LNG as fuel for shipping
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1. Current status LNG as fuel for shipping
2. Results of LOT 1 LNG study for DG MOVE
3. Conclusions – Q&A
1. Current status LNG as fuel for shipping
Why we do not have today 1000 ships running on LNG as fuel?

- First non gas carrier with LNG: already introduced in 2000
- But: 2-stroke engine available: late 2012 (MAN), mid 2014 (Wartsila)
- First bunker ships available: late 2016 (seven ships on order)
- IMO IGF-Code for LNG and CNG
  - Adopted at IMO MSC-95, 12 of June 2015
  - In force: 2017
- Drop in oil price
- 79 vessels running, 93 vessels are ordered (End of July 2016)
Confirmed LNG ship fuel projects

Additional orders beyond 2018 are confirmed

Updated 2 August 2016
Excluding LNG carriers and inland waterway vessels
Area of operation of LNG fuelled vessels

Operating area

- Norway: 53; 67%
- Europe: 14; 18%
- America: 5; 6%
- Asia & Pacific: 7; 9%

Operating area confirmed orderbook

- Norway: 11; 12%
- Europe: 24; 26%
- America: 3; 3%
- Asia & Pacific: 1; 1%
- Middle East: 54; 58%

Updated 2 August 2016
Excluding LNG carriers and inland waterway vessels
All engine concepts are in use for ship propulsion

Gas engine technology - ships in operation

- Gas: 17%
- DF: 33%
- Gas + Diesel: 49%
- Other: 1%

Gas engine technology - confirmed orderbook

- Gas: 7%
- DF: 5%
- Gas + Diesel: 88%
- Other: 0%

Updated 2 August 2016
Excluding LNG carriers and inland waterway vessels
General status for LNG as fuel

- Different new fuels will become relevant in shipping.
  - The major drivers for the application of new fuels are price, availability and legislation.
- LNG is the only alternative fuel which is already logistically available world wide in quantities which can meet shipping demand.
  - In principle any LNG import or export terminal can distribute LNG to ships
- The environmental footprint of LNG as fuel is by far lower than the footprint of HFO with Scrubber or MGO
  - 0,1% S still means 1000 ppm S
  - NOx emissions according Tier II are well above emissions of LNG fuelled engines. With LNG as fuel emissions can be below NOx Tier III requirements
  - Particle emissions are much lower than for any oil fuelled system

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Reduction compared to traditional fuels</th>
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<tbody>
<tr>
<td>SO\textsubscript{x}</td>
<td>Almost 100%</td>
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<tr>
<td>PM</td>
<td>95%</td>
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<tr>
<td>CO\textsubscript{2}</td>
<td>20%</td>
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<tr>
<td>NO\textsubscript{x}</td>
<td>85 %</td>
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The environmental and supply challenges
Legislation supports the use of clean fuels
- Possible developments towards 2030 -

**Adopted**
- EU Recycling Regulation
- US BW requirements
- EEDI phase 1
- NOx tier III for new builds in North America
- Ballast Water Convention - entry into force
- EU CO₂ monitoring, reporting and verification
- Operational requirements on CO₂
- EEDI phase 2
- EU 0.5% sulphur cap
- Additional ECAs established
- BC, noise, bio-fouling and VOC regulation
- EEDI phase 3
- HK Recycling convention ratified
- Global CO₂ monitoring, reporting and verification
- 0.5% global sulphur cap
- EEDI phase 4

**Possible**

**Ungraded**

0.1% ECA sulphur limit

0.5% global sulphur cap

EU 0.5% sulphur cap

EEDI phase 1

EEDI phase 2

EEDI phase 3

EEDI phase 4

0.5% global sulphur cap

0.5% global sulphur cap
Sulphur emission control areas for Shipping

- Dark blue: 0.1% S since 2015 (IMO)
- Light blue: 0.5% S from 2020 (EU)
- Green: under discussion
- World wide: 0.5% S (2020 or 2025; to be decided by IMO until 2018)
MDO & HFO contain too high sulfur content to comply with future IMO sulfur emission limits

MGO is currently the only distillate fuel that can comply with regulations. However, current ship machinery still is mostly designed to operate on high quantities of HFO.
Emissions (4-stroke)

- PM (Port)
- SOx (ECA)
- NOx (US ECA)
- CO2 (EEDI)

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<tr>
<th>LNG</th>
<th>DF LNG</th>
<th>LS fuel</th>
<th>HFO &amp; Scrubber</th>
<th>HFO &amp; SCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Green</td>
<td>Yellow</td>
<td>Red (*</td>
<td>Red (*)</td>
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(*) requires Energy
LNG Intelligence - There are still obstacles to overcome for the small scale LNG development

“One of the biggest barriers for accelerated uptake of LNG as fuel is the uncertainty regarding LNG availability”

“Feedback from individual stakeholders indicate that it is very difficult 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”
LNG Intelligence provides all needed information to keep you on top of LNG bunkering for ships

- **Map** of 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 01.01.2016-11.01.2016
Price Challenge
The price challenge for LNG as fuel

- The price for LNG as ship fuel will above the natural gas price because the distribution to the ship needs to be covered
  - Currently there is no developed market for LNG as ship fuel and therefore the distribution costs are high

- The low oil price lead to a competition between LNG and HFO + Scrubber
  - Compared to MGO LNG is competitive
  - HFO case
    - In Europe the price difference allows only a very small payback because the LNG price is very close to the HFO price.
    - In the US the price difference is bigger and allows a payback even at the current oil price level
2. Results of LOT 1 LNG study for DG MOVE
The overall study is divided into 4 lots:

- **lot 1:** analysis and evaluation of identified gaps and of the remaining aspects for completing an EU-wide framework for marine LNG distribution, bunkering and use
- **lot 2:** creating awareness on LNG risks and opportunities
- **lot 3:** analysis of the LNG market development in the EU
- **lot 4:** explore financing opportunities, assess and develop financial mechanisms beyond the EU financial framework aiming at supporting the deployment of marine LNG technology

The objectives of the current study are the following:

- **Objective 1:** To address the remaining aspects for completing an EU-wide framework for marine LNG distribution, bunkering and use
- **Objective 2:** To create awareness
- **Objective 3:** To provide a market overview
- **Objective 4:** To assess and develop financial mechanisms
The take-up of LNG as fuel for ships is still in an early stage and key stakeholders typically identify as main barriers:

1. Infrastructure
   - Directive 2014/94/EU on the deployment of alternative fuels infrastructure

2. Legislative/regulatory framework
   - LOT 1 of the DG MOVE LNG Study: to complete an EU-wide framework for marine LNG distribution, bunkering & use

3. Harmonized standards (technical requirements but also safety rules, training requirements, gas quality measurements)
### Study structure: practical: 4 work packages

| WP1 | • Identification of remaining gaps and barriers of previous EMSA study + additional evolutions since |
| WP2 | • Identification and elaboration of possible policy actions, rules, standards and guidelines |
| WP3 | • Social, environmental and economical impact analysis |
| WP4 | • Input to the development of the LOT 2 awareness campaign |

- Study duration: 9 months
- Regular progress meetings with DG MOVE & EMSA
- ESSF subgroup on LNG acted as soundboard and steering group
- 3 stakeholder events to collect feedback on preliminary recommendations
Presentation of main findings
Gap analysis, Recommendations & action plans

- In total 35 gaps were identified and discussed, categorized as either:
  - **Type 1** – Legal Gap
  - **Type 2** – Harmonization Gap
  - **Type 3** – Knowledge Gap

- Gaps have been worked out into recommendations & action plans, detailing:
  - Scope of the recommendation
  - Recommended actions
  - Justification for recommendation
  - Consequences of non-implementation
  - **Prioritisation**: Prioritisation based on two axes:
    - Impact on LNG small scale market development and
    - Implementation effort (time, cost, legal)
    - scale from ---, --, -, 0, +, ++, +++
The common justifications underlying all recommendations:

- Safeguarding **people**, the integrity of physical **property** (and that of other assets in general) and the protection of the **environment**.

- Compatibility with existing internationally recognized **rules, regulations, standards and guidelines** and compliance with emerging industry standards.

- Ensure the successful development of a **feasible roadmap** for the implementation of LNG bunkering services in Europe and achieve the **reputational, economic and commercial benefits** without any form of compromise on safety.

- Highlight the importance of **strategic planning** and **structured communication** between Authorities, project developers, operators, international community and market.

- **EU location specific considerations** such as the vision for the LNG bunkering segment, port locations and configuration, traffic type and density, weather conditions and existing facilities and rules and regulations.
An overview of our recommendations (1/2)

- Previous EMSA study identified 19 gaps, 4 were found closed, the rest only partially closed.
- We suggested **18 new recommendations** based on the remaining EMSA study gaps

- Main recommendations:
  1. Establish EU-wide guidance for **LNG bunkering procedures**
  2. Establish clear guideline for **SIMOPS operations**
  3. Concept of **safety zones** and approach to define the limits should be accounted for in bunker procedures
  4. Guarantee that **crew training requirements** for LNG carrying or fuelled inland vessels and barges will exist for all EU inland waterways
  5. Establish a comprehensive approach for **methane slip management**, i.e. boil-off gas, vapour management and emergency venting
An overview of our recommendations (2/2)

- We identified 13 new (non-EMSA) gaps, which were broken down and detailed into **17 new recommendations**
  - **General**: 3 recommendations
    - Create a level playing field *wrt* **harmonisation of fines**
    - Harmonise requirements for **emergency repairs** of LNG fuelled vessels
    - Develop **standards** for small scale LNG equipment
  - **Focus point risk assessment**: 4 recommendations
    - Collection of / agreement on specific **failure frequencies**
    - Agreement on **methodologies, models, tools** and software for RA
  - **Focus point permitting**: 8 recommendations
    - Enhance **knowledge** with authorities
    - **One-stop shop** principle
    - Clear **processes and time schedules**
  - **Focus point incident investigation**: 2 recommendations
    - Targeted improvements on **existing databases**
Economic, Social and Environmental IA
Key drivers influencing the LNG adoption rate:

- **POLICIES** – EU, Member States and local authorities (e.g. ports) play a key role in developing the regulatory framework to facilitate the use of LNG.

- **FUEL PRICE SPREAD** – An important driver for LNG adoption by shipping industry is the fuel price spread, i.e. the price of LNG compared to traditional fuel prices.

- **GROWTH OF SHIPPING SECTOR** – Another driver is the growth of the shipping sector (seagoing and inland vessels).

- **LNG FUEL AVAILABILITY** - LNG production + LNG infrastructure (LNG fuel stations, small scale terminals, bunker vessels, ...).
**Scenarios development**

Policy scenarios

- Do nothing scenario (= Business as usual or baseline scenario);

- Alternative policy options:
  - No harmonisation across EU; (“Must haves”)
  - Low/Moderate harmonisation across EU; (“low hanging fruits”)
  - Full harmonisation across EU. (“Nice to haves”)

- Policy options are assumed to influence two factors:
  - LNG adoption rate by shipping industry
  - availability of critical LNG infrastructure
Forecast calculations as input in the impact assessment

- LNG fuelled fleet development towards 2030 (seagoing + inland)
  - Total share of LNG fleet
  - Share new building vs retrofitting
  - Share being built in EU shipyards

- LNG bunker demand for the number of ships estimated (seagoing + inland)

- From this LNG demand, the infrastructure needs to meet this demand have been estimated

- For all this: economic, social, environmental and other impact have been assessed
**Results scenario analysis**

- All options have overall positive economic, social and environmental effects
- Full harmonisation has overall the highest impact on economic, social, safety and environmental aspects
  - Positive score counterbalanced by a significant negative score for administrative burden, flexibility and implementation efforts.
  - Complex compromises to be made at EU level with risk of: Policy objective not reached/Significant delays
- Low/moderate option seems most workable policy option in terms of efforts versus impact ratio
  - Transposition of Directive on Alternative Fuels by MS with ‘light touch’ while retaining the benefits
  - Application of minimum harmonised standards
- Final ranking of the options depends on how the different parameters are being weighted: judgement by decision makers to make a final assessment
3. Conclusions – Q&A
We believe that LNG will become a major fuel – it is only a question of when

LNG as fuel is now a proven and available solution

LNG is seriously considered for all new builds

From a legal point of view, there are no remaining major showstoppers for the use of LNG as fuel

Further harmonisation on EU level, for sure for the bunkering activity itself, would facilitate further LNG bunkering developments

Partnerships and close cooperation is vital for commercial projects to succeed in this early phase

The (commercial) risk of choosing LNG is considered high – but what is the risk of not considering LNG fuel?
Lots of interfaces and stakeholder – lots of challenges and opportunities

- Accident with LNG
- Access to capital
- Sea – to – road
- Security of supply
- Misfit of market mechanism
- Lack of competences
- More regulations
- OPEX
- Short-term financial expectation
- CAPEX
- Technology leadership
- 1st mover advantage
- Societal wealth
- OPEX
- Improved local environment
- Brand
- alliances
- Commercial niches
- Business model
Thank you for your attention

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