Overview of Louisiana LNG issues and trends.

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LNG Background
19th century - British chemist and physicist Michael Faraday experimented with liquefying different types of gases

1873 - German engineer Karl van Linde built the first practical compressor refrigerator machine

1912 - First LNG plant built in West Virginia

1941 - First commercial liquefaction plant is built in Cleveland, Ohio

1964 - British Gas Council imports from Algeria, making the UK the world's first LNG importer and Algeria the first exporter

January 1959 - The world's first LNG tanker, the Methane Pioneer carries LNG from Lake Charles, LA, to Canvey Island, UK

1971 - Everett, MA import facility is built

1974 - Cove Point, MD import facility is built

1978 - Elba Island, GA import facility is built

1981 - Lake Charles, LA import facility is built

1969 - LNG exported from Kenai plant, AK to Japan
Liquefied natural gas (LNG) is natural gas that has been turned into a liquid by cooling it to a temperature of -256°F at atmospheric pressure.

It consists of primarily methane (typically, at least 90 percent).

LNG is odorless, colorless, non-corrosive and non-toxic.

Liquefying natural gas reduces its volume by a factor of approximately 610.

LNG’s flammability range limits are 5 to 15 percent in air.
Considerable reserves around the world (6,700 Tcf), just not in the areas where the natural gas is needed.

- Russia, 25%
- Iran, 18%
- Qatar, 13%
- Saudi Arabia, 5%
- Turkmenistan, 4%
- United Arab Emirates, 3%
- China, 3%
- Venezuela, 3%
- Nigeria, 3%
- Algeria, 2%
- Iraq, 2%
- Rest of World, 19%

Source: U.S. Energy Information Administration.
Economic sharing in the LNG chain.

Regasification terminals are one small portion of overall LNG trade.

Gas Producer
$3.08 - $4.88/MMBtu
50% of total cost

Liquefaction
$0.98 - $1.56/MMBtu
16% of total cost

Shipping*
$1.85 - $2.93/MMBtu
30% of total cost

Receiving Terminal
$0.40 - $0.63/MMBtu
7% of total cost

Cost out of Plant
$6.15 – $9.75 / MMBtu

Note: *Shipping cost will vary depending on distance.
LNG schematic: production to end user.

- One 1 LNG tanker carries approximately 120,000 to 140,000 cubic meters of LNG, which will provide about 4.2 to 4.9 bcf of natural gas.
- Average monthly power usage of 22.7 Bcf;
- Average monthly industrial usage of 91.4 Bcf

Source: U.S. Energy Information Administration.
A number of small LNG facilities are located throughout the US and used for peak shaving or to meet the needs of areas isolated from storage and/or pipeline infrastructure.

Source: U.S. Energy Information Administration.
Current U.S. LNG import capacity.

- Everett, MA: 1.035 Bcfd
- Offshore Boston, Excelerate: 0.8 Bcfd
- Offshore Boston, Neptune: 0.4 Bcfd
- Cove Point, MD: 1.8 Bcfd
- Elba Island, GA: 1.6 Bcfd
- Lake Charles, LA: 2.1 Bcfd
- Sabine Pass, TX: 2.0 Bcfd
- Freeport, TX: 1.5 Bcfd
- Sabine, LA: 4 Bcfd
- Pascagoula, MS: 1.5 Bcfd
- Cameron, LA: 2.1 Bcfd

Source: Federal Energy Regulatory Commission; and company websites.
Louisiana LNG Development
Natural gas price reductions (and reductions in volatility) are the direct result of unconventional oil and gas development.

Average 1997-2000: $2.79
(standard deviation: $1.28)

Average 2001-2008: $6.24
(standard deviation: $2.39)

Average post 2008: $3.42
(standard deviation: $0.88)

Source: U.S. Energy Information Administration.
GOM LNG capacity.

Existing
A. Everett, MA: 1.035 Bcfd
B. Cove Point, MD: 1.8 Bcfd
C. Elba Island, GA: 1.6 Bcfd (+0.5 Expansion)
D. Lake Charles, LA: 2.1 Bcfd
E. Northeast Gateway, Offshore MA: 0.8 Bcfd
F. Freeport, TX: 1.5 Bcfd (+2.5 Expansion)
G. Sabine, LA: 4.0 Bcfd
H. Hackberry, LA: 2.1 Bcfd
I. Neptune, Offshore MA: 0.4 Bcfd
J. Sabine Pass, TX: 2.0 Bcfd
K. Pascagoula, MS: 1.5 Bcfd

Under Construction
L. Corpus Christi, TX: 2.14 Bcfd

Approved
M. Lake Charles (Magnolia): 1.08 Bcfd
Natural gas/crude oil price spreads well in excess of $60 per Bbl and as high as $90 per Bbl. These differentials have collapsed by about half.
Example: Changes in competitiveness of US-sourced LNG.

Economics of LNG development are important, but there are additional factors that can influence development such as geopolitical and supply stability concerns that could sustain continued projects.

<table>
<thead>
<tr>
<th>Region</th>
<th>Feedgas 40-60% ($/MMBtu)</th>
<th>Liquefaction 12%-20% ($/MMBtu)</th>
<th>Shipping &amp; Fuel 20%-40% ($/MMBtu)</th>
<th>Regas 5%-8% ($/MMBtu)</th>
<th>Delivered Cost ($/MMBtu)</th>
<th>Equivalent Oil Price* ($/BOE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe:</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Low</td>
<td>$3.00</td>
<td>$1.25</td>
<td>$1.40</td>
<td>$0.50</td>
<td>$6.15</td>
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<td>$5.00</td>
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<td>$1.65</td>
<td>$0.50</td>
<td>$8.40</td>
<td>$48.72</td>
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<tr>
<td>Low</td>
<td>$3.00</td>
<td>$1.25</td>
<td>$2.50</td>
<td>$0.50</td>
<td>$7.25</td>
<td>$42.05</td>
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<tr>
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<td>$3.00</td>
<td>$0.50</td>
<td>$9.75</td>
<td>$56.55</td>
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<td>Caribbean:</td>
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<tr>
<td>Low</td>
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<td>$0.75</td>
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<tr>
<td>High</td>
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<td>$1.00</td>
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<td>$7.75</td>
<td>$44.95</td>
</tr>
</tbody>
</table>

Note: *uses a BOE conversion of 5.8 Mcf/BOE.
Source: Various sources

Henry Hub (Apr-2019): $2.72
WTI (Apr-2019): $63.25
Brent (Apr-2019): $70.48
If all of the LNG applications currently filed with the Department of Energy were to come online, U.S. liquefaction capacity would exceed 60 Bcf per day by 2025.

Current capacity around 2.6 Bcf/d.

50 Bcf/d on GOM alone.
Recent Market Trends:
LNG Imports
World LNG trade volumes have increased at an **average annual rate of seven percent over the last 18 years** and have increased **73 percent over the last 10 years**.

Post global recession (2010) shift increase of almost 4 Bcf/d.

Asian markets (Japan, China, S. Korea) dominate the share of world LNG imports. Note this is total usage/imports, not import “growth” in percentage terms.

- Japan, 26%
- S. Korea, 14%
- China, 17%
- India, 7%
- Chinese Taipei, 5%
- Spain, 3%
- Turkey, 3%
- Mexico, 2%
- France, 3%
- Pakistan, 2%
- Italy, 2%
- Thailand, 1%
- UK, 2%
- Chile, 1%
- Kuwait, 1%
- Belgium, 1%
- Portugal, 1%
- U.S., 1%
- Singapore, 1%
- Argentina, 1%
- Jordan, 1%
- Other, 5%
- Egypt, 1%

64 percent of market

While Japan is the largest importer of LNG, China and other Asian markets will see their share of trade increase, reaching **45 percent of total trade volumes by 2023**, more than **double their 2013 share** of 20 percent.


Large percentage increase (2016-2017) concentrated in Asian. **Japan**, while large in absolute, is **small in percentage growth**.

Over the last five years, most of China’s gas demand has been from the industrial sector. Industrial consumption has accounted for half of the demand growth, and electric power made up 20 percent.
China’s natural gas demand has increased eight times in the last 18 years, and **66 percent in the last five years**.

Source: U.S. Energy Information Administration.
Recent Market Trends:
LNG Exports, Capacity, & Prices
Qatar and Australia are the biggest competitors to U.S. LNG exports.

Source: International Gas Union, 2018 World LNG Report
U.S. exports are up considerably (on percentage basis) but have a long way to go to match the Middle East, much less Australia. Middle east, however, appears to be losing market share to these other countries/basins.

Excess capacity facilitating considerable competition – “nirvana” (for developers) is anticipated to arrive around 2021-2022 as capacity tightens and it becomes sellers’ market.
A more competitive market was reflected by **shorter average contract durations** – where buyers set contract duration terms, but a **resurgence in longer term contracts** will support new supply projects.

Note: Author’s estimate from source. 
Source: Shell LNG Outlook 2019.
Total contract volumes decreased significantly in recent years contributing to excess supply conditions.
Contracted sales are becoming **increasingly more risky**, developers having to assume more contracting risk to get limited volumes to the market.

#did not find update for this one#

Note: Author’s estimate from source.
Source: Shell LNG Outlook 2018.
Law of one price: energy prices moving to HH price, not vice versa.

Asian prices building over this past year (2018) **but will likely correct with recent crude oil corrections. #and are so far staying high?#**
Global LNG Forecast Drivers: Environmental Concerns
Environmental concerns (emission) will likely contribute significantly to the move to LNG.
China and India represent the “trifecta” for greater LNG use: high energy demand; high coal shares; high environmental risk.
Policy actions for clean energy support gas and LNG.

**GLOBAL**

Increasing recognition of environmental benefits

- G20 endorses the role of natural gas in energy transition
- IEA credits levelling of global CO2 emissions to coal displacement

**REGIONAL**

EU policies supporting coal phase out

- More than 10 countries announce coal phase-out ambitions – 25% of coal power capacity in EU
- EU confirms reforms to strengthen EU Emissions Trading Scheme

**NATIONAL**

Policies favor gas and renewables

- China reforms gas market to increase competitiveness of delivered gas
- South Korea’s 8th Basic Plan for Energy prioritizes renewables and gas, while not sanctioning new nuclear and coal

**LOCAL**

Policy makers targeting air quality

- Berlin closes local coal-fired power plants to improve air quality
- Beijing meets ambitious 2017 air quality targets, supported by coal to gas switching

Source: Shell LNG Outlook 2018.
Global LNG Forecast Drivers:
Energy Demand Growth
World energy demand is projected to increase at an average annual rate of one percent. **Renewables and natural gas** will account for most of this growth, followed by oil and nuclear. Coal demand is expected to decrease.
World natural gas demand is projected to increase almost 30 percent. Most of this demand growth will be in the electric power (39%) and industrial (36%) sectors, followed by transportation (15%), residential (8%) and commercial (2%).

Source: U.S. Energy Information Administration.
World natural gas demand is projected to increase almost 30 percent. Most of this demand growth will be in Asia (52%), followed by the Middle East (19%) and the Americas (16%). Europe accounts for 9 percent and the rest of the world 4 percent.

Source: U.S. Energy Information Administration.
World natural gas demand is expected to increase at an **average annual rate of 1.6 percent over the next five years**. China accounts for one-third of this demand growth.

Interesting geopolitical battle over a declining market.

Industrial usage will be the main driver for natural gas demand in China. Residential and commercial growth will also increase due to the ongoing coal-to-gas switch.

Conclusions
• LNG is an important part of Louisiana’s energy export economy.
• These facilities represent $9 billion to $12 billion in capital investment.
• Large project announcements, not all will get developed, GOM will be a strongly preferred location.
• Market is current in excess supply – nirvana is supposed to come in the 2022 time period – there are, emerging storm clouds to this expected market shift.
• Current trade disputes do not help LNG development.
• To date, world prices have moved down to Hub prices, and not vice versa – how long will this last?
Questions, Comments and Discussion.

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