DEVELOPMENT OF

SHELL LNG FOR MARINE

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PROJECT LNG SUPPLY & DEMAND

Impact of limited supplies (existing supplier issues, deferred projects)
Results in 2012 supply to be lower than 2011

Source: Shell analysis, 2013 IEA New Policies Scenario
## LNG as a Cleaner Burning Transport Fuel

### Drivers

<table>
<thead>
<tr>
<th>Supply</th>
<th>Abundant global gas reserves</th>
</tr>
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<tbody>
<tr>
<td>Environment</td>
<td>Lower emissions NOx, SOx and particulate matter</td>
</tr>
<tr>
<td>Cost</td>
<td>Lower cost alternative to diesel</td>
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</tbody>
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### Challenges

<table>
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<tr>
<th>Infrastructure</th>
<th>Increasing infrastructure development in conjunction with demand</th>
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<tbody>
<tr>
<td>Engine &amp; Fuel System Cost</td>
<td>Developing technology</td>
</tr>
<tr>
<td>Regulatory</td>
<td>Requires framework that facilitates infrastructure and market development</td>
</tr>
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</table>
LNG CAN OFFER A COMPELLING VALUE PROPOSITION

1. Cost competitive fuel
2. Cleaner burning fuel
   - Can contribute to lower local exhaust emissions and global greenhouse gas emissions
3. Proven and reliable LNG engine technology availability
4. LNG Availability, Safe and reliable supply chain
LEVERAGING GASNOR

BUNKER FROM SEMITRAILER

SHIP TO SHIP BUNKERING

BUNKER FROM TERMINAL
The new vessel will be built by STX Offshore & Shipbuilding. It will be based at the port of Rotterdam in the Netherlands, and will load from the new LNG break bulk terminal and jetty to be constructed by the Gas Access to Europe (Gate) terminal. It will also be sea-going and, therefore, able to bunker customers at other locations.
GATE – LONG-TERM LNG FOR TRANSPORT
Environmental related regulations will affect the economics of shipping industry to a large extent.

**Acid rains**
- Tier II (2011)
- Tier III

**Sulphur content in fuel**

**Greenhouse effect**
- Under evaluation by IMO

**Particulate matter**
- Direct impact on humans
  - Locally regulated
Wärtsilä’s Gas Experience: Dual-Fuel applications – Gas history

- **4S GAS-DIESEL (GD)**
- **4S DUAL-FUEL (DF) WITH BACKUP FUEL MODE**

Timeline:
- **1973 / 1986**: 2S GAS PROTOTYPES
- **1987**: 4S SPARK-IGNITION GAS (SG)
- **1992**: 4S GAS-DIESEL (GD)
- **1995**: 2S DF PROTOTYPE
- **2011 / 2013**: 4S DUAL-FUEL (DF) WITH BACKUP FUEL MODE
## Dual-Fuel applications: References

<table>
<thead>
<tr>
<th>Category</th>
<th>Application Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Plants</strong></td>
<td>DF Power Plant: 57 installations, 225 engines, Online since 1997</td>
</tr>
<tr>
<td><strong>Merchant</strong></td>
<td>LNGC: 121 vessels, 481 engines. Conversion: 1 Chem. Tanker, 2 engines conv., Complete gas train, Complete design</td>
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<tr>
<td><strong>Offshore</strong></td>
<td>PSVs/FPSOs: 20 vessels, 93 engines. Online from 1994. New orders: Harvey Gulf, the first 5 LNG-PSV to be operated in the Gulf of Mexico!</td>
</tr>
<tr>
<td><strong>Cruise and Ferry</strong></td>
<td>LNG ferries: 1 vessel, 4 engines per vessel, Complete gas train, 2800 passengers, In service early 2013</td>
</tr>
<tr>
<td><strong>Navy</strong></td>
<td>Coastal Patrol: DF-propulsion, DF main and auxiliary engines</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>IWW: 2 vessel, 3 engines (6 and 8L20DF), 1 pusher option (4x6L20DF)</td>
</tr>
<tr>
<td></td>
<td>TUG: 2 vessel, 2 engines each, Mechanical drive</td>
</tr>
</tbody>
</table>

→ 6 segments → >1300 Engines → > 13’000’000 running hours
Wärtsilä - Your Shorter Route to the Gas Age

**Exploration & Drilling**
- LNG fuel gas systems for OSVs
- Gensets
- On- & Offshore small scale liquefaction
- Antiflaring/VOC
- Oil separation
- Gas FPSO

**Production & liquefaction**
- LNG fuel gas systems
- LPG, LEG & LNG cargo handling

**Transport & storage**
- LNG fuel gas systems
- Jetty & Floating regasification
- Bunkering & barges
- Receiving terminals

**Receiving terminals & regasification**
- Gas/LNG distribution/logistics
- Feed gas to Power plants

**Distribution & transport to the users**
World’s biggest LNG powered Cruise Ship: Viking Grace

VIKING GRACE

Vessel: Cruise Ship
Passengers: 2800
Yard: STX Turku, Finland
Owner: Viking Line
Delivery: Jan 2013

Scope of supply:

4*W8L50DF
LNGpac
Fuel Gas handling system
Propulsion
Compact Silencer System

Main Particulars:

L.O.A: 218 m
Breadth: 31.8 m
Draught: 6.8 m
Gross Tonnage: 57000
Service Speed: 22.1 kn
The Viking Grace makes under 50 dB noise at 100 meters distance

This small boat is making more noise than the 2800 passengers Cruise

Source: Viking Line
Viking Grace has been carrying out LNG bunkering since 2013

- Viking Grace has been in operation since January 2013
- Cargo loading/unloading, passengers boarding and LNG bunkering - all at the same time
- Zero missed voyage and Zero delays
- Viking Grace has been on LNG – 24/7

Source: Viking Line
Inland Waterway DF References: Danser Group Koppelverband “Eiger”

1st LNG refit on Inland vessel! Inauguration June 2014!

Built: 2000
Overall length: 177 meter
Width: 11.45 meter
Draft: 2.56 meter
Tonnage: 5300 tonnes
Capacity (4 layers): 348 TEU
Engines: 2x 900 kW
Inland Waterway DF References: Chemgas, 2700 m3 LPGC

Yard: Shipyard Constr. H-Foxhol
Owner: Chemgas Shipping
Delivery: 2014/2015
Amount of vessels: 1 + 1

Wärtsilä scope of supply:

- 1*W8L20DF main engine (8L20DF, 1'408kW)
- Shaft, S&B
- CPP, HR Nozzle

Pictures: Chemgas/Wärtsilä
Inland Waterway DF References: Ostfriesland, Island ferry

Re-engining
Owner: AG Ems
Delivery: 2014
Amount of vessels: 1

Wärtsilä scope of supply:

• 2*W6L20DF main engine (6L20DF, 1'056kW)
• LNGPac 45 m³

Pictures: AG Ems
Complete peace of mind with Wärtsilä total Gas Solutions

Scope of supply: 2x Wärtsilä 6L50DF dual-fuel main engines
2x 6L20DF Auxiliary Gensets
Greabox, CPP, LNG tanks and fuel supply and cargo handling equipment, Safety and Automation systems

Shipowner: Evergas
Shipyards: Sinopacific Offshore Engineering

- Largest ethylene carrier ever
- Reliquefaction plant for high grade C-ethane, Ethylene and LPG
- LNG fuel from deck fuel tanks and from cargo tank boil off gas
- Energy savings from integrated fuel supply and cargo handling systems
Wärtsilä 31: Recipient of the Ultimate Efficiency Award

MOST EFFICIENT 4-STROKE DIESEL ENGINE
YOUR KEY TO LNG
THANK YOU

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