 billion; possibly 4 more, additional $7 billion

**Several LPG, condensate and ethane export projects along the coast**

**Long-distance pipelines to** Gulf Coast from Permian, Marcellus and Cushing; gas export pipelines to Mexico.
## Oil & Gas Price Scenarios through 2030*

<table>
<thead>
<tr>
<th>Low oil ($50-60), low gas ($3-4)</th>
<th>Low oil ($50-60), high gas ($4-$5)</th>
<th>High oil ($60-90), high gas ($4-6)</th>
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</thead>
<tbody>
<tr>
<td>• OPEC/others fail to maintain production cuts</td>
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<tr>
<td>• U.S. unconventional D&amp;C costs remain low</td>
<td>• U.S. unconventional D&amp;C costs recover some</td>
<td>• “Lasting” crises in Nigeria, Venezuela, Libya, Iraq, and/or Iran (not an exclusive list)</td>
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<tr>
<td>• Technological improvements</td>
<td>• Increasing cost of frac sand, rig rates</td>
<td>• U.S. unconventional D&amp;C costs recover strongly</td>
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<tr>
<td>• Operational improvements</td>
<td>• Global oil demand slow to grow</td>
<td>• Increasing cost of frac sand, rig rates</td>
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<tr>
<td>• Low oil price</td>
<td>• Weak macroeconomics (China+)</td>
<td>• High oil price</td>
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<tr>
<td>• Global oil demand slow to grow</td>
<td>• Alternatives</td>
<td>• Depleting best geology</td>
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<td>• Weak macroeconomics (China+)</td>
<td>• Efficiency gains</td>
<td>• Global oil demand grows stronger</td>
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<td>• Alternatives</td>
<td>• Strong gas demand growth in the U.S.</td>
<td>• China and others recover</td>
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<td>• Efficiency gains</td>
<td>• Slowing penetration of renewables</td>
<td>• Limited penetration by alternatives</td>
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<td>• Gas demand slow to grow in the U.S.</td>
<td>• Coal &amp; nuclear retirements</td>
<td>• Limited efficiency gains</td>
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<td>• Renewables, efficiency</td>
<td>• Second wave of industrial renaissance</td>
<td>• Strong gas demand growth in the U.S.</td>
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<td>• Saving nuclear, coal units</td>
<td>• LNG exports grow stronger</td>
<td>• Slowing penetration of renewables</td>
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<td>• Stagnant load growth</td>
<td>• Global gas demand grows faster</td>
<td>• Coal &amp; nuclear retirements</td>
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<tr>
<td>• Limits to industrial renaissance</td>
<td>• Pipeline exports to MX grow stronger</td>
<td>• Second wave of industrial renaissance</td>
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<tr>
<td>• LNG exports slow to grow</td>
<td>• Low oil price &amp; cost increase ➔ less associated gas ➔ need higher gas price to drill for dry gas</td>
<td>• LNG exports grow stronger</td>
</tr>
<tr>
<td>• Too much liquefaction capacity globally</td>
<td></td>
<td>• Global gas demand grows fast</td>
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<tr>
<td>• Global gas demand slow to grow</td>
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<td>• Pipeline exports to MX grow stronger</td>
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<tr>
<td>• Pipeline exports to MX grow as expected</td>
<td></td>
<td>• Higher cost, higher gas demand ➔ higher gas price</td>
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</tbody>
</table>

*Assume cyclicality; price movements above and below these ranges are likely. For example, 2020-25 may see oil price collapse if oil price recovers soon.
Gürcan Gülen
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A Strong “Gas Demand Stack” Scenario v EIA AEO 2017

- Two largest uncertainties: Power generation and LNG exports
- Potential drivers:
  - Price of natural gas
  - Renewables generation
    - Declining costs
    - Federal subsidies?
  - Coal retirements
    - Env’t regulations?
  - Nuclear retirements
    - Aging fleet, rising costs, state subsidies
  - CO₂ prices
  - Load growth
    - EE, DER, DR

CEE analysis; EIA AEO 2017
CEE Industrial Projects Database - About 100 Projects; Incremental NG demand of ~3 BCFD
Our Portfolio and Examples

Hydrocarbons System:
- Upstream
  - Oil & Gas E&P
- Midstream
  - Transportation, storage, processing, shipping, LNG
- Downstream
  - Liquids, gas conversion, end use

Power System:
- Power Generation
- Transmission, distribution
- Power demand, end use

**Upstream**
- U.S. producer cost benchmarking
- CEE/World Bank NOCs
- BEG Sloan Foundation shale resource assessments
- Upstream regimes, HC sector governance (Shell; USAID; DOS-ENR)
- CO₂-EOR, carbon capture (BEG/GCCC, Texas FutureGen)
- Oil price drivers (USEIA)

**Midstream**
- Natural gas studies (OIES)
- LNG public knowledge base and economic, community benefits (Industry Donors)
- Midstream, MLP review (BEG STARR)
- ERCOT/US power dispatch scenarios (BEG STARR, Industry Donors)

**Downstream**
- Natural gas market for petrochemicals (MHTL)
- Industrial gas demand project inventory (BEG STARR)
- Texas renewables (State Energy Conservation Office)
- CEE gas demand stack (BEG STARR)

**Notes:**
- NOC=national oil company; GCCC=Gulf Coast Carbon Center; OIES=Oxford Institute for Energy Studies; STARR=State of Texas Advanced Resource Recovery Program; MLP=master limited partnership; MHTL=Methanol Holdings of Trinidad and Tobago Ltd.