LNG as a marine fuel
– meeting environmental standards

Klaipeda, 15.11.2017
Preben Hagelskjær Lauridsen
Go LNG

Agenda

- Who are we?
- Energy awareness!
- MARPOL Annex VI
- Energy Awareness on ships
- LNG International rules
- Future LNG stakeholders
OSK Group / Who are we?

- OSK Group is today one of the biggest Consulting Naval Architect companies in Scandinavia and working for the biggest companies in the Marine and Offshore Wind business on an international scale.

- OSK have customers world wide and have worked in all parts of the world. This have led to a significant knowledge of the International business and the culture that are the driving force in effective performance.
OSK GROUP / Company Structure

OSK GROUP

- OSK-ShipTech A/S
- OSK-OffShoreA/S
- OSK-China Ltd. (HK)
- Steen Friis A/S
Business Areas/ What do we offer?

- **Concept Design**
  - Passenger vessels
  - Cargo vessels
  - Offshore support vessels
  - Special vessels
  - Turbine installation vessels

- **Interior Design**
  - Interior Layouts
  - Exterior styling
  - Detail design
  - Onsite supervision
  - Materials Specification

- **Carbon Footprint**
  - Hull lines optimization
  - Trim optimization
  - Propeller evaluation
  - Engine room consumption
  - Alternative fuels
  - Hybrids
  - Ballast water management

- **Basic design**
  - General Naval Architecture
  - Mechanical
  - Electrical
  - Outfitting
  - Statutory drawings

- **Detail design**
  - Production fairing
  - Cutting files
  - Procurement lists

- **Project Management**
  - Project Preparation
  - Feasibility studies
  - Tender documentation
  - Contract Negotiation
  - Class and Flag state contact
  - Plan Approval
  - Progress reports
  - Development projects

- **Supervision**
  - Full Site management
  - Technical meetings
  - Shipyard Evaluation
  - Commissioning
  - Taking over / deliver
Energy Awareness!
MARPOL annex VI
- Regulation for the Prevention of Air Pollution from Ships

Requirements for
Emission control areas (ECA)
- Sulphur Oxides SOx
- Nitrogen Oxides NOx
China:
- Yangtze and pearl river delta
SOx limits

<table>
<thead>
<tr>
<th>Date</th>
<th>SOx ECA</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1.50 %</td>
<td>4.50 %</td>
</tr>
<tr>
<td>2010.07</td>
<td>1.00 %</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>3.50 %</td>
</tr>
<tr>
<td>2015</td>
<td>0.10 %</td>
<td></td>
</tr>
<tr>
<td>2020 *</td>
<td></td>
<td>0.50 %</td>
</tr>
<tr>
<td></td>
<td>* alternative 2025, to be decided by review in 2018</td>
<td></td>
</tr>
</tbody>
</table>
## NOx limits

<table>
<thead>
<tr>
<th>TIER</th>
<th>Date</th>
<th>NOx Limit, g/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( n ) is rated engine speed (rpm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( n &lt; 130 )</td>
</tr>
<tr>
<td>Tier I</td>
<td>2000</td>
<td>17.0</td>
</tr>
<tr>
<td>Tier II</td>
<td>2011</td>
<td>14.4</td>
</tr>
<tr>
<td>Tier III</td>
<td>2016*</td>
<td>3.4</td>
</tr>
</tbody>
</table>

* In NOx Emission Control Areas (Tier II is standard outside ECA’s)
- Sulphur Oxides SOx < 0.1 %
- Nitrogen Oxides NOx Tier III
Energy Awareness - on ships

Ship Design – Tier I Solution
- Sailing patterns
- Life time/ Future sale
- Optimize Hull Lines (CFD)
- Search for best Engine Solution
- Optimize Propeller Design/Solutions
- Light Weight Solution !!!
- Innovative Solutions
- Etc.

Energy Efficient Solutions
Energy Awareness - on ships

Ship Design – Tier II Solution

- Energy Recovery Solution
  - Steam Generators
  - Waste heat recovery
  - Heat Exchangers (Heat Pumps)
  - Frequency controlled pumps

- Energy Saving Solutions (add ons)
  - Windows
  - Insulation
  - Power “on-demand”

Energy Efficient Solutions
Energy (Environment) Awareness!

Ship Design – Tier III Solution

EEDI Intended to ensure that new ships are energy efficient

Fulfilling EEDI does not make it “Green” – it makes you comply!

- 75% ME power
- Max draught

• Alternative “Fuel” LNG (Methane)
  • Reduces CO2
  • Reduces NOx
  • Reduces SOx
  • Compatible cost
Example Ropax

TIER III Ropax
4 x ME = 42,000 kWatt
4 x Aux = 6,400 kWatt

HFO
- SCR (selective Catalytic Reduction) + Urea tank
- Silencer
- Exhaust Gas Boiler
- Scrubber, closed loop, holding tank
Example Ropax

Low Sulphur Fuel Oil

- No Scrubber
- Cost appr. 1.50 x HFO
- Future price...
- Ship owners
- Payback period, scrubber
Example Ropax

LNG
- Silencer
- Exhaust Gas Boiler

+
- Smaller casing => more accom.
- Save weight appr. 250 ton
- Save energy appr. 1000kW
- Stability issue

- 50% less fuel (energy/vol)
- LNG tank only uses 50% of the tank space
- New systems to be included
- Other requirements to be met
IGF Code

Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels

Risk assessment – to ensure that the use of low-flashpoint fuels do not affect:
- The ship
- Persons onboard
- Environment

Items to consider and requirements to be dealt with:
- LNG equipment, tanks TCS
- Protection or fuel tanks from outside damage
- Gas safe machinery space
- Pipe design
- Gas tanks space, Airlocks
- Extra ventilation
- Fire safety for storage and transfer of gas
- Explosive prevention, hazardous zone 0
- Bunker stations and bunkering process
LNG Risk analysis

Bunkering process can be divided into two perspectives:
Stakeholders differ, but it is essential to have a good collaboration to ensure the best practical and safe solutions is obtained.

<table>
<thead>
<tr>
<th>Ship side:</th>
<th>Quayside:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Yard</td>
<td>- Owner</td>
</tr>
<tr>
<td>- Owner</td>
<td>- Port administration</td>
</tr>
<tr>
<td>- Ports the ship enters</td>
<td>- National authority (mainly fire)</td>
</tr>
<tr>
<td>- Engine supplier(s)</td>
<td>- Supplier of bunkering equipment on land (not</td>
</tr>
<tr>
<td>- Classification Society</td>
<td>necessarily the same suppliers as for the ship)</td>
</tr>
<tr>
<td>- Flag state</td>
<td>- LNG supplier</td>
</tr>
<tr>
<td>- Supplier of bunkering equipment on ship</td>
<td></td>
</tr>
</tbody>
</table>

Safety during bunkering is also the ‘Human element’ such as:
- Organisation and management
- Training of personnel

Missing rules for bunkering Ship to Ship loading/unloading cargo/passengers
Missing rules for bunkering Quaside to Ship loading/unloading cargo/passengers
Danish stakeholders future view on LNG

- Denmark has already coverage by the natural gas grid Subsequently reducing the need for industry.

- It is estimated that the LNG productions plants in Frederikshavn and Hirtshals will cover the demand.

- LNG is mainly driven by the maritime sector where ship owners and port operators are the ‘Stakeholders’ and the ship owners the ‘End User’.

- The stakeholders prefer a mobil bunkering facility in form of a bunker ship or barge.

- Ports are still awaiting the marked demand for LNG before making any investments. It is expected that this may be the cruising industry.

- Stakeholders do not predict any other LNG users
Danish stakeholders future view on LNG

- LBG potential

- LBG is considered to have large potential as it is NON-fossil fuel reducing Green House Gases.

- The present draft of ‘Renewable Energy Directive’ include indications, that Bio fuels will be favoured in the future

- Biotickets

- It is expected that this will have huge commercial value to the cruise ship industry
H-H Ferries – 0-Emission Solution

Selected References/ Ferries

OSK services to Stena:

- Technical Tender Documents
- Specification
- Contract Negotiations
- Plan Approval
- Owners Rep
- Project management

From DE to pure battery / charging solutions, vessel and port. 50% EU funded
THANK YOU!