



Ports Playbook for Zero-Emission Shipping

WRITTEN BY:

Allyson Browne, Pacific Environment
Aoife O’Leary, Opportunity Green

September 2022

 Ports for People

 opportunity
Green

 PACIFIC
ENVIRONMENT



Table of Contents

Introduction	4
9-point playbook	8
Commitments	9
Policy	14
Progress	20
National and international shipping policy	23
The price of zero	25
Fossil fuels & biofuels cannot get us to zero by 2040	26
Conclusion	27
About us	29
Acknowledgments	30
Annex 1: Glossary	32
Annex 2: Endnotes	33

Introduction

Today, 50,000 ships hauling 90% of the world's cargo emit as much carbon dioxide as Germany.¹ If maritime shipping were its own country, it would be the sixth largest polluter of climate-warming emissions in the world.² These greenhouse gases (GHG) include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Air pollution from ships 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.³

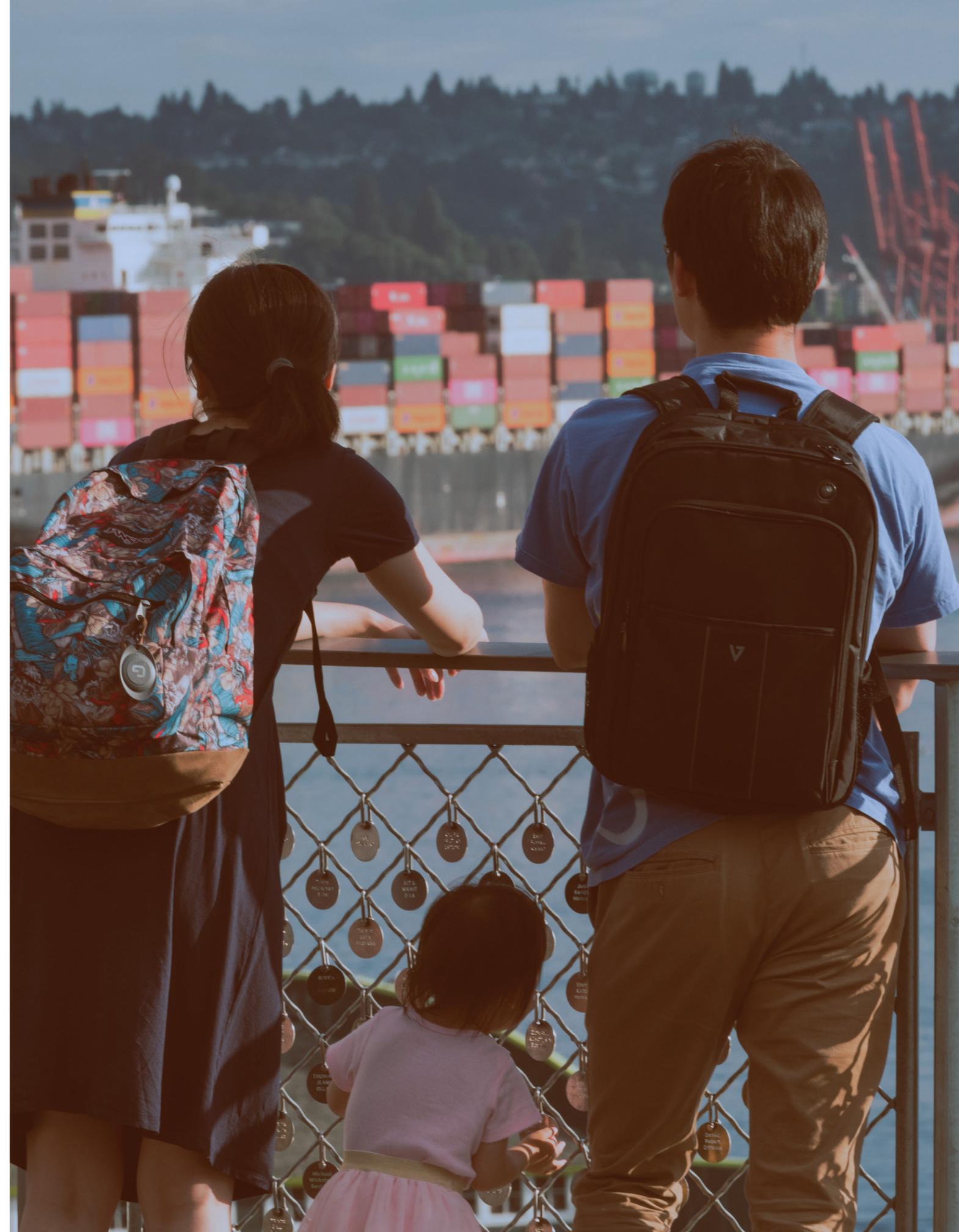
While industry efforts are underway to decarbonize shipping in compliance with the United Nations International Maritime Organization's (IMO) initial GHG strategy, the goal is severely inadequate to keep global warming under 1.5°C. Currently, the IMO GHG strategy sets a target to reduce total annual GHG emissions from international shipping by at least 50% by 2050, compared to 2008 levels.⁴ However, based on the updated carbon budgets from the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report, shipping's proportional share of the remaining 1.5°C and 2°C carbon budgets is about 10 Gigatons (Gt) and 17 Gt, respectively.⁵ With maritime trade expected to triple today's volumes by 2050,⁶ the industry must achieve zero GHG emissions by 2040 in order to align with a 1.5°C scenario, or zero by 2050 for a 2°C scenario.⁷

Now, we need a tipping point in the maritime value chain that can set the industry onto a path of accelerated action. As we see it, ports have the power to trigger this chain reaction. Many ports are powerful economic engines, and they possess substantial legal power too. Through port state authority, ports can establish rules and regulations for all ships calling their port, set and negotiate fees, and prioritize infrastructure projects that support electrification and zero-emission fuel bunkering capacity. Even small or niche operation ports can support industry decarbonization.

All ports around the world have this legal power of port state authority. The United Nations Convention on the Law of the Sea (UNCLOS) reflects this position.⁸ In this report, "port" is inclusive of all relevant entities charged with "port state" powers and authorities.

The depth and breadth of port authority varies based on the nation's laws and port ownership models. Therefore, ports must work collaboratively with government and private sector partners to maximize impact and affect change. In particular, ports must work closely with agencies that regulate air quality and environmental protection, ensuring that their combined efforts will be sufficient to achieve zero GHG emissions by 2040.

By leveraging port state authority and economic power, and collaborating with government partners and industry stakeholders, ports can play a leadership role in catalyzing the zero-emission ocean shipping transition this decade — and beyond.



9-POINT PLAYBOOK

We are urging ports to take high ambition action across three lines of effort:



1. COMMITMENTS

These three categories prioritize actions that will end port pollution, accelerate the market for zero-emission technologies, reward first movers and ensure reliable access to zero-emission infrastructure and fuels.

Our playbook provides ports with an opportunity to leverage their legal authority and economic power to revitalize port communities with sustainable and resilient port infrastructure, safe and stable jobs for new and existing port workers, and improved human and ecosystem health.



2. POLICY



3. PROGRESS

We acknowledge that the global shipping industry is complex, and that ports cannot bear the burden of this transition alone. Along with many industry decarbonization initiatives, we support collaborative efforts to develop the energy market necessary to deploy renewable electrification and zero-emission fuels at scale. We recognize the foundational work of the Global Maritime Forum, the Aspen Institute's Shipping Decarbonization Initiative and Cargo Owners for Zero Emission Vessels Initiative (coZEV), C40's Green Ports Forum and industry associations like the International Association of Ports and Harbors (IAPH). IAPH's World Ports Climate Action Program and the Environmental Ship Index (ESI) partnership with the Green Award Foundation serve as great models for progress.

Now, ports must act with ambition, speed and scale. This transition is more than an imperative for our climate, community and ocean health — it is the most sustainable and equitable way for ports to ensure stable growth and enduring profitability in a competitive industry confronting global challenges and a changing climate.

Our 9-point playbook challenges ports to take ambitious action across three lines of effort, with a focus on bold commitments, progressive policies and demonstrable progress.

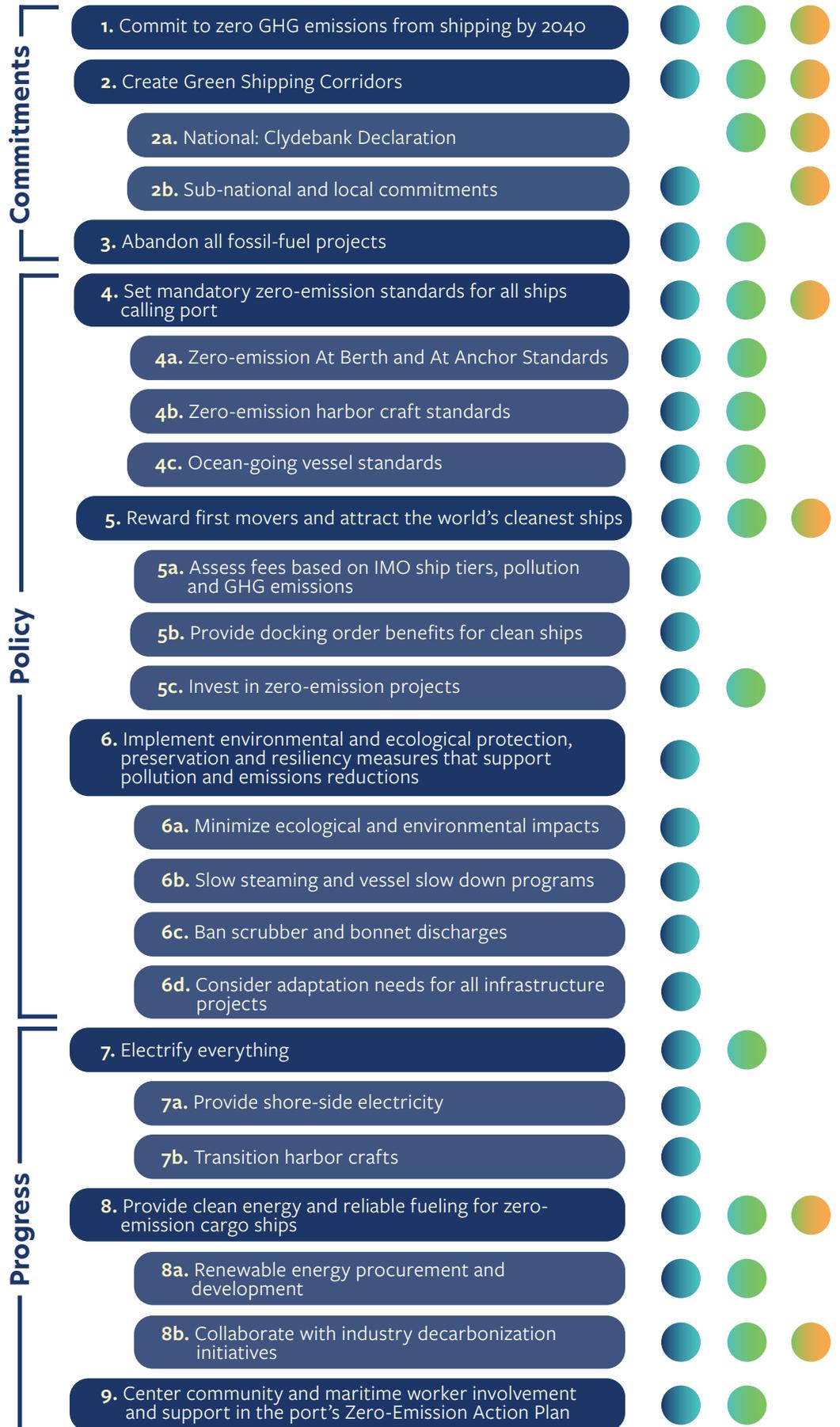
Together, these tracks prioritize nine recommendations to accelerate ambition to zero-emission shipping by 2040, incentivize adoption and early compliance and deploy immediate measures to reduce air quality pollutants and greenhouse gas emissions. Our recommendations cover ships, shore and harbor operations and aim to advance a common regulatory and investment framework to reduce emissions from ocean shipping. Ports can integrate these actions into their existing and future clean air and climate plans, or adopt Zero-Emission Action Plans.

When implemented in collaboration with an international network of green ports, these actions will have a ripple effect on the industry, starting with market signals to the cargo shipping value chain to build zero-emission vessels at scale and to retrofit existing ships with lifesaving and energy-saving technologies. To achieve this transformation, ports must unite behind a network of high ambition blocs that propel the industry on a 2040 trajectory. Shipping decarbonization will drive billions of dollars of economic investment into ports and port communities, including infrastructure development and sustainable job creation, while simultaneously improving the health of local communities through reduced air, water and land pollution.

9-POINT PLAYBOOK FOR PORT ACTION

Our 9-point action plan recommends commitments, policies and immediately actionable progress for ports and their government partners at the local, national and international levels. This framework can help ports mobilize against the climate crisis and play their part in building a healthier future for port-adjacent communities and the most climate-vulnerable populations around the world.

We recognize that ports possess varied levels of port state authority based on different port and terminal ownership structures. For this reason, we acknowledge that multiple levels of government may be involved or required for taking these actions. Our recommendations focus on elements that ports, at minimum, hold a significant power to influence, adopt and implement under port state jurisdiction.



COMMITMENTS



The first step for climate action is committing to a zero-emission future. These commitments may require collaboration with local, state, national, and international partners. They may take form as policies at the port, city, or sub-national (state level), national commitments or international agreements. Irrespective of form, ports must dedicate port policy, resources and investment to deliver on these commitments.

1. Commit to end port and shipping pollution with a goal of zero GHG emissions by 2040. Announce, publish and implement a port-specific **Zero-Emission Action Plan** (co-designed with the local community) that includes:

- a. Concrete GHG emissions targets in line with the Paris Agreement goal of a maximum 1.5°C of warming, including emissions from all the ships that call at the port in an effort to address emissions in international waters, as well as a detailed plan for emission inventory tracking, management and analysis.

Emission Control Areas

Emission Control Areas (ECAs) are areas where ships are subject to air pollution limits via pollution regulations contained in the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI.⁹ They exist around some of the European and North American coastlines, including the

Pacific and Atlantic coasts of the U.S. and Canada, the U.S. coast of the Gulf of Mexico, the U.S. Caribbean Sea area, the U.S. coasts of the Hawaiian Islands and the Atlantic coast of France. Additional ECAs include the Baltic Sea area and the North Sea area, including the English Channel.¹⁰

In June 2022, the IMO approved the designation of the Mediterranean Sea Emission Control Area for sulfur oxides and Particulate Matter (Med Sox ECA), which will be considered for adoption at the 79th session of the IMO's Marine Environment Protection Committee (MEPC), taking place in December 2022.¹¹

China and South Korea have also designated their own ECAs; however, their ECAs are domestic law and are not IMO-designated.

Although ECAs bring reduced emissions of smog-forming nitrogen oxide (NO_x), sulfur and particulate matter (PM) compared to similar-sized ports elsewhere, ECAs do not address climate impacts, and they require country-level action through the IMO.

Nonetheless, ports should work with national governments and the IMO to bolster emission control areas along all coasts, supporting a common standard for pollution and emission reductions for ports within each ECA, and creating a global network of ECAs.

Calculating emissions for voyages: the EU's proposed strategy

In July 2022, the European Parliament voted to adopt the European Commission's proposal to include shipping emissions in the European Union (EU) Emissions Trading System (ETS), which is a cap-and-trade system for emissions in the EU.¹² The policy is part of the EU's Fit for 55 legislative package, also known as the European Green Deal.¹³

The program's scope will include Co₂ emissions from large ships (above 5,000 gross tonnage), regardless of ship flag. 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."¹⁴

Whether ports choose to measure emissions within their air shed boundary or set a clear-cut percent of emissions per voyage, stakeholders must collaborate to ensure accurate and complete accounting of at sea and at berth emissions.

- b. A roadmap and timeline to require 100% at berth electrification by no later than 2030, with plans for lifecycle zero-emission electrification, including onsite renewable energy generation, power purchase agreements for renewable electricity and/or long-term planning with utilities to procure renewable electricity for electrification.
- c. A ban on fossil-fueled ships entering the port no later than 2040 and a pathway for 100% zero-emission harbor craft by 2035.
- d. Beyond the GHG emissions target, a roadmap and timeline to reduce and eliminate air quality and water pollutants from all vessel types that operate in or dock at the port.
- e. The steps the port will take to explore the feasibility of and enter into one or more green shipping corridor networks by 2025.
- f. A jobs plan demonstrating how the port will contribute to the development of local zero-emission maritime-related careers, with a focus on job training, safety and a just transition for the port community, including support sponsored by national or state jobs programs.
- g. A project funding and budget plan for critical decarbonization infrastructure projects, including onshore power, zero-emission fuel bunkering facilities and programmatic components of the port's Zero-Emission Action Plan. This plan should include identifying existing sources of government funding as well as targets for additional sources of funding, including private financing.

U.S. Inflation Reduction Act allocates \$3 billion for ports

In August 2022, U.S. President Joe Biden signed into law the Inflation Reduction Act (IRA), which provides deficit reduction funding to fight inflation, invest in domestic energy production and manufacturing and reduce carbon emissions by roughly 40% by 2030. Included in the IRA is a \$3 billion allocation for Grants to Reduce Air Pollution at Ports, plus an additional \$1 billion to replace heavy-duty vehicles with zero-emission alternatives, including those that service ports.¹⁵

U.S. ports must develop plans and programs eligible for this funding — and they need to start now. Eligible infrastructure projects include electric charging stations and onshore power, or cold ironing stations, onsite renewable energy generation and storage systems and bunkering for zero-emission shipping fuels.

In addition to the IRA grant, U.S. ports can access funding through the U.S. Department of Transportation Maritime Administration (MARAD) Port Infrastructure Development Program (PIDP), which can grant awards for environmental projects including electrification, hydrogen infrastructure and coastal resiliency.¹⁶

Around the world, ports should seek government funding for critical infrastructure development to improve their environmental and public health impact, economic efficiency and resiliency in the wake of our changing climate. Beyond public funds, the ports should prioritize private sector investments that will further the port's drive toward a zero-emission future.

2. Create green shipping corridors, which are zero-emission maritime routes between two or more ports. The purpose of these corridors is to create an ecosystem of ports that can support zero-emission ships, with onshore power (cold ironing), zero-emission fuel bunkering and shipyards that can service a zero-emission fleet.

In addition to support for zero-emission vessels, ports committing to green shipping corridors can decarbonize harbor and onshore operations as well, including harbor crafts, cargo handling equipment, trucks and port buildings.

a. International and National Commitments. In countries committed to the Clydebank Declaration,¹⁷ ports should collaborate with international port partners to establish green shipping corridors between their countries.

For countries that did not sign on to the Clydebank Declaration, ports should encourage national action on green shipping corridors. China, which is the world's largest shipbuilder and home to the world's largest shipping fleet, noticeably refrained from signing onto the Clydebank Declaration. Yet its participation in green shipping corridor creation will be vital to the industry's decarbonization.

The Clydebank Declaration

At COP26 in November 2021, the United Kingdom launched the Clydebank Declaration, which formed an international coalition to support the establishment of green shipping corridors. To date, 24 signatories have committed to working with domestic and international ports, operators and others in the shipping value chain to decarbonize maritime routes around the world.

As of August 2022, the 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.¹⁸

- b.** Local and Sub-National Commitments. At the local level, ports should collaborate to join existing or to establish new green shipping corridors.
- i.** If feasible, ports can join the C40 Green Ports Forum, which is working to connect port cities and ports around the world to take collective action to decarbonize global supply chains related to ports.¹⁹

Los Angeles & Long Beach-Shanghai Green Shipping Corridor

In January 2022, the Port of Los Angeles, Port of Shanghai and C40 Cities announced a partnership to create the world's first transpacific green shipping corridor, with the Port of Long Beach joining the initiative in June 2022.²⁰ This collaboration will reduce GHGs from the movement of cargo throughout the 2020s and will begin to transition to zero-carbon-fueled ships in service on this route by 2030. The first step will be preparing and releasing an implementation plan in late 2022. The implementation plan aims to provide a framework and a process for green corridor development, so that LA-Shanghai can serve as a model for future green corridors.

Members of the Green Shipping Corridor partnership include the Ports of Los Angeles, Long Beach and Shanghai as well as C40 Cities; A.P. Møller – Mærsk (Maersk); CMA CGM; Shanghai International Ports Group (SIPG); Shanghai Municipal Transport Committee (SMTTC); COSCO Shipping Lines; Ocean Network Express; the Aspen Institute's Shipping Decarbonization Initiative; facilitators of Cargo Owners for Zero Emission Vessels (coZEV); and the Maritime Technology Cooperation Centre – Asia.²¹

The LA & LB-Shanghai Corridor is part of C40's Green Ports Forum, which now includes 20 of the world's leading port cities from every region.²²

Singapore-Rotterdam Green and Digital Corridor

In August 2022, the Maritime and Port Authority of Singapore (MPA) and the Port of Rotterdam signed a memorandum of understanding (MoU) to establish the world's longest Green and Digital Corridor to enable low- and zero-carbon shipping. The ports, which are among the world's largest bunkering ports, are vital links on Asian-European shipping routes.

Through the MoU, the port authorities committed to collaborate with the Global Centre for Maritime Decarbonisation (GCMD) and the Mærsk Mc-Kinney Møller Center for Zero-Carbon Shipping, as well as industry partners across the supply chain, including BP, CMA CGM, Digital Container Shipping Association, Maersk, Mediterranean Shipping Company S.A. (MSC), Ocean Network Express, PSA International and Shell.

The Green and Digital Corridor aims to “raise investment confidence, attract green financing, and kick start joint bunkering pilots and trials for digitalization and the use of low- and zero-carbon fuels along the route.”²³

- 3. Abandon all fossil fuel projects.** The Inter-governmental Panel on Climate Change climate science makes clear that the world does not have the carbon budget to build any new fossil fuel assets or infrastructure projects if we hope to limit warming to 1.5-2°C.²⁴

Ports can support the fossil fuel phase-out by retrofitting and replacing fossil fuel infrastructure and assets, and by abandoning any plans to build new fossil fuel assets. To mitigate financial losses, ports can work with public and private partners to repurpose stranded assets for brownfield projects. These transactions can help finance zero-emission infrastructure projects.

POLICY



In order to deliver on its climate commitments, ports must adopt a myriad of policies to achieve measurable progress benchmarks and set clear guidelines for compliance. These policies will most likely take form as port policy, city law or regulation or sub-national (state) law or regulation.

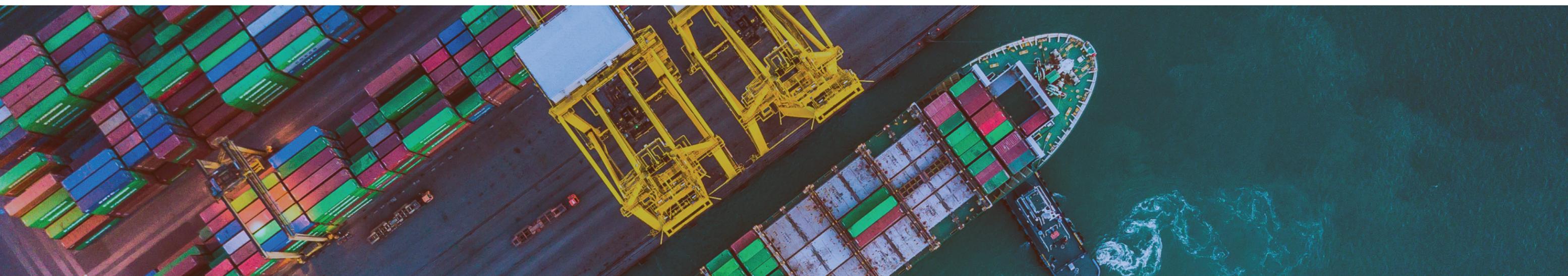
- 4. Set mandatory zero-emission standards for all ships calling port,** sending a clear market signal to the shipping value chain to move toward zero emissions.

It is imperative that we phase out the most heavily polluting ships from our waters as soon as possible. At the same time, we must build and phase in new, cleaner ships. Unfortunately, at present, there are more than 676 new ships on order — and almost every one of them will run on fossil fuels — locking in emissions for decades.²⁵ Approximately 25% of the global order book is container vessels built to run on liquefied natural gas (LNG),²⁶ but LNG-powered vessels emit dangerous and potent methane

(CH₄) emissions, which are up to 86 times more potent than carbon dioxide (CO₂) on a 20-year Global Warming Potential (GWP).²⁷ These decisions fly in the face of IPCC's climate science, which reported that we must cease fossil fuel development in order to avoid the climate tipping point of 2°C of warming. We must change tack.

Below are model policies for ports to set measurable progress benchmarks for zero-emission shipping, providing prioritization for ship owners to decarbonize their fleet:

- a. Zero-emission At Berth and At Anchor standards,** with 100% At Berth electrification by no later than 2030. Requiring zero emissions from all ships at berth and at anchor is critical for public health and environmental justice. At Berth and At Anchor standards will reduce toxic air pollutants and emissions in port, improving air quality in local and regional air sheds.



California's At Berth Regulation

In 2020, the California Air Resources Board (CARB) expanded its 2007 At Berth Regulation to increase emissions reductions from ocean-going vessels at berth in California ports. The 2020 Regulation requires regulated entities to use a CARB-Approved Emissions Control Strategy (CAECS) including shore power, one of the capture and control systems currently approved for use with the 2007 Regulation, or a future CARB-approved shore- or vessel-based solution (including alternative fuels, etc.).

The state regulation applies to vessel operators, terminal operators, ports and third-party CARB-CAECS operators. Emissions controls for the 2020 Regulation will phase-in beginning on Jan. 1, 2023, but all vessel types will be required to report their emissions beginning Jan. 1, 2023. California's At Berth Regulation is the gold standard for shore power policy. Regulators estimate the policy will save 237 lives and yield \$2.31 billion in public health benefits for Californians.²⁸

California's Commercial Harbor Craft Regulation

In March 2022, the California Air Resources Board (CARB) approved updates to its Commercial Harbor Craft Regulation, aimed at significantly reducing emissions from harbor craft like tugboats and ferries operating near California's coast by 2035. The amendments require zero-emission engines where feasible, and cleaner combustion EPA Tier 3 and 4 engines on all other vessels.

The amendments include, for all vessel categories, compliance flexibilities such as fleet averaging or additional compliance time on other vessels in a fleet if a zero-emission vessel is deployed where it is feasible but not required.

California's Harbor Craft Regulation sets the nation's first zero-emission marine standard for ferries, and it is the first of its kind for emission standard requirements for commercial passenger fishing vessels, pilot vessels, tank barges over 400 feet, workboats and research vessels. The amendments will begin phasing in starting in 2023 through the end of 2032. Regulators estimate the policy will save 531 lives statewide and yield \$5.25 billion in public health benefits for Californians.²⁹

b. Zero-emission harbor craft standards, specifically 100% zero emissions from harbor crafts by 2035. Today's technology can already equip harbor vessels like ferries, tugboats and workboats for electrification. If enacted quickly, a zero-by-2035 target is achievable, as ports around the world are already accepting delivery on zero-emission tugs and other harbor crafts (see "Sparky, the electric tugboat," p. 20).

c. Establish low- and zero-emission ocean-going vessel standards for ships calling port, mandating ships to:

- i.** Report their fuel consumption and emissions. Ships must already keep track of this data and report it to their flag state every year. If they stop at a port in the European Union, they must report to the European Union as well. Ports can use this data to manage emissions inventories, support green shipping corridor initiatives, ensure ship compliance and project future reduction needs.
- ii.** Maximize energy efficiency through best practice recommendations, including battery backup systems, wind propulsion and slow steaming.
- iii.** Immediately require ships to retrofit to IMO Tier III compliance or better, and to phase out the dirtiest Tier I and Tier II ships for ships equipped for low- and zero-emission technologies and fuels. This will achieve short-term pollution reduction for port communities and port workers.

5. Reward first movers and attract the world's cleanest ships:

- a.** Assess fees based on IMO ship tiers, pollution and GHG emissions. This can be achieved by reducing wharfage rates or docking fees for zero-emission cargo ships (e.g., ships running on renewable electricity, wind propulsion, batteries and green hydrogen-based fuels) and/or increasing fees for the dirtiest ships. These fees can be set on a per-call basis, in long-term lease agreements or in berthing agreement negotiations, but they must be leveled to incentivize conversion to the cleanest technologies over the target period.
 - i.** Ships running on fossil fuel liquefied natural gas (LNG) should not be eligible for fee reductions, despite the fuel's comparative pollutant reductions against heavy fuel oil. LNG is a fossil gas that emits methane (CH₄), which is up to 86 times more potent than carbon dioxide (CO₂) in its climate-warming potential.
- b.** Provide docking order benefits for ships using renewable electricity-powered auxiliary engines, wind propulsion or running on zero-emission fuel cell systems. These benefits could include prioritized access to preferred docks or to dual charging and fueling stations that allow for quicker ship turnaround, etc.
- c.** Invest in zero-emission projects. Investigate whether there is national or regional funding available to support zero-emission projects, or support the creation of funds to finance projects for the port directly, or indirectly to finance zero-emission vessels.

- i. Promote and facilitate demonstration projects that show alternative-fueled vessel viability. By bringing together vessel owners, operators, fuel providers, harbor craft operators and advocacy groups to develop pilot projects, ports can serve as an industry convener and technology accelerator.

The majority of these policies are “carrot” approaches to incentivizing decarbonization, and they should serve as short-term or interim measures to jumpstart adoption of clean technologies and zero-emission fuels. Incentives are complementary to commitments and mandates for zero-emission shipping, and they should only reward first movers, early compliance with port mandates and environmental excellence.

Norway's NOx Fund

Norway's NOx Fund collects a fee from industry enterprises, from which affiliated companies can apply for NOx funding for NOx reduction measures. The NOx Fund reports that “support from the Fund has triggered an increase in demand for NOx-reducing technologies with NOK 14 billion since 2008, especially within the maritime sector where the largest share of the Fund's support has been granted. This has contributed to a Norwegian maritime industry with a leading edge in an international market.”³⁰

6. Implement environmental and ecological protection, preservation and resiliency measures that support pollution and emissions reductions, including efforts to:

- a. Minimize channel-widening, dredging and other environmental and ecological impacts to the ecosystem comprising the port, bays and shipping channels. Expansion projects should be limited, and ports should retrofit or repurpose assets to minimize the need to expand the port's physical, carbon and ecological footprint.
- b. Join or establish a Slow Steaming or Vessel Slow Down program to improve fuel efficiency and reduce CO₂ emissions, with the added benefit of reducing underwater noise and whale strikes. These programs are in place along North America's western and eastern seaboard, in the Gulf of Panama and in Spain. Slow steaming reduces greenhouse gas emissions, air pollution, whale strikes and ocean noise, which causes stress to marine life.

Port of Vancouver's ECHO Program

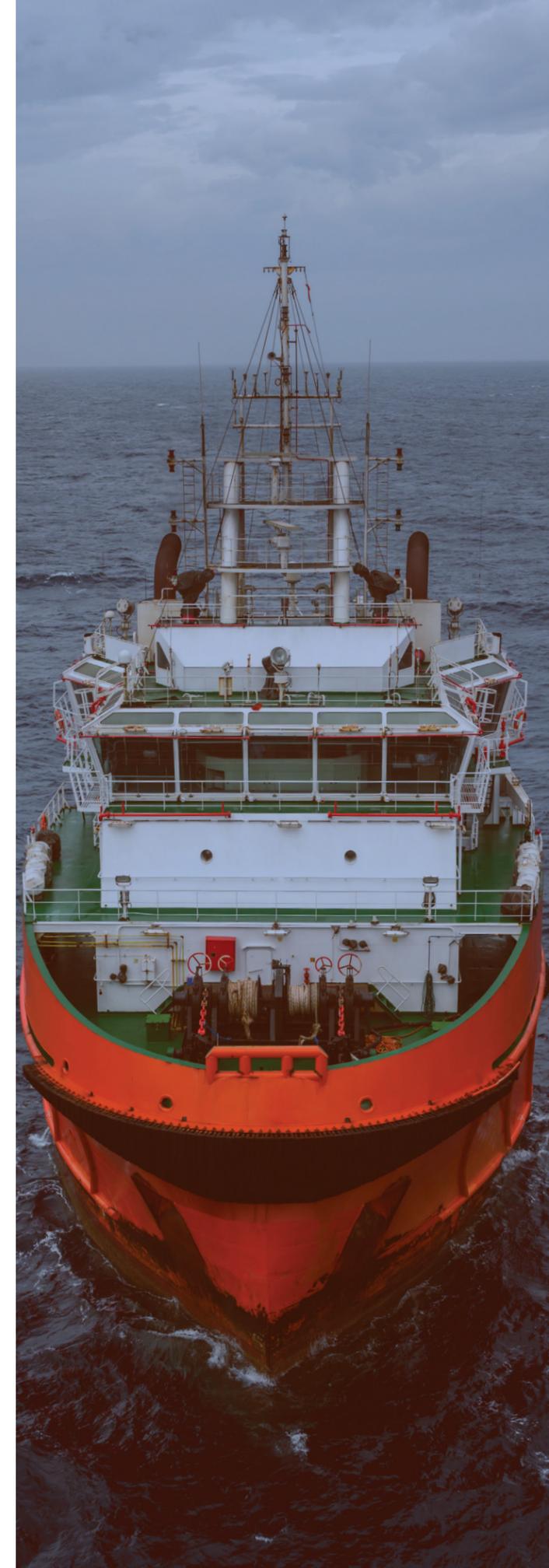
In Vancouver's Swifsure Bank, Harot Strait and Boundary Pass waterways, more than 80 marine transportation companies — including major bulk and container shippers — participate in the Port of Vancouver and the Enhancing Cetacean Habitat and Observation (ECHO) Program's voluntary slowdowns. The program, now in its sixth season, has reduced underwater sound intensity by up to 55% in key orca foraging seasons since 2017.³²

Maersk's Svitzer Tugboat Operations slow steam, reduce emissions

In August 2022, Maersk's tugboat operations, Svitzer, reported results from its Aim for 8 initiative to implement slow steaming during mobilization and demobilization. The pilot program was a success, reducing emissions from the global tugboat fleet by 1,000 tons of CO₂.

Svitzer sees huge potential for this program to have a tangible impact at no cost to their operations and with very little disruption to their way of working. All they ask is for crews to stay below eight knots before and after the towage job.³¹

- c. Ban scrubber and bonnet discharges in waters under port's jurisdiction and conduct ongoing water and sediment monitoring for acids, PAHs, heavy metals, nitrates and nitrites to reduce and eliminate in-water pollution.³³
- d. Consider adaptation needs for all infrastructure projects, including reinforced seawalls, battery backup systems and drainage for high tides and flood events. In the face of a changing climate, including sea level rise, unpredictable climate patterns and increased storm severity, resilient design reduces risks and minimizes vulnerabilities, and it will provide port workers with a safer work environment. Adaptation measures will reduce operational and maintenance costs, including insurance, thereby increasing profitability.



PROGRESS



7. Electrify everything possible:

- a. Provide shore-side electricity. Renewable energy, ship electrification technology and existing electricity infrastructure make onshore power, or cold ironing, a feasible decarbonization project for most ports. Requiring ships to plug in to onshore power at berth will significantly reduce pollutants and emissions in portside communities, providing immediate public health benefits.
- b. Transition harbor crafts, including tugboats, ferries, pilot craft, etc. to zero emissions. Ports around the world are already welcoming electric harbor crafts into their waters, bringing zero-emission ship handling within reach.

Sparky, the electric tugboat

The Ports of Auckland, New Zealand are now home to the world's first full-sized ship-handling electric tug, aptly named Sparky through a public naming competition.

Dutch maritime manufacturer Damen Shipyards built the tug, which has 80 battery racks housing 2,240 batteries — totaling 2,784 kWh of power onboard. It will be able to complete as many as four shipping moves on a single charge and can recharge in two hours.

Sparky is estimated to save the Ports of Auckland around 465 tons of CO₂ emissions each year. Most impressive of all: the expected cost to operate the tug is less than a third of the cost of a diesel equivalent. Sparky — tugging ships while saving money and the planet.³⁴



8. Provide clean energy and reliable fueling for zero-emission cargo ships:

- a. Renewable energy procurement and development: work with partners to identify sites near the port suitable for renewable energy development, and then form partnerships to invest and develop renewable energy projects to support zero-emission fuel production. There are studies showing how the U.S.,³⁵ Morocco,³⁶ Chile,³⁷ South Africa,³⁸ Mexico,³⁹ Indonesia⁴⁰ and many other countries have significant potential to develop renewable energy projects that can power zero-emission shipping fuel production.
- b. Collaborate with industry initiatives cited in this report, as well as with clean energy industry, utilities, regulators and the broader energy market to support the development of clean energy marine hubs. Much of the work involved in establishing and scaling energy markets is beyond the scope of ports; however, ports must engage in these efforts and ensure that zero-emission fuel supply will meet demand along maritime routes.

HyDeal Los Angeles

In Los Angeles, the Green Hydrogen Coalition is working to create the first scale ecosystem for green hydrogen in North America, targeting under USD 2.00/kg delivered green hydrogen in the LA Basin. The initiative is working to assess community impacts, offtake and infrastructure needs, policy and regulatory barriers, and funding opportunities across state, local, regional and national levels.

Efforts like HyDeal LA can serve as a model for rapid acceleration for additional green hydrogen ecosystems throughout the U.S. and globally.⁴¹

9. Center community and maritime worker involvement and support the port's Zero-Emission Action Plan.

Engage with local communities to understand their concerns around current emissions and activity. Community and environmental groups will have justified concerns about nascent energy technologies and their impact on public health. Ports must be prepared to raise awareness about energy plans, educate the public and act in the best interest of public health.

Ports have a responsibility to ensure a just transition for the many maritime workers that keep the port running. Ports and their government partners must connect with labor unions to understand job security and safety concerns, and create opportunities to transition workers into new and sustainable jobs.

Jobs for the future of shipping

Zero-emission cargo ships will create tremendous economic opportunities, including high-quality jobs. In the United States, a study by the School of Public Policy at the University of California, Berkeley found that federal port and ship decarbonization investments planned for the next five years will create 316,700 jobs. Of that, more than 80,000 jobs come from construction of new power and communications structures from decarbonization activities such as shore-side power.⁴²

While there is no study looking at decarbonization's impact on job creation on a global scale, a World Bank study reported that "many countries, including developing countries, are very well positioned to become future suppliers of zero-carbon bunker fuels — namely ammonia and hydrogen. By embracing their potential, these countries would be able to tap into an estimated \$1+ trillion future fuel market while modernizing their own domestic energy and industrial infrastructure. However, strategic policy interventions are needed to unlock these potentials."⁴³



National and international shipping policy

Beyond port and sub-national policies and programs, many countries can leverage port state authority to impose regulations to reduce pollution on all ships that call their nation's ports. Notably, China and the European Union have requirements on all ships calling their ports to report on emissions, including those emitted on the high seas, to and from that port stop.

In July 2022, the European Parliament voted to adopt the European Commission's proposal to include shipping emissions in the European Union (EU) Emissions Trading System (ETS), which is a cap-and-trade system for emissions in the EU.⁴⁴ The policy is part of the EU's Fit for 55 legislative package.⁴⁵ Other countries can follow suit by including shipping emissions in their carbon markets or carbon budget systems.

Also in July 2022, U.S. Rep. Alan Lowenthal and co-sponsor Rep. Nanette Barragán introduced the U.S. Clean Shipping Act, legislation aimed at zeroing out pollution from all ocean shipping companies that do business with the U.S. Rep. Lowenthal and Rep. Barragán represent the citizens of Long Beach and Los Angeles, respectively. These communities hold the busiest container port complex in the Western Hemisphere, the San Pedro Bay Complex. The bill directs the Environmental Protection Agency (EPA) to set carbon intensity standards for fuels used by ships consistent with a 1.5°C decarbonization pathway and to set requirements to eliminate in-port ship emissions by 2030.⁴⁶ Together with the IRA allocations for ports, the bill could accelerate industry decarbonization and establish the U.S. as a global climate leader in addressing pollution from the shipping industry.

A 2021 report by the Ocean Conservancy and Pacific Environment, which outlines a policy menu for the U.S., contains additional examples of measures that ports can impose to reduce emissions from international shipping.⁴⁷

In the spirit of this positive momentum, ports must accelerate ambition and deliver reductions quickly.

We recognize that decarbonizing the global shipping industry is an immense task requiring international and regional cooperation, national commitments and local planning and implementation, but we also know that the climate crisis is so urgent that no sector can wait for top-down action. For support, ports can rely on local communities, who have a lot at stake in the face of climate change: their health, their homes and their livelihoods. The clean energy transition can bring economic and public health revitalization, including higher-paying and sustainable jobs and communities safe from air pollution and carbon emissions coming from ships at port.

Even the international regulator for shipping, the International Maritime Organization (IMO), encourages ports to move forward with regulations. The IMO has been considering what to do about emissions from shipping for many decades. Unfortunately, there are no regulations in place that impose reductions in line with the Paris Agreement 1.5°C scenario. However, there are a number of tangential IMO regulations in place, and the IMO adopted a Ports Resolution⁴⁸ and produced a Port Emissions Toolkit⁴⁹ in 2019 to support ports in developing or improving their air pollutant and/or GHG emissions assessments and implementing emissions reductions strategies.

The time to act is now. Public pressure campaigns and litigation are increasing around the world against countries and companies that are not taking action quickly enough to reduce emissions commensurate with the climate emergency. International shipping is a large source of pollution, and communities will demand action from their ports to mitigate and adapt to air pollution and climate change. The Paris Agreement and the Law of the Sea very clearly impose an obligation on signatory countries to meet the temperature increase limits of the Paris Agreement and to preserve and protect the marine environment under the Law of the Sea.⁵⁰ Ports should work with their government partners, community members, local environmental groups and legal advocates to understand their port state authority and maximize the change they can affect.

Cargo owners commit to zero by 2040

In 2021, some of the largest cargo shippers in the world came together to launch “Cargo Owners for Zero-emission Vessels” (coZEV).⁵¹ Amazon, IKEA, Unilever and other companies stated they would:

- » Aim to lead this transition by decarbonizing their own maritime freight by 2040, a target well aligned with a Paris Agreement 1.5°C trajectory
- » Call for full decarbonization of the maritime sector by 2050 at the latest
- » Ask supply chain partners and policymakers around the world to take swift and ambitious action to bring zero-carbon shipping solutions to scale

The Port of Los Angeles celebrated this announcement,⁵² and several container lines such as South Korean HMM and European carriers Hapag-Lloyd and Maersk responded to confirm that they too could meet this target.⁵³



The price of zero

While shipping can promote economic development, its pollution also imposes huge health and climate costs on countries. Shipping is exempt from corporate taxation and instead pays “tonnage tax,” which the Organization for Economic Co-operation and Development (OECD) classifies as a subsidy.⁵⁴ In addition, shipping does not pay any fuel or sales taxation. Only in the EU is a proposal currently going through the legislative process that would require shipping to begin to pay for its pollution (see “Calculating emissions for voyages: the EU’s proposed strategy,” p. 10). In 2021, the Marshall Islands and the Solomon Islands submitted a proposal to the IMO MEPC for a \$100 per ton of CO₂ equivalent levy on all ships.⁵⁵ While this proposal is winding its way through the International Maritime Organization, ports cannot rely on international measures to curtail the industry’s egregious pollution.

In fact, the OECD study on shipping taxation pointed out that “impact studies do not find much evidence of the effectiveness of maritime subsidies in achieving their stated aims.” This is because shipping companies can pass costs like sales or pollution tax through the supply chain to the consumer, while financial subsidies often go directly to shipping companies’ bottom lines (rather than resulting in savings for the end consumer). This regressive cost structure is a major factor in why consumers have seen inflation on the cost of goods during the pandemic — congestion in the supply chain has led to increased freight rates, resulting in unheard of profits for shipping companies, running into the billions of dollars, all while consumers have been taking a hit to their wallets.⁵⁶ To counter this regressive scheme for pollution controls, the OECD study offers a number of recommendations, such as making maritime subsidies conditional on positive impacts.

By focusing on rewarding positive behavior (such as electrification, renewable energy fueled-ships, etc.) through financial incentives (such as dock prioritization and reduced wharfage rates or docking fees), ports can drive adoption of clean energy technologies directly without adding significant costs to their bottom line or to consumers’ wallets.

Many will challenge that this model is not financially viable, but market leaders disagree. Denmark-based Maersk, the world’s largest shipping company, committed to zero-emission ocean shipping by 2040, with milestone 2030 targets,⁵⁷ and it estimates that decarbonizing shipping would add only six cents to a pair of \$100 running shoes. The company has been public in supporting \$150-a-Ton Carbon Tax on Shipping Fuel, a tax level that may be sufficient to

bridge the gap in fuel costs between carbon-based and clean energy fuels — making the latter more financially viable.⁵⁸

While ports do not have the legal jurisdiction to change the taxation regime in their country, ports may be able to control port fees to ensure they incentivize the use of zero-emission fuels and the adoption of other clean energy technologies.

Fossil fuels & biofuels cannot get us to zero by 2040

In the immediate term, ports must stop all new fossil fuel build-out, including bunkering for Liquefied Natural Gas (LNG), which is 85-95% methane. LNG is not an emissions-reduction fuel; in fact, it is often worse on a well-to-wake basis than conventional fuels.⁵⁹ This fossil fuel will only exacerbate the industry’s effect on global warming, with methane leaking at every stage of the production lifecycle. Methane (CH₄) is up to 86 times more potent than carbon dioxide (CO₂) on a shorter timescale, meaning more warming, and faster. Recent research by the European Federation for Transport and Environment on LNG-fueled ships found significant methane slips (leaks) with “alarming repercussions for the climate.”⁶⁰

Due to its climate impact, the LNG market is already showing signs of industry rejection. Investment companies are ending financing for natural gas projects due to pressure for climate action and public opposition.⁶¹ There is a risk that LNG-related projects will not be bankable in the near future. The World Bank advised countries to pull back from investing in LNG infrastructure, saying that fossil gas “is likely to play a limited role in the decarbonization of the shipping sector.”⁶² Moreover, some of the largest container shipping lines have opted against the use of LNG in their ships, such as Maersk, whose leadership said they would “rather go from what we do today straight to a CO₂-neutral type of fuel.”⁶³ The message is clear: the only place fossil fuels belong is in the ground.

Biofuels including ethanol and biodiesel are another false solution for fueling ships. These fuels are often blended with fossil fuels and require organic matter (biomass) feedstock. With climate change increasingly affecting global food supply systems, we must preserve and prioritize agricultural land to grow food, not biomass feedstock. Moreover, biofuels necessitate the use of bioenergy carbon capture and storage (BECCS) to capture the CO₂ that plants release in the fermentation process.⁶⁴ We should not prioritize fuel options that would further increase demand for these solutions. Committing to biofuels will detour us on our path to zero-emission fuels, and the climate crisis is too urgent not to go as directly and as rapidly as possible toward renewable electrification, wind propulsion, batteries and green hydrogen-based fuels.

Studies from the International Council on Clean Transportation found that 99% of the voyages made along the U.S.-China container shipping corridor can be powered by green hydrogen, with only minor changes to fuel capacity or operations — i.e., by replacing 5% of cargo space with more hydrogen fuel or by adding one additional port of call to refuel. Importantly, 43% of these voyages could be completed with no changes at all. Wind assisted propulsion and batteries can complement other zero-carbon, zero-emission fuels and propulsion systems to power a decarbonized ship.⁶⁵

Conclusion

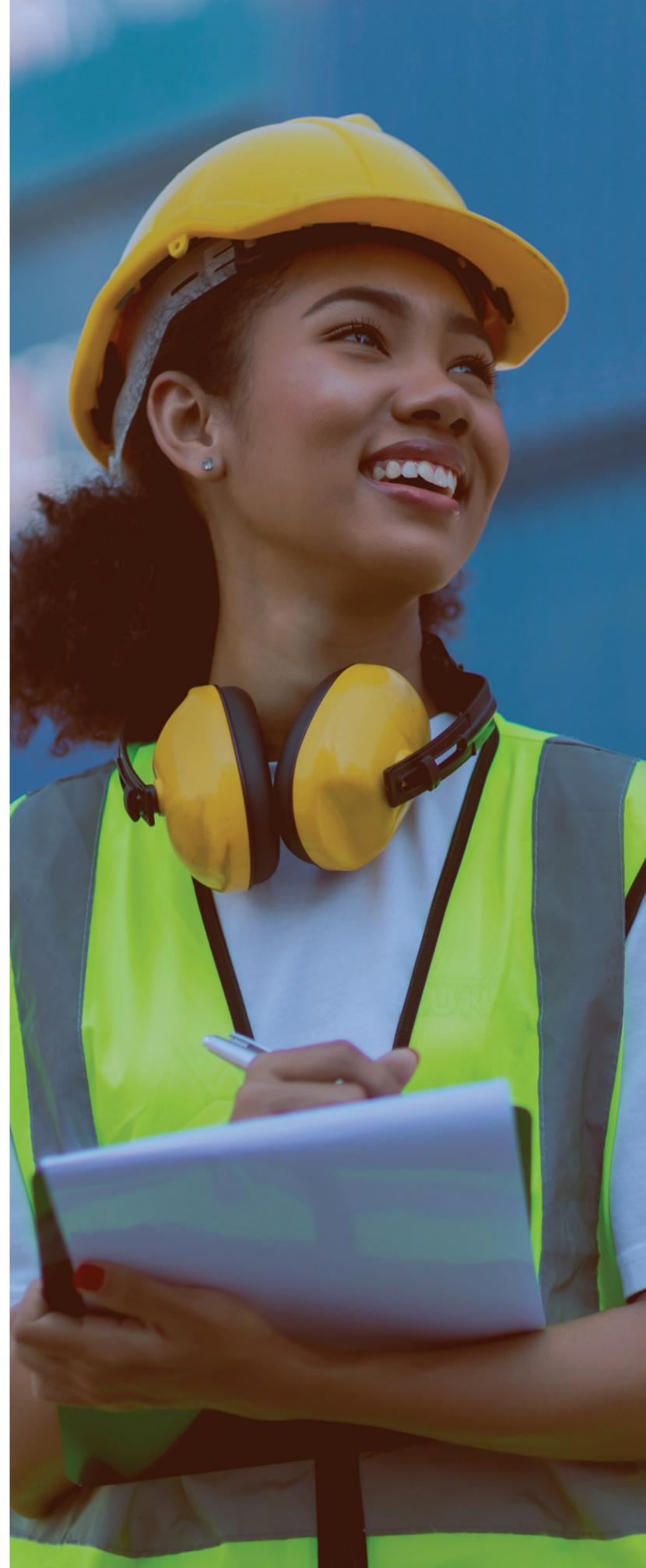
The latest Intergovernmental Panel on Climate Change Sixth Assessment Report shows that sea level rise and the increased frequency and severity of storms are already affecting port activity and infrastructure, but adaptation planning does not (and cannot) adequately prepare for these hazards.⁶⁶ Analysis by the Environmental Defense Fund shows that ports and the wider shipping industry will be susceptible to billions of dollars in infrastructure damage and trade disruption from climate change.⁶⁷ These impacts are more severe in developing and least developed countries — that have contributed little to global shipping’s fossil fuel addiction. If nothing changes, ship emissions could double by 2050.

We must transition ships off fossil fuels entirely, both to save lives and to combat climate change. Luckily, ports and the communities around them are mobilizing to halt this climate and health crisis and seeking to do more to put themselves at the forefront of decarbonization.

Businesses and their customers are increasingly moving to zero-carbon shipping for products and materials. Ports with the capacity and infrastructure to offer new zero-emission fuels for commercial vessels will have a commercial and competitive advantage for the goods traded through their ports, improving port attractiveness in the global market and thereby increasing port revenues.

Now is the moment for ports to transform beyond their roles as the centers of trade — and leverage their authority and economic power to become climate champions and hubs of clean energy and innovation. Strong commitments to decarbonization, progressive policies and immediate action for progress will fuel sustainable economic growth in port and surrounding communities for generations to come.





The Ports for People campaign is on a mission to end port and ship pollution. Together with local communities, allies and partners, we seek 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.

About Pacific Environment

Pacific Environment is a global environmental organization that protects 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.

About Opportunity Green

Opportunity Green is an NGO working to unlock the opportunities from tackling climate change using law, economics and policy. Opportunity Green helps countries, civil society and businesses access the solutions that reduce emissions and bring enormous opportunities for economic development, improved health and increased democracy. At Opportunity Green, we believe lawyers are obligated to analyze the existing legal systems and regulations to stop climate change. We use legal innovation to forge new pathways on climate action or, where that is not possible, find pathways within the present legal structure to facilitate the legislation needed to slash carbon pollution.

Acknowledgments

Pacific Environment and Opportunity Green are grateful to the many port communities, port authorities and shipping and maritime experts who provided valuable insights and comments on this report. Thank you to Pacific Environment team members Madeline Rose, Teresa Bui, Antonio Santos, Mandeera Wijetunga, Dawny'all Heydari, Bōžon McClung, James Gamble, Gwen Dobbs and Kevynn Gómez for their expertise and contributions to our campaign. We would also like to acknowledge the impactful work of our allies, including the International Council on Clean Transportation (ICCT), the European Federation for Transport & Environment, Friends of the Earth, Ocean Conservancy, World Wildlife Fund-Mexico, Interamerican Association for Environmental Defense, member organizations of T.H.E. Impact Project and the Moving Forward Network. Thank you to RALLY and to Pacific Environment's Jessica Wright for branding and design.

ANNEX 1

Glossary

CH₄	Methane
CO₂	Carbon dioxide
coZEV	Cargo Owners for Zero Emission Vessels
ECA	Emission Control Areas
EU	European Union
GHG	Greenhouse gas
Gt	Gigatons (<i>1 gigaton is equal to 1,000,000,000 kilograms</i>)
GWP	Global Warming Potential
H₂	Hydrogen (<i>GH₂ = Green Hydrogen</i>)
IMO	International Maritime Organization
ICCT	International Council on Clean Transportation
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquefied natural gas
NGO	Non-governmental organization
NO_x	Nitrous oxide
OECD	Organization for Economic Co-operation and Development
PM	Particulate matter
T&E	European Federation for Transport & Environment
UNCLOS	United Nations Convention on the Law of the Sea

ANNEX 2

Endnotes

^[1] Schlanger, Z. (2018, April 18). If shipping were a country, it would be the world's sixth-biggest greenhouse gas emitter. *Quartz*. Retrieved September 1, 2022, from <https://qz.com/1253874/if-shipping-were-a-country-it-would-the-worlds-sixth-biggest-greenhouse-gas-emitter/>

^[2] (Schlanger, 2018)

^[3] University of Delaware. (2018, February 7). 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. *ScienceDaily*. Retrieved September 1, 2022, from www.sciencedaily.com/releases/2018/02/180207140420.htm

^[4] International Maritime Organization (IMO). (n.d.). *Initial IMO GHG Strategy*. Retrieved September 1, 2022, from <https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx>

^[5] Comer, B. (2021, September 8). 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. *The ICCT*. Retrieved September 1, 2022, from <https://theicct.org/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/>

^[6] OECD. (n.d.). *Ocean shipping and shipbuilding*. Retrieved September 1, 2022, from <https://www.oecd.org/ocean/topics/ocean-shipping/>

^[7] (Comer, 2021)

^[8] O'Leary, A. et al. (2022, February). Legal implications of EU action on GHG emissions from the International Maritime Sector. *Transport & Environment*. Retrieved September 1, 2022, from <https://www.transportenvironment.org/discover/freedom-to-regulate-the-high-seas/>

^[9] International Maritime Organization (IMO). (n.d.). *Emission*

Control Areas (ECAs) designated under MARPOL Annex VI. Retrieved September 1, 2022, from [https://www.imo.org/en/OurWork/Environment/Pages/Emission-Control-Areas-\(ECAs\)-designated-under-regulation-13-of-MARPOL-Annex-VI-\(NOx-emission-control\).aspx](https://www.imo.org/en/OurWork/Environment/Pages/Emission-Control-Areas-(ECAs)-designated-under-regulation-13-of-MARPOL-Annex-VI-(NOx-emission-control).aspx)

^[10] (*Emission Control Areas (ECAs) designated under MARPOL Annex VI*. n.d.)

^[11] United Nations Environment Programme / Coordinating Unit for the Mediterranean Action Plan. (2022, June 14). *IMO body grants green light to the proposal on curbing emissions from ships in the Mediterranean* [Press release]. <https://www.unep.org/unepmap/fr/node/23042?%2Fnews%2Fnews%2Fimo-body-grants-green-light-joint-proposal-curbing-emissions-ships-mediterranean=>

^[12] Schuler, M. (2022, June 22). EU Parliament votes to include shipping in EU carbon market. *gCaptain*. Retrieved September 1, 2022, from <https://gcaptain.com/eu-parliament-votes-to-include-shipping-in-eu-carbon-market/>

^[13] European Commission. (n.d.). *Delivering the European Green Deal*. Retrieved September 1, 2022, from https://ec.europa.eu/clima/eu-action/european-green-deal/delivering-european-green-deal_en

^[14] European Commission. (n.d.). *Reducing emissions from the shipping sector*. Retrieved September 1, 2022, from https://ec.europa.eu/clima/eu-action/transport-emissions/reducing-emissions-shipping-sector_en

^[15] Mandra, J. O. (2022, August 9). US ports eye \$3bn for electrification from Inflation Reduction Act. *Offshore Energy, Business & Finance*. Retrieved September 1, 2022, from <https://www.offshore-energy.biz/us-ports-eye-3bn-for-electrification-from-inflation-reduction-act/>

^[16] U.S. Department of Transportation, Maritime Administration (MARAD). (n.d.). *Port Infrastructure Development Program Grant Information*. [https://www.maritime.dot.gov/ports/port-infrastructure-development-](https://www.maritime.dot.gov/ports/port-infrastructure-development-program)

program

^[17] Clydebank Declaration signatories. (2022, April 13). *COP 26: Clydebank Declaration for green shipping corridors*. United Kingdom Department for Transport. <https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors>

^[18] (COP 26: *Clydebank Declaration for green shipping corridors*, 2022)

^[19] C40 Cities (2022, August 15). *Green Ports Forum*. <https://www.c40.org/what-we-do/scaling-up-climate-action/air-quality/green-ports-forum/>

^[20] Port of Long Beach. (2022, June 9). *Port of Long Beach Joins the Green Shipping Corridor* [Press release]. <https://polb.com/port-info/news-and-press/port-of-long-beach-joins-the-green-shipping-corridor-06-09-2022/>

^[21] C40 Cities. (2022, January 28). *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* [Press release]. <https://www.c40.org/news/la-shanghai-green-shipping-corridor/>

^[22] C40 Cities. (n.d.). *Green Ports Forum*. <https://www.c40.org/what-we-do/scaling-up-climate-action/air-quality/green-ports-forum/>

^[23] Maritime and Port Authority of Singapore (MPA). (2022, August 2). *Maritime and Port Authority of Singapore and Port of Rotterdam to establish world's longest Green and Digital Corridor for efficient and sustainable shipping* [Press release]. <https://www.mpa.gov.sg/media-centre/details/maritime-and-port-authority-of-singapore-and-port-of-rotterdam-to-establish-world-s-longest-green-and-digital-corridor-for-efficient-and-sustainable-shipping>

^[24] IPCC (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the

Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press. <https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/>

^[25] *Alphaliner Top 100*. (n.d.). Alphaliner. Retrieved June 2, 2022, from <https://alphaliner.axsmarine.com/PublicTop100/>

^[26] Dixon, G. (2022, April 13). LNG container ships reach 25% of orderbook but is the gas too expensive to use? *TradeWinds*. <https://www.tradewindsnews.com/gas/lng-container-ships-reach-25-of-orderbook-but-is-the-gas-too-expensive-to-use-2-1-1201914>

^[27] The Challenge | UNECE. (n.d.). United Nations Economic Commission for Europe (UNECE). <https://unece.org/challenge>

^[28] California Air Resources Board (CARB). (n.d.). *Ocean-Going Vessels At Berth Regulation*. Retrieved Sept 1, 2022, from <https://ww2.arb.ca.gov/our-work/programs/ocean-going-vessels-berth-regulation>

^[29] California Air Resources Board (CARB). (2022, March 24). *CARB passes amendments to commercial harbor craft regulation* [Press Release]. <https://ww2.arb.ca.gov/news/carb-passes-amendments-commercial-harbor-craft-regulation>

^[30] The NOx Fund. (n.d.). <https://www.noxfondet.no/en/>

^[31] The Maritime Executive. (2022, August 26). Svitzer tugs reduce Co2 emissions by slow steaming to and from jobs. *The Maritime Executive*. Retrieved September 1, 2022, from <https://maritime-executive.com/article/svitzer-tugs-reduce-co2-emissions-by-slow-steaming-to-and-from-jobs>

^[32] Kloster, D. (2022, June 1). Vessel slow zones expanded to protect whales. *Times Colonist*. Retrieved September 1, 2022, from <https://www.timescolonist.com/local-news/vessel-slow-zones-to-protect-whales-expanded-5432172>

ANNEX 2

Endnotes continued

[33] Osipova, L. (2021, April) Global scrubber washwater discharges under IMO's 2020 fuel sulfur limit. *The ICCT*. <https://theicct.org/sites/default/files/publications/scrubber-discharges-Apr2021.pdf>

[34] Doll, S. (2022, June 8). Meet Sparky, the electric tugboat operating in the Ports of Auckland with 2,784 kWh of power. *Electrek*. <https://electrek.co/2022/06/08/meet-sparky-the-electric-tugboat-operating-in-the-ports-of-auckland-with-2784-kwh-of-power/>

[35] Georgeff, E. et al. (2022, June 22). Scaling U.S. Zero-Emission Shipping: Potential Hydrogen Demand At Aleutian Islands Ports. *The ICCT*. Retrieved September 1, 2022, from <https://theicct.org/publication/marine-us-aleutians-hydrogen-jun22/>

[36] Ash, N. and Scarbrough, T. (2019, May). Sailing on solar: Could green ammonia decarbonise international shipping? *Environmental Defense Fund*. Retrieved September 1, 2022, from https://www.researchgate.net/publication/332845713_Sailing_on_Solar_-_Could_green_ammonia_decarbonise_international_shipping

[37] Ash, N. et al. (2019). Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile. *Environmental Defense Fund*. Retrieved September 1, 2022, from <https://www.edf.europa.org/news/2019/10/12/electrofuels-shipping>

[38] Ash, N., Carpenter-Lomax, O., Wilkinson, G., Environmental Defense Fund and Ricardo Energy & Environment. (2021, June [Revised 2022, June]). South Africa: fueling the future of shipping. *Global Maritime Forum*. P4G Getting to Zero Coalition Partnership. Retrieved September 1, 2022, from <https://www.globalmaritimeforum.org/content/2022/06/Zero-carbon-shipping-South-Africa-Issue-2.pdf>

[39] Carpenter-Lomax, O., Martinez, V., Wilkinson, G., Environmental Defense Fund and Ricardo Energy & Environment (2021, September [Revised 2022, June]). Mexico: fuelling the future of shipping. *Global Maritime Forum*. P4G

Getting to Zero Coalition Partnership. Retrieved September 1, 2022, from <https://www.globalmaritimeforum.org/content/2022/06/Zero-carbon-shipping-Mexico-Issue-2.pdf>

[40] Lomax-Carpenter, O., Martinez, V., Wilkinson, G., Environmental Defense Fund and Ricardo Energy & Environment (2021, November [Revised 2022, June]). Indonesia: fuelling the future of shipping. *Global Maritime Forum*. P4G Getting to Zero Coalition Partnership. Retrieved September 1, 2022, from <https://www.globalmaritimeforum.org/content/2022/06/Zero-carbon-shipping-Indonesia-Issue-2.pdf>

[41] Green Hydrogen Coalition. (n.d.). *HyDeal Los Angeles*. Retrieved September 1, 2022, from <https://www.ghcoalition.org/hydeal-la>

[42] Wooley, D. et al. (2021, July 30). Maritime port clean energy infrastructure jobs Study. *Center for Environmental Public Policy*. Retrieved September 1, 2022, from <https://oceanconservancy.org/wp-content/uploads/2021/09/Maritime-Port-Clean-Energy-Infrastructure-Jobs-Study.pdf>

[43] Englert, D. et al. (2021, April 15). The potential of zero-carbon bunker fuels in developing countries. *The World Bank*. Retrieved September 1, 2022, from <https://openknowledge.worldbank.org/handle/10986/35435>

[44] Schuler, M. (2022, June 22). EU Parliament votes to include shipping in EU carbon market. *gCaptain*. Retrieved September 1, 2022, from <https://gcaptain.com/eu-parliament-votes-to-include-shipping-in-eu-carbon-market/>

[45] European Commission. (n.d.). *Delivering the European Green Deal*. Retrieved September 1, 2022, from https://ec.europa.eu/clima/eu-action/european-green-deal/delivering-european-green-deal_en

[46] Office of Congressman Alan Lowenthal. (2022, July 12). *Congressman Lowenthal introduces bill to clean up massive emissions-generating maritime shipping industry* [Press release]. Retrieved September 1, 2022, from <https://lowenthal.house.gov/media/press-releases/congressman-lowenthal-introduces-bill-clean-up-massive-emissions-generating-maritime-shipping-industry>

<https://lowenthal.house.gov/media/press-releases/congressman-lowenthal-introduces-bill-clean-up-massive-emissions-generating-maritime-shipping-industry>

[47] Barry, J., Rose, M., and Hubbell, D. (2021). All Aboard: How the Biden-Harris administration can help ships kick fossil fuels. *Ocean Conservancy & Pacific Environment*. Retrieved September 1, 2022, from https://www.pacificenvironment.org/wp-content/uploads/2021/04/All-Aboard-US-Policy-Zero-Emissions-Report_FINAL.pdf

[48] International Maritime Organization. (2019, May 17). *Resolution MEPC.323(74): invitation to member states to encourage voluntary cooperation between the port and shipping sectors to contribute to reducing GHG emissions from ships*. Retrieved September 1, 2022, from [https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.323\(74\).pdf](https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.323(74).pdf)

[49] GEF-UNDP-IMO Global Maritime Energy Efficiency Partnerships (GloMEEP) Project & the International Association of Ports and Harbors (IAPH). (2018). *Port Emissions Toolkit, Guide No.1, Assessment of port emissions*. International Maritime Organization (IMO) GloMEEP Project Coordination Unit. Retrieved September 1, 2022, from <https://glomeep.imo.org/wp-content/uploads/2018/10/port-emissions-toolkit-g1-online.pdf>

[50] O'Leary, A. et al. (2011). Legal implications of EU action on GHG Emissions from the International Maritime Sector. *Transport & Environment*. Retrieved September 1, 2022, from <https://www.transportenvironment.org/discover/freedom-to-regulate-the-high-seas/>

[51] Cargo Owners for Zero-emission Vessels (coZEV). <https://www.cozev.org/>



ANNEX 2

Endnotes continued

^[52] Gazzar, B. (2021, November 20). Inside the ‘aggressive’ goal to make LA port ships 100% zero emission. *dot.la, Civic Tech*. Retrieved September 1, 2022, from <https://dot.la/port-of-los-angeles-2655766011/particle-1>

^[53] Pico, S. and Thomsen, J. (2021, October 20). Three container carriers welcome demand from major customers: “2040 does not scare us.” *Shipping Watch*. Retrieved September 1, 2022, from <https://shippingwatch.com/regulation/article13386533.ece>

^[54] International Transport Forum (ITF). (2019, September 17). Maritime Subsidies: Do They Provide Value for Money? *International Transport Forum Policy Papers*, No. 70. OECD/ITF. Retrieved September 1, 2022, from <https://www.itf-oecd.org/maritime-subsidies-do-they-provide-value-money>

^[55] Climate Vulnerable Forum. (2021, November 2). *Dhaka-Glasgow Declaration of the CVF* [Press release]. Retrieved September 1, 2022, from <https://thecvf.org/our-voice/statements/dhaka-glasgow-declaration-of-the-cvf/>

^[56] Wackett, M. (2022, January 20). Containership earnings bonanza continues in the red hot charter market. *The Loadstar*. Retrieved September 1, 2022, from <https://theloadstar.com/containership-earnings-bonanza-continues-in-the-red-hot-charter-market/>

^[57] Maersk. (2022, January 12). *A.P. Moller – Maersk accelerates Net Zero emission targets to 2040 and sets milestone 2030 targets* [Press release]. Retrieved September 1, 2022, from <https://www.maersk.com/news/articles/2022/01/12/apmm-accelerates-net-zero-emission-targets-to-2040-and-sets-milestone-2030-targets>

^[58] Wittels, J. (2021, June 2). Maersk Seeks \$150-a-ton carbon tax on shipping fuel. *Bloomberg*, Daily Tax Report: International. Retrieved September 1, 2022, from <https://news.bloombergtax.com/daily-tax-report-international/shipping-giant-maersk-seeks-150-a-ton-carbon-tax-on-ship-fuel>

^[59] Pavlenko, N. et al. (2020, January 28). The Climate

implications of using LNG as a marine fuel. *The ICCT*. Retrieved September 1, 2022, from <https://theicct.org/publication/the-climate-implications-of-using-lng-as-a-marine-fuel/>

^[60] Transport & Environment (T&E). (2022, April 13). Methane at Sea: Finding the Invisible Climate Killer. *Transport & Environment*. <https://www.transportenvironment.org/discover/methane-finding-the-invisible/>

^[61] Tani, S. and Imahashi, R. (2022, February 6). Asia faces billions in stranded assets if gas becomes energy pariah. *NIKKEI Asia*, Commodities. Retrieved September 1, 2022, from <https://asia.nikkei.com/Business/Markets/Commodities/Asia-faces-billions-in-stranded-assets-if-gas-becomes-energy-pariah>

^[62] The World Bank. (2021, April 15). Charting a Course for Decarbonizing Maritime Transport. *The World Bank*. Retrieved September 1, 2022, from <https://www.worldbank.org/en/news/feature/2021/04/15/charting-a-course-for-decarbonizing-maritime-transport>

^[63] Ship & Bunker News Team. (2020, November 19). Maersk: No Big Role for LNG Bunkers as Transitional Fuel. *Ship & Bunker*, World News. Retrieved September 1, 2022, from <https://shipandbunker.com/news/world/130170-maersk-no-big-role-for-lng-bunkers-as-transitional-fuel>

^[64] Pontecorvo, E. (2020, September 11). Biofuels are a controversial climate solution. Could they still help save the planet? *Grist*. Retrieved September 1, 2022, from <https://grist.org/energy/biofuels-are-a-controversial-climate-solution-could-they-still-help-save-the-planet-negative-emissions-direct-air-capture/>

^[65] Mao, X. et al. (2022, March 3). Refueling Assessment of a Zero-Emission Container Corridor between China and The United States: Could Hydrogen Replace Fossil Fuels? *The ICCT*. <https://theicct.org/publication/refueling-assessment-of-a-zero-emission-container-corridor-between-china-and-the-united-states-could-hydrogen-replace-fossil-fuels/>

and Georgeff, E. et al. (2020, October 14). Liquid Hydrogen Refueling Infrastructure to Support a Zero-Emission U.S.–China Container Shipping Corridor. *The ICCT*. <https://theicct.org/publication/liquid-hydrogen-refueling-infrastructure-to-support-a-zero-emission-u-s-china-container-shipping-corridor/>

^[66] IPCC (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press. <https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/>

^[67] Van Houtven, G. et al. (2022, March). Act Now or Pay Later: The Costs of Climate Inaction for Ports and Shipping. *RTI International*. Climate Change 2022: Impacts, Adaptation and Vulnerability. <https://www.edf.org/sites/default/files/press-releases/RTI-EDF%20Act%20Now%20or%20Pay%20Later%20Climate%20Impact%20Shipping.pdf>

LEARN MORE

 portsforpeople.pacificenvironment.org

 opportunitygreen.org



 **Ports** for
People