# The Maritime Path to Decarbonization: A Comparative Analysis of Proven Technologies for Container Terminals and Ports

This presentation will provide an overview of the benefits and challenges of complying with the EU ETS (Directive 2003/87/EC) for the maritime sector, and offer recommendations for enhancing environmental performance and competitiveness by adopting decarbonization technologies for container terminals and ports.

**by Douglas Mafra**

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# EU ETS for Maritime Transport: Rationale and Features

The EU ETS, a market-based mechanism, sets a cap on GHG emissions in certain sectors and allows trading of emission allowances. Maritime transport, included since 2023, covers ships above 5,000 gross tonnage calling at or departing from ports in the EEA. The emission reduction target is 30% by 2030 and 75% by 2050 compared to 2018 levels. Ship operators monitor, report, and verify their emissions, and surrender one emission allowance for each tonne of $CO_2$ emitted.

# EU ETS for Maritime Transport: Benefits

1. Long-term Cost Reduction: Improve energy efficiency and reduce operational costs.
2. Sustainable Market Access: Gain a competitive edge in regions that value environmental responsibility.
3. Positive Brand Image: Demonstrate social and environmental responsibility.
4. Incentives and Subsidies: Access funds and subsidies for low-carbon operations.

# EU ETS for Maritime Transport: Challenges

1. Legal Requirement Compliance: Face additional administrative and operational burdens.
2. Carbon Leakage and Market Distortion: Face competitive disadvantages and trade barriers.
3. Technological and Financial Barriers: Face challenges in adopting low-carbon technologies for SMEs.

# Decarbonization Technologies for Container Terminals and Ports:

## Overview and Scope

Container terminals and ports are crucial nodes in the maritime supply chain but significant sources of emissions. Decarbonization technologies include optimized yard planning, battery-electric equipment, onshore power supply, smart port technologies, and more. This presentation will focus on key technologies, comparing energy savings, emission reductions, cost, maturity, suppliers, and delivery status.

# Automation and Digitalization

Enhance efficiency, reduce labor costs, and optimize resource utilization leading to up to 15% emissions reductions.

Digital Twin Port: Digital twin technology creates a virtual replica of the port, enabling simulation and optimization of operations.

Data Sharing and Collaboration: Sharing data and collaborating across port stakeholders can optimize operations and identify decarbonization opportunities.

These technologies are commercially available, with costs varying depending on the specific application. Automation challenges and benefits:

- ensuring business continuity, interoperability, compatibility, and high productivity.
- reducing operating costs, improving safety, increasing capacity, and enhancing sustainability.

# Smart Port Technologies

Embracing smart port technologies, such as intelligent yard management systems and real-time data analytics, can optimize operations and reduce energy consumption by up to 20%.

Smart berth allocation can reduce vessel idling time by up to 50%, significantly lowering fuel consumption.

Automated yard management systems can achieve fuel savings of up to 30% by optimizing cargo handling operations.

Predictive maintenance can reduce unplanned downtime by up to 20%, minimizing the need for fuel-intensive maintenance activities.

These technologies are commercially available, with costs varying depending on the specific technology.

# Renewable Energy

Integrating renewable energy sources, such as solar and wind power, into port operations can significantly reduce reliance on fossil fuels and achieve up to 100% emissions reduction potential.

This technology is commercially available, but costs vary depending on the specific renewable energy source.

While there are moderate upfront costs, this technology is commercially available and increasingly adopted by suppliers Siemens, Vestas, Schneider Electric, Enel, Ibedrola.

# Optimized Yard Planning and Equipment Utilization

By employing intelligent algorithms and real-time data analytics, ports can optimize yard planning and equipment utilization, reducing fuel consumption and emissions.

Energy savings and emission reductions can reach up to 20%.

This technology is commercially available and widely deployed by suppliers such as DSP, Portwise, and Navis.

# Battery-Electric Container Handling Equipment

Battery-electric container handling equipment offers advantages such as zero emissions, low noise and vibration, low energy costs, and workforce availability.

Four key levers can accelerate the adoption of BE-CHE and close the gap with diesel CHE: scaling up demand and production, reducing cost through standardisation and modularisation, preparing terminal operations for rollout, and introducing incentives to develop the market.

Different stakeholders in the port ecosystem have different roles and responsibilities to enable the transition to BE-CHE, and they should work together to achieve a collective impact

Energy savings and emission reductions can reach up to 50% and 60% respectively.

While there are moderate upfront costs, this technology is commercially available and increasingly adopted by suppliers like Konecranes, Liebherr, ZPMC and Kalmar.

# Onshore Power Supply and Shoreside Cold Ironing

Onshore Power Supply (OPS) and Shoreside Cold Ironing (SSI) technologies reduce emissions by providing electricity to docked ships from the grid.

Energy savings and emission reductions of up to 50%, while SSI can reach up to 70%. OPS requires high upfront investment costs, while SSI has moderate upfront costs.

Both technologies are commercially available, widely deployed for OPS, and increasingly adopted for SSI by suppliers such as ABB, Siemens, Eaton, Ingeteam, Tratos Group and Schneider Electric.

# Liquefied Natural Gas

Liquefied Natural Gas (LNG) serves as a cleaner-burning alternative to traditional bunker fuels, offering energy savings and emission reductions of up to 25%. However, LNG requires high upfront investment costs.

This technology is commercially available and has a growing adoption by suppliers like Shell, TotalEnergies, and ExxonMobil.

# Battery-Electric and Hybrid-Electric Vessels and Hydrogen Fuel Cells

Battery-electric and hybrid-electric vessel propulsion systems eliminate emissions from vessel operations and offer energy savings and emission reductions up to 100%.

Hydrogen fuel cells represent a zero-emission technology with the same potential for energy savings and emission reductions.

Both technologies have high upfront costs and are in the early stages of development. Suppliers include Siemens, ABB, Rolls-Royce for battery-electric and hybrid-electric vessels, and Toyota, Air Liquide, Linde for hydrogen fuel cells.

# Key Considerations for Technology Selection

## 1 Emissions Reduction Potential

Prioritize technologies with the highest potential for reducing GHG emissions.

## 2 Technology Readiness

Assess the maturity and availability of each technology to ensure a smooth transition.

## 3 Cost-Effectiveness

Evaluate upfront investment costs and ongoing operating expenses for financial feasibility.

## 4 Port-Specific Factors

Consider unique needs, constraints, and infrastructure of each port to identify suitable technologies.

# Recommendations for Accelerated Decarbonization

1. **Establish Robust Policy Frameworks**

   Implement clear policy frameworks and incentives to promote decarbonization investments.

2. **Foster Collaboration and Knowledge Sharing**

   Encourage collaboration to share knowledge, best practices, and innovation.

3. **Mobilize Financial Support**

   Develop funding mechanisms to support decarbonization projects, especially for emerging technologies.

4. **Enhance Capacity Building**

   Implement training and education programs to equip port personnel.

# Success Cases: Inspiration for Sustainable Maritime Practices

*Several ports worldwide have embraced innovative decarbonization strategies, demonstrating the feasibility and effectiveness of these technologies.*

The Port of Long Beach in California, USA, has implemented optimized yard planning and equipment utilization, resulting in a 10% reduction in fuel consumption.

The Port of Rotterdam in the Netherlands has deployed automated stacking cranes, achieving a 30% reduction in energy consumption.

The Yantian International Container Terminal in China has transitioned to hybrid and electric yard equipment, reducing emissions by 50%.

The Port of Valencia in Spain has implemented a comprehensive digitalization strategy, achieving a 10% reduction in fuel consumption through optimized yard planning and real-time traffic management.

# References


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- EU Emissions Trading System (ETS)
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- UNIQUE - Navigating the Maritime Path to Decarbonization: A Comparative Analysis of Proven Technologies for Container Terminals and Ports.

# Who we are

Douglas Mafra, CEO at UNIQUE Tecnologia.

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