GREEN Technologies and Eco-Efficient Alternatives for CRANES and Operations at Port Container Terminals

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GREENCRANES Technical Manager

Tallinn (Estonia), 16 October 2013
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GREENCRANES Consortium

GREENCRANES is a pilot action involving three Member States: Spain, Italy and Slovenia, including public administrations, strategic ports, port industrial partners and innovation centres.

Implementing Bodies

Budget: 3,688,000 € (50% TEN-T Fund)
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2. Objectives

Specific objectives:

- Definition of Methods and Measures to **Describe PCTs Energy Profiles and GHG Emissions Mapping**
- Assessment of **Technological and Organizational Process Improvement Opportunities** for Port Container Stakeholders
- Design **an Eco Efficient Indicators (EEI) System** to be integrated into the Balanced Scorecard of PCTs
- **Test Prototypes and Pilot Deployment** to demonstrate the viability of the proposed low-carbon emission fuel alternatives
- **Definition of Standards and Policies** Based on the Project Results to Ensure the Adoption of These Technologies by a Critical Mass of PCTs in the EU
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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?
Consumer Centres at Port Container Terminals

Container Terminal Machinery and Equipment

- Ship-to-Shore Crane
- Reefer Containers
- Offices
- Lightning
- Rubber Tyred Gantry Crane (RTG)
- Terminal Tractor
- Reach Stacker
- Empty Forklift
Activity 1. Mapping of Port Container Terminals Energy Profile

How Much Energy? Electrical Consumption

<table>
<thead>
<tr>
<th>Description</th>
<th>kWh</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCTV Electrical Consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STS Cranes</td>
<td>12,522,629</td>
<td>43%</td>
</tr>
<tr>
<td>Yard Lightning</td>
<td>11,006,280</td>
<td>37%</td>
</tr>
<tr>
<td>Offices</td>
<td>4,801,013</td>
<td>15%</td>
</tr>
<tr>
<td>Container Reefers</td>
<td>1,815,477</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td>30,145,399</td>
<td>80%</td>
</tr>
</tbody>
</table>

Carbon Footprint (Electricity): 4.15 Kg CO2eq / TEU
How Much Energy? Fuel Consumption

**Activity 1. Mapping of Port Container Terminals Energy Profile**

- **NCTV Yard Machinery. Total Fuel Consumption 2012**
  - RTGs: 4049138 L (58%)
  - Yard Tractors: 2245147 L (32%)
  - Reach Stackers: 611460 L (9%)
  - Empty Forklifts: 80819 L (1%)

- **Livorno TDT Yard Machinery. Total Fuel Consumption 2012**
  - RTGs: 6986564 L

**Carbon Footprint (Fuel): 7.57 Kg CO2eq / TEU**
Feasibility Evaluation: Noatum Business Case

Terminal Tractors

- 2,4 Million L
- 1,8 Million € GoB

RTGs

- 4,6 Million L
- 3,4 Million € GoB

STS + Other

- 17,8 GWh
- 2,2 Million € kWh

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)
Fleet Concept: Environmental vs. Financial Optimum

- It is imperative to know *when* and *where* the energy is consumed.
- It *does not make sense to invest* in machines or places in the terminal *where there is no energy consumption*.
- The *optimum* does *not* need to be *everything* or *nothing*.
- **Critical mass is a must:** The break-even point may not appear until a considerable number of machines (critical mass) is included in the investment program (fixed initial investment is high).
- The *environmental optimum* (minimum CO₂ emissions without losing money) is *not the same as the economic optimum*.

- A private company (terminal operator in this case) will always choose the option generating the maximum NPV (if IRR > WACC). However, that option may not coincide with the maximum socio-economic NPV point. In order for private operators to choose the alternative producing the highest socio-economic benefits, public incentives may be needed.
Activity 2. Evaluation of Eco-Efficient GREENCRANES Alternatives

Single Variable Investment Model. Diesel vs. LNG Fleet Simulator

Performance

Service Life

Demand Curve

Financial Impact

Environmental Impact

Critical Mass: 19 units
Activity 2. Evaluation of Eco-Efficient GREENCRANES Alternatives

RTG Electrification

Bus Bar

Cable Reel

Source: Vahle

Source: Conductix

Green Technologies and Eco-efficient Alternatives for Cranes and Operations at Port Container Terminals
Activity 2. Evaluation of Eco-Efficient GREENCRANES Alternatives

Bus Bar Evaluation

<table>
<thead>
<tr>
<th>n° Years</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>WACC</td>
<td>10,00%</td>
</tr>
<tr>
<td>Δ INVESTMENT</td>
<td>6,697,939,57 €</td>
</tr>
<tr>
<td>NPV</td>
<td>10,066,877,38 €</td>
</tr>
<tr>
<td>IRR</td>
<td>25,50%</td>
</tr>
<tr>
<td>Payback</td>
<td>4</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>1,501,339,77 €</td>
</tr>
</tbody>
</table>

Cable Reel Evaluation

<table>
<thead>
<tr>
<th>n° Years</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>WACC</td>
<td>10,00%</td>
</tr>
<tr>
<td>Δ INVESTMENT</td>
<td>6,070,827,00 €</td>
</tr>
<tr>
<td>NPV</td>
<td>4,497,810,81 €</td>
</tr>
<tr>
<td>IRR</td>
<td>19,97%</td>
</tr>
<tr>
<td>Payback</td>
<td>5</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>898,981,44 €</td>
</tr>
</tbody>
</table>

14 RTGs
18 Blocks

10 RTGs
12 Blocks
Pilots and Demonstrations. Noatum – Port of Valencia (Spain)

The first pilot and demonstration will be based on the evaluation of both LNG and Diesel Stage IV fuel alternatives for PCT yard equipment. The pilot will consider the adaptation of existing machinery to allow the supply of LNG and compare them with last generation Diesel fuels as an alternative to the current diesel powered yard machinery.

Pilot Phases:
- Evaluation of the Existing Port Machinery for the Adaptation to LNG Supply
- Yard Truck Adaptation to LNG Supply Requirements
- Study of the Investment Return and Environmental Impact
- Use of the Pilot as a Decision-Making Tool
Pilots and Demonstrations. Noatum – Port of Valencia (Spain)

This side free to install the 323 liters LNG tank

- 3.500 mm wheelbase
  - Instead 3.300 mm standard

Hydraulic tank, battery and air compressor moved to the same side
Pilots and Demonstrations. Noatum – Port of Valencia (Spain)

Design

Manufacturing

On-Site Deployment
Pilots and Demonstrations. Noatum – Port of Valencia (Spain)

Organised by:

External Industrial Partners:

Green Technologies and Eco-Efficient Alternatives for Cranes and Operations at Port Container Terminals

“GREENCRANES VALENCIA DEMO DAY”

It is a great pleasure for us to invite you to the Valencia Demonstration Day of the TEN-T Action GREENCRANES. The general objective of GREENCRANES is to test new technologies and alternative fuels including pilot deployment in port container terminals contributing thereby to mitigating climate change and reducing GHG emissions.

The first one will consist on the deployment of the first European LNG powered terminal tractor prototype in a port container terminal. The vehicle will be tested jointly with a diesel powered terminal tractor equipped with the latest emission control technologies (non-road machinery Stage IV standard). Both terminal tractors will carry out the same operations and several performance indicators such as fuel consumption, GHG emissions, cycle timing, among other will be shown in order to allow their benchmarking. The goal of these real-life tests will be demonstrating the feasibility for the adoption of LNG as an alternative and environmentally-friendly fuel for terminal tractors at European port container terminals.

The second demonstration will consist on the presentation of a retrofitted eco-RTG crane, modified with a low power gen-set and electronics optimisation, resulting in significant reduction of fuel consumption and Greenhouse Gas Emissions (GHG) whilst keeping the same operational level of service.

Venue: Salón de Actos, Sede APV - Fase III, Avda. Muelle del Turia, s/n, 46024, Valencia (Spain).

Time: 09:00 (Maximum punctuality is kindly requested).

* Please express your interest in attending before 18 November to rgarci@fundacion.valenciaport.com

As there is limited space, we will send you back a confirmation of participation if there is still place available.
Pilots and Demonstrations. Port of Livorno (Italy)

The second pilot and demonstration will be based on the adaptation of a Reach Stacker to a different motorisation for reducing the environmental impact and the energy consumption.

Pilot Phases:

- Design of a Reach Stacker that adopts alternative environmental compatible fuelling (i.e. Full LNG power, dual fuel technology, etc.)
- Integration and realisation of a prototype according to the design
- Functional testing of the prototype
- Pilot of the prototype and analysis of performance in a real PCT
Pilots and Demonstrations. Port of Livorno (Italy)

Design  Manufacturing  On-Site Deployment
The third pilot and demonstration will be based on the implementation of a real time energy monitoring system which will be able to control energy consumption associated to port container operations, thus allowing port stakeholders to better evaluate the impact of such operations from the point of view of eco-efficiency and GHG emissions.
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4. Expected Results

- **Provide decision criteria, recommendations and standardisation rules** derived from the pilots results, for the adoption of alternative-fuel based technologies at PCTs.

- **Allow PCT stakeholders and policy makers to define suitable strategies** to foster the **evolution towards a low-carbon emission model** at European PCTs and the compliance with Europe’s 20/20/20 objectives.

- Evaluate the proposed eco-efficient **GREENCRANES alternatives** for PCTs yard equipment based on alternative fuels, electrification and efficient management of PCTs processes.

- Compare each alternative including **financial and cost-benefit analysis**, as well **environmental impact in terms of GHG emissions** reduction.

- **Test new technologies and alternative fuels including pilot deployment** in PCTs contributing thereby to **mitigate climate change** and reduce GHG emissions.

- **Obtain an Energy Efficiency Indicators (EEI) System** to be implemented on the Balanced Scorecard of PCTs.
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http://www.greencranes.eu

LinkedIn: GREENCRANES

Twitter: @GreenCranesPrj

We are at Stand 2A at Solaris Centre during the TEN-T Days!

Email: greencranes@fundacion.valenciaport.com
THANKS FOR YOUR ATTENTION!

GREENCRANES, AN ACTION DEVELOPED THANKS TO:

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

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Consortium:

- Fundación Valenciaport
- Municipality of Valencia
- Autoridad Portuaria de Valencia
- MIT
- Luka Koper
- Port of Koper
- Noatum
- Scuola Superiore Sant’Anna