Green Port Transformation

HPC’s Approach and Insights from Projects

- Reduced Air Pollution
- Improved Working Conditions
- Renewable Energies
- Improved Profitability
Agenda

1. Introduction: HPC Hamburg Port Consulting GmbH

2. Motivation

3. Achieving a Green Port Transformation
   - Situation, Challenge and Solution
   - Approach and Insights from Previous Projects

4. Outlook
HPC Hamburg Port Consulting GmbH

Background, Goal, Focus, Clients

- Founded in 1976 as subsidiary of HHLA Hamburger Hafen und Logistik AG
- Full-service provider focussing on ports, logistics and intermodal facilities, ranging from smaller break-bulk facilities to fully-automated container terminals
- HPC Hamburg Port Consulting GmbH is the leading management consultant in the worldwide port and transport sector
  - Around 100 experts, annual turnover in 2016: approx. € 13m
  - Since 1976 port and transport-related projects in more than 100 countries, both in the private and public sector
- Support from the first project idea, via planning and implementing of project up to running operation
Motivation

Need for a More Sustainable Energy Use in Ports and Terminals

Drivers towards achieving more energy sustainable port operation

High energy consumption in ports and terminals

Yearly energy consumption of HHLA container terminals

△ Energy consumption of > 40,000 private persons
Achieving a Green Port Transformation
Situation, Challenge and Solution

**Situation:** ports and terminals need to improve their environmental impact but also their profitability

**Challenge:** how to identify not only feasible but also the most (cost-) efficient energy sustainability measures?

**Solution:** approach to pursue a cost-effective “green port transformation”
**Approach to Pursue a Green Port Transformation**

**Step 1: Pre-Evaluation of Measures**

- Identification of feasible measures based on terminal inspection
- Pre-selection of measures using an energy sustainability catalogue

**Energy sustainability catalogue**

- > 200 measures for all kind of terminals and port authorities
  - Type of measures: operation, technical and behaviour
  - Categorization according to energy consumer clusters
  - Pre-evaluation of measures according to three main criteria

**Energy sustainability measures (port authority)**

**Energy sustainability catalogue (extract for terminal type: container terminal)**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Energy consumer</th>
<th>Layer</th>
<th>Measure</th>
<th>Evaluation</th>
<th>Efforts for implementation</th>
<th>Total score</th>
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<td>Cargo handling equipment</td>
<td>Ship to shore cranes</td>
<td>LED floodlights and walkway lights</td>
<td>10 10 8</td>
<td>9.2</td>
<td></td>
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<tr>
<td>Cargo handling equipment</td>
<td>Yard transport equipment</td>
<td>Electrification of power train</td>
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<td>Yard transport equipment</td>
<td>Eco-driving</td>
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<td>Cargo handling equipment</td>
<td>Yard loading / unloading equipment</td>
<td>Unsynchronised Moves</td>
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<td>3.6</td>
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</tbody>
</table>
Step 1: Pre-Evaluation of Measures

Exemplary Measures for Container Terminals

- Exemplary resource measure: electrification of yard transport equipment
  - Energy / emission saving potential: battery-powered AGVs require up to 30% less energy compared to conventional designs
  - Efforts for implementation: operators should expect to make major modifications at the terminal level / B-AGVs are still much more expensive

- Exemplary operation measure: unsynchronized moves for RMGs
  - Energy / emission saving potential: even out energy consumption of RMGs can result in savings of more than 30%
  - Efforts for implementation: movements or operations of any cranes must not be affected

- Exemplary behaviour measure: eco-driving lessons (e.g. for straddle carrier)
  - Energy / emission saving potential: average fuel savings of 5–10% per operating hour can be achieved at unchanged terminal performance levels
  - Efforts for implementation: can be provided in the form of on-road training or with simulator
Step 2: Detailed Analysis

Simulation Model

Main goal: achieve a highly accurate, specific assessment of energy effects and operational implications of energy sustainability measures

Components of simulation model

1. Logistics model: to model all terminal operations considering
   - Terminal-specific layout
   - Equipment
   - Processes
   - Cargo flows

2. Energy tracker: to capture the resulting energy consumption and emissions of a terminal on basis of:
   - Incremental equipment movements considering all sub-movements (e.g. accelerating) and energy-relevant criteria (e.g. loaded weight or equipment characteristics)
   - Baseload (e.g. office)
   - Own energy generation and energy storage
Simulation Model

Insights from Previous Projects

- Project goal: analysis of energy consumption pattern of a container terminal and identification of most effective energy sustainability measures

  ➢ Main result 1: simulated terminal load profile

  ![Load profile of container terminal (one week period)](image)

  ▪ Largest energy consumers: AGVs and yard cranes
  ▪ Minor energy consumer: rail cranes and trucks
  ▪ Occurrence of several high peak loads
Simulation Model

Insights from Previous Projects

- Main result 2: evaluation of energy sustainability measures
  - Detailed investigation of measure “LED floodlights and walkway lights on STS”

- Total energy savings: > 20%
- Reduction of auxiliary energy consumption: > 50%
- Additional benefits: reduction of unscheduled equipment downtime / reduced light pollution, light spill and glare / improved employee safety / possibility of dimming and programing
Step 2: Detailed Analysis
Profitability Analysis: Procedure and Project Insights (1/2)

1. Cash flow analysis to quantify the economic consequences of energy sustainability measures

Example from project: cash flow analysis for electric and conventional AGV fleets
Step 2: Detailed Analysis
Profitability Analysis: Procedure and Project Insights (2/2)

2. Optimization models: for utilizing flexible load-shifting potential in ports or terminals

Example from project: optimization of charging costs of battery-electric AGVs

Battery charging and idle times

Optimization of charging times
Outlook
Achieving a Future-oriented, Environmentally Friendly Transportation Sector

- The need for a more sustainable energy use is especially relevant for ports, which are crucial hubs in the global trading system
  - The main challenges of adopting measures in this field is the limited knowledge about potential measures and their effectiveness, as well as conflicting preferences between different actors in the port
- Detailed information about the effectiveness of energy sustainability measures prerequisite for its application

- Port and vessel operation need to be analysed together in future in order to actually achieve a “green port transformation

Potential measures

Pre-evaluation  Simulation analysis  Life cycle assessment  Profitability analysis

Most promising measure
Thank you for Your Attention

For further information, please contact

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Backup
Background

Energy consumption in ports

1. Different role of port authority and terminals
   - Since port authorities do not carry out port operations, their share on a port’s total energy consumption is relatively low
   - Energy sustainability programs initiated by the port authority are usually politically motivated; however, only few options exist to directly initiate energy sustainability measures for port authorities

2. Different terminal types in ports
   - All terminal types differ with regard to the cargo handling equipment as well as storage structure
     - The energy consumption pattern of each terminal type differ significantly
     - There are different measures to be applied on each terminal type
   - Usually, the main energy consumers in terminals is the cargo handling equipment

3. Energy consumption of vessels in ports
   - Emissions from shipping at berth are approx. ten times greater than those from port’s own operations
   - Especially port authorities can have an influence on reducing such emissions

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Energy consumption by port users

Source: Luskien Center, 2013.

CO₂ emission sources at Felixstowe port

Source: Gibbs et al., 2014.
Motivation

Drivers towards achieving more energy sustainable port operation

- Threat of climate change
- Increase of cost-effectiveness
- Improvement of “green” image
- Port stakeholder requirements
Motivation

Yearly energy consumption of HHLA container terminals

- Electricity
- Petrol
- Heating gas
- Heating oil
- District heat
- Total

△ Energy consumption of > 40,000 private persons (in Germany)