Current State & Outlook for the LNG Industry

Explore the critical strategic issues facing global E&C industries & help impact the future.
• LNG Industry History

• LNG Value Chain

• LNG Supply & Demand

• LNG Cost Trends

• USA LNG Import / Export
The first commercial liquefaction plant was built in Cleveland, Ohio in 1941.

January 1959, the world's first LNG tanker (Methane Pioneer) carried a LNG cargo from Lake Charles, Louisiana to Canvey Island, United Kingdom.

- Demonstrated that large quantities of LNG could be transported safely across the ocean.
- Established LNG as an Energy Transportation Industry.

Methane Pioneer at UK Dock
Converted Cargo Vessel
5000 m3 of LNG
• Liquefied Natural Gas (natural gas at atmospheric pressure & -160°C)

• Liquefaction reduces gas volume by a factor of 600

• Allows transportation:
  – from countries with gas but no market
  – to countries with a market but no gas
The LNG Value Chain

- LNG Liquefaction
- LNG Regasification
- LNG Peak Shaver
- FLNG & FSRU
LNG VALUE CHAIN

LNG Baseload Liquefaction Facilities
LNG Baseload Liquefaction Facilities

Peru LNG – 4.45 Mtpa liquefaction
Floating LNG: LNG FPSO FSRU
no FLNGs are in operation; Shell’s Prelude LNG is likely to be the 1st

10 FSRUs are operational; 3 others at FID
LNG VALUE CHAIN

LNG Import Terminals & Regasification Facilities
LNG VALUE CHAIN

LNG Import Terminals & Regasification Facilities

Golden Pass LNG – 2 BSCFD vaporization
LNG Peak Shaving Facilities
LNG Peak Shaving Facility

Over 100 units operating in North America

Memphis Light – 5.5 MMSCFD liquefaction
150 MMSCFD vaporization
## CURRENT SUPPLY CAPACITY

<table>
<thead>
<tr>
<th>Pacific Basin</th>
<th>Mtpa</th>
<th>Middle East</th>
<th>Mtpa</th>
<th>Atlantic Basin</th>
<th>Mtpa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska Kenai</td>
<td>0.7</td>
<td>Abu Dhabi</td>
<td>5.7</td>
<td>Algeria Arzew</td>
<td>17.3</td>
</tr>
<tr>
<td>Brunei</td>
<td>7.2</td>
<td>Qatargas 1</td>
<td>10.0</td>
<td>Algeria Skikda</td>
<td>2.9</td>
</tr>
<tr>
<td>Indonesia Bontang</td>
<td>17.5</td>
<td>Qatargas 2</td>
<td>15.6</td>
<td>Libya Marsa El Brega</td>
<td>0.6</td>
</tr>
<tr>
<td>Indonesia Arun</td>
<td>2.5</td>
<td>Qatargas III</td>
<td>7.8</td>
<td>Norway Snohvit 1</td>
<td>4.1</td>
</tr>
<tr>
<td>Indonesia Tangguh</td>
<td>7.6</td>
<td>Qatargas IV</td>
<td>7.8</td>
<td>Trinidad &amp; Tobago</td>
<td>15.7</td>
</tr>
<tr>
<td>Malaysia Satu</td>
<td>8.1</td>
<td>RasGas 1</td>
<td>6.6</td>
<td>Nigeria 1 to 6</td>
<td>22.3</td>
</tr>
<tr>
<td>Malaysia Dua</td>
<td>9.0</td>
<td>RasGas 2</td>
<td>14.1</td>
<td>Egypt Damietta</td>
<td>5.0</td>
</tr>
<tr>
<td>Malaysia Tiga</td>
<td>7.4</td>
<td>RasGas 3</td>
<td>15.6</td>
<td>Egypt Idku</td>
<td>7.2</td>
</tr>
<tr>
<td>Australia NWS</td>
<td>16.6</td>
<td>Oman LNG</td>
<td>7.4</td>
<td>Equatorial Guinea 1</td>
<td>3.6</td>
</tr>
<tr>
<td>Australia Darwin</td>
<td>3.6</td>
<td>Oman Qalhat</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia Sakhalin</td>
<td>9.6</td>
<td>Yemen LNG</td>
<td>6.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>4.4</td>
<td></td>
<td>100.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>94.2</strong></td>
<td></td>
<td></td>
<td><strong>Total Current Supply Capacity = 273.8 Mtpa</strong></td>
<td></td>
</tr>
<tr>
<td>Pacific Basin</td>
<td>Mtpa</td>
<td>Middle East</td>
<td>Mtpa</td>
<td>Atlantic Basin</td>
<td>Mtpa</td>
</tr>
<tr>
<td>------------------</td>
<td>------</td>
<td>-------------</td>
<td>------</td>
<td>-----------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Australia Pluto</td>
<td>4.3</td>
<td>None</td>
<td>0</td>
<td>Algeria Skikda rebuild</td>
<td>4.5</td>
</tr>
<tr>
<td>Australia Gorgon</td>
<td>15.0</td>
<td>0</td>
<td>0</td>
<td>Algeria Arzew 3</td>
<td>4.7</td>
</tr>
<tr>
<td>Australia Santos</td>
<td>3.9</td>
<td></td>
<td></td>
<td>Angola LNG</td>
<td>5.2</td>
</tr>
<tr>
<td>Australia BG</td>
<td>4.2</td>
<td></td>
<td></td>
<td></td>
<td>14.4</td>
</tr>
<tr>
<td>Australia APLNG</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PNG</td>
<td>6.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Projects that have reached FID
Total Supply Under Construction = 52.4 Mtpa
## TOTAL LNG SUPPLY

<table>
<thead>
<tr>
<th>Region</th>
<th>Operating Mtpa</th>
<th>Under Construction Mtpa</th>
<th>Total Mtpa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Basin</td>
<td>94.2</td>
<td>38.0</td>
<td>132.2</td>
</tr>
<tr>
<td>Middle East</td>
<td>100.9</td>
<td>0</td>
<td>100.9</td>
</tr>
<tr>
<td>Atlantic Basin</td>
<td>78.7</td>
<td>14.4</td>
<td>93.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>273.8</strong></td>
<td><strong>52.4</strong></td>
<td><strong>326.2</strong></td>
</tr>
</tbody>
</table>
2010 SUPPLY COUNTRIES

In 2010 – 500 million m³ (220 Mtpa) of LNG was produced & exported

Export Countries by Market Share
Import Countries by Market Share

- Japan
- South Korea
- Spain
- United Kingdom
- Taiwan
- France
- China
- United States
- India
- Italy
- Turkey
- Belgium
- Mexico
- Chile
- Portugal
- Brazil
- Kuwait
- Canada
- Argentina
- Greece
- Dominican Republic
- Puerto Rico
- United Arab Emirates

2010 IMPORTING COUNTRIES
Demand slowed for 2-3 years following the 2008 recession.

Demand driven by Europe and non-OECD Asia (OECD Asia = Japan & Korea).

In non-OECD Asia, 74% of the demand growth is from China and India.

European share of LNG imports expands from 30% to 42%.

Source: BP 2011 Statistical Review
Current Supply (operating & under construction) = 326 Mtpa

2030 Demand = 500 Mtpa

Demand – Supply = Shortfall = 174 Mtpa

Equates to 35 to 40 new LNG trains (PERU LNG size - 4.5 to 5 Mtpa) to be built by 2030

Equates to 25 to 30 new LNG Import Terminals (Golden Pass size-2 BSCFD) to be built by 2030 assuming import capacity = 2 times supply capacity (the historical average)

Supply expansion will be in two phases:
- First phase from 2015 to 2017; over 50% of growth will come from the Australian projects
- Second phase from 2018 to 2030; over 40% will come from Africa with Russia the second highest contributor
Long Term prospects for demand look positive

- Preference for natural gas over other fossil fuels for environmental reasons
- Post Japan earthquake/tsunami driving increased LNG demand to replace nuclear for power generation in Japan and parts of Europe
- Natural gas being used as a transition fuel to support intermittent renewables
- Growth in demand countries without pipeline alternatives
- Countries wanting LNG for security of supply reasons
- Declining production in some natural gas consuming countries

Can supply respond?
LNG SUPPLY ISSUES

- Governments in some countries are prioritizing domestic gas consumption over LNG exports (e.g., Nigeria, Indonesia & Peru)
- Gas supply problems have affected LNG production in Indonesia, Oman, Egypt, Trinidad, Nigeria and Algeria
- Lack of new proven reserves is delaying projects, such as Egypt – Daimetta & Idku, Trinidad Tr X, Equatorial Guinea Tr 2, Darwin Tr 2 & Pluto Tr 2 & 3
- Qatar has a moratorium on further LNG expansion but has reserves for over 100 years at current production rates
- Availability of Engineering and Construction resources
- Rising costs of LNG Plants
LNG Liquefaction Capex

Year
$/tpa


5 Mtpa = $6.5 bil

5 Mtpa = $2 bil

Source: Wood Mackenzie Group
Liquefaction Plant Capital Costs

Source: Andrew Flower, LNG Consultant
European Regas Costs

- Bahia di Bizkaia
- Sines
- Grain 1
- Reganosa
- Dragon LNG
- South Hook LNG
- Fos Cavaou
- Grain 3 Expansion
- Zeebrugge Expansion
- South Hook LNG Phase II
- GATE LNG Terminal

Start-up Date


EPC Unit Costs (US$ million/(Bcm/y)

100 80 60 40 20 0

Source: Poten & Partners

* Data from company press releases
** Estimated Cost
LNG VALUE CHAIN: TYPICAL COSTS

- **Upstream**: 5 Mt, $400 per tonne capacity
- **Liquefaction**: 5 Mtpa single train, $750 per tonne capacity
- **Shipping**: 5 ships, $220M per ship
- **Re-gas**: $90M per 1 BCM/yr capacity (113 mmSCFD)

<table>
<thead>
<tr>
<th>.Component</th>
<th>Cost</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>US$2.0bn (27%)</td>
<td>15-20% or above</td>
</tr>
<tr>
<td>Liquefaction</td>
<td>US$3.75bn (50%)</td>
<td>8-12% if “tolling”</td>
</tr>
<tr>
<td>Shipping</td>
<td>US$1.1bn (15%)</td>
<td>8-10%</td>
</tr>
<tr>
<td>Re-gas</td>
<td>US$0.6bn (8%)</td>
<td>8-10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>US$7.45bn (100%)</td>
<td><strong>13.7%</strong> (weighted average)</td>
</tr>
</tbody>
</table>

Source: Wood Mackenzie, Deutsche Bank
Prior to the Shale Gas “revolution” in the North America the USA was on the verge of being a net gas importer.

There were 20 new Import Terminals approved for construction in North America with another 9 in the planning stages; today two are under construction & only 9 others are still on the FERC books.
As of July 2011 there are 14 existing terminals

A total of 33 million m3 of LNG (15 Mtpa) was imported to those terminals in 2010; most of that LNG was re-exported.

Three terminal operators have DOE approval to liquefy and export LNG:
- Sabine Pass
- Freeport
- Lake Charles

Cove Point has applied to the DOE for a permit to liquefy and export LNG.

None of the 4 have FERC approval yet to construct.
North America LNG Export Economics:

- Gas / LNG forward prices as of 30 Aug 2011
  - Henry Hub gas = $ 4.00 mmBtu
  - Europe NBP gas = $ 11 to 13 mmBtu
  - Asia LNG = $ 14 to 16 mmBtu (Aug spot prices)

- Cost ($ / mmBTU) to deliver gas from USGC to Europe or Asia
  - Henry Hub gas = $ 4.00
  - Fuel surcharge = $ 0.60
  - Liquefaction cost = $ 2.00 ($ 1.50 to $2.00 range)
  - Shipping = $ 1.00 to Europe or $ 3.00 to Asia
  - **Delivered cost** = $ 7.60 to Europe or $ 9.60 to Asia

- Risks
  - Shale gas E&P costs increase
  - Europe or Asia LNG cost from other supply decreases
• LNG demand will continue to rise at twice the growth rate of natural gas

• The current state and outlook for the LNG Industry is strong on both the export and import fronts

• North America could be a significant LNG supply source from 2015
For any questions / comments, please contact:

Gerald Humphrey
Sr. VP Global LNG Sales
ghumphrey@cbi.com