



# CONGRESO 2024

24<sup>th</sup> October A Coruna

## Decarbonisation in Bulk Handling

Pat O' Leary Head of Technology

- Port Equipment Manufacturers Association (PEMA) is a non-profit making international association with more than 130 member companies
- Founded 2004, PEMA's mission is to provide a forum and public voice for the global port equipment and technology sectors
- Members of PEMA are entities involved in the design, manufacture, supply and support of port equipment and technology including:
  - Port and terminal equipment and Services
  - Components or attachments for port equipment
  - Technology that controls or interfaces with port equipment
  - Consultants in port and terminal equipment design, specification

**Activities Include:** Industry Representation, White Papers, Member Meetings, Student Challenge, Equipment Surveys,



PEMA is the Global Voice of the  
Port Equipment manufacturing  
industry



#PEMA20

# Decarbonisation in Bulk Ports

## Definition:

The reduction or elimination of carbon emissions, particularly CO<sub>2</sub>, in port Bulk Handling Operations.

**Bulk Cargo Types:** Dry Bulk - Break Bulk - Liquid Bulk

**Bulk Cargo accounts for >70% of World Shipping**

## Importance for Ports:

- Ports are responsible for a significant portion of global greenhouse gas emissions.
- Decarbonising ports contributes to meeting international climate goals (e.g., the Paris Agreement) and reducing environmental impacts.

## Key Drivers:

- Global Emissions Targets.
- Port Authorities' commitment to sustainability.
- Pressure from stakeholders (governments, communities, investors).



# Examples of Bulk Handling Equipment



# Equipment Overview

## Bulk Handling :

Ports handle large quantities of bulk materials (e.g., coal, iron ore, grain, foodstuffs )

Energy-intensive processes that contribute to carbon emissions.

## Key Equipment Types:

- **Ship Loaders / Unloaders:** Essential for loading (or discharging) bulk materials from vessels.
- **Conveyor Systems / Hoppers:** Transport bulk materials from vessels to storage or processing areas.
- **Stackers and Reclaimers:** Loading and unloading bulk materials at storage yards.
- **Cranes and Grabs:** For moving materials in bulk with high operational energy use.
- **Front Loaders and Fork Lifts:** Smaller equipment used in the ship, on the quayside and warehouse.

## Energy Consumption and Emissions:

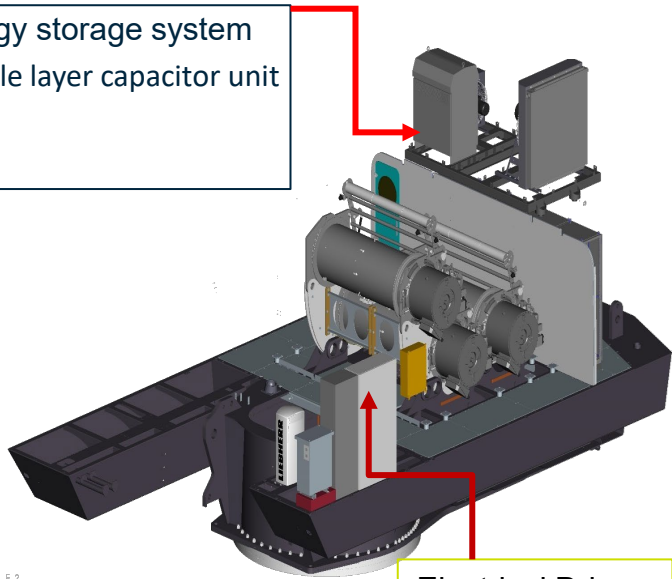
These systems traditionally operate mainly either on **Diesel** or **Electricity** sourced from oil/coal-fired power.

# Crane Technology

Main power supply  
via cable reel

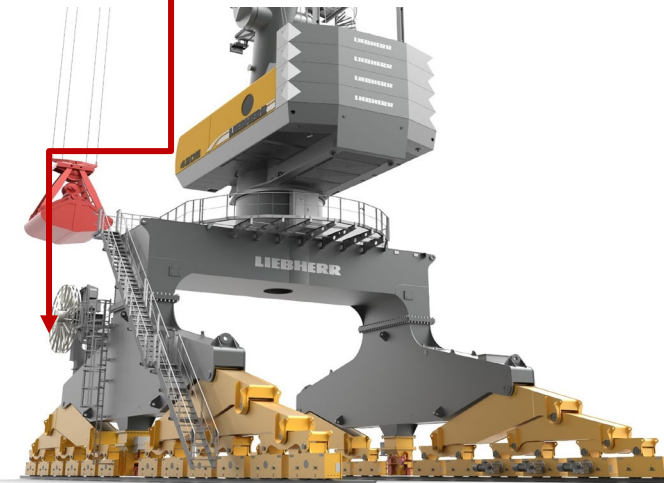
- Low-voltage  
(380 – 460 V)
- Medium voltage  
(3.3 - 20kV)

Energy storage system  
Double layer capacitor unit



## High Efficiency

- Permanent Magnet Synchronous Motors
- Liquid Cooling Technology



# Hopper Technology

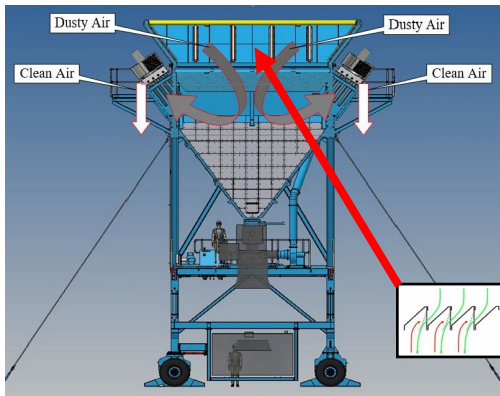


**Intelligent Laser-controlled** dust filters that adjust fan speed based on grab location.

**Differential pressure sensing** between atmospheric pressure and air pressure inside the Eco Hopper, the compressed **air cleaning** system engaged only when required.

A **flex-flap barrier** between the hopper and the outside atmosphere significantly reduces the air volume required for keeping constant air speed at the grab discharge point.

**Integral filters result in** power saving by eliminating the need to return collected dust to the material flow using conveyor systems.

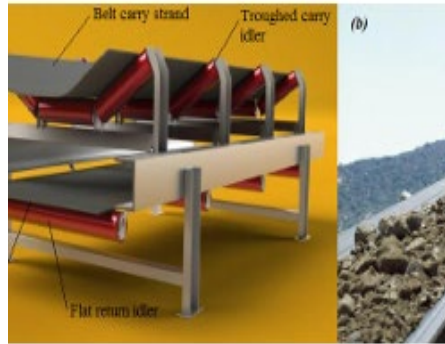
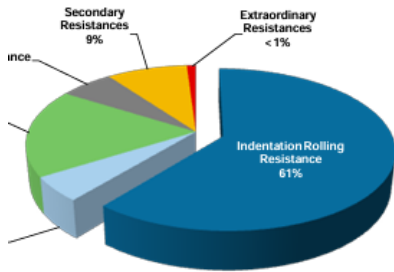
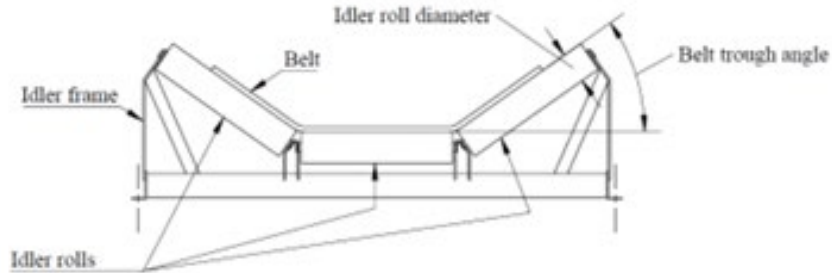




# Conveyor Technology

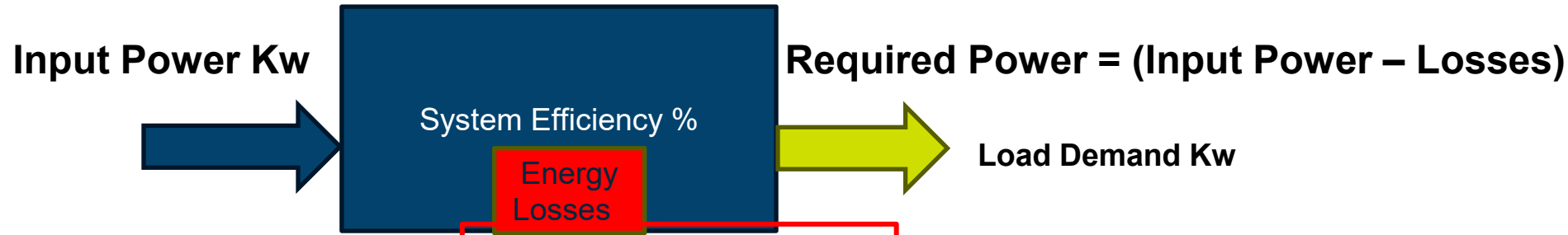


The most important main conveyor design parameters affecting power consumption are: **Idler Frame, Belt, Idle Roller Diameter, Belt Trough Angle, Idler Rollers**



**Filter fans /Belt speeds** reduced if the sensors do not detect material in the shipload inlet.  
**Intelligent Control** and monitoring - Laser and AI technology.  
**Low resistance coefficient idler** technology  
**Gearless VFC Drives** with Synchronous motors  
**Energy Saving Belt** designs.  
**Powered rollers**

# Importance of Equipment Efficiency in Decarbonisation



**Electrical Losses:**

- Transformers
- Motors
- Inverters
- Cooling Systems
- Lighting



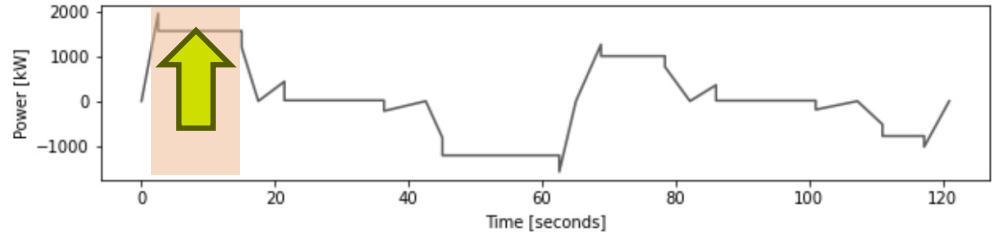
**Mechanical/Friction Losses:**

- Gear Units
- Sheaves
- Rollers
- Bearings
- Lubrication
- Rope Reeving

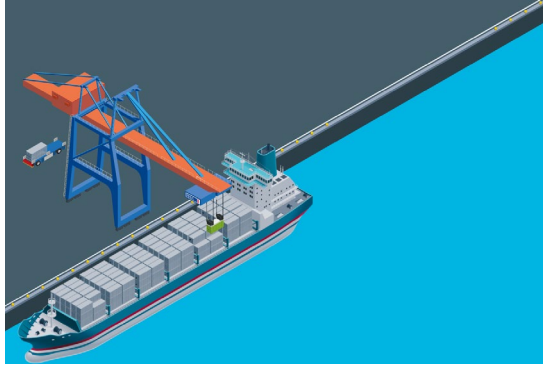
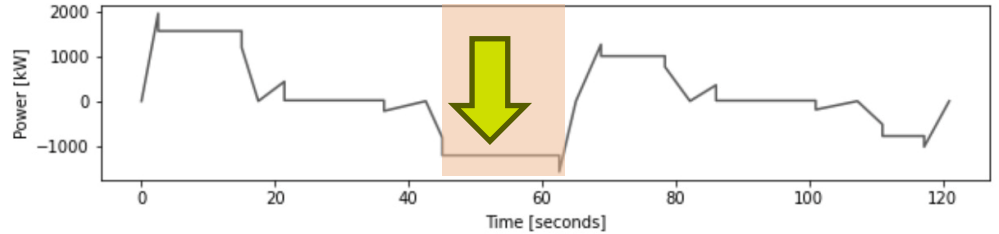
# Regeneration Power Recovery Principle - Hoisting Equipment

## Efficiency of Equipment % / Energy Storage

### Hoisting



### Lowering



Local or  
Centralised  
Battery  
Storage

# Roadmap for Decarbonising Bulk Handling Equipment

## **Electrification of Equipment:**

Change from diesel-powered to electric-driven equipment.

Integrate renewable energy sources (e.g. solar or wind) to power port operations.

## **Battery Electric and Hybrid Technologies:**

Battery electric and Hybrid bulk handling equipment with electric Drives and energy storage systems

## **Energy Efficiency Improvements:**

Replacing or Upgrading existing machinery and implementing automation.

## **Low-Carbon Fuels:**

Transitioning existing ICE equipment to Hydrogen, Biofuels, or LNG.

## **Digitalisation and Smart Port Solutions:**

Implementing digital twins and AI to improve the operational efficiency of equipment.

Predictive maintenance and monitoring systems reduce energy use and increase lifespan.

# Bulk Handling Equipment Green Fuel Options

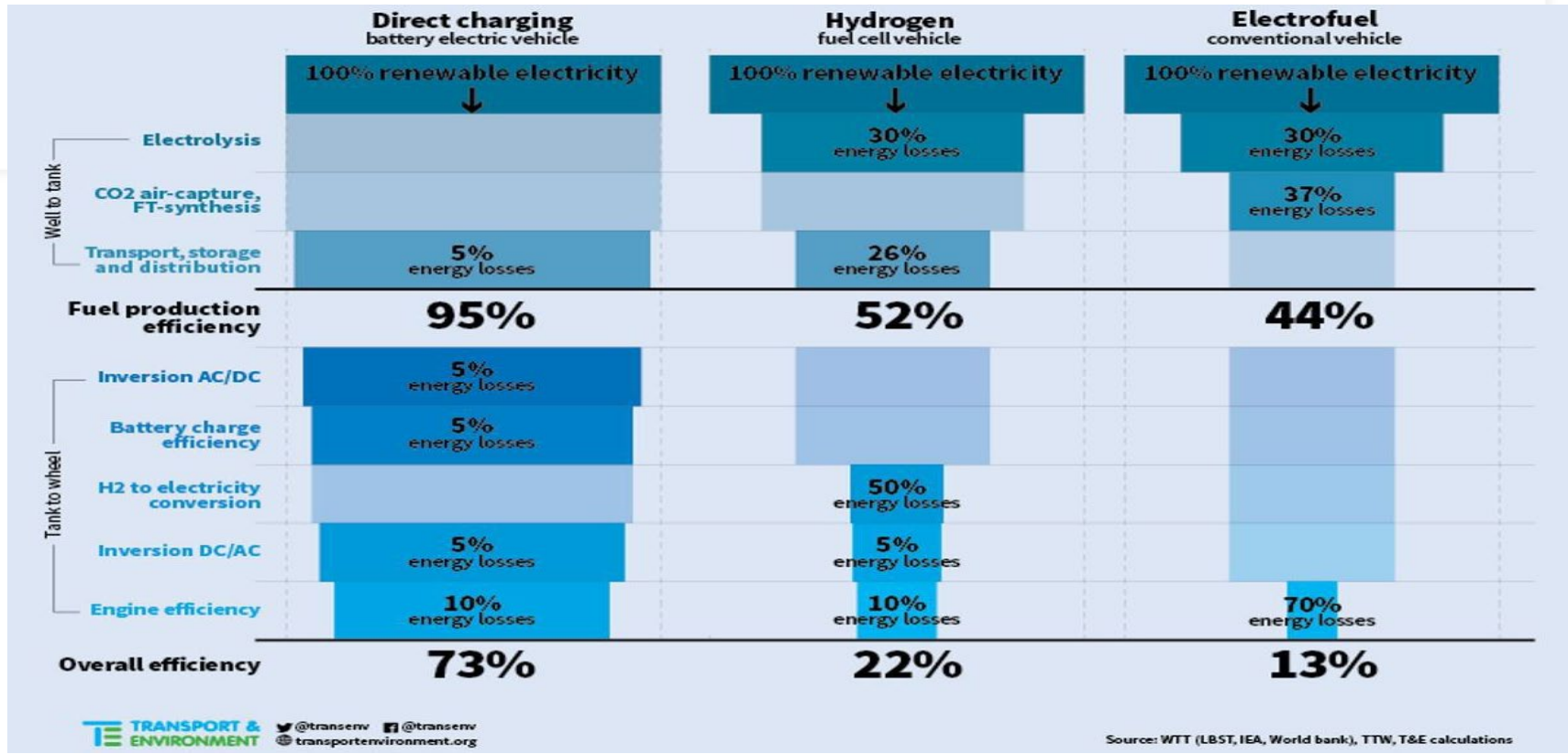
**Battery Electric**

**Hydrogen Fuel Cells**

**Hydrogen - Biofuels conventional ICE**

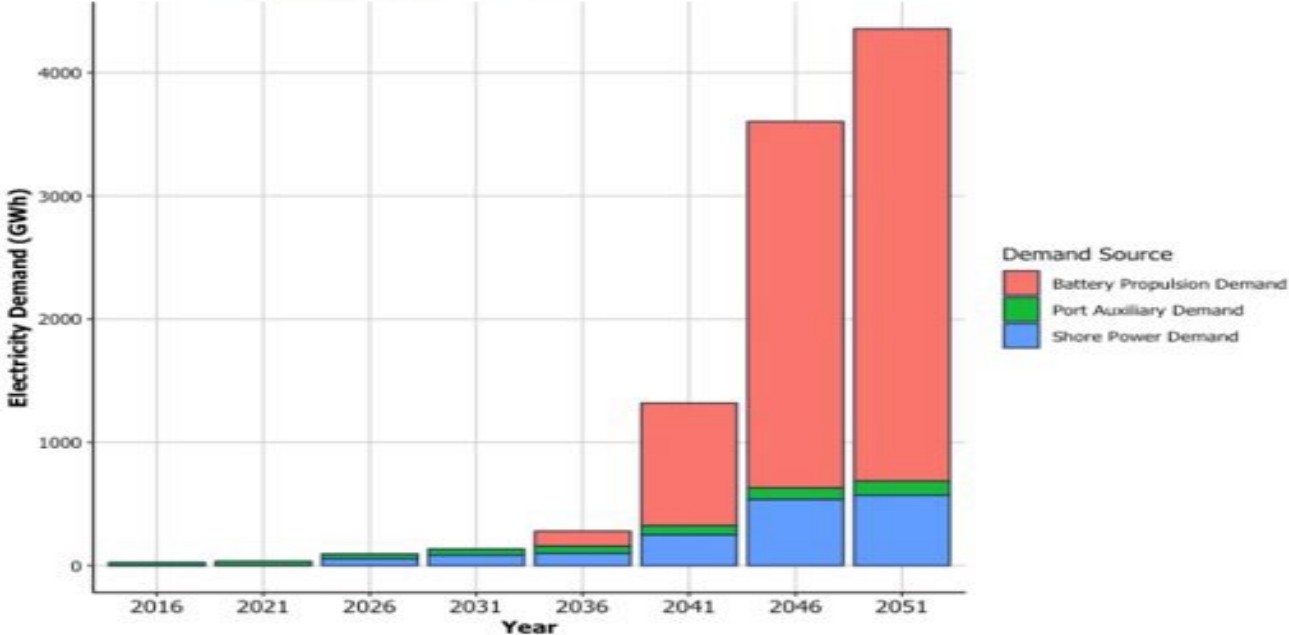


# Case for Direct Electrification



# Port Energy Demand in UK Expected to Grow x 100

Figure 9 Annual total UK port electricity demand under an ambitious de-carbonisation scenario



# Sources and Storage of Green Electrical Energy

Wind Energy



Solar Panels



Small Modular Reactor (SMR)



Battery Storage



Super Capacitor Storage



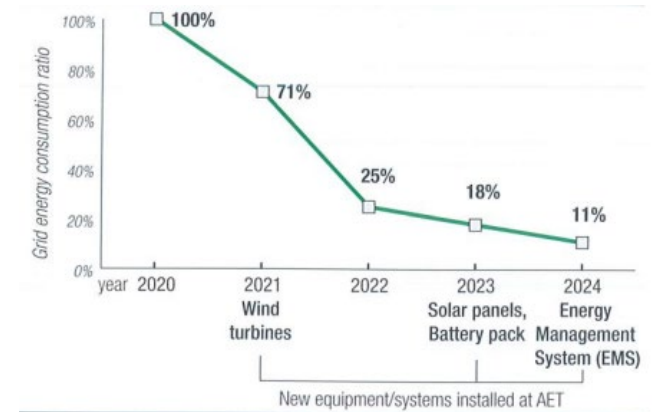
# Multi-purpose Port Example

## Wind Turbine / Solar Panel

- 3 wind turbines on quay => 5 windmills
- 2 Mw solar park => 6,8 Mw
- 2,1 Mwh Battery storage => 42,1 Mwh



Elect. Capacity	2021	2023	2025	2028	
Wind Turbines	3,5	10,5	10,5	20,5	Mwh
Solar	0	2	2	6,8	Mwh
Prod Capacity	3,5	12,5	12,5	27,3	Mwh
Battery Buffer	0	2	2	42	Mwh



# Summary

- Decarbonisation of bulk handling operations and equipment is a critical element of sustainable port operations.
- Through electrification, energy efficiency, and the use of low-carbon fuels, bulk handling can reduce emissions.
- Investment in cleaner technologies and infrastructure with consideration of not only **Scope 1** but also **Scope 2 and 3** emissions to achieve sustainability goals.
- Ports that lead with decarbonisation can set a global example and gain competitive advantages in a low-carbon economy.

## Actions:

- Promote collaboration between Stakeholders (port authorities, equipment manufacturers, and governments).
- Encourage Investment in green technologies with a focus on the role of Automation, AI and IoT in the decarbonisation process.



# Thank You