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E-port WP2

Assessing viability of different electric initiatives linked to ports, encompassing both immediate and future perspectives.

Introduction

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The energy needed to operate today's port-based operations are typically a mix of fossil fuels and green energy such as HVOC-100 and green electricity. To continue the green transition of ports, a higher degree of electrical operations is needed.

This presentation presents possible future port-based activities and operations that rely on increased electrical capacity. The presentation is accompanied by a high-level feasibility study that validates the alternatives' possible impact on the environment.

The purpose is to stimulate increased investment and development of electrical infrastructure in ports supporting the green transition for both the port and its customers.

Unveiling the future of electric ports

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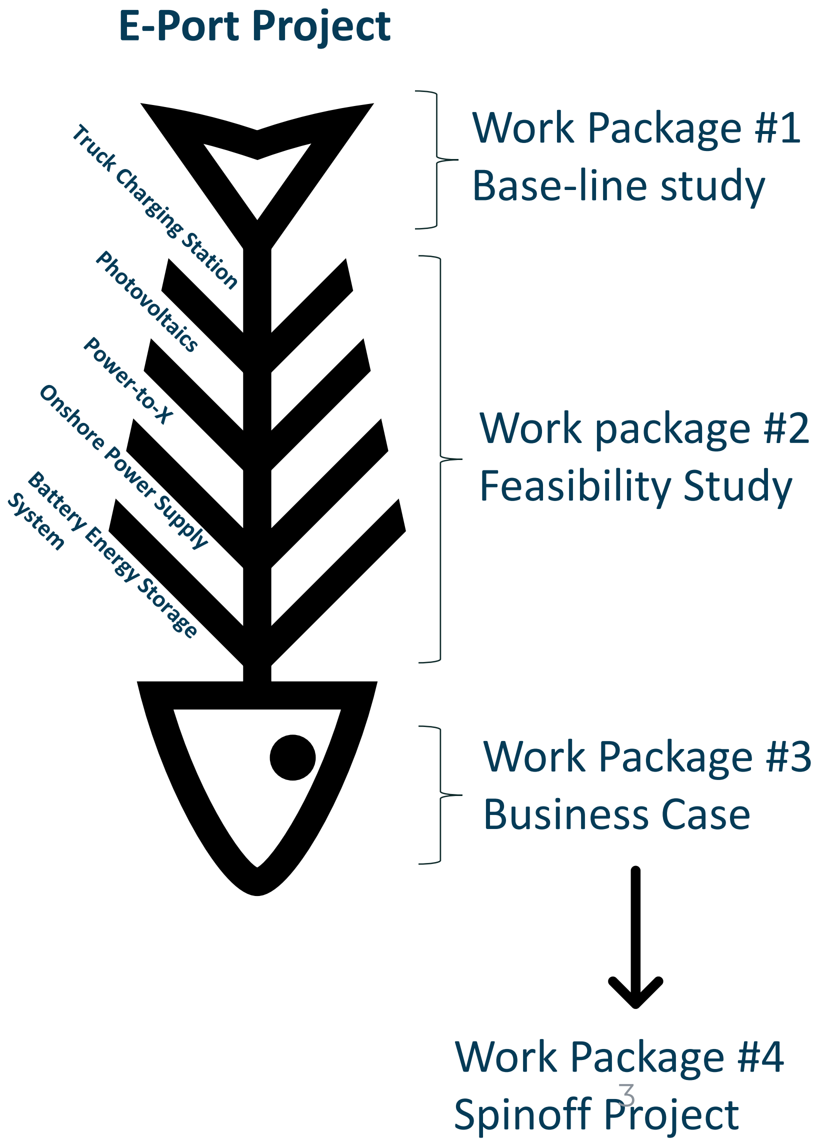
This work package (#2) under Ocean Valley's E-Port project sets out to assess what the future may bring of port-based infrastructure activities that require extra electrical capacity. It is based on the thorough analyses of electrical demand and supply in the Oresund region presented in E-Ports Work Package 1.

Work Package #2 shifts focus to evaluating the feasibility of pioneering e-activities. From short-term implementation to long-term sustainability.

The following sections assess various innovative initiatives against a set of relevant criterions uncovering the most promising opportunities poised to reshape the port landscape and drive the electrification of future port operations.

In the remaining work packages, the project will investigate further to which degree a business case for acceleration of e-grid investment can be validated and which projects may be spun out from the E-Port project.



Electrification projects in ports

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In the following two slides, we will describe common and transformative electrification projects in ports. The purpose is to list the opportunities for electrical infrastructure activities.

The common case section lists the low-hanging fruits whereas the transformative project section offers examples of projects with larger impact that rests on more speculative business cases.

Categorizing electric projects

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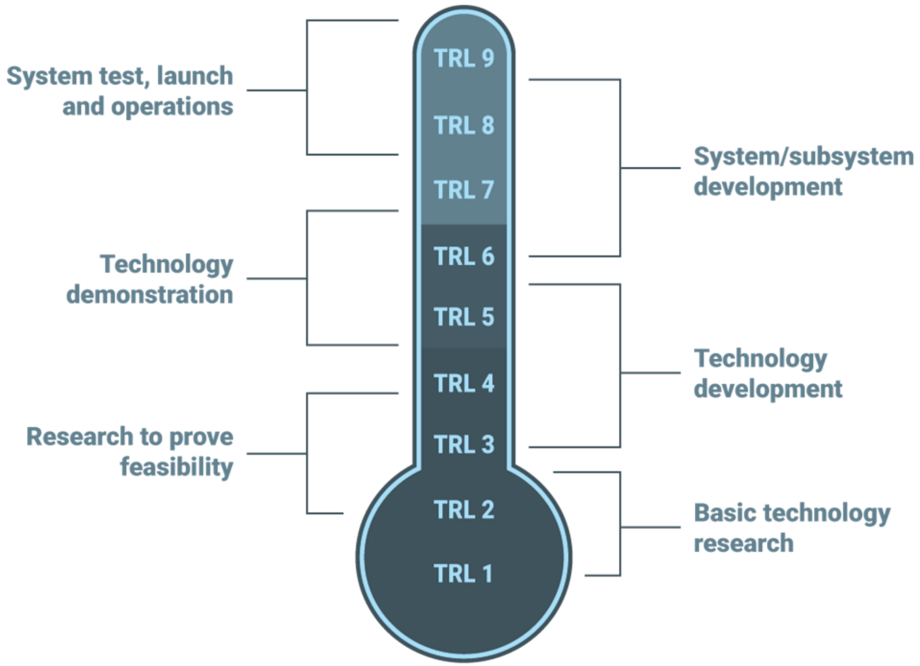
Categorizing electric projects into "common activities" and "transformative projects" is crucial for effective resource allocation, risk management, and long-term planning. "Common activities", with their short implementation time and feasible funding, address immediate regional needs, while "transformative projects", though more speculative, offer long-term benefits and scalability. Understanding these categories helps stakeholders prioritize investments, manage risks, and align projects with broader development goals.

Common Electric Activities

- Short implementation time
- Funding is relatively feasible
- Technological Readiness Level*: 6+
- Fits to current infrastructure
- Small immediate impact
- High Market Readiness

Transformative Electric Projects

- Long-term (relatively long time and adjusted to future regional/global context
- Difficult to attract funding
- More speculative
- Technological Readiness Level*: 2-6
- Scale requires infrastructure upgrade
- Big future impact
- Low Market Readiness



*Technological Readiness Level

Common Electric Projects

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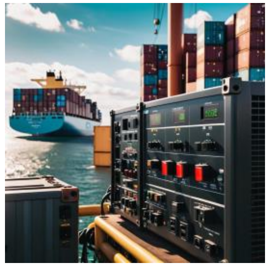


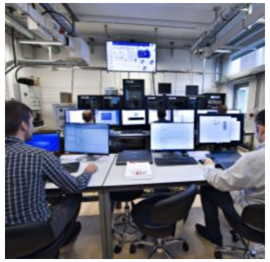
Onshore Power Supply (OPS) to RoRo, Cruise and Container
- Eliminate emissions during port stay
- Costly infrastructure
- Induced by regulations

Photovoltaics
- Installation on buildings and roofs
- Ports offers optimal location close to users
- Most productive during summer

Wind Power
- Requires lots of space
- Year-round supply of green energy
- Fluctuations in daily and monthly supply

Truck/EV Charging Stations
- Accelerate share of e-mobility
- Needs access to e-grid and space
- High willingness among logistic providers, but "supply-driven"

Heat Pumps for buildings
- Efficient heating of buildings on port
- Retrofitting is often difficult
- May be combined with battery storage systems



Balancing services (IoT, smart balancing, digital solutions)
- Optimize e-grid usage
- Users/usage difficult to control/predict accurately
- AI will improve use cases

Electrification of Container Handling Equipment
- Reduce fossil energy usage
- Investment heavy
- May be implemented fast

Transformative Electric Projects

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Power-to-X (PtX)
- Supply of green energy
- Expensive investment
- Requires lots of space, high investments and access to high electricity capacity
- Ports are a natural junction point between supply and demand

Battery Energy Storage System (BESS)
- Balance e-grid supply/demand, shave off peak-loads
- Must be placed next to point-of-use but requires a lot of space as well
- AI will improve utility of BESS considerably

Small (mobile) nuclear power plants
- The most efficient green energy of the future, highly scalable
- Still under development
- Modular nuclear power plants can be placed closed to points-of-usage

The three listed examples are all of transformative nature to improve green energy solutions, either requiring more electrical capacity or improving supply.

PtX facilities and BESS are already under construction or even in use, but still to be scaled fully. Modular nuclear power plants are still under research.

Port operators can offer valuable test bed environments to validate and further develop these technologies and facilitate strong partnerships through their network of customers and stakeholders

Shedding light on implementation constraints

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As ports worldwide endeavor to embrace electrified operations, they confront a multitude of overarching constraints challenging the attractiveness and feasibility of otherwise appealing and eco-friendly electrification projects such as:

- **Grid Expansion Timeline**: Grid expansion typically takes 3-7 years from Final Investment Decision (FID) to final completion, posing a significant time constraint for implementing electric activities.
- **Electrical Capacity Requirement:** Major electric installations demand high voltage infrastructure, necessitating careful planning and investment.
- **Power Balancing Challenges:** Managing peak load variations and accommodating the needs of numerous future users presents complexities in maintaining power stability and reliability.
- **Limited Physical Space:** Ports face spatial constraints due to urban expansion, limiting opportunities for infrastructure expansion and electric activity implementation.
- **Regulatory Constraints:** Regulatory frameworks may weaken certain business cases, such as onshore power supply (OPS), complicating the adoption of electric activities in ports.
- **Public Perceptions:** Public acceptance may be difficult to obtain due to “not-in-my backyard” – principle. Providing holistic sustainable solutions are essential considerations for successful implementation.
- **Access to Data:** Implementing advanced technologies like AI, Blockchain, and Machine Learning requires access to significant amounts of data, which may be confidential or difficult to obtain

Comparing feasibility of port-based e-activities

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The ten e-projects listed previously is now assessed on 10 different parameters (defined on following page) to determine their assessed feasibility.

For each parameter, the individual projects are rated using traffic light.

Green is best, Yellow intermediate. Red worst; white means n/a.

Disclaimer
All assessments are exclusively based on the authors assumptions but supported by project member's knowledge and field expertise.

	Onshore Power Supply	Balancing Services	Truck Charging Stations	Heat Pumps for Buildings	Container Handling Equipment	Battery Energy Storage Systems	Modular Nuclear Power Plants	Power-to-X	Photo-voltaics	Wind Power
Space requirement	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Red
Technical maturity	Green	Yellow	Green	Green	Green	Yellow	Red	Yellow	Green	Green
Danger level	Yellow	Green	Green	Green	Green	Yellow	Red	Yellow	Yellow	Yellow
Energy requirements	Red	White	Yellow	Yellow	Yellow	Yellow	White	Red	White	White
Regulatory constraints	Red	Yellow	Green	Green	Green	Green	Red	Yellow	Red	Yellow
Ease of implementation	Yellow	Yellow	Green	Green	Green	Yellow	Yellow	Red	Red	Red
Financing	Yellow	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
Innovation potential	Yellow	Green	Yellow	Yellow	Yellow	Green	Green	Green	Green	Yellow
Scalability	Green	Green	Green	Yellow	Green	Green	Green	Green	Yellow	Green
Public Acceptance	Green	Green	Green	Green	Green	Green	Red	Red	Red	Yellow
Assessed Feasibility	Yellow	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Green

10 parameters to assess feasibility of 10 e-activities

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1. **Space requirement**: The amount of physical space needed for the project's installation or implementation.
2. **Technical maturity**: The level of advancement and readiness of the technology or solution proposed for the project.
3. **Danger level**: Assessment of the potential risks and hazards associated with the project, including safety concerns.
4. **Energy requirements**: The amount of energy needed to operate and sustain the project.
5. **Regulatory constraints**: Compliance with legal and regulatory frameworks that govern the implementation of the project.
6. **Ease of implementation**: The simplicity and feasibility of executing the project within a given timeframe and resources.
7. **Financing**: Availability of funds and financial resources required to initiate and complete the project.
8. **Innovation potential**: The extent to which the project introduces novel or groundbreaking approaches, technologies, or methodologies.
9. **Scalability**: The capacity of the project to expand or adapt to accommodate future growth or changes in demand.
10. **Public acceptance**: The level of approval and support from stakeholders, communities, and the general public for the project's implementation.

Feasibility Barometer

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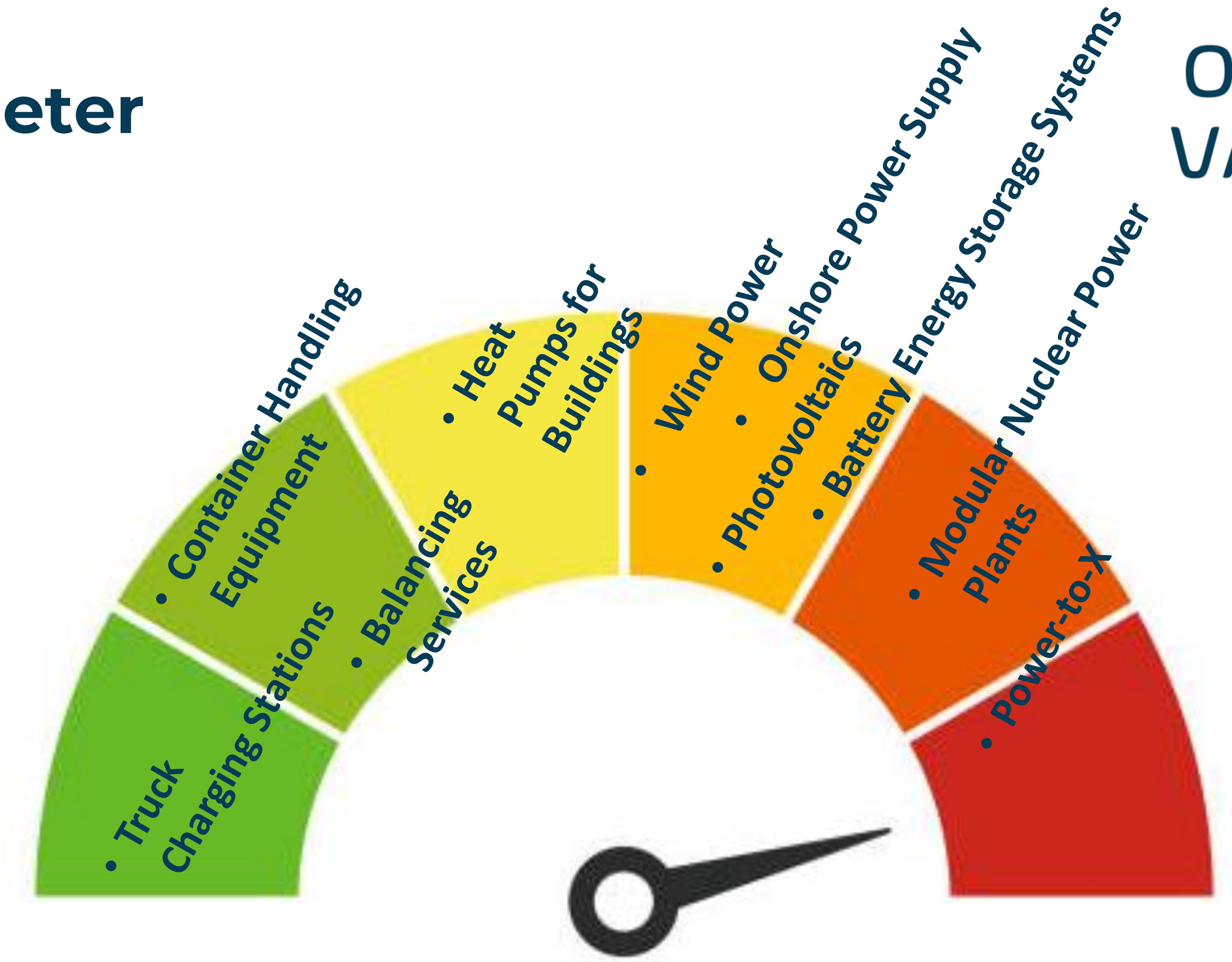
The Feasibility Barometer evaluate the potential feasibility of various e-projects critical for sustainable energy solutions.

In this assessment, we've categorized the projects into a spectrum of red, yellow, and green based on their feasibility across multiple parameters, defined on previous page. **Feasibility** here refers to the likelihood of successful implementation considering these parameters.



Prioritizing transformative and common projects

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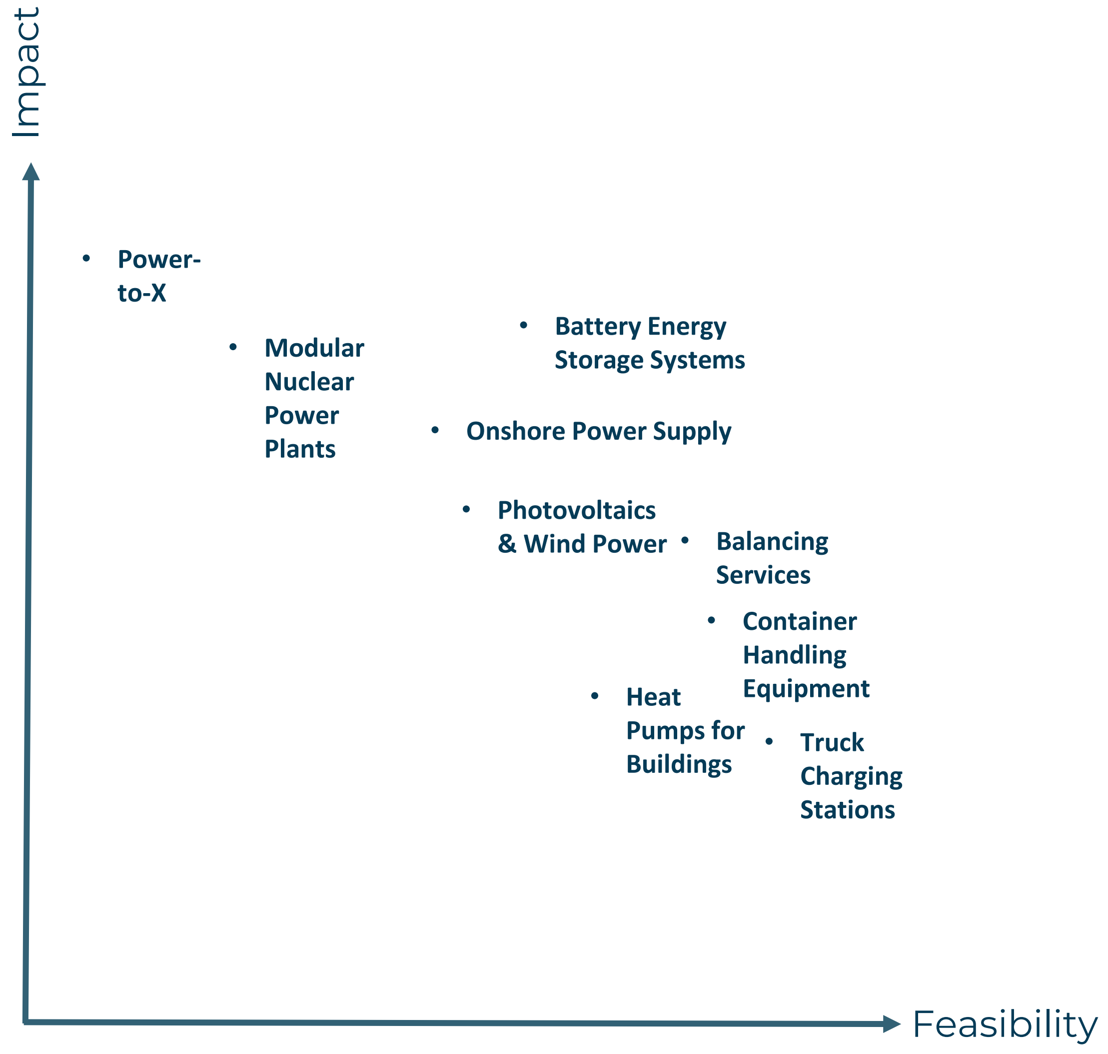
Summarizing all feasible criterions of the nine reviewed e-projects highlights **truck charging stations, container handling equipment** and **balancing services** as the most feasible projects. However, these e-projects also have the lowest individual impact on the green transition.

Projects with highest impact are the implementation of **power-to-x, modular nuclear power plants** and **battery energy storage systems**. These projects are also called 'transformative projects' on previous pages. However, implementation constraints reduce the likeliness of implementation in current regional context. If these projects should be implemented, it would be necessary to find ways of dealing with the identified constraints.



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Best electrical practices from other ports

A sample of inspirational cases to illustrate usecases and opportunities

Shore Power Systems (Cold Ironing):

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Port of Los Angeles, United States

The Port of Los Angeles has been a pioneer in implementing shore power infrastructure also referred to as AMP® (Alternative Maritime Power) back in 2004. It offers shore power connections at several terminals, enabling vessels to plug into the electrical grid and turn off their engines while berthed. Today, it offers 80 AMP vaults, more than any other port in the world

Port of Vancouver, Canada

In 2009, the Port of Vancouver became the first port in Canada – and the third port globally – to offer shore power for cruise ships at its Canada Place cruise terminal. Since then, the port authority has expanded its shore power facilities to the Centerm and Deltaport container terminals, preventing more than 30,000 tonnes of greenhouse gas emissions since 2009 – the equivalent of taking nearly 7,000 gasoline-powered cars off the road for one year. The port authority offers up to a 75% discount on harbour dues for shipping lines that use shore power

Energy Storage Solutions:

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Port of Rotterdam, Netherlands
The Port of Rotterdam has deployed energy storage solutions as part of its efforts to transition to sustainable energy sources. It has implemented battery storage systems to store excess renewable energy generated by wind and solar installations within the port area and has allocated 24 hectare for a conversion park that will convert green electricity from offshore wind farms into green hydrogen using electrolysis. Another 26 hectare has recently been purchased by Advario to develop a cutting-edge energy storage terminal in the port.

Port of Long Beach, United States
The Port of Long Beach has invested in energy storage projects to improve grid reliability and reduce peak demand. It has deployed battery energy storage systems to optimize energy usage and provide backup power during emergencies via microgrid and solar power.

Electrification of Port Equipment:

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Port of Gothenburg, Sweden

With the Tranzero Initiative, the Port of Gothenburg has electrified a significant portion of its port equipment, including cranes and straddle carriers.

It has replaced diesel-powered equipment with electric alternatives to reduce emissions and noise pollution.

Electric trucks are being granted priority passage and handling in the container terminal (operated by APM)

Port of Auckland, New Zealand

The Port of Auckland has initiated a program to electrify its vehicle fleet and port equipment. In 2021 it took the Worlds first electrical tugboat (70 tons bollard pull) into service and the port has introduced electric-powered forklifts, reach stackers, and yard tractors to minimize its environmental impact and promote sustainability.

Smart Grid Technologies

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Port of Hamburg, Germany

The Port of Hamburg has implemented smart grid technologies to optimize energy distribution and consumption within its facilities. It uses advanced metering systems, intelligent sensors, and automation solutions to monitor and control electricity usage in real-time.

With its SmartPORT energy project, Port of Hamburg aims to be the flagship port for renewable energy via three project pillars: renewable energies, energy efficiency and mobility concepts.

Port of Singapore

The Port of Singapore has deployed smart grid technologies as part of its efforts to enhance energy efficiency and reduce carbon emissions. It utilizes predictive analytics and machine learning algorithms to optimize energy management and identify areas for improvement.

The system is part of a smart grid management system, which also includes photovoltaic panels. Batteries will help balance the power grid load at the peak demand, which at the Pasir Panjang terminal is irregular.

The system will also be used partially for electricity storage and supply to the Singapore general power grid.

Conclusions

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- To continue the electrification of ports, it is relevant to implement both transformative and common electric projects, however it is important to assess project's impact and feasibility as all projects have different attributes.
- Common electric projects are low-hanging fruits based on the 10 feasibility parameters. These projects are to a wide extent already implemented but can be scaled even more.
- The most promising opportunities poised to reshape the port landscape and drive the electrification of future port operations are power-to-x, BESS, and modular nuclear power plants. The feasibility of each project is somewhat remarkable low implicating low implementation likeliness.
- Ports worldwide faces a multitude of overarching constraints challenging the attractiveness and feasibility of appealing and eco-friendly electrification projects.
- Collaboration and knowledge sharing between ports could accelerate the green transition of the maritime industry. All e-projects assessed in this presentation are either ready to be implemented or under continuous development before commercializing.