Tri-State Delaware Bay LNG Bunkering Workshop

“LNG Bunkering Industry Overview”

REV LNG MARINE LLC.

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REV LNG, LLC.

Full Service Supplier of LNG
- Pennsylvania Limited Liability Company (LLC)
- 2012 Pennsylvania Governors Award Winner
- 50% JV participant in REV LNG Marine
- Fully integrated LNG solutions provider
- Leading Eastern USA distributor of LNG
- REV Co. Owns, operates, and develops a diverse portfolio of complimentary energy assets (upstream/downstream)
- Vertically integrated supply chains, from “Well to Wheel”
- Specialists: LNG storage, Re-Gas, & “Instant Infrastructure” (Private mobile LNG Fueling Stations)
- Design / Own / Operate liquefaction & transport assets
- Innovative LNG supply solutions to utility markets
- 20 Million(+) Documented Safe Miles

Innovators in LNG Supply Chain Management

Proven, Experienced, Safe & Reliable

On & Off Road Customers

Instant Infrastructure “Private Fueling Island”
Your Partner in LNG Bunkering

- Pennsylvania Limited Liability Company (LLC)
- Fully integrated LNG marine fuel solutions provider
- Specialists in LNG bunkering project development
- Bunkering & supply chain consultancy services
- Cooperative industry mandate placing essential elements of LNG value chain in place today – positioned for tomorrow...
- Strategic alliances, JDA’s, global marketing & services agmt’s
- Developers of IP and patented innovations in LNG bunkering, LNG Floating Storage, and Production designs (Mini-FLNG)
- Diverse experience: LNG operations, LNG vessels, LNG emergency response, commodities, systems design, public participation Marine LNG Advisory Boards & SGMF
- Training & Competency Development/Quality assurance

Vertically integrated Supply Chains

Proprietary designs:
- Floating Storage
- Inland Fueling
- Mini FLNG

Bunkering and Supply Chain Consulting

Experience that Counts
- TTS “Truck-To-Ship”
- STS “Ship-To-Ship”
- PTS “Pipeline-To-Ship”

Ship-to-Ship Transfer & Midstream Bunkering Specialists
**REV LNG MARINE ("WELL TO KEEL")**

**Gas Supply**
- Partnerships with proven upstream E+P producers
- Firm access to gas reserves = Firm LNG service!
- LNG at production source = No transport & demand fees
- Not subject to seasonal regional index variations

**Liquefaction**
- Partnerships in Liquefaction
- Proprietary designs, modular (liquefaction) technology
- Deployable on land or floating asset

**Transportation**
- Cryogenic tanker fleet – nationwide service agreements
- Rapidly deployable virtual pipeline solutions
- Servicing: E&P’s, fleet vehicles, industrial/power sector
- Connecting marine customers to reliable, redundant Supply

**Bunkering:**
- Capital efficient integrated bunkering solution specialists
- Low profile/low equipment count bunker facilities
- Siting optionality spanning 10 of 15 largest US ports
- Enhanced services: safety assurance/midstream bunkers/safety
PENNSYLVANIA PROJECT
Commercial LNG Facility
Southwestern Energy Clark Pad – Towanda, PA

- Joint Venture Partnerships between REV LNG and RWE the Americas
- Strategically located within economic access of Inland, great Lakes, sea ports
- Closed on equity investment – construction underway
- Rapid deployment (9-15 months)
- Reliable – Low equipment count
- Modular, scalable, expandable
- 35,000 - 125,000 GPD output
Background Facts:
• Distillates (MDO/MGO) and HFO are the traditional marine fuel options
• Emissions regulations are becoming increasingly stringent globally
• CO2 (carbon) emissions is targeted and measured across all industries
• IMO affirmed decision for a global Sulphur cap of 0.5% on marine fuels, effective 2020
• Ship Owners, Operators, and global supply chains are making major investments to comply
• Compliant solutions include: LNG, HFO with scrubbers, and low Sulphur marine fuel oils

LNG provides an essential long-term fuel solution:
• Positioned to meet or exceed future increases in emissions restrictions
• Insulating companies from the impact of future regulations
• When employing best practices and technologies, GHG are reduced by 10-20% (up to 25%)
Comparison of MARPOL Annex VI compliance options

<table>
<thead>
<tr>
<th>Fuel Option</th>
<th>LNG</th>
<th>Distillates (1)</th>
<th>HFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Removal</td>
<td>Up to 25%</td>
<td>None</td>
<td>Requires Abatement</td>
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<tr>
<td>SOx Removal</td>
<td>Up to 100%</td>
<td>Up to 98%</td>
<td>Requires Abatement</td>
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<tr>
<td>Infrastructure</td>
<td>Early Stages</td>
<td>Required Increased Refinery Capacity</td>
<td>Infrastructure in Place</td>
</tr>
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Survey of ship owners on deep sea trade routes (Lloyds):
- Distillates as a short term solution,
- HFO (with Abatement technology- scrubbers) as a medium term option,
- LNG as a viable long term option

(1) Marine distillates refers to Low Sulfur Fuel Oil (LSFO) as an alternative to HFO. LSFO includes Marine diesel Oil (MDO) and Marine Gas Oil (MGO). LSFO may comply with sulfur limitations but will NOT reduce CO2 or PM.
BUNKER TERMINALS
Size – Scope - Scale

Supply, production, transport
Portable tank & Mobile Fueling services
Terminal To Ship Bunkering
Marine Supply Chains
Ship To Ship Bunkering
Truck To Ship Bunkering
## SERVICE SCALE (Small-Scale Liquefaction)

<table>
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<td>Handy-Size Tank</td>
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<td>6,000HP</td>
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<td>Offshore Supply</td>
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<th>8,500</th>
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<tr>
<td>Bunker Capacity</td>
<td>5</td>
<td>4</td>
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<td>11</td>
<td>20</td>
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GLOBAL LNG FUELED VESSEL FLEET SIZE

Most new-builds presently planned are LNG fueled or “LNG-Ready”

There are currently 162 confirmed LNG ship fuel projects

Future Projections:
- Rapid growth after 2020
- 2,000+ by 2025 (Lloyds)
- 3,200 by 2025 (DNV-GL, 2014)
WHY LNG FOR SHIPS?
A ship owners perspective

Supply, production, transport
Portable tank & Mobile Fueling services
Terminal To Ship Bunkering
Marine Supply Chains
Truck To Ship Bunkering
Ship To Ship Bunkering
Oil Market volatility – The basics...

CRUDE Oil price volatility:
- Global/geopolitical Market factors
- OPEC production swings
- Terrorism / War
- “Spikes” can be long term
- Volatility projected to continue

MDO/CRUDE move together
- 2/3 the price of diesel is oil commodity cost
- Diesel ‘follows’ crude
- Consistent spread

A “CRUDE” HISTORY OF VOLATILITY

U.S. DIESEL Follows CRUDE OIL CONSISTENTLY

CRUDE

DIESEL

SPREAD

http://www.eia.gov/forecasts/steo/report/us_oil.cf
Gas Pricing has Limited Volatility:
- A continental market
- Transported by pipelines
- Volatility is domestically induced:
  - US politics
  - Supply & Demand
  - Hurricanes / Extended cold
- “Spikes” of limited duration

**Unlike Oil, Domestic Gas prices portray relatively stable range-based economics**

The LNG ‘Secret Weapon’ for stability:
- Only 1/4 the price of LNG is commodity cost
- If Henry Hub doubles ($2.85 to $5.70) then LNG may increase only 25%

Conclusion:
- FO volatility and uncertainty has a profound effect on shipping
- Stability of natural gas better fits ‘long term horizon’ of ship ownership
FUEL COST/PREDICTABILITY/STABILITY IS IMPORTANT

COST:
• Fuel can be over 50% of a ship owner’s budget
• New sulfur limits are driving up the cost of traditional options

If budgeting is by definition a process of planning systematic spending then how does the ship-owner navigate such a sea of business uncertainty?
WHAT ARE THE CONSEQUENCES

Potential consequences of underperforming cost control policy / budgeting:

• Owner and/or charterer: loss of revenue, business, reputation
• The vessel may suffer (operationally, maintenance, asset value)
• Potential higher operational risk

“Oil has tumbled to 40 bucks and may be back up to 85 or 90 a year from now. Who knows? You can’t run a business with a long term horizon with that kind of volatility”

Peter Keller, Tote, Bloomberg, 23-Sept-16
If history was our guide THEN... LNG the clear winner

Stability vs. volatility
Predictability vs. uncertainty

Chart data sourced from eia. Historical “weekly U.S. Gulf Coast ULSD No 2 spot price” & eia. Weekly historical Henry Hub spot price expressed in $$/MMBtu + $7.00
LNG BUNKER TRANSFER MODES
quick review

1. Terminal – To – Ship (Ex-Pipe)
2. Truck – To – Ship (Direct / Mobile)
3. Ship – To – Ship (Bunker Vessel)
4. Portable Tank Transfer (Package transfer)
Supply, production, transport

Portable tank & Mobile Fueling services

Terminal To Ship Bunkering

Marine Supply Chains

Truck To Ship Bunkering

Ship To Ship Bunkering
1. Regional Utility Supply (Peak Shaving & Gas Utilities)
2. Major Suppliers (export Facilities)
3. Custom facilities (Specialty inside the fence solutions / projects)

What is the starting Point?
Regional Utility Supply (primarily owned by regulated utilities):

- Traditionally (seasonally) interruptible during periods of high demand;
- Supply may be distant from marine demand centers;
- May require trucking for distribution;
- May require add’l infrastructure;
- Selective potential for marine supply chains

Utilities in close proximity to marine demand centers, if approved by regulators, may in the future offer competitive supply solutions.
MARINE SUPPLY: CHALLENGES TO MAJOR SUPPLIERS

Major Suppliers:

**Infrastructural:**
- Berthing capacity concerns;
- Often requires dedicated jetty;
- Logistics / Road and port traffic concerns;

**Operational / commercial:**
- Increases back office, manpower and staffing;
- Consolidation of commercial relationships;
- Aggregation of small scale demand.
Merchant and Custom Facilities have limited challenges
- Existing facilities may require additional infrastructure;
- Connecting liquefaction to demand may require ‘virtual pipeline’;

Small-scale modular facilities offer quick to market solutions
- Modular, scalable, capital efficient process technology
- Scalable production
- Economics rival larger scale
- Quick to market (<18 months vs. 4 to 6 years)
- Reduce or eliminates need for short-sea shipping
- Deployable on a fixed or floating asset (Mini-FLNG)
WHY DEVELOP CUSTOM FACILITIES/SUPPLY CHAINS?

- LNG marine Bunker clients demand supply certainty and resilient, redundant supply chains.

- Three (3) of eleven (11) commercial plants offer firm service (Birmingham/Indianapolis/REV).

- Remaining (8) commercial plants are utility owned (and must satisfy utility needs).

- There is a need for firm liquefaction towards marine and it's altering traditional supply

REV liquefaction (PA/NJ) + Lifting supply agreements at all (11) commercial plants = Firm supply Today
“HOW TO” SUPPLY CHAINS EFFICIENCIES / INTEGRATED MODELS

Supply, production, transport

Portable tank & Mobile Fueling services

Terminal To Ship Bunkering

Marine Supply Chains

Truck To Ship Bunkering

Ship To Ship Bunkering
• Every step in the supply chain adds incremental cost
• 50% or more of delivered cost is transportation (2x that of oil)
• The closer to supply the lower the delivered cost
• Distance considerations (Production to Consumption)
• Trucking and over-water transport add considerable cost
• **Vertical integration / volumes of scale** serve towards reducing cost
SUPPLY CHAIN DEVELOPMENT

EFFECTIVE SUPPLY MANAGEMENT (Gas Supply):

- Strategically position Gas Supply
- Proper quantity, quality, volume, and pressure
- Inside the city gate (marine) or remote – pros and cons -cost
- Negotiated basis differential – effects on model economics

Gas Supply Cost Control Strategies (Marcellus):

- Vertically integrate across supply chain
- Partnerships upstream (E&P producers)
- Production at source = no transport/demand fees
- Firm Gas reserves = Firm service
- Exploit negative basis gas supply
- Select Index with limited regional variation
### INDEX SEASONAL VOLATILITY

#### Statistical data

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<tr>
<th></th>
<th>Start</th>
<th>End</th>
<th>Average</th>
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<td>Henry Hub</td>
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<td>Transco Z6 non NY</td>
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SUPPLY CHAIN DEVELOPMENT

EFFECTIVE SUPPLY MANAGEMENT (Liquefaction):

- Proper selection of process technology
- Proper scale – not over-reaching the market
- Sufficient volumes to base-load (FID closure)
- Diversified customer portfolios

Liquefaction

- Flexible small-scale Liquefaction
- Modular proprietary (liquefaction) technology
- Economics rival that of larger processing units
- Proximity to demand-base improves economics
- Integrates within our embedded terminal model
- Deployable on land or floating asset (Mini-FLNG)
EFFECTIVE SUPPLY MANAGEMENT (Over-road Transport):

• Proximity / Distance considerations (Production to Consumption)
• Diversified portfolio within Economic radius (Northeast markets)
• Seasonal considerations (may extend driver-hire /cost of transport)

For every 100 miles from source, add $1.00/MMBtu
SUPPLY CHAIN DEVELOPMENT

EFFECTIVE SUPPLY MANAGEMENT (Bunker terminal & transport):

- Mode supporting lowest delivered cost
- Least operationally disruptive
- Contractually flexible terms
- Optimized design (economics and safety)
- Harmonized with physical attributes of the port
- Minimal disruption to flow of traffic
- Safety considerations (separation criteria/SIMOPS/risk management)

Terminal & Delivery (Marine)
- Partnership with customers – integrated solutions
- Consulting to optimize the supply chain efficiencies
- Drive out unnecessary expenses in transport
- Bundle infrastructure, processes, and technologies
- Completes the vertical value-chain
- Create value-added benefits to customer
EFFECTIVE SUPPLY CHAIN DEVELOPMENT

INTEGRATED SERVICE MODEL

From “WELL TO WHEEL”

Leveraging tools, relationships, partnerships, and experience
Forming integrated solutions for marine customers

From “WELL TO KEEL”
SUPPLY CHAIN DEVELOPMENT

Customized to:
• Client
• Location
• Host Facility
• Aggregate Demand

Cost components for illustrative purposes only and should not be construed as commercially representative of REV and/or REV LNG Marine.
SUPPLY CHAIN DEVELOPMENT

YOUR BUNKER PROVIDER MUST ASSEMBLE THE SAFEST AND MOST COST EFFECTIVE SUPPLY CHAIN MODEL

Cost components for illustrative purposes only and should not be construed as commercially representative of REV and/or REV LNG Marine
BUNKER PROVIDER SELECTION OF INFRASTRUCTURE

- Volumes of scale drive infrastructure selection
- Volumes of scale drive mode of bunkering
- Economics drive client decision
- Bunker supplier and terminal project developer must understand the interplay between economics and volumes of scale and the tipping points of economics of each delivery mode
HUB AND SPOKE OPENS EXPANDED MARKETS

- On-Road regional markets are easily supported by Marine distribution Infrastructure.
- Marine hubs are capable of servicing multiple cross-sector markets (marine, rail, power, on/off road sectors)

Marine terminals service local needs:
- ISO container distribution (land/sea/rail)
- CNG for terminal trucks & equipment pool
- LNG/CNG for trucks
- CNG for cars
Over the industry’s 60 year history of 40,000 voyages there has never been a spill from a ship into the water from either a collision or grounding. Zero loss of life and Zero loss of vessel from incidents of significance (1).

- Technical and operational defenses
- High quality management
- Effective risk management
- Broad set of standards, codes and regulations apply
  - Standards guide the industry
  - Standards enable public officials to evaluate activities
  - Regulatory compliance ensures transparency and accountability
- LNG is therefore a tremendously “successful” industry
- Historically confronted the challenge of its risks and managed them with success
- Industry recognizes crucial importance of preserving LNG’s reputation

“Loss of confidence in the LNG Industry in one part of the world will undermine confidence elsewhere and threaten the reputation of the industry as a whole”

Society of International Gas Tanker and Terminal Operators - 2002

(1) 2012 study of LNG safety conducted by the Center For Energy Economics
SAFETY

LNG Bunkering:
- Introduces a new way of utilizing LNG
- Has effectively “down-sized” LNG
- Multiplies the volume of equipment & participants
- Increases new entrants (suppliers/transporters/engineers/technicians)
- New entrants may have limited experience with LNG
- Divergent safety cultures: At each interface along the supply chain (supplier and a receiver) there is potential risk and potential disparity in levels of training and experience.

LOI and permitting Process:
- early engagement of regulators (USCG and others) is critical
- Full disclosure – transparency – trust – information sharing, all build effective teams
- Efficient and expedient processing
Safety is not only technical, it is a function of manpower, behavior, and culture.
SAFETY, SERVICE, QUALITY, SUPPLY ASSURANCE

Consulting and FEED Services available
Full Design, Construction, commissioning and operation services
Supply chain consultancy and full spectrum LNG bunkering services

REV LNG, LLC
"Where the REVolution began"
An established market leader in the
safe sourcing, transport, and
production of LNG.
"From "Well-To-Wheel"

REV LNG MARINE, LLC
"The REVolution Sets Sail..."
LNG supply chain & infrastructure
development. Scalable solutions
which grow in step with demand.
From "Well-To-Keel"
Tri-State Delaware Bay LNG Bunkering Workshop

“THANK YOU”

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