

# ***LNG as a Marine Fuel***

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# *Panel Overview*

- Why are we talking about LNG?
- What do ports need to know about LNG?
- What can ports do to prepare for LNG?
- Will hear about four elements of the value chain:
  - Fleet
  - Port
  - Bunker operations
  - LNG provider

# Speakers

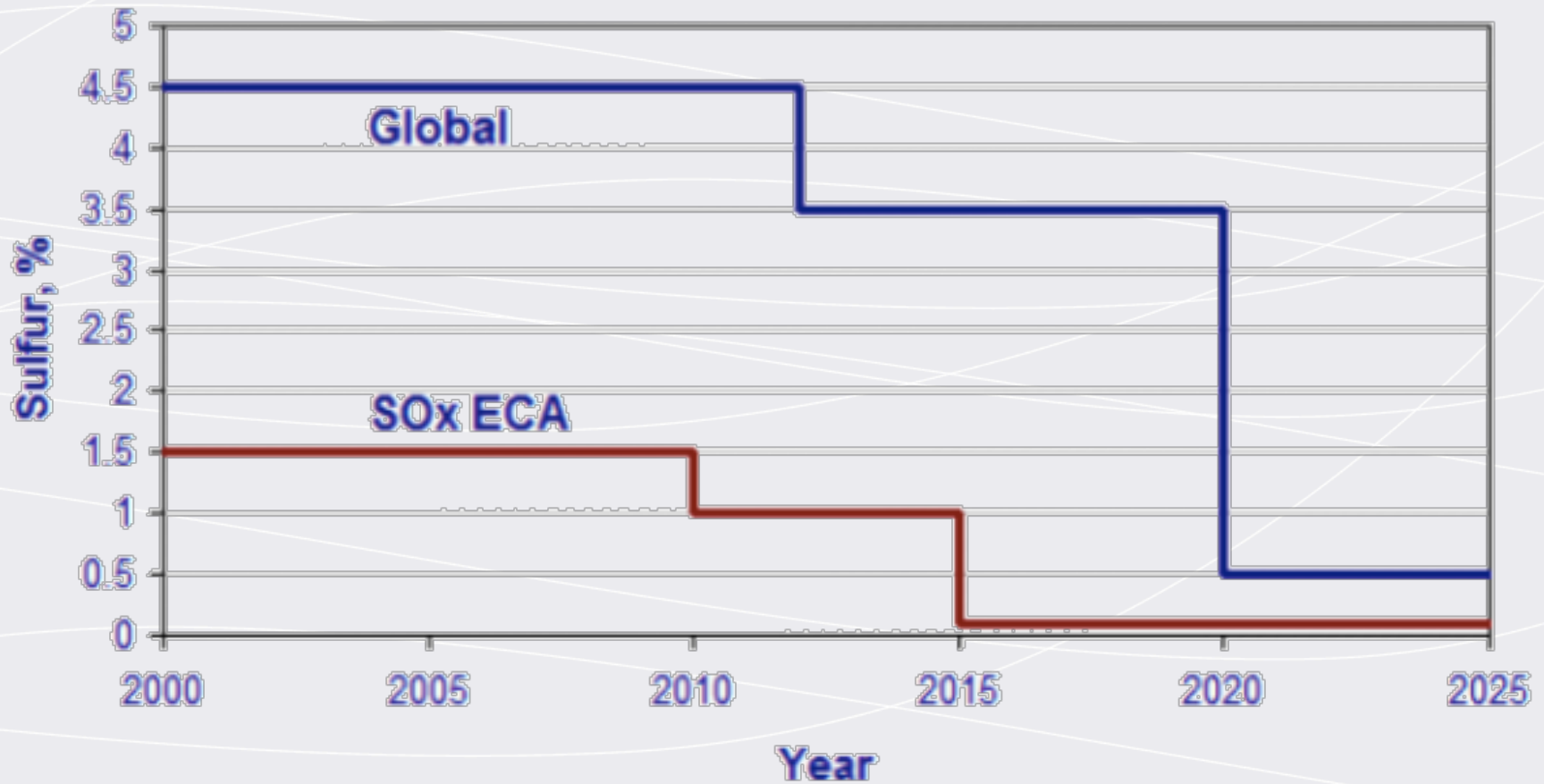
Cliff Gladstein  
President  
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Santa Monica, CA

Amelia L. Pellegrin, AICP,  
LEED AP  
Environmental Services  
Manager  
Port of New Orleans

Phil Morrell  
Vice President,  
Marine & Terminal Operations  
Totem Ocean Trailer Express,  
Inc. (TOTE)  
Tacoma, WA

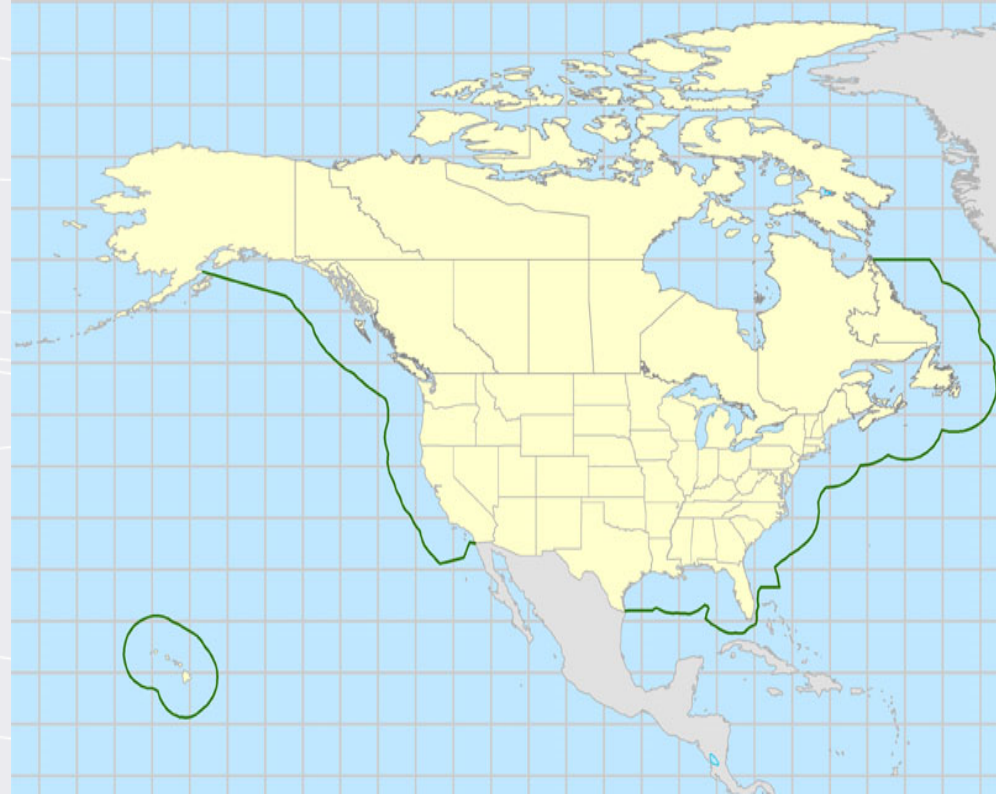
Charles Mitchell  
Vice President, Global LNG  
ABS Consulting Inc.  
Arlington, VA

# 2008 Amendments to MARPOL Annex VI Will Reduce Sulfur Levels in Marine Fuel Worldwide



# ***North America is the World's First ECA for Both SO<sub>x</sub> and NO<sub>x</sub>***

- U.S./Canadian application approved in 2010
- Key implementation dates through 2016
- Covers all ships within 200 nm from most of the US and Canadian coasts



Source: IMO, EPA, and USCG

# LNG Can Be A Cost-Effective Solution for Achieving ECA Compliance

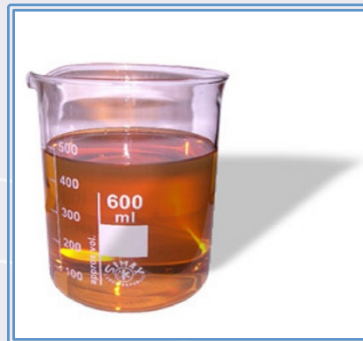
## OPTION 1:

Liquefied natural gas (LNG)



## OPTION 2:

Low sulfur fuel oil (MDO / MGO)



## OPTION 3:

Existing high-sulfur fuel and install advanced emissions control technology



# Shale Gas Revolution

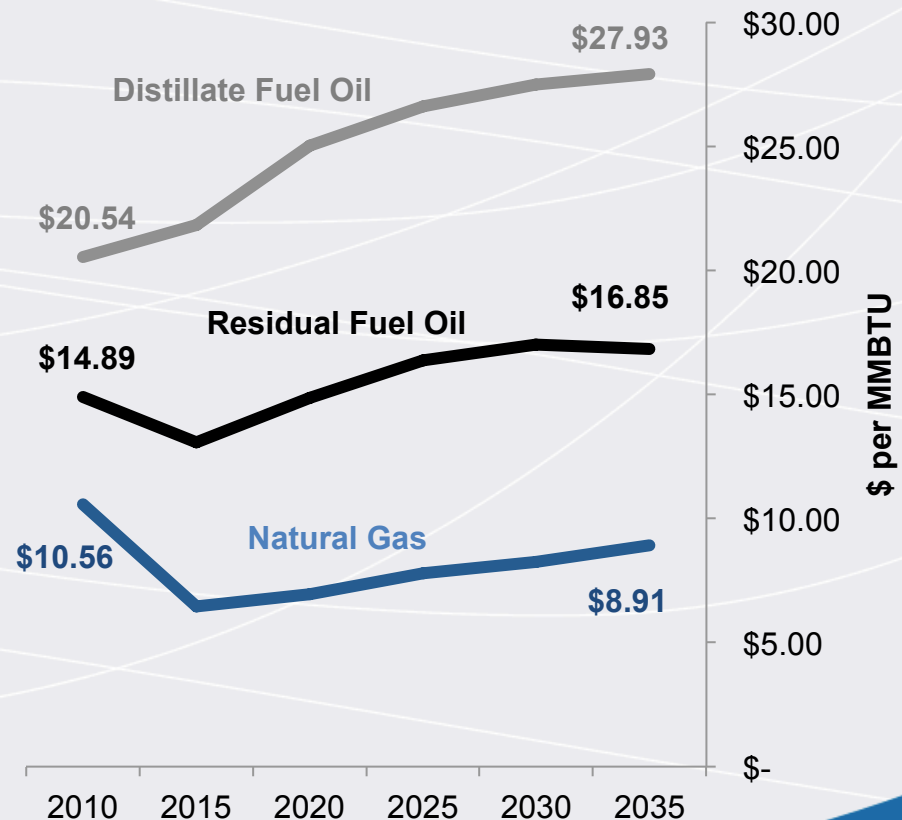
- Unconventional production has altered the energy landscape for the U.S.
- U.S. Natural gas production is projected to exceed consumption through at least 2040, even with substantial exports.
- Low gas prices projected to spur robust growth in U.S. industrial sector.
- Low gas prices projected to increase the use of natural gas in all forms of transportation



# LNG Emerging as Lowest-Cost Fuel Option in North American ECA

- Many refineries are blending high-cost ULSD and lower-cost high-sulfur fuels to achieve ECA-compliant levels
- Key factors:
  - Share of time in the ECA
  - Price differential b/w LNG and conventional marine fuel
  - Investment costs for LNG tank system and other infrastructure

US Energy Prices by Source  
(Source: US EIA)





# ***LNG Supply and Suppliers and the Challenges and Opportunities of Providing Marine LNG***

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# ***Kinds of LNG Suppliers***

- **Peakshaver** (30,000 – 80,000 g/d)
  - Typically owned by local gas utility
  - Restrictions on sales
- **Field Gas Treatment** (20,000 – 50,000 g/d)
  - Associated with exploration and production
  - Liquefaction used to separate commodity gases
- **LNG Import/Export** (>10,000,000 g/d)
  - Largest volumes/highest efficiencies
  - Competition with world markets drives up prices
- **Merchant** (100,000 – 250,000 g/d)

# *Kinds of LNG Plants*



Clean Energy Boron Plant -  
Merchant Facility



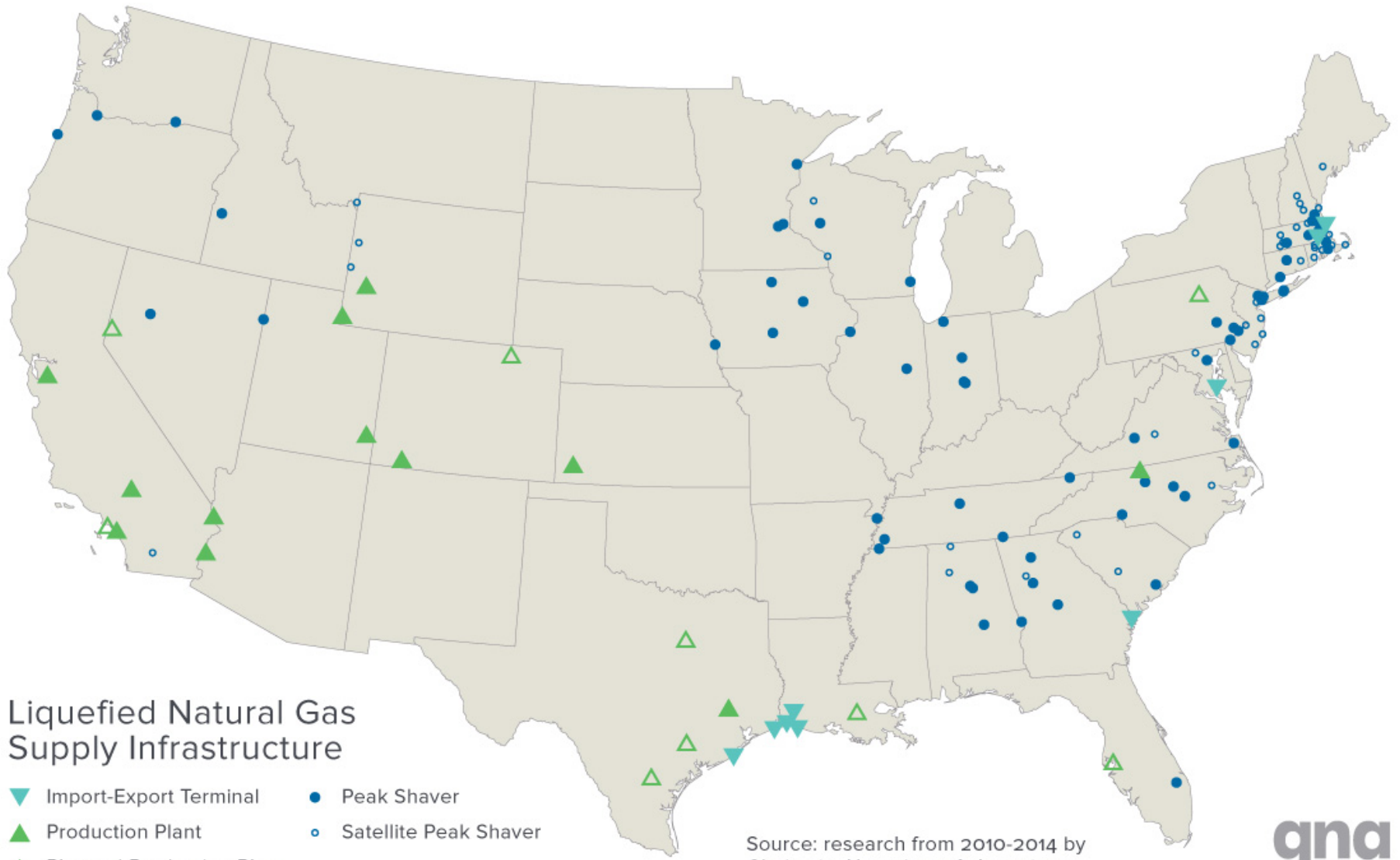
Cameron LNG – LNG Export



Exxon Shute Creek Gas Processing Plant



AGL Cherokee LNG – Peakshaver



## Liquefied Natural Gas Supply Infrastructure

- ▼ Import-Export Terminal
- ▲ Production Plant
- △ Planned Production Plant
- Peak Shaver
- Satellite Peak Shaver

Source: research from 2010-2014 by Gladstein, Neandross & Associates



# Companies In U.S. Marine LNG Market



# *LNG Supplier*

- The desire of the LNG supplier to operate water side or as close to water side as possible at the port, either in terms of liquefaction, bulk storage to support loading a bunker barge or tanktainers
- The role of the port: help facilitate these projects by working with other regulatory agencies (i.e.: permitting, regulations, coast guard regulations) as well as marine operators
- Concern same as operator: What will be the exclusion zones and other regulations required to ensure the safe handling of LNG within the port

# ***Marine Based LNG Terminal Advantages***

- Ship demand is large enough to anchor a small scale LNG plant
- Ports generally receptive to new business to create jobs and tax base
- LNG fuel availability can convey a competitive advantage to a port
- Shippers are quickly adopting LNG and are looking for Ports to support their efforts
- Provides an opportunity to tell a good environmental story
  - Cleaner emissions
  - No risk of environmental contamination from spills

# ***Fuel Consumption – Gulf of Mexico Vessels***

<b>Vessel Type</b>	<b>Average Installed Engine Power (kW)</b>	<b>Annual Fuel Use (MT HFOe per vessel)</b>	<b>Annual LNG Demand (Gallons per vessel)</b>
<b>Articulated Tug-Barge</b>	<b>5,508</b>	<b>2,502</b>	<b>1,240,036</b>
<b>Cargo (General)</b>	<b>7,891</b>	<b>4,477</b>	<b>2,218,831</b>
<b>Cargo (Ro-Ro)</b>	<b>4,184</b>	<b>2,502</b>	<b>1,240,036</b>
<b>Carrier (Dry Bulk)</b>	<b>9,608</b>	<b>4,427</b>	<b>2,193,896</b>
<b>Containership</b>	<b>34,341</b>	<b>13,643</b>	<b>6,761,983</b>
<b>Offshore Support Vessel</b>	<b>2,937</b>	<b>681</b>	<b>337,688</b>
<b>Tugboat - Open Water (&gt; 6,000 hp)</b>	<b>5,788</b>	<b>2,147</b>	<b>1,064,318</b>



# ***Marine Based LNG Terminal Challenges***

- Vessels needed for different markets require unique dock designs
  - Bunkering vessel versus bulk transport
- Lengthy cryo-pipe to dock increase capex and require a boil off management system
- Large and infrequent bunkering events require large LNG storage capacity and a boil off management system

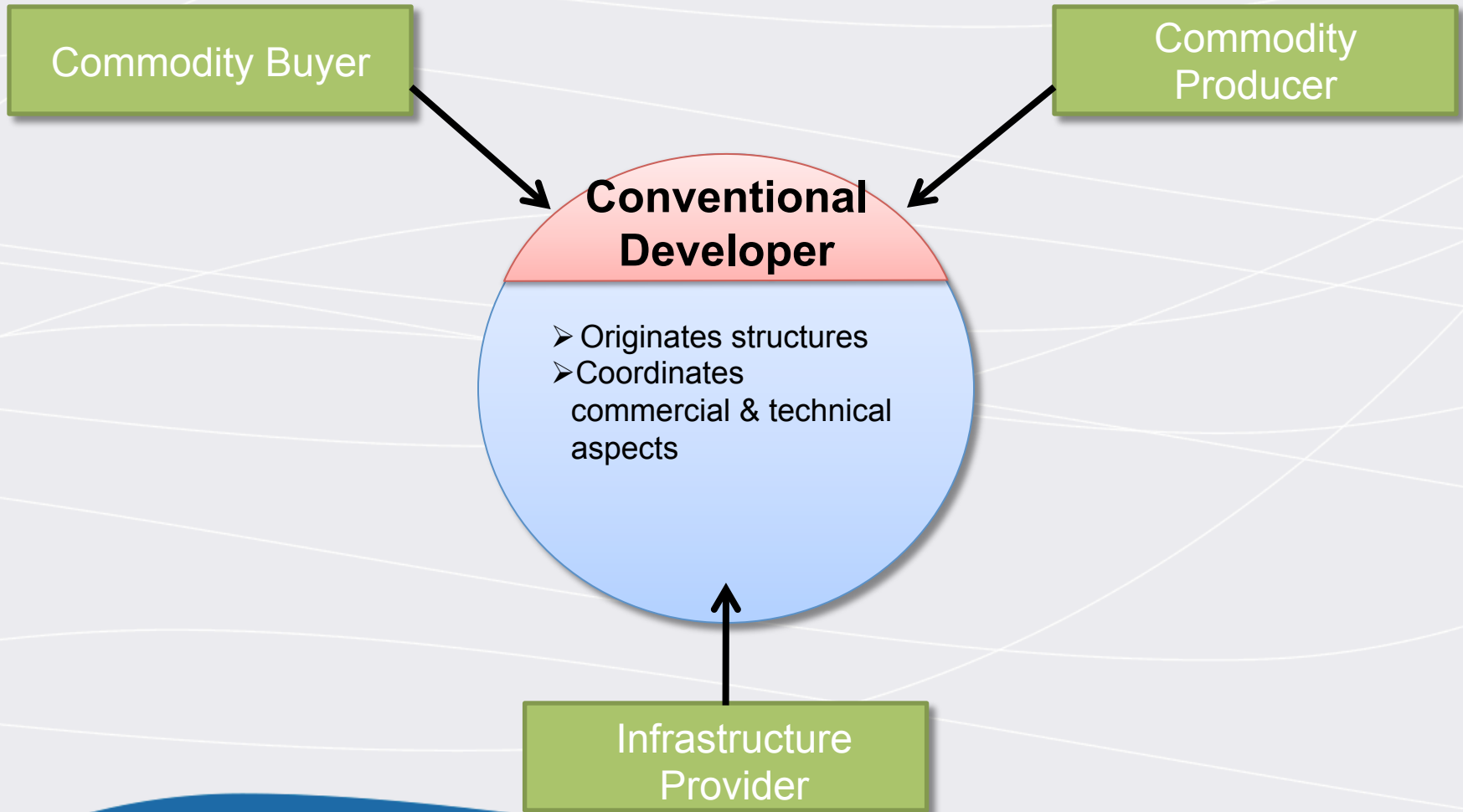
# ***Marine Based LNG Terminal Challenges***

- Access to other terrestrial based markets may be limited by logistical challenges associated with locating in a port location
- Port gas supply often times constrained and subject to rate stacking from local LDC
- Appropriate port properties often limited and expensive
- Supply chains need to be developed for small scale marine applications
- Speaking the same language in terms of units of sale

# ***Preferred Contract Terms – LNG Supplier***

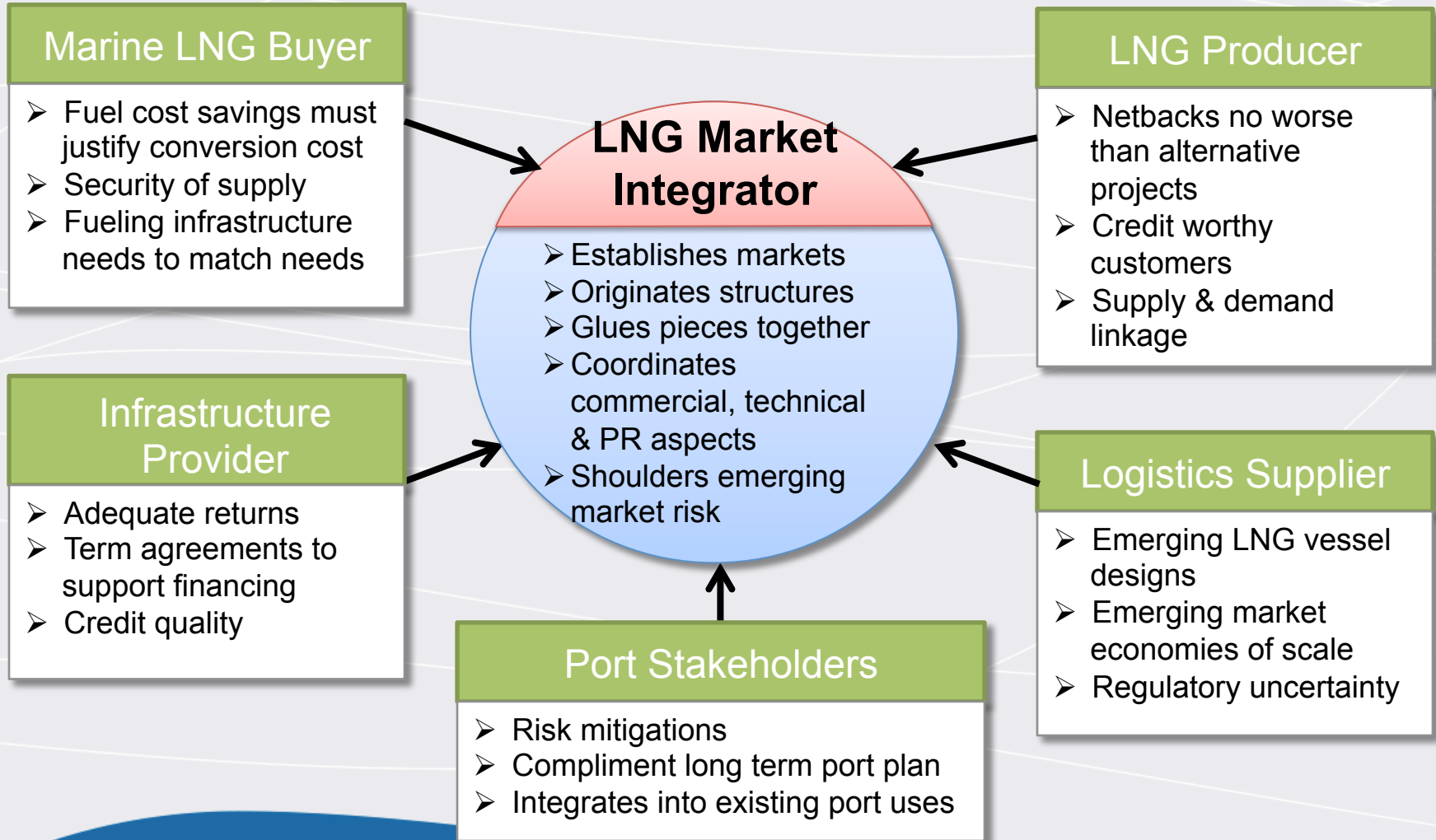
- Merchant LNG plants with appropriate storage cost >\$80 million (100,00 gpd cap)
- Suppliers need certainty of demand (under contract) to secure financing
- Suppliers want long term contracts (minimum of five year, prefer 10+) in order to invest
- Runs counter to how ship owners historically have purchased fuel
- Issue of fuel surcharge

# ***Conventional Midstream Developer Business Model Does Not Apply To Developing LNG Markets***



# Emerging Market Integrator Development Model

## Multiple Stakeholder Interests Must Be Addressed to Implement LNG Project



# *Summary*

- Ports need to get educated about LNG – reach out to local LDC, regional LNG providers, bunker operators
- Organize stakeholders - Begin to work closely with permitting and regulatory agencies, particularly the USCG, to prepare for marine LNG
- Identify and work closely with marine operators who are interested in LNG
- Begin to plan for plant, bunker facility site selection
- Begin to think through port policies and procedures: vessel & traffic operations, response support