GoLNG Workshop
Decarbonising Port Operations
Valencia 13th March 2019
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The Port Authority of Valencia and the Spanish Port System

28 Port Authorities
Valenciaport Cluster 2017

**Port of Sagunto**
- 5.72 Mio. Tonnes
- 52,401 TEU
- 271,155 Vehicles

**Port of Valencia**
- 67.49 Mio. Tonnes
- 4.78 Mio. TEUs
- 1,029,288 Passengers
  - 616,960 Regular Lines Passengers
  - 412,328 Cruise Passengers
- 523,791 Vehicles

**Port of Gandia**
- 0.35 Mio. Tons

Valenciaport: 73 Mio Tonnes
4.83 Mio TEUs
### World and Europe TEU Volume Ranking 2017

1. Shanghai (40.2 M)
2. Singapore (33.6 M)
3. Shenzhen (25.2 M)
4. Rotterdam (13.6 M)
5. Algeciras (25.2 M)
6. Los Angeles (9.3 M)
7. New York (6.3 M)
8. Bremerhaven (5.5 M)
9. Felixstowe (4.78 M)
10. Tanger Med (4.78 M)

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Port</th>
<th>Country</th>
<th>2016</th>
<th>2017</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Rotterdam</td>
<td>The Netherlands</td>
<td>12,38</td>
<td>13,73</td>
<td>10,9</td>
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<tr>
<td>2</td>
<td>Antwerp</td>
<td>Belgium</td>
<td>10,03</td>
<td>10,45</td>
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<td>8,80</td>
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<tr>
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<td>6</td>
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<td>4,38</td>
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<td>9</td>
<td>Felixstowe</td>
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80%

- 12,522,629 kWh (43%)
- 11,006,280 kWh (37%)
- 4,801,013 kWh (15%)
- 1,815,477 kWh (5%)

30,145,399 kWh (30.1 GWh)

90%

- 4,049,138 L (58%)
- 2,245,147 L (32%)
- 611,460 L (9%)
- 80,819 L (1%)

6,986,564 L

Carbon Footprint (Fuel): **11.7 Kg CO2eq / TEU**
LNG TERMINAL TRACTOR PROTOTYPE
LNG Terminal Tractor Prototype Design Requirements

- 3.500 mm wheelbase instead of 3.300 mm standard
- Hydraulic tank, battery and air compressor moved to the same side
- This side free to install the 323 liters LNG tank
LNG SUPPLY MOBILE STATION
# Pollutant Emission Measurement

<table>
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<th>Particulate (g/h)</th>
<th>NOx (g/h)</th>
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<tbody>
<tr>
<td>1st G VOLVO 720 TAD (Stage II)</td>
<td>9.6</td>
<td>481</td>
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<tr>
<td>2nd G VOLVO 750 TAD (Stage IIIA)</td>
<td>8.8</td>
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<td>3rd G CUMMINS QSB 6.7 (Stage IIIA)</td>
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<tr>
<td>Gas 2nd CUMMINS ISL9 G 250 (Stage IV)</td>
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LNG DUAL-FUEL REACH STACKER
• The Dual-Fuel engine delivers same power as the diesel powered reach stacker even in full demand conditions.

• The diesel substitution rate varies between 60% (at low rpm) and 35% (at high rpm)
LNG dual fuel Rubber Tyred Gantry Crane (dual fuel-RTG)

First RTG powered with LNG:

LNG / Diesel Dual Fuel Technology

LNG Supply Station Prototype

Safety Concerns:

LNG Tank Location

Collisions
LNG dual fuel Rubber Tyred Gantry Crane (dual fuel-RTG)
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Full Electrical Tractor

**Batteries**

Traction battery capacity 206[kWh]
Traction battery type Lithium Iron Phosphate
Nominal voltage 299 [V] (260-380 Volt)
Current 700Ah

**Driveline**

Power/torque 160/180 hp @ 1800-2800 RPM
RPM 633/712 Nm @0-1800 RPM

**Autonomy**

6 hours (1 operational shift)

**Recharging Time**

Between 3-5 hours (depending on plug type)
LNG vs Electrification

LNG Terminal Truck

- Refuelling time similar to Diesel
- Equipment cost similar to Diesel
- LNG availability
- Less Autonomy than Diesel
- Not Zero-Emission solution

Full Electric Terminal Truck

- Zero-Emission solution
- Electricity price lower than Diesel
- Charging time higher than Diesel refuelling
- Low autonomy (less than 6 hours)
- Equipment cost much higher than Diesel
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Towards Zero-Emission Port Operations

- 2013: LNG Terminal tractor
- 2014: Eco Diesel RTG
- 2015: LNG Dual Fuel Reach Stacker
- 2016: e-Terminal Tractor
- 2017: LNG Dual Fuel RTG
- 2018: HDG RTG
- 2019: e-HDG RTG
- 2020: Hydrogen Fuel Cell Terminal Tractor
  - Electric Container Loader
  - Hydrogen Fuel Cell Container Loader
  - Terminal Carbon Footprint Sensor Network
  - Hybrid Full LNG-electric Reach Stacker
Hydrogen Fuel Cell Reach Stacker and Yard Truck

Location: MSC Container Terminal Valencia (container operations) / Valencia Terminal Europe (ro-ro operations)

Fleet Fuel Consumption: 2 Mio L / year

Operational Time: 5,000 h (2 years)

Fuel Cell Power Range: 90-120 kW Reach Stacker

60-80 kW Yard Truck

Benefits:

• Local zero emissions and powertrain noise;
• Reduced vehicle maintenance costs with the elimination of the engine, transmission and other mechanical-driven components;
• Downsizing of the battery pack, keeping an autonomy of 8 hours;
• Improved total energy consumption with electrification of the powertrain and energy recovery through regenerative braking/load management.
Open Questions

**Hydrogen supply logistics**: supply vs on-site production

**Compatibility with port operations**: autonomy, performance

**User’s acceptance**: terminal operator and stevedoring

**Port Regulatory Framework**: new alternative fuel

**Safety procedures**: refuelling, tank pressures

**City perception**
Conclusions

- Port container operations can (and must) be decarbonised: electrification and low carbon / zero-emission fuels;

- This task is challenging: not all port operators are prepared for making the transition towards zero-emission solutions;

- There are knowledge and awareness gaps in the port industry about zero-emission alternatives. Need to bridge the gaps with successful stories;

- Need for cooperative innovation among technology providers and end users;

- Financial feasibility and short pay-backs are critical factors for real implementation of disruptive technologies (like Hydrogen).