LNG Marine Fuel: LNG Bunkering Project Status

Tri-State Delaware Bay Liquefied Natural Gas Bunkering Workshop
Friday, April 7, 2017
The Independence Seaport Museum
Philadelphia, PA

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Global Reach

Our network of more than 2,000 professionals can be reached in over 30 countries with regional offices in:

- **Americas/Corporate**
  - Houston, Texas

- **Europe**
  - Warrington, UK

- **Middle East**
  - Dubai, U.A.E

- **Asia/Pacific**
  - Republic of Singapore
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• For more than 40 years, we have built a reputation for setting standards of excellence in the areas of safety, risk and integrity for a broad spectrum of clients in the marine; offshore; oil, gas and chemical; government and power sectors.

• Our mission is to be a leading global provider of technical services that better enables our clients to operate safely, reliably, efficiently and in compliance with applicable regulations and standards; we are focused on adding value to the industries we serve.
LNG Carriers were the first LNG fueled vessels

Starting with the first LNG carrier, Methane Pioneer in 1959

Since the mid 1960’s, LNG carriers have been designed to use their cargo as fuel:
- Steam Turbine era, 60s – present
- Dual fuel Diesel Electric (DFDE) 90’s to present
- Tri fuel diesel electric(TFDE), 90s – present
- ME-GI, 10’s to present
- Gas turbine (proposed)

About 120 (28%) current conventional trading LNGC fleet are dual fuel diesel

About 110 (67%) of on order LNGCs are dual fuel diesel

Technical development over 50 years of operational experience is adopted for use in gas fueled ships (non-LNGC) today
100+ gas fueled ships currently in service

~97 proposed or under construction

Representing annual LNG consumption of about 1MM mtpa by 2020

Perspective:
- 0.2% of global fleet
- 1.0% of LNG traded worldwide

Potential:
- 2020 entry into force of 0.5% global fuel sulfur cap
- Scrubbers, USLD, LNG, other?

ABS Group
103 LNG fueled vessels in service, 97 on order March 2017

Ongoing Challenges?

- Supply and Distribution Infrastructure
- Equipment and Installation Cost
- Technical, Risk and Operations Issues
Scandinavia and Europe Dominate:
- NOx Tax (Norway)
- TEN-T Incentives, Motorways of the Seas (EU)
- Port Fee Reductions (Rotterdam)
- Risk Based Approach

North America catching up
- Natural gas is cheap, abundant, available, accessible
- Regulatory framework clearer (USCG Policy letters, IGF Code)
- Project experience (HGIM, TOTE)
- Limited port incentives for low EEDI ships (NY, VA)

Where?

Operating area

- Norway: 56%
- Europe: 17%
- America: 10%
- Asia Pacific: 8%
- Mid East: 3%
- Global: 6%

Source: Author pie chart from LNG Ships in Operation Worldwide Dec 2016
How?

LNG DELIVERY MODE

Now Predominantly / initially by Truck

LNG Bunker Barges:
• Clean Marine Energy (TOTE)
• Seagas (Viking Grace)
• ENN Clean Fuels (China)

LNG Bunker ships:
• Anthony Veeder (Baltic)
• Engie/ NYK / Mitsui (Zeebrugge)
• Shell (NW Europe)

LNG Bunker Facilities:
• Harvey Gulf (Port Fourchon)
• GATE Terminal (Rotterdam)
• Fluxys (Zeebrugge)
• Skangas (Pori, Finland)

Source: Author pie chart from Lloyds Register LNG Bunkering Survey 2014
USA

Jacksonville-
- 2 TOTE containerships, Jax to PR scheduled service
- 2 Crowley container ships next year, Jax to PR liner service
  - truck to ship (TTS) for now, barge in service for STS bunkering next year

Port Fourchon, LA-
- 4 Harvey Gulf PSVs for offshore GoM service
- Facility to ship (FTS) bunkering from HGIM leased slip
## LNG Ready (US Flag)

<table>
<thead>
<tr>
<th>Shipbuilder</th>
<th>Owner/Operator</th>
<th>Type of Vessel</th>
<th>Size</th>
<th>Delivery (est)</th>
<th>Est Annual LNG Fuel Cons (tpa)</th>
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<tr>
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<td>Product Carrier</td>
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<td>16-Dec</td>
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330,200
Canada

2 Seaspan Ferries
• 5 BC Ferries (Salish Class (3) and Spirit Class (2))
  • – truck-on-ship bunkering
2 Transport Desgagnés (Asphalt tankers)
• - truck to ship

2 STQ Ferries
• - truck to ship

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Europe

Epicenter for LNG marine Fuel
Active LNG bunkering operations:
- The Netherlands - Rotterdam
- Belgium - Zeebrugge
- Germany- Rostock, Hamburg
- Norway- Risavika, Stavanger
- Sweden- Gothenburg, Nynäshamn
- Finland- Puri
- Estonia- Tallin
- Spain- Barcelona
- Portugal- Lisbon, Leixoes, Sines
Rest of the World

Asia:
- Singapore
- Japan - Yokohama
- Korea - Ulsan
- China - Zhoushan, Shanghai
- Australia – Fremantle, Dampier

South America:
- Argentina - Buquebus fast ferry “Francisco” in Buenos Aires

Source: http://www.lngbunkering.org/lng/map/node
What’s Next?

New Drivers:
• Global fuel sulfur limit drops to 0.5% 2020
• Desire for charterer’s and shippers to improve green credentials
• LNG bunkering infrastructure build out
• Project Experience and Lessons Learned
• Regulatory clarity
• Port competition for LNG fueled ships
• Oil price?

Gas fueled fleet “projected” to grow to 250 by 2020

There have been 100 projects since early 2000, 100 more on the books for this year and next

50 more over the next 3 years?

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