A View from the Bridge: LNG in Marine Applications

Rich Kassel
Senior Vice President
Gladstein, Neandross & Associates
Rich.Kassel@Gladstein.org
(646) 783-4090
www.gladstein.org

Presentation Overview

- Gladstein, Neandross & Associates
- Current Status of Liquefied Natural Gas Use
- Marine Market Assessment and Projections
- Key Challenges for the Marine Sector
- Next Steps and Recommendations for Ports

Gladstein, Neandross & Associates

- GNA focuses on clean transportation and energy consulting
- More than 20 years of experience in all facets of natural gas-fueled transportation
- Marine sector clients include vessel owners, certification societies, government agencies, port authorities, engine and fuel suppliers, and NGOs
- Based in Santa Monica and New York
- More than 40 engineers, project managers, procurement and funding staff, policy experts, and others
  - Technical Project Development
  - Procurement Assistance
  - Grant Funding & Incentives
  - Policy & Analysis
  - Project PR & Marketing
  - Conferences and Events

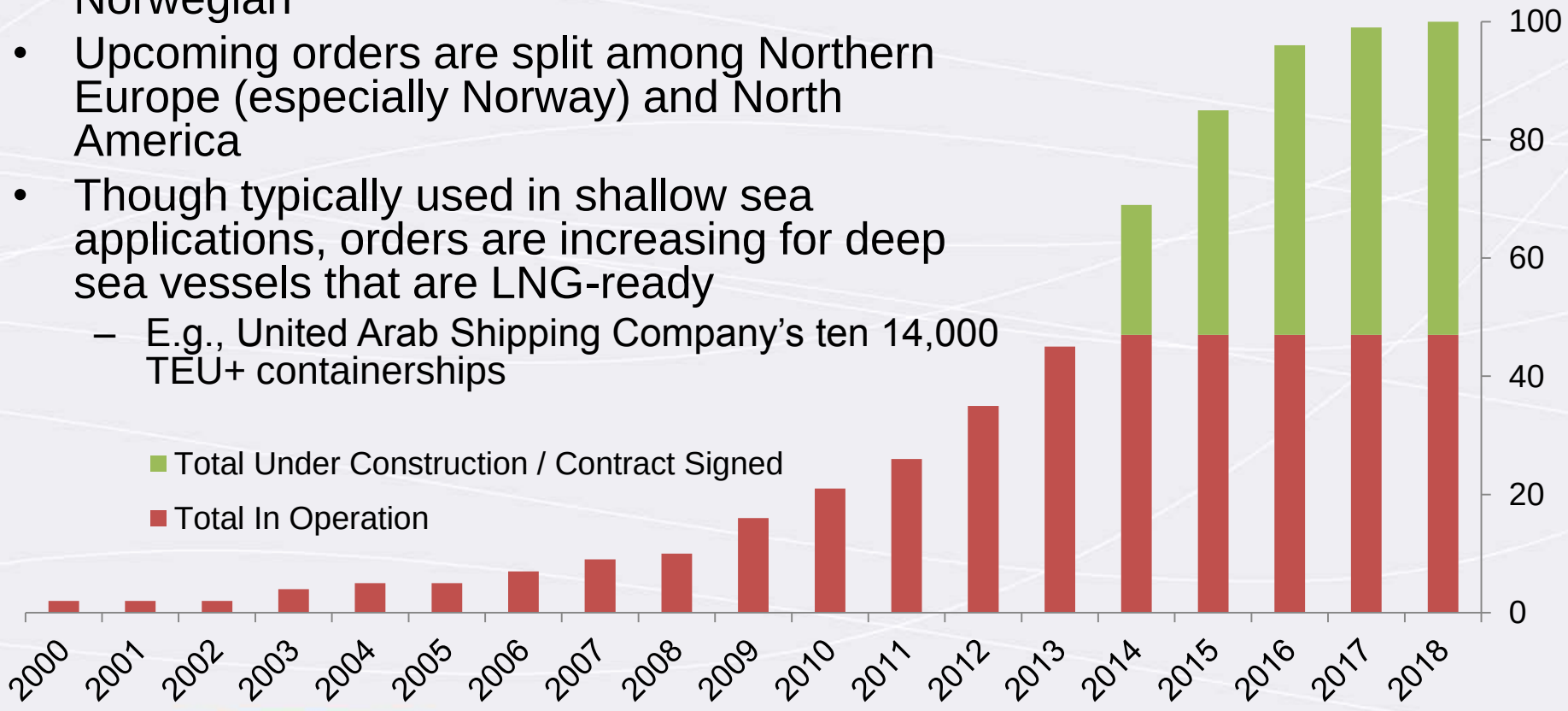
GNA's Approach to Creating a Successful LNG Marine Project

- Develop a strategic implementation plan
- Provide economic modeling
- Evaluate the engine and fuel options
- Ensure safe, effective, and efficient fueling
- Secure incentive funding and tax credits
- Assist in operations and maintenance
- Liaise/coordinate/partner with key stakeholders
- Public affairs, community outreach and communications strategies

Current Status of LNG Use

By 2018, There Will Be At Least 100 LNG Marine Vessels Worldwide

- 90% of LNG vessels in use today are Norwegian
- Upcoming orders are split among Northern Europe (especially Norway) and North America
- Though typically used in shallow sea applications, orders are increasing for deep sea vessels that are LNG-ready
  - E.g., United Arab Shipping Company's ten 14,000 TEU+ containerships



NB: Excludes tankers and inland waterway vessels

Many LNG Infrastructure Projects Are Underway

LNG Import / Export Terminals

- IMPORT: 15 North American Terminals (11 in US)
- EXPORT: 8 US Terminals (all applications approved since 08/2012)

Merchant Liquefaction

- ~10 US Plants and growing
- Competition from on-road trucking, drill rig and pressure pumping, and locomotives

Peak Shave / Utility

- Over 100 US Facilities store fuel for peak utility usage
- Regulatory challenges with the state-level Public Utilities Commission or FERC

The North American ECA is a Key Regulatory Driver for LNG

- Covers all vessels operating within 200 nm of most US and Canada coastlines
- Requires lower-sulfur fuels and NOx controls to reduce NO_x, SO_x, and PM emissions
- Will cut up to 31,000 premature deaths and $130 billion in health costs by 2030
- Coast Guard has MOU with EPA to enforce compliance

Source: IMO, EPA, and USCG

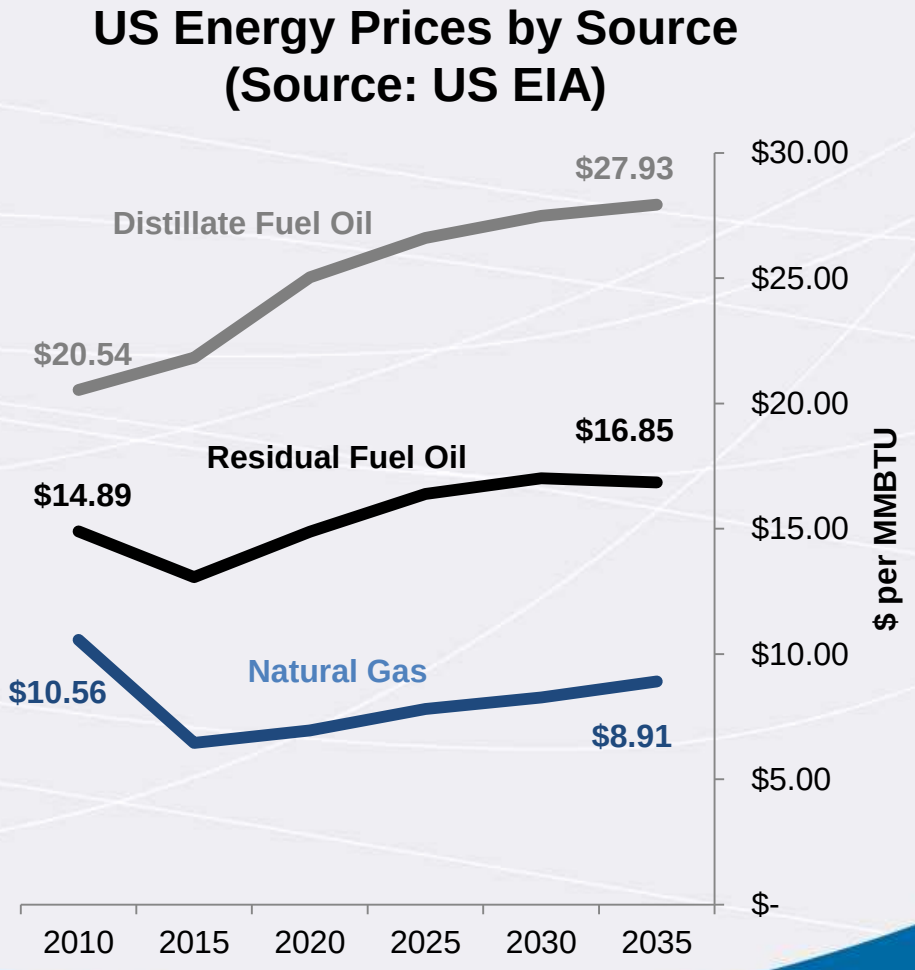
ECA Imposes Stricter Fuel and Emissions Requirements

Year	Fuel Sulfur Level	NO_x Control	Potential Cost Impacts
2012	10,000 ppm (1%)	-	~40% Fuel Cost Increase
2015	1,000 ppm (0.1%)	-	~70% Fuel Cost Increase
2016	-	Tier III via after-treatment	More CAPEX & OPEX

Note: Starting in 2016, new engines operating in ECA must use emission control technology that achieves an 80% reduction in NO_x

ECA Affects Fuel Prices in the Marine Market

- Refineries constrained by difficulties in processing available crude to ECA-compliant levels
- Consequently, marine fuel providers must blend higher cost ULSD
- LNG is emerging as a cost-effective fuel option, especially for vehicles that operate mostly or solely in the ECA



Marine Market Assessment and Projections

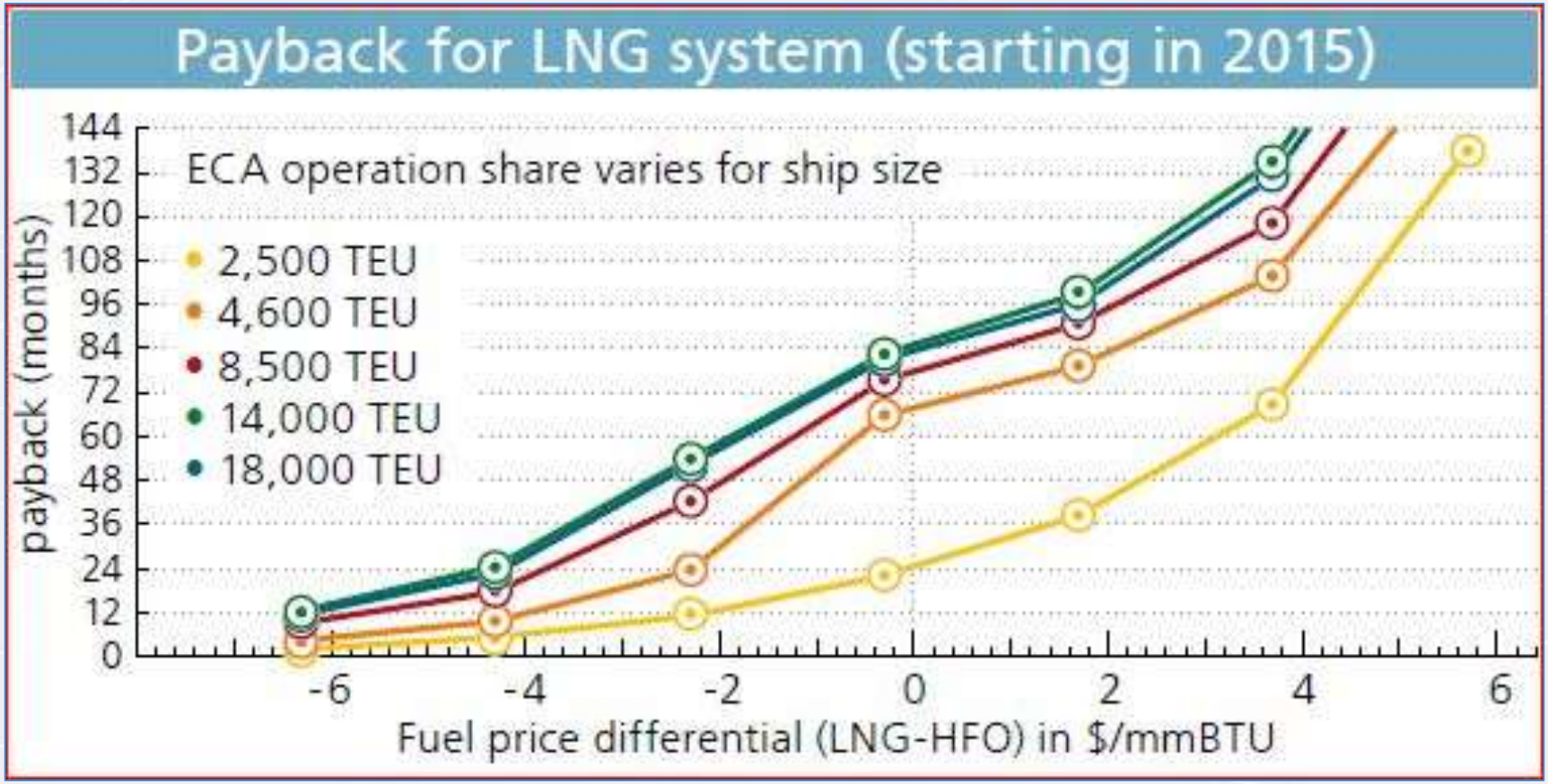
LNG has Great Potential in the US Market

Ship Type	Quantity*
Tugs / Push	5,707
Tanker	234
Dry Bulk	221
Container	102
Ro-Ro	58
General	38
OSV	689
Ferries	611

Source: "Greener Shipping in North America", February 2011, DNV

- Thousands of potential LNG vessels
- Because of fueling infrastructure and conversion cost barriers, LNG adoption will be slow at first
- Potential cost savings will drive market for smaller vessels in first stage
  - Tugs/push boats, OSVs and ferries
  - Most tugs / push boats already use ECA-compliant distillates
  - Lower fuel consumption and migratory nature of these vessels is an issue
- ECA will also impact other larger vessels (tanker, dry bulk, container, Ro-Ro)

LNG Has A Favorable Payback Period for A Wide Range of Vessels



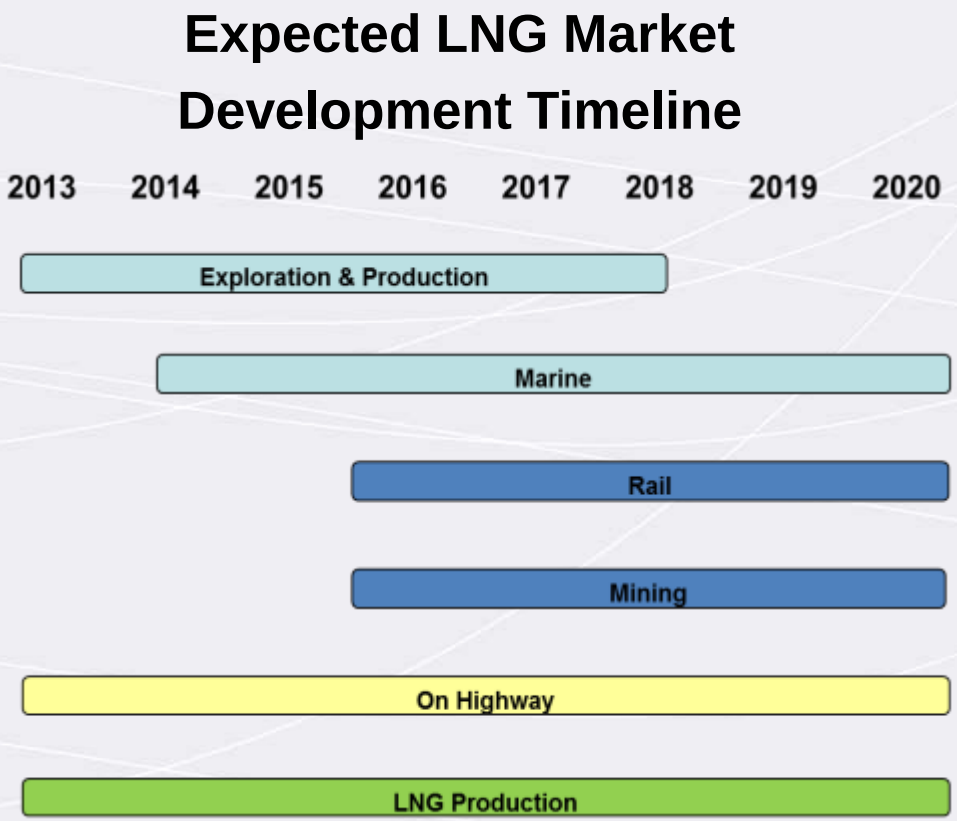
Source: Germanischer Lloyd and MAN

The North American LNG Marine Market Is Starting to Take Off

- GNA projects 40 additional units will be operational by 2017
  - There are orders for ~25 North American LNG vessels across a range of vessel types
    - Ro-ro's, OSVs, tankers, container ships, dry bulk vessels, and ferries
  - Another ~15 expected to be ordered in next 12 months
- DNV projects that 5% of total marine fuel sold in North America will be LNG by 2020—and that there will be 1,000 LNG vessels worldwide by then

The Marine Sector is Part of a Competitive LNG Fuel Market

- LNG fuel use is increasing among high horsepower applications
- This is leading to growth in fuel supply and infrastructure
- Marine, rail, and mining have potential to quickly eclipse growth of truck/ highway market

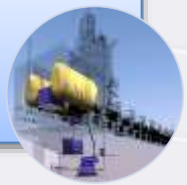


Key Challenges for the Marine Sector

Key Technical Challenges

- High engineering costs for custom tanks, hulls, support in design, and regulatory review
- 8 types of vessels, but many variations within each type

Engineering Requirements



- Significant volumes of LNG will be required to supply this market
- Example: 1,000-ton ferry requires ~1.2 million gallons LNG annually

High Volume Requirements

- LNG must be made available where and when needed
- Sufficient LNG production requires significant permitting efforts and 3-5 years' lead-time

Production Infrastructure

Key Regulatory / Market Challenges

- US Coast Guard and others still determining LNG safety requirements in North America
- Until recently, concerns about IMO ECA implementation persisted
- Lack of regulatory certainty leads potential fleets to delay LNG investments

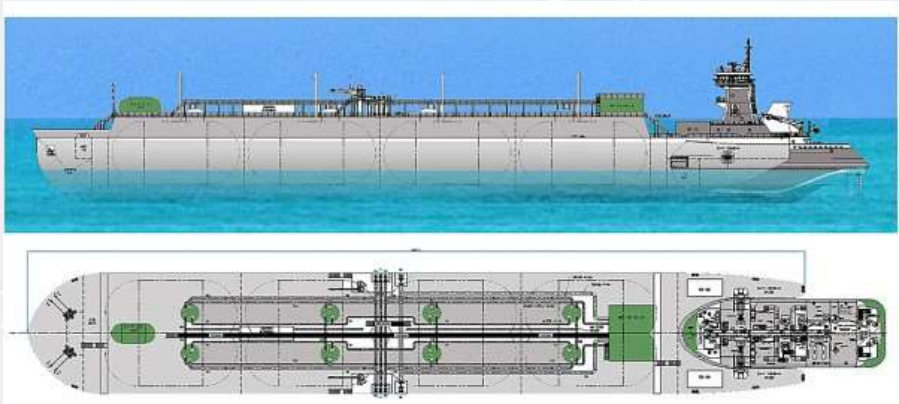
Uncertain Regulations

- Low annual unit volumes and low turnover rate
- Most likely vessels to adopt LNG are tugs/push boats, OSVs, and ferries
- Market for deep water vessels is emerging

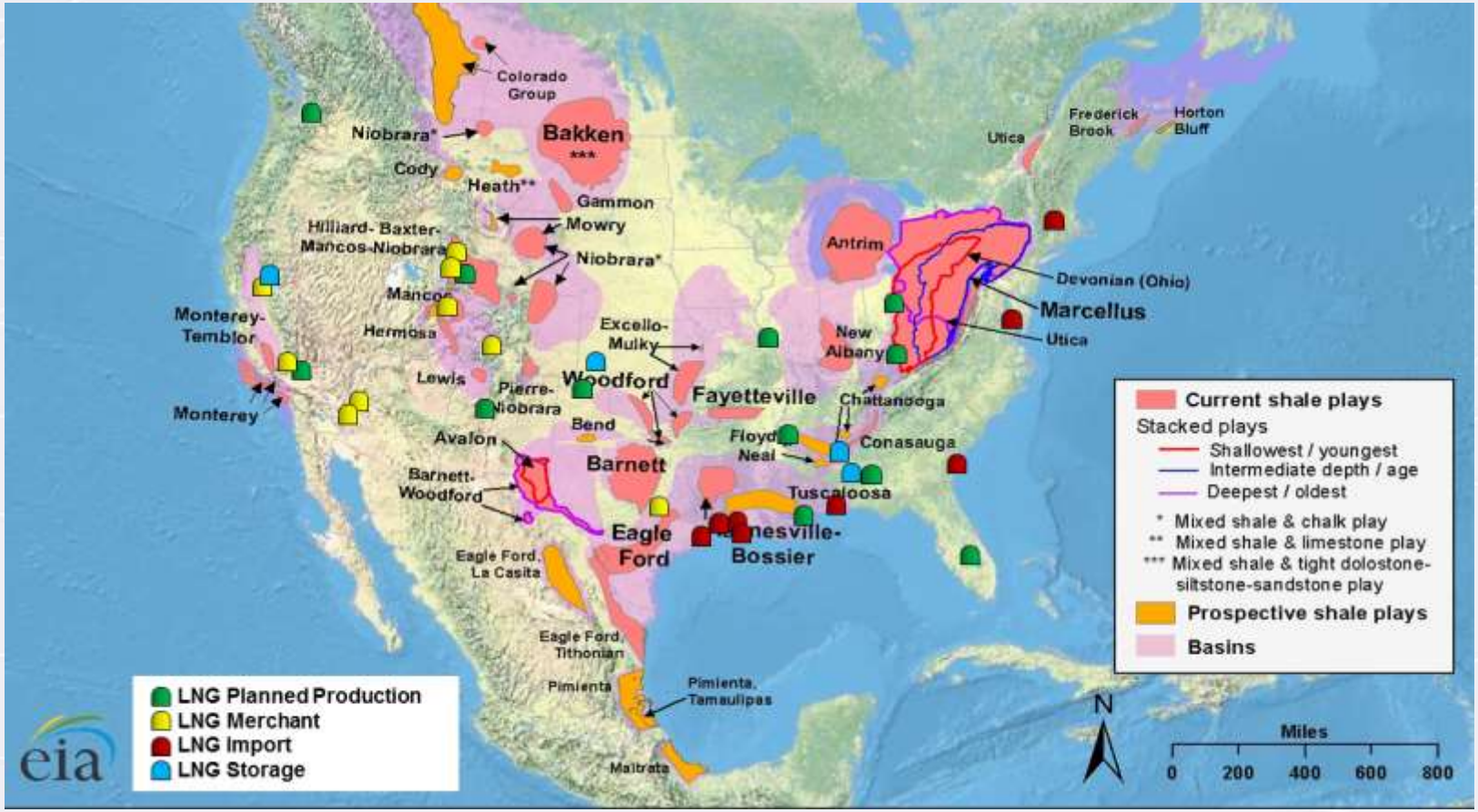
Small Market Size

Inadequate supply of LNG Bunkering & Transport Barges Remains a Challenge

- Bunkering and transport require highly customized tanks and applications
  - Range from 100,000 – 1 million gallons
- We can foresee up to a dozen orders in the next ~ 3 years for marine bunkering (TOTE, Harvey Gulf, Matson, Horizon, etc.) and transport (Shell Sarnia and Geismer)
- Additional bunkering projects have not been announced
- Chicken and egg problem: Additional market demand for bunkering barges will come only as LNG marine market develops



Co-Location is Critical to LNG Growth in North American Markets



Source: US EIA

Recommendations and Next Steps for Ports

3 Key Elements for Ports To Ensure Success of LNG Marine Projects

Supply and Infrastructure

- Provide fueling options for multiple vessel sizes
- Evaluate on-site LNG fuel storage, fueling equipment options, and operational issues
- Develop synergies with other regional hubs to further support the market, especially for vessels that operate solely in ECA
- Take advantage of the likely increasing market demand for bunkering barges
- Maintain awareness of lengthy 3-5 year timeline for permitting and construction

Cost and Availability

- Target larger investments and co-location of LNG plants
- Leverage existing LNG sources to support RD&D projects and jump start the market
- Secure incentive funding and tax credits whenever possible

Support, Training and Communications

- Provide regulatory support as USCG and EPA regulations are developed and come in to effect
- Design and coordinate training on best management practices for personnel safety and fuel handling, as well as for engine, fuel system, and bunkering equipment maintenance
- Review existing projects and case studies for lessons learned and best practices assessment
- Communicate status and benefits with key stakeholders, including media, government agencies, elected and appointed officials, community members, and environmental organizations

Thank You!

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