LNG fuel for shipping: The Rotterdam Perspective

LNG FUEL FORUM – Stockholm – 20th & 21st September 2011
Ir Bas van den Beemt

TNO introduction

- TNO is an independent research organisation
- Mission and Strategy: TNO connects people and knowledge to create innovations that boost the sustainable competitive strength of industry and well-being of society.
Introduction: Case Port of Rotterdam

Traffic:
- Cargo transfer: 400 mt
- Sea going ships: 33,000#
- Inland ships: 110,000#

Claims:
- The largest port in Europe,
- World's busiest port until 2004, taken over by Shanghai and Singapore,
- World's second largest bunker port

Introduction: Inland shipping

West European inland shipping fleet (2008/2009):

<table>
<thead>
<tr>
<th>Country</th>
<th>Registered inland vessels:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Cargo vessels, Tug and Pusher boats)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>6290</td>
</tr>
<tr>
<td>Germany</td>
<td>3311</td>
</tr>
<tr>
<td>Belgium</td>
<td>1959</td>
</tr>
<tr>
<td>France</td>
<td>1710</td>
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</tbody>
</table>
Development of LNG as fuel for shipping
Which steps need to be taken?

Development

Innovation barrier

TNO’s Mission: Breaking innovation barriers

Optimisation

Standardisation

Distribution: supply

Legislation: Safety

Pilots

Emission: Environmental chain analysis

Knowledge: transfer from LNG to shipping industry

Time

Yes, it seems we have an interesting business case for LNG as fuel for shipping

LNG as fuel for shipping chain analysis project
emission comparison LNG/Diesel through the fuel supply chain

Base case: The Netherlands, Rotterdam
Options: Short sea shipping, Tug service, Inland shipping
Funding: Maritime Innovation Program, industrial participants
Participants:

- Rolls-Royce
- Cofely
- Smit
- Wärtsilä
- Gasunie
- Damen
- GE
- DONG Energy
- Argos
- Shell
- Vopak
Overview of “the chain”

greenhouse gas emissions, complete chain: Well-to-Propeller

- Production + conditioning at source
- Transformation at source
- Transportation to market
- Transformation in market
- Conditioning and distribution
- Use in engine

air quality emissions

from ship only: Tank-to-Propeller

air pollutant emissions: 60% to 85% improvement vs diesel (for 2011-2015)

2011 – 2015

- NOx
- SOx
- PM

Reduction with LNG:

- Short Sea (MDO)
- Port ship (EN590)
- Inland ship (EN590)

2016 →

- NOx
- SOx
- PM

Reduction with LNG:

- Short Sea (MDO)
- Port ship (EN590)
- Inland ship (EN590)
GHG emissions with LNG around 10% lower

Economics positive, but advantage is not immediate

Key insights:
- Cost of LNG engine plus fuel tank is ~2x cost diesel engine plus fuel tank

LNG is economically attractive if:
- The application in question shows a high fuel consumption per year
- Operational costs could be lower,
- Future fuel prices MDO, MGO are high (?)

<table>
<thead>
<tr>
<th>Case 2010</th>
<th>Time-to-breakeven [years]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OUT OF DATE</td>
</tr>
<tr>
<td></td>
<td>Use of existing Facility (PS)</td>
</tr>
<tr>
<td>Short sea</td>
<td>8</td>
</tr>
<tr>
<td>TUG</td>
<td>31</td>
</tr>
<tr>
<td>Inland ship</td>
<td>6</td>
</tr>
</tbody>
</table>
Development of LNG as fuel for shipping

Which steps need to be taken?

Development

- Innovation barrier
- Standardisation
- Distribution: supply
- Legislation: Safety
- Optimisation
- Pilots
- Emission: Environmental chain analysis
- Knowledge: transfer from LNG to shipping industry

Time

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Current status of LNG as fuel development (NL)

Where are we now?

Status LNG as fuel for ships NL:

- Deen shipping (inland), Ecoflow and AVR pilot under construction
- Several pilot project under development
- ...,

Targeted applications:

- Deen Shipping (inland ship)
- AVR (inland tug boat)
Development of LNG as fuel for shipping

Which steps need to be taken?

- Development
- Legislation: Safety
- Distribution: Supply
- Pilots
- Optimisation
- Standardisation
- Emission: Environmental chain analysis
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LNG LESAS Rotterdam project

How to deal legislation and safety?

Project proposal: Legal and safety barriers

- **Objective:** To supply recommendations for **public authorities and industry** on legislation and safety practice.
- **Role:** Enabling the development of a small scale LNG supply chain and application of LNG as transport fuel
- **Method:** LNG safety practice and evaluations of RCS (Regulations, Codes and Standards) based on stakeholder viewpoints on how an **economical stable supply chain** should look like (Joint Industry Assessment)
- **Base case:** The Netherlands, Rotterdam (representative for NL)
- **Project Partners:** TNO, DNV, NEN
Joint Industry Project: LNG LESAS Rotterdam

Participants: Primary and Secondary Stakeholders, observers,

WP1: Joint vision on the supply chain (Roadmap definition)
WP2: Supply chain definition / quantification
WP3: Legal assessment (regulation, codes and standards)
WP4: Safety assessment (Technical and safety review)
WP5: Technical and organisational description (locations)
Supply chain vision overview

Result WP1

16 April 2011

1. Bulk LNG supply
   GATE or peakshaver

2. Cryogenic pipeline
   Break Bulk LNG terminal ~30.000m³
   Truck loading ~40m³

3. (modular) Local LNG buffer ~1.500-15.000m³
   Inland vessels ~40m³
   LNG bunker barge ~1.500m³

4. Port vessels ~40m³

5. Deep sea vessels ~5.000-10.000m³
   Short sea vessels ~550m³

Alternative LNG import route

Landbased facility
Waterbased facility
Land/Water based facility fixed location

Traditional LNG Terminal, Gate, Rotterdam

First commissioning LNG at Gate Rotterdam

http://www.gateterminal.nl/
Loading of LNG (bunker) barge at LNG terminal
Anthony Veder, Fluxys, Zeebrugge

http://www.lng-shipping.com

LNG truck loading at LNG Terminal,
Fluxys, Zeebrugge

http://www.fluxys.com
Bunkering Station (potential LNG buffer)
Slurink, Amsterdam

http://www.slurink.nl/onsnetwerk.htm

Ship to ship bunkering
Container ship Hatsu Shine moored at the Amazone harbour, Port of Rotterdam

www.shipsandharbours.com/picture/number14190.asp
Bunker Barge Small, Ship-to-ship bunkering
Slurink, Dordrecht

Supply chain vision overview
Result WP1

Bulk LNG supply
- GATE or peakshaver

Break Bulk LNG terminal ~30,000m³

LNG bunker barge ~10,000m³

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Alternative LNG import route
### LESAS Project status

<table>
<thead>
<tr>
<th>WP</th>
<th>Description</th>
<th>Status</th>
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<tbody>
<tr>
<td>WP1</td>
<td>Supply chain vision</td>
<td>Done</td>
</tr>
<tr>
<td>WP2</td>
<td>Supply chain definition</td>
<td>Draft report</td>
</tr>
<tr>
<td></td>
<td>Gas composition</td>
<td>Draft report</td>
</tr>
<tr>
<td></td>
<td>Main WP2</td>
<td>Starting</td>
</tr>
<tr>
<td>WP3</td>
<td>Legal assessment (NEN)</td>
<td>Draft report</td>
</tr>
<tr>
<td>WP4</td>
<td>Technical and safety review</td>
<td>TD</td>
</tr>
<tr>
<td>WP5</td>
<td>Technical and organizational description</td>
<td>TD</td>
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### Development of LNG as fuel for shipping

*Which steps need to be taken?*

- **Development**
  - Innovation barrier: Optimisation
  - Distribution: supply
  - Legislation: Safety
  - Pilots
  - Emission: Environmental chain analysis
  - Knowledge: transfer from LNG to shipping industry

- **Time**

Yes, it seems we have an interesting business case for LNG as fuel for shipping
Future development: optimisation

Important fields of technology development:
- Technology development to reduce infrastructural costs
- Bunkering: LNG Ship to ship transfer operation
- LNG storage on board: Development of new containment systems
- Engine performance (efficiency, emissions etc)

TNO LNG projects under development

Inform ship owners: Branch Innovation Contract KVNR (BIC LNG)
- Objective: LNG knowledge transfer to ship owners
- Method: Provide a “LNG for shipping” manual for ship owners
- Subjects: All issues that are relevant to know for a ship owner to consider LNG ship propulsion (e.g. LNG storage systems and propulsion, LNG supply, bunkering operation, safety aspects, LNG storage and handling)
Thank you for your time and attention

Questions?

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