Environmental Sustainability in Ports
time to advance

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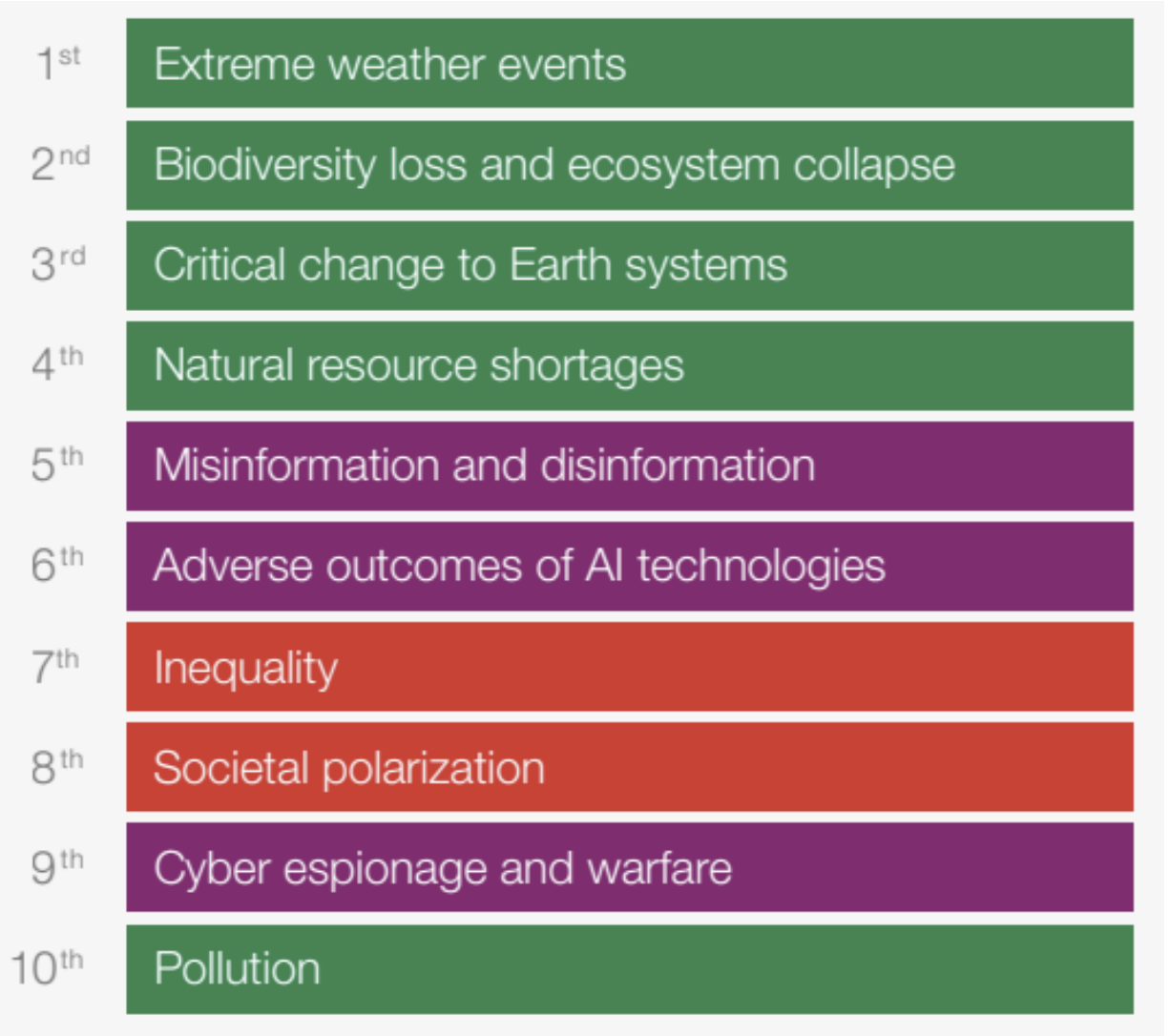
"Which of the following best characterizes your outlook for the world over the next decade?"

Top 10 Risks in terms of impact

10 years perspective



Source: World Economic Forum 2025, Global Risks Reports.
Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: water crises and rising income disparity were re-categorized first as societal risks and then as a trend in the 2015 and 2016 Global Risks Reports, respectively.

Why should we transition our port operations?

Image

Competitiveness

Risk management

Economic impact

Responsibility

Environmental Sustainability

Ports and the environment - main issues

- Climate change
  - The role of ports in contributing to decarbonization
  - Greenhouse gas emissions in ports
  - Mitigation measures
  - Adaptation measures
- Air quality
- Water
  - Water quality and pollution
  - Water consumption and footprint
- Noise and vibration pollution
- Light pollution
- Waste
- Land use management
- Dredging operations
- Biodiversity

SDGs and environmental priorities in ports

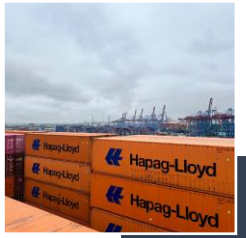
Environmental priorities and SDGs	3 GOOD HEALTH AND WELL-BEING	6 CLEAN WATER AND SANITATION	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION	14 LIFE BELOW WATER	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
air quality	●						●
climate change			●		●		●
community engagement				●			●
dredging operation		●			●	●	●
land use management				●			●
light pollution	●				●	●	●
noise and vibration pollution	●				●		●
ship and port waste	●	●		●	●	●	●
water		●		●		●	●

Source: own elaboration, based on https://unstats.un.org/sdgs/

The role of ports in contributing to decarbonization

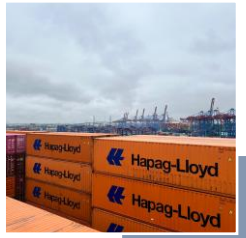
Port emissions

decarbonization of port operations



Maritime transport emissions

ports are critical to facilitating the decarbonization of the shipping industry by providing the necessary storage and supply infrastructure to provide green bunkering fuel to ships



National energy transition

ports are critical to facilitate the decarbonization of the national energy system by importing, exporting, or storing green energy sources, and/or having industry clustered in the vicinity of ports that help facilitate the energy transition

Main port stakeholder roles

Port Authority /Port Management Entity

A port authority

- a public or a private entity that operates at a port, regional port cluster or national level.
- empowered, under national law or regulation, to carry out the administration, development, management of the port land and infrastructure, and the coordination and control of port operation activities. U

The most common form is a local port authority, an authority administering only one single port area.

Port terminal operators

operate the terminal infrastructure and facilities and are responsible for the future planning of operations and capital investments in superstructures as part of the overall port infrastructure.

Port (maritime) foreland

Shipping lines, tramp service operators, and other port services providers, i.e., mooring and towage operators, pilotage, dredging.

Transport providers - Port hinterland

Inland transport providers, i.e., road, rail, and inland waterways logistics service providers and other operators that bring freight or passengers from and to the port. These include truck, rail and barge companies, or those operating pipelines.

Success of Mitigation measures – emission example

1. impacts of any mitigation measure should be evaluated in terms of the tons of CO2e reduced in comparison to the baseline year, and its contribution to the NDCs of the country and the overall global target of net-zero GHG emissions by 2050.

2. the efficiency of any mitigation effort should also be measured in terms of cost (investment) per ton of GHG emissions reduction.

   Should also account for positive effects on the overall operation affected (e.g., lower energy use and thereby lower operating costs), and the social cost of carbon.

   Over the medium and long term, a positive result should be expected, particularly as the valuation of the social cost of carbon will increase as climate change progresses.

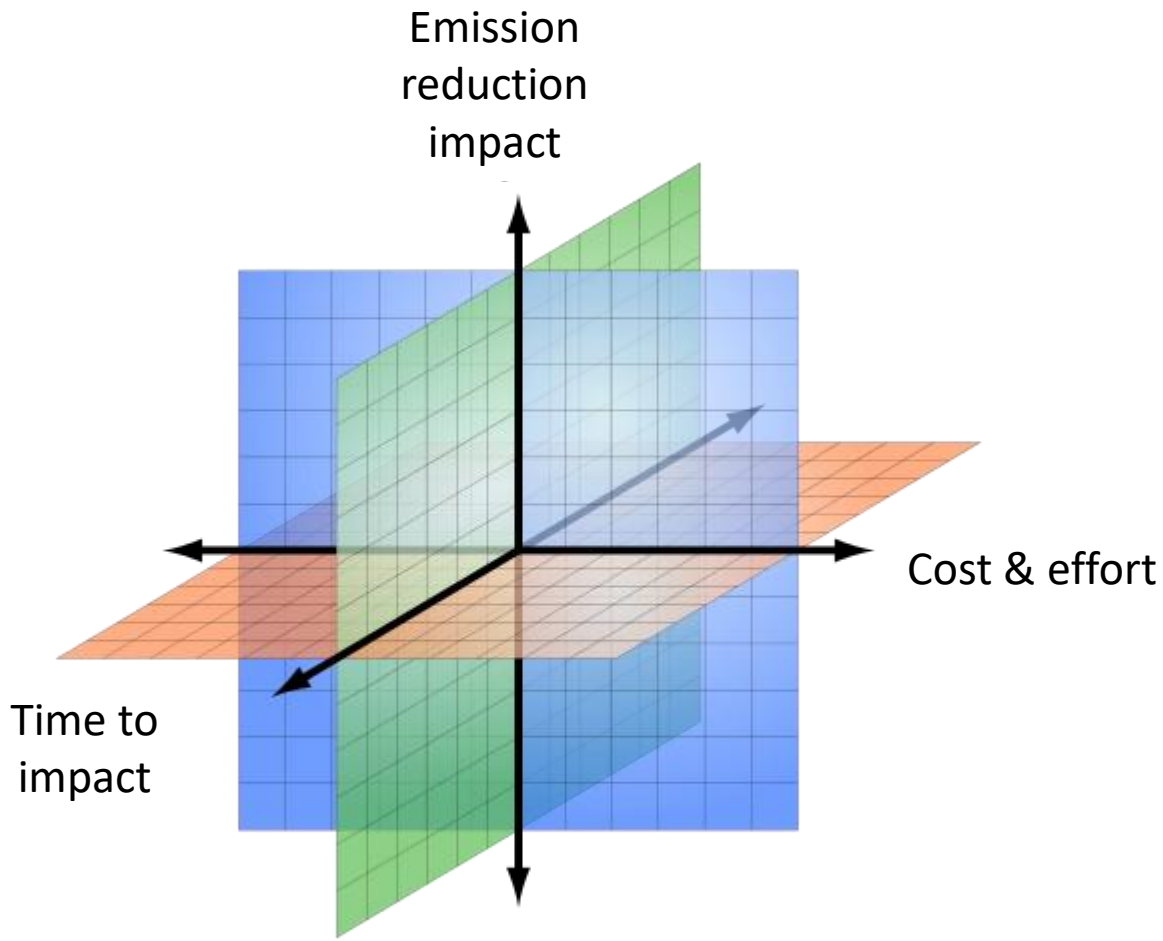
3. the efficiency of the mitigation action needs to be measured in terms of return of investment, which in most cases will determine the financial viability of the proposed solution.

The monetary value that society places on one tonne of carbon dioxide equivalent.
For details on the social cost of carbon see: https://www.brookings.edu/bpea-articles/the-social-cost-of-carbon/

Developing an effort impact matrix

Four impact categories:

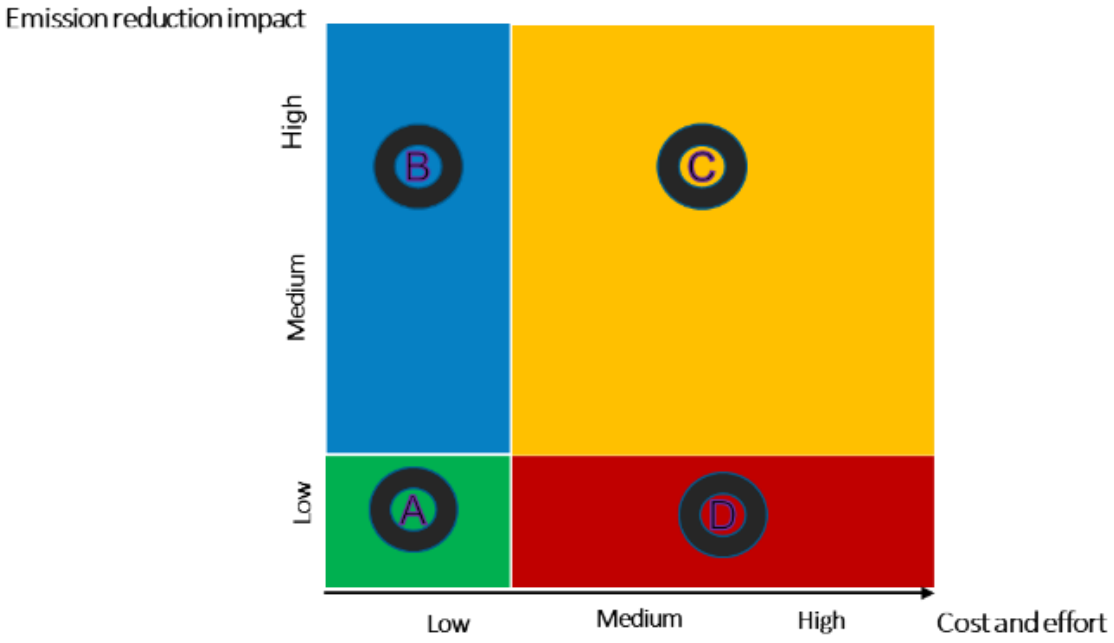
- A: Quick wins – low cost with limited emission reduction impact.
- B: Priority projects – yield the best return given relatively low costs and have a significant GHG emissions reduction impact.
- C: High-cost projects – provide significant GHG emission reductions but may be more complex and costly to execute.
- D: Hidden traps – medium and high cost and effort-consuming activities with low impact that should be managed carefully.



- **The first axis** depicts how much climate mitigation impact the measures will have in terms of GHG emissions reduction. Reduction in terms of percentages, from different studies, proposes the following classification. Any measure with a reduction of more than 20% (>20%) - high, between 10 and 20% (10-20%) – medium, less than 10% (<10%) - low.
- **The second axis** measures the cost to reduce one ton of CO_2e. This is based on the upfront capital expenditures and operating costs of the solution divided by the number of tons of CO_2e emissions reduced over the implementation period. The range of estimated cost/GHG emissions reduction is proposed as follows: low (less than 50 US$/ton CO_2); medium (50 -300 US$/ton CO_2); high (More than 300 US$/ton CO_2).
- **The third axis** is the implementation time required from taking the decision to the implementation, which will define the period until the impact becomes directly measurable. Three main categories are defined: short term - 1-2 years, medium term - 3-6 years, long term - > 6 years.

Source: Wilmsmeier et al. (2025)

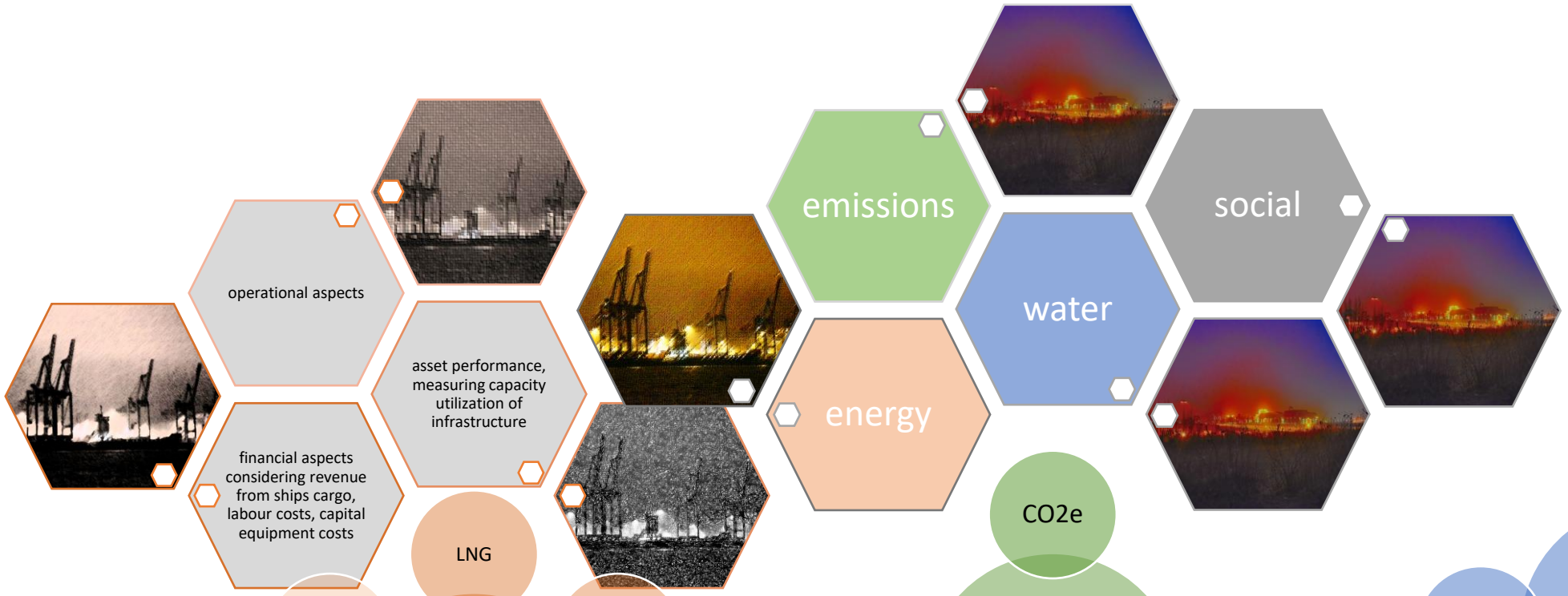
Effort matrix and time to impact of mitigation measures in ports.

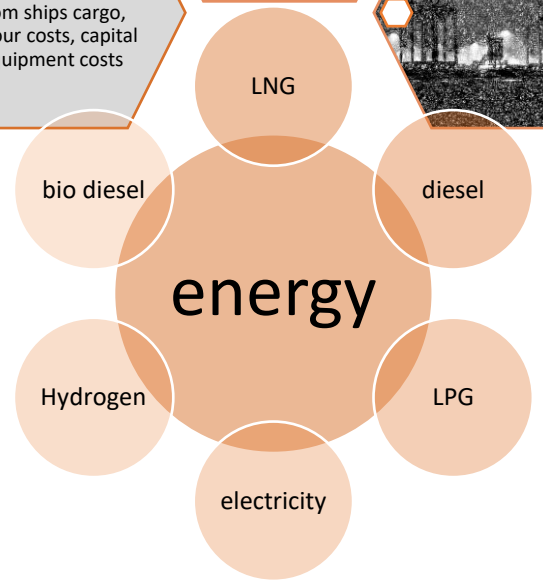


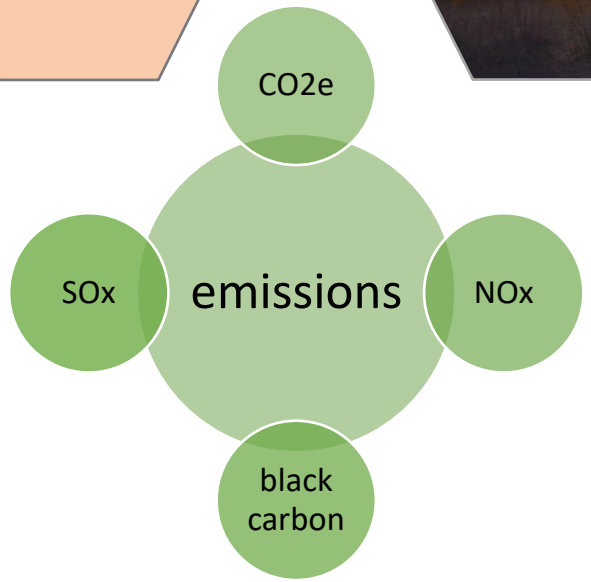
Source: Wilmsmeier et al. (2025)

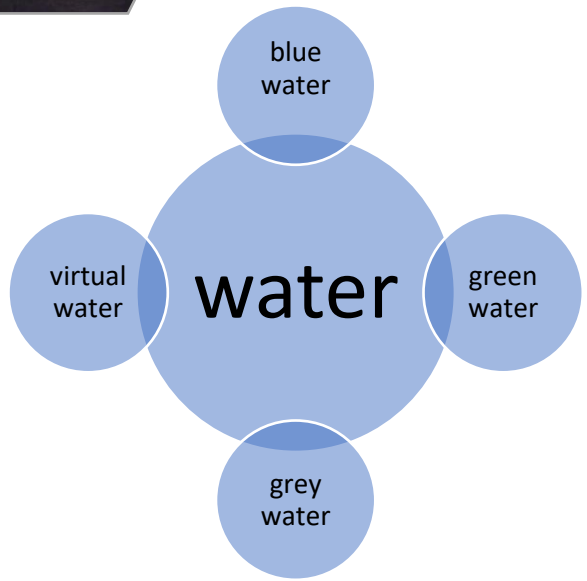
Measure	Matrix cat.	Time to impact
MMGS: Measure, monitor and goals setting	B	S
ECO: Eco-driving	B	S
FM: Fleet management	A	S
PGPD: Pricing green port dues	A	S
LEE: Low electricity lighting	A	S
SS: Slow steaming in port area	A	S
STD: program to implement international relevant standards	A/B	S
TTTEE: Technological transition terminal equipment (electric)	B	M
AG: Automate gates and appointment systems	D	M
OM: Operational measures (storage optimization in terminals)	D	M
GP: Green procurement strategies	A	M
PSM: Promote sustainable mobility and community awareness	B	M
RPDFF: Review port development of fossil fuel specialized terminals	C	M
CI: Onshore power supply or cold ironing	C	M
TTTEH: Technological transition technical equipment (hydrogen or other energy fuel)	C	L
TTT: Technological transition trucks (hydrogen)	C	L
TTBT: Technological transition barges and trains (electric)	C	L
DP: Dry Ports	C	L
MS: Modal Split	C	L
PE: Produce electricity	D	L
PAF: Provide / procure alternative fuels for port users	C	L

We need to work with a wider set of performance measures?









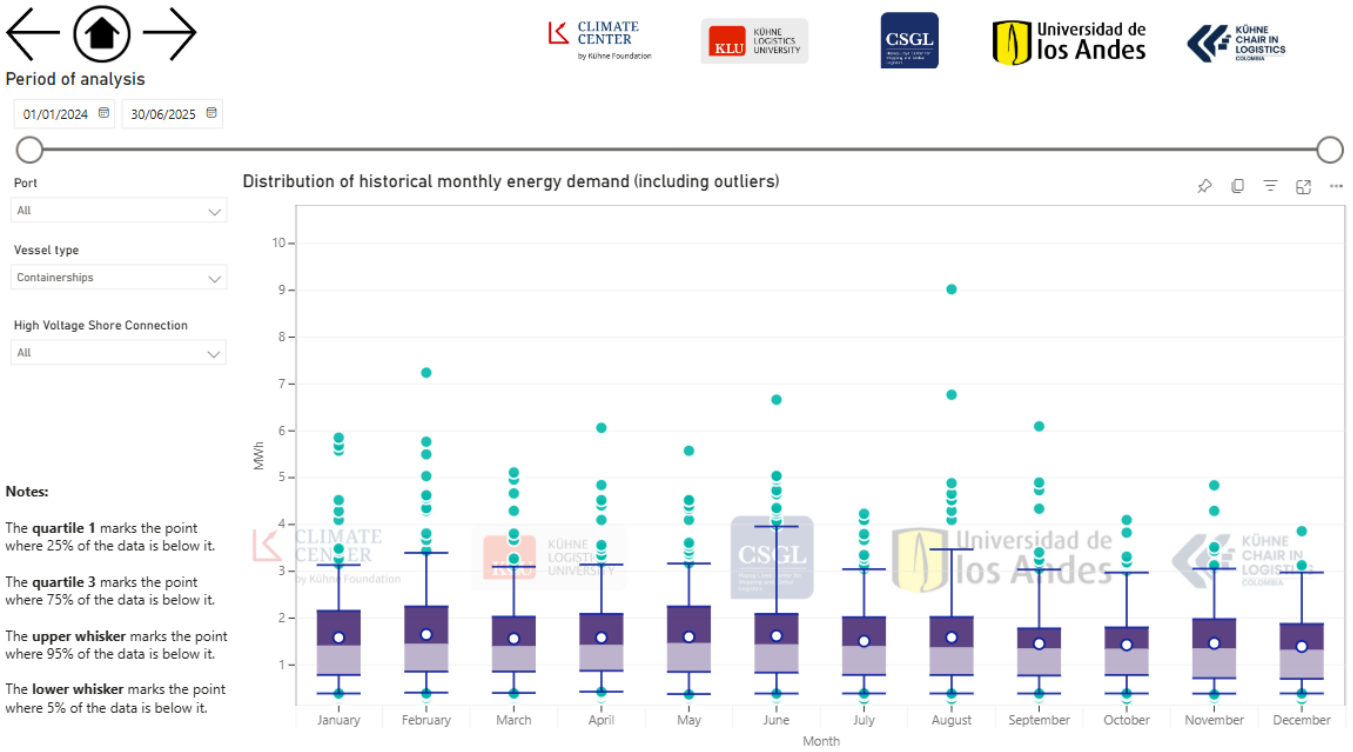
Example: Cartagena Port, Colombia

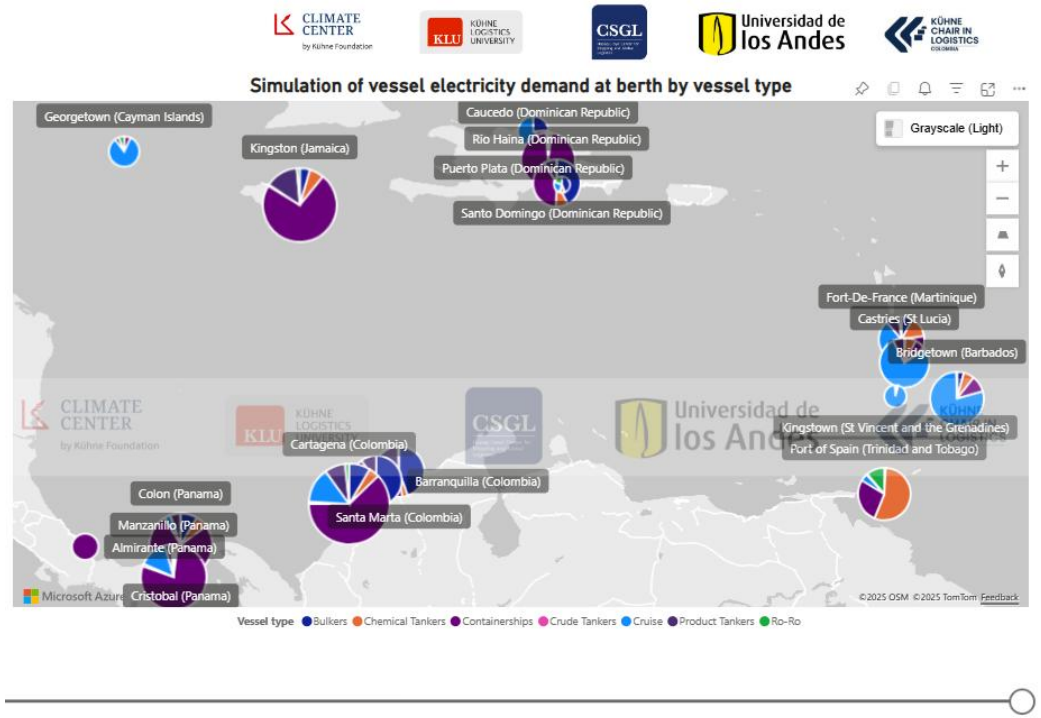
- The Port of Cartagena in the SPRC terminal implemented the electrification of RTG cranes to reduce not only fuel consumption and costs but also GHG emissions.
- Technological change:
  - Share of total diesel consumption of RTG cranes in the terminal from 53% (2015) to 29.1% (2022), equiv. to a reduction from 848 to 200.4 thousand gallons.
  - Electricity-powered RTG (e-RTG) cranes consumed 0.38 MWh (2015) and 2.3 MWh (2022), respectively.
  - Led to a net GHG emissions reduction from 4595 tons CO_{2e} to 2138 tons CO_{2e} (2022) from this type of equipment.
- The sustainability reports of the Port of Cartagena at terminal level have continuously improved over time and are an excellent reference for other terminals. Reports have been available online since 2014.

Example: OnShore Power Supply as an investment opportunity

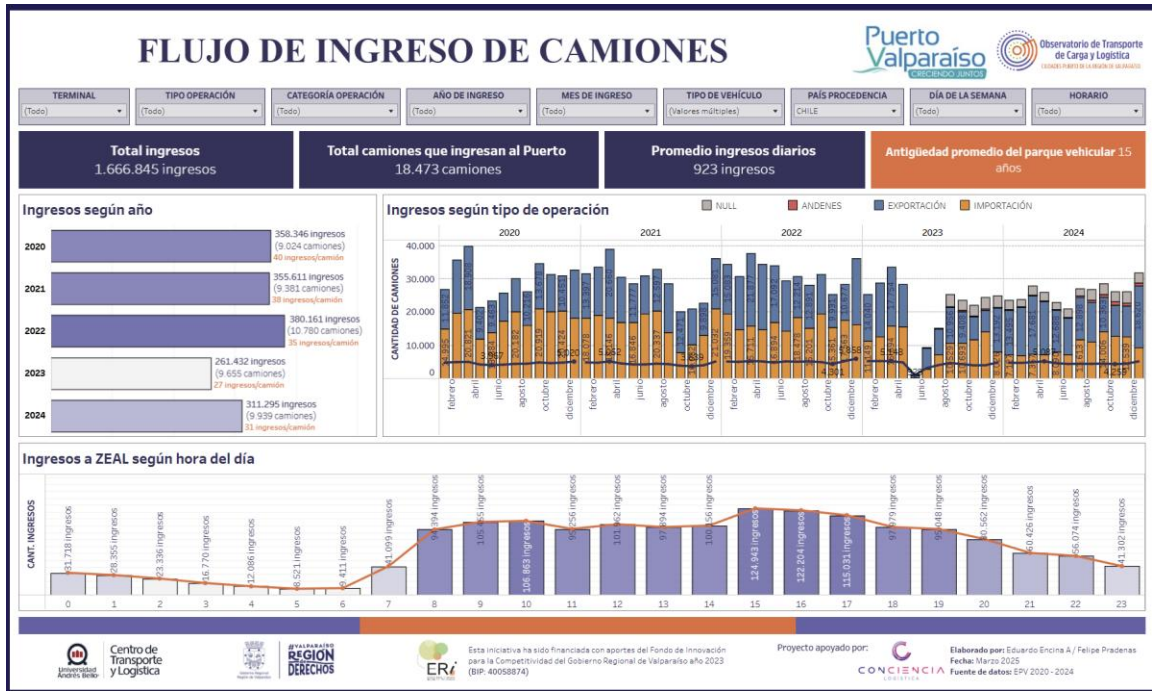
The *Onshore Power Supply Demand Simulator* enables ports and energy planners to analyze and optimize shore power demand, supporting the transition to cleane, emission-free port operations.

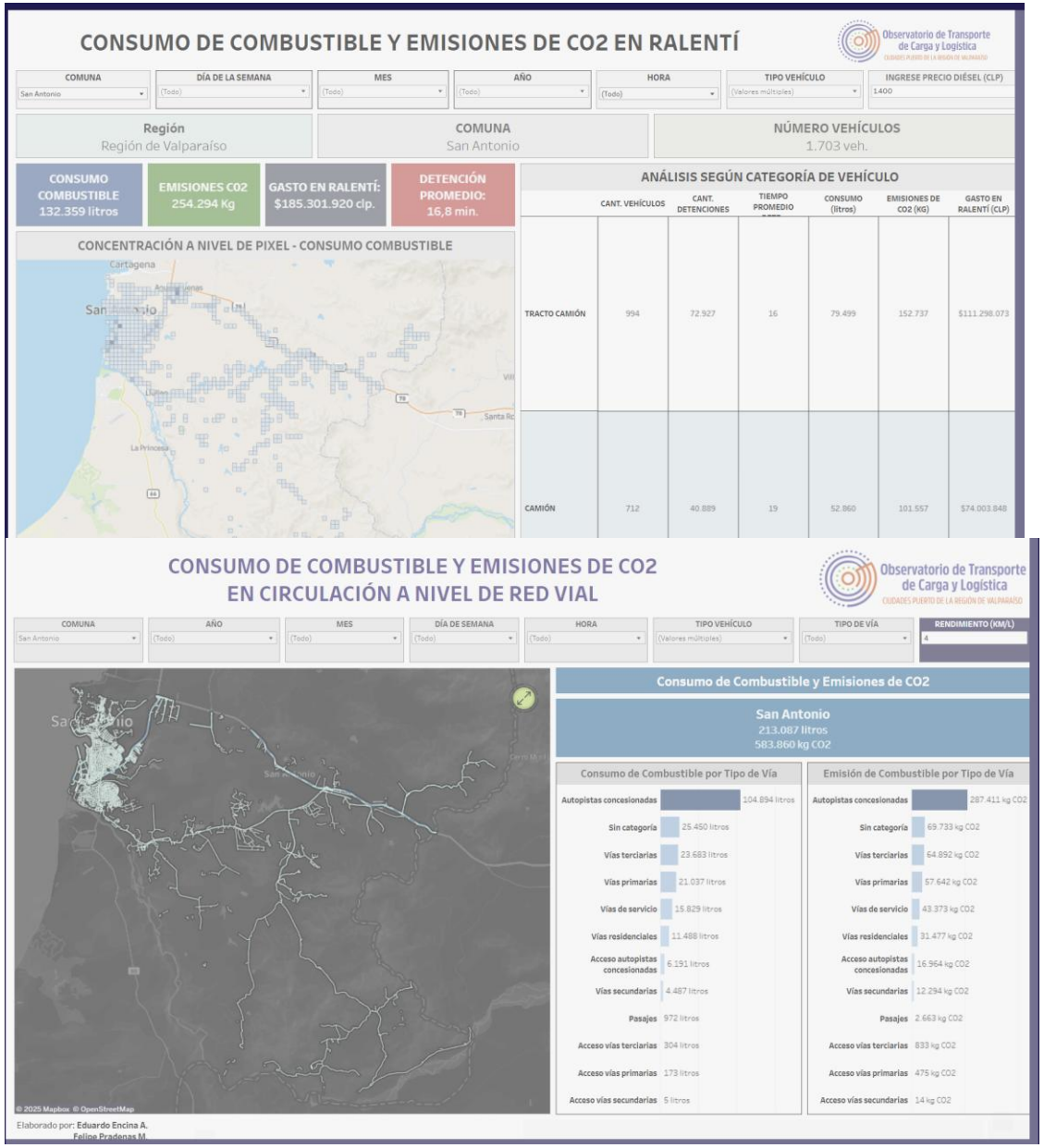
The simulator helps evaluate the impact of vessel electrification and identify effic ient power management strategies.





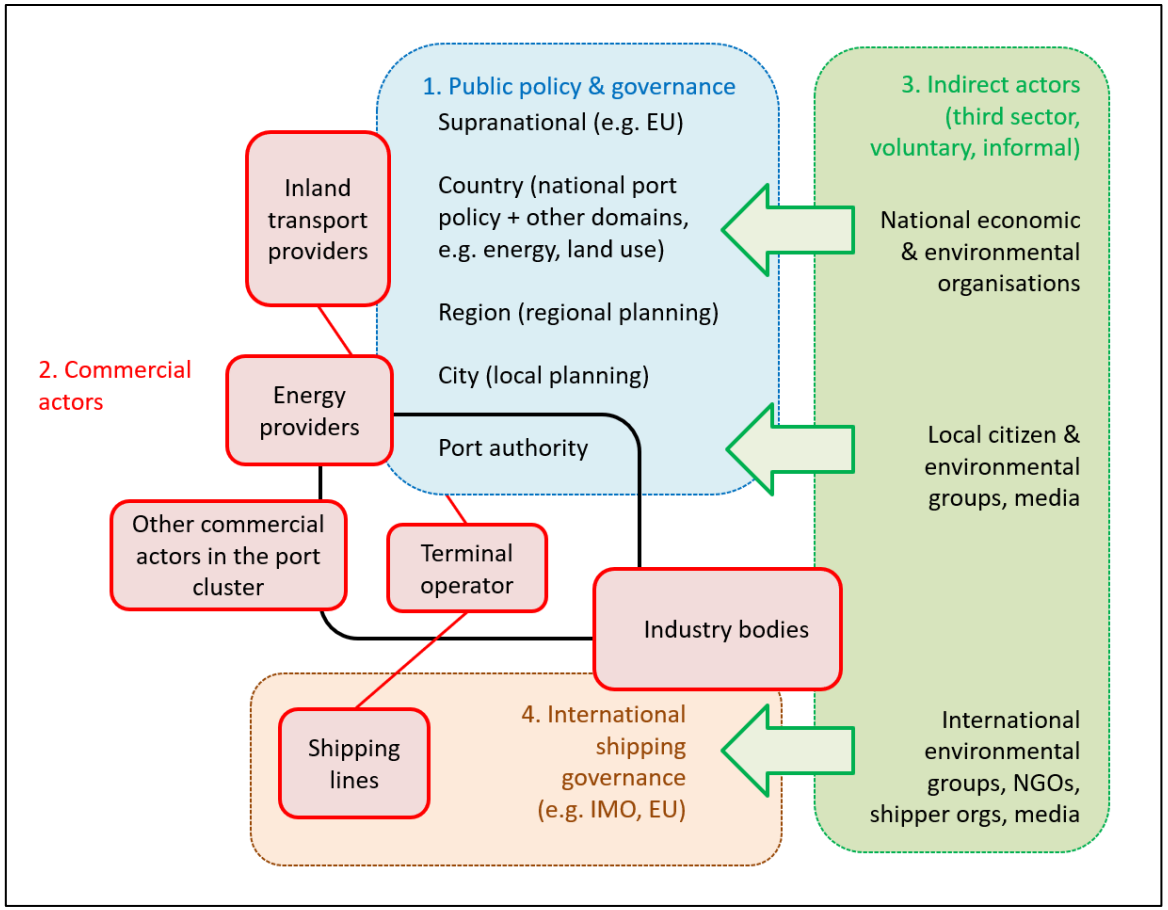
Example: Freight Transport and Logistics Observatory, Port Cities Valparaiso Region, Chile





Source: https://www.observatoriopuertos.cl/#inicio

A changing environment – key actor groups to drive environmental transitions in ports a port governance perspective



Sources: Monios, Wilmsmeier, Martinez & Pomaska, 2024

Let´s discuss...
What are our environmental strategy options?

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Recommended Material

Recent Publications:

- Monios, J., Wilmsmeier, G., Martínez Tello, G., Pomaska. L. 2024. *A new conception of port governance under climate change*. https://www.sciencedirect.com/science/article/pii/S0966692324001972

- World Bank (2025) *Port Reform Toolkit : Module 8 - Environmental Sustainability (English).* Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/099073025114570099

- Kerstin Dobers, K.,Perotti, S, Wilmsmeier, G., Mauer, G., Jarmer, J.J., Spaggiari, L., Hering, M., Romano, S., Skalski, M. 2023. Sustainable logistics hubs: greenhouse gas emissions as one sustainability key performance indicator. Transportation Research Procedia. https://www.sciencedirect.com/science/article/pii/S2352146523008700

- Spengler, T., Wilmsmeier, G. 2019. Chapter 7 - Sustainable Performance and Benchmarking in Container Terminals—The Energy Dimension. In: Green Ports. https://www.sciencedirect.com/science/chapter/edited-volume/abs/pii/B9780128140543000074 (institutional access)

Tools:

- Port and shipping activity in Latin America: https://nexusenergiamovilidad.uniandes.edu.co/dashboardses/

- Freight Transport and Logistics Observatory – port citis in the Valparaiso Region, Chile: https://www.observatoriopuertos.cl/