Green Port Transformation

HPC‘s Approach and Insights from Projects

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*

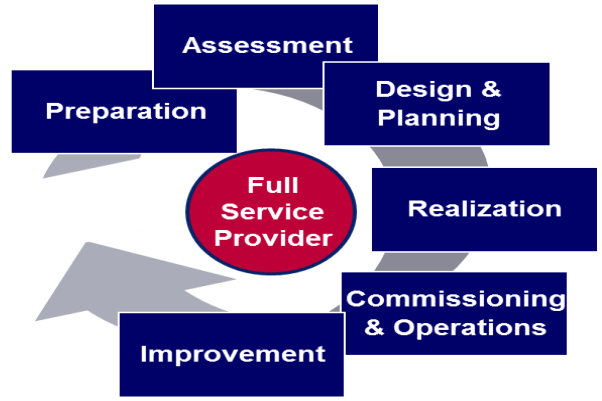
4. **Outlook**

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

Scope of services



Completed projects

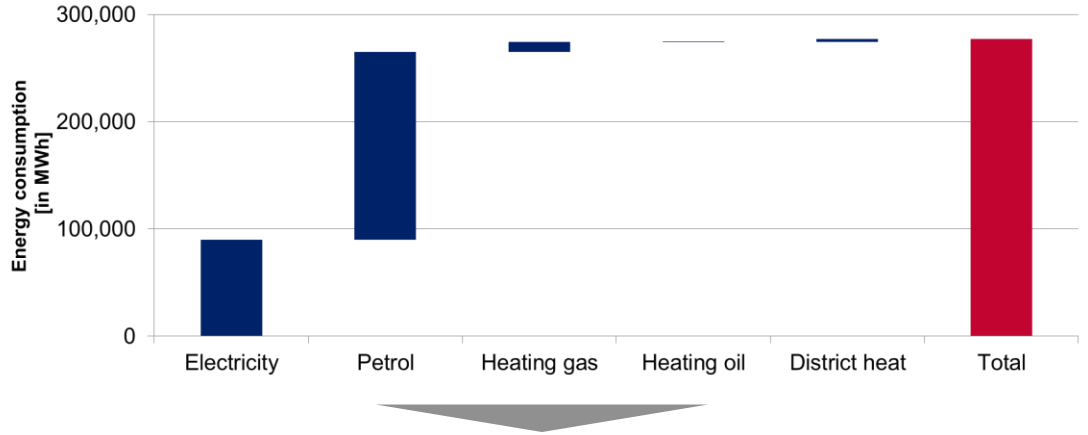
Motivation

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

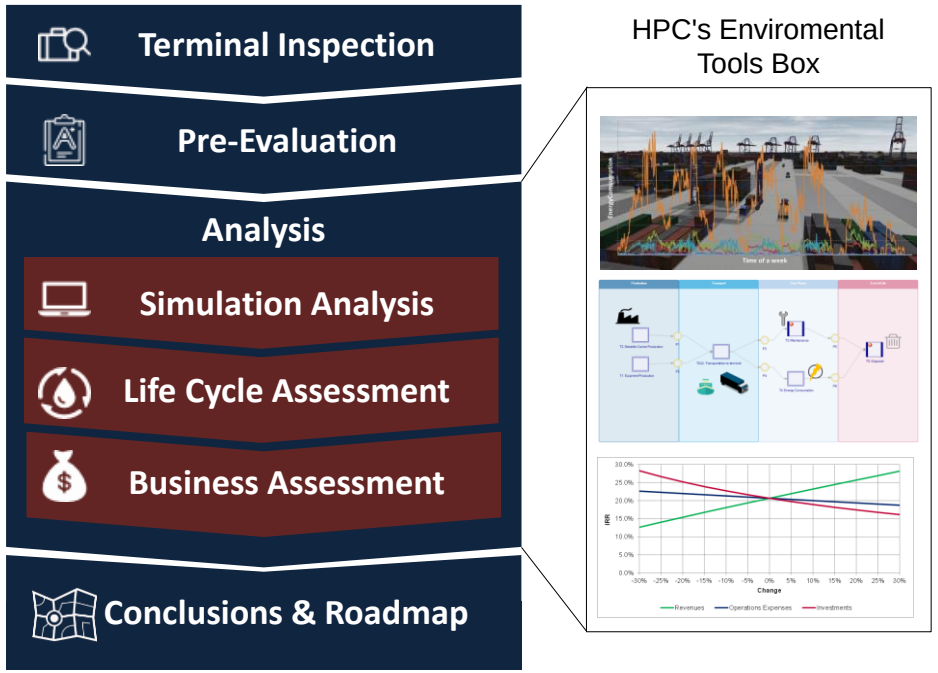
Achieving a Green Port Transformation

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

Terminal Inspection

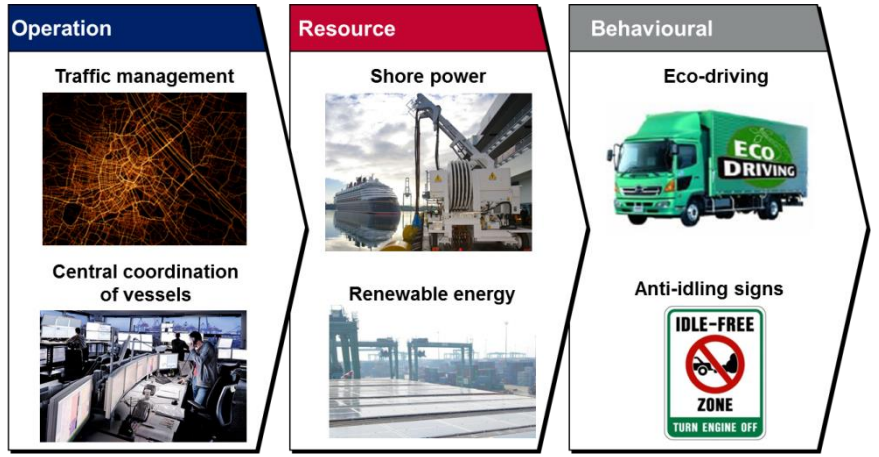
Pre-Evaluation

- 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)

Measures				Evaluation			
Category	Energy consumer	Layer	Measure	Emission saving potential	Energy saving potential	Efforts for implementation	Total score
Ressource	Cargo handling equipment	Ship to shore cranes	LED floodlights and walkway lights	10	10	8	9.2
Ressource	Cargo handling equipment	Yard transport equipment	Electrification of power train	10	10	5	8.1
Behavior	Cargo handling equipment	Yard transport equipment	Eco-driving	6	6	10	7.7
Operation	Cargo handling equipment	Yard loading / unloading equipment	Unsynchronised Moves	10	10	2	6.8
Ressource	Reefer		Energy management	2	2	6	3.6

Step 1: Pre-Evaluation of Measures

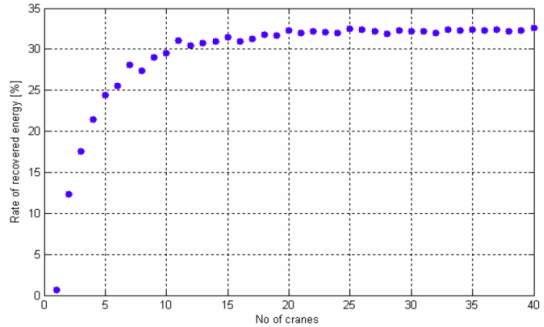
Exemplary Measures for Container Terminals

Terminal Inspection

Pre-Evaluation

- 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

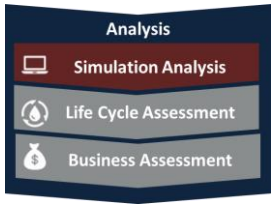
- Exemplary operation measure: unsynchronized moves for RMGs
  - Energy / emission saving potential: even out energy consumption of RMGs can result in savings of more than 30%
  - Efforts for implementation: movements or operations of any cranes must not be affected



- 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

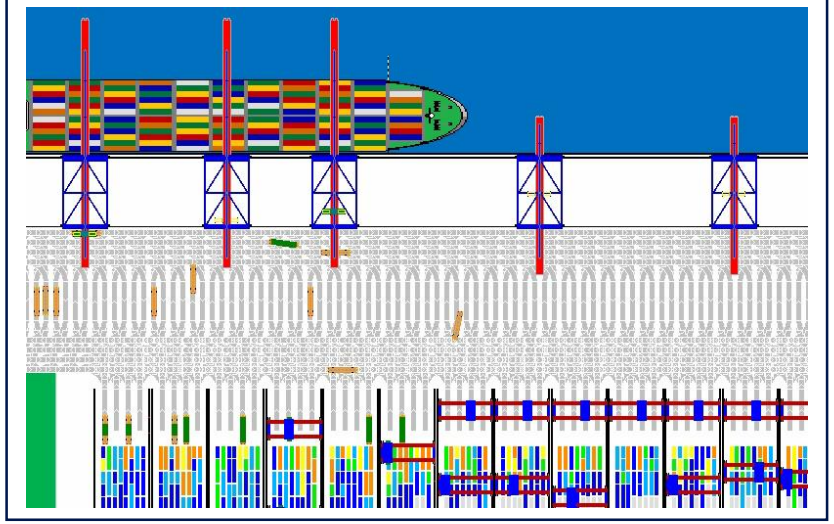


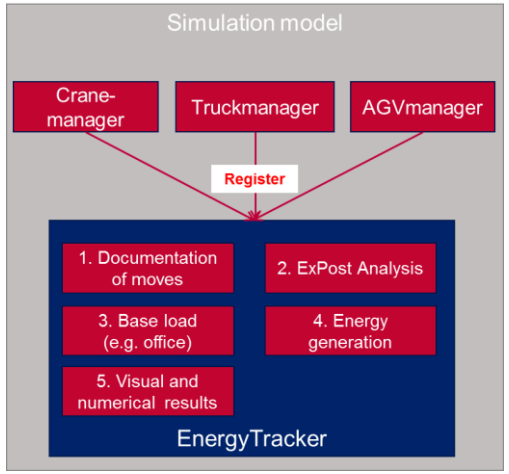
Main goal: achieve a highly accurate, specific assessment of energy effects and operational implications of energy sustainability measures

<u>Components of simulation model</u>

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

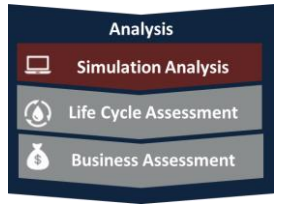
HPC simulation model





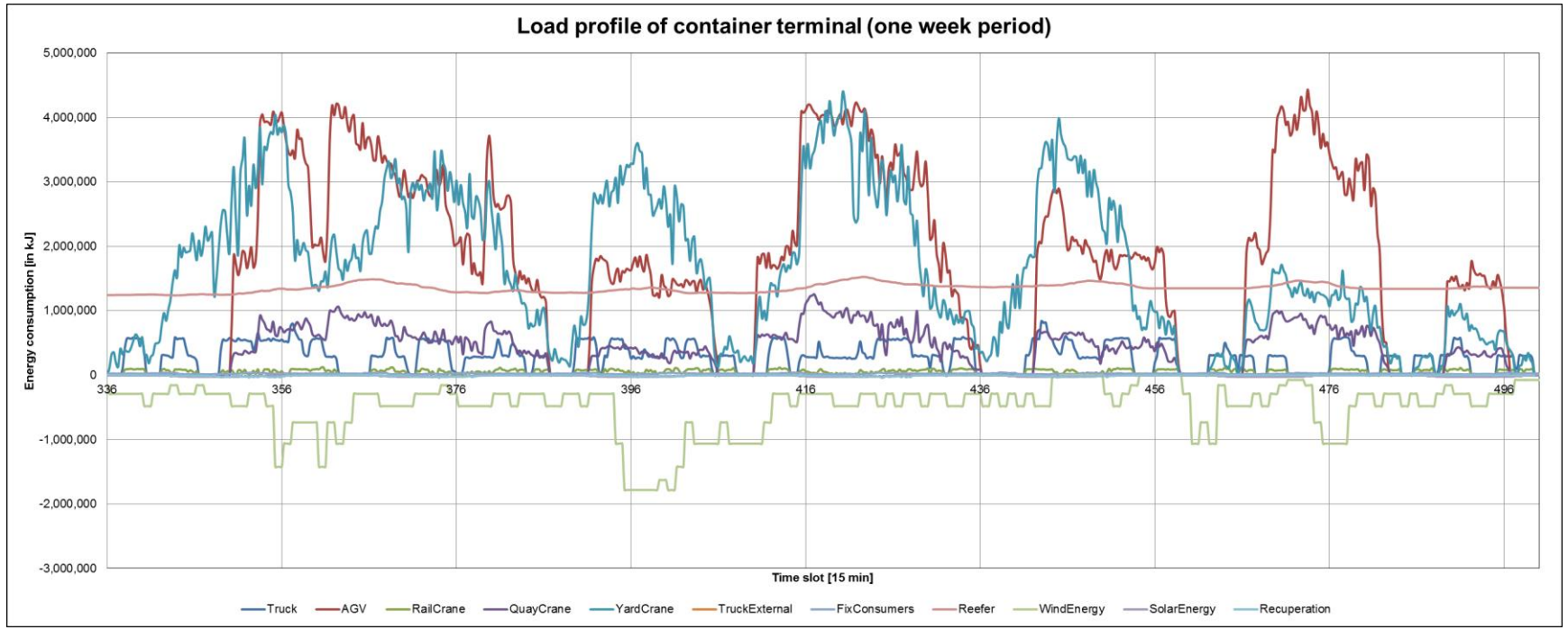
Simulation Model

Insights from Previous Projects



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

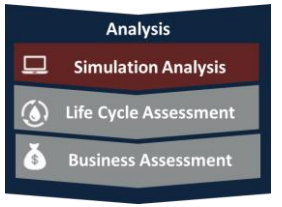
➢ Main result 1: simulated terminal load profile



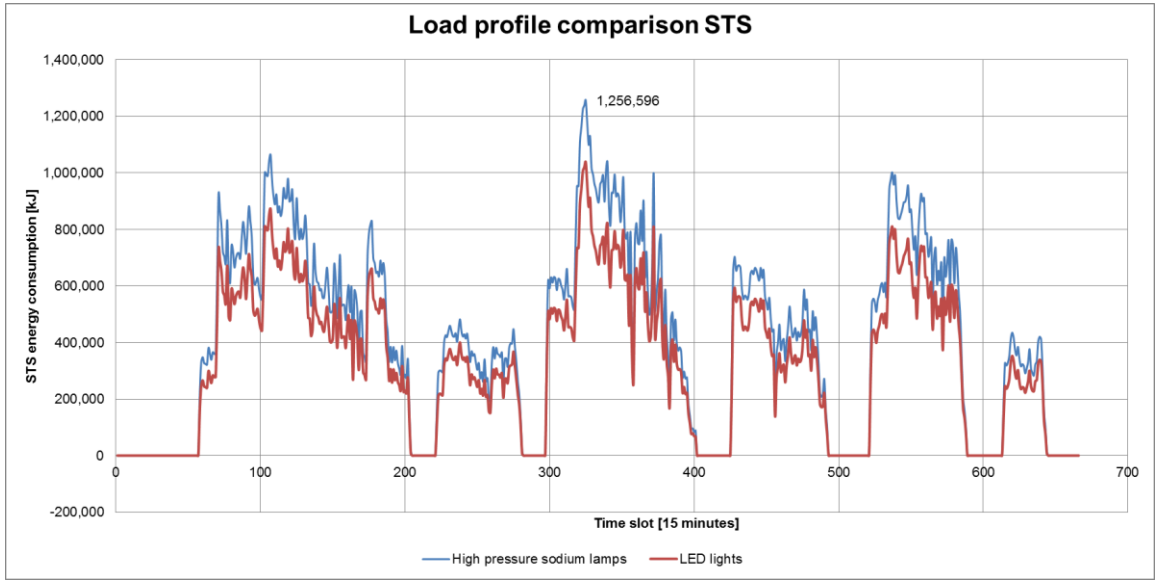
- Largest energy consumers: AGVs and yard cranes
- Minor energy consumer: rail cranes and trucks
- Occurrence of several high peak loads

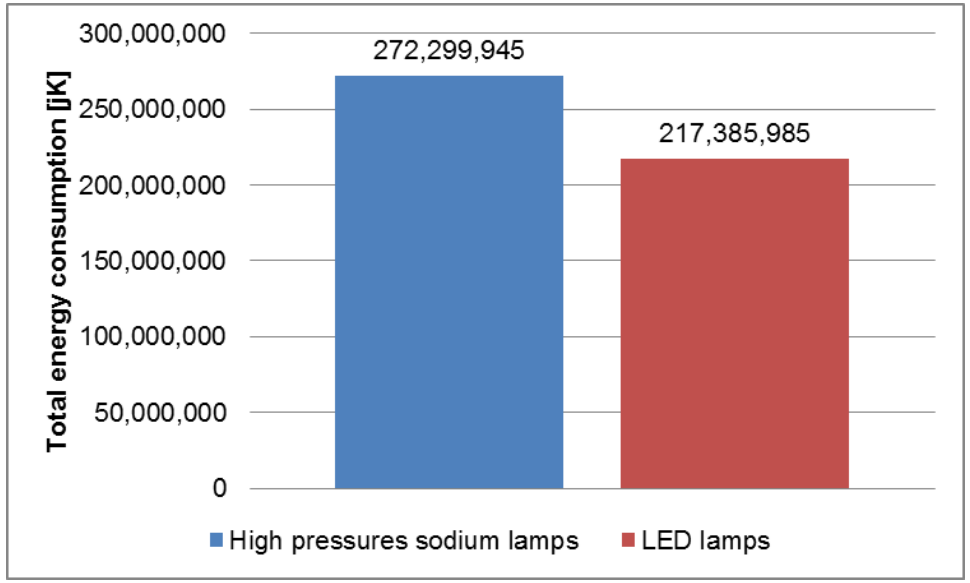
Simulation Model

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

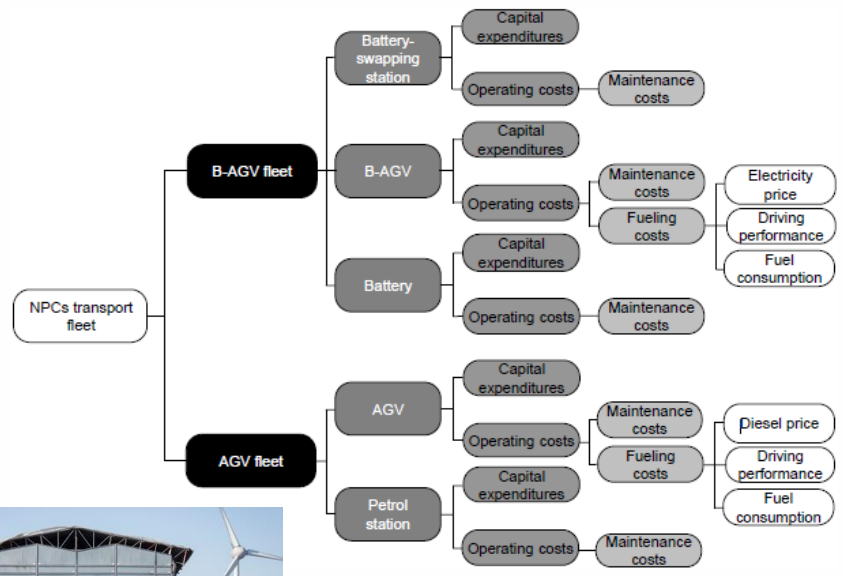
Step 2: Detailed Analysis

Profitability Analysis: Procedure and Project Insights (1/2)

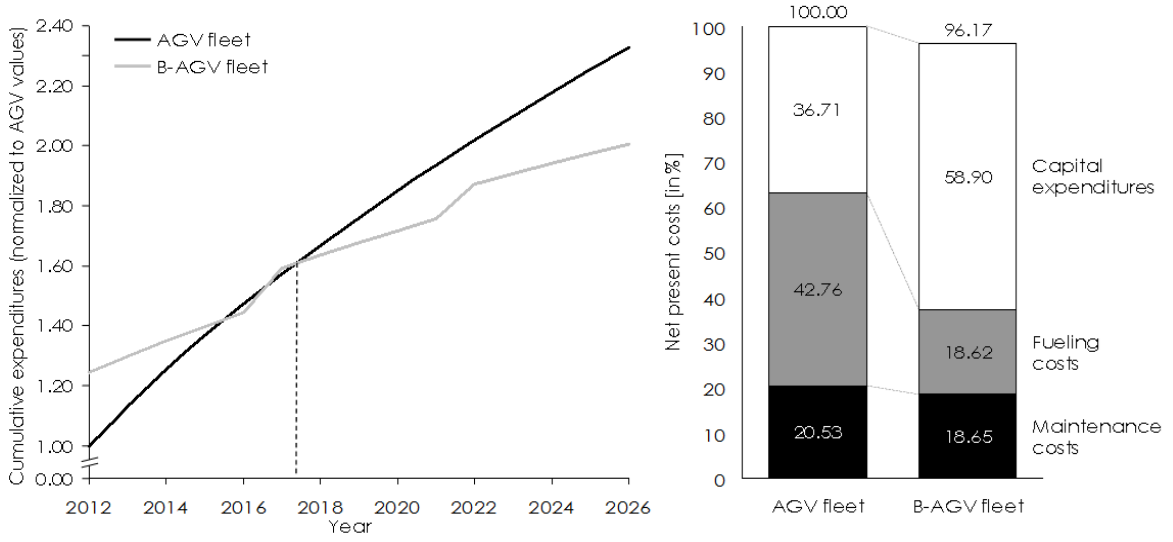
1. Cash flow analysis to quantify the economic consequences of energy sustainability measures

Example from project: cash flow analysis for electric and conventional AGV fleets

Elements considered in TCO model



Results



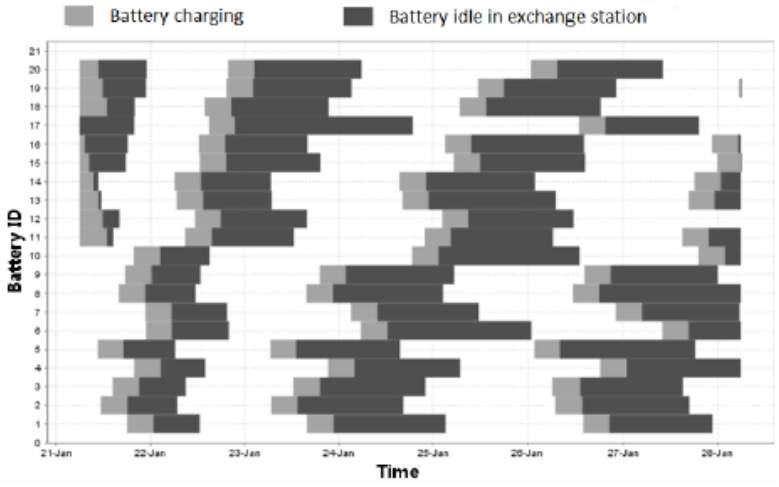
Step 2: Detailed Analysis

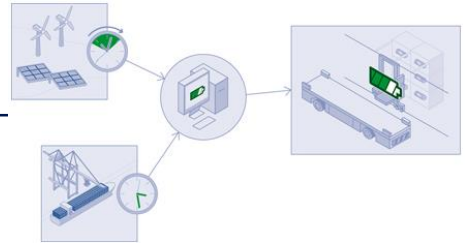
Profitability Analysis: Procedure and Project Insights (2/2)

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

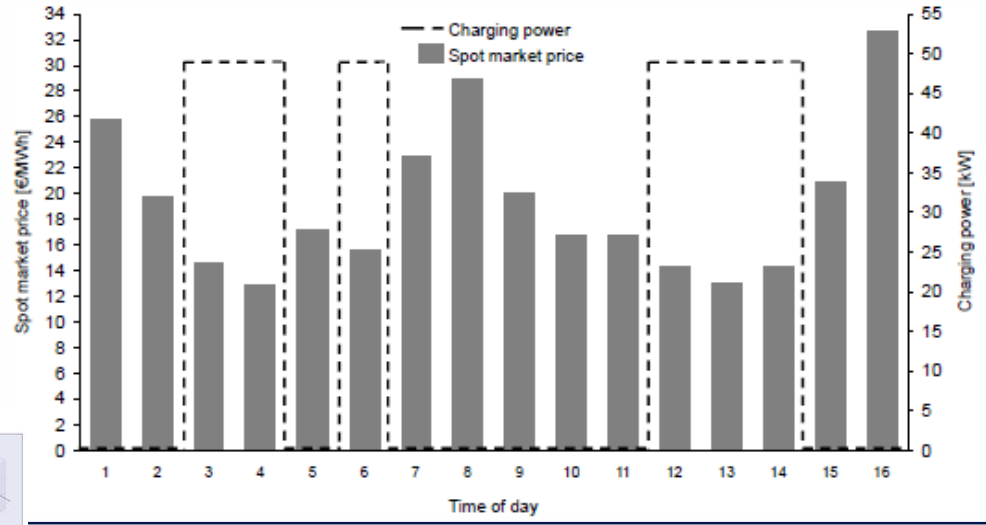
Example from project: optimization of charging costs of battery-electric AGVs

Battery charging and idle times





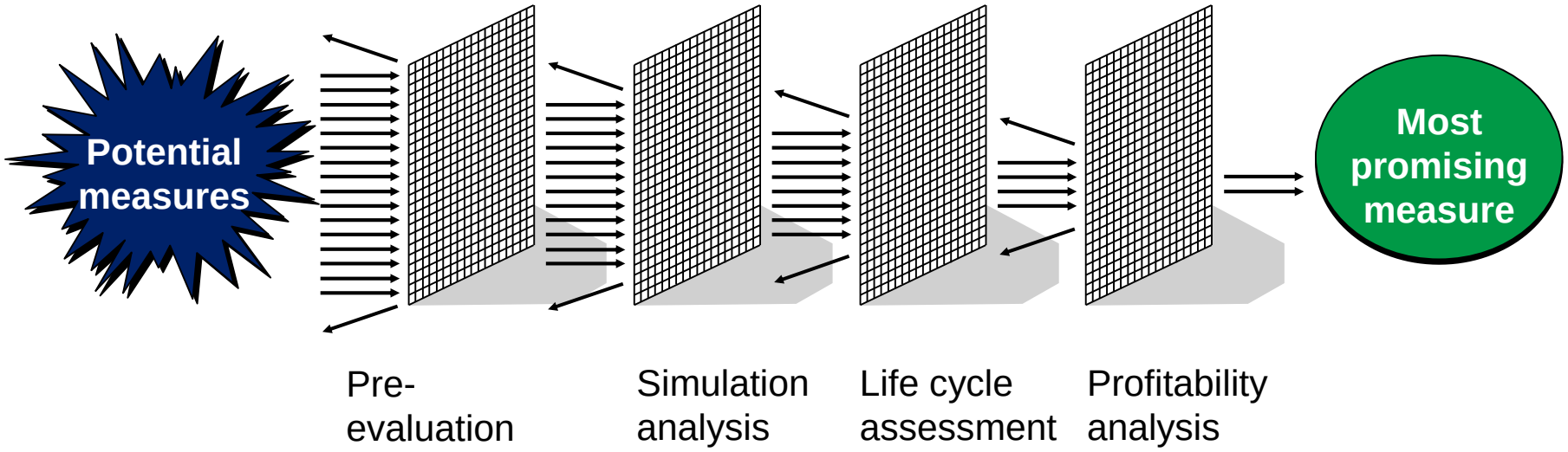
Optimization of charging times



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

Thank you for Your Attention

For further information, please contact

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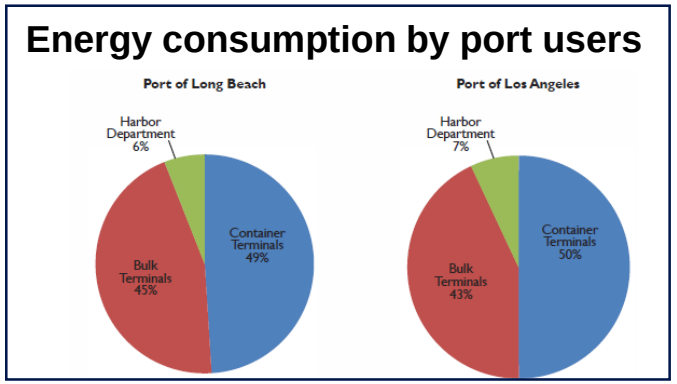
Backup

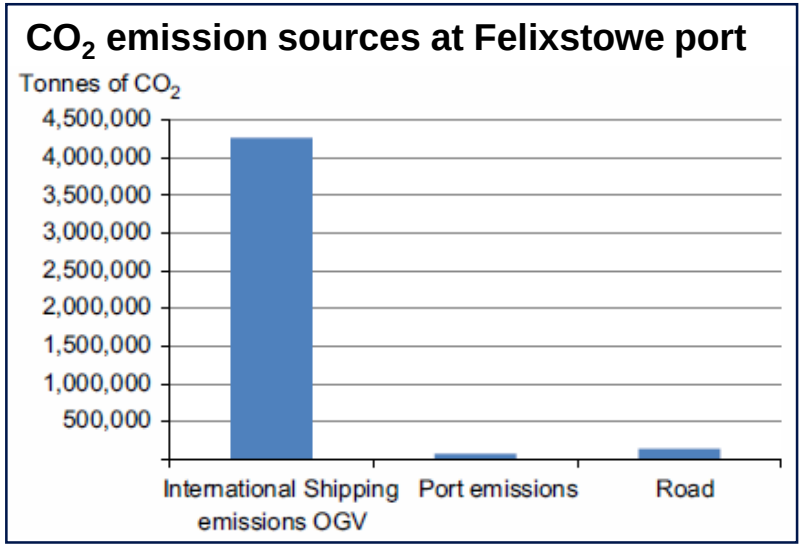
Background

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



Source: Luskien Center, 2013.



Source: Gibbs et al., 2014.

Motivation

Drivers towards achieving more energy sustainable port operation

Increase of cost-effectiveness

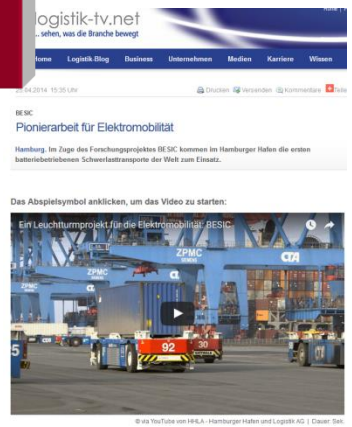
Threat of climate change

Green Port Operation

Improvement of “green” image

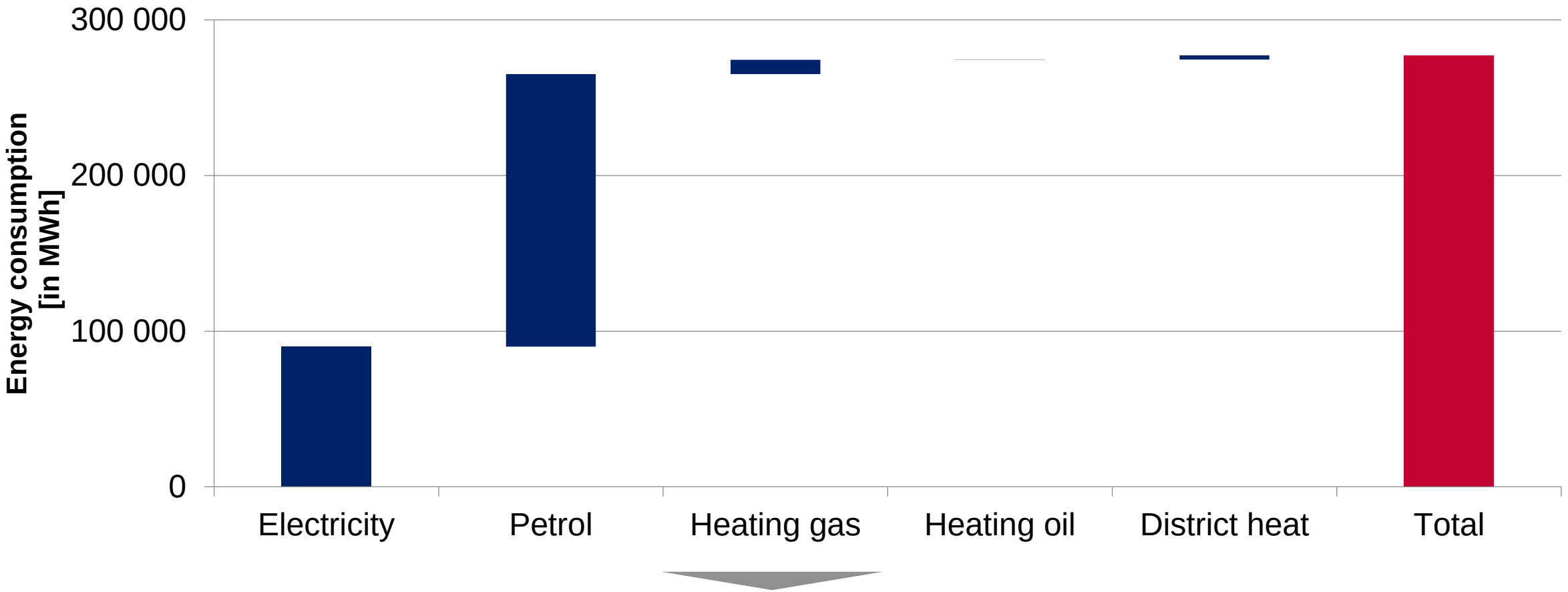
Port stakeholder requirements

Port of LONG BEACH
The Green Port



Motivation

Yearly energy consumption of HHLA container terminals



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