

**160 YEARS OF HISTORY,
KNOWLEDGE AND EXPERIENCE**



**THE ROYAL INSTITUTION
OF NAVAL ARCHITECTS**

**Scaling Decarbonisation
Solutions:**

Reducing Emissions by 2030

**29th November – 1st December 2022,
Rotterdam, The Netherlands**

In Partnership with:



**Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping**

**TOGETHER WE WILL SHAPE OUR
FUTURE**



THE ROYAL INSTITUTION
OF NAVAL ARCHITECTS

Scaling Decarbonisation Solutions: **Reducing Emissions by 2030**

29th November – 1st December 2022
Rotterdam, The Netherlands

© 2022: The Royal Institution of Naval Architects

The Institution is not, as a body, responsible for the opinions expressed by the individual authors or speakers

Papers published in these conference Proceedings are peer reviewed.

THE ROYAL INSTITUTION OF NAVAL
ARCHITECTS
8-9 Northumberland Street
London WC2N 5DA

Telephone: 020 7235 4622
Fax: 020 7259 5912

ISBN No: 978-1-911649-37-3
ISSN No: 2752-6569

BUILDING ON GREEN SHIPPING CORRIDORS: INTERNATIONAL BLOCS FOR ZERO-EMISSION SHIPPING

A Browne, Pacific Environment, USA

SUMMARY

This paper assesses the scalability of port-to-port green shipping corridors and suggests a collaborative model to build on corridor development. In addition to corridors, nations, sub-nationals and their ports can align with regional partners to create international blocs of high ambition ports. By leveraging economic buying power and public-private investments and aggregating demand for renewable electricity and zero-emission (ZE) fuels, regional alliances can develop infrastructure at scale, create clusters for innovation and promote rapid deployment of ZE ships. We examine arguments ports cite as concerns about decarbonisation policies, including cargo diversion, increased costs and reduced profits. By looking to existing examples of regional policy and multi-port collaboration, we challenge the assertion that first movers will suffer loss of business. Regional alliances can generate a rising tide – ensuring that ports of all sizes, economic niches and vessel specialisation can reduce emissions on a trajectory commensurate with our climate emergency.

NOMENCLATURE

CH ₄	Methane
CO ₂	Carbon dioxide
ETC	Energy Transitions Commissions for the Global Maritime Forum for the Getting to Zero Coalition
ETS	Emissions Trading System of the European Union
EU	European Union
Gt	Gigatons (or Gigatonnes)
ICCT	International Council on Clean Transportation
IMO	International Maritime Organization
IRA	U.S. Inflation Reduction Act
LNG	Liquefied natural gas
MARAD	U.S. Department of Transportation Maritime Administration
MoU	Memorandum of Understanding
N ₂ O	Nitrous oxide
NWPCAS	Northwest Ports Clean Air Strategy
NWSA	Northwest Seaport Alliance
PIDP	Port Infrastructure Development Program
UMAS	University Maritime Advisory Services
UNCTAD	United Nations Conference on Trade and Development
ZE	Zero-Emission

1. INTRODUCTION

Maritime shipping is a significant contributor to both climate-warming emissions and air pollution. If the industry were its own country, it would be the sixth largest polluter of greenhouse gas (GHG) emissions [1], including carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Studies show that air pollution from shipping contributes to 250,000 premature deaths and 6.4 million cases of childhood asthma globally each year, with critical impact zones in China, Singapore, Panama and Brazil, and along the coastlines of Asia, Africa and South America [2]. Beyond nations' commitments under the Paris Agreement to keep global temperature rise below 1.5 to 2 degrees Celsius, nations have a moral imperative to accelerate the transition to zero-emission shipping to eliminate this lethal pollution for port communities and their regional air sheds. To account for maritime trade's exponential growth trajectory, the shipping industry must achieve zero GHG emissions by 2040 in order to align with a 1.5 degrees Celsius scenario [3]. The 2020s are a decisive decade for climate action, and nations, sub-nationals and their ports must step up to the challenge.

This paper assesses the scalability of port-to-port green shipping corridors to solve this urgent need for global action and suggests a collaborative model to build on corridor development. In addition to corridors, nations, sub-nationals and their ports can align with regional partners to create international blocs of high ambition ports. By joining together to take bold climate and public health actions, regional alliances can accelerate the zero-emission (ZE) shipping transition this decade. These international alliances of high ambition ports can reinforce the green shipping corridors developed under the COP26 Clydebank Declaration, helping to bring zero-emission shipping to ports around the world. We look to existing examples of regional policy and multi-port alliances as models for collaboration. Finally, we challenge the assertion that first movers will suffer cargo diversion, increased costs and reduced profits. Regional alliances can generate a rising tide – ensuring

that ports of all sizes, economic niches and vessel specialisation can reduce emissions on a trajectory commensurate with our climate emergency.

Together with green shipping corridors, these international blocs of high ambition ports will send a clear market signal to the shipping value chain. The renewable electricity and ZE marine fuels market will scale to support aggregated demand across the region, ensuring reliable access to zero-emission electricity and fuel bunkering for ships. With sufficient ZE mandates in place, shipping companies will have no choice but to transition their fleet: retrofitting their current fleets with lifesaving and energy saving technologies and ordering zero-emission vessels at scale. Shipping's energy transition will drive billions of dollars of economic investment into ports and port communities, including infrastructure development and job creation, while simultaneously improving the health of local communities through reduced air, water and land pollution.

2. THE FOUNDATION: GREEN SHIPPING CORRIDORS FOR ZERO-EMISSION SHIPPING

2.1 NATIONAL COMMITMENTS TO GREEN SHIPPING CORRIDORS

Under the COP26 Clydebank Declaration, 24 countries acknowledged the “need for the formation of an international coalition between ambitious governments, to act together and demonstrate that maritime decarbonisation is possible, while unlocking new business opportunities and socioeconomic benefits for communities across the globe.” The signatories committed to support the establishment of at least six green corridors by 2025, “while aiming to scale activity up in the following years”. As of October 2022, signatories include Australia, Belgium, Canada, Chile, Costa Rica, Denmark, Fiji, Finland, France, Germany, Ireland, Italy, Japan, Republic of the Marshall Islands, Morocco, Netherlands, New Zealand, Norway, Palau, Singapore, Spain, Sweden, the United Kingdom of Great Britain and Northern Ireland and the United States of America. [4]

In June 2022, the United States and Norway announced their global Green Shipping Challenge for COP27. The initiative calls for stakeholders across the shipping value chain to “come forward with concrete steps that will help put the international shipping sector on a credible pathway this decade toward full decarbonisation no later than 2050.” For ports, the initiative highlights the need for zero-emission bunkering and recharging capabilities to support low- or zero-emission vessels. The countries invited leaders to announce specific actions under the initiative at COP27 in November 2022 [5].

Globally, the message is clear: collaboration is key to success. With the foundation of an international coalition in place, nations and ports must do all they can to deliver on the promises made at COP26 and as required by the Paris Agreement.

2.2 GREEN SHIPPING CORRIDORS UNDER DEVELOPMENT

In less than a year, ports around the world announced green shipping corridor commitments encompassing some of the busiest global trade routes and key bunkering ports. COP27 will celebrate the one-year anniversary of the Clydebank Declaration and the leadership of these ports.

The Dutch Port of Antwerp and the Canadian Port of Montreal were the first ports to establish a green shipping corridor in the North Atlantic. The Port of Antwerp CEO Jacques Vandermeiren declared the port's intent to play a “pioneering role in the integration of carbon-neutral fuels in the bunkering market” – recognizing the need for key bunkering ports to lead the transition to cleaner fuels. Building on their framework partnership in place since 2013, the North American and European ports pledged to mobilize their respective public- and private-sector partners in the assessment, identification, development and adoption of shared or complementary solutions and infrastructures [6].

In January 2022, the Californian Port of Los Angeles and the Chinese Port of Shanghai were the first ports to announce a transpacific green shipping corridor [7]. Port of Los Angeles' sister Port of Long Beach joined the corridor in June 2022 [8], solidifying a green corridor commitment from the largest seaport complex in North America (Los Angeles-Long Beach). Together with key maritime stakeholders, the ports intend to release their “Green Shipping Corridor Implementation Plan” at COP27, including deliverables, milestones and roles for the partnership [9]. As one of the busiest trade routes in the world, the L.A.-L.B.-Shanghai corridor network will affect a significant number of vessels and countries that move goods between these ports.

A European corridor network was the next to emerge. With support from the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, port authorities in Northern Europe and the Baltic Sea established the European Green Corridors Network in March 2022, including Hamburg, Germany; Gdynia, Poland; Rønne, Denmark; Rotterdam, the Netherlands and Tallinn, Estonia. The European Green Corridors Network aims to demonstrate the early commercialisation of alternative fuel supply chains, showcase and support first-mover solutions, and create a blueprint for rolling out green

corridors in other areas and regions. Most importantly, it was the first regional network to materialise, though timing for its phased approach is unclear. The initiative will begin with a pre-feasibility phase to establish “high impact green corridors in the region” before moving into a technical, regulatory and commercial feasibility study of shortlisted routes and a final implementation phase [10].

Rotterdam added to its green corridor commitments in August 2022, signing a Memorandum of Understanding (MoU) with Singapore to establish the world’s longest Green and Digital Corridor to enable low- and zero-carbon shipping. The coalition aims to bring together stakeholders from across the supply chain in an effort to raise investment confidence, attract green financing, and kick start joint bunkering pilots and trials for digitalisation [11]. Vital to bunkering on Asian-European shipping routes, these ports’ commitment to a green shipping corridor reinforces the importance of prioritizing infrastructure development to accelerate the zero-emission transition. If zero-emission ships have nowhere to bunker zero-emission fuels, the shipping value chain will be hard-pressed to purchase, build and deploy these ships. Ports have a responsibility to scale the infrastructure necessary to fuel the future of shipping.

2.3 ASSESSING GLOBAL SCALABILITY OF PORT-TO-PORT CORRIDORS

Port-to-port agreements are a step in the right direction for decarbonisation, but they may be difficult to scale globally. This is due in large part to how few shipping routes are direct, port-to-port routes (or direct service corridors). Only 2.9 per cent of the world’s 12,748 port pairs have a direct service corridor. For trade between the remaining 97.1 per cent of port pairs, cargo must be transhipped in other ports [12]. In other words, green shipping corridor agreements for approximately 12,378 of the world’s port pairs would need to involve more than two ports to ensure that all ports along that pair’s corridor were aligned on zero-emission policy, infrastructure and bunkering. To date, we have four green corridor agreements for shipping, and only the European Green Corridor Network aligns more than three ports on decarbonising their shared corridors. To bring the rest of the world’s ports and trade routes under green shipping corridors would be a complicated undertaking, to say the least.

With data from MDS Transmodal, the United Nations Conference on Trade and Development (UNCTAD) illustrated this port connectivity in two key figures, shown below. The figures describe each port’s position in the shipping network by two metrics:

- The node *degree*: the number of other ports with which the port has a direct connection
- The node *betweenness*: How important is a port for trade between other ports that connect with each other via transshipment.

Figure 1 depicts the top 50 ports ranked by *degree* (all data is for the second quarters of each year). **Figure 2** shows the top 50 ports ranked by their *betweenness* [13].

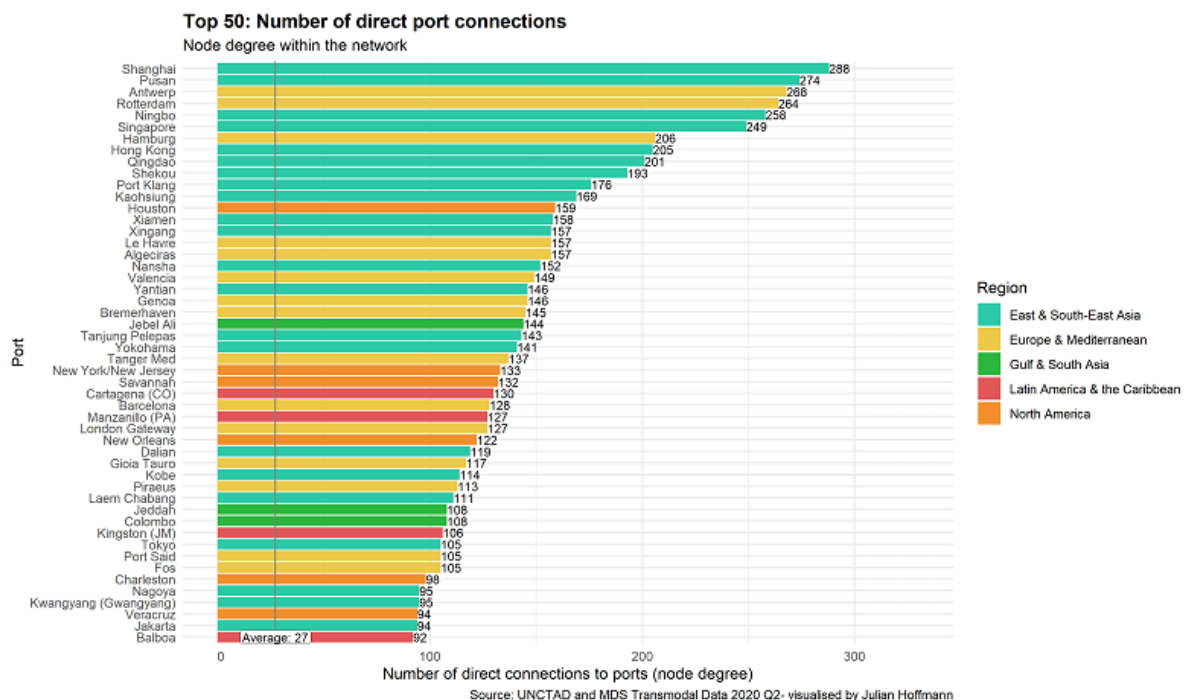


Figure 1: The world’s top 50 container ports by *degree*, 2020

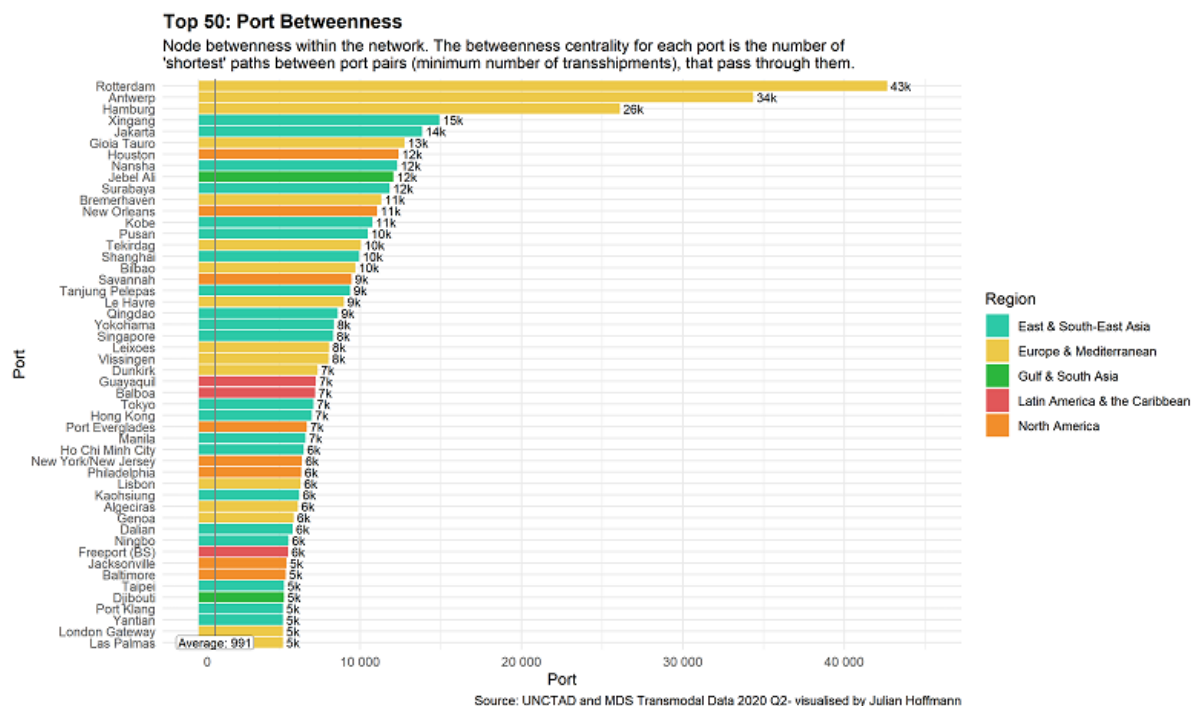


Figure 2: The world's top 50 container ports by *betweenness*, 2020

The study highlighted the Port of Rotterdam as the leader for *betweenness*, meaning it is a key stop for the highest number of indirect shipping routes. Approximately 43,000 shipping corridors include Rotterdam on their optimal routes, which is nearly 10 per cent of the global total of 440,391 port-to-port connections [14].

To put it simply, it would take thousands of multi-port green shipping corridor agreements to decarbonise the industry from a corridor approach. Given what we have seen in green shipping corridor development in the last twelve months, these corridors will take years to progress from concept to zero emissions. While ports should continue to pursue green shipping corridors as a means to jumpstart development of zero-emission infrastructure and fuels along the most heavily trafficked trade routes, ports of all sizes can simultaneously pursue regional collaboration to accelerate the global transition. This approach is our best chance of deep and swift industry decarbonisation.

2.4 DECARBONISATION IS A WHOLE SYSTEM CHALLENGE & OPPORTUNITY

Research by University Maritime Advisory Services (UMAS) and the Energy Transitions Commissions for the Global Maritime Forum for the Getting to Zero Coalition (ETC) shows that 87 per cent of the investments needed to decarbonise shipping are for land-based infrastructure and production facilities for low carbon fuels. On the study, Lord Adair Turner, Chair of the Energy Transitions Commission affirmed: "Much of shipping's decarbonisation will take place on land. It is a systemic transformation that goes beyond the capabilities of the maritime industry alone. We need to bring together the full range of upstream and downstream fuels value chains to unlock shipping's shift to zero carbon energy sources. Done right, this represents a trillion-dollar market opportunity" [15].

Ports can leverage public- and private-sector funding to stake a claim in this trillion-dollar market – positioning themselves as market makers and leaders in the clean energy transition for ocean shipping. Studies show that the U.S. [16], Morocco [17], Chile [18], South Africa [19], Mexico [20], Indonesia [21], and other countries around the globe have significant potential to develop renewable energy projects for zero-emission shipping fuel. For ports to engage on this development, they will need to collaborate with clean energy industry, utilities, regulators and the broader energy market. This is a tall order for ports of varying size and economic influence, but there are ways for ports to level up, and it starts with regional collaboration.

3. SCALING DECARBONISATION: INTERNATIONAL BLOCS FOR ZERO-EMISSION SHIPPING

3.1 REGIONAL POLICY AS A MODEL

3.1 (a) The European Union's ETS & FuelEU Maritime

In July 2022, the European Parliament adopted a historic proposal to include shipping emissions in the European Union (EU)'s Emissions Trading System (ETS), which is the bloc's cap-and-trade system [22]. The program's scope will include CO₂ emissions from large ships above 5,000 gross tonnage, regardless of ship flag. g. The extension will include "all emissions from ships calling at an EU port for voyages within the EU (intra-EU) as well as 50% of the emissions from voyages starting or ending outside of the EU (extra-EU voyages), and all emissions that occur when ships are at berth in EU ports" [23].

The European Union's (EU) Fit for 55 package includes the FuelEU Maritime proposal to reduce the greenhouse gas (GHG) intensity of energy of marine fuels. In October 2022, the European Parliament approved a target to reduce GHG intensity 80 per cent by 2050 from a 2020 baseline. The target applies to all energy used on ships involved in intra-EU traffic and 50 per cent of energy used for outbound and inbound international voyages [24].

Although the policies are pending finalisation through the EU trilogues – the inter-institutional negotiations for the adoption of EU legislation – we see how a bloc of nations committed to a common goal can target emissions from this sector via standardized policy and market mechanisms. Of course, the EU is unique in that it has created a robust structure for international governance and regulation, but regional alliances need not have this structure to adopt common goals and standardized policies for decarbonisation.

3.1 (b) U.S. Clean Shipping Act of 2022

In the United States, California Representative Alan Lowenthal introduced federal legislation that would mandate the shipping industry to achieve 100 per cent GHG reductions by 2040. Specifically, the bill directs the EPA to promulgate regulations by January 1, 2026, to reduce GHG emissions from marine vessels of 400 gross tonnage and above that call on ports in the United States. The bill also directs the EPA to require zero in-port emissions from marine vessels by 2030. Like the FuelEU Maritime policy, the U.S. Clean Shipping Act focuses on the carbon intensity of marine fuels, but the legislation requires decarbonisation on a faster timeline than EU – calling for 100 per cent reductions by 2040 [25].

If the Clean Shipping Act passes, ports could leverage existing funding designated by the U.S. Inflation Reduction Act (H.R. 5376, Sec. 60102). Included in the IRA is a USD 3 billion allocation for Grants to Reduce Air Pollution at Ports, plus an additional USD 1 billion to replace heavy-duty vehicles with zero-emission alternatives, including those that service ports [26]. Beyond the IRA, U.S. ports can already access funding through the U.S. Department of Transportation Maritime Administration (MARAD) Port Infrastructure Development Program (PIDP), which grants awards for environmental projects including electrification, hydrogen infrastructure and coastal resiliency [27].

This policy plus funding combination demonstrates how nations can support port infrastructure for zero-emission shipping while mandating a zero-emission transition from the industry at large. As regions consider how best to approach these alliances, nations must prioritize funding and financing to accelerate sustainable infrastructure development for renewable electricity, batteries and zero-emission marine fuel hubs.

3.2 REGIONAL PORT COLLABORATION IN THE PACIFIC NORTHWEST

Along the Northwest Pacific Coast of the U.S. and Canada, ports have joined forces to alleviate competitive pricing *and* to encourage environmental action above competition. This regional collaboration demonstrates the power and benefit of allying with domestic and international partners.

In 2014, the seaports of Seattle and Tacoma in Washington, U.S. "announced a bold vision: instead of competing, the two ports would join forces and form an alliance to better compete on a global scale." The ports established the Northwest Seaport Alliance (NWSA) in 2015, the first of its kind marine cargo operating partnership for North America. Under a port development authority, the NWSA manages the container, breakbulk, auto and some bulk terminals in Seattle and Tacoma. Today, NWSA is the fourth-largest container gateway in the U.S., handling USD 66 billion of waterborne trade with 189 trading partners globally in 2020. The Alliance collaborates with the Ports of Seattle and Tacoma – which still operate independently – to enhance the region's community by creating jobs, reducing the gateway's environmental footprint and boosting the state's economy [28].

Washington's key ports took their collaboration international with the Northwest Ports Clean Air Strategy (NWPCAS). First adopted in 2008, the strategy sought to "encourage environmental action above competition" to reduce seaport-related emissions that contribute to air pollution in the shared Puget Sound-Georgia Basin Air shed. The Northwest Seaport Alliance, Port of Seattle, Port of Tacoma and Port of Vancouver, British Columbia adopted the updated Northwest Ports Clean Air Strategy in 2021 with a vision to "phase out emissions from seaport-related activities by 2050, supporting clean air for our local communities and fulfilling our shared responsibility to help limit global temperature rise to 1.5°C." The initiative seeks to reduce emissions from ocean-going vessels, drayage trucks, cargo-handling equipment, rail, harbour vessels and port administration and facilities [29].

Partners of the NWPCAS initiative include the U.S. Environmental Protection Agency, the Washington State Department of Ecology, Puget Sound Clean Air Agency, Metro Vancouver, Province of British Columbia, Transport Canada, and Environment Canada, with input from non-governmental organizations, near-port community groups, industry, and local governments. The international initiative ensures that "environmental performances is not compromised but driven forward over and above competing interests" [30].

The Northwest Seaport Alliance and the NWPCAS demonstrate that allied action can enable ports to succeed both economically and environmentally to benefit the greater good. That is, ports need not choose between economic profitability and environmental responsibility. These alliances serve as a model for what green shipping corridors have the potential to become – an international network of port alliances committed to a zero-emission future for shipping.

3.3 ESTABLISHING REGIONAL ALLIANCES

International blocs of high ambition ports can complement and reinforce green shipping corridors. More importantly, addressing emissions from shipping on a regional level – much like the European Union is working to do with the European Trading Scheme and FuelEU Maritime – can provide stronger pollution and emissions reductions for regional air sheds and maximize the environmental and economic benefits of a zero-emission shipping industry.

3.3 (a) Economic and Environmental Benefits of a Regional Alliance on Zero-Emission Shipping

By leveraging economic buying power and public-private investments and aggregating demand for renewable electricity and zero-emission fuels, regional alliances can develop infrastructure at scale, create clusters for innovation and promote rapid deployment of zero-emission ships. Moreover, international collaboration will ensure that ports of all sizes, economic niches and vessel specialisation can reduce emissions on a trajectory commensurate with our collective climate emergency.

By advancing a regional commitment to achieve zero-emission shipping by 2040, nations, sub-nationals and their ports can:

- Establish common targets and policies to standardize regional compliance for ships.
- Maximize national funding earmarked for infrastructure development by demonstrating unified prioritisation to decarbonise shipping and reduce pollution.
- Accelerate adoption of electric shore power and zero-emission fuels.
- Send unified market signals to the cargo shipping value chain.
- Level the playing field for ports to progress in a collaborative environment.
- Identify market gaps for the region, creating economic opportunities for smaller ports, including handling specialty cargo or specialised vessels.
- Unite ambition across shipping and aviation for joint sea- and airport authorities for scalable decarbonisation across freight transportation sectors.

3.3 (b) Goals and Implementation

Once established, regional alliances must agree on a common mission and goals. The mission is already set accelerate ocean shipping decarbonisation and eliminate emissions by 2040 in order to align with a 1.5 degrees Celsius scenario. This target is based on shipping's proportional share of the remaining 1.5 degrees Celsius and 2 degrees Celsius carbon budgets of 10 Gigatons (Gt) and 17 Gt, respectively [31].

Each region should collaborate to achieve three key goals:

- Create an international, high ambition bloc of nations, sub-nationals and ports.
- Advance a common regulatory and funding framework to eliminate emissions from ocean-going vessels by 2040.

- Achieve measurable progress benchmarks for zero-emission ports and shipping, accounting for emissions from ships on route, on shore and in harbour.

Our *Ports Playbook for Zero-Emission Shipping* lays out three main tracks for ports to achieve zero-emission shipping: commitments, policy and progress. These tracks lay out nine actions to end port pollution, accelerate the market for zero-emission technologies, reward first movers and ensure reliable access to zero-emission infrastructure and fuels [32]. As nations, sub-nationals and ports work to develop their goals and implementation strategies for zero-emission shipping, we encourage a standardized set of commitments, policies and progress priorities like those in the *Ports Playbook*.

3.3 (c) Framework & Convention

Based on port ownership models and the necessitated involvement of regulatory and government agencies, there is no one-size-fits-all model for governing regional alliances. However, we recommend alliances to incorporate the following steps and processes into their framework, convening and implementation plans:

- Establish a forum for alliance communications.
- Hold an inaugural meeting for stakeholder alignment, goal setting and timeline planning.
- Integrate input and support from community, environmental justice, climate action and labour groups, and designate stakeholder representatives from each group.
- Set short-term (interim) targets to achieve measurable progress benchmarks on the path to zero emissions.
- Conduct ongoing initiative assessments and progress reports.

These steps and processes are critical to developing, implementing and achieving a just and equitable zero-emission transition for the region and its people.

3.3 (d) Priority Regions for Alliances

Any combination of countries within a region could ally to form an international bloc of high ambition ports. Taking into account the world's largest container ports, critical impact zones for air pollution caused by shipping, and regions ripe for economic and clean energy development, we have identified several regions critical to scaling decarbonisation, including:

- **The Western Pacific**, spanning from Alaska, U.S. through British Columbia, Canada, the U.S. states of Washington, Oregon and California to the Pacific Coast of Mexico.
- **The Eastern Pacific and Southeast Asia**, including key port nations of Japan, the Republic of Korea, Singapore, China, Malaysia, Thailand, Taiwan, Indonesia and Vietnam.
- **The North Atlantic and Baltic Sea**, including the ports of Western Europe and Scandinavia.
- **The Eastern Atlantic**, including Canadian and U.S. East Coast ports, including the Ports of Montreal, Canada; New York-New Jersey; and Savannah, Georgia.
- **Central and South America**, including key ports in Brazil, Panama, Colombia, Peru and Ecuador.
- **Southern Europe and the Mediterranean**, including key ports in Spain and Greece.
- **Africa and the Middle East**, including ports in Sub-Saharan Africa and the coasts of the Arabian Sea.

3.4 REGIONAL COLLABORATION ADDRESSES ECONOMIC CONCERNS ON DECARBONISATION

3.4 (a) Claims of Cargo Diversion Are a Red Herring

Ports around the world have hesitated and balked on climate action for myriad reasons, chiefly among them: fear of cargo diversion. Port authorities claim that adopting policies mandating zero-emission ships will divert cargo from their docks, resulting in reduced profits and economic harm to the port, its labourers and its community.

This argument fails to consider the opportunity costs of such evasive behaviour against the cost of complying with regulatory requirements. Ocean shipping is the most efficient and cost-effective method of international transportation for the movement of goods, moving 90 per cent of total cargo every year [33], meaning that transshipping cargo through indirect trade routes or alternative modes of transport (air, rail, or truck) would significantly increase the cost of getting those goods to their final destination. In the case of major direct and throughput trade routes, shipping companies would be unlikely to divert cargo to a neighbouring port unless the opportunity cost (increased cost of transshipment) was less than the increased cost of compliance at the primary port.

Analysis conducted by the European Commission as part of its Impact Assessment of the FuelEU Maritime legislative proposal support this principle. The assessment concluded that re-routing trips to neighbouring countries to evade FuelEU

Maritime requirements would be more costly than simply complying with the requirements [34]. In short, evading compliance by re-routing ships would be more costly than compliance and untenable as a long-term solution.

When considering standardised policies adopted on a regional scale, long-distance cargo diversion is even less probable. For example, rerouting Trans-pacific trade to Atlantic seabords is highly unlikely to be economically feasible. Beyond the opportunity costs of transshipment, this argument ignores the significant logistical complexities of international re-routes, including new ocean and hinterland transport routes and potential international import complications.

3.4 (b) The Cost of Decarbonisation is High, but Negligible

Decarbonising the global ocean shipping industry is an expensive undertaking. UMAS and ETC estimate that full decarbonisation by 2050 would cost USD 1.4 trillion to 1.9 trillion [35].

Despite this hefty price tag, studies show that economies of scale in global supply chains can absorb the vast majority of increased transport costs to cargo companies. In 2022, the European Federation of Transport & Environment estimated what effect the EU's existing proposal to charge carbon pollution from ships, combined with the proposal to mandate small amounts of green e-fuel use by 2030, would have on container shipping pricing and consumer goods coming from China. The results debunked claims that industry decarbonisation would be prohibitively expensive and cause exorbitant price hikes for consumers – finding that running ships entirely on green hydrogen-based fuels (e-fuels) would add less than EUR 0.10 to the price of a pair of trainers, and up to EUR 8.00 for a refrigerator [36].

3.4 (c) Regional Collaboration Can Help End Fossil Fuel Investments This Decade

One of the most important benefits of regional alliances on shipping decarbonisation would be ending fossil fuel investments this decade, including investments in liquefied natural gas (LNG). LNG is not an emissions-reduction fuel; in fact, it is often worse on a well-to-wake basis than conventional fuels. LNG is 85-95 per cent methane, which is up to 86 times more potent than CO₂ on a shorter timescale [37]. Increasing the use of LNG as a marine fuel will exacerbate the industry's effect on global warming. Regional alliances can counter and stop this dangerous trajectory by ending LNG's future as a marine fuel, and shifting focus to renewable electricity, batteries, energy efficiency, wind propulsion and zero-emission marine fuels, including green hydrogen-based fuels like green methanol and liquid green hydrogen for fuel cells.

Luckily, existing fleets can be retrofitted or accommodate green hydrogen fuels, in addition to new dual-fuel ships that will replace the most heavily polluting ships on the water. Studies from the International Council on Clean Transportation found that 99 per cent of the voyages made along the U.S.-China container shipping container corridor could be powered by green hydrogen, with only minor changes to fuel capacity or operations. For example, ships would need retrofits to replace 5 per cent of cargo space with hydrogen fuel storage or to add one additional port of call to refuel [38].

4. CONCLUSIONS

Building on the success of green shipping corridors, international blocs of high ambition ports formed under regional alliances have the potential to accelerate the transition to zero-emission shipping this decade. Given the urgency of our climate, ecological and public health crises, the trajectory of global shipping growth, and the importance of a sustainable shipping economy, zero-emission shipping is a moral imperative for all nations, sub-nationals and ports.

5. ACKNOWLEDGEMENTS

Pacific Environment is a global environmental organisation with a mission to protect communities and wildlife of the Pacific Rim. We support community leaders to fight climate change, protect the oceans, build just societies and move from fossil fuels toward a green economy. Pacific Environment has a consultative status at the International Maritime Organization (IMO).

In September 2022, Pacific Environment launched its **Ports for People** campaign to end port and ship pollution. Together with local communities, allies and partners, Ports for People seeks to transform ports from hotspots of fossil fuel pollution to thriving hubs of sustainable economic development and environmental protection – where clean tech innovations enable port communities to benefit from renewable energy, clean air and clean oceans, and provide a safe home for people and wildlife to live in harmony. Learn more at www.portsforpeople.org.

This report builds on our **Ports Playbook for Zero-Emission Shipping**, which calls on ports to take action across three lines of efforts: commitments, policy and progress. These tracks lay out nine actions that will end port pollution, accelerate the market for zero-emissions technologies, reward first movers and ensure reliable access to zero-emissions infrastructure and fuels.

The author appreciates the support of her team at Pacific Environment, including strategic guidance, policy, research and editorial support from Madeline Rose, Climate Campaign Director; Teresa Bui, State Climate Policy Director; and Antonio Santos, Federal Climate Policy Director. We are grateful to the many port communities, port authorities and shipping and maritime experts who provide valuable insights to inform our *Ports for People* campaign. We would also like to acknowledge the impactful work of our campaign partners and allies, including Opportunity Green, Friends of the Earth-U.S., World Wildlife Fund-Mexico, the International Council on Clean Transportation (ICCT), the European Federation for Transport & Environment, Ocean Conservancy, Interamerican Association for Environmental Defense, member organisations of T.H.E. Impact Project and the Moving Forward Network.

6. REFERENCES

1. SCHLANGER, Z., 'If shipping were a country, it would be the world's sixth-biggest greenhouse gas emitter', *Quartz*, 18 April 2018.
2. UNIVERSITY OF DELAWARE, 'New fuel standards will decrease childhood asthma cases: Most significant improvement in global fuel standards for the shipping industry in 100 years, will also reduce number of premature deaths', *Science Daily*, 07 February 2018.
3. COMER, B., 'Zero-emission shipping and the Paris Agreement: Why the IMO needs to pick a zero date and set interim targets in its revised GHG strategy', *ICCT*, 08 September 2021.
4. 'Clydebank Declaration for Green Shipping Corridors', *COP26*, 2021.
5. 'Fact Sheet: President Biden to Galvanize Global Action to Strengthen Energy-Security and Tackle the Climate Crisis through the Major Economies Forum on Energy and Climate', *The White House Briefing Room*, 17 June 2022.
6. 'The Port of Antwerp and the Port of Montreal pledge to create a green shipping corridor', *American Journal of Transportation*, 04 November 2021.
7. 'Port of Los Angeles, Port of Shanghai, and C40 Cities announce partnership to create world's first transpacific green shipping corridor between ports in the United States and China', *C40 Cities*, 28 January 2022.
8. 'Port of Long Beach joins the Green Shipping Corridor', *Port of Long Beach*, 09 June 2022.
9. 'Port of Los Angeles, Port of Shanghai, and C40 Cities announce partnership to create world's first transpacific green shipping corridor between ports in the United States and China', *C40 Cities*, 28 January 2022.
10. CHAMBERS, S., 'Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping launches port partnership to establish the European Green Corridors Network', *Splash247.com*, 30 March 2022.
11. 'World's Longest Green Corridor Planned between Singapore and Rotterdam', *The Maritime Executive*, 02 August 2022.

12. HOFFMAN, JAN; HOFFMAN, JULIAN, 'Ports in the global liner shipping network: Understanding their position, connectivity, and changes over time', *UNCTAD Transport and Trade Facilitation Newsletter N°87, Third Quarter 2020, Article No. 57*, 10 August 2020.
13. *Id.*
14. *Id.* Footnote [i] The network is considered symmetric, so the total number of bilateral connections is $939 \times (939 - 1) / 2 = 440,391$.
15. UMAS; ETC, 'New Study by UMAS Shows that Decarbonisation of the Shipping Sector is a Whole System Challenge and Not Something Just for Shipping', *UMAS*, January 2020.
16. GEORGEFF, E., ET AL., 'Scaling U.S. Zero-Emission Shipping: Potential Hydrogen Demand at Aleutian Islands Ports', *ICCT*, 22 June 2022.
17. ASH, N.; SCARBROUGH, T., 'Sailing on solar: Could green ammonia decarbonise international shipping?', *Environmental Defense Fund*, May 2019.
18. ASH, N., ET AL., 'Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile', *Environmental Defense Fund*, 2019.
19. ENVIRONMENTAL DEFENSE FUND; RICARDO ENERGY & ENVIRONMENT, ET AL., 'South Africa: fueling the future of shipping', *Global Maritime Forum, P4G Getting to Zero Coalition Partnership*, June 2021 [Revised June 2022].
20. CARPENTER-LOMAX, O., MARTINEZ, V.; WILKINSON, G.; ENVIRONMENTAL DEFENSE FUND; RICARDO ENERGY & ENVIRONMENT, 'Mexico: fuelling the future of shipping', *Global Maritime Forum, P4G Getting to Zero Coalition Partnership*, September 2021 [Revised June 2022].
21. CARPENTER-LOMAX, O., MARTINEZ, V.; WILKINSON, G.; ENVIRONMENTAL DEFENSE FUND; RICARDO ENERGY & ENVIRONMENT, 'Indonesia: fuelling the future of shipping', *Global Maritime Forum, P4G Getting to Zero Coalition Partnership*, November 2021 [Revised June 2022].
22. SCHULER, M., 'EU Parliament votes to include shipping in EU carbon market', *gCaptain*, 22 June 2022.
23. 'Reducing emissions from the shipping sector', *The European Commission*.
24. BOCKMANN, M.W., 'EU Parliament passes world's first marine fuel targets for decarbonisation', *Lloyd's List*, 19 October 2022.
25. H.R. 8336 – Clean Shipping Act of 2022, *U.S. Congress*, 12 July 2022 [introduced].
26. MANDRA, J.O., 'US ports eye \$3bln for electrification from Inflation Reduction Act', *Offshore Energy*, 09 August 2022.
27. 'Port Infrastructure Development Grant Information', *U.S. Department of Transportation, Maritime Administration (MARAD)*.
28. NORTHWEST SEAPORT ALLIANCE, 'About Us', *nwseaportalliance.com*.
29. NORTHWEST SEAPORT ALLIANCE, 'Northwest Ports Clean Air Strategy', *nwseaportalliance.com*.
30. *Id.*
31. COMER, B., 'Zero-emission shipping and the Paris Agreement: Why the IMO needs to pick a zero date and set interim targets in its revised GHG strategy', *ICCT*, 8 September 2021.
32. BROWNE, A.; O'LEARY, A., 'Ports Playbook for Zero-Emission Shipping', *Pacific Environment*, <https://portsforpeople.pacificenvironment.org/policymaker/ports-playbook/>, 20 September 2022.
33. 'Ocean shipping and shipbuilding', *OECD*, <https://www.oecd.org/ocean/topics/ocean-shipping/>.
34. 'Impact Assessment Accompanying the Proposal for a Regulation of the European Parliament and of the Council on the use of renewable and low-carbon fuels in maritime transport: Annex 4: Analytical methods, 7. Methodological approach and results of the risk of carbon leakage analysis', *European Commission*, 14 July 2021.

35. UMAS; ETC, ‘New Study by UMAS Shows that Decarbonisation of the Shipping Sector is a Whole System Challenge and Not Something Just for Shipping’, *UMAS*, January 2020.
36. ‘Green shipping would add just 8 cents to a pair of Nikes’, *Transport & Environment*, 28 June 2022.
37. PAVLENKO, N., ET AL., ‘The Climate implications of using LNG as a marine fuel’, *ICCT*, 28 January 2020.
38. MAO, X., ET AL., ‘Refueling Assessment of a Zero-Emission Container Corridor between China and The United States: Could Hydrogen Replace Fossil Fuels?’, *ICCT*, 03 March 2022.

7. AUTHOR’S BIOGRAPHY

Allyson Browne serves as Pacific Environment’s Climate Campaign Manager, Ports, leading their *Ports for People* campaign to end port and ship pollution and emissions. Allyson has more than ten years of experience in renewable energy, climate, and sustainability, including expertise in sustainable policy development and implementation, campaign and program management, and impactful research and data analysis. Allyson previously served as Director of Regulatory Affairs & General Counsel for SRECTrade, where she collaborated with solar industry and grassroots organizations to advocate for renewable energy policies in U.S. states. As Chief of Staff to Jared Blumenfeld for California Governor Gavin Newsom’s 2018 gubernatorial campaign, Allyson led a team to develop policies on a range of climate and energy issues. She has contributed to climate-related projects in fields ranging from renewable energy and energy efficiency in the cannabis industry to developing a global database of climate movements with Climate 2025.

Allyson holds a Juris Doctor degree from Golden Gate University School of Law, with a focus on Environmental Law and on EU & French Law studies at the Université Paris Nanterre in Paris, France. She earned her bachelor’s degree in Business Administration from the University of Southern California, Marshall School of Business, with a concentration in International Business and a Spanish Language Minor from the College of International Studies in Madrid, Spain.