Ports as clean energy hubs

How port cities can power the global energy transition

Illustration by Njung'e Wanjiru

C40 CITIES

ARUP

Contents

AUTHORS

C40 Cities
Elyse Lawson
Ariane Colson
Juvarya Veltkamp
Thomas Baujet
Alisa Kreynes

Arup
Tom Patrinos
Mark Button
Josie Sun

CONTRIBUTORS

C40 Cities
Jonathan Terrefe
Irene Skoula
Kausar Khan
Majka Wankiewicz
Yana Prokofyeva

External
David Hume,
Pacific Northwest National Labs

Gregory Lampman,
New York State Energy Research and Development Authority

Peter Lion,
New York State Energy Research and Development Authority

Baskar Vairamoha,
Electric Power Research Institute

Allyson Browne,
High Ambition Climate Collective

Xiaoli Mao,
International Council for Clean Transportation

Tom Decker,
International Council for Clean Transportation

Mark Wray,
Connected Places Catapult

Philly Strahan,
Connected Places Catapult

C40 CITIES ARUP

"In the coming decade, ports will be vital to the global energy transition; they will not only scale sustainable shipping fuels and facilitate the decarbonisation of shipping, but also serve as marine export and import hubs of clean energy.

The *Ports as clean energy hubs* report and toolkit develops a compelling pathway to harness the potential of port cities, aligning with the national commitments of the Clean Energy Marine Hubs initiative of the Clean Energy Ministerial, the International Chamber of Shipping, and IAPH."

Patrick Verhoeven
Managing Director,
International Association of Ports and Harbours

"At the heart of Long Beach's climate action plan is the key commitment to equity: all residents, and especially economically disadvantaged communities, must benefit from a just transition. *Ports as clean energy hubs* generates handy insights for port city leaders, ensuring that a strong economy and healthy environment are intrinsically linked, leaving no one behind."

Mayor Rex Richardson
City of Long Beach

Who should read this

This report presents the role ports can play to accelerate the transition to a green and clean energy future. It builds the strategic case for investment in ports as clean energy hubs, with a focus on the co-benefits this can unlock for cities. It then describes the actions cities can take, in collaboration with ports and other stakeholders, to deliver on this vision. It is intended for city decision-makers, including Mayors, Chief Executive Officers, and Heads of Departments, as well as city officials seeking to advocate for investment in ports as clean energy hubs.

The report is also of interest to ports themselves, investors, as well as energy sector stakeholders – all of whom have a key role to play in unlocking this opportunity.

Relevant city officials may work within departments such as:

- Business development and industry relations
- Climate action and air quality
- Economic development
- Engineering
- Environment/sustainability
- Green economy
- Innovation
- International affairs/international relations
- International trade and investment
- Ports and coastal areas
- Public affairs
- Stakeholder engagement
- Sustainability
- Urban design

Photo: Unsplash

Glossary

Word/acronym	Definition
Bunkering	Refuelling of ships
Capex	Capital expenditure
Clean Energy Hub	Clean Energy Hubs are sites which enable the energy transition by carrying out crucial energy activities such as sustainable fuels trade, electrification of transport and offshore wind deployment
COP	The United Nations' Conference of the Parties
Devex	Development expenditure
Electrification	The process of transitioning from fossil fuel combustion to electric energy sources such as the grid or batteries
EU	European Union
FLOW	Floating offshore wind
Green ammonia	Ammonia produced from renewable energy and green hydrogen (hydrogen produced from renewable energy)
GW	Gigawatt - a unit of power equivalent to approximately 13,000 cars
Ha	Hectare. A unit of area slightly larger than a football pitch
HGV	Heavy goods vehicle, also known as heavy-duty vehicle
ICCT	International Council on Clean Transportation
IFI	International Financial Institution - an organisation, typically established by multiple countries through international treaties, that provides financial services, loans, grants, and technical assistance to promote economic development, poverty reduction, and financial stability across nations
IMO	International Maritime Organization
M&I	Marshalling and installation - refers to the process of organising and storing wind turbine components at marshalling ports before transporting them to the installation site. This includes preparing the components for efficient loading onto vessels and subsequently installing them at the offshore wind farm
MVA	Megavolt-ampere - a unit of power commonly used to measure the capacity of large electrical systems
MW	Megawatt - a unit of power equivalent to 1/1000th of a GW, or 13 cars
NGO	Non-governmental organisation
O&M	Operation and maintenance
OSW	Offshore wind
Port typology	Example ports that are actively facilitating the future energy transition under the themes of sustainable fuels, electrification and offshore wind
SEZ	Special Economic Zone - a designated area within a country that operates under different economic regulations than the rest of the country, typically offering incentives like tax breaks, reduced customs duties, and streamlined regulations to attract foreign investment and boost economic development
Sustainable fuels	Fuels which are produced and used in a way which produces zero, or close to zero emissions over their lifetime (including production and use) rather than the use of fossil fuels. Also known as Scalable Zero Emission Fuels (ZEF) in other publications
Total Value	The Total Value approach considers the full range of financial, social, environmental, and economic impacts to capture long-term value creation, ensuring decisions support sustainable and inclusive outcomes

Executive Summary

Introducing ports as clean energy hubs

Ports have historically played a critical role in the global energy sector, serving as key hubs for the import, export, and distribution of fossil fuel resources. However, climate action is driving a fundamental transformation in how we produce, store, transport, and use energy. As the world shifts away from traditional fossil fuels like oil, gas, and coal, renewable sources such as wind and solar are being deployed at unprecedented rates to generate clean, green electricity.

Ports will play a different but very key role in our future resilient, decarbonised, and cost-effective energy systems.

To date, much of the focus on ports around climate action has been on limiting environmental impacts through decarbonising port operations. Acting on emissions from ports themselves is important, but can miss the biggest impact ports can make, which is through their role as industrial and transport hubs.

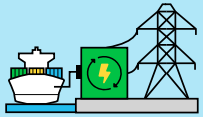
Many ports, and the cities they are embedded in, can maximise their climate impact by becoming clean energy hubs: sites that facilitate offshore wind development, enable sustainable fuel trade and use, or serve as centres for electrified transport networks – all while continuing to handle over 90% of global trade.[1]

This report presents the role ports and cities can play in accelerating the transition to our green and clean energy future. It builds the case for investment in ports as clean energy hubs and it outlines the actions cities can take, in collaboration with ports and other stakeholders, to deliver on this vision. It is intended for city decision-makers, including Mayors, Chief Executive or Administrative Officers, and Heads of Departments, as well as city officials seeking to advocate for investment in ports as clean energy hubs.

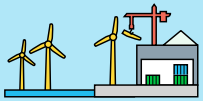
Introducing the *ports as clean energy hubs* typologies

We have shaped three port 'typologies' that highlight the evolving roles ports will play in a future clean, affordable, and resilient energy system:

Ports as Sustainable Fuels Export and Bunkering Hubs: These ports will enable the export and bunkering (ship refuelling) of sustainable fuels, which will play a vital role in the global energy system.



Ports as Hubs for Electrification: These ports will act as multimodal transport decarbonisation hubs, facilitating the electrification of transport services on land and sea.



Ports as Offshore Wind Manufacturing, Marshalling, and Installation Hubs: These ports will support the rollout of offshore wind, acting as hubs for their manufacture, construction, and installation.

1 International Chamber of Shipping. (n.d.). Shipping and World Trade: Top Containership Operators. Retrieved 12 August, 2025, from https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-top-containership-operators/

Photo: Port of Long Beach

Incentives for cities to accelerate action

Ports are intrinsically connected to their cities - through shared infrastructure, regulatory frameworks, economic interdependence, workforce, historical and cultural ties, and connection to international trade. Trade is the lifeblood of urban economies, powering supply chains, building industries, enabling innovation, and supporting billions of lives.

By realising ports as clean energy hubs, port cities can unlock broader ecosystem investment, which together will deliver huge benefits to people, planet, and the economy.

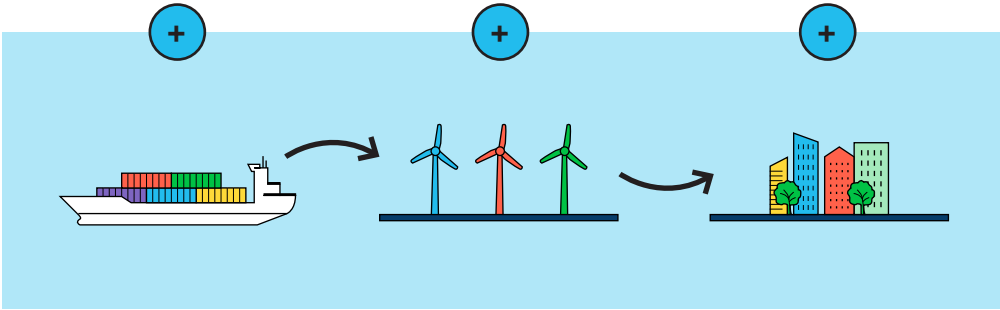
Depending on location, policy context, and business environment, some of these benefits can be monetised, creating a business case for investment. However, nascent technology, immature policy and commercial drivers, as well as the fact that the social value of projects can exceed the commercial value of projects, often hinder market-led investment, so a strategic approach is needed to identify, amplify, and leverage the broad value that port and ecosystem investment can unlock.

This type of approach positions the city at the heart of the solution, creating a model for public-private partnerships that drive port ecosystem investment, maximise benefits, and support climate action.

STEP 1
Cities work with ports to unlock investment and development

STEP 2
Broader ecosystem investment catalysed

STEP 3
Huge benefits unlocked for the city



Building the case for investment

The report emphasises the significant local benefits that can be unlocked through investment in ports as clean energy hubs. By taking a **Total Value approach** to shape port investments, cities and ports can uncover a strategic case for investment that goes beyond traditional cost-benefit analysis. This approach considers the full range of **financial**, **social**, **environmental**, and **economic** impacts, ensuring decisions support sustainable and inclusive outcomes while delivering a case for investment which is both visible and compelling. This case for action is not only based on the environmental benefits of supporting the energy transition, but also the local co-benefits which can be unlocked for communities, investors and the economy.

Benefits of ports as clean energy hubs

The following highlights the key benefits delivered by ports as clean energy hubs and their applicability to each port typology where:

✓✓✓	✓✓	✓
High applicability of benefit to port typology	Mid applicability of benefit to port typology	Low applicability of benefit to port typology

Value Area	Benefit	Applicability to Port Typology		
		Sustainable Fuel Hubs	Hubs for Electrification	Offshore Wind Hubs*
Social	**Supporting an equitable transition to green jobs:** Investment in ports as clean energy hubs can support the transition to high-quality green jobs from legacy industries such as oil and gas.	✓✓✓	✓✓	✓✓✓
	Public Health Improvements: Electrification and sustainable fuel bunkering can reduce air pollution, leading to significant public health benefits. Improved air quality can also enhance the quality of life for local communities.	✓✓	✓✓✓	✓
Economic	**Green Growth:** Ports as clean energy hubs can stimulate local economies by attracting investment in renewable energy and related industries. This can lead to increased economic activity, and generate thousands of jobs in new green industries.	✓✓✓	✓✓	✓✓✓
	Future-proofing Economies: Ports as Clean Energy Hubs future-proof local economies to capitalise on the opportunities presented by the energy transition.	✓✓✓	✓✓✓	✓✓✓
Financial	**Revenue Generation:** Export of sustainable fuels, or offshore wind components in particular can generate significant revenue for ports and investors. This can also create revenue for related industries including ship operators and upstream supply chains including material suppliers, construction and energy producers.	✓✓	✓✓	✓✓
Environmental	**Decarbonisation:** Ports as clean energy hubs can facilitate the integration of renewable energy into the power grid, displacing fossil fuel generation and driving overall decarbonisation.	✓✓✓	✓✓✓	✓✓✓
	Improvement in air quality and noise: Investment in clean energy hubs can reduce particulate emissions and noise from combustion of fossil fuels.	✓✓	✓✓✓	✓

Transforming port cities: The Action Toolkit

The Action Toolkit is a set of collaborative actions that cities, in collaboration with ports and other stakeholders, can implement to transform ports into clean energy hubs, attract investment, and realise the huge opportunities they can bring. The toolkit is aimed at city officials who are looking to identify the role cities can play in accelerating the development of ports as clean energy hubs, though is relevant to other areas of city-led climate action. Other actions will be required by ports, energy stakeholders, investors, policy makers and others – this focuses on the city lens.

You can find a quick overview of these actions on the right of this page, where we indicate at a high level for each action:

- **City resource requirement** – highlighting the level of staffing requirement to deliver the action
- **$ Anticipated city cost level** – representing the level of capital expenditure likely to be required from the city. This might include direct grants/funding, investing in infrastructure, commissioning studies or attending/hosting events.
- **Potential impact** – referring to the impact of the action in terms of moving towards the ports as clean energy hubs vision.

In the table:

👤	Lower city resource requirement	$	Lower city cost level	🏆	Lower potential impact
👤👤	Mid city resource requirement	$ $	Mid city cost level	🏆🏆	Mid potential impact
👤👤👤	Higher city resource requirement	$ $ $	Higher city cost level	🏆🏆🏆	Higher potential impact

	Action	👤	$	🏆
	Leadership and strategy			
1	Align with ports on decarbonisation vision and strategy for the region	👤👤	$	🏆🏆🏆
2	Advocate for action on clean energy hub ports and higher delegated powers for the city	👤👤	$	🏆🏆🏆
3	Convene and support key actors to accelerate impactful investment	👤	$	🏆🏆
4	Gather evidence to inform goals, strategies, actions and investment decisions	👤	$ $	🏆🏆
	Policy and planning			
5	Integrate port and city land-use planning	👤👤	$ $	🏆🏆🏆
6	Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning	👤👤	$	🏆🏆🏆
7	Support effective consenting for infrastructure development	👤👤👤	$	🏆🏆🏆
8	Create and enforce effective policy to drive local emissions reduction and air quality improvements	👤👤👤	$	🏆🏆
9	Embed sustainability into port lease agreements	👤👤	$	🏆🏆
10	Shape tax incentives (as well as port fees) to enhance green investment	👤👤👤	$	🏆🏆🏆
	Investment and finance			
11	Support port grant and finance applications	👤👤👤	$	🏆🏆
12	Implement targeted taxes or levies and ringfence funds for targeted port investment	👤👤👤	$	🏆🏆🏆
13	Utilise city/municipal investment banks to fund investments through debt instruments and increased financial attractiveness	👤👤	$ $ $	🏆🏆🏆
14	Invest in port connectivity	👤👤	$ $ $	🏆🏆
15	Support catalytic port DEVEX and CAPEX funding	👤👤	$ $ $	🏆🏆🏆
	Society and workforce planning			
16	Work with other stakeholders to shape the ports as clean energy hubs workforce	👤👤👤	$	🏆
17	Tell the Total Value story of ports as clean energy hubs	👤👤	$	🏆🏆🏆
18	Increase city competitiveness to attract and retain talent	👤👤	$ $ $	🏆

Photo: Unsplash

City-levers and levels of influence

Cities' ability to drive and support climate action in ports varies based on their location, jurisdiction, and capacity, influenced by port governance and available resources. For instance, a city might have less influence in a privately-owned port but can still advocate for action through policy and planning or support national funding applications.

For each general action in the Toolkit, we have defined specific sub-actions which cater for different levels of influence within the main body of the report. The three levels of influence we use to shape sub-actions in the report are:

- **Mandate:** Where cities can set regulations and enforce policies, such as emission standards and requiring specific technologies.
- **Enable:** Material interventions which can create favourable conditions for climate action. This could include financial tools such as grants or tax incentives, or investments in enabling infrastructure.
- **Support:** Cities can use their position to advance initiatives through partnerships, knowledge-sharing, advocacy, and strategic studies.

Some actions may include possible sub-actions across all levels of influence, while others might only fit one or two. The actions should be seen as a menu for cities to select from, rather than a prescriptive list.

Introduction: The role of ports as clean energy hubs

Ports in traditional energy systems

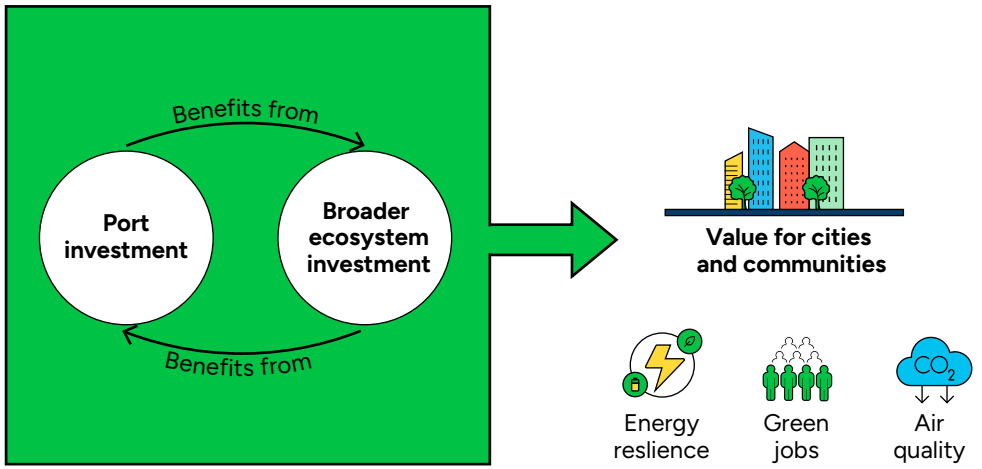
Ports have historically played a critical role in the global energy sector, serving as key hubs for the import, export, and distribution of fossil fuel resources. Today, with over a third of maritime trade still linked to fossil fuels, many ports remain central to high-emission energy supply chains.

However, climate action is driving a fundamental transformation in how we produce, store, transport, and use energy. As the world shifts away from traditional fossil fuels like oil, gas, and coal, renewable sources such as wind and solar are being deployed at unprecedented rates to generate clean, green electricity.

The energy transition extends beyond power generation - sectors traditionally dependent on fossil fuel combustion, from transport to industry and heating, are rapidly electrifying, requiring fundamental changes to our electrical infrastructure. In areas where electrification proves challenging, hydrogen and other zero-emission sustainable fuels are emerging as viable alternatives. This shift is reshaping global energy trade patterns, with the dynamics of who produces energy and who uses energy also changing.

The role of ports as clean energy hubs

To date, much of the focus on ports around climate action is on limiting environmental impacts through decarbonising port operations. Acting on emissions from ports themselves is important, but can miss the biggest impact ports can make, which is through their role as industrial and transport hubs.



Many ports can maximise their climate impact by becoming clean energy hubs: sites that facilitate offshore wind development, enable sustainable fuel trade, or serve as centres for electrified transport networks – all while continuing to handle over 90% of global trade.

90%
of global trade is handled by ports[2]

In addition, through ports as clean energy hubs, port cities can unlock broader energy system investment, which together, can create significant social, economic, financial, and environmental benefits. This creates a compelling case for cities to pursue ports as clean energy hubs – not only for their role in the energy transition, but also for the local co-benefits which can be unlocked for communities, investors, and the economy.

2 International Chamber of Shipping. (n.d.). Shipping and World Trade: Top Containership Operators. Retrieved 12 August, 2025, from https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-top-containership-operators/

How to use this report

In this report, we highlight the opportunity that ports as clean energy hubs can bring, so that cities, ports and other stakeholders can prioritise timely port investment, accelerate the energy transition and mitigate climate change – the greatest challenge of our times. It is intended for city decision-makers, including Mayors, Chief Executive Officers, and Heads of Departments, as well as city officials seeking to advocate for action towards ports as clean energy hubs.

It acts as a guide split into three sections: exploring what clean energy hubs are, why ports and cities should act to unlock investment, and how cities can unlock the inherent value they can provide.

Section Title	Intended audience	Intended outcomes
The what 'Introducing the Ports as Clean Energy Hubs Typologies'	City officials looking to understand the different roles ports will play in a future energy system.	A baseline understanding of the role that ports are likely to have in a future decarbonised energy system.
The why 'Empowering cities to support ports as clean energy hubs'	City officials looking to build the case for investment in clean energy hubs to take to key decision makers.	Identification of the co-benefits that can be unlocked through ports as clean energy hubs to build a strategic case for investment.
The how 'Transforming port cities: The Action Toolkit'	City officials looking to identify the role cities can play in unlocking action towards clean energy hubs.	A roadmap of city actions which can unlock the huge benefits of ports as clean energy hubs.

Photo: Ports of Stockholm

Introducing the ports as clean energy hubs typologies

Who is this section for?

This section is for city officials - as well as wider stakeholders - looking to understand the different roles ports will play in a future green, resilient and cost effective energy system.

What will I get from this section?

An understanding of the potential role and form that ports are likely to have in a future decarbonised energy system across the themes of sustainable fuels, electrification and offshore wind.

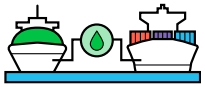
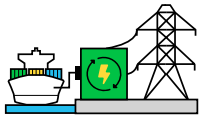
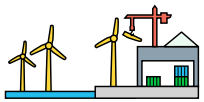
It is crucial to first understand ports' evolving role in our future clean, affordable, and resilient energy system. Our three port typologies highlight example roles that ports will play under the fast-emerging sectors of sustainable fuels, electrification and offshore wind.

The table below lists these three typologies and describes our rationale for selection. Each is described in more detail in the following pages of this report.

While presented in separate themes, each typology need not be considered in isolation, as their components share potential synergies. For example, it might be that by becoming a hub for electrification, ports can also become offshore wind manufacturing hubs as a result of increased electrical power supply to the port.

Similarly, these typologies are not prescriptive – ports do not need to carry out all activities described in order to be considered energy hubs. They present a menu of possible options for consideration. For example, a port may offer sustainable fuels export without bunkering operations.

However, we hope that by exploring the variety of roles ports are likely to play through these three theoretical typologies, ports and cities can see which aspects are more aligned to their future vision and apply learnings that are most relevant to them.

Typology	Outline	Selection logic
 **Ports as sustainable fuels export and bunkering hubs**	A port with liquid bulk facilities to enable the export and bunkering of sustainable fuels. In this example we focus on green ammonia* as a sustainable fuel.	Today, ports enable the trade of energy through shipping of fossil fuels. Sustainable fuels will play a different but still vital role in the global energy system.
 **Ports as hubs for electrification**	An electrified port with vessel, vehicle and equipment charging, as well as onsite renewables, energy storage and microgrid solutions.	As multimodal transport hubs, ports act as the interchange of transport services on land and sea which are increasingly looking to electrify. Furthermore, ports can become contributors and not just consumers to decentralised electrical power networks.
 **Ports as off-shore wind manufacturing, marshalling and installation hubs**	A port with co-location of marshalling/installation facilities, with offshore wind component manufacturing.	Offshore wind deployment is accelerating at a significant pace. As the interface between land and sea, ports are vital to the rollout of this key renewable resource acting as hubs for their manufacture, construction and installation.

***Why ammonia?**

Several sustainable fuels are being developed in response to the challenge of emissions reduction, each with unique benefits and challenges. Green ammonia, despite its toxicity, is expected to become a widely adopted clean shipping fuel and a hydrogen carrier for long-distance energy transport. It offers improved scalability compared to biofuels and even other e-fuels like green methanol. However, it currently faces high production costs and lacks appropriate safety guidelines and regulations for use as a fuel. For more information on sustainable shipping fuels, and a guide to how port cities can support the transition to clean marine fuels, **see our online article** (C40 Cities, 2025).

Port typology #1: Ports as sustainable fuels export and bunkering hubs

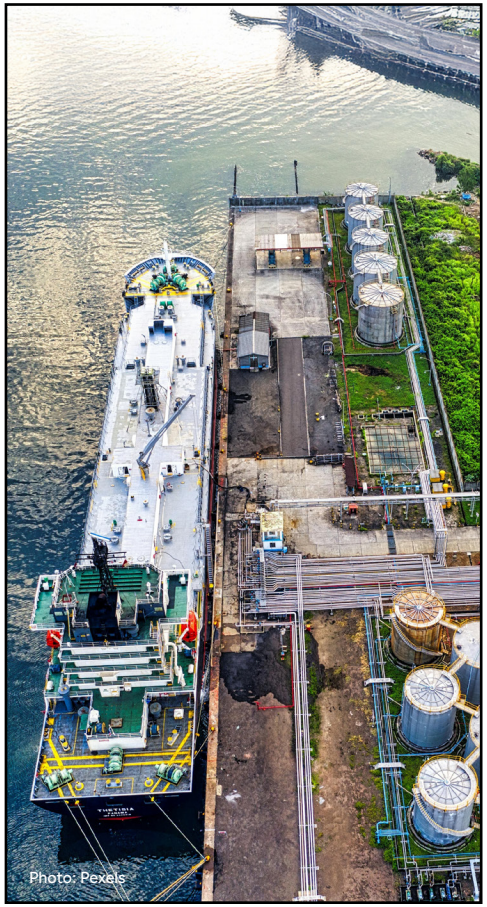


Photo: Pexels

Sustainable fuels context

Shipping already plays a crucial role in the movement of energy around the globe. As we decarbonise, the fuels being transported are likely to change, as will export and import locations, and what the sustainable fuels are used for. Sectors such as agriculture, shipping, aviation, and industry will need green fuels and feedstocks alongside low carbon power.

Locations with significant renewable energy generation potential can produce sustainable, hydrogen-derived fuels such as green ammonia at a lower cost. These locations – primarily in the Global South – are often remote from demand centres in the Global North, suggesting a significant market for international trade of these fuels will emerge, with ports acting as both import and export facilities (World Bank, 2021).

Shipping itself also represents a significant potential demand for sustainable fuels. Ports equipped for fuel exports can also offer refuelling services, creating dual-purpose infrastructure that maximises returns on investment. Supply patterns are likely to shift geographically, and because these fuels have lower energy density than conventional options, ships may need to refuel more often, opening up opportunities for new regions to gain a foothold in the future bunkering market.

Typology description

This typology comprises green ammonia export, combined with refuelling of vessels calling at the port. In this example, we focus on the upstream effects of the port investment. The aim is that by investing in export and bunkering capabilities, this can attract local investment in the sustainable fuels supply chain, enabling up- and downstream industries near to the port, unlocking huge opportunities.

The port is a medium-sized city port which has nearby land available for development. This port is in the Global South, where cheap renewable energy enables production of cost-competitive green fuels. This example describes a port able to export in the region of 1 million tonnes per year of green ammonia, alongside half a million tonnes per year for bunkering, enough to meet the annual energy demand of ~4 large container ships.[3] If all green ammonia (export and bunkering) is used as a shipping fuel, this has the potential to save over 2.3 million tonnes of GHG emissions per year, equivalent to taking over 500,000 cars off the road.[4]

Port investment in this typology is likely to be in the region of hundreds of millions of dollars, though this can be reduced if existing infrastructure can be repurposed. For example, ports may have an existing liquid bulk jetty and/or storage which can be repurposed.

3 From IMO DCS data for 2022, the annual consumption of a large container ship (>80,000 DWT) is ~20,000t HFOe, equivalent to ~50,000t of ammonia.
4 From the US Environmental Protection Agency, the average annual emissions from a passenger car is 4.6 tCO2e per year (United States Environmental Protection Agency, n.d.).

Note: While this typology assumes ample local land availability, we know that many port cities face significant land constraints. However, there are potential strategies to address this challenge - for example, ports could identify underutilised industrial land in nearby communities and invest in the necessary energy transportation infrastructure to support offsite solutions.

The following describes the key **port infrastructure investment** for this typology, also shown in the accompanying diagram:

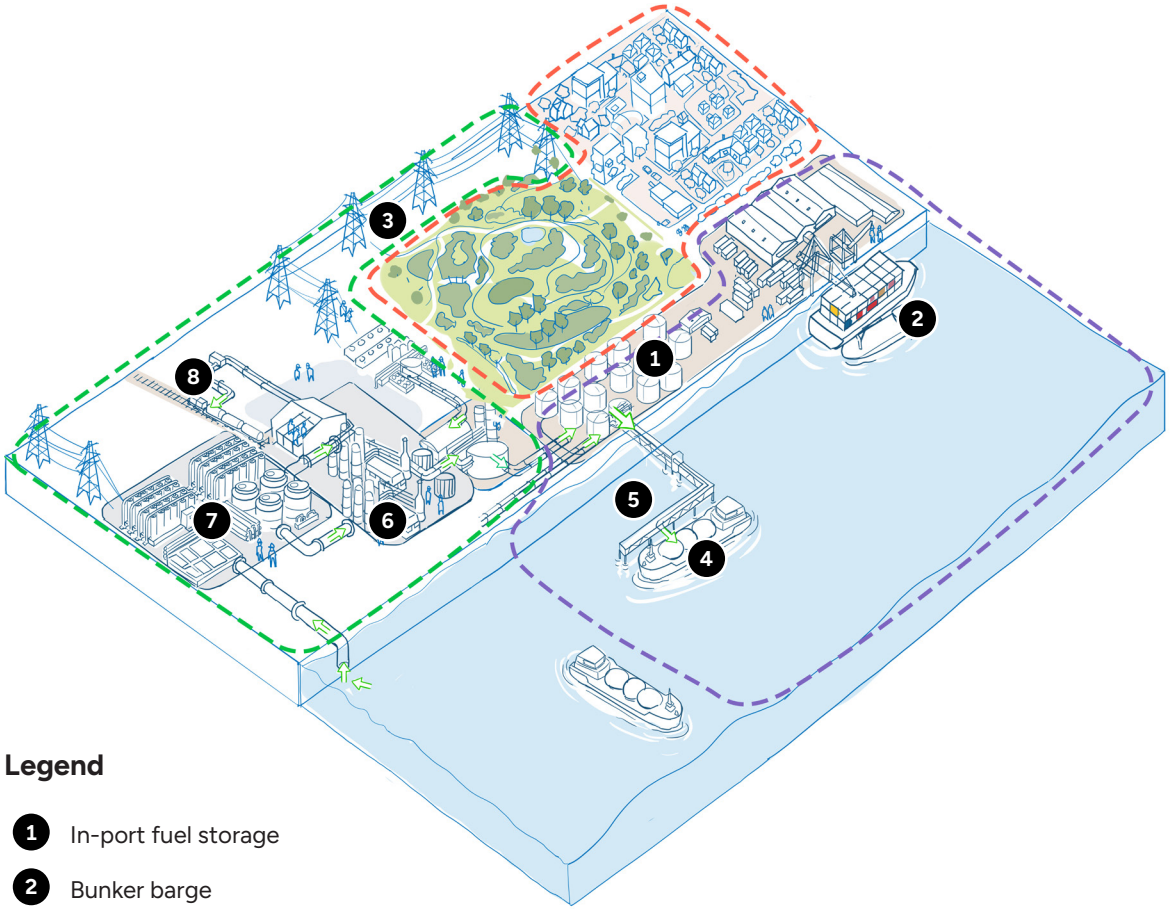
- **Export jetty** – infrastructure for ships to berth, where they are loaded with ammonia for export.
- **In-port ammonia storage** – to store ammonia ready for loading into vessels via the jetty.
- **Pipeline and transfer systems** – to distribute sustainable fuels from port storage facilities to vessels at the jetty.
- **Bunker barge(s)** – vessels powered by sustainable fuels can be fuelled via hoses connected to dedicated bunker barges.

This investment has the potential to unlock significant **upstream ecosystem investment** in the following which can synergise with the bunkering and export facilities:

- **Sustainable fuels production** – to locally produce fuels for export.
- **Feedstock production** – for green ammonia, this includes hydrogen production.
- **Renewable energy generation** – to power the production of feedstocks and sustainable fuels.

Example: Ports as sustainable fuels export and bunkering hub

This model typology is presented for illustrative purposes



Legend

1. In-port fuel storage
2. Bunker barge
3. Connection to renewable energy
4. Ammonia tanker
5. Jetty
6. Amonia production
7. Desalination plant
8. Transport to in-land end-users

- Port Investment
- Broader Ecosystem Investment
- Huge benefits unlocked for the city

Port typology #2: Ports as hubs for electrification

Photo: Stockholm Hamnar/Ports of Stockholm

Port electrification context

Ports are, at their heart, intermodal transport hubs, acting as the interchange of ships, road, and rail in the movement of goods and people. Increasingly, these services are seeking to electrify, whether that's with onshore power for vessels, zero-emission cargo handling equipment, or the replacement of diesel trucks and passenger ferries with battery-powered alternatives. This is to reduce the carbon intensity of their operations, but also to mitigate local impacts by improving air quality.

Ports have the potential to become key players in a decentralised energy system by generating and storing electricity from renewable sources both on land and at sea. With wind, solar, and even tidal energy, ports can produce clean power while battery storage and other technologies help balance the grid by storing excess energy and releasing it during peak demand. This not only enhances energy resilience but also reduces reliance on centralised power systems, further supporting grid flexibility and the transition to a low-carbon economy.

Typology description

Port electrification will vary by port size and traffic. For example, ports with short-sea ferries may need vessel charging, while large container ports might focus on shore power. Investments would likely be phased based on the port's specific needs and resources. This example shows a medium-sized city port serving diverse vessels – ferries, containers, bulk carriers, and seasonal cruises – and includes both energy supply infrastructure and new electrified demands. The following describes the **port infrastructure investment** for this typology, also shown in the accompanying diagram:

- **Network reinforcement** – investment in new substations and/or distribution is likely required, with many potential high-power electrical demands anticipated to exceed current grid connections for typical ports.
- **Local renewable generation** – ports can use their footprint to install renewable generation on land and water such as onshore wind turbines and solar, floating solar and even tidal energy.
- **Battery energy storage systems** – to store excess energy and reduce power draw on the grid during peak demand.
- **Microgrid technology** – A port microgrid integrates renewables, storage, and smart management to provide reliable power, manage demand, cut peak demand, and reduce the need for grid reinforcement. This can increase energy resilience and energy independence.

- **On-shore power systems** – on-shore power connections will allow vessels to switch-off their engines at berth. A berth for large vessels may consume over 30,000 MWh of energy over the year, enough to meet the annual electricity consumption of over 10,000 average UK households.[5]
- **Vessel charging** – High-power charging for electric vessels, such as ferries, operating on shorter routes to enable charging during turnaround and maintain route timetables. Depending on the vessel, charging power requirements can be higher than for shore power.
- **Charging facilities for cargo handling equipment and HGVs** – By providing this facility, the port can remove potential barriers of electrification of CHE, HGV and port equipment fleets.

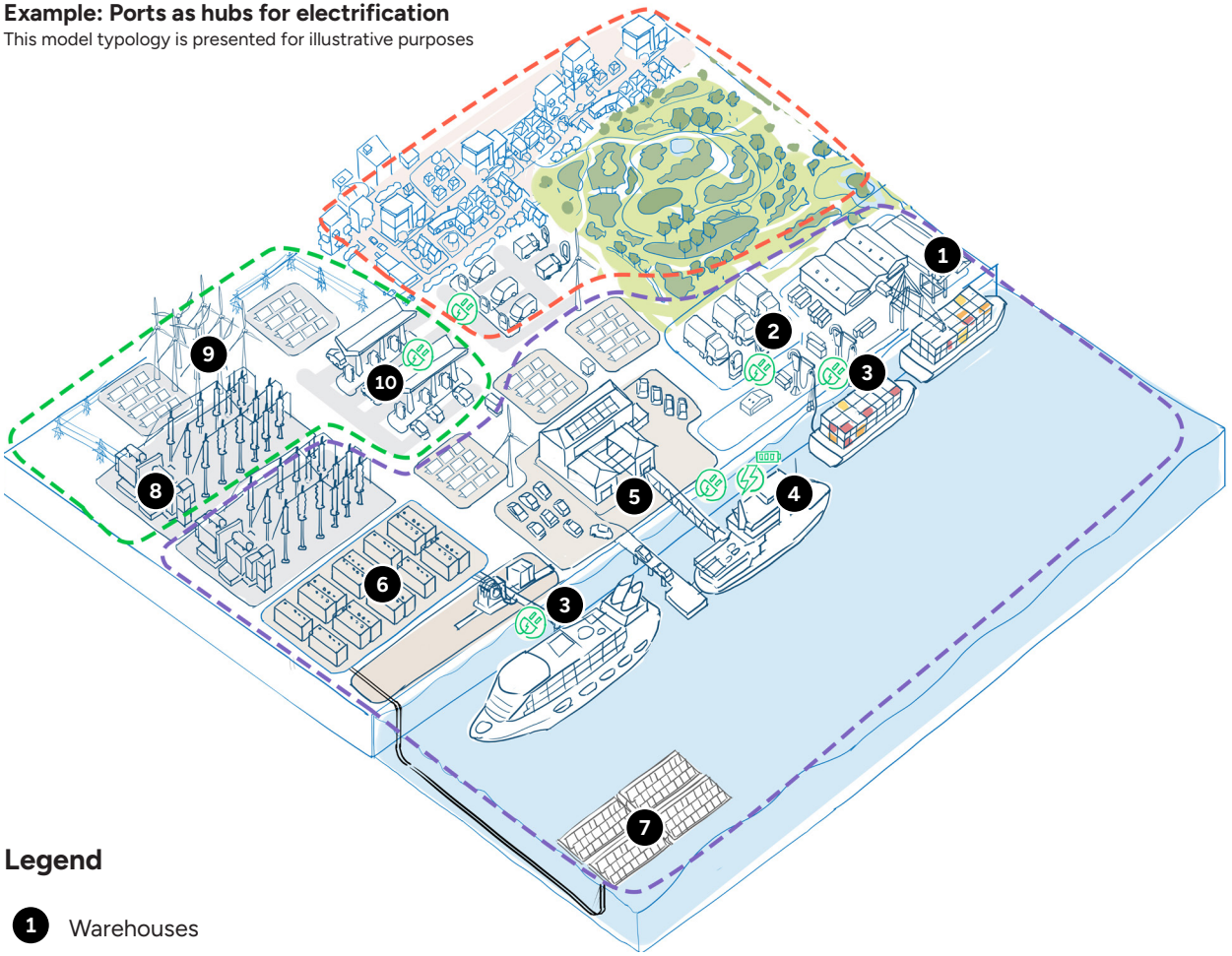
This investment has the potential to unlock significant **upstream ecosystem investment** in the following which can synergise with port electrification:

- **Renewable energy generation and grid reinforcement** – to meet increased electrical demands at the port.
- **Electrified transport demands** – investments in HGV and port vehicle fleets can be encouraged through the provision of sufficient grid and charging infrastructure.
- **Local supply chains** – investments in local supply chains supporting broader electrification. For example, manufacturing linked to electrical components or transmission, battery giga-factories, or electric vessel building facilities.

The investment required for port electrification infrastructure is highly dependent on the port's size, traffic and existing grid capacity, but for a port of this size, investment could reach hundreds of millions of dollars.

5 According to Ofgem's 2023 Typical Domestic Consumption Values (TDCVs), the average annual electricity consumption for a UK household is 2,900 kWh for a medium user (Ofgem, n.d.).

Example: Ports as hubs for electrification
This model typology is presented for illustrative purposes



Legend

1. Warehouses
2. HGV parking with chargers
3. Shorepower
4. Vessel charging
5. Ferry terminal
6. Battery storage
7. Marine renewable energy and storage
8. Transformer/substation
9. Renewable energy generation
10. EV chargers

- Port Investment
- Broader Ecosystem Investment
- Huge benefits unlocked for the city

Port typology #3: Ports as offshore wind manufacturing, marshalling and installation hubs

Photo: Unsplash

Offshore wind context

Ports will play a crucial role in meeting ambitious deployment targets for offshore wind, which is expected to increase to 3.5 times current levels by 2030 (4C Offshore, 2024). The deployment required to support this is significant. For context, the largest wind farms in the world are currently between 1-2 GW and occupy a space equivalent to approximately 100,000 football pitches. Many countries have national offshore wind targets which port cities can help to achieve, whilst also capturing local benefits (see 'Empowering cities to support ports as clean energy hubs' for a discussion on these potential benefits).

Ports supporting the offshore wind sector come in all shapes and sizes. For example, ports may be operation and maintenance (O&M) bases, or marshalling and installation (M&I) facilities – critical hubs for assembling and deploying offshore wind.

O&M ports provide a valuable entry point for smaller ports into the offshore wind sector, as they require relatively modest infrastructure upgrades. These ports can secure long-term revenue and job opportunities by hosting dedicated service bases for individual wind farms, often through multi-year contracts with developers. However M&I ports require significant investment in port infrastructure (see below), and installations for a single windfarm typically only last for 1–2 years, making it difficult for ports to recoup their investments. This is compounded by a lack of visibility into future contracts, which often makes the business case unclear for M&I ports.

Typology description

This typology combines component manufacturing and M&I facilities to develop a regional offshore wind cluster. This set-up strengthens the investment case through long-term leases and boosts the port's broader offering. By doing so, the city, alongside the port, can attract mature supply chains to mitigate the potential impacts of short project cycles and future contract visibility, driving social and economic benefits.

Additionally, situating manufacturing alongside marshalling and installation allows for the shared use of port infrastructure (such as heavy lift quays and deep water berths) to export components to other markets, while also reducing the need for long-distance transport of large, heavy components. This lowers installation costs, cuts emissions, and crucially strengthens the overall business case for port investment through increased utilisation of infrastructure. Manufacturing would necessitate access to suitable and adjacent industrial land.

A port of this scale would require significant investment in the below infrastructure. While each case is individual, we would expect investment at the scale of hundreds of millions of dollars, though less is possible if a port has existing infrastructure which can be repurposed.

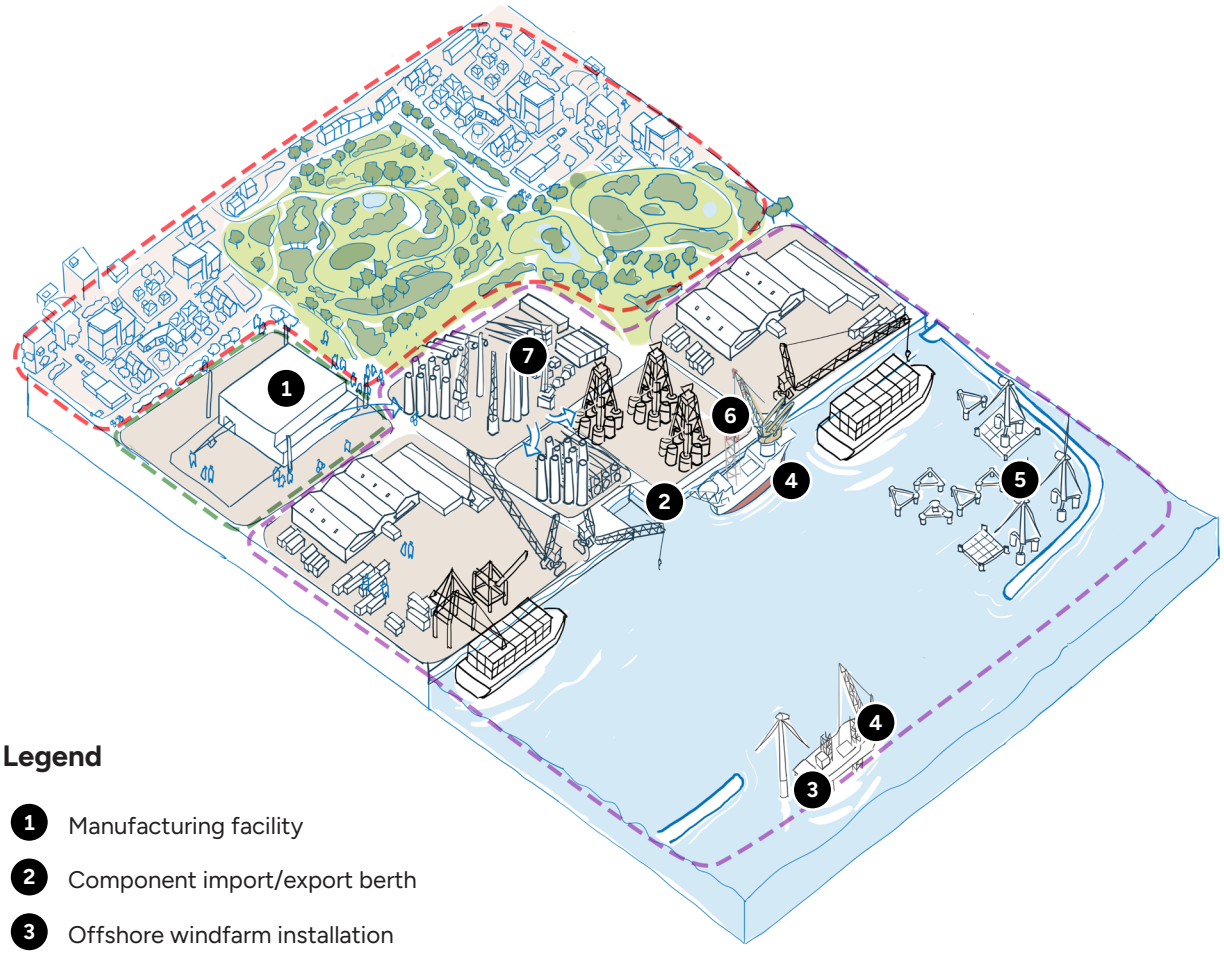
As an example, we have described a medium-large sized port with significant space available in/adjacent to the port, which can support up to 1 GW per year of local offshore wind deployment. Key **port infrastructure investment** for this typology includes:

- **Quay upgrades** – a quay of up to 0.5 km which can handle heavy loads will be required to accommodate large installation vessels.
- **Increased harbour depth and entrance width** – harbours will need to be maintained to increased water depths and potentially widened to accommodate heavy component transport vessels.
- **Marshalling/assembly facility** – an area of suitable strength and size (15-20+ ha) to store, assemble and load out turbine components including turbine blades and/or foundations.
- **Wet storage** – sheltered areas of water with suitable moorings can be used to store components on barges, complimenting onshore storage areas.
- **Allocated space for manufacturing** – a 20-30ha+ area prepared and allocated for manufacturing will enable fabrication of a major component (such as turbine blades) which could be exported via the new quay.

This investment has the potential to unlock significant **upstream ecosystem investment** which can synergise with offshore wind M&I facilities, including:

- **Component manufacturing supply chains** – an offshore wind manufacturing supply chain could be established, taking advantage of the new port infrastructure to manufacture components for installation and export to nearby installations.
- **Energy system investment** – offshore wind deployment can drive investment in grid infrastructure, enhancing local energy resilience by improving transmission capacity and integrating renewable power.

Example: Ports as offshore wind manufacturing, marshalling and installation hubs
This model typology is presented for illustrative purposes



Legend

1. Manufacturing facility
2. Component import/export berth
3. Offshore windfarm installation
4. Jack-up installation vessels
5. Wet storage
6. Marshalling/assembly facility
7. Component storage

- Port Investment
- Broader Ecosystem Investment
- Huge benefits unlocked for the city

Empowering cities to support ports as clean energy hubs

Who is this section for?

City officials looking to build the case for investment in clean energy hubs to take to key decision makers.

What will I get from this section?

Identification of the co-benefits that can be unlocked through ports as clean energy hub to build a strategic case for investment.

Challenges to enabling ports as clean energy hubs

The previous section highlighted how ports can drive the energy transition and climate action as clean energy hubs. However, immature technology, policy, and commercial drivers often hinder market-led investment, presenting several challenges outlined below.

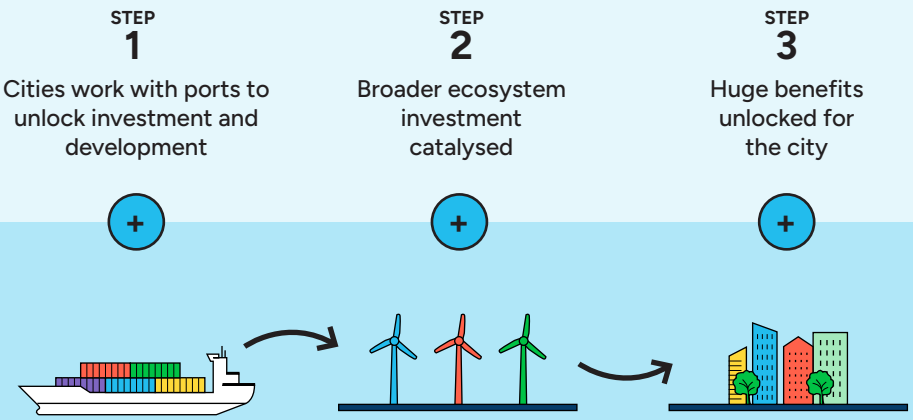
Port typology #1	Port typology #2	Port typology #3
Challenges preventing ports as sustainable fuels hubs	**Challenges blocking investment in ports as hubs for electrification**	**Challenges blocking investment in offshore wind manufacturing, marshalling and installation hub**
• Unclear and complex policies on sustainable fuels create uncertain business cases (C/R). • Low technology maturity of sustainable fuels value chain (T). • Lack of regulations driving uncertainty in the safety case (R). • Difficulty securing offtake agreements (C). • Lack of available land adjacent to port (T).	• Ports are competing with other critical infrastructure for limited renewable generation (T). • Planning complexity for energy generation and storage infrastructure (R). • Insufficient grid infrastructure to meet increased electrical demand (T). • Split incentive and fragmented decision making (equipment decisions made by terminal operators and not the port directly) (C).	• Lack of pipeline certainty of offshore wind projects (C). • Prohibitive capital investment in ports to enable offshore wind deployment (C). • Low technology maturity for floating offshore wind (T). • Lack of available land adjacent to port (T).

Challenges to enabling ports as clean energy hubs. (T) = technical, (R) = regulatory, (C) = commercial.
Note: This list is not exhaustive.

Incentives for cities to accelerate action

Cities can collaborate with ports and wider stakeholders to overcome these barriers, unlock investment and accelerate the energy transition. However, beyond this environmental imperative, ports as clean energy hubs have the potential to unlock broader ecosystem investment – such as a sustainable fuels supply chain – which together can deliver huge benefits to communities, the economy, and investors.

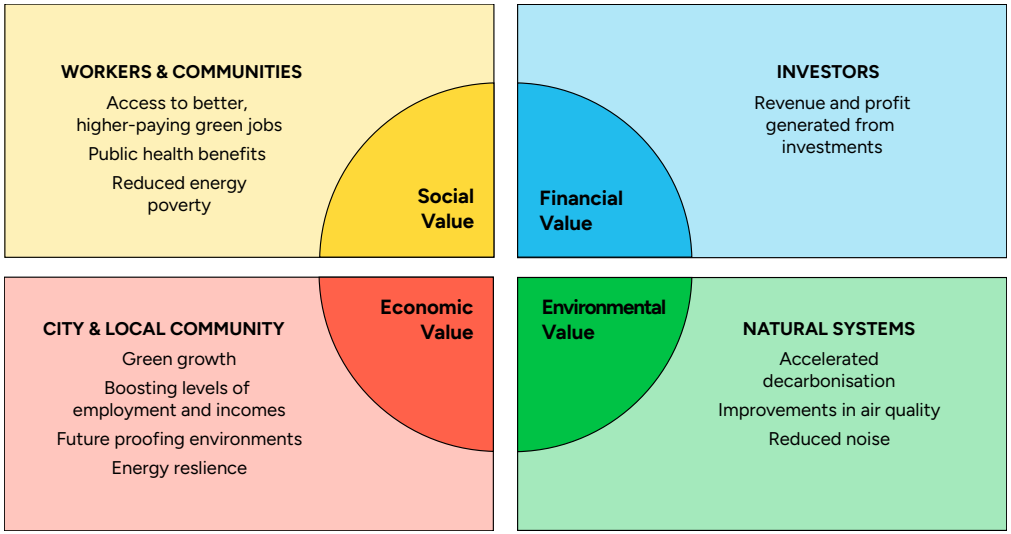
By highlighting these significant benefits, a strong strategic case for action can be made for both public and private actors. This approach positions the city at the heart of the solution, creating a clear framework for public-private partnerships that drive port investment, amplify benefits, and support the energy transition.



Leveraging the Total Value Approach

A key way to identify, maximise, and leverage these benefits is by using a Total Value framework. This goes beyond traditional cost-benefit analysis by considering the full range of **financial**, **social**, **environmental**, and **economic benefits**, accrued to a range of stakeholders. It aims to capture long-term value creation, ensuring decisions support sustainable and inclusive outcomes. Also, by considering the broader impacts of clean energy hubs in this way, cities – alongside ports and other stakeholders – can shape a strategic case for investment that brings together multiple beneficiaries.

In this section, we explore the significant local benefits which can be captured through investment across the three clean energy hub typologies.



TYPOLOGY #1

Why cities should support ports as sustainable fuels hubs

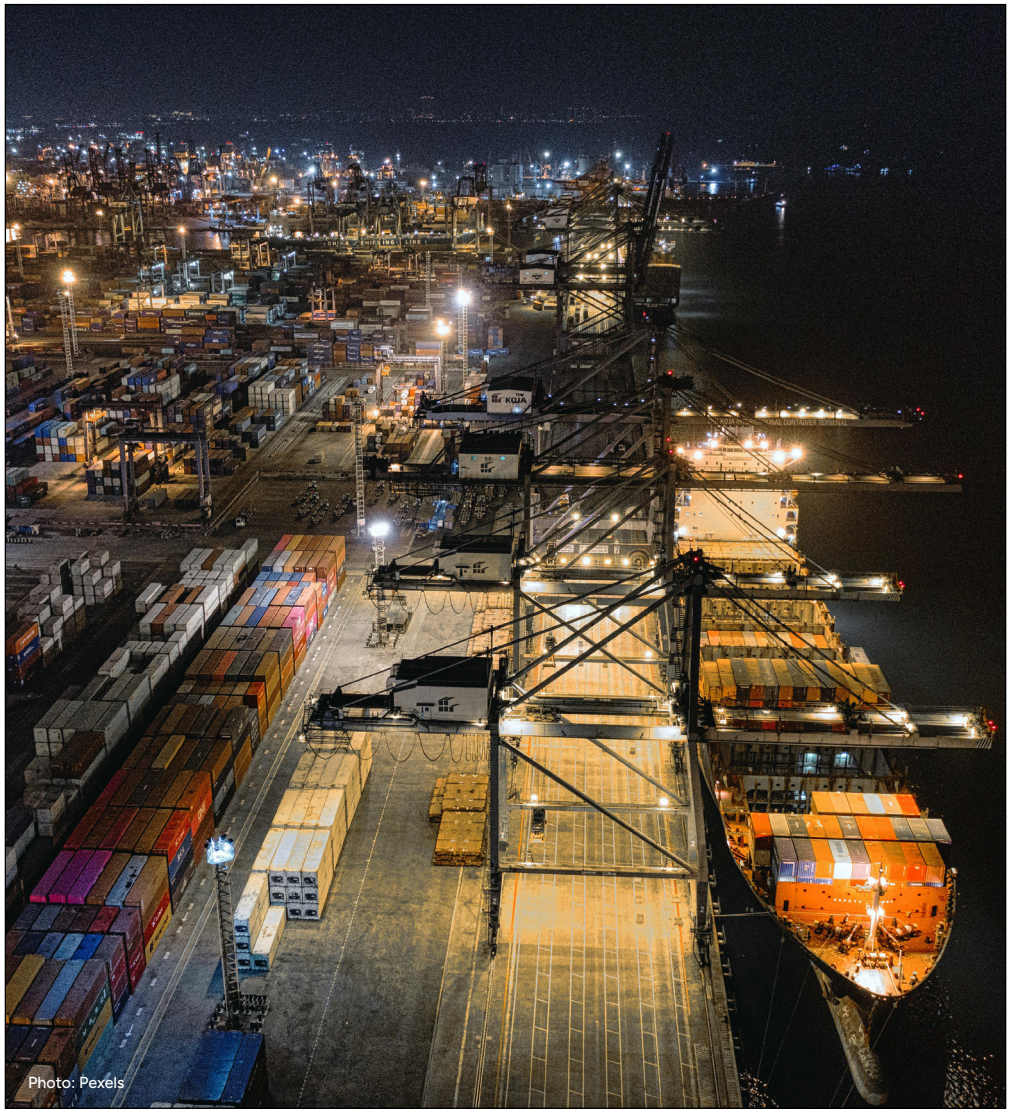


Photo: Pexels

Unlocking broader ecosystem investment in a sustainable fuels supply chain

Port facilities for exporting and bunkering sustainable fuels can catalyse broader supply chain investments, positioning port cities as key players in the global transition to cleaner energy whilst unlocking significant co-benefits.

The process effectively follows these three stages:

STEP 1
Port and city collaborate, unlocking investment in port infrastructure to support export and bunkering of sustainable fuels.

↓

STEP 2
This foundational investment enables investment in sustainable fuels production, feedstock production and renewable energy, unlocking supply chain opportunities.

↓

STEP 3
Together, these investments unlock significant value for the city and its communities.

The scale of investment required will vary depending on the size of port and quantities of fuels to be produced and exported. However, for a large production and export hub as described in our typology, port infrastructure investment could reach hundreds of millions of dollars, while ecosystem investments in renewable energy generation, feedstock production and sustainable fuels production could reach billions of dollars.

This section explores the value unlocked through these investments, highlighting the wider economic, financial, social, and environmental benefits. These impacts have been identified using our Total Value approach, ensuring that the full strategic case for sustainable fuels production and export is visible and compelling.

Social value

- Supporting the just transition to long-term, high quality green jobs by developing a centre of excellence and skills economy for sustainable fuels.
- A local sustainable fuels supply chain can reduce reliance on imported fossil fuels, enhancing energy security and stabilising energy costs for people, helping to tackle energy poverty.

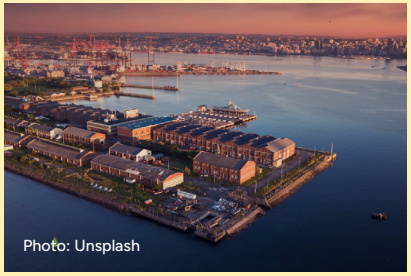


Photo: Unsplash

Hydrogen Valley, Port of Durban

The Port of Durban's proposed Hydrogen Valley initiative could create 2.9–5.8 thousand jobs by 2030, supporting the transition to green jobs. Most roles will be medium-skilled, with high-skilled opportunities in manufacturing, installation, and plant operations. Training will be provided to build workforce capability and ensure equal opportunities for all (Department of science and innovation & engie impact, 2021).

Economic value

- Direct investment in ports and a sustainable fuels supply chain unlocks indirect supply chain investment, which in turn drives induced economic impacts. Together, this generates broader economic value for the city.
- Short term jobs in manufacturing, construction and installation of port infrastructure and the sustainable fuels supply chain. Long term jobs in operation of sustainable fuels production and export.
- Diversification and future-proofing port revenue streams in an emerging energy landscape.

We estimate that investment of similar scale to this typology could generate **tens of thousands of jobs (direct, indirect, and induced) in renewable generation, hydrogen production, e-fuel production and their supply chains.**

Unigel Camaçari Project, Brazil

The Unigel Camaçari Project in Bahia, Brazil, is the country's first industrial-scale green hydrogen and ammonia facility. With an initial $120m investment, it has the potential to attract a further $1.5bn in private investment. The project aims to produce 40,000 tons of green hydrogen annually by 2025, scaling to 100,000 tons by 2027. It is expected to create over 500 jobs and boost the local economy (Hydrogen Central, 2023) (Compressor Tech2, 2022).

Financial value

- Export of sustainable fuels would generate revenue and profit for investors in sustainable fuels production, feedstock production, and renewable generation.
- It could also create revenue and profit for port investors from bunkering activity, new additional lease agreements, and additional port fees.
- These new activities would also generate revenue and profit for related industries, including ship operators, process safety engineers and construction companies.

Environmental value

- A sustainable fuels supply chain, driven by hydrogen production, can foster the growth of a local hydrogen economy. This shift from fossil fuels can improve air quality and deliver public health benefits.
- Sustainable fuels production could open a revenue stream which can stimulate investment in renewable energy, helping to reduce the overall grid emissions intensity and contribute to wider energy system decarbonisation.

Photo: Unsplash

Sustainable fuels bunkering, Port of Singapore

Work from RMI and GMF modelled sustainable fuel demand in the Port of Singapore by 2030, estimating 1.89 million metric tons for ammonia and 3.30 million metric tons for methanol – around 2.5% of the port's total bunkers (RMI & Global Maritime Forum, 2024). This could generate billions of dollars in annual bunkering revenue. While Singapore is a major bunkering hub, these figures highlight the significant financial potential of a sustainable fuels bunkering.

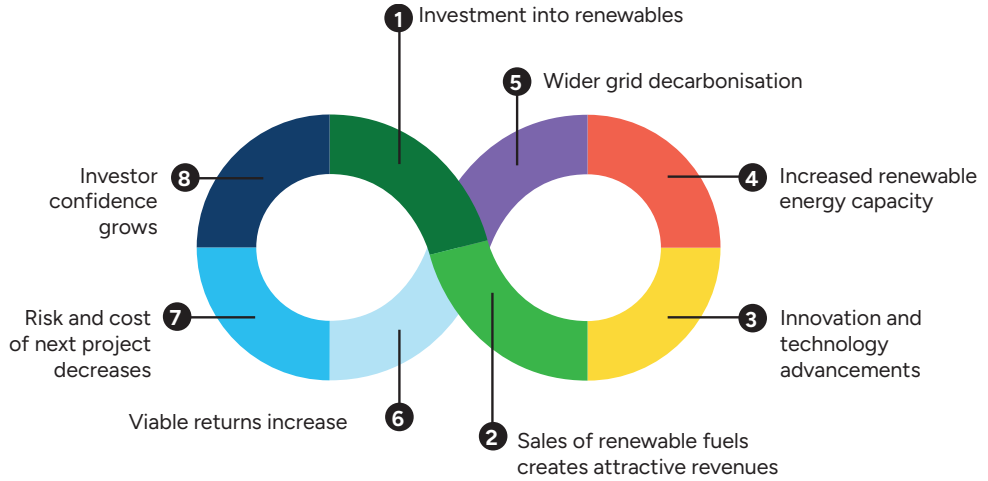
Photo: Unsplash

How sustainable fuels production can drive energy system decarbonisation

Powering a large-scale sustainable fuels production facility capable of producing >100,000 tonnes of sustainable fuel per year requires significant renewable energy infrastructure, with potentially hundreds to thousands of MWs of installed capacity.

Despite the need for a sizable investment, investors may be attracted to the security of revenue generated by the sale of sustainable fuels, which can provide a stable return on investment. This in turn can stimulate greater investment in renewable energy generation, accelerating the deployment of new capacity that not only supports fuel production, but also contributes to wider grid decarbonisation. As successful projects demonstrate viable returns, investor confidence can grow, encouraging further investment in renewables. This creates a virtuous cycle where each project lowers the risk and cost of the next, ultimately leading to the decarbonisation of the energy system.

The virtuous cycle of investing in renewable energy



TYPOLOGY #2

Why cities should support ports as hubs for electrification

Photo: Stockholm Hamnar/Ports of Stockholm

Unlocking broader ecosystem investment in electrification

Ports as hubs for electrification can catalyse broader electrification of energy users, delivering an accelerated local energy transition.

The process effectively follows these three stages:

STEP 1
Port and city collaborate, unlocking investment in port infrastructure to support transport electrification.

↓

STEP 2
This foundational investment instigates demand for electrification of transport and supply chain investments.

↓

STEP 3
Together, these investments unlock significant value for the city and its communities.

The scale of investment required will vary depending on the scale of energy system upgrades to meet the demands of the port. However, for a mid-sized port, investments of hundreds of millions of dollars is a reasonable estimate, while ecosystem investments in electrification could be of a similar scale.

The rest of this section explores the value unlocked through these investments, highlighting the wider economic, financial, social, and environmental benefits. These impacts have been identified using our Total Value approach, ensuring that the full strategic case for ports as hubs for electrification is clear.

Social value

- Electrification of ports and other local energy users will deliver air quality improvements and public health benefits as fossil fuel use is reduced in the port and the surrounding area.
- Port electrification can improve air quality, creating opportunities to repurpose surrounding land for green spaces or housing.

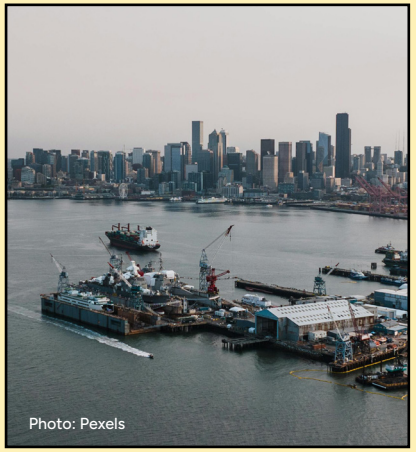


Photo: Pexels

Air quality impacts of port electrification, ICCT

In 2019, the ICCT estimated the emissions from ocean going vessels, harbour craft and drayage trucks at the Port of Seattle and Port of New York and New Jersey (NY/NJ). They found that full electrification could reduce fine particulate matter (PM2.5) emissions by 75% in the Port of Seattle and 69% in the Port of NY/NJ. This translates to at least $150 million in public health benefits in the area of the Port of NY/NJ (ICCT, 2023).

Economic value

- Short term jobs in manufacturing, construction, and installation of electrified port infrastructure and supply chains.
- Long term operation and maintenance jobs for charging, grid management, and energy systems.
- Jobs can be created in adjacent industries which can support electrification including digital and tech sector jobs linked to smart grid and energy systems, manufacturing high-voltage cables, or jobs supporting renewable energy generation.
- Improvements in air quality and noise from electrification of port operations can unlock urban redevelopment in areas adjacent to the port, attracting investment, increasing property values, and stimulating economic activity through new commercial, residential, and recreational projects.

Waterfront redevelopment, Port of Los Angeles

Land surrounding the Port of Los Angeles is currently being redeveloped as part of the LA waterfront with public spaces including restaurants, retail, fresh markets, offices, and a waterfront promenade. Previously used for barrel petroleum storage tanks, the land has potential to increase **local tourism spending** as well as **land value** as a result of the amenities and improved walkability as part of the waterfront's revitalisation (Urban Land Institute, 2007) (Port of Los Angeles, n.d.). Whilst indirect, electrification will provide more opportunities like this for redevelopment of land as a result of land use changes and air quality improvement.

Financial value

- Electrification positions the port as a climate-forward asset, improving its competitiveness and ability to attract sustainable trade and investment.
- Electrification of transport such as HGVs, vessels or port equipment can reduce running costs compared to fossil fuel equivalents, leading to increased profits.
- Integrating renewable generation and storage strengthens a port's energy infrastructure, ensuring critical operations continue during outages and disruption and mitigating revenue loss during these periods.
- Ports with facilities to generate electricity can make chargers available for public use to generate additional revenue.

Photo: Unsplash

Battery energy storage systems, Port of Long Beach

As part of their port microgrid infrastructure, the Port of Long Beach has Battery Energy Storage Systems (BESSs) that are able to provide energy to assets during outages of the main power grid. This allows for critical operations at the port to continue to run during outages decreasing the probability of total failure (Port of Long Beach, n.d.).

Environmental value

- The provision of charging infrastructure at the port to support electrification of the port's tenants and customers (such as cargo handling equipment, HGVs, or vessels) leading to broader decarbonisation and air quality improvements.
- Ports with facilities to generate electricity can aid the transition to electric vehicle transition. This will drive the increased availability of electric vehicles to support wider decarbonisation targets.

TYPOLOGY #3

Why cities should support offshore wind manufacturing, marshalling, and installation hubs

Photo: Unsplash

Unlocking broader ecosystem investment in an offshore wind supply chain

Investing in port infrastructure – such as marshalling and installation facilities, with dedicated space for adjacent manufacturing – has the potential to catalyse wider ecosystem investment in the offshore wind supply chain. This collaborative approach between ports and cities strengthens the local renewable energy sector and stimulates further private sector investment in offshore wind manufacturing.

The process effectively follows three stages:

STEP 1
Port and city collaborate to invest in port infrastructure to support offshore wind marshalling and installation.

↓

STEP 2
This foundational investment attracts offshore wind manufacturing facilities, unlocking supply chain opportunities.

↓

STEP 3
These investments unlock significant value for the city and its communities.

The scale of investment required will vary depending on the size and type of port and which components are to be manufactured. Typically port infrastructure for a marshalling and installation port demands hundreds of millions of dollars, while ecosystem investments in component manufacturing facilities can match or exceed this.

This section explores the value unlocked through these investments, highlighting the wider economic, financial, social, and environmental benefits. These impacts have been identified using our Total Value approach, ensuring that the full strategic case for offshore wind supply chain investment is both visible and compelling.

Social value

- Supporting the just transition to long-term, high quality green jobs through manufacturing, assembly, installation, and maintenance of wind turbines.
- By harnessing offshore wind energy, countries can reduce reliance on imported fossil fuels, enhancing energy security and stabilising energy costs for people, helping to tackle energy poverty.

Mawarid Turbine Company's wind turbine manufacturing facility in the Special Economic Zone at Duqm (SEZAD)

Marwaid Turbine Company has launched the first phase of its turbine manufacturing facility in SEZAD, Oman. With an investment of over $200 million, the plant will have an annual production capacity of up to 1 GW and will play a key role in advancing Oman's renewable energy ambitions. Scheduled to be operational in 2026, it will become the region's first hub for wind turbine manufacturing and is expected to create around 1,080 job opportunities.

This initiative also includes a memorandum of cooperation signed between Oman's Ministry of Labour and Mawarid Turbine to train and qualify the first 350 Omani jobseekers to equip them with the skills to support the renewable energy manufacturing sector (Foreign Ministry of Oman, 2025).

Economic value

- Direct investment in ports and manufacturing unlocks indirect supply chain investment, which in turn drives induced economic impacts. Together, this generates broader economic value for the city.
- Short term jobs in manufacturing, construction and installation of port infrastructure and manufacturing facilities. Long term jobs in component manufacturing, marshalling and installation.
- Diversification and future-proofing port revenue streams in an emerging energy landscape.

We estimate that investment in a port typology of similar scale could generate **thousands to low 10s of thousands of jobs** (direct, indirect, and induced) in offshore wind manufacturing, marshalling, and installation and their supply chains.

Offshore wind hub redevelopment, South Brooklyn Marine Terminal, New York

The South Brooklyn Marine Terminal is transforming into a flagship hub for offshore wind staging, operations, and maintenance. Led by Equinor in partnership with New York City Economic Development Corporation, the site will serve as the base for the Empire Wind 1 project, delivering 810 MW of renewable energy directly into the New York City grid by 2026, enough to power 500,000 homes. Once underused, this 73-acre waterfront site in Sunset Park is now poised to become a long-term clean energy anchor with low-emission operations, hybrid vessels, EV charging infrastructure, and on-site solar power. By 2027, the site will open to other developers and businesses seeking staging and maintenance facilities for offshore wind.

Financial value

- Export of wind turbine components would generate revenue and profit for manufacturing facility investors.
- Increased port activity could also create revenue and profit for port investors, such as from new tenants and additional port fees.
- These new activities would also generate revenue and profit for related industries, including ship operators, wind developers, and the suppliers of the manufacturer(s).

Photo: Unsplash

Turbine blade export, Port of Pecém

The Port of Pecém (Brazil) hosts two wind blade factories and supports offshore wind component production for the 3 GW Pecém Offshore Wind Project, set for completion by 2030. So far, the port has exported components internationally, including the production of 2,000 blades in 2019 alone, showing how a city can capture markets beyond its territory (Datamar News, 2020).

Environmental value

- Supporting offshore wind deployment can facilitate the integration of renewable energy into the power grid, displacing fossil fuel generation.
- The energy infrastructure and expertise developed through offshore wind manufacturing can support other renewable technologies, such as a sustainable fuels supply chain, which can drive overall decarbonisation.

Overcoming space constraints, Port and city of Hamburg

The challenge of space constraints in port cities for developments such as offshore wind manufacturing, marshalling, and installation is a common challenge.

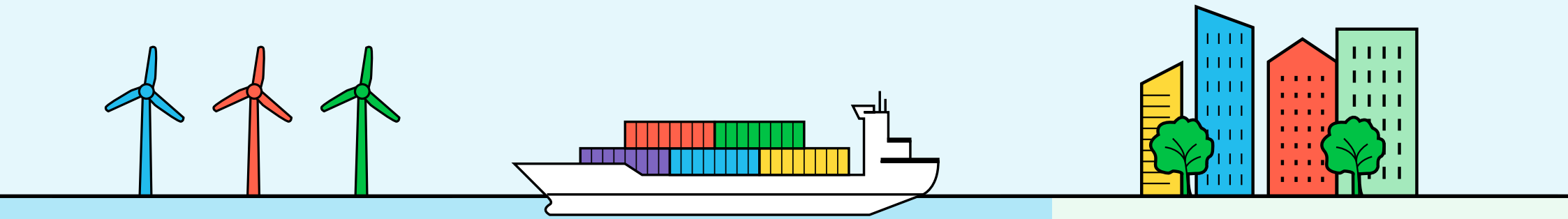
For example, both the port and the city of Hamburg have growth ambitions that are constrained by the availability of land (*The Competitiveness of Global Port-Cities: The Case of Hamburg* - Germany, 2012).

The former port area was recently redeveloped for the HafenCIty waterfront redevelopment, yet at the same time, the port is considering introducing industrial activity that adds regional value to the port areas.

To overcome this challenge, the port announced measures through its Port Development Plan (Port of Hamburg, 2023), to modernise cargo handling, enhance hinterland rail connections, and implement digital and more automated technologies (such as use of predictive maintenance of machinery) to improve cargo flow without extensive physical expansion.

Transforming port cities: The Action Toolkit

- Leadership and strategy
- Policy and planning
- Investment and finance
- Society and workforce planning



Transforming port cities: The Action Toolkit

Who is this section for?

City officials looking to identify the role cities can play in unlocking action towards clean energy hubs.

What will I get from this section?

A roadmap of city actions which can unlock the huge benefits of ports as clean energy hubs.

Photo: C40

What is the Action Toolkit?

The Action Toolkit is a set of collaborative strategies that cities, in collaboration with ports and other stakeholders, can implement together to transform ports into clean energy hubs and realise the huge opportunities that ports as clean energy hubs can bring. The aim is that by carrying out these actions in collaboration with ports, cities can catalyse further action and investment, accelerating the deployment of technologies and infrastructure which can deliver on the clean energy hub vision. The actions listed in this Toolkit are not comprehensive, but act as a guide to help cities drive investment in ports as clean energy hubs, and unlock the huge benefits that these investments can bring.

While this paper is focussed on the role of the city in collaboration with ports, it does not cover the individual wider actions required by ports, energy organisations, policy makers, or investors to unlock these port investments. These include actions around technical, commercial, and regulatory feasibility. These subjects are complex and are covered in numerous other studies, so this report complements them with a city lens. The Toolkit is aimed at cities and towards the development of clean energy hub concepts, but in many cases can also be applied to other forms of city-led climate action.

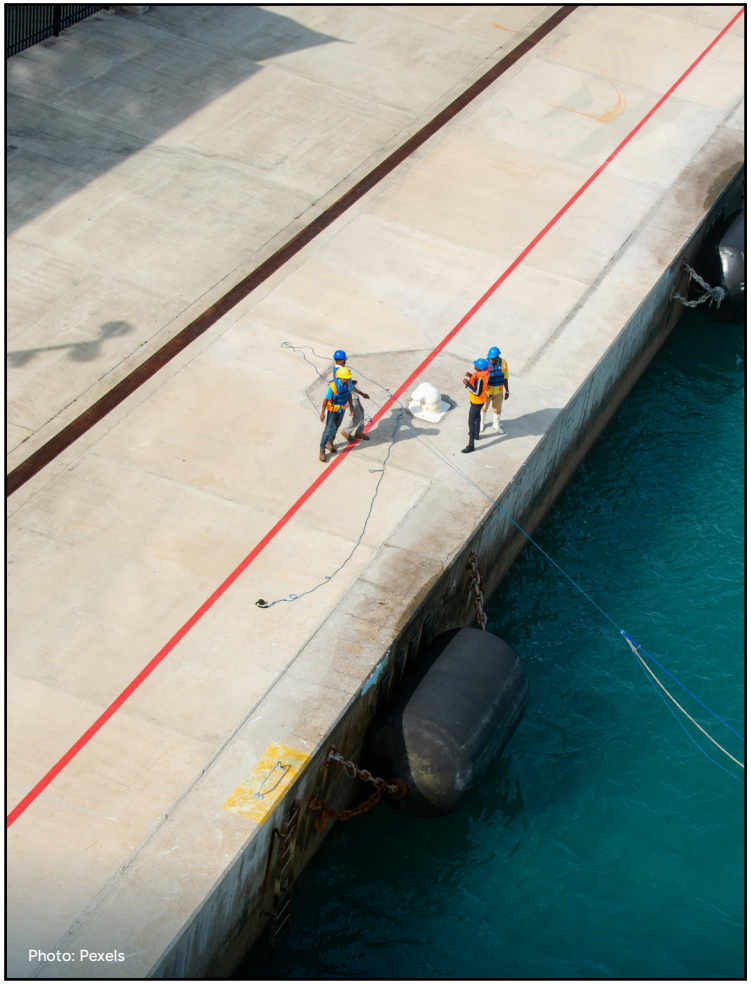


Photo: Pexels

City-levers and levels of influence

Cities' ability to drive climate action within ports can vary significantly based on their geographical location, jurisdiction, and capacity. Their influence is shaped by several factors, including port governance structures, delegated powers, and available resources. For example, a city will have less ability to drive port electrification within a privately-owned port, but they can still have a role to play to accelerate action in terms of enabling policy, integrated port-city energy planning, or even advocating the port for accelerated action.

Similarly, cities with limited resources will not be able to directly fund new port infrastructure, but instead may be able to support applications to national or international funding opportunities.

To reflect this we have developed a framework for categorising the actions based on levels of city influence.

Mandate	Cities can directly require specific actions through regulatory powers, enforcement mechanisms, and binding policy. This might include setting emission standards, requiring specific technologies, or enforcing environmental regulations within their jurisdiction.
Enable	Material interventions which can create favourable conditions for climate action. This could include financial tools such as grants or tax incentives, or investments in enabling infrastructure.
Support	Cities can use their position and influence to advance climate initiatives through relationship-building, knowledge-sharing, and advocacy. This includes facilitating partnerships between stakeholders, commissioning strategic studies which can remove informational barriers to action, raising awareness, or advocating for policy changes at higher levels of government.

Photo: Unsplash

For each general action in the Toolkit, we have defined specific sub-actions which cater for different levels of influence. Whilst some general actions will include sub-actions across the three levels of influence, for others, the sub-actions will only fall into one or two of the levels above. In other words, for a given action there might be specific sub-actions for cities to 'enable' or 'support' but none for cities to 'mandate'.

Levels of resource requirement, anticipated cost level and potential impact of actions

Throughout the Action Toolkit, we indicate at a high level for each action:

- **City resource requirement** – highlighting the level of staffing requirement to deliver the action
- **$ Anticipated city cost level** – representing the level of capital expenditure likely to be required from the city. This might include direct grants/funding, investing in infrastructure, commissioning studies or attending/hosting events.
- **Potential impact** – referring to the impact of the action in terms of moving towards the ports as clean energy hubs vision.

We do this by introducing the following icons to each action, where:

👤	Lower city resource requirement	$	Lower city cost level	🏆	Lower potential impact
👤👤	Mid city resource requirement	$ $	Mid city cost level	🏆🏆	Mid potential impact
👤👤👤	Higher city resource requirement	$ $ $	Higher city cost level	🏆🏆🏆	Higher potential impact

You can find a quick overview of the actions in the Toolkit on the right of this page.

	Action	👤	$	🏆
	Leadership and strategy			
1	Align with ports on decarbonisation vision and strategy for the region	👤👤	$	🏆🏆🏆
2	Advocate for action on clean energy hub ports and higher delegated powers for the city	👤👤	$	🏆🏆🏆
3	Convene and support key actors to accelerate impactful investment	👤	$	🏆🏆
4	Gather evidence to inform goals, strategies, actions and investment decisions	👤	$ $	🏆🏆
	Policy and planning			
5	Integrate port and city land-use planning	👤👤	$ $	🏆🏆🏆
6	Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning	👤👤	$	🏆🏆🏆
7	Support effective consenting for infrastructure development	👤👤👤	$	🏆🏆🏆
8	Create and enforce effective policy to drive local emissions reduction and air quality improvements	👤👤👤	$	🏆🏆
9	Embed sustainability into port lease agreements	👤👤	$	🏆🏆
10	Shape tax incentives (as well as port fees) to enhance green investment	👤👤👤	$	🏆🏆🏆
	Investment and finance			
11	Support port grant and finance applications	👤👤👤	$	🏆🏆
12	Implement targeted taxes or levies and ringfence funds for targeted port investment	👤👤👤	$	🏆🏆🏆
13	Utilise city/municipal investment banks to fund investments through debt instruments and increased financial attractiveness	👤👤	$ $ $	🏆🏆🏆
14	Invest in port connectivity	👤👤	$ $ $	🏆🏆
15	Support catalytic port DEVEX and CAPEX funding	👤👤	$ $ $	🏆🏆🏆
	Society and workforce planning			
16	Work with other stakeholders to shape the ports as clean energy hubs workforce	👤👤👤	$	🏆
17	Tell the Total Value story of ports as clean energy hubs	👤👤	$	🏆🏆🏆
18	Increase city competitiveness to attract and retain talent	👤👤	$ $ $	🏆

Photo: Unsplash

Action Toolkit for port cities: Leadership and strategy

By exercising leadership and demonstrating a clear vision for ports as clean energy hubs, cities can bring stakeholders together around a common goal, fostering collaboration and driving investment in sustainable infrastructure aligned to this vision.

	Action	👤	$	🏆
	Leadership and strategy			
1	Align with ports on decarbonisation vision and strategy for the region	👤👤	$	🏆🏆🏆
2	Advocate for action on clean energy hub ports and higher delegated powers for the city	👤👤	$	🏆🏆🏆
3	Convene and support key actors to accelerate impactful investment	👤	$	🏆🏆
4	Gather evidence to inform goals, strategies, actions and investment decisions	👤	$ $	🏆🏆

ACTION 1:

Align with ports on decarbonisation vision and strategy for the region

Centring ports in city decarbonisation strategy recognises the opportunity for port investment to be the engine which can accelerate clean power, low carbon transport, and industrial decarbonisation. By framing this vision of ports as clean energy hubs, cities can foster buy-in and support across government, business, and civil society, driving ambitious climate action in both the short and long term to enable meaningful and lasting transformation.

For example, integrating ports into a city's Climate Action Plan (CAP) helps align port decarbonisation with broader climate goals. C40 Cities' CAP Framework and Planning Guide offers step-by-step support for developing Paris Agreement-aligned plans. More recently, C40's Climate Action Transition Framework (CATF) emphasises adaptation, resilience, equity, and robust governance to help cities mainstream climate action.

City influence	Sub-action
Mandate	Include the port in a city's Climate Action Plans, with binding targets for climate action.
Enable	Collaborate with the port on the CAP and integrate actions.
Support	Commission a study with the port to identify a realistic and ambitious climate action.

Several C40 port cities have incorporated port decarbonisation initiatives directly into their CAP. These cities are actively working to reduce maritime and port-related emissions through ambitious strategies and targeted projects. Below are key examples from C40's Green Ports Forum members:

Auckland

Auckland's CAP features a greenhouse gas emission reduction pathway for its port, including trials of renewable diesel and hydrogen, a fully operational hydrogen refueling facility, and the world's first full-sized electric tug.

Copenhagen

The city's CAP includes initiatives to reduce maritime emissions, such as a CO_2 capture and storage project at Copenhagen Malmö Port. The port is a central player in storing and distributing captured CO_2 for offshore storage, supporting Copenhagen's goal to be carbon-neutral by 2025.

eThekwini (Durban)

Durban's CAP sets out a pathway to carbon neutrality by 2050, with a 40% emission reduction by 2030. The plan includes specific actions for port and shipping emissions reductions.

Los Angeles and Long Beach

The San Pedro Bay Ports Clean Air Action Plan (CAAP) establishes a strategy for reducing port-related air pollution and related health risks, while allowing port development, job creation and economic activity associated with that development to continue. The plan, a collaboration of the Port of Los Angeles and Port of Long Beach, targets port emissions reductions through cleaner trucks and cargo handling equipment, aiming for zero emissions for port-serving trucks by 2035 and sets a goal for Cargo Handling Equipment (CHE) to be zero emissions by 2030.

Oslo

Oslo's CAP includes a dedicated action plan for the Port of Oslo to become a zero-emission port, targeting an 85% reduction in port-related greenhouse gas emissions by 2030 through electrification, shore power, and zero-emission technology for ships.

Rotterdam

The Port of Rotterdam's CAP targets a 55% reduction in carbon emissions by 2030 and full carbon neutrality by 2050, focusing on hydrogen infrastructure, carbon capture and storage, and renewable energy integration.

Seattle

Seattle's CAP includes initiatives to transition port operations to zero emissions, such as electrification, clean fuels (including hydrogen and ammonia), and infrastructure to allow ships to plug into the grid.

Stockholm

Stockholm's CAP prioritises electrification of shipping, expansion of onshore power connections, and other sustainability initiatives to reduce quayside emissions as part of its 2030 climate goals.

*Long Beach is not a C40 city, but is part of the Green Ports Forum.

Port of Durban: Decarbonisation plan

Action 1: Align with ports on decarbonisation vision and strategy for the region

The C40 Ports and Shipping Programme is working with eThekwini Municipality and Transnet National Ports Authority to deliver a data-driven decarbonisation plan for the Port of Durban. The initiative targets electrification, renewable energy integration, and clean fuel readiness, ensuring compliance with International Maritime Organization (IMO) policy and positioning Durban as a competitive, future-ready port.

C40's technical assistance is strengthening coordination between municipal and port authorities, closing capacity gaps, and aligning decarbonisation efforts with existing operational strategies. Through targeted emissions assessments and stakeholder engagement, the programme identifies actionable priorities and benchmarks progress against international standards.

By integrating climate objectives with core business operations and exploring funding avenues, this collaboration not only mitigates environmental risk but also enhances operational efficiency and unlocks new commercial opportunities in green fuels and renewable infrastructure. The result is a scalable model for climate action that supports economic growth, workforce development, and long-term resilience - benefiting the city, port, and the broader business ecosystem.

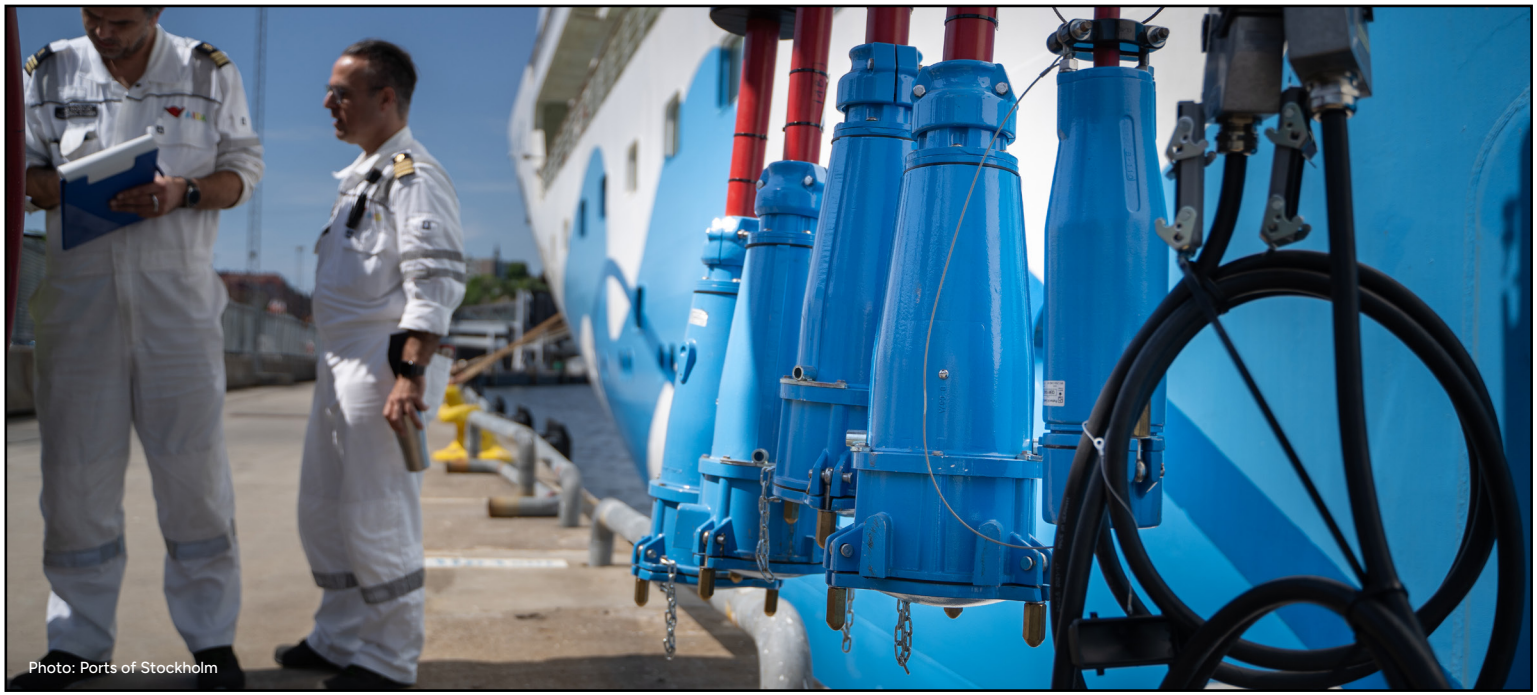


Photo: Ports of Stockholm

ACTION 2:

Advocate for action on clean energy hub ports and higher delegated powers for the city

Using their soft powers and influence, cities can advocate for action in ports as clean energy hubs. This could include shaping international policy through events such as COP, where they can influence organisations such as the IMO and EU to deliver supportive policy for energy hub concepts.

At the national level, cities can advocate to the national government for policy/funding to enable ports as clean energy hubs. Similarly, they can advocate for greater delegated powers so they have more power to drive impactful climate action tailored to local needs.

City influence	Sub-action
Support	Join and participate in national and international forums to advocate for policy changes at the national and international level.

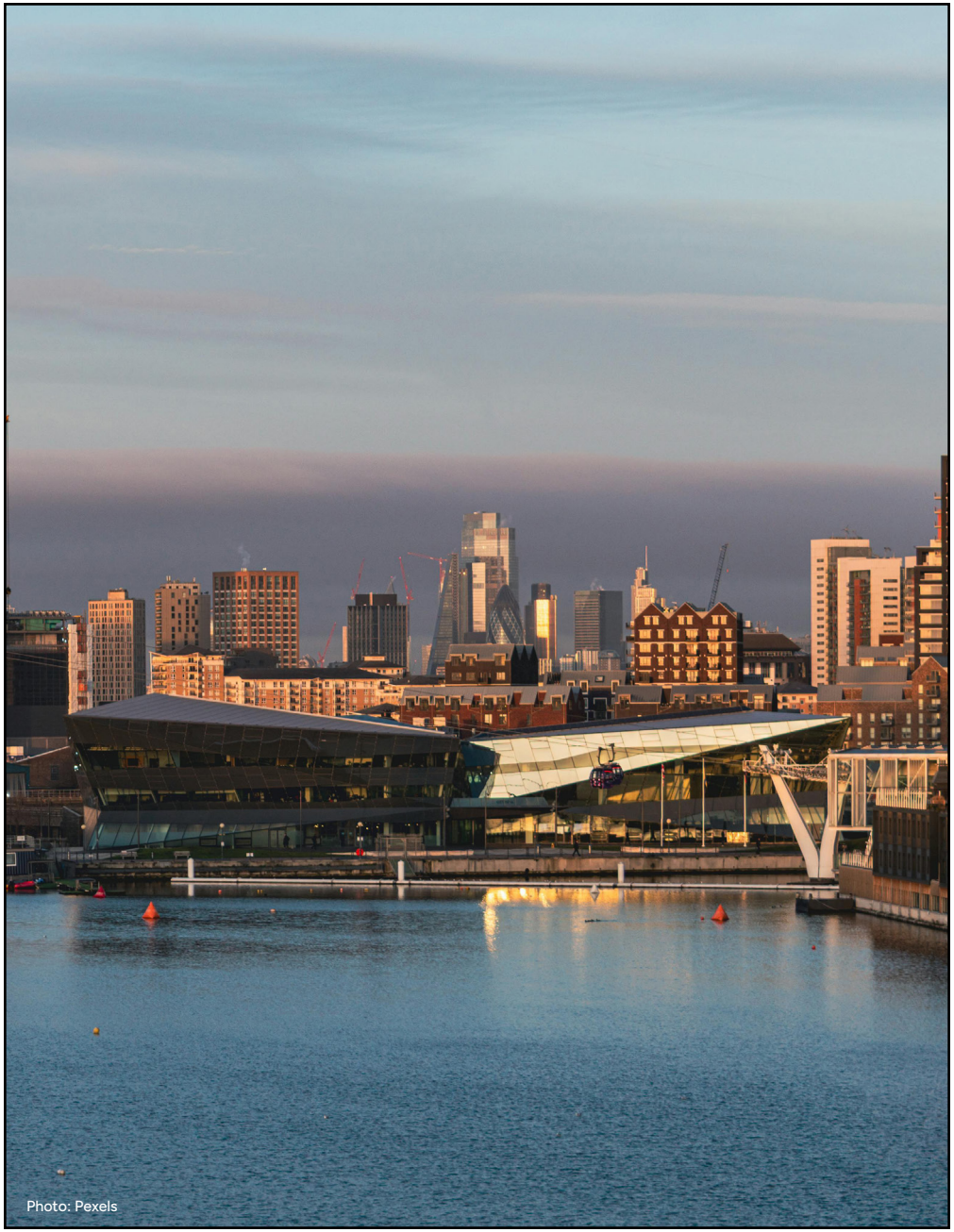


Photo: Pexels

ACTION 3:

Convene and support key actors to accelerate impactful investment

Using their convening powers, cities can bring together port authorities, port landlords and port operators with energy developers, fuel producers, utilities providers to raise ambition, shape joined-up clean energy plans, remove market barriers and agree actions to accelerate investment.

Actions could include developing task forces or working groups with key stakeholders including industry, port operators and investors, focussed on action in key areas.

City influence	Sub-action
Enable	Establish working groups tied to key challenges/ opportunities for ports as Clean Energy Hubs and drive collective action. For example, groups could formalise a commitment to transition to zero-emission technologies and aggregate future transition plans of fleet equipment to stimulate investment in equipment and energy supply infrastructure. This is explored by C40 Cities in the Implementation Roadmap for Accelerating Zero-Emission Port Technologies.
Support	Support existing industry groups through knowledge sharing or knowledge creation to drive collective climate action.

Photo: Pexels

Yokohama's multi-stakeholder partnership for advancing offshore wind energy

Action 3: Convene and support key actors to accelerate impactful investment

The **collaboration** between the City of Yokohama, TEPCO Power Grid, and Ocean Power Grid exemplifies how municipal support - alongside national coordination and private sector innovation - can drive the development of offshore wind energy projects. Through such partnerships, stakeholders jointly overcome market barriers, shape integrated energy plans, and catalyse impactful climate action (C40 Cities, 2025).

Note: While Yokohama's project is a strong example of city engagement, the work was convened at the national level, highlighting the value of both local and national coordination in advancing clean energy goals.

ACTION 4:

Gather evidence to inform vision, strategy, actions and investment decisions

Often, key decision makers lack the data and information required to make investment decisions. By contributing to a robust evidence base, cities can drive action from national governments, ports and other key stakeholders.

For example, cities can partner with or commission research institutions to study the impacts of specific interventions to develop strategies which will have the greatest impact in terms of unlocking the benefits of ports as clean energy hubs.

City influence	Sub-action
Mandate	Enact regulation which requires key emitters in the city boundary to contribute to the city's emissions inventory.
Enable	Commission studies which can highlight the value and the opportunity for investment in ports as clean energy hubs.
Support	Contribute data to NGOs and/or philanthropic organisations to support ongoing studies or assessments.

Photo: Unsplash

New York State's Offshore Wind Master Plan 2.0

Action 4: Gather evidence to inform vision, strategy, actions and investment decisions

In 2022, Governor Hochul launched the "New York State Offshore Wind Master Plan 2.0: Deep Water" to guide the future of offshore wind development and to position New York State to maximise the benefits with OSW development. The plan aims to encourage the Department of the Interior's Bureau of Ocean Energy Management (BOEM) to initiate new leasing in the New York Bight. To support this, the State is collaborating with stakeholders and advancing studies to analyse data, helping identify areas with the least conflict and the greatest potential for offshore wind projects (New York State Energy Research and Development Authority, n.d.).


Photo: Pexels

Action Toolkit for port cities: Policy and planning

Joined up planning between ports and the cities has potential to create efficiencies, address environmental issues, and improve quality of life for local communities. Collaborative planning between ports and cities as well as developing policy that can enable those plans can deliver mutually beneficial development, ensuring that both entities thrive and contribute positively to the wider region.

	Action	👤	$	🏆
	Policy and planning			
5	Integrate port and city land-use planning	👤👤	$ $	🏆🏆🏆
6	Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning	👤👤	$	🏆🏆🏆
7	Support effective consenting for infrastructure development	👤👤👤	$	🏆🏆🏆
8	Create and enforce effective policy to drive local emissions reduction and air quality improvements	👤👤👤	$	🏆🏆
9	Embed sustainability into port lease agreements	👤👤	$	🏆🏆
10	Shape tax incentives (as well as port fees) to enhance green investment	👤👤👤	$	🏆🏆🏆

ACTION 5:

Integrate port and city land-use planning

Ports and cities should work together to develop integrated land-use strategies (including masterplanning), considering port development, multimodal transport connectivity and the co-location of complementary facilities to leverage industrial symbiosis. This type of integrated spatial planning will ensure alignment across sectors and help to unlock the full benefit of ports as clean energy hubs.

City influence	Sub-action
Enable	Lead on the development of fully integrated port and city masterplans to ensure they are developed in a mutually supporting way.
Support	Cities can engage in the port masterplanning process to emphasise the important role of ports as clean energy hubs for the city.

Photo: Ports of Stockholm

Stockholm's eco-district: Royal Seaport Development

Action 5: Integrate port and city land-use planning

This 650-acre district is a model of sustainable urban development, aiming to be fossil fuel-free by 2030. It's designed to eventually produce more energy than it consumes, with all new homes required to be passive houses, adhering to strict energy efficiency standards (Stockholms stad, 2025).

Barcelona's Port Vell waterfront revitalisation

Action 5: Integrate port and city land-use planning

Port Vell is the oldest part of the Port of Barcelona, and it is still in use today. It used to separate the city from the water but has now been remodelled and converted into a seafront promenade. (Port de Barcelona, n.d.)

Copenhagen's 5-minute city: Nordhavn

Action 5: Integrate port and city land-use planning

The carbon-neutral neighborhood of Nordhavn was once the industrial and docklands area of the port of Copenhagen, and has since been re-imagined as homes, workplaces, community public space, and more (The Guardian, 2024).

ACTION 6:

Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning

A strategic approach to energy planning increases the likelihood that ports will secure the energy needed to advance their development as clean energy hubs.

Energy supply to ports and the surrounding area will need to change dramatically with increased electrification of energy demands and sustainable fuels production, with ports potentially acting as a key hub for energy demand, storage, and supply.

Grid managers – distribution network operators and transmission network operators – will have an important role in prioritising energy use in a future electrified society. By fostering collaboration between ports and grid managers, cities can ensure that the energy needs of ports are factored into future grid investment decisions.

City influence	Sub-action
Enable	Establish regular dialogue with ports and grid managers to discuss and align energy demands and future infrastructure needs.
Support	Commission studies in collaboration with the port to understand the port's future energy demands and integrate into future energy system planning.

Photo: Pexels

Joint energy planning in Seattle

Action 6: Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning

In April 2025, the Port of Seattle, The Northwest Seaport Alliance, and Seattle City Light released the Seattle Waterfront Clean Energy Strategy, a joint plan to align port electrification with city energy planning through 2050. The strategy forecasts a fourfold increase in port electricity demand and identifies $208–$457 million in infrastructure investments needed to support zero-emission operations, including shore power for vessels, electrification of equipment, and grid upgrades. The ten-year partnership, initiated in 2021, ensures technical, policy, and funding coordination among all stakeholders to deliver a unified, resilient clean energy system for the city and port (Port of Seattle, 2025).

Coordinated energy transition planning in Barcelona

Action 6: Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning

Barcelona's city government and Port Authority have an established framework to coordinate energy transition planning, integrating port electrification and shore power projects into the city's climate and energy strategies. This collaboration includes joint assessments of current and projected energy needs, infrastructure upgrades, and renewable energy sourcing, ensuring port decarbonisation is embedded in municipal energy roadmaps and capital investment cycles. The approach supports Barcelona's 2030 and 2050 climate targets by synchronising port and city energy transitions.

ACTION 7:

Support effective consenting for infrastructure development

Cities play a key role in promoting efficient consenting (including permitting and licensing) for port developments, recognising both the climate benefits and local economic opportunities this can unlock.

Port consenting typically involves a mix of local, national, and port authority jurisdictions, with permitting often requiring coordination among multiple stakeholders. Approaches vary by region:

- **The UK**, for example, uses a discretionary system, where developers must meet specific criteria for consent, but an active decision – usually planning permission – is still required.
- **Other regions** such as the US, parts of Africa, New Zealand, and Australia, often use zoning systems, where areas are assigned zoning codes that define permitted developments.

Regardless of the system, cities can support ports as clean energy hubs through two main strategies:

- **Policy Setting** – establishing zoning frameworks or discretionary planning criteria can have the biggest impact from a planning perspective. Whilst this can be resource intensive, involving other organisations – including ports – in shaping zoning policies can ease the burden on city authorities by aligning development goals and providing technical expertise.
- **Streamlining Processes** – achieved by relaxing non-critical requirements (while maintaining essential ones like safety) can accelerate consenting, often through national policy changes, for example, by introducing SEZs or similar mechanisms. Without this, streamlining can be more challenging to achieve. Alternatively, cities can ensure sufficient resources and support for port projects to prevent delays in the consenting process.

Port of Barcelona: Your Port Opens Up Again project

Action 5: Integrate port and city land-use planning

The Port of Barcelona has set up the 'Your Port Opens Up Again' project to integrate port and city activity (World Ports Sustainability Program, 2022). The project is transforming its old port to strengthen its connection with the city.

By relocating marine activities to the commercial port, the project creates space for community use, innovation hubs and Blue Economy research. The redesign will reduce the port's environmental impact whilst improving port-city integration. In addition, moving passenger traffic to a single wharf will enable the deployment of shore power for all cruise vessels.

Portsmouth International Port: SEACHANGE

Action 6: Coordinate efforts with the port, grid manager, and other stakeholders to create a holistic picture of energy needs and integrate into city energy planning.

Portsmouth International Port is leading the SEACHANGE (Sustainable Energy and Air Quality Improvement for Coastal Harbours to Achieve Net-zero with Grid Enhancements) project. This 4.5-year initiative focuses on implementing shore-side power solutions and smart energy demand management to reduce emissions from vessels while alongside (Portsmouth International Port, n.d.).

As well as providing £4.6 mn in project funding, the city council supported the port to secure an extra 15 MVA capacity from the district network operator, SSE, providing a further £3 mn of funding to upgrade the grid infrastructure to supply the port (MSE International, 2024).

ACTION 8:

Create and enforce effective policy to drive local emissions reduction and air quality improvements

Policy and regulations can be used by cities to deliver climate action including air quality improvements. As an example, low-emission zones (LEZs) have been used by many cities' to overcome poor air quality, reduce greenhouse gas emissions, and mitigate congestion. Similar schemes focussed on reducing the impact of port operations in the city could help support investment in sustainable technologies.

In addition, these tools can be used to ensure that any port expansion does not inadvertently result in an increase of local emissions due to increased activity by requiring vehicles and vessels operating in the expanded port areas to meet stringent environmental standards. This safeguards local air quality even as port operations grow.

City influence	Sub-action
Mandate	Mandate sustainability criteria for technologies and/or sectors through policy.
Support	Advocate national or regional governments to implement policy which can mandate uptake of sustainable technologies and improve air quality.

ACTION 9:

Embed sustainability into port lease agreements

Landlord ports can incentivise or mandate the use of low carbon technologies in their lease agreements with port tenants.

Where port tenants are in existing lease agreements, the port landlord can work with the tenants to support them to be more sustainable. For example, port landlords could provide charging points to enable the tenants to invest in electrified cargo handling equipment.

Where ports are city-owned, this can be driven by the city. Where ports are privately owned, cities may need to work with and/or actively lobby these ports to secure their buy-in.

City influence	Sub-action
Mandate	Where cities have control over port leases, embed sustainability criteria into port tenant lease agreements.
Enable	Where landlord ports are city-owned, work with existing port tenants to drive climate action.
Support	For cities without direct control, advocate for the inclusion of sustainability criteria in port lease agreements as and when they come up for renewal.

ACTION 10:

Shape tax incentives (as well as port fees) to enhance green investment

Tax incentives can be implemented to stimulate investment and action in ports as clean energy hubs. This can take several forms such as reduced tax rates for targeted technologies/activities or financial penalties for less sustainable alternatives.

One example of this could be through the implementation of an SEZ at ports. These are designated areas that offer businesses preferential tax rates, streamlined regulations, and other financial incentives to attract investment, foster international trade, and stimulate regional economic development.

Typically, this requires support from national governments to enact policy which can enable SEZs. One example of this is the UK's Freeport programme. The role of the city could be in leading the application for SEZ designation. Where the port is city-owned, the city can drive the application process with port cooperation. Where ports are privately owned, the city may need to focus on convening the relevant port owner(s) and operator(s) to support the application.

City-owned ports can also change fee structures to promote decarbonisation of port operators and port users. As an example, ports can use known indicators such as the Environmental Ship Index (ESI), Carbon Intensity Indicator (CII) or the Energy Efficiency Existing Ship Index (EEXI) to measure environmental performance of incoming vessels and reduce port fees for those which meet certain criteria. Revenues from this fee can be used to fund sustainable investments at the port such as sustainable fuels bunkering and electrification initiatives. Cities without direct port control can lobby privately owned ports to introduce similar fee structures.

City influence	Sub-action
Mandate	Where cities have control over ports, mandate additional fees for all but the most sustainable vessels entering the port boundary.
Enable	Offer businesses preferential tax rates, streamlined regulations, and other financial incentives aligned to environmental priorities to encourage investment in ports as clean energy hubs.
Support	Convene the port and other relevant stakeholders to support an application to become a designated SEZ as part of a national programme such as the UK Freeport programme.

Port of Los Angeles: Clean Truck Program

Action 8: Create and enforce effective policy to drive local emissions reduction and air quality improvements

Mayor Villaraigosa set a plan to take 16,000 dirty-diesel trucks off the road and slash port-related truck pollution by 80% in 4 years. In 2008, the Ports of Los Angeles and Long Beach jointly launched the Clean Truck Program (CTP) as part of the San Pedro Bay Ports Clean Air Action Plan. The program progressively banned older, high-emission diesel trucks from port terminals, culminating in a complete ban of trucks not meeting 2007 emission standards by 2012. This initiative led to a reduction in port truck emissions by over 90% (The Port of Los Angeles, n.d.) (C40 Cities, 2023). This is discussed in greater detail on page 46.

Port of Rotterdam: Sustainability-linked port tariff reduction

Action 10: Shape tax incentives (as well as port fees) to enhance green investment

In January 2025, the Port of Rotterdam embedded sustainability into its port tariffs to support its goal of becoming carbon-neutral by 2050. Seaport dues, traditionally based on vessel size, type, and cargo throughput, now include a sustainability component. Ships with high scores on the Environmental Ship Index (ESI) or a Green Award certificate may pay lower dues. Additionally, tariffs per tonne of cargo have been reduced for vessels using their shipping capacity efficiently, helping to cut emissions per transhipped tonne (Naida Hakirevic Prevljak, 2024).

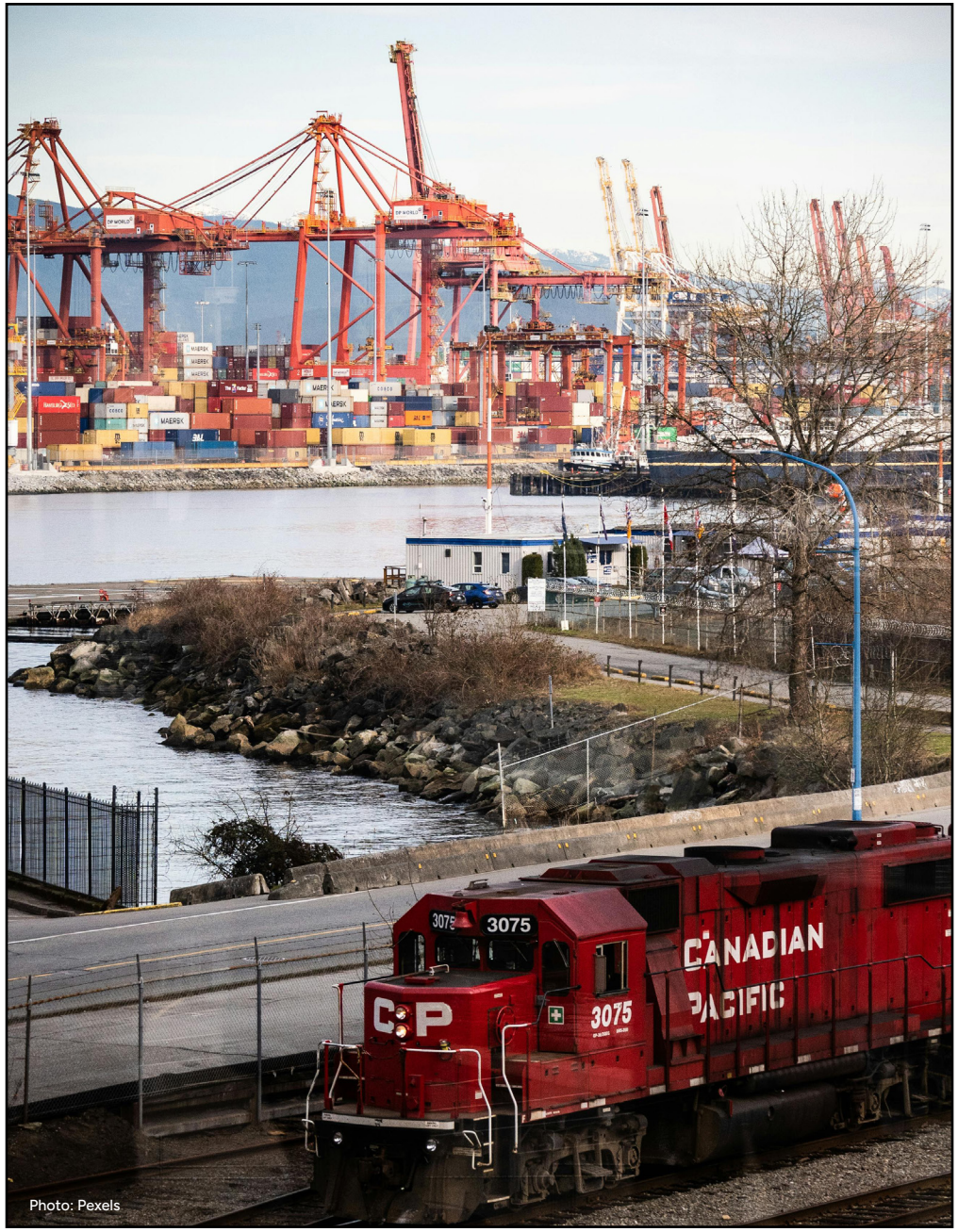


Photo: Pexels

Action Toolkit for port cities: Investment and finance

Often the revenues/returns from the operation of the port will not be sufficient to fund the development of clean energy hubs and additional funding may be required. In some cases, this may be able to be directly funded by the city, but often the scale of investment can be prohibitive and require external sources.

In the investment and finance section, we explore actions on how cities can secure the necessary funding to support port development, splitting actions into two distinct categories:

1. **Actions to raise funds for investment in ports** – including from funding applications, private investors or tax revenues.
2. **Actions for use of those funds to stimulate further investment and activity** – cities can begin to deploy this through targeted investments which in turn can catalyse further private investment in ports as clean energy hubs.

	Action	👤	$	🏆
	Investment and finance			
11	Support port grant and finance applications	👤👤👤	$	🏆🏆
12	Implement targeted taxes or levies and ringfence funds for targeted port investment	👤👤👤	$	🏆🏆🏆
13	Utilise city/municipal investment banks to fund investments through debt instruments and increased financial attractiveness	👤👤	$ $ $	🏆🏆🏆
14	Invest in port connectivity	👤👤	$ $ $	🏆🏆
15	Support catalytic port DEVEX and CAPEX funding	👤👤	$ $ $	🏆🏆🏆

ACTION 11:

Support port grant and finance applications

There is potentially a role for cities to support ports by generating awareness of current funding opportunities, connecting ports and industry to development banks and other funders, leading applications, offering guidance, convening key partners, and providing data to strengthen proposals.

There are numerous national and international funding competitions for sustainable port investment. This funding can come in the form of grants, for example from national governments, or in the form of debt/equity, typically from development banks or International Financial Institutions. In addition, the inclusion of the city in proposals can add credibility to an application, enabling a greater chance of success for the port.

City influence	Sub-action
Enable	Lead applications for national and international funding opportunities aligned to ports as clean energy hubs. Develop procurement frameworks to enable access to advisors who specialise in supporting institutions in unlocking this funding.
Support	Share information relating to upcoming funding opportunities with ports and other key stakeholders.

ACTION 12:

Implement targeted taxes or levies and ringfence funds for targeted port investment that benefit port stakeholders

Funds could be raised by local tax or levies placed on local businesses or activities, with revenues ringfenced for investment in ports as energy hubs. By ringfencing funds for reinvestment in port applications, this will prevent the funds being used for other city applications and support acceptance for the tax/levy, assuming stakeholders are aligned to the goals and investment the levy will deliver.

These levies could be tied to sustainability criteria to align to wider city goals and initiatives. For example, a levy placed on vehicles or vessels which do not meet emissions standards. Similarly, levies could be placed on local businesses which are likely to benefit from planned port investment.

City influence	Sub-action
Enable	Place a levy on businesses within a port district and ringfence for investment in a new access road which will benefit their operations.

ACTION 13:

Utilise city/municipal investment banks to fund investments through debt instruments and increased financial attractiveness

City or municipal investment banks help cities bridge funding gaps for large-scale infrastructure projects, acting as catalysts to mobilise private capital. Unlike commercial banks, these publicly backed institutions can assume higher risk, with government support boosting investor confidence. While not a formal guarantee against failure, this backing aligns projects with public policy goals and reduces perceived risk

To attract private investment, these banks can use tools like risk guarantees and credit enhancements, such as providing a wrapper that improves a project's credit rating. This makes investments more secure, lowering borrowing costs and increasing financial appeal.

Often, city or municipal investment banks have targeted mandates to invest in sectors like clean energy. Their effectiveness, however, can depend on local tax structures. Cities in countries like the UK, where tax revenues are centralised, may face challenges in ringfencing funds for investment. In these locations, national investment banks, such as the UK Investment Bank (UKIB), are more common.

Photo: Port of Los Angeles

City influence	Sub-action
Enable	Provide initial capital, raised through local taxes or levies or through funding raised from IFIs, to fund a city investment bank. Provide guarantee to reduce risk to private investors.

Port of Long Beach and Los Angeles: Clean Truck Fund (CTF)

Action 12: Implement targeted taxes or levies and ringfence funds for targeted port investment

In 2022, a rate on all trucks entering the Port of Los Angeles and the Port of Long Beach marine terminals was introduced, with exemptions for trucks that meet near-zero or zero emissions. These funds were collected and pooled in a Clean Truck Fund (CTF).

In 2023, the Port of Los Angeles and Port of Long Beach made $60 million (100% of funds collected in the first year of operation) in CTF funding available through the California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) for purchase of Class 8 drayage trucks that operate at the San Pedro Bay ports complex. The funding aimed to support the deployment of up to 800 trucks (The Port of Los Angeles, 2023)As of January 2024, more than $115 million had been collected to help facilitate a changeover to cleaner trucks (The Port of Los Angeles, n.d.).

ACTION 14:

Invest in port connectivity

By providing enabling transport infrastructure, cities can unlock barriers to private port investment whilst maximising potential benefits of any investment.

With increased activity at the port as a result of investment in the energy hub concepts, there will be a need for the city to invest in common-user infrastructure which can enable this change such as transport connectivity. This may include upgrading or building new access roads or improving public transport services to the port.

Photo: Pexels

City influence	Sub-action
Enable	Use city funds to invest in enhanced bus services carrying passengers and workers to/from the port.
Support	Commission a study to assess the potential impact of transport interventions to inform investment decisions.

City of Vancouver: Rail corridor strategies

Action 14: Invest in port connectivity

Rail corridor strategies are an important component of Vancouver's Transportation 2040 to support Vancouver's role as a major port and gateway and to maximise the opportunities to move goods and people by rail.

The Burrard Inlet Rail Corridor connects the False Creek Flats railyards with the Port of Vancouver container terminals on the south shore of the Burrard Inlet.

The Commissioner Street Road and Rail Realignment project was completed in 2022, which widened and realigned Commissioner Street along the south shore of Burrard Inlet in Vancouver. The realignment of the street north between Nanaimo and Slocan streets supported improved capacity on the south shore to move goods and improve road and port operations.

In addition to improving port truck movements and traffic flow, the project helped improve access to terminal facilities for commercial traffic and enabled safe and efficient access to port lands for employees and service providers. It also provides land for rail track expansion, supporting trade growth and increased supply chain-related jobs (Port of Vancouver, n.d.) (Port of Vancouver, 2023).

ACTION 15:

Support catalytic port Devex and Capex funding

Capex funding could provide gap funding to cover expected shortfalls in revenue from commercial investments, reducing risk and creating the conditions for investors and supply chains to be drawn to the port. Cities could also invest directly in enabling infrastructure to encourage inwards investments which can take advantage of these initial investments. This could include a new substation to increase power supply to the port or EV charging infrastructure to support the transition to zero-emission trucks.

Devex funding could be made available to conduct necessary development to support port investment, including feasibility studies, engineering designs and environmental reviews. This can enable stakeholders to gain knowledge which can build momentum and accelerate deployment of these new technologies.

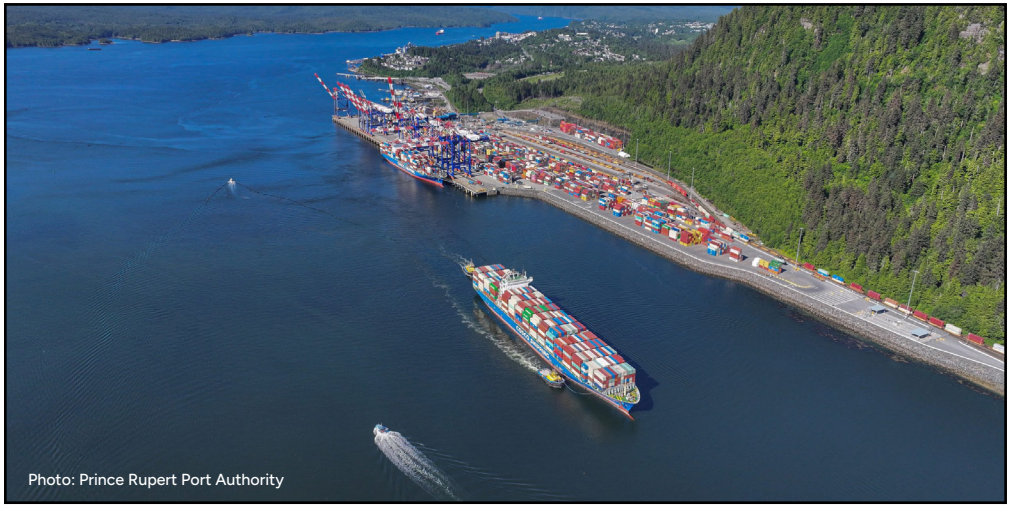


Photo: Prince Rupert Port Authority

City influence	Sub-action
Enable	Use funds to invest in enhanced grid infrastructure including substations and HV distribution which can serve increased electrification at the port. Provide gap funding to reduce risk for investors and ensure port infrastructure can be funded.

Port of Prince Rupert: Canada Infrastructure Bank's Indigenous Community Infrastructure Initiative

Action 11: Support port grant and finance applications

Action 14: Support catalytic port Devex and Capex funding

In 2025, the City of Prince Rupert, in partnership with the Prince Rupert Port Authority and the Metlakatla Development Corporation, secured a $60.7 million loan from the Canada Infrastructure Bank (CIB) to develop the Indigenous-led South Kaien Import Logistics Park. This funding, part of the CIB's Indigenous Community Infrastructure Initiative, is dedicated to site infrastructure and heavy civil construction, enabling the transformation of 56 acres near Fairview Terminal into a logistics and warehousing complex. The investment is designed to catalyse further private sector Capex for transloading and warehousing facilities, expanding the port's capacity and supporting regional economic growth, job creation, and Indigenous business leadership. The project is a cornerstone for anchoring Prince Rupert as a full-service trade gateway and exemplifies coordinated public and private funding for catalytic port development.

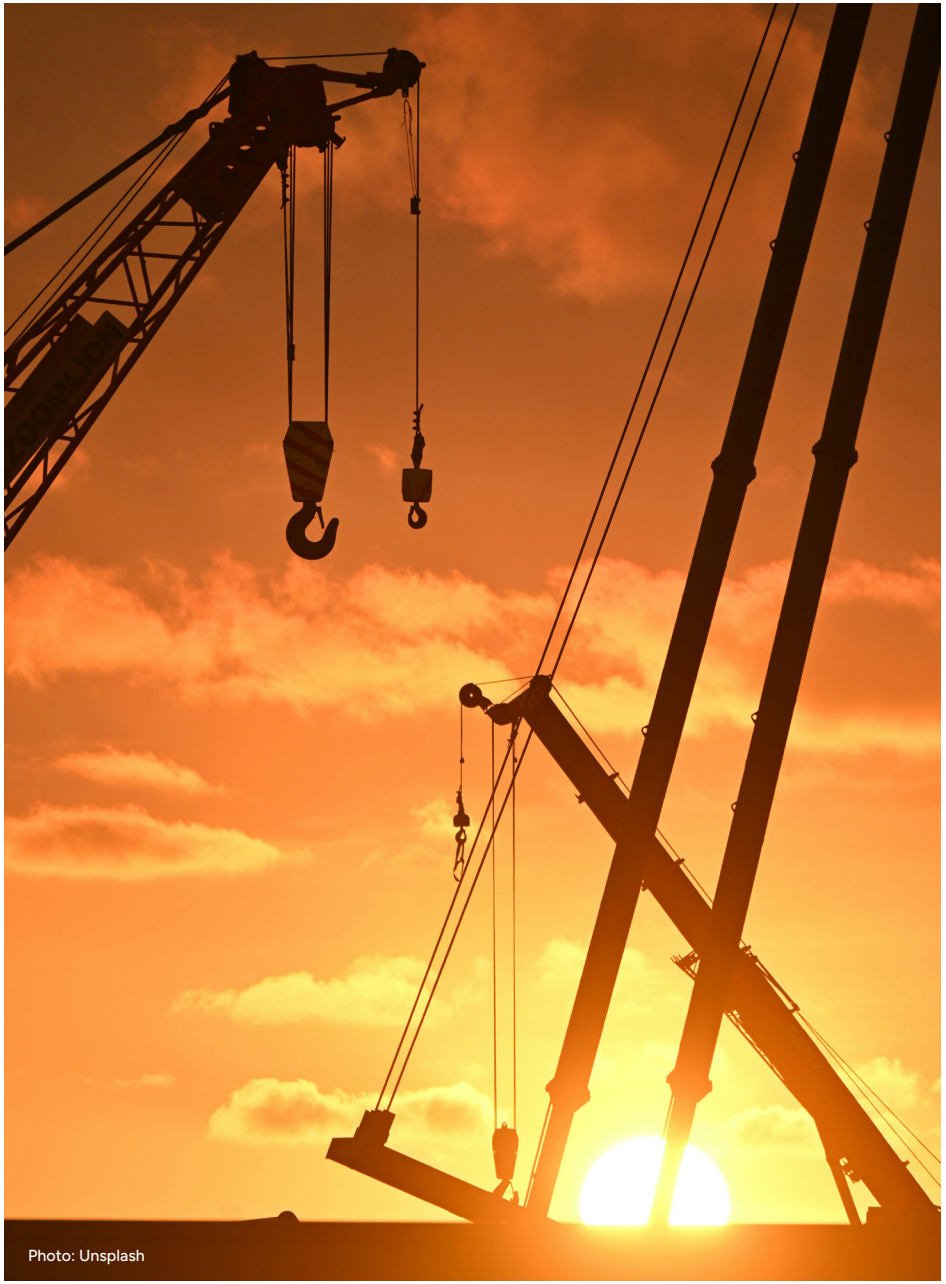


Photo: Unsplash

Teesworks investment in Tees Valley

Action 11: Support port grant and finance applications

Action 14: Support catalytic port Devex and Capex funding

UK freeports are designated zones that receive government support to boost trade, investment, and innovation through planning powers, skills development, infrastructure investment, and economic regulations. This includes tax relief, business rate retention, planning powers, and public investment. All Freeports are near major ports, driving investments in port infrastructure.

In 2021, the Tees Valley Combined Authority and the Tees Valley Mayor successfully bid for Freeport status. The Teesside Freeport includes the Teesworks site, the UK's largest industrial zone focused on advanced manufacturing, clean energy, and innovation. Teesworks has received £560m in public resources, including £246m in government grants and £257m in prudential borrowing, with a further £238m planned.

Funds have been used for land acquisition, remediation, and port infrastructure development. A new 1km quay supports the UK's offshore wind sector, offering 125 acres for manufacturing, storage, and mobilisation. It secured £107m from the UK Investment Bank. The quay provides firms with 500 acres of development land and unlocks the wider Teesworks site. The new £8m South Bank Link Road enhances connectivity, unlocking 200 ha of land for development (Teesworks, n.d.) (Hakimian, 2024).

Although the site is at an early stage of development, it can be stated that these initial investments have helped to attract the following private investments:

- **SeAH Wind**: The South Korean firm currently constructing a new £900 million offshore wind facility. It will construct monopiles before transporting these to a new quay prior to installation in the North Sea (Teesworks, n.d.).
- **NZT Power**: the world's first commercial scale gas-fire power station attached to a carbon capture network. It is expected over the long-term to help the UK government plan the decarbonisation of the power system.
- **Circular Fuels:** plans to build a new £150m low carbon plant producing 50,000 of fuel per year from non-recyclable household and industrial waste.
- **Energy Optimisation Solutions**: Teesworks Ltd has entered into a deal to develop a £62m battery energy storage system with an installed capacity of 100MW.


Photo: Unsplash

Action Toolkit for port cities: Society and workforce planning

As cities and ports transition towards becoming clean energy hubs, it is crucial to address the workforce and social dimensions of this transformation. Close collaboration among cities, port authorities, industry stakeholders, trade unions and workers, educational institutions, and national governments is crucial to ensure integrated, inclusive, and effective planning throughout the transition. This also involves engaging with local communities, stakeholders, and the workforce to build trust and support for these initiatives.

In addition, developing a workforce that is equipped to work within these energy hub contexts is vital for the sustainability and success of these projects. This requires targeted training programs, skills development, and collaboration between educational institutions, industry, and government.

By integrating just transition principles to develop ports as clean energy hubs, cities can ensure that the transition to clean energy hubs is inclusive, equitable, and beneficial for all. Through these efforts, cities can unlock the full potential of ports as clean energy hubs and drive meaningful climate action.

	Action		$	
	Society and workforce planning			
16	Work with other stakeholders to shape the ports as clean energy hubs workforce		$	
17	Tell the Total Value story of ports as clean energy hubs		$	
18	Increase city competitiveness to attract and retain talent		$ $ $	

ACTION 16:

Work with other stakeholders to shape the ports as clean energy hubs workforce

New workforce requirements will emerge as ports transition into clean energy hubs. To prepare for this shift, cities can:

- **Conduct workforce assessments and skills gap analyses:** align these assessments with the city's clean energy hub vision to identify current and future workforce needs, informing targeted training activities.
- **Design targeted training programmes:** collaborate with industry partners, trade unions, workers, and local educational institutions to create specialised courses and curricula that build the necessary skills and capabilities for the evolving workforce. This also helps those working in legacy industries such as oil and gas to transition to new green jobs.
- **Facilitate social dialogue:** foster ongoing dialogue between governments, employers, trade unions, and workers to understand concerns, co-design tailored transition pathways, and ensure that affected workers are supported in moving to new green jobs. This also helps uphold strong labour rights and decent work standards.
- **Promote diversity and equitable access:** identify underrepresented or marginalised communities and provide targeted training, scholarships, job placement initiatives, and retention support to ensure equitable access to green job opportunities.

City influence	Sub-action
Support	Commission and/or undertake a workforce assessments and skills gap analyses, focused on the emerging skills needed for a ports as clean energy hub workforce. Facilitate social dialogue between government, employers, unions and workers to ensure inclusive planning and implementation and uphold labour rights. Promote greater workforce diversity through targeted training and support to marginalised groups. Work with industry, trade unions,and educational institutions to develop targeted courses and curricula that will build the required workforce capability.

City of Seattle's workforce development initiatives

Action 16: Work with other stakeholders to shape the ports as clean energy hubs workforce

The City of Seattle is actively shaping its port as a clean energy hub by developing a citywide Green Jobs and Climate Careers strategy in partnership with the Port of Seattle, King County, and local organisations. Through the Coalition for Climate Careers, Seattle fosters regional collaboration and secures federal funding to expand clean energy training programs, while also providing equitable access and support for underrepresented communities in the green workforce. This multi-stakeholder approach ensures that workforce needs are assessed, training is targeted, and labour rights are upheld as the port transitions to a cleaner future (City of Seattle, 2025).

The Port of Rotterdam's Human Capital Coalition and Energy Transition

Action 16: Work with other stakeholders to shape the ports as clean energy hubs workforce

The Port of Rotterdam's **Human Capital Coalition Energy Transition** brings together port authorities, industry, educational institutions, and government to collectively address workforce needs as the port transforms into a clean energy hub. Through this coalition, the port identifies skills gaps, develops targeted training, and fosters ongoing dialogue to ensure a smooth and inclusive transition, supporting the creation of up to 15,000 new jobs in the clean energy sector. This multi-stakeholder approach prepares both current and future workers as the port moves toward net-zero emissions (Rotterdam Maritime Capital of Europe, 2023).

ACTION 17:

Tell the Total Value story of ports as clean energy hubs

Ports as clean energy hubs deliver significant value to communities, investors, industry, and the environment, but realising this potential depends on deliberate, transparent, and inclusive approaches.

Securing social license for these developments requires actively engaging local stakeholders, including residents, workers, and marginalised groups, as co-designers and co-implementers of climate action.

When climate action is guided by community needs and concerns, ensures fair distribution of benefits and costs, and encourages collective ownership, it builds lasting mutual trust and fosters stronger collaboration. This approach also enhances advocacy efforts and increases community influence over policy and investment decisions. Approaches such as public fora, participatory planning workshops, Port Days, and transparent communications are effective in ensuring that local voices are meaningfully involved in both shaping and implementing climate action at ports.

Climate action must prioritise equity and social inclusion to ensure a fair transition. Ignoring this can entrench inequalities and weaponise the climate debate, leading to pushback (C40 Cities, 2024). By exploring and sharing these benefits through community engagement, cities can secure social acceptance and successfully implement climate action.

City influence	Sub-action
Support	Commission studies which can tell the total value story and quantify benefits to local communities. Findings can be used in public engagement and media campaigns to garner support. Regularly hold open forums such as community town halls which can address concerns and gather feedback.

City of Oslo's Climate Agency and public engagement

Action 17: Tell the Total Value story of ports as clean energy hubs

Oslo's Climate Agency directly engages the public and stakeholders in port climate planning by hosting public consultations, workshops, and forums that involve residents, businesses, and environmental groups. This inclusive approach ensures that community needs and concerns are integrated into decision-making, building trust and accelerating the port's transformation into a clean energy hub.

The Rotterdam Climate Initiative

Action 17: Tell the Total Value story of ports as clean energy hubs

The City of Rotterdam, as a majority owner of the port, leads the Rotterdam Climate Initiative, collaborating with the Port Authority and local stakeholders to ensure inclusive participation through Port Days, Community Advisory Panels, and open meetings. These mechanisms allow residents, businesses, and environmental groups to co-design and shape the port's sustainability and climate strategies, ensuring transparency and fostering collective ownership of the clean energy transition (Port of Rotterdam, n.d.).

The Port of Seattle Community Action Team

Action 17: Tell the Total Value story of ports as clean energy hubs

The Seattle Community-Port Collaboration Pilot Project, supported by the EPA, brought together the Port of Seattle, a local health equity non-profit (Just Health Action), and near-port communities – especially those in the Duwamish Valley such as Georgetown and South Park – to address health and economic inequities and co-develop solutions. Key outcomes include the formation of the Duwamish Valley Port Community Action Team (PCAT), which elevates community voices in Port decision-making and empowers community members as paid consultants (United States Environmental Protection Agency, n.d.).

ACTION 17:

Increase city competitiveness to attract and retain talent

In addition to developing talent, cities will need to compete with other cities both nationally and internationally to ensure they can attract and retain the skills needed to deliver their port energy hub vision.

Cities play a crucial role in making themselves competitive by investing in essential infrastructure which makes them attractive places to live.

This includes investment in transport infrastructure, utilities and digital infrastructure as well as education, parks and green spaces which can improve quality of life.

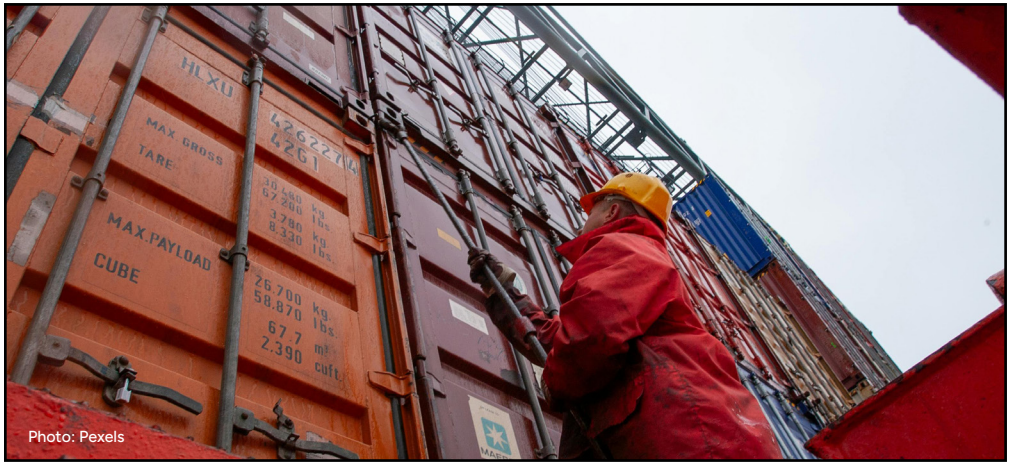


Photo: Pexels

City influence	Sub-action
Enable	Invest in improving parks and public spaces to increase city liveability.

Mayor's Green Skills Academy: South London Partnership

Action 16: Shape the ports as clean energy hubs workforce

The South London Partnership Green Skills Academy supports the UK's 2050 net-zero goal by helping South London residents gain the skills needed for green jobs. Working with local training providers and employers, the Academy focuses on aligning green skills training with employer needs to build a future-ready workforce (South London Partnership, n.d.).

Singapore's plan to boost maritime innovation through local start-ups

Action 16: Shape the ports as clean energy hubs workforce

Pier71 is a joint venture between the Singapore Maritime and Port Authority of Singapore (MPA) and the National University of Singapore which aims to boost innovation in the maritime industry by attracting talent, exchanging knowledge, and attracting start-up investments (PIER 71, n.d.)

Ho Chi Minh City: City regeneration

Action 18: Increase city competitiveness to attract and retain talent

Ho Chi Minh City has transformed its urban landscape through the Thu Thiem Smart City Project, creating a green district with eco-friendly offices, parks, and cultural spaces. The city has also revitalised the Saigon River, turning polluted waterfronts into vibrant public spaces while developing flood-resilient urban forests and wetlands. Investments in public transport, bike lanes, and pedestrian-friendly areas have improved liveability, attracting foreign investors and major companies like Intel and Samsung.

Yokohama: Supporting a clean waterfront

Action 18: Increase city competitiveness to attract and retain talent

Yokohama City and Kanagawa University signed an "Agreement on Mutual Cooperation in the Waterfront Area" to strengthen cooperation for decarbonisation of the waterfront area and enhancement of the functions of the Port of Yokohama, taking the opportunity of the establishment of Kanagawa University's "Sea and Port Research Institute" (City of Yokohama, 2023).

Catalysing port-city collaboration for clean energy hubs


Photo: Unsplash

Ports are poised to act as catalysts and accelerators for the energy transition, enabling both local and global decarbonisation.

Through unlocking investment in ports as clean energy hubs, cities can capitalise on this opportunity, delivering economic, financial, social, and environmental benefits to their communities, industries, and investors.

This report identifies three key typologies for ports as clean energy hubs: Sustainable Fuels Export and Bunkering Hubs, Hubs for Electrification, and Offshore Wind Manufacturing, Marshalling, and Installation Hubs. Each typology highlights the unique contributions ports can make in supporting the energy transition, from enabling the trade of sustainable fuels to facilitating the electrification of transport networks and supporting the deployment of offshore wind.

These typologies also show that ports as clean energy hubs offer significant benefits, including economic growth, job creation, improved public health, and environmental sustainability. By adopting a Total Value approach, cities and ports can unlock a strategic case for investment that goes beyond traditional cost-benefit analysis, considering the full range of financial, social, environmental, and economic impacts.

The **Action Toolkit** provides port cities with a framework for action in clean energy hubs, highlighting key actions which city officials can take in collaboration with the port and other stakeholders to unlock investment and deliver on the clean energy hub vision. The Toolkit covers actions in:

- Leadership and strategy
- Policy and planning
- Investment and finance
- Society and workforce planning

Looking ahead, there is a unique opportunity for port cities to pilot the approaches outlined in the report and share best practices. By collaborating with ports, energy stakeholders, and other key actors, cities can drive impactful investment, foster innovation, and accelerate the energy transition. This collaborative effort will not only support climate action but also deliver substantial local co-benefits for communities, investors, and the economy.

References

C40 Cities. (2023, April). *Why port cities should include ports and shipping in climate action plans*. Retrieved June 30, 2025, from https://www.c40knowledgehub.org/s/article/Why-port-cities-should-include-ports-and-shipping-in-climate-action-plans?language=en_US

C40 Cities. (2024, October). *An urban just transition: Issue Brief*. Retrieved July 01, 2025, from https://www.c40.org/wp-content/uploads/2024/10/RC4040a-Issue-Brief-A-Urban-Just-Transition-v8.pdf

C40 Cities. (2025, March). *Port of Yokohama leveraging battery tankers and floating offshore wind*. Retrieved June 27, 2025, from https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/Vo000000UdvB/O4t2pOJcoJjX6L74weLkK8VG6bI44jeGDCAbs7YS4Wk

C40 Cities. (2025, April 01). *How cities and their ports can support the transition to clean marine fuels.* C40 Knowledge Hub. How cities and their ports can support the transition to clean marine fuels

City of Seattle. (2025, January). *One Seattle Transportation and Climate Justice Executive Order: 2024 Progress Report*. Retrieved June 30, 2025, from https://www.seattle.gov/documents/departments/ose/climatechange/te/121724-transport-seattlecity-report-hiz.pdf

City of Yokohama. (2023, July 18). *Initiatives to create a carbon-neutral port at Yokohama Port* (横浜港における カーボンニュートラルポート形成に向けた 取組について). Retrieved June 30, 2025, from https://www.jfsan.org/gaisenkyo_jfsa_download_file/11689904287.pdf

The Competitiveness of Global Port-Cities: The Case of Hamburg - Germany. (2012). OECD Regional Development Working Papers. Retrieved June 27, 2025, from https://www.oecd.org/content/dam/oecd/en/publications/reports/2012/06/the-competitiveness-of-global-port-cities-the-case-of-hamburg-germany_g17a215c/5k97g3hm1gvk-en.pdf

Compressor Tech2. (2022, July 22). *Unigel plans $120 million green hydrogen plant.* Retrieved June 27, 2025, from https://www.compressortech2.com/news/Unigel-plans-120-million-green-hydrogen-plant/8022339.article?zephr_sso_ott=RUHnvh

Datamar News. (2020, March 12). *Pecém ships largest wind turbine ever produced in the southern hemisphere.* Retrieved June 27, 2025, from https://datamarnews.com/noticias/pecem-ships-largest-wind-turbine-ever-produced-in-the-southern-hemisphere/

Department of science and innovation & engie impact. (2021, October). *South Africa Hydrogen Valley Final Report.* https://www.dsti.gov.za/images/2021/Hydrogen_Valley_Feasibility_Study_Report_Final_Version.pdf

Foreign Ministry of Oman. (2025, April 13). *Launch of Oman's first wind turbine factory*. Retrieved June 27, 2025, from https://www.fm.gov.om/launch-of-regions-first-wind-turbine-factory/

4C Offshore. (2024). *2024 4C Offshore: Market Overview Report.* 4C Offshore.

The Guardian. (2024, December 10). *The five-minute city: inside Denmark's revolutionary neighbourhood.* Retrieved June 26, 2025, from https://www.theguardian.com/lifeandstyle/2024/dec/10/the-five-minute-city-inside-denmarks-revolutionary-neighbourhood

Hakimian, R. (2024, April 09). *£114M deep water quay at Teesworks completed ahead of summer operation.* New Civil Engineer. Retrieved June 30, 2025, from https://www.newcivilengineer.com/latest/114m-deep-water-quay-at-teesworks-completed-ahead-of-summer-operation-09-04-2024/

Hydrogen Central. (2023, January 20). *Brazil – Unigel to Invest up to $1.5 Billion in 'Green Hydrogen' Production.* Hydrogen Central. Retrieved June 27, 2025, from https://hydrogen-central.com/brazil-unigel-invest-1-5-billion-green-hydrogen-production/

ICCT. (2023, February 06). *Electrifying ports to reduce diesel pollution from ships and trucks and benefit public health: Case studies of the Port of Seattle and the Port of New York and New Jersey*. Retrieved June 27, 2025, from https://theicct.org/publication/marine-ports-electrification-feb23/

MSE International. (2024, December 11). *Groundworks start on Sea Change pioneering shore power system at Portsmouth International Port.* Retrieved June 27, 2025, from https://www.mseinternational.org/news/?story_id=954

Naida Hakirevic Prevljak. (2024, November 12). *With sustainability in mind, Port of Rotterdam sets tariffs for next 3 years.* Offshore Energy. Retrieved June 30, 2025, from https://www.offshore-energy.biz/with-sustainability-in-mind-port-of-rotterdam-sets-tariffs-for-next-3-years/

New York State Energy Research and Development Authority. (n.d.). *Offshore Wind Master Plan Master Plan 2.0.* Retrieved June 27, 2025, from https://www.nyserda.ny.gov/All-Programs/Offshore-Wind/About-Offshore-Wind/Master-Plan

Ofgem. (n.d.). *Average gas and electricity usage.* Ofgem. https://www.ofgem.gov.uk/information-consumers/energy-advice-households/average-gas-and-electricity-use-explained

PIER 71. (n.d.). *Home.* PIER71™: Boosting Maritime Innovation | Reimagine MarineTech. Retrieved June 30, 2025, from https://pier71.sg/

Port de Barcelona. (n.d.). *El Port Vell.* Retrieved June 27, 2025, from https://www.barcelona.cat/en/conocebcn/pics/el-port-vell-92086030198

Port of Hamburg. (2023, June). *2040 Port Development Plan: Strategic Vision.* Retrieved June 27, 2025, from https://cdn.sanity.io/files/sxgebz2d/production/aca84f10afa3d4a22fc6c011c9fd64bdacedce42.pdf

Port of Long Beach. (n.d.). *Energy Initiatives.* Retrieved June 27, 2025, from https://polb.com/environment/energy-initiatives/#program-details

Port of Long Beach. (n.d.). *Microgrid Demonstration Project.* Retrieved June 27, 2025, from https://polb.com/environment/energy-initiatives/#microgrid-demonstration-project

The Port of Los Angeles. (n.d.). *Port of Los Angeles Clean Truck Program Overview.* Retrieved June 30, 2025, from https://www.portoflosangeles.org/environment/air-quality/clean-truck-program

Port of Los Angeles. (n.d.). *Wilmington Waterfront Development Project Draft Environmental Impact Report*. Retrieved June 26, 2025, from https://kentico.portoflosangeles.org/getmedia/95269ca6-1b92-4624-9941-22f1097effa8/7-0_-socioeconomics?utm_source=chatgpt.com

The Port of Los Angeles. (2023, November 9). *Ports Of Los Angeles, Long Beach To Make $60 Million Available For Zero-Emission Trucks.* Retrieved June 30, 2025, from https://www.portoflosangeles.org/references/2023-news-releases/news_110923_hvip_ze_trucks

Port of Rotterdam. (n.d.). *Corporate Citizenship.* Retrieved June 30, 2025, from https://www.portofrotterdam.com/en/about-port-authority/port-authority-society/corporate-citizenship

Port of Seattle. (2025, April). *Seattle Waterfront Clean Energy Strategy*. Retrieved June 26, 2025, from https://www.portseattle.org/sites/default/files/2025-04/Seattle%20Waterfront%20Clean%20Energy%20Strategy%20-%20FINAL.pdf

Port of Vancouver. (n.d.). *Commissioner Street Road and Rail Realignment Project.* Retrieved June 30, 2025, from https://www.portvancouver.com/project/commissioner-street-road-and-rail-realignment-project

Port of Vancouver. (2023, December 8). *Commissioner Street Road Realignment Project.* Youtube. Retrieved June 30, 2025, from https://www.youtube.com/watch?v=4JWpJWRlmZM

Portsmouth International Port. (n.d.). *SEA CHANGE*. Retrieved June 27, 2025, from https://portsmouth-port.co.uk/about-us/sustainability/sea-change/

RMI & Global Maritime Forum. (2024). *Oceans of Opportunity: Supplying Green Methanol and Ammonia at Ports.* https://rmi.org/insight/oceans-of-opportunity/

Rotterdam Maritime Capital of Europe. (2023, February 22). *Human Capital Coalition Energy Transition launched.* Retrieved June 30, 2025, from https://www.rotterdammaritimecapital.com/news/human-capital-coalition-energy-transition-launched

South London Partnership. (n.d.). *Mayor's Green Skills Academy.* Retrieved June 30, 2025, from https://southlondonpartnership.co.uk/mayors-green-skills-academy/

Stockholms stad. (2025, June 25). *Stockholm Royal Seaport shows the way towards a sustainable future.* Retrieved June 27, 2025, from https://www.norradjurgardsstaden2030.se/about/the-development-project

Teesworks. (n.d.). *South Bank: 508 acres redeveloped with access to an all-new 1km quay.* Retrieved June 30, 2025, from https://www.teesworks.co.uk/the-development/zones/south-bank

United States Environmental Protection Agency. (n.d.). *Seattle Community-Port Collaboration Pilot Project*. Retrieved June 30, 2025, from https://www.epa.gov/ports-initiative/seattle-community-port-collaboration-pilot-project

Urban Land Institute. (2007). *Ten Principles for Coastal Development*. Retrieved June 27, 2025, from https://uli.org/wp-content/uploads/ULI-Documents/Ten-Principles-for-Coastal-Development.pdf

World Bank. (2021, January 01). *The potential of zero carbon bunker fuels in developing countries*. World Bank Document. Retrieved June 27, 2025, from https://documents1.worldbank.org/curated/en/110831617996384433/pdf/The-Potential-of-Zero-Carbon-Bunker-Fuels-in-Developing-Countries.pdf

World Ports Sustainability Program. (2022). *Port of Barcelona – Your port opens up again.* Retrieved June 27, 2025, from https://sustainableworldports.org/project/port-of-barcelona-your-port-opens-up-again/

Appendix: Cases

Typologies

Sustainable Fuel Hubs

Hubs for electrification

Offshore wind manufacturing, marshalling, and installation

Toolkit

Leadership and strategy

Policy and planning

Finance and investment

Society and workforce planning

Ports as clean energy hubs

How port cities can power the global energy transition

C40 Ports and Shipping
c40.org/ports-and-shipping
ports@c40.org

C40 CITIES

ARUP