LNG & Port Equipment: Possible Opportunities & Synergies?

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We are aiming at developing LNG as a business opportunity
LNG BUNKERING = Ideas?

If necessity is the mother of invention then vision is the father of innovation.
What is ”THE business”: case of Container Terminals
Market & Customer Trends
Market size
5,5 Billion €
Market Description and Segmentation

- Ports and terminals industry projected growth rate of 6% - till 2017

- Total global container throughput will be 830 million TEU (Twenty-foot Equivalent Units) by 2017. Growth rate of 40% between 2011-2017.

- Conservative growth rate of 5% will double current global container volumes by 2025

- Containerisation growth linked to global trade with strong port development in various regions.

- More Large ships ordered, 445 new ships with capacity of 3.27 million TEU

- Larger ships means more time at port - leading to more costs.
Main drivers and characteristics of the Market

Trends:
- Increasing competition of terminals
- Globalization
- Bigger Vessels
- Increase in energy costs
- Increasing environmental demands

Consequence:
- More efficient systems
- New investments in modern port facilities
- Bigger Cranes and faster logistics
- Energy Savings
- Automation of Container Yards

Container Ports:
- GTOs
- Carriers/Liners
- Port Authorities

Part-financed by the European Union (European Regional Development Fund)
Introduction

Port Container Terminals have been studied with the aim of obtaining their energy profiles and the global carbon footprint produced, taking into account the activities carried out by the whole group of machinery and equipment involved.

The aim is to characterise PCTs energy profiles by means of the evaluation of the energy performance of their activities and processes, thus quantifying their impact in terms of GHG emissions.

How much energy is consumed?
Where is the energy consumed?
Methodology

Container Terminal Machinery and Equipment

- Rubber Tyred Gantry Crane (RTG)
- Terminal Tractor
- Reach Stacker
- Empty Forklift
A TYPICAL Port
How Much Energy? Electrical Consumption

NCTV Electrical Consumption 2012 (kWh)
- 12,522,629 kWh (43%)
- 11,006,280 kWh (37%)
- 4,801,013 kWh (15%)
- 1,815,477 kWh (5%)

80%

Livorno TDT Electrical Consumption 2012 (kWh)
- 30,145,399 kWh (30.1 GWh)

X 3,000 (10,000 kWh / year)
Activity 1. Mapping of Port Container Terminals Energy Profile

How Much Energy? Fuel Consumption

<table>
<thead>
<tr>
<th>Category</th>
<th>Fuel Consumption</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCTV Yard Machinery</td>
<td>4,049,138 L</td>
<td>58%</td>
</tr>
<tr>
<td>2,245,147 L (32%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>611,460 L (9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80,819 L (1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livorno TDT Yard Machinery</td>
<td>6,986,564 L</td>
<td>90%</td>
</tr>
</tbody>
</table>

6,986,564 L

X 4,000 (1,300 L / year)
Activity 2. Strategies for reducing RTG energy costs

Feasibility Evaluation: Terminal Tractors

<table>
<thead>
<tr>
<th>Terminal Tractors</th>
<th>RTGs</th>
<th>STS + Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4 Million L 1,8 Million € GoB</td>
<td>4,6 Million L 3,4 Million € GoB</td>
<td>17,8 GWh 2,2 Million € kWh</td>
</tr>
</tbody>
</table>

**Alternatives TT**
- Gasoil TIER 4 / Stage IV (2014)
- LNG
- Dual Fuel

**Alternatives RTG**
- RTG Engine Replacement TIER 4 (2014)
- LNG / Dual Fuel
- Electrification
  - Conductor Bar
  - Cable Reel

**Supply Alternatives**
- Current Electrical Tariff
- Tariff 6.1 (Electrical Supplier)
- Tariff 6.3 (Electrical Supplier)
Green Technologies and Eco-efficient Alternatives for Cranes and Operations at Port Container Terminals

3.500 mm wheelbase
Instead 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

Pilots and Demonstrations. Noatum – Port of Valencia
What is the Pay Back?

LCC = (Initial Cost of Vehicle) – Purchase Incentives + PVFuel – PVResale

where

• Purchase Incentives = Value of Grants, Tax Credits, etc. Applied to Vehicle Purchase
• PVFuel = Present Value of Fuel Expenses During Vehicle Service Life
• PVResale = Present Value of Resale Value of Vehicle at End of Service Life
• PV = Ft / (1 + d)t
• Ft = Future Cash Flow in Year t
• d = Discount Rate
<table>
<thead>
<tr>
<th>Factor</th>
<th>Diesel</th>
<th>LNG – No Incentives</th>
<th>LNG – LNG Incentives</th>
<th>LNG – SCAQMD (Max. 25 Vehicles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Cost of Vehicle</td>
<td>$80,000</td>
<td>$120,000</td>
<td>$120,000</td>
<td>$120,000</td>
</tr>
<tr>
<td>Purchase Incentives</td>
<td>$0</td>
<td>$0</td>
<td>$32,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Fuel Cost/Gallon After Tax</td>
<td>$2.60</td>
<td>$0.50</td>
<td>$0.50</td>
<td>$0.50</td>
</tr>
<tr>
<td>Gallons/Operating Hour</td>
<td>1.7</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Annual Operating Hours</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Annual Fuel Costs</td>
<td>$8,840</td>
<td>$3,800</td>
<td>$3,800</td>
<td>$3,800</td>
</tr>
<tr>
<td>Service Life</td>
<td>10 Years</td>
<td>10 Years</td>
<td>10 Years</td>
<td>10 Years</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Present Value Fuel</td>
<td>$77,669</td>
<td>$33,387</td>
<td>$33,387</td>
<td>$33,387</td>
</tr>
<tr>
<td>Resale Value</td>
<td>$5,000</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Present Value Resale</td>
<td>$3,832</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>LCC</td>
<td>$153,837</td>
<td>$153,837</td>
<td>$121,387</td>
<td>$113,387</td>
</tr>
</tbody>
</table>
LNG vs. Non-Road Diesel – TT Industrial Phase

<table>
<thead>
<tr>
<th>Fleet</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>12%</td>
</tr>
<tr>
<td>51</td>
<td>14%</td>
</tr>
<tr>
<td>20</td>
<td>24%</td>
</tr>
<tr>
<td>14</td>
<td>28%</td>
</tr>
<tr>
<td>12</td>
<td>35%</td>
</tr>
</tbody>
</table>

(IRR: Internal Rate of Return)
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Other equipment to be "LNG-nized"

RTG – Rubber Tyred Gantry Cranes
Opportunities for LNG?:
NEW RTGs Deliveries by Region, 993 units: 2012 - 2014 (2Qtr)

- **EUROPE**: Total 103
- **AFRICA**: Total 63
- **MIDDLE EAST**: Total 93
- **INDIA**: Total 83
- **NORTH EAST ASIA**: Total 185
- **SOUTH AMERICA**: Total 233
- **SOUTH EAST ASIA**: Total 166
- **UNDISCLOSED**: Total ??

Part-financed by the European Union (European Regional Development Fund)
Kalmar is to engineer and produce a diesel-LNG powered reachstacker prototype as part of the GREENCRANES project.

"The LNG power is a very interesting future fuel alternative both for port equipment business as well as for the whole shipping industry. Natural gas extractions are increasing and this can clearly be seen as one of the future trends."
Other equipment to be "LNG-nized"

AGV – Automated Guided Vehicles

Straddle Carriers
Conclusions on Port Container Terminal Energy Use

- Port Container Terminals are huge energy consumers, especially on those energy sources based on fossil fuels. Average values show a yearly fuel consumption of nearly 7 million fuel litres (in form of diesel oil) and 30 GWh of electricity consumption including the three participant terminals.

- From the economic point of view, the general increase of energy prices is affecting port installations, representing every day more a significant cost which reduces their competitiveness.

- In terms of environmental impact, the use of the current fuels in a non-stop operative model generates a great amount of GHG emissions, with an estimation of nearly 25,000 CO$_{2eq}$ tonnes derived from the use of diesel oil at the three participant PCTs in 2012.

- Concerning social impact, port installations are usually located near populated cities and urban areas, especially in the Mediterranean. Port operations affects nearby population as direct GHG emissions (derived from diesel oil) are locally deployed, not only CO$_2$, but also other pollutant and toxic gases like N$_2$O, Sulphur compounds and suspension particles.

- Efforts to reduce fuel consumption and GHG emissions produced by RTGs, yard tractors and reach stackers are strongly recommended.
MORE at
WWW.GOLNG.EU
THANK YOU
Thank You for your attention!
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