LNG Shipping

Anchorage, AK
August 5-9, 2013
North Slope Gas & LNG Symposium
Executive Summary

- Shipping costs impact the LNG delivery cost

- Shipping costs serve as a benchmarking tool to compare one project to another

- New projects are typically associated with newbuild orders delivered in coordination with the projects’ start date

- Decisions regarding new vessels are largely dependent on the type of LNG contracts (FOB vs. Ex-Ship) signed by project
Middle of the LNG Value Chain: Shipping

Source: www.lngfacts.org
On a Cargo Basis, Shipping Cost is Not Insignificant

- All costs along the value chain are variable and depend on the LNG project.
- Shipping costs depend on:
  - Type of Vessel
  - Cost of Vessel
  - Size of Cargo
  - Voyage Distance
  - Running Costs
  - Charter Rate

### Delivered Cost by LNG Value Chain Segment

- **Delivered Cost**
- **Regasification Cost**
- **Shipping**
- **Liquefaction Cost**
- **Feedstock Cost**

$/MMBtu

<table>
<thead>
<tr>
<th>Chain Segment</th>
<th>Delivered Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- All costs along the value chain are variable and depend on the LNG project.
- Shipping costs depend on:
  - Type of Vessel
  - Cost of Vessel
  - Size of Cargo
  - Voyage Distance
  - Running Costs
  - Charter Rate

### Delivered Cost by LNG Value Chain Segment

- **Delivered Cost**
- **Regasification Cost**
- **Shipping**
- **Liquefaction Cost**
- **Feedstock Cost**

$/MMBtu

<table>
<thead>
<tr>
<th>Chain Segment</th>
<th>Delivered Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Global LNG Fleet: Key Figures

- **~360** LNG vessels in the global fleet
  - Average age of existing fleet is ~11 years

- **111** vessels on order as of July 2013

- **~146,000 cm** is the average size of the existing fleet
  - LNG vessels range in size from 7,000 cm to 266,000 cm
  - Similar to a Panamax container vessel

- **56%** of the current fleet was built in South Korea

- **24** shipyards delivered vessels during last decade
Global LNG Fleet: Key Figures (continued)

- 75+ equity ownership consortia, typically using JV structures
  - Independent Shipping Companies
    - Teekay, NYK Line, MOL, Dynagas
  - International Oil Companies
    - BG, BP, Shell
  - Utility Companies
    - TEPCO, Tokyo Gas, GDF SUEZ
  - Liquefaction Projects
    - North West Shelf, Angola LNG
### Vessel Types: Moss vs. Membrane Containment

<table>
<thead>
<tr>
<th></th>
<th>Moss</th>
<th>Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Filling Limit</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Boil Off</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Pressure Discharge</td>
<td>+</td>
<td>−</td>
</tr>
</tbody>
</table>

**Global Fleet by Containment Type**

- **Moss Type:** LNG Ebisu
- **Membrane Type:** GasLog Singapore

Source: [blogs.yahoo.co.jp/nji8635/30991132.html](http://blogs.yahoo.co.jp/nji8635/30991132.html)

Source: [www.marinetraffic.com](http://www.marinetraffic.com)
**Vessel Types: Ice Class / Winterized**

- Additional Insulation
- Additional Heating & De-icing Systems
- Stronger Hull
  - Ice
  - Lower Temperatures
- Higher Charter Rate
- Used by Snøhvit LNG project in Norway

*Source: PetroView*[1](https://www.hoeghlng.com)

*Arctic Lady*
Vessel Types: Q-Series

- Larger Capacity
  - Q-Flex: ~213,000 cm
  - Q-Max: ~266,000 cm

- Unable to pass through expanded Panama Canal

- Unable to deliver to all regasification terminals given size

Al Khuwair

Source: www.ameinfo.com

Source: PetroView
LNG Project Timeline: Ordering Vessels

Window for ordering vessels

Year 1

Year 2

Year 3

Year 4
(Project Online)

Project FID
LNG Contracts Determine Who Orders the Vessels

- **FOB LNG Contract**
  - LNG Offtaker orders vessel

- **Ex-Ship LNG Contract**
  - LNG Project or Seller orders vessel
Liquefaction Project Association

- **LNG projects are typically associated with a group of vessels**

- **Number of associated vessels depends on:**
  - Production volume of liquefaction project
  - Number of offtakers from project
  - FOB / Ex-ship LNG offtake contracts
  - Distance to end markets
  - Size of vessels
  - Vessel Ownership
  - Nature of charter agreements

---

### Current Fleet: Vessels Associated with Top Liquefaction Projects

- **Qatargas/RasGas**: 89 vessels
- **NLNG**: 27 vessels
- **MLNG**: 24 vessels
- **Arzew/Skikda**: 14 vessels
- **Sakhalin 2 LNG**: 10 vessels
- **Bontang LNG**: 10 vessels
- **Tangguh LNG**: 9 vessels
- **Oman LNG**: 9 vessels
- **ADGAS LNG**: 9 vessels
- **Yemen LNG**: 8 vessels
- **Peru LNG**: 7 vessels
- **Brunei LNG**: 7 vessels
- **Angola LNG**: 7 vessels
- **Snøhvit LNG**: 6 vessels
Growth of Current LNG Vessel Fleet

- **Orders typically made prior to new supply**
  - Vessel orders placed 3 years in advance of new supply
  - Vessel orders by liquefaction projects
  - Vessel orders by LNG offtakers

- **Growth in trade routes**
  - Europe, Japan and Korea dominated early decades of LNG imports
  - Growth in Asian demand
  - Growth in non-OECD LNG demand
  - Demise of U.S. as a LNG importer
  - Growth of trade between Atlantic and Pacific basins
LNG Shipping Market Dynamics: Spot vs. Long Term

- **Long Term**: Charters of 4-5 years or more
- **Spot / Short Term**: 3 months to 3 years

Estimated LNG Charter Rates

$'000/day
LNG Shipping Market Dynamics: Role of Fukushima

- **Long Term**: Charters of 4-5 years or more
- **Spot / Short Term**: 3 months to 3 years

*Estimated LNG Charter Rates*

- Spot Market
- Long-term

*Fukushima Nuclear Event*

---

North Slope Gas and LNG Symposium | © PFC Energy 2013 | Page 15
LNG Shipping Market Dynamics: Cyclicality

Estimated LNG Vessel Deliveries: 2013-2017

<table>
<thead>
<tr>
<th>Year</th>
<th># of vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>15</td>
</tr>
<tr>
<td>2014</td>
<td>40</td>
</tr>
<tr>
<td>2015</td>
<td>28</td>
</tr>
<tr>
<td>2016</td>
<td>18</td>
</tr>
<tr>
<td>2017</td>
<td>5</td>
</tr>
</tbody>
</table>
What Does This Mean for an Alaskan LNG Project?

- LNG projects and offtakers typically order new vessels to serve the duration of a specific LNG contract associated with a specific LNG project
  - LNG contract durations range, but are typically 15-25 years

- Focus on the long-term rate due to long-term duration of LNG contracts

- Long-term charter rates are predominantly a function of the NPV value of the underlying vessel asset. Key drivers of the rate include:
  - Sticker price (i.e. shipyard cost)
  - Financing terms and interest rates
Shipping Costs
*Basic variables to consider when calculating cost*

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship size (m$^3$) LNG</td>
<td>170,000</td>
</tr>
<tr>
<td>Vessel Cost (mn)</td>
<td>$200</td>
</tr>
<tr>
<td>Charter Rate ($/day)</td>
<td>75,000</td>
</tr>
<tr>
<td>Vessel sailing speed (knots)</td>
<td>18.5</td>
</tr>
<tr>
<td>Vessel sailing speed (mi/hr)</td>
<td>21</td>
</tr>
<tr>
<td>HFO price/ton</td>
<td>$600</td>
</tr>
<tr>
<td>Marine diesel price/ton</td>
<td>$900</td>
</tr>
<tr>
<td>Port charges/call</td>
<td>$50,000</td>
</tr>
<tr>
<td>Canal passage/trip</td>
<td>$250,000</td>
</tr>
</tbody>
</table>
Shipping Costs

LNG Shipping Distance & Cost Calculator
## Southern Alaska to Pacific Basin

<table>
<thead>
<tr>
<th>Shipping Destinations</th>
<th>Japan - Chita</th>
<th>South Korea - Incheon</th>
<th>China – Guangdong</th>
<th>India – Hazira</th>
<th>Mexico - Costa Azul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Cost ($/MMBtu)</td>
<td>$0.62</td>
<td>$0.71</td>
<td>$0.83</td>
<td>$1.44</td>
<td>$0.41</td>
</tr>
<tr>
<td>One-Way Distance (nautical miles)</td>
<td>3,612</td>
<td>4,158</td>
<td>4,953</td>
<td>8,905</td>
<td>2,223</td>
</tr>
<tr>
<td>Round Trip Time (days)</td>
<td>15</td>
<td>17</td>
<td>22</td>
<td>38</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: PetroView
Gulf of Mexico to Pacific Basin (via Suez Canal)

<table>
<thead>
<tr>
<th>Shipping Destinations</th>
<th>Japan - Chita</th>
<th>South Korea - Incheon</th>
<th>China – Guangdong</th>
<th>India – Hazira</th>
<th>Mexico - Costa Azul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Cost ($/MMBtu)</td>
<td>$2.67</td>
<td>$2.63</td>
<td>$2.44</td>
<td>$1.88</td>
<td>$2.16</td>
</tr>
<tr>
<td>One-Way Distance (nautical miles)</td>
<td>14,544</td>
<td>14,328</td>
<td>13,194</td>
<td>9,744</td>
<td>13,316</td>
</tr>
<tr>
<td>Round Trip Time (days)</td>
<td>62</td>
<td>61</td>
<td>56</td>
<td>41</td>
<td>57</td>
</tr>
</tbody>
</table>

Source: PetroView
Panama Canal Expansion

- Online by end-2015
- Expansion accommodates LNG vessels up to 180,000 cm
- Panama Canal transit tariff system has yet to be announced
- For LNG projects located in US GOM, could save 20%-30% of shipping cost depending on tariff system

Source: www.canalmuseum.com
## Gulf of Mexico to Pacific Basin (Panama Canal Access)

<table>
<thead>
<tr>
<th>Shipping Destinations</th>
<th>Japan - Chita</th>
<th>South Korea - Incheon</th>
<th>China – Guangdong</th>
<th>India – Hazira</th>
<th>Mexico - Costa Azul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Cost ($/MMBtu)</td>
<td>$1.83</td>
<td>$1.94</td>
<td>$2.06</td>
<td>N/A</td>
<td>$1.03</td>
</tr>
<tr>
<td>One-Way Distance (nautical miles)</td>
<td>9,471</td>
<td>10,160</td>
<td>10,866</td>
<td>N/A</td>
<td>4,407</td>
</tr>
<tr>
<td>Round Trip Time (days)</td>
<td>40</td>
<td>43</td>
<td>46</td>
<td>N/A</td>
<td>19</td>
</tr>
</tbody>
</table>

Source: PetroView
## Southern Alaska to Atlantic Basin (Panama Canal Access)

<table>
<thead>
<tr>
<th>Shipping Destinations</th>
<th>UK – Grain LNG</th>
<th>Spain - Bilbao</th>
<th>Brazil - Guanabara LNG</th>
<th>Brazil – Pecém</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Cost – Round Trip ($/MMBtu)</td>
<td>$2.20</td>
<td>$2.15</td>
<td>$2.13</td>
<td>$1.83</td>
</tr>
<tr>
<td>One-Way Distance (nautical miles)</td>
<td>9,863</td>
<td>9,570</td>
<td>9,502</td>
<td>7,880</td>
</tr>
<tr>
<td>Round Trip Time (days)</td>
<td>43</td>
<td>42</td>
<td>42</td>
<td>36</td>
</tr>
</tbody>
</table>

*Source: PetroView*
Does Alaska Have a Shipping Advantage?

<table>
<thead>
<tr>
<th></th>
<th>Japan / S. Korea</th>
<th>China</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Alaska</td>
<td>0.67</td>
<td>0.83</td>
<td>1.44</td>
</tr>
<tr>
<td>Western Canada</td>
<td>0.82</td>
<td>0.99</td>
<td>1.65</td>
</tr>
<tr>
<td>US - GOM</td>
<td>1.89</td>
<td>2.06</td>
<td>1.88</td>
</tr>
<tr>
<td>Australia</td>
<td>0.60</td>
<td>0.60</td>
<td>0.62</td>
</tr>
<tr>
<td>East Africa</td>
<td>1.18</td>
<td>0.97</td>
<td>0.58</td>
</tr>
</tbody>
</table>

- Alaska’s shipping costs are an advantage
  - Generally superior to East Africa
  - Considerably less than expected shipping costs from projects located in US GOM
  - But more expensive than Australia
Conclusion

- An Alaskan LNG project is not directly exposed to the volatility of charter market for LNG vessels
- It is potentially exposed to the shipyard cost to build a vessel and the cost of financing a vessel
- Exposure will ultimately depend on the nature of LNG contracts (FOB vs. Ex-Ship) and whether the project or the offtakers take responsibility for shipping the LNG
  - In the event that FOB contracts account for all LNG production, the project is not exposed to the shipping portion of the value chain
  - If all contracts are signed on an Ex-Ship basis, the project has complete responsibility for shipping