LNG as a ship fuel- developing competence to utilize business opportunities
GO LNG Conference – Vilnius, 2017-04-27

Dr Gerd Würsig, Business Director Alternative Fuels
Shipping becomes greener and more complex
- Regulatory timeline towards 2030 -

**Adopted**

- Core ports in Chinese area 0.5% sulphur
- All ports in Chinese area 0.5% sulphur
- Chinese area 0.5% sulphur
- 0.5% global sulphur cap
- Ballast Water Convention - entry into force

**In the pipeline, or possible...**

- EU Recycling EiF
- Global CO2 monitoring, reporting and verification
- EEDI phase 2
- EEDI phase 3
- 2017-2018
- 2019
- 2020
- 2021-2024
- 2025-

- California shore power
- EU CO2 monitoring, reporting and verification
- California sulphur regs to lapse?
- IMO GHG strategy
- EEDI Phase 4

- Baltic / North Sea NECA
- BC, noise, bio-fouling and VOC regulation
- Operational requirements to CO2 emissions

- Chinese ECA(s) application?
- EU ETS includes shipping?
- HK Recycling convention EiF?
Challenges for shipping today and in future

- Reduce CO2 footprint
  - MRV/IMO DCS → start of permanent public monitoring of ship efficiency
  - EEDI → pressure to improve ship efficiency

- Catch up with state of the art technology on land and in the air
  - ECA and ECA like areas → pressure to reduce ship emissions
  - SO2 0.5% limit →
    - possible phase out HFO as ship fuel
    - open the way for new technologies in shipping

- Price: Fuel price must justify added investment
IMO Assumptions is a complete change in ship fuel

- MEPC 70/5/3; MEPC 70.INF6
  - Assessment of fuel oil availability – executive summary/final report –
- 2020: Fuel consumption in shipping: **308 to 352** Mio t/a (approx. 3300 t/(a ship))
  - Up to 0,1% S: 33 to 48 Mio t/a
  - 0.1 to 0.5 % S: 233 to 290 Mio t/a (**70 to 88 %**)
  - Above 0.5 % S: **14 to 36** Mio t/a (HFO plus Scrubber; **4 to 11%** (100%=(330 Mio t/a)); approx. 4000 ships (**today: 350**))
  - LNG: 12 to 13 Mio t/a (**2 to 3** Mio t for LNG fueled ships other than LNG carriers, approx. 4%)
What are alternative fuels/technologies

- HFO (including low S HFOs), MGO (reference fuels)
- Diesel from H2 and CO2 (CCS CO2, H2 (in future from access wind power,...)
- Gases: LNG, LPG, Ethane, DME, Biogas (CH4), Hydrogen
- Liquids: Methanol, Ethanol, Bio Diesel,
- Technologies: Batteries, Fuel Cell System, Sails
- Others: Nuclear, Cold Ironing/Shore power, On-board CCS
The most relevant alternative fuels and technologies

- Fuels: LNG, Methanol, LPG, Hydrogen, Bio Fuels
- Technologies: Batteries, fuel cells, wind supported propulsion
- Competences needed
  - in fuel handling, safety, system operation
  - System design, building
  - Logistics, economics
LNG stays most relevant!

1. price:
   1. Amount of supply possible (no boundaries from availability):
   2. Market price: Most competitive price level among all alternatives

2. infrastructure,
   1. Distribution network starts to establish: bunker infrastructure,
      storage exists worldwide (import and export terminals)

3. Regulation
   1. Int. rules for ships exist, bunker requirements exist, port regulations
      are missing for most ports

4. Availability:
   1. Available on the large scale needed to play a relevant role

5. Environmental impact low for: C02, NOx, Sox, PM, others
   1. CO2 effect of methane slip must be cleared urgently (on agenda of
      SGMF)

6. Technology is availability and CAPEX goes down

7. OPEX: potential to compete with HFO plus Scrubber
There are still obstacles to overcome for the small scale LNG development

“One major barrier for accelerated uptake of LNG as fuel is the uncertainty regarding LNG availability”

“Feedback from individual stakeholders indicate that it is challenging to keep track of the developments in the LNG fuel industry, especially for shipowners”

“DNV GL experience indicates that more shipowners would consider LNG as fuel if reliable LNG availability information was accessible”
LNGi keeps you on top of the development of LNG bunkering for ships

- **Map** with LNG bunkering infrastructure with **detailed** project data
- Heat map and vessel positions of LNG fuelled fleet operating area using **AIS**
- Detailed **statistics** of LNG fuelled fleet development
- Scrubber + alternative fuels overview
- LNG related studies and publications

The heat map and vessel positions are based on AIS data from 01.03.2016-11.03.2016
There are currently 201 confirmed LNG ship fuel projects

Additional orders beyond 2018 are confirmed

Excluding LNG carriers and inland waterway vessels

Updated 15 February 2017
LNG uptake by vessel segment

Updated 15 February 2017
Excluding LNG carriers and inland waterway vessels

- Bulk ship
- Car carrier
- Car/passenger ferry
- Container ship
- Cruise ship
- Gas carrier
- General Cargo
- HSLC
- Oil/chemical tanker
- Patrol vessel
- PSV
- RoPax
- Ro-Ro
- Tug
- Specialized vessel
Investments in scrubbers are higher in total numbers but LNG fuel is the most frequent choice for newbuilds

*Number of ships are shown. Number of scrubber units are higher.

Updated 15 February 2017
Excluding LNG carriers and inland waterway vessels
Changing drivers of LNG demand growth
Liquefied Natural Gas (LNG) - the current alternative fuel?

- CH₃OH (Methanol)
  - 4 hydrogen atoms
  - 1 carbon atom
  - 1 oxygen atom

- CH₄ (LNG)
  - 4 hydrogen atoms
  - 1 carbon atom

LHV, density, boiling point at 1 bar abs
- CH₃OH: approx. 20 MJ/kg, 750 kg/m³, +65°C
- CH₄: approx. 49 MJ/kg, 422 kg/m³, -163°C
LPG

- Propan (C3H8) + Butan (C4H10) (LPG)
- LPG production approx 280 Mio t/a; 10% lower CO2 emissions comp. to diesel
- Price related Ethan, Naphta and crude oil price (mostly higher than crude)
- Not regulated by the IGF Code.
LPG and crude oil prices are closely related

Data from Shell LPG Study 2015
Price differentials to crude oil brent

- HFO 380/brent [$/S]
- MGO/ brent [$/S]
- LNG (H-Hub) /Crude (brent); lhv; [$/S]
- LNG (Europe)/Crude (brent); lhv; [$/S]
(based: German import prices (until 2013), TTF (2014))
WTT and TTP emissions for alternative fuels

- **WTT:** Well To Tank (g/MJ)
- **TTP:** Tank To Propeller (g/MJ)
Alternative energy conversion on board
- only possible with clean fuels -

Why Fuel cell Systems?

E4ships is the most serious, most advanced, and largest FC development initiative world wide!
30 kW PaXell I test installation on board of MS Mariella (July 2016)
The next big thing
FC in Cruise Ships, RoPax, Yachts and Navy Ships after 2020

World wide leading FC projects are the e4ships projects
DNV GL is technology leader among class societies


First commercial applications 2020 (beta test systems)
(or earlier?)

PEM, SOFC (Forester, Mariella tests):
Installed: Mai 2016
50 kW Test installation on board of MS Forester

- Betrieb auf MS FORESTER
- Verlängerte Laufzeit
- Design-Review zur Kostensenkung
- Erweiterte Rückgewinnung der Abwärme
- Erweiterung Automation für Verbundnetz
- Entwicklung Gleichspannungsnetz

23.06.2016

Dipl.-Ing. Keno Leites, thyssenkrupp Marine Systems
PERFECT Ship – only possible with clean fuel! - Piston Engine Room Free Efficient Container Ship -

Instead of loosing containers with LNG you gain containers with LNG

- Phase I finished end of 2015 – concept feasibility
- Phase II running in 2016/2017 – concept design and business case

PERFECT Project Phase II partners:
- ABB, CMA Ships, GTT, DNV GL, OMT, Solar Turbines -