



LNG BUNKERING -A Perspective

What is LNG ?

Natural Gas is liquefied by cooling it to -160 degree Celsius (-260 degree Fahrenheit) at atmospheric pressure.

LNG occupies 1/600th volume of natural gas at atmospheric temperature and pressure.

Storage in double walled vacuum insulated tanks

LNG Value Chain – Infrastructure, Cost / Liquefaction / Storage & Shipping.



LNG as a Bunker Fuel

- Liquid Natural Gas (LNG) has characteristics that impact ship design and operation
- Liquid only at cryogenic temperatures (-163°C) so it requires special storage tanks, pipe systems, and handling.
- Slowly evaporate when stored so a means to deal with boil off gas (BOG) is required – venting to air is not allowed.
- Can be explosive in an enclosed space at the right mixture with air – ventilation system needed.
- Clean burning so low SO_x, Particulate, and NO_x emissions – compliant with ECA regulations.
- LNG has half the density of diesel fuel - larger storage tanks for the same range are needed – tanks are not at high pressure - can be stored below deck, unlike CNG



Drivers for LNG as Bunker Fuel:

Environmental & Regulatory Compliance:

- Emission Norms post 2020
- Global Sulphur cap in Marine Fuels.
- Nil Sulphur Content in LNG
- Low NOX Compared to Fuel oil & Marine Diesel Oil

Economic Advantage:

- Traded on Calorific Value basis
- With Increased availability & falling crude prices LNG prices are lower than global bunker fuel prices.



MARPOL Annex VI Requirements:

- Annex VI of the International Maritime Organization (IMO) for the Prevention of Pollution from Ships (MARPOL) entered into force in May 2005.
- The mandate limits the sulfur content of marine fuels on a global basis:
 - 4.5% Sulphur from May 2005.
 - Annex VI also imposed a 1.5% sulfur limit on marine fuels in Emission Control Areas (ECAs) effective May 2006.
Limit was reduced to 1.0% sulfur effective 1 July 2010
Limit further reduced to 0.1% sulfur beginning January 2015
 - 3.5% Sulfur global cap from January 2012.
 - The larger effect from Annex VI will come when the requirement to reduce sulfur content of marine fuels to 0.5% on a global basis effective 2020.

The issue for ship owners and operators is how to find alternatives to economically meet the low sulfur fuel mandate from year 2020.



MARPOL Annex VI Compliance:

Marpol Annex VI SOX reduction requirement

Options	<p>Low Sulphur Fuel oil MDO/MGO</p>		<p>Scrubber +High Sulphur Fuel Oil</p>	<p>LNG</p>		
Issues	<p>Low Sulphur Fuel Availability</p>	<p>Price Relative to Alternatives</p>	<p>Installation Cost, Waste Disposal, High Sulphur Fuel Cost</p>		<p>LNG Equipment cost, Conversion Time & Cost</p>	<p>LNG, LNG Bunker Facility Availability & Cost</p>
Pros & Cons	<p>No extra fuel tanks or handling needed</p> <ul style="list-style-type: none"> - Scrubbers needed to meet NOx - Low sulphur fuel availability and cost - Ships required to use low sulphur fuel, but refiners not required to produce / supply 		<p>Scrubbers available</p> <ul style="list-style-type: none"> + HFO and bunkering facilities available + Fuel price - Capital investment and off hire time for conversion - Waste disposal facility availability and compliance 		<p>Meets SOx, particulate and Nox requirements-</p> <ul style="list-style-type: none"> - More shipboard storage capacity - Capital investment in LNG equipment - LNG and fuelling facility availability outside limited areas-Price 	

LNG Handling : International Regulations

- ❑ LNG Being stored and handled in cryogenic conditions – Dealing with Safety Requirements.

- ❑ The Various Standards & Codes in use for LNG Bunkering are :
 - IACS 142 – June 2016 LNG Bunkering Guidelines.
 - IGC – International Gas Carrier Code for carrying Liquefied gases in Bulk adopted by IMO
 - IGF – International Codes for Safety of ships for Using Gases.
 - ISO/TS 18683 : 2015 - Guidelines for systems and installations for supply of LNG as fuel to ships
 - ISO 20519 : 2017 -Specification for bunkering of liquefied natural gas fuelled vessels
 - TR -56 : 2017 – Technical Reference for LNG Bunkering –Singapore Standard.

- ❑ Technical committee -comprising experts from OISD, DG Shipping , Indian Register of Shipping, PESO, GAIL, OIDB, DNV-GL, Lloyds Register, Bureau Veritas, Petronet, Ministry of Shipping to develop guidelines on the Technical Requirements of LNG fuelled ships & bunkering Infrastructure.

- ❑ Functional committee - Working under OISD consisting of Experts from Industry to formulate guidelines in safety in LNG Bunkering facilities at Ports ,for large ships Coastal Shipping & Inland Waterways Terminal.



LNG bunkering by vessel



LNG bunkering by truck

Two Main Options for Bunkering

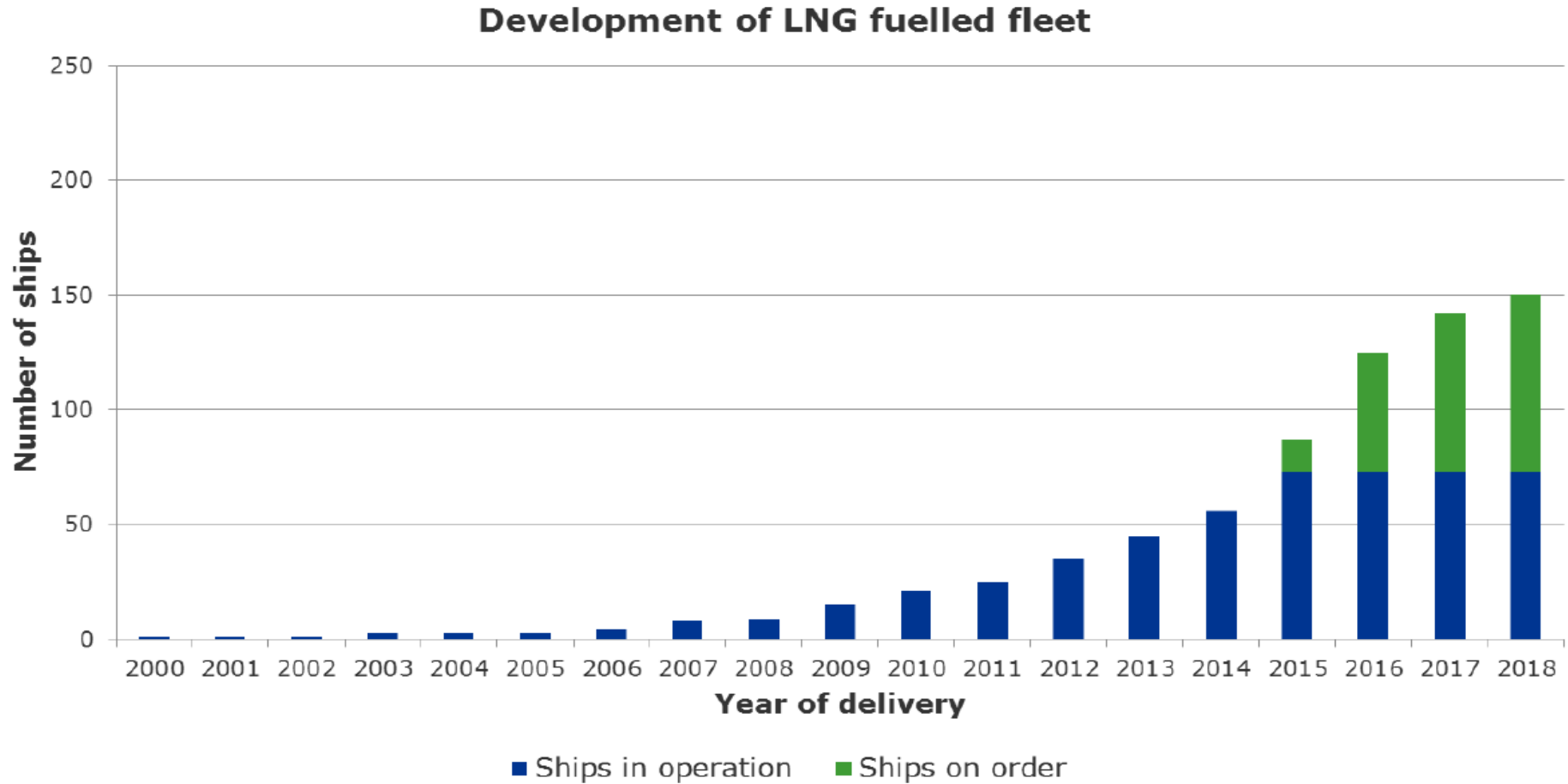
- From Barges or Small Ships
- From Shore by Truck or Pipeline

- Barges or Small Ships – similar to fuel bunkering, at pier or anchorage
- Truck or Pipeline – Trucks have limited volume – 38 m³ so for small ships only, pipelines require dedicated LNG storage facilities and piers

LNG as Bunker fuel : Potential Demand

- ❑ Future gas demand is expected to Outpace Oil demand
Annual gas demand currently around 3500 BCF expected to reach 4500 BCF by 2025 and over 5000 BCF by 2035.
- ❑ 8000 Seaport in 200 Countries : 46 ports are planning for LNG infrastructure and 15 Ports open for general LNG bunker business.
- ❑ LNG demand for ship fuel is estimated to increase to 30 MTPA by 2030.
- ❑ Europe leading the way with Government Initiatives & Financial support – ECA regulations in place. All European ports to offer LNG bunkers by 2020 and Inland waterways by 2025.
- ❑ USA – Regulatory Compliance / Economics /Local availability
- ❑ Asia Pacific
 - Oil Indexed LNG prices reduce economic incentives
 - Absence of Initiatives from Government .
 - Singapore –Worlds Largest bunkering port has started LNG bunkering.
 - China : Worlds 1/4th Commercial fleet to be owned by 2030.
 - Japan's Mitsui OSK lines – LNG fuelled 20000 TEU Container ships.
- ❑ India : Government pushing for increasing the share of Natural gas in Energy Mix from 6 % to 15 %.
Developing our own Guidelines on Safety In LNG Bunkering.
Promoting the usage of LNG fuel in Inland waterways and Coastal shipping.

Growth of LNG fuelled ships



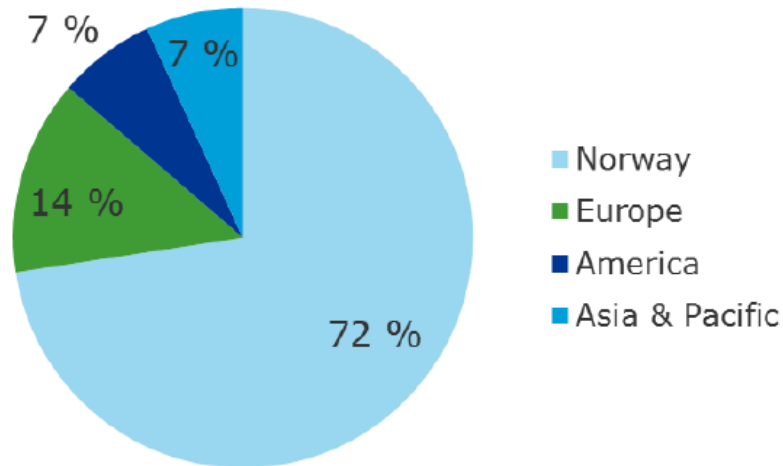
Excluding LNG carriers and inland waterway vessels



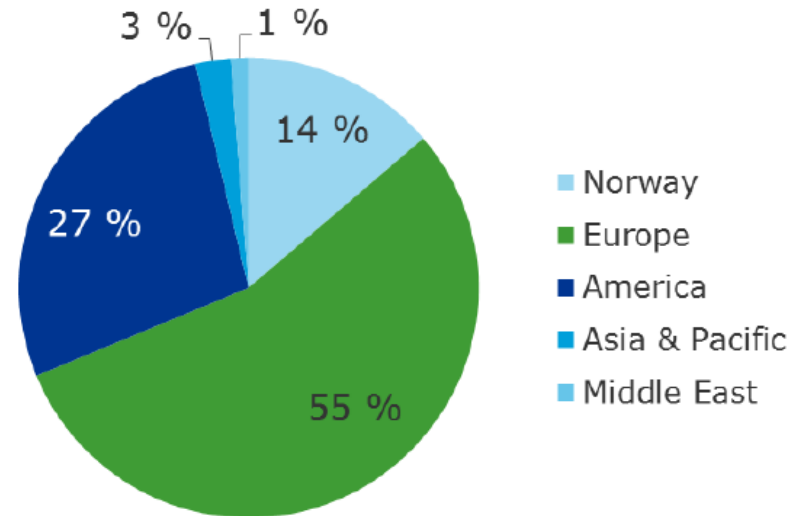
Operational areas for LNG fuelled vessels

Area of operation of LNG fuelled vessels

**Global development
- ships in operation**



**Global development
- confirmed orderbook**



Excluding LNG carriers and inland waterway vessels

LNG Bunkering : Challenges

- ❑ Chicken and Egg syndrome - Ships are chasing LNG bunker ports & Vice Versa.

- ❑ Investment Required
 - ✓ In ships propulsion
 - ✓ Fuel handling System
 - ✓ Bunkering Infrastructure
 - ✓ Barges with Trained Crew

- ❑ International Safety Regulations : International Conformity , Co-ordination and Co-operation is needed in LNG bunkering world.

- ❑ Availability & Cost of LNG as bunker Fuel



LNG Bunkering -The Kochi Advantage

❑ Kochi all weather natural harbor port - located strategically close to the busiest international sea routes:

Gulf to Singapore & Far East (At 11 Nautical Miles)

Suez to Singapore & Far east (At 74 Nautical Miles)

❑ Petronet LNG has fully operational LNG Terminal at Kochi with capacity to handle a volume of 5 MMPTA with facilities to receive and reload LNG cargoes.

❑ Spare berth capacity available at PLL terminal at Kochi, it offers an ideal port location for supply of LNG bunkers by direct pipeline transfer

❑ Bharat Petroleum - Pioneers in LNG bunkering with supply of first ever LNG bunker at Kochi on 26.02.2015 by supplying 130 MT to LNG vessel MV.KVITBJORN through M/s LNG Bunkering AE Ltd.

❑ Bharat Petroleum Corporation have been supplying bunker fuels directly and through our joint venture Matrix Bharat Pte. Ltd.



Thank You

