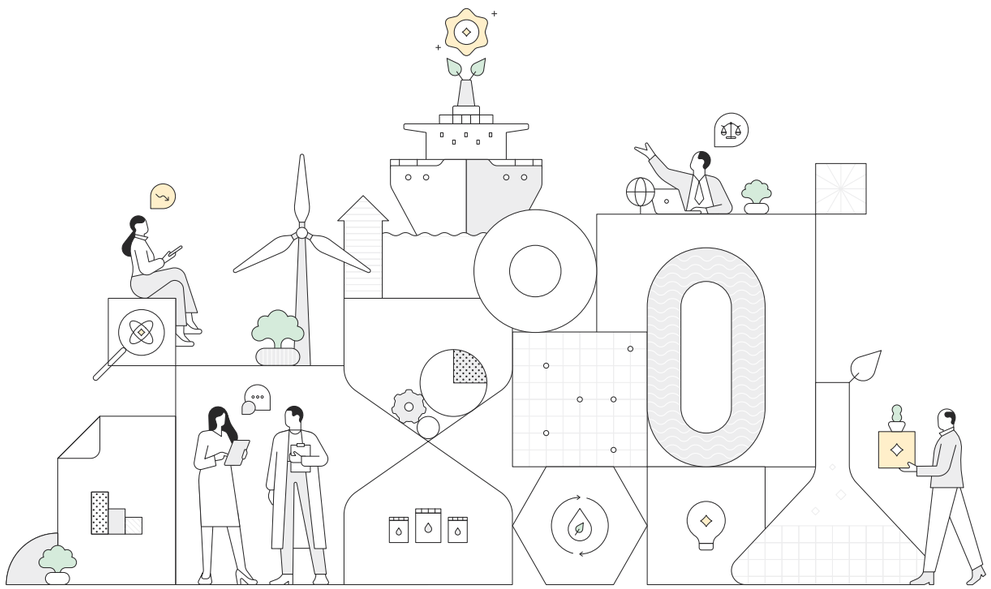
Navigating the Green Transition: First Steps for Ports

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Contents



Executive Summary

The International Maritime Organization has set an ambitious target for the shipping industry to achieve net-zero greenhouse gas emissions by 2050, necessitating a complete decarbonization of the sector. While much of the initial focus has been on improving vessel efficiency and transitioning to alternative fuels, ports will provide a crucial link between vessels and alternative fuel supplies.

This report explores which ports are best positioned to be first movers in bunkering alternative fuels and how ports can position themselves advantageously in the transition.

Our analysis reveals that ports specializing in handling chemicals—referred to as "chemical ports"—are better positioned to transition to alternative fuels compared to ports with specialized cargo, such as containers. This is due to their existing infrastructure and expertise in managing hazardous substances, which reduces the additional effort required to handle alternative fuels. Conversely, container ports, while commercially significant, face challenges such as proximity to urban areas and limited experience with chemical handling, making the transition to alternative fuels more complex.

To identify ports most suited for early adoption of alternative fuels, we employ the Chemical Port Score (CPS), a metric that rates a port's chemical handling capabilities based on its infrastructure and operations involving chemicals like ammonia, methanol, liquefied petroleum gas (LPG), and liquefied natural gas (LNG). In addition to CPS, the report discusses the Port Readiness Level (PRL) framework, which assesses a port's preparedness for bunkering alternative fuels. Combining CPS and PRL scores allows for a nuanced understanding of a port's readiness for the green transition, guiding strategic decisions and resource allocation for ports aiming to become part of green corridors.

Given the critical role ports will play in the maritime industry's decarbonization, it is imperative that ports assess their CPS and PRL to gauge their readiness and identify areas needing improvement. Chemical ports, with their inherent advantages, should capitalize on their position as potential first movers by engaging actively in green corridor projects and other decarbonization initiatives. Ports with lower CPS and PRL scores must recognize the challenges ahead but should also begin preparing for the transition by enhancing their infrastructure and capabilities to handle alternative fuels.

01 Introduction

The International Maritime Organization has now set a target to reduce greenhouse gas emissions from the shipping industry to net zero by 2050.[1] As a result, the whole industry must decarbonize. Although so far much of the attention on reducing emissions has been focused on improving vessel efficiency and switching to alternative fuels, ports will play a key role as they provide the link between fuel supply chains and vessels. Ports are also increasingly becoming aware of their position in the transition and have started investigating:

Are there some ports that will find transitioning easier than others and why?

What can ports do to place themselves favorably in the emerging landscape of alternative fuels and support the acceleration of the transition?

In this report, we attempt to answer these questions using key insights gained through the work on green corridors conducted at the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS). Furthermore, we provide guidance on the critical first steps for ports in the green transition.
The term 'port' is used broadly in this context and acknowledges the various stakeholders involved, including port authorities, operators, owners, landlords, and others. Each of these decision-makers plays a vital role in accelerating the green transition.

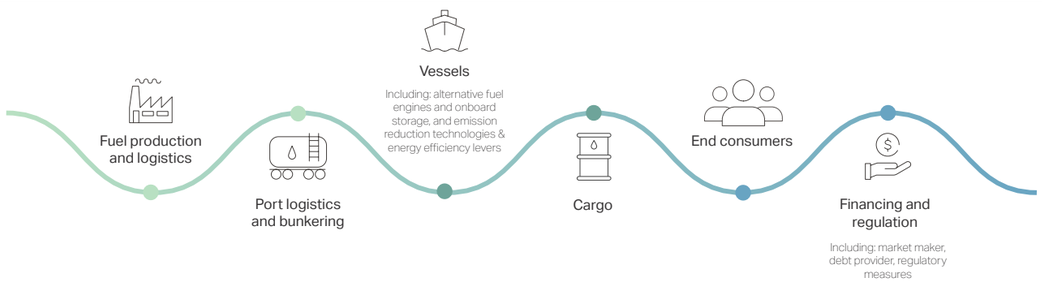
1.1. Green corridors through an MMMCZCS lens

Green corridors came into prominence after the Clydebank Declaration was signed at COP26.[2] There are several definitions of green corridors.[2,3,4] The MMMCZCS methodology[6] describes a green corridor as "the commercial deployment of a specific low/zero emission fuel on a specific number of vessels on a dedicated route, being single point, point-to-point or network".

Today there are more than 50 announced green corridor projects worldwide.[7] MMMCZCS is currently involved in around 15 green corridor projects at different maturation stages of both pre-feasibility and feasibility (Figure 1), and the project portfolio covers multiple alternative fuels, vessel segments and geographies. The MMMCZCS's work through these projects has provided a unique insight into the roles of the various players along the entire value chain (Figure 2).

Figure 1: Green corridors projects where MMMCZCS is involved.

Figure 2: Green shipping corridors involve the entire value chain.

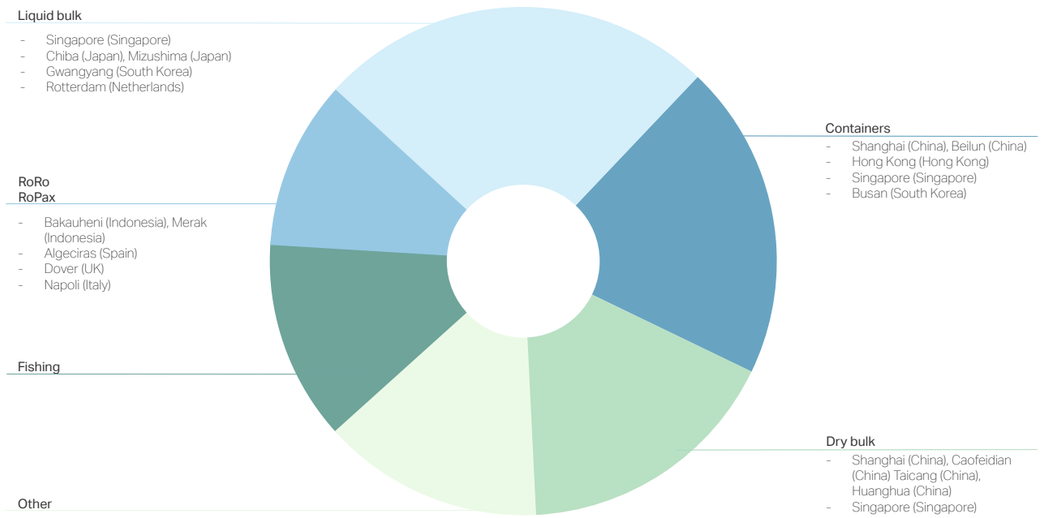


02 Which port segments could be first movers?

In decarbonization initiatives, there is often a strong focus on container routes and ports with large container handling capacity. However, when looking at the relative share of emissions from different vessel segments, the container segment does not stand out. In fact, the dry and liquid bulk segments account for similar shares of industry emissions (Figure 3).

The largest ports based on number of port calls for each of the segments are listed in Figure 3. This illustrates that a variety of ports will play an important role in the green transition. As a result, identifying which ports should be first movers in the green transition requires a more nuanced approach.

Figure 3: Relative share of CO_2 emissions from vessel segments in 2024 [8, 9] and the top 5 ports for each vessel segments based on port calls.[10] (Main ports for other and fishing are not included in this study).



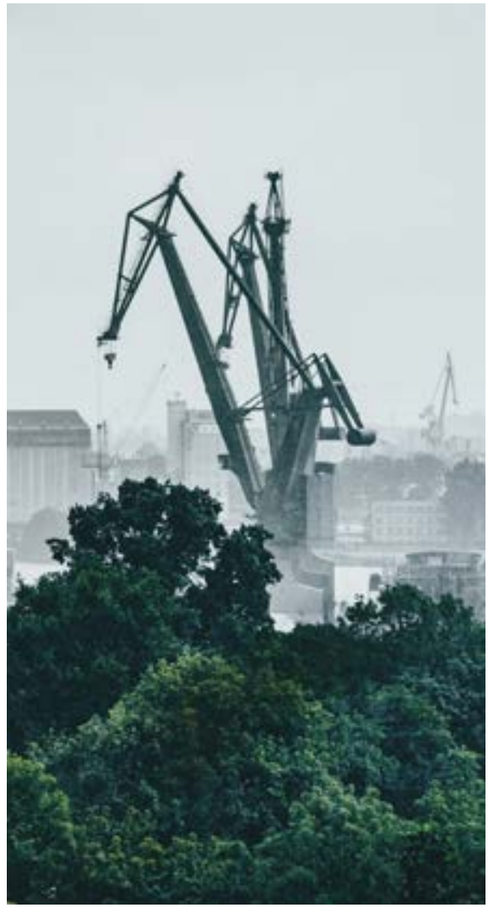
RoRo= roll-on roll-off, RoPax= roll-on/roll off and passenger

Ports are frequently ranked in reports and literature according to their container handling capabilities. Large container ports, typically developed around major cities or vice versa, often serve as commercial hubs connected to companies transporting and owning goods along busy shipping routes, making them obvious choices for green corridors. However, their proximity to urban areas can pose challenges when considering the storage and bunkering of alternative fuels. Examples of container ports include Shanghai (China), Busan (South Korea), Singapore (Singapore), Long Beach (US), and Yokohama (Japan).

While container ports play a significant role in decarbonization discussions due to their commercial importance and large decarbonization potential, other port segments are better placed to participate in green corridors and lead the transition to alternative fuels. As a result, ports leading the transition are typically not high-volume container handlers. Instead, early adopters are typically 'chemical ports' capable of handling alternative fuels and their derivatives, including ammonia, methanol, LPG, and/or sulfuric acid, often in large quantities. Located near chemical production plants like refineries and not major cities, these ports are well-equipped to manage the safety, permitting, and training requirements associated with chemicals, making the transition to handling alternative fuels easier. Furthermore, ports with existing LNG bunkering facilities can further streamline their transition. This makes the chemical ports favorable candidates for first movers in decarbonization and green corridors. However, a challenge for these ports in green corridors is their connection to the commercial companies transporting and owning the goods. Examples of chemical ports from the MMMCZCS green corridor work include Ulsan (South Korea), Mejillones (Chile), Gothenburg (Sweden) and Antwerp (Belgium).

Looking beyond established chemical ports, the green transition is also fostering the growth of emerging ports located near renewable energy sources. These ports could become new bunkering hubs, if the industry shifts from transporting fuel to centralized large hubs to bunkering close to production sites, thus reducing fuel waste. However, emerging ports face challenges due to their limited experience in handling chemicals and fuels, and limited commercial activity. Additionally, they often lack the necessary infrastructure or water depth to function as a bunkering hub. Examples of emerging ports from the MMMCZCS green corridor work include Lüderitz (Namibia), Batangas (Philippines) and Tan Tan (Morocco).

Overall, our analyses reveal that chemical ports are uniquely positioned to transition to alternative fuels compared to other port types.



03 Rating chemical handling capabilities

Although chemical ports are the best candidates for leading the transition to alternative fuels, they can vary in their facilities and abilities. Due to the limited number of chemical ports involved in green corridors so far, there is insufficient data to design a sophisticated model assessing how well a port handles chemical substances. However, we have developed a straightforward 'Chemical Port Score' (CPS) that rates a port's chemical handling capabilities on a scale ranging from 0 to 1.

Equation 1: Chemical Port Score (CPS).

$$CPS = \frac{1}{3} \times NH_3 + \frac{1}{3} \times CH_3OH + \frac{1}{6} \times LPG\&Chem + \frac{1}{6} \times LNG$$

Where:

- NH_3 denotes if a port has an ammonia importing and/or exporting terminal
- CH_3OH denotes if a port has a methanol importing and/or exporting terminal
- LPG&Chem denotes if a port can handle chemical substances*
- LNG denotes if a port has an LNG terminal

*This was calculated using Automatic Identification System (AIS) data identifying instances of LPG/Chemical tanker visits to a port and where the vessel remained at the port for a duration exceeding 10 hours.

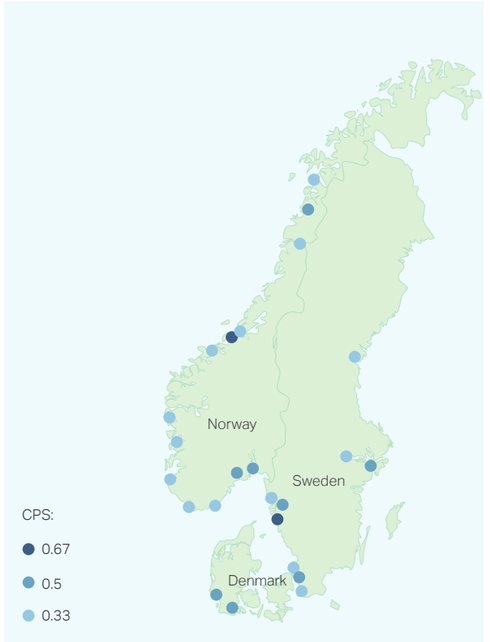
We deployed the CPS on approximately 20,000 ports in Rystad Energy's Port Database[11], using available AIS data and reported storage and bunkering capabilities. The port list has not been reviewed in detail, and hence may contain minor discrepancies. Eight of the 20,000 ports analyzed stood out with a maximum score of 1 (Figure 5): Nanjing (China), Bintulu (Malaysia), Singapore (Singapore), Newcastle (Australia), Algeciras (Spain), Antwerp (Belgium), Hamburg (Germany), and Rotterdam (Netherlands). A total of 221 ports have a CPS of 0.48 or better. This data does not say that certain types of ports cannot be greener ports, but it does indicate which ports are most likely to find the transition easier.

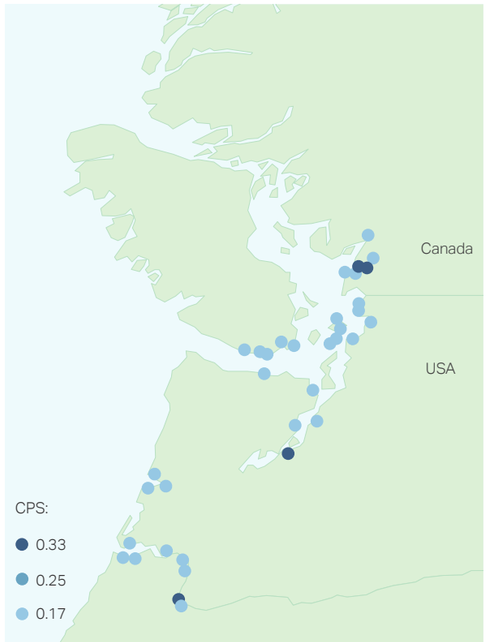
It is not surprising that multiple ports have the same CPS as it uses a simple equation. To further distinguish among the ports, we used the population density in the port as a secondary separator as, when all other factors are equal, a low-population port will be more optimal as a future bunker hub than a port with a high population.

The CPS can be used to identify likely candidates for first moving green ports within regions or countries. For example, in Norway, Sweden and Denmark, CPS calculations make it clear that ports like Gothenburg (Sweden), Porsgrunn (Norway) and Hirtshals (Denmark) are more likely to find the transition to alternative fuels easier than the more traditional container ports (Figure 5a). It should be noted that Gothenburg is both a chemical and container port. Similarly, Tacoma (US) and Vancouver (Canada) have higher CPS than the other ports on the Northwest Coast of North America (Figure 5b).

Figure 4: Ports with a CPS score of 1 (large dot) and 0.8 (small dot).[11]

Figure 5a & 5b: CPS used to screen at a regional level.[11]





CPS = Chemical Port Score

04 Evaluating port readiness for alternative fuels

In addition to varying chemical handling capabilities, ports have varying readiness levels for alternative fuels. To determine and track readiness, the ports of the World Ports Climate Action Program (WPCAP) under the International Association of Ports and Harbors (IAHP) have outlined a port readiness level (PRL) assessment,[12] which outlines the tasks required to prepare a port to bunker an alternative fuel (Figure 6).

This guideline builds on the experience from several ports when introducing LNG as a bunkering option, as well as recently acquired insight by the ports. The guideline is a useful starting point. However, it must not be seen as a final list for the work that needs to be done, as local and regional authorities may have additional requirements.

Figure 6: PRL for marine fuels as defined by IAHP and WPCAP.[12]

		Call of target-fueled vessels	Bunkering of target fuel
PRL- MF 9	Deployment	Market penetration and growth for calls of target-fueled vessels	Market penetration and growth for bunkering of target fuel
PRL- MF 8		Full capabilities for calls of target-fueled vessels	Full capabilities for bunkering of target fuel
PRL- MF 7		Calls of target-fueled vessels established on a project basis	Bunkering of target fuel established on a project basis
PRL- MF 6	Development	Pilot-scale demonstration of call of call of target-fueled vessel	Pilot-scale demonstration of bunkering of target fuel
PRL- MF 5		Framework for calls of target-fueled vessels implemented and tested	Framework for bunkering of target fuel implemented and tested
PRL- MF 4		Framework for call of target-fueled vessels drafted, timeline developed	Framework for bunkering of target fuel drafted, timeline developed
PRL- MF 3	Research	Detailed research, analysis and conclusions	
PRL- MF 2		Stakeholder interests and feasibility assessment	
PRL- MF 1		Foundational background information	

PRL-MF = Port Readiness Level for Marine Fuels, IAHP = International Association of Ports and Harbors, WPCAP = World Ports Climate Action Program.

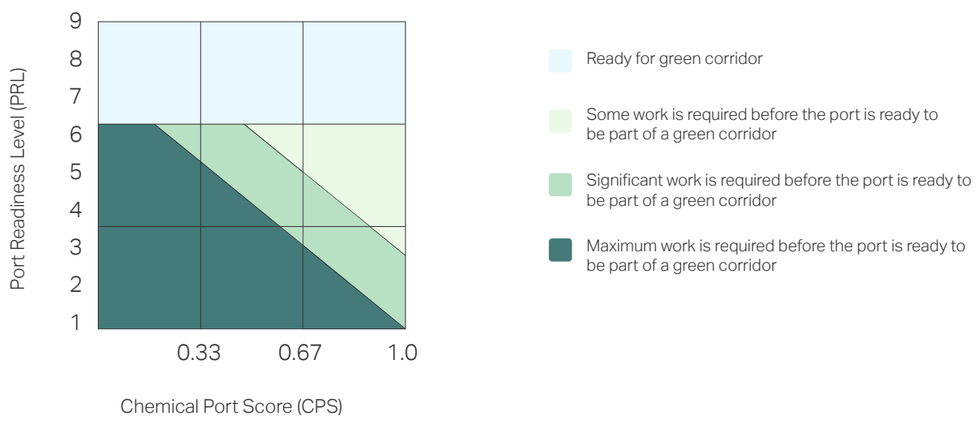
05 Ports in green corridors

One way for ports to get involved in maritime decarbonization is through green corridors. As mentioned above, large container ports are currently over-represented in the announced green corridor projects.[7] Although these ports are important for the decarbonization of the industry due to their high activity, other ports are equally important because they are likely to be candidates for initiating the first green corridors.

The CPS and the PRL describe elements of effort required for ports to store and handle alternative fuels and can be used together to identify ports that may be well suited to green corridors. The CPS and the PRL of a port can be plotted in the matrix shown in Figure 7 to determine the ease of transition to alternative fuels.

The ease of transition matrix should only be seen as a guide, and the actual amount of work should be determined for the specific case. As shown by the matrix, ports with a high CPS will most likely find it easier to participate in early phases in green corridors and mature them to implementation. However, this should not exclude ports with a lower CPS from participating in green corridor projects. It simply suggests that more work is needed for the port to go through the individual project phases, and this insight will be important when allocating manpower and financial resources to the green corridor work.

Figure 7: Ease of port transition based on CPS and PRL.

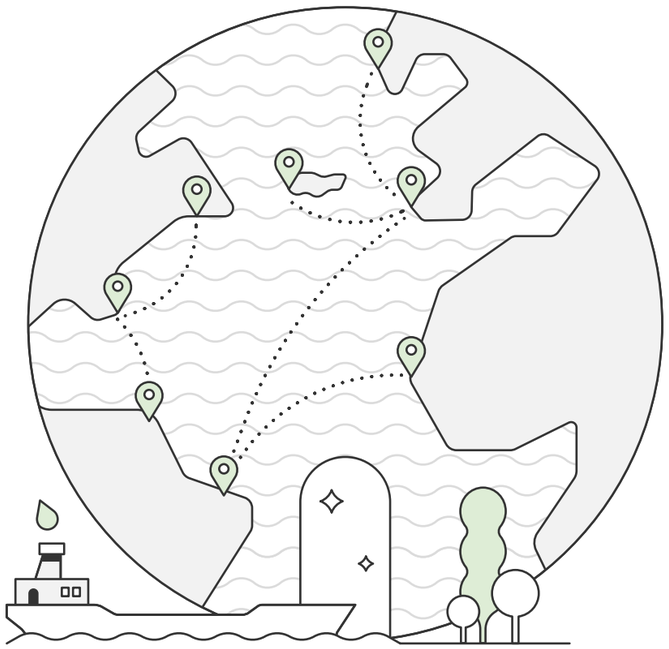


06 Conclusions and next steps for ports

The transition to net-zero greenhouse gas emissions by 2050 necessitates a comprehensive shift within the shipping industry. As outlined in this report, ports will play a pivotal role in this transformation, acting as the critical link between alternative fuel supply chains and vessels.

While container ports have been the focus of many of the announced green corridors and other decarbonization initiatives so far, our analyses show that ports specializing in chemical handling are uniquely positioned to lead the transition to alternative fuels. Their existing infrastructure and expertise in handling chemicals make them prime candidates for early adoption of new fuel types. As a result, chemical ports should capitalize on their position as potential first movers and actively seek to get involved in decarbonization projects such as green corridors. Other ports should also prepare for the green transition, knowing that it may take more effort but can and must be done

Ports who are aiming to participate in green corridor projects should assess their CPS and PRL to determine their readiness. For ports that are not taking part in green corridor projects CPS and PRL assessments can still help them build an understanding of the efforts that will be required for the transition and should be a critical element of any port transition roadmap or strategy.



07 References

1. 2023 IMO Strategy on Reduction of GHG Emissions from Ships, International Maritime Organization, 2023

2. Canada joined the Clydebank Declaration at the 26th Conference of Parties to the UN Framework Convention on Climate Change | Department of Economic and Social Affairs. Clydebank Declaration signed at COP26, 2021

3. Green Corridors, Global Maritime Forum, 2021

4. Key considerations for establishing a green shipping corridor, DNV Maritime Impact, 2024

5. Discovering the benefits of green shipping corridors, Admiralty, 2024

6. New guide provides approach to designing and demonstrating the feasibility of green corridors | Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, MMMCZCS, 2024

7. Green Shipping Corridor Route Tracker - Mission Innovation (mission-innovation.net), Mission Innovation, 2024

8. CO_2 data: Calculations by Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, April 2024. Original data from Fourth Greenhouse Gas Study 2020 (imo.org), International Maritime Organization, 2020

9. CO_2 data for fishing: Calculations by MMMCZCCS, April 2024. Original data from Energy transition of fishing fleets: Opportunities and challenges for developing countries | UNCTAD, UN Conference on Trade and Development, 2024

10. Port data: Sea, April 2024

11. Rystad Database, April 2024

12. Port Readiness Level For Marine Fuels (PRL-MF), International Association of Ports and Harbors, 2023

08 The project team

This report was prepared by the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) with assistance from our partners.

Lead authors: Gitte Livbjerg (MMMCZCS), Johan Byskov Svendsen (MMMCZCS).

Editors: Asha Mahadevan (MMMCZCS), Emily Nordvang (MMMCZCS).

Design: Julia Garbowska (MMMCZCS).

Front page photo courtesy of Martijn Coopman of the Port of Rotterdam.

09 Appendices

Figure A: 27 ports in North America have a CPS of 0.5 or above. Reference: Port data by Rystad Energy.

Figure B: 17 ports in South America have a CPS of 0.5 or above. Reference: Port data by Rystad Energy.

Figure C: 23 ports in Oceania have a CPS of 0.5 or above. Reference: Port data by Rystad Energy.

Figure D: 59 ports in Asia have a CPS of 0.5 or above. Reference: Port data by Rystad Energy.

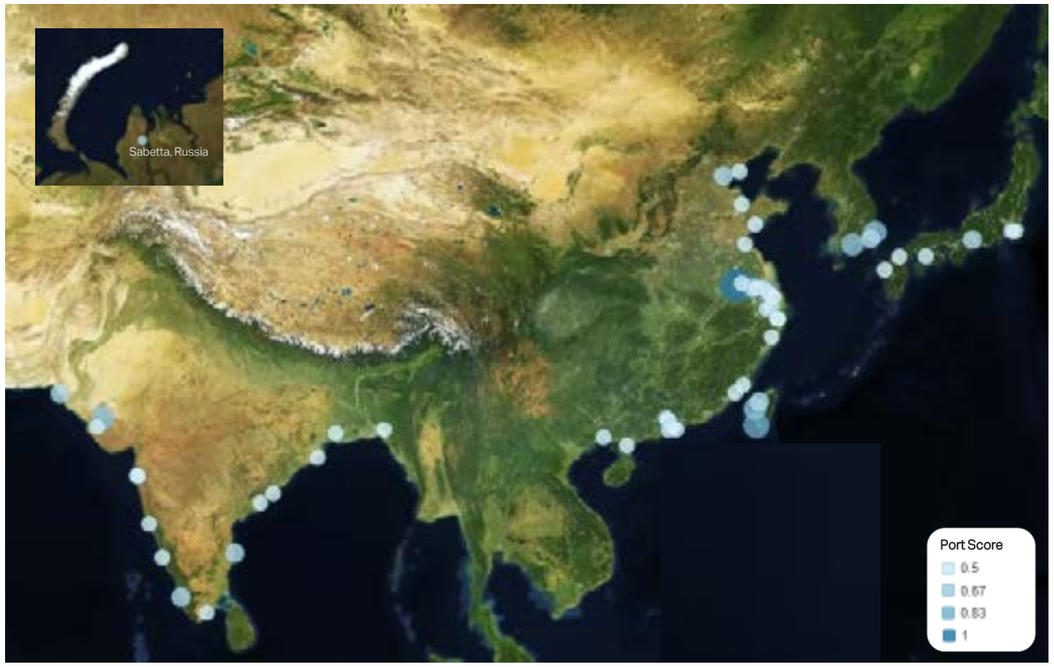


Figure E: 36 ports in Africa and the Middle East have a CPS of 0.5 or above. Reference: Port data by Rystad Energy.

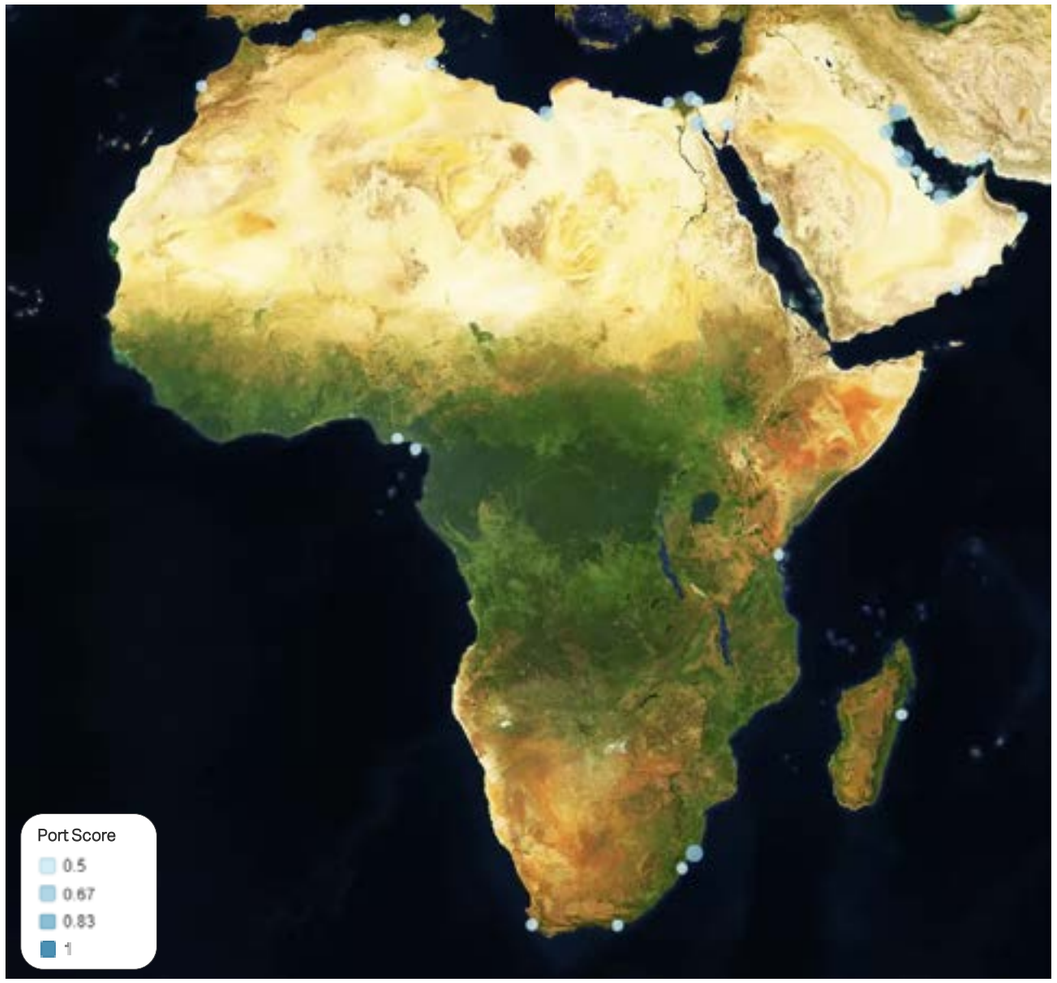
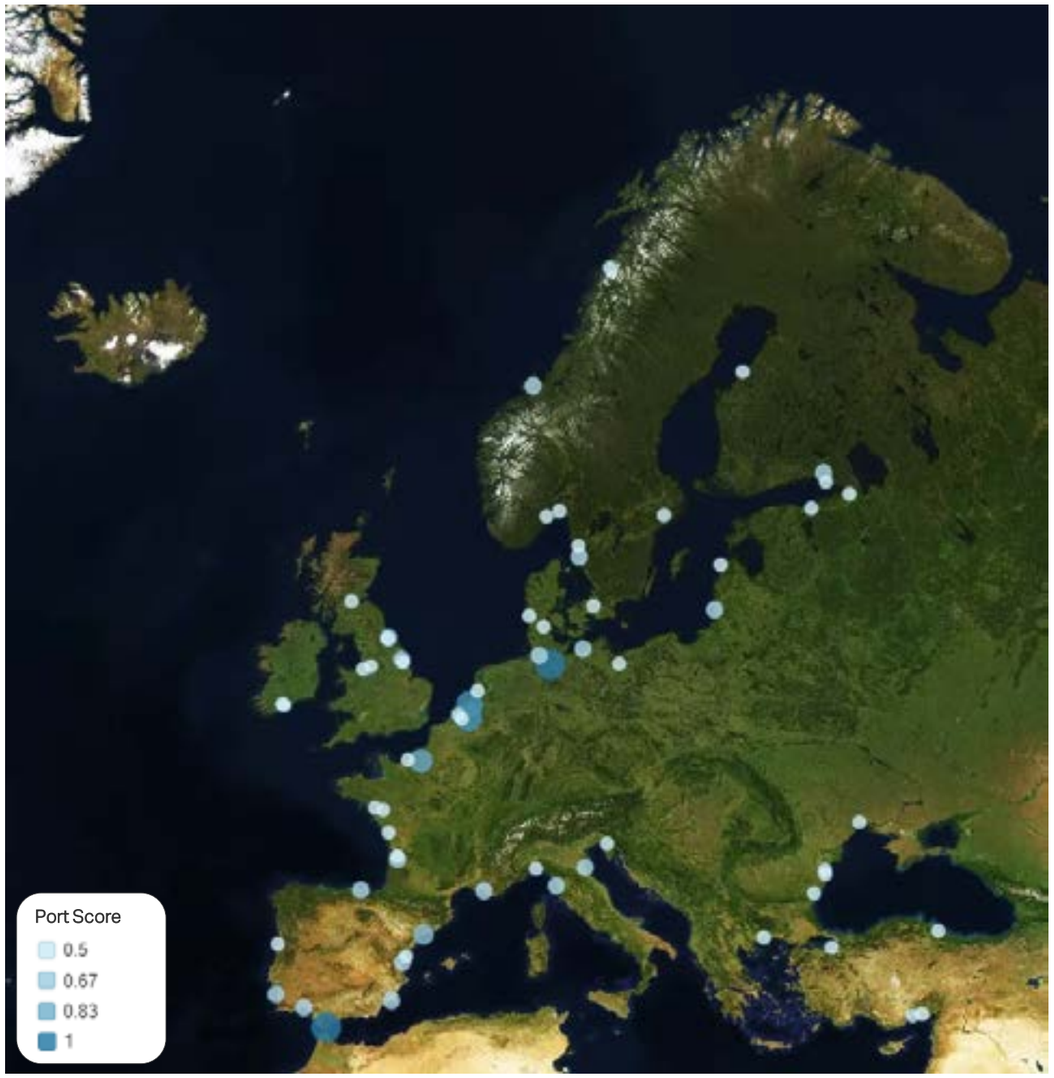
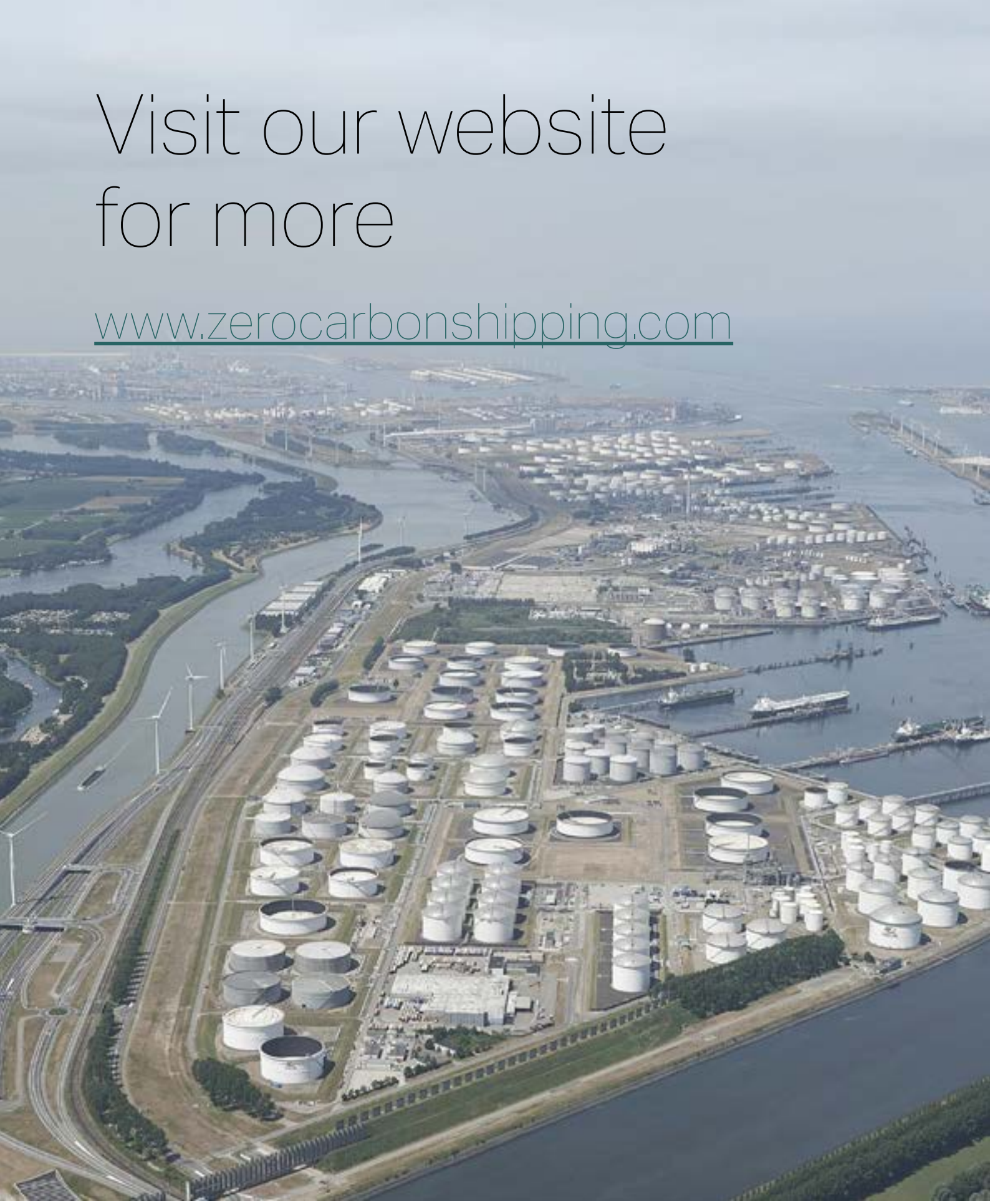


Figure F: 59 ports in Europe have a CPS of 0.5 or above. Reference: Port data by Rystad Energy.



Visit our website for more

www.zerocarbonshipping.com



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping