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Collaborative Partnerships for Effective Maritime Decarbonization: A White Paper for Global Port Leaders

Port leaders share experiences on best practices and pitfalls and explore potential collaborations in their decarbonization efforts.

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Corporate Leaders at the Round Tables

The Collaborative Partnerships for Effective Maritime Decarbonization Leadership Roundtable stands out as one of the most compelling and successful events within the U.S. port industry. This exclusive, invite-only event engages U.S. port leaders to share experiences on best practices and pitfalls, and to explore potential collaborations in their decarbonization efforts.

Port of Houston - Trae Camble, Director Of Environmental Affairs

Port of Corpus Christi - Priscila Torres, Manager, Trade Development

Port of Los Angeles - Eric Caris, Director Cargo Marketing & Teresa Pisano Marine, Environmental Supervisor-Air

Port of San Diego - Jason Giffen, Vice President, Planning & Environment & Phillip Gibbons, Program Director, Climate and Sustainability

Port of Hueneme - Giles Pettifor, Environmental Manager

Port of Oakland - Angela Clapp, Port Environmental Supervisor

Port of Cleveland - Matthew Wenham, Chief of Engineering & Capital Development

Port Authority of NYNJ - Laura Malo, Program Manager, Port Sustainability & Resilience & Andrew Lo, Port Sustainability & Resilience

Port of Philadelphia - Lindsay Young, Manager Business Development & Planning

Port of Jacksonville - Nick Primrose, Chief of Regulatory

Port of Tampa Bay - Patrick Blair, Vice President of Engineering

Port Everglades - Roberto Barceló, Senior Manager, Business Development

Alabama Port Authority - Catherine Reaves, VP, Policy and State Affairs

FOREWORD

In the realm of U.S. maritime decarbonization, the Collaborative Partnerships for Effective Maritime Decarbonization Leadership Roundtable stands out as one of the most compelling and successful events within the U.S. port industry. This exclusive, invite-only event engages U.S. port leaders to share experiences on best practices and pitfalls and to explore potential collaborations in their decarbonization efforts. Over the past year, this strategic gathering of senior executives from leading ports has fostered thought-provoking discussions and achieved remarkable collaboration and engagement.



The sessions were hosted and moderated by Professor Dr. Beatriz Canamary, a U.S. knowledge maritime expert, supported by PortXchange

Dr Beatriz Canamary is a Professor of Business Analytics with a professional career in the Port Industry. Holding a BS and MS in Civil Engineering, a Certificate in M&A from Harvard Business School, and a Doctorate in Business Administration with an emphasis on Sustainability for the US Port Industry, Beatriz brings world-class expertise in sustainability, decarbonization strategies, energy transition, circular economy, infrastructure investment, and climate change solutions. She is an accomplished global business leader with experience spearheading sustainable growth, innovation, and cultural transformation for complex multinational infrastructure projects across different countries.

INTRODUCTION

As the global maritime sector moves toward full decarbonization by 2050, it is essential to remain receptive to new information in this ever-changing landscape. To meet decarbonization targets, a globally coordinated innovation strategy is essential across the entire maritime value chain. This encompasses ships, future zero-emission fuels, and the necessary supporting infrastructure. Ports, situated at a crossroads, are uniquely positioned as key enablers with multiple avenues to propel transformation.

Through the Department of Energy (DoE), Department of Transportation (DoT), and the Environmental Protection Agency's (EPA) Port Initiative, under the Inflation Reduction Act (IRA), the U.S. is advancing ambitious decarbonization targets for the maritime transportation sector, both domestically and internationally. Among other goals, the country aims to increase the number of large international ships running on zero-emission fuels; increase zero-emission fuels annual production; and increase the number of key ports offering zero-emission bunkering.



The leaders at the roundtables discussed together the direction of maritime industry decarbonization by 2050, the levers of opportunity, the directions of investment needed and other enablers that will be required to achieve the net-zero targets and take the industry forward. Weighing on the landscape of current efforts, as well as systemic challenges, the opportunities to better actualize this collective goal were discussed during the sessions.

Executive Summary

With the global decarbonization mandates, the international maritime transport system must proceed urgently while recognizing its critical role in the global economy

This effort requires a holistic approach that addresses challenges from multiple perspectives, emphasizing collaboration and mutual learning.

The awareness of this imminent change is unprecedented, prompting industry stakeholders to consider the best strategies for tackling the monumental challenge of reorganizing the maritime industry's energy supply.

With some U.S. ports progressing in their decarbonization goals while others strategizing their milestones according to each one's ecosystem, the roundtable leaders urged the industry to build on its core business activities while strengthening their capabilities for pursuing the sustainability agenda.

During the meetings, the U.S. industry leaders delved into the strategic levers needed to actualize the ambitious decarbonization goals, which include equipment electrification, shore power technology, scopes 1 and 2 emissions monitoring, operations efficiency/optimization, and integration of digitalization.

The leaders called for the strategic and widespread adoption of sustainability and decarbonization mandates, preserving operational efficiency while driving long-term economic growth. It is an industry's shift, from profit-driven to value-driven approach that goes beyond economic gains, encompassing various environmental advantages with a shared vision for a greener and more resilient future. Thus, the focus should also be on Scope 3 emissions monitoring to drive this decarbonization transformation



CHAPTER ONE

CREATING VALUE CHAINS FOR EFFECTIVE MARITIME DECARBONIZATION

In the maritime sector, the value chain is not concentrated within a single company but is distributed across extensive global supply networks. Therefore, efforts to drive sustainability cannot stop at the focal company's borders. It is crucial to understand and assess decarbonization enablers and build partnerships beyond industry boundaries.

The maritime operational value chain involves a wide range of players, including ship owners and operators, cargo owners, charterers, marine fuel producers and suppliers, shipbuilders, engine makers, technology providers, port authorities and operators, maritime service providers and policy makers.

Effective, large-scale maritime decarbonization requires alignment and collaboration across the entire ecosystem. Three interrelated value chains from the maritime ecosystem are playing a critical role in decarbonizing shipping:

The marine fuel, shipbuilding, and maritime operational value chains.

Although ports are more actively involved in the maritime value chain, they also play a critical role in both the marine and the shipbuilding value chains by providing the necessary infrastructure to operationalize these systems.

To effectively leverage the opportunities presented by these interconnected value chains, it is imperative to explore innovative approaches that can facilitate collaboration among various stakeholders. One such approach that is gaining traction is the concept of Green Corridors. By establishing dedicated routes for vessels that prioritize sustainability, we can enhance the efficiency of operations and significantly reduce emissions throughout the maritime industry. Green Corridors represent not just a technical advancement but also a strategic framework that encourages the integration of eco-friendly practices across the entire supply chain. In the next chapter, we will look further into how green corridors can serve as vital drivers for decarbonization, examining their potential to reshape operational frameworks and align industry goals towards a greener, more sustainable future.

The Benefits of Green Shipping Corridors

To illustrate a type of maritime value chain involving a wide range of players to foster global decarbonization, the Port of Los Angeles discussed about the Trans-Pacific Green Shipping Corridor – a voluntary partnership of leading maritime goods movement stakeholders, including the Ports of Los Angeles, Long Beach, and Shanghai, some of the largest carriers in the world, and key leading cargo owners.

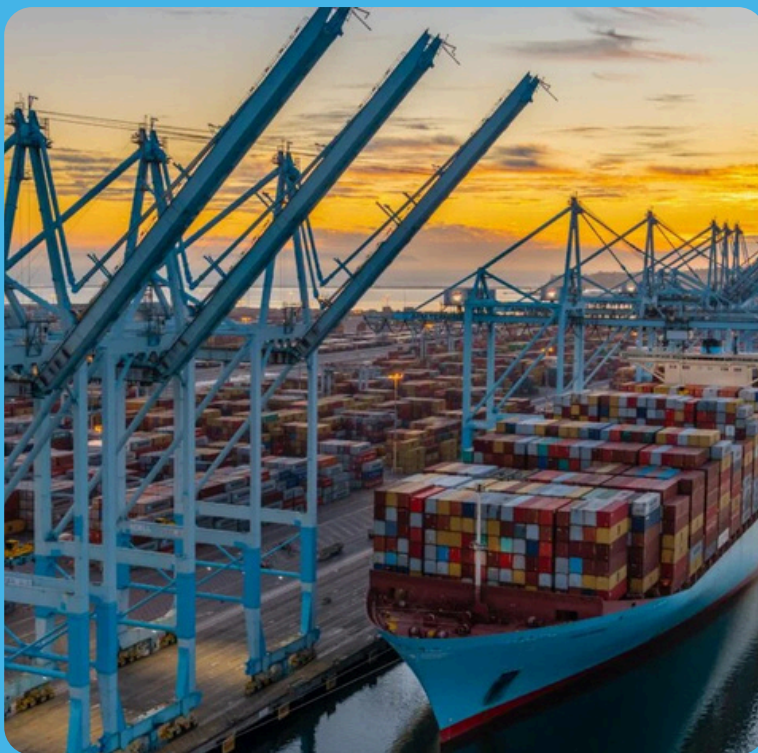


Aiming at accelerating emissions reductions on one of the world's busiest container shipping routes across the Pacific Ocean, this green shipping corridor stands out as one of the most well-structured and advanced corridors across the globe.

Green Shipping Corridors emphasize partnerships between ports, carriers, and energy providers to create a structured framework and align objectives for decarbonization.

Currently, there are over 50 green shipping corridors announced globally spanning continents and connecting major ports.

These corridors, led by port authorities, governments, industrial players, or public-private partnerships, aim to reduce carbon emissions and advance the digital transformation of maritime transport. They focus on various aspects such as fuel production and infrastructure, technology development, regulatory frameworks, policy development, and meeting market demand.



Similar to the corridor between the Port of Singapore and the Port of Rotterdam, which is recognized as a green and digital corridor, the corridor connecting Shanghai, Los Angeles, and Long Beach is also considered a green and digital corridor. Digitalization is an essential component for these corridors to move from the feasibility stage to effective implementation.

Carbon Intensity Indicator (CII): Collaboration between Ports and the Shipping Industry

Decarbonizing the maritime sector requires a holistic and simultaneous approach, encompassing carbon calculation, design, planning, financing, management, and policymaking. The goal is to decarbonize the entire cluster of value chains, sector by sector, ideally in parallel, to avoid gaps and bottlenecks. These gaps across the chains often discourage more substantial commitments to decarbonization.

By addressing each segment of the value chain collectively and cohesively, the maritime industry can ensure a more efficient and comprehensive transition to sustainable practices.

With the International Maritime Organization (IMO) Carbon Intensity Indicator (CII) regulation in force, shipowners and operators are paying more attention to green fuels, as well as fuel-saving technical and operational measures available today. While many shipowners are taking a wait-and-see approach to ship orders, the fuel choice uncertainty remains.

Fuel availability concerns are very real, with traders facing challenges due to the lack of off-take agreements. Increasingly stringent fuel standards have ruled out the use of lower-emission fuels that were initially poised to be the first alternatives in the market. The timeline for shipping to access green fuels at scale remains uncertain.

Another significant value chain creation that involves marine fuels and shipbuilding is the Zero Emission Maritime Buyers Alliance (ZEMBA), established in 2020. Co-founded by Amazon, Patagonia, Brooks Running, DB Journey, Green Worldwide Shipping, Meta, New Balance, Nike, and REI Co-op, it focuses on Zero Emission Vessels (coZEV). Since its inception, these cargo owners have been actively investigating and implementing innovative solutions to decarbonize the maritime industry.

In September 2021, Maersk, in collaboration with Amazon, transported goods on the first-ever zero-emission capable cargo ship using methanol from Shanghai to Rotterdam, and in June 2024, in collaboration with Vestas and Nike, Maersk announced the addition of two more vessels powered by methanol, set to navigate between Denmark and the U.S., through the Port of Los Angeles.



The port of Hueneme is focusing on the landside infrastructure needed to meet future demand for green fuels and expand bunkering capacity.

So the port is working closely with carriers to understand their energy transfer needs and are fostering the development of bunkering facilities to support the shipping industry.

To facilitate and maintain these facilities, the port is beginning to accommodate barge-based bunkering, ensuring vessel movements are efficient. We are also looking into incorporating barge-based emissions filtration systems to comply with California regulations.

The port is planning capital engineering projects with a ten-year horizon, considering the anticipated global demand for biofuels. This involves understanding where raw materials will come from and where bunkering facilities should be located to optimize supply chains and meet future volume requirements.





**According to Phillip Gibbons,
Program Director, Climate and
Sustainability with the Port of
San Diego:**

"California currently boasts an estimated 300 commercial drayage trucks and numerous other pieces of zero carbon emissions equipment operating within its ports, underscoring the state's commitment to sustainable practices, and the population is continuing to grow."

Gibbons highlighted that the Port of San Diego, in collaboration with the CEC, is successfully embedding sustainability into port operations with a focus on advanced technologies such as zero emissions equipment. Their primary goal is to advance decarbonization in the land side, with equipment electrification, distributed generation, battery energy storage, and Drayage Trucks.

"Efforts are concentrated on utilizing funding from the California Energy Commission (CEC) to spur innovation in the world of zero emission handling equipment and trucks."



The port is working in collaboration with the CEC, other California ports and major O&Ms players in the state that are building these technologies.

"We are working with the energy commission to figure out the best way to allocate funds, and how to create the appropriate type of grants, so that the ports, or the tenants, or the port operators can apply for these grants." – Gibbons, P.

The Port of San Diego is also working closely with Crowley tugs to facilitate the operation of the United States' first all-electric tugboat, the eWolf. This vessel arrived in San Diego earlier this year, and Crowley is working with the Port and other stakeholders to continue to develop a 3MW solar and battery microgrid system to offset the vessel's charging from the grid.



**PORT of
SAN DIEGO**

Decarbonizing Through Collaborative Partnerships

Partnering is a core activity in achieving effective decarbonization. Setting a clear objective and outlining a business model for decarbonization efforts is an important starting point for ensuring successful collaboration. Many industry initiatives and Public and Private Partnerships (PPPs) have been formed to address the challenge and to bring key stakeholders to the same table.

An emblematic example of a PPP to reach decarbonization targets is the JAXPORT Express – an alliance between the Port of Jacksonville and two port tenants, SSA Jacksonville and Crowley.



According to Nick Primrose, Chief of Regulatory with The Port of Jacksonville: *"This partnership, initiated two years ago, aims at expanding energy-efficient terminal infrastructure, increasing JAXPORT's cargo throughput, and developing a plan to transition to lower emission port infrastructure and maritime operations. Investments include the purchase of hybrid-electric rubber-tired gantry (RTG) cranes; low- and zero-emission container top picks forklifts; zero-emissions equipment for cargo handling including specialty yard tractors and forklifts, and electric refrigerated cargo charging stations (reefer plugs)."*



The initiative is funded by a grant from the U.S. Department of Transportation's (DoT) Maritime Administration (MARAD) Port Infrastructure Development Program (PIDP) grant, awarded in November 2022, as well as private funds from Crowley and SSA. The main focus is to meet the needs of the port's tenants who are transitioning to electric cargo equipment, including cranes.



"For the Port of Jacksonville, which follows the landlord management model, addressing the needs of cargo operators is crucial. Tenants are increasingly focusing on their climate emission goals, and carriers prefer ports with advanced emissions reduction strategies." - Primrose, N.



This initiative aligns with the broader industry trend toward sustainability and positions the port as a leader in environmental stewardship. Similarly to the JAXPORT Express, are the partnerships formed between the Port Authority under the landlord management model and its tenants, as the case of the Port Authority of New York and New Jersey and the Tampa Bay Port, in Florida.



According to Andrew Lo, Port Sustainability & Resilience Manager:

"The Port of New York and New Jersey collaborates with tenants to apply for grants and share costs for various projects, fostering a partnership approach to funding and resource allocation. This collaborative effort ensures that both the port and its tenants can jointly benefit from available financial opportunities and support sustainable development initiatives."



Decarbonizing Through Collaborative Partnerships

In the Port of Tampa Bay, tenants are required to invest in the necessary infrastructure and equipment.



"Port Tampa Bay has committed to installing the electrical infrastructure needed to support the electrification from the local utility substation to the meter as well as switch gear, transformers and other gear required on the site to support the tenants electrification." – Patrick Blair, Vice President of Engineering with Tampa Bay Port.



The Port of Tampa is actively working towards implementing ship-to-shore power. These projects do not have tenants and are solely endeavored by the Port. Federal grants play a critical role in this. So, an EPA grant application has been submitted to secure funding for these investments. In addition to collaborating with port tenants to promote the transition to more sustainable port equipment, the Port of Houston has launched an ambitious initiative to decarbonize the trucking industry.



Another port representative stated:
"Our port is collaborating with the trucking community to effectively utilize available funding through an 80/20 split investment strategy, driving significant change in the process."

In the Great Lakes region, the Port of Cleveland is at the forefront of climate action initiatives. Last year, they completed an electrification and decarbonization study to align with their climate action plan and achieve net-zero emissions. Additionally, they are designing a project for port electrification to be prepared for shore power and zero emissions equipment.



"The port is partnering with The Great Lakes Towing Company to build an American-made electric tugboat in Cleveland harbor, further demonstrating our commitment to sustainability. This proactive approach in collaboration with our terminal operator addresses the growing demand from international shipping partners who seek ports equipped with shore power capabilities." – Matthew Wenham, Chief of Engineering & Capital Development.



Decarbonizing Through Collaborative Partnerships

Other port professionals present in the roundtables agree that prioritizing partnerships with stakeholders is essential for effective maritime decarbonization.

Different partnerships have different purposes and fall into distinct categories. This is important for choosing the right form of collaboration and the actors' wishes to establish or join. A clear understanding of the types of partnerships helps in communication and increases the chances of success.

Creating value chains through collaborative partnerships for maritime decarbonization can transcend industry boundaries while staying within the same sector, as demonstrated by the collaboration between the Port of Rotterdam and The Hague Airport. In a recent announcement, both parties signed a collaboration agreement aimed at accelerating the decarbonization of the transportation sector. This agreement underscores the increasing efforts to implement sustainable practices across various modes of transportation.

Similarly, the zero emissions goals at the Port of Oakland extend to the airport boundaries as well, as the Port oversees the San Francisco Bay Oakland International Airport, the Oakland Seaport and nearly 20 miles of waterfront including Jack London Square and a publicly owned utility.

In Port of Oakland, many grants target both facilities, with a significant focus on the seaport side, while the airport is progressively aligning with these objectives. Despite this shared vision, leadership is actively driving efforts on both fronts, even though the strategies for the seaport and airport are distinct and separate.

Identifying Key Decarbonization Enablers

Moving towards the current and future global decarbonization targets set by the IMO requires the adoption of multiple enablers with varying GHG reduction impact and different levels of required investment. These enablers are not to be found in one value chain but also in adjacent value chains within and beyond the maritime industry.

There are multiple decarbonization enablers, including technology, practices, zero-carbon fuels, and policies and regulations that are relevant for a specific player and project. In the transition towards decarbonization targets, the investment needed increases from regulations to zero-carbon fuels.



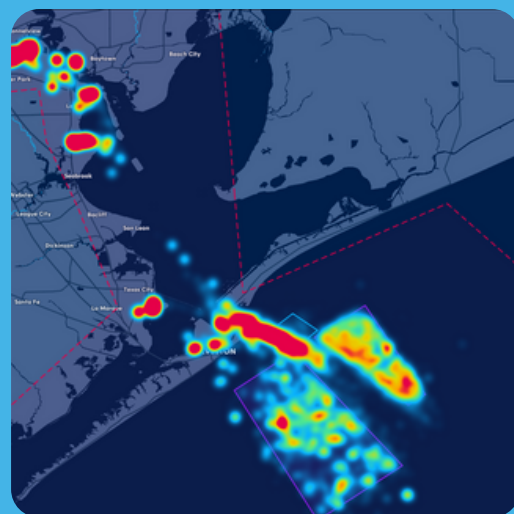
Digitalization can significantly optimize port operations and reduce emissions by connecting operational planning and enabling just-in-time sailing. This is an easy solution; it's a low-hanging fruit that can be implemented today. Although not every ship will arrive precisely on time, many inefficiencies—such as the prevalent “sail fast, then wait” behaviour—can be entirely avoided.

Data sharing among ports, shipping lines, and operators is crucial. When these entities collaborate in a structured manner and share data, inefficiencies can be mitigated. For example, vessels can be informed of future port delays, allowing them to optimize speed, reduce waiting times and lower emissions.

*Sjoerd de Jager - Managing Director,
PortXchange*

While ports may engage with regulations, ships' energy efficiency technologies, energy conversion and shipbuilding technology and zero-carbon fuels and infrastructure in a more reactive manner, they are at the forefront of operational and commercial practices and the implementation of digital technologies to reach decarbonization targets.

Energy efficiency measures and transition to alternative fuels can have a global impact in the long term, however, operational measures are mandatory to reach the mid-term decarbonization targets. That is why, international regulations targeting improvements in ship operations, such as the IMO CII, are fostering the adoption of technological solutions and collaborative approaches to the decarbonization challenge.



Port of Houston's Emissions Heatmap as seen in the Emissioninsider Platform



CHAPTER TWO

U.S. PORTS DIVERSE CHALLENGES IN DECARBONIZATION EFFORTS

Ports across the U.S. differ significantly in the development and implementation of their decarbonization strategies. Many ports are developing decarbonization strategies and planning for action, but the scope, detail, and evidence base of these plans vary widely.

One of the reasons for the varied progress towards decarbonization is that U.S. ports face systemic challenges to meaningfully address decarbonization.

These challenges can be:

Regulatory Environment: Different states have varying levels of environmental regulations and policies, influencing the pace and extent of decarbonization efforts. For instance, California has stringent environmental standards and robust support for green initiatives, driving faster adoption of decarbonization measures.

Economic Factors: The economic priorities and resources available in different regions affect their ability to invest in decarbonization. Wealthier states or regions with more significant economic incentives can allocate more funds toward sustainable infrastructure and technologies.



Local Industry and Commerce: The types of industries and commercial activities surrounding a port can impact its decarbonization strategies.

Port Size and Capacity: Larger ports with higher volumes of traffic and more extensive infrastructure may have different decarbonization needs and capabilities compared to smaller ports. The scale of operations influences the types and extent of measures that can be implemented.

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Geographical Factors: Geographic location influences the types of renewable energy sources available and the specific environmental challenges faced by each port. Coastal ports might focus more on marine-based renewable energy, while inland ports may have different priorities.

Diverse Governance Structures: The diverse nature of port governance – with separate entities such as port tenants (landlords), port statutory bodies (authorities), and terminal operators – results in many decarbonization efforts being fragmented or containing significant gaps. This varied governance structure hinders collaboration, accountability, and overall impact.

Federal and State Support: The availability of federal and state support, including grants, subsidies, and incentives for green initiatives, varies and significantly impacts the decarbonization efforts of ports in different regions.

Technology Adoption: The willingness and ability to adopt new technologies differ across regions. Some ports may be early adopters of cutting-edge green technologies, while others might be slower due to financial constraints or lack of technical expertise.

Geographical Factors: Geographic location influences the types of renewable energy sources available and the specific environmental challenges faced by each port. Coastal ports might focus more on marine-based renewable energy, while inland ports may have different priorities.

Stakeholder Needs and Engagement: The level of collaboration and engagement with local governments, communities, and private sector stakeholders varies depending on their needs, which impacts the effectiveness and speed of decarbonization initiatives.



U.S. Ports Diverse Challenges in Decarbonization Efforts

In terms of economic factors, regulatory mandates, and stakeholders needs, Jason Giffen, Vice President, Planning & Environment of Port of San Diego, highlights:



"Setting goals for the Port of San Diego is challenging due to the need to balance market opportunities, competitiveness for grants, while meeting regulations. So the strategy is to stay slightly ahead of regulation. Ports in California face competition in pursuing market opportunities and grants while navigating ever-changing regulations. Establishing goals can sometimes lead to frustration among stakeholders if those goals become outdated or are not achieved quickly enough, leading to additional pressure to set new ones."



When setting their milestones, Giffen considers a five-year business plan beneficial, especially in the context of political and regulatory cycles that can accelerate the pace for achieving a set of goals.



"Continuous learning and adaptation are essential for setting and attaining meaningful, forward-looking objectives in this dynamic environment, and these roundtable discussions are extremely important to learn from each other's progress and experiences. Listening to the Port of Houston's stretch goal for zero-emission trucks, for instance, highlights the different types of goals ports set." - Giffen, J.

The Port of San Diego established their carbon emissions equipment baseline in 2006 and began air quality planning in 2008. Since then, the port has conducted frequent inventories for cargo equipment, rail locomotives, among others. Tracking truck emissions is one of the most challenging tasks. While the Ports of Los Angeles and Long Beach have their own truck inventories, the Port of San Diego has recently installed license plate readers at terminals, as an in-house developed digital technology system. This system enables the port to assess truck types and build a comprehensive truck inventory.

The technology adoption in the Port of Hueneme is motivated by different factors. With the absence of an industrial buffer zone, the port is closer to the surrounding community, becoming their primary stakeholders concern. The community has requested zero tailpipe emissions within the port's gates and air quality monitoring. To address this, flow meters have been installed throughout the port and in the community. In addition, the port conducts an annual emissions inventory, which is sparking important conversations with the local community.

With a database, the port creates culturally relevant analogies and storytelling to help the community understand and interpret the emissions data. Currently, the emissions inventory is compiled manually with the assistance of consultants.

As digitalization of carbon emissions tracking advances globally, the port is closely monitoring these developments to potentially adopt digital solutions in the future.

The port has also set equipment electrification as a primary goal by 2030, that includes retrofitting for shore power and upgrading cargo handling equipment.

In terms of data gathering, the Port of New York & New Jersey has adopted a slightly different approach.

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"This year, we decided to move towards digitalization to gather data from fuel consumption and material handling equipment. By collecting this data we improve the input for our Annual Air Emissions Inventory Report." — Laura Malo, Program Manager, Port Sustainability & Resilience at Port of New York & New Jersey



The port faces challenges in dealing with different and fragmented efforts from their tenants to decarbonize, impacting in significant gaps, lack of collaboration and accountability. Another strategy The Port of New York & New Jersey implemented to address this tenants goals fragmentation is incorporating green Key Performance Indicators (KPIs) into the leasing agreements, aligned with the Port's strategies.

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"Tenants are Scope 3 emissions for the Port, so they have to be aligned with the Port's goals."- Lo, A.

Although the Port Authority leader believes that KPIs should be those they can control, he acknowledges that the overarching goal is for every port to achieve scope 1, 2, and 3 emissions reductions by 2050. Scope 1 and 2 are now under control. The most challenging Scope 3 emissions come from the trucking industry.

With regard to geographic region, Robert Barceló – Senior Manager, Business Development from the Port Everglades – highlighted:



"The ports on the Southeast Coast face significant challenges in establishing their decarbonization strategies due to their reliance on the Caribbean region, which is struggling with sustainability and electrification initiatives."



Another concern pointed out by Barceló is the increasing costs that carriers are beginning to incur with decarbonization mandates and subsequently passing on to customers.



"This cost transfer has led to push back from the shipping public being shifted onto the ports. As carriers strive to manage expenses, the financial burden on ports is becoming a significant issue." – Barceló, R.

A similar concern was pointed out by the Port of Tampa Bay, but with respect to the weather events this geographic region suffers and the investments needed to increase infrastructure resilience.

The Port Everglades has begun its electrification efforts to serve the cruise industry better. While these efforts primarily focus on the land aspect, they also contribute to broader sustainability goals. The port's commitment to electrification underscores its proactive approach to addressing environmental concerns while enhancing operational efficiency.

Similarly to the Port Everglades (and San Diego), the Port Tampa Bay is initially focusing on electrification of equipment as the first step toward achieving zero emissions. The port is confident that it will eventually create its zero emissions strategy and, from that, create an inventory to track carbon output. Currently, the port is proposing a study of the electrical grid as part of an EPA grant application to support these efforts.

Economic factors, local industry and commerce factors, port size and capacity, and geographic location highlight the difference, for instance, between ports on the Great Lakes and ports on the West Coast, as well as observed by Wenham from Port of Cleveland

Ports are undergoing a significant decarbonization transition, and there is no one-size-fits-all solution.

The unique characteristics and challenges of each port necessitate tailored approaches to achieve decarbonization goals.

Digital technologies offer powerful tools for ports to navigate the complex decarbonization transition. By leveraging customized solutions, ports can address their unique challenges and make significant strides towards reducing emissions. While there are challenges to overcome, the benefits of digitalization in achieving sustainable port operations are substantial and pave the way for a greener future in maritime logistics.



CHAPTER THREE

THE ROLE OF DATA AND DIGITAL TECHNOLOGY IN MARITIME DECARBONIZATION

In the past decade, ports and terminals have been improving their operational efficiencies, and ship operators and charterers are co-operating to achieve optimum ship speeds to reduce waiting times. Technology tools for real time data sharing and communications are being implemented to eliminate bottlenecks in the logistics chain. Just-in-time arrival is a concept that strives for improved efficiency, but port congestion and long waiting times are frequently the reality, even with the progress made by various stakeholders.

Port Leaders have argued that from a digitalization perspective, there are two key ways to leverage digital technologies: improving cargo velocity through the supply chain and optimizing vessel voyage times to reduce carbon emissions. Enhanced tracking and tracing of cargo operations provide a more accurate and efficient method to foresee and address bottlenecks.

Digitalization supports the global supply chain by offering better visibility and control, thus enhancing the overall efficiency of the supply chain network. These advancements lead to more streamlined operations and significant carbon reductions, ultimately contributing to a more sustainable maritime industry by enabling: operations monitoring and reporting, voyage optimization, fleet allocation and schedule optimization, port call optimization, energy efficient ship design, and monitoring the cost and supply of alternative fuels.

Here's an overview of how digital technologies can assist in the decarbonization efforts of ports:

Collaborative Platforms: Digital platforms can facilitate collaboration among various stakeholders, including port authorities, operators, and logistics companies. These platforms can help coordinate efforts, share best practices, and implement unified decarbonization strategies.

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AI and Machine Learning: AI and machine learning algorithms can analyze large datasets to identify patterns and predict future trends. These insights can inform decision-making, optimize logistics, and improve fuel efficiency.

Blockchain for Transparency and Efficiency: Blockchain technology can enhance transparency in supply chains, ensuring more efficient and sustainable practices. It can also facilitate carbon credit trading and track emissions reductions in a verifiable manner.

IoT and Sensor Networks: The Internet of Things (IoT) and sensor networks provide real-time data on energy use, equipment performance, and environmental conditions. This data can be used to optimize operations, improve maintenance schedules, and reduce emissions.

Digital Twin Technology: Digital twins create a virtual model of the port's physical assets, allowing for real-time monitoring and simulation. These models can predict the impact of various decarbonization strategies, optimize operations, and reduce emissions.

Site-Specific and Customized Decarbonization Strategies: Each port can develop decarbonization strategies that account for its unique operational, geographical, and economic conditions. Customized approaches ensure that strategies are both practical and effective.

Scalable Customized Technologies: Digital technologies can be scaled to meet the needs of different ports, whether large or small. This scalability ensures that ports of all sizes can benefit from advanced decarbonization solutions.



"Digitalization, operational efficiency, and sustainability will collectively shape the future of the industry. A significant shift is occurring as we move away from fossil fuels towards new sustainable alternatives. This transition offers a unique opportunity to enhance operational efficiency, which is currently highly inefficient. Through data analytics, ports are able to identify new business opportunities, cut administrative expenses due to paperless processes, optimize workforce allocation, and enhance security measures."



In terms of carbon footprint, Sjoerd believes that digitalization accelerates decarbonization movement in the maritime industry, while shipowners and cargo owners are struggling with the new fuels technologies, production, operation, price, and regulation. He states that:

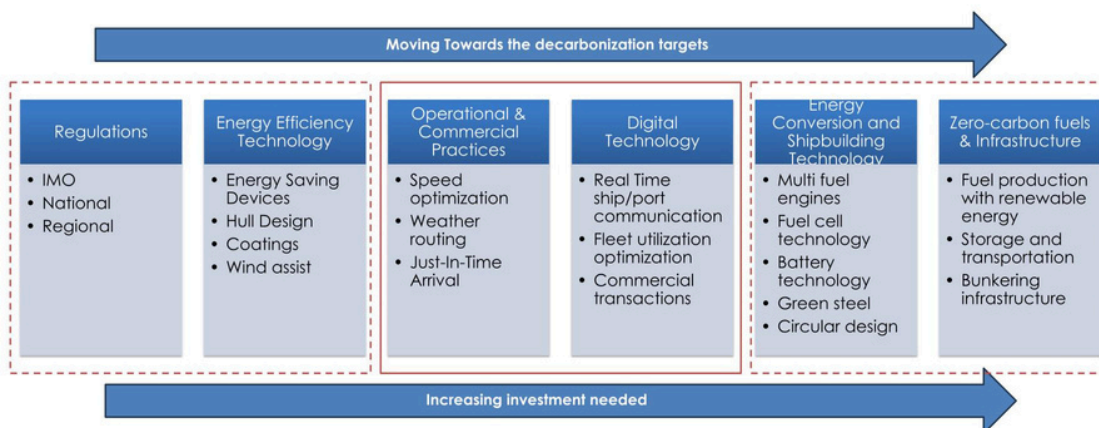


"Currently, the shipping industry accounts for 3% of global carbon emissions, a figure projected to rise to 17% by 2050 if current trends continue. Delaying decisions on which e-fuels to adopt only postpones decarbonization targets, given the 30-year lifecycle of ships. Digitalization can reduce this impact. Its first contribution lies in operational planning, enabling just-in-time arrivals, optimizing speed, and reducing waiting times, thereby minimizing emissions. Ports, with better insights into emission sources, can more effectively map their carbon footprint and allocate decarbonization investments, whether in shore power, just-in-time arrivals, terminal operations, or shifting cargo transport from road to barge.

By leveraging advanced digital tools, we can accurately identify and monitor emissions, develop effective strategies, and foster collaboration among stakeholders. Ports play a crucial role in aiding the shipping industry's decarbonization efforts. The goal is to connect as many ship owners and managers to ports as possible to accelerate the adoption of future fuels.

"As a company, PortXchange is committed primarily to making a significant impact. We support ports where our investments can yield the greatest benefits"

Moving Towards decarbonization targets



PORT CASE STUDIES

In 2020, **the Port of Algeciras** adopted **PortXchange Synchronizer** to improve visibility into the port call process, creating a single point of truth for all parties involved. By sharing planning schedules on the Synchronizer platform, the port enhanced situational awareness, allowing for the successful implementation of Just-In-Time (JIT) arrivals. This led to a 40% reduction in idle time per vessel and an average decrease of 32.9 tons of CO2 per port call. To further enhance data analysis and forecasting capabilities, the port has since **migrated to EmissionInsider**, building on its commitment to reducing emissions and improving operational efficiency across its value chain.



Similarly, at the end of 2021, **Texas Mooring** was introduced to **PilotTracker** – a one-stop-shop for all viable information regarding a vessel coming into the port. PilotTracker provides a dynamic map powered by AIS data to assist in tracking the vessel, as well as detailed information about each vessel, including the current operator. Both dispatchers and executives, who use the system regularly, have acknowledged that PilotTracker improves productivity and helps significantly reduce time by providing all relevant information in a single place.

They will continue to discover more benefits as they continue to explore **PortXchange Green Tech solutions** and as the Greater Houston Port Bureau, together with PortXchange, continues to implement changes based on industry feedback.

Our launching customer, **The Port of Rotterdam**, is still partnering with us and was the first to implement **PortXchange EmissionInsider**, the digital solution for analyzing and measuring emissions of all transport emissions for developing an actionable decarbonization strategy. The EmissionInsider is used across different teams in the Port of Rotterdam, and it helps in three key areas: standardized reporting, prioritization of decarbonization projects, and enabling the port community and its customers to reach their decarbonization goals.

WE LAUNCHED

EMISSIONINSIDER CARBON INSIGHT SUITE



CHAPTER FOUR

THE IMPORTANCE OF REGULATORY MANDATES

Around the world, the introduction of new policies such as the US Inflation Reduction Act, the (Securities Exchange Commission) SEC's New Climate-Related Disclosure Rule, U.S. Maritime Decarbonization Action Plan, the IMO Strategy on Reduction of GHG Emissions from Ships, the EU Emissions Trading System (EU ETS), following the EU's policy to combat climate change, the European Union's Carbon Border Adjustment Mechanism (CBAM), Corporate Sustainability Reporting Directive (CSRD), and European Sustainability Reporting Standards (ESRS) signals a concerted effort to expedite decarbonization and climate action.

In terms of regulatory mandates, U.S. port leaders acknowledged they are primarily focusing on state-level requirements.

Environmental regulations are expected to remain at the state level, and if ports cannot meet these regulations, it poses a significant problem for the state. Many of these regulations require substantial investments, and the challenge is exacerbated in California, where multiple regulations were implemented simultaneously. While these regulations provide opportunities for improvements, the key challenge lies in how quickly progress can be made.

In contrast, Texas lacks the stringent set of regulations seen in California, making it more difficult for ports to secure cooperation from the trucking industry, for example, even with an 80/20 investment split.

A uniform set of federal regulations applying to all ports would provide a baseline and simplify compliance across the board. When considering international regulations and trade, the focus should remain on infrastructure investment and trade corridors. Major ports across continents are setting agreements that can influence scalability and efficiency. Ultimately, container ports are expected to lead the way in advancing green shipping initiatives.



"The biggest challenge is understanding the economic and financial realities of meeting these regulations. With adequate funding, it becomes significantly easier to implement and control regulatory requirements."— Giffen, J, Port of San Diego



CHAPTER FIVE

WAY FORWARD

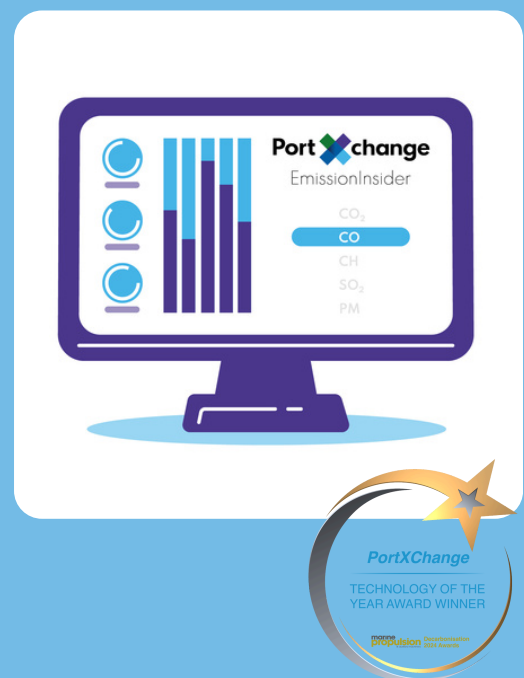
We acknowledge that the U.S. maritime industry has been progressing. Pioneers and influencers have emerged, triggering followership and giving birth to the decarbonization movement in the maritime sector. The immediate goal is to reach the critical mass of stakeholders that support the initiatives that accelerate GHG emissions reductions.

While the port industry must pursue advancements in equipment electrification, energy-saving technologies, shore power solutions, and alternative fuels infrastructure, we cannot overlook the immediate potential of digitalization for reducing emissions. The impact of digitalization on CO₂ reduction varies by port, but our findings show a significant and replicable effect.

To decarbonize the maritime industry, we should not wait for consensus on the right fuel type(s) or the availability of necessary infrastructure. Immediate action is crucial, with ports, terminal operators, landlords, and shipping lines working together to leverage digitalization for emission reduction.

PortXchange collaborates with ports, terminals, and industries to align and adopt existing, tested, and proven technologies. The cost of reducing a ton of CO₂ through digitalization is a fraction of the cost associated with new infrastructure without a proper study and strategy.

As the U.S. port industry continues its efforts towards reaching national carbon neutrality targets, PortXchange is committed to aiding ports with immediate, tailored solutions for tracking and monitoring emissions in and around port areas and facilitating Just-in-Time arrivals. Our commitment to social responsibility and ethical business practices across the ports' value chain enhances transparency, accountability, credibility, efficiency, and resilience for ports and their stakeholders.





EmissionInsider

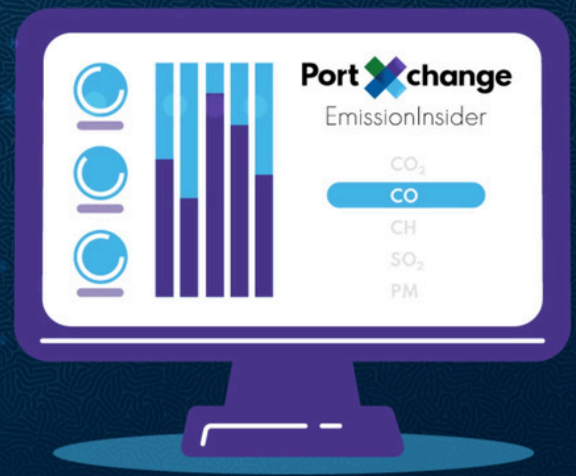
Emissions tracking and analysis platform featuring a customizable dashboard.



Assess multiple scenarios to cut emissions.



Analyze your current footprint



Make data-driven decisions.

Port Xchange

www.port-xchange.com

Port Emissions Report

Detailed analysis of vessels, cargo handling equipment, railways and trucking emissions.



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