Scottish Ports and Climate Change

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Background

This document assesses the growing regulatory and societal pressure to limit the impacts of climate change, how this applies to shipping, and the implications of this for Scottish ports and agencies concerned with climate change.

It is based on a review of academic, industry, regulator and other literature on shipping and port decarbonisation, and assessment of over 40 individual port strategies and actions, in the UK and abroad. In addition 6 ports were interviewed about their ongoing experiences in addressing climate change.

It was written in March 2021 as an input to an initial feasibility study into shore power at Aberdeen Harbour Board, led by Buro Happold, which was funded by Scottish Enterprise. A February 2022 update flags policy developments since this initial report.

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NB: All views contained with this report are attributable solely to the author and do not necessarily reflect those of researchers within the wider Tyndall Centre

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Executive summary

- In recent years there has been growing international and national pressure on all sectors to cut their greenhouse gas emissions. This pressure will increase. The Scottish Government is unequivocal when it says "*our contribution to climate change will end, definitively, within one generation*"[1].
- Global temperature rises are dependent on cumulative greenhouse gas emissions. It is overwhelmingly emissions reductions in the next 10 years which determine whether the world keeps to the 1.5^{0}C temperature target set out in the Paris Climate Agreement.
- Shipping needs to develop zero carbon fuels, but because their deployment at scale will only accelerate after 2030, other actions on emissions reductions are critical and urgent for the 2020s.
- As part of this challenge, ports need to develop decarbonisation strategies. This will have knock-on advantages:
    - Action on decarbonisation also cuts local air pollution and noise;
    - Growth in electrification of vessels, mobile machinery and land-vehicles is inevitable. Ports are ideally placed to become smart-grid managers of electricity flows;
    - Ports will be increasingly vulnerable to climate change impacts such as rising sea-levels and storm surges, and have a strong vested interest in leading the way on climate change mitigation.
- Each port faces unique circumstances, but six guiding principles should guide ports' next steps:
    - Emissions inventories are important, but there will always be data-holes and difficulties in categorisation and baselines. A broad overview assessment is sufficient to prioritise. Desire for precision should not be a delay on action. **Reducing emissions this decade is the priority.**
    - Although ports do not have direct control over ships or their emissions, these emissions will dwarf land-side emissions for most ports. **Port decarbonisation strategies and inventories must include ship emissions,** and a plan for how ports can try to influence them, not just their own operation "scope 1 and 2" emissions.
    - **Ports have influence over ship emissions**. Ports can provide shore-power for vessels at berth, they can affect time and speed of vessels in transit and manoeuvring, they are involved in infrastructure provision for future zero-carbon fuels.
    - **Inventories will be essential for determining priority areas.** At Aberdeen, carbon dioxide (CO_2) emissions from vessels at berth are over 100 times higher than the emissions from land-side electricity used at the port.
    - **A port decarbonisation strategy will need to be integrated with other goals – notably air pollution reduction, resilience, just transition, and climate change adaptation**. The United Nations Sustainable Development Goals offer an overarching framework for ensuring goals are not in conflict.
    - **National regulatory bodies and agencies have an essential role to help ports and shipping operators decarbonise**, particularly given the slow and inadequate pace of policy development at the international level, for example on carbon pricing. This could include:
        - Capital funding for infrastructure projects;
        - Reductions in taxation on low-carbon electricity used by ships;
        - Clarity on low-carbon pathway for shipping to 2030 in Scottish Climate Plan.

1) Regulatory landscape: Climate change, shipping and Scottish ports

193 countries have ratified the Paris Climate Agreement, which includes the target to keep global warming to 1.5^{0}C above pre-industrial levels[2]. The UNFCCC states that to meet this 1.5^{0}C goal "*global net anthropogenic CO_2 emissions need to decline by about 45 per cent from the 2010 level by 2030, reaching net zero around 2050*"[3].

Countries and sectors are ratcheting up their climate change ambitions. The EU, UK and Scotland have all tightened their targets in recent years; the USA[4] and China have set net-zero targets. After the 2021 COP26 climate summit in Glasgow, ECIU report that 88% of the world's emissions are now covered by a net-zero emission target.[5]

For shipping, the International Maritime Organisation (IMO) has set an initial climate change strategy, with a target of at least 50% reductions in international shipping emissions on 2008 levels by 2050[6]. The UNEP emissions gap report[7] states that this target is not consistent with the Paris Climate Agreement's 1.5^{0}C goal, and it is described as "critically insufficient" by independent analysts Climate Action Tracker[8]. This target would require tightening to zero emissions before 2050 to be 1.5^{0}C compatible[9].

The IMO's shipping strategy is due for revision in 2023. Following multiple further interventions by industry and Governments in 2021 on the need for stronger climate targets for shipping[10,11,12,13] the IMO agreed at its November 2021 MEPC77 meeting that "*The Committee, in view of the urgency for all sectors to accelerate their efforts to reduce GHG emissions as emphasized in the recent IPCC reports[1] and the Glasgow Climate Pact, recognized the need to strengthen the ambition of the Initial IMO GHG Strategy during its revision process*"[14].

In many respects, action on shipping is being driven not by the IMO, but by other actors. From the private sector this includes the 150-company Getting to Zero coalition of shipbuilders and operators[15], the financial community's Poseidon Principles[16], proposals from ship charterers Trafigura[17] for a strong international carbon price for marine fuels, and proposals from the International Chamber of Shipping on a R&D fund[18]. As a Governmental level, progress has been led by the EU, particularly through the July 2021 package of proposals for their Fit for 55 strategy[19]. These include bringing maritime emissions into the EUETS[20], mandates for renewable fuels in shipping[21], and regulations on port[22] and ship[23] infrastructure for shore-power. At COP 26 in Glasgow, 22 nations signed the Clydebank Declaration, committing to develop green shipping corridors[24].

The Scotland context for shipping

The UK and Scotland both have legal requirements to reach net-zero GHG emissions. Scotland's legal target is tighter, with a 2045 net-zero date[25], compared with the UK's 2050 date. Scotland's target explicitly includes emissions from international shipping, and in June 2021 the UK Government legislated to also include international aviation and shipping emissions in the UK's carbon budgets towards meeting their 2050 target[26].

Transport is a devolved issue. In some respects, the UK Government has moved further on shipping decarbonisation than the Scottish Government. The UK Government set out a Clean Maritime Plan (CMP) in 2019[27], and has followed this up with further detail on the shipping sector in its 2021

Transportation Decarbonisation Plan (TDP)[28], with announcements of likely future consultations on specific policies. In 2022 the Department announced a call-for-evidence on policies to accelerate deployment of shore-power[29], but overall there is still lack of policy to deliver the CMP and TDP's ambitions. It has also set out guidance for major English ports to produce Port Air Quality Strategies, the guidance for these includes carbon dioxide alongside local air pollutants such as particulates, NOx and SO_X. There are no equivalent strategies in Scotland, and the February 2020 Scotland National Transport Strategy is light on shipping, referring only to EU and global legislation, with no mention of ports. The Scottish Government's December 2020 climate change plan has a greater coverage of initiatives on ports and shipping, and in January 2021 the Scottish Government announced its slant on the UK Government's freeports, saying "*we propose to take the Freeport model and apply Scotland's priorities to it, so that it meets our ambition to deliver a net zero, wellbeing economy…"*[30]*;* later updates include "*a just transition to a net zero economy*" as one of five "key objectives" of the Scottish freeport model[31].

Overall, Scotland's approach to climate change is evolving quickly, and its statement "*our contribution to climate change will end, definitively, within one generation*"[32], is as unequivocal and ambitious as any nation on earth. It is also likely that, as has happened in the last decade, as climate change impacts worsen, the political and societal pressure to tighten targets and accelerate policy will only increase.

In this overall context, Scottish ports should expect that National and International regulation, pressure and policy on climate change, and shipping within this, will only intensify in the coming years.

2) Port strategies on climate change

As recently as 2016, climate change wasn't even a top 10 environmental concern for European ports, coming lower than issues such as dust. This situation has changed rapidly. In 2021, it is seen as the 2nd highest priority, behind air quality:

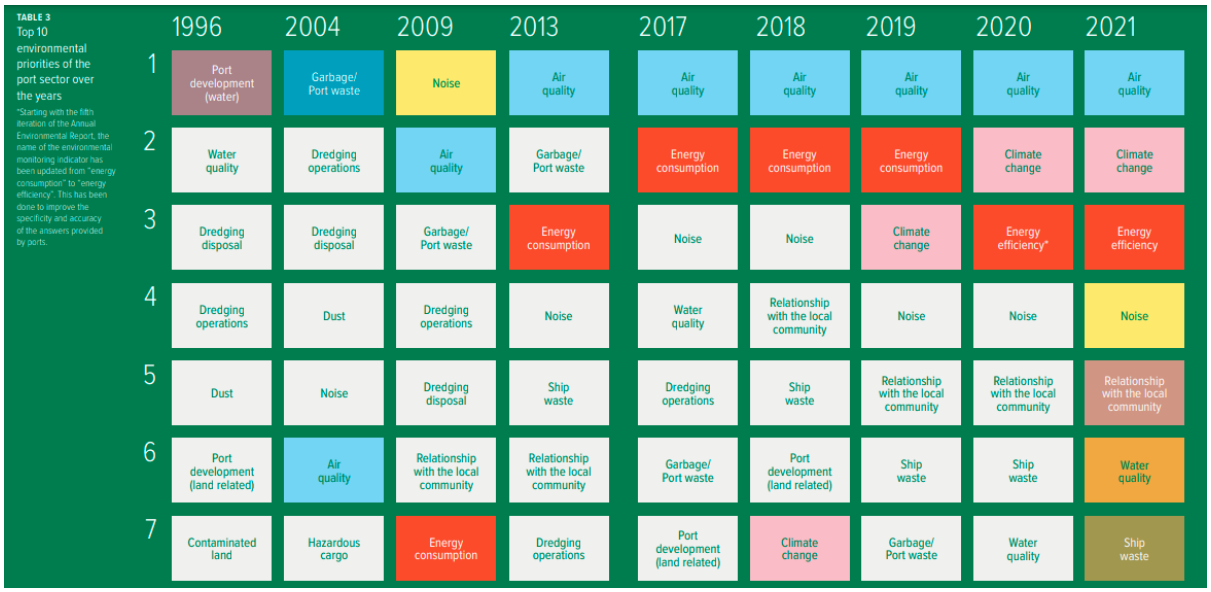

Figure 1: Top 10 environmental priorities of European Ports (Source: ESPO)[33]

Perhaps because the issue is new, and complex, reviews of port action on climate change have conclusions such as "*there is not any unified method to calculate carbon footprint in ports*"[34] and "*the literature gives an insufficient foundation for decision-making in ports*"[35].

However, there is a great deal of global practical experience of implementing measures which cut either local air pollution, or greenhouse gas emissions, or both. Many ports have been taking multiple actions to cut energy use, for years. There is similarly a raft of differing but often overlapping guidance from different entities on how ports can address air pollution and climate change. These range from (See Appendix 1 for further detail):

- ISO standards, such as ISO 50001 and 14001;
- Carbon footprint tools;
- Inventory and strategy guidance tools produced by GLOMEEP at the IMO, and by ESPO.
- Categorisation tools:
    - Into "scopes" of control: scope 1 (port own control), scope 2 (indirect emissions eg through purchase electricity) and scope 3 (indirect influence only, eg over ship operations)
    - By location (in port, at sea, hinterland)
    - By measure, split in multiple ways (eg shore power vs energy efficiency)
    - By policy tool – eg port dues incentives, concession agreements, management strategy
- Prioritisation tools, such as the work of Poulsen et al[36], looking at which factors determine whether actions on shipping emissions are successful.

There is then an extremely wide and often bewildering range of approaches taken. Partly this reflects that ports vary wildly in size, function and pressures. A vast container port will have very large energy consumption for moving cargo around the port, whereas a port with a greater ferry and cruise focus may have greater proportion of emissions from ships at berth. A long urban estuary port will face greater local pressure to reduce air pollution. But although there is no one-size-fits-all strategy, there are certain issues which cut across all ports, with some critical decisions needed on each of these. Throughout, the broad approach – set out in slightly different ways in a myriad different publications – is one of "measure-prioritise-act-review-repeat". The critical decisions however are what to measure, how to prioritise, and what level of action is required. The following sections set these issues out, and recommend a course of action for each.

2.1 Emissions coverage

There is a fundamental issue of "what emissions are counted", and ports take two very different approaches. One is to focus very narrowly - a port will measure just its "own" emissions – often defined as Scope 1, its own operations, buildings and machinery, and Scope 2 emissions, ie those associated with purchased electricity. The opposite approach is to cast wide, and count "indirect" emissions (Scope 3) – for example the emissions from vessels while in port, and from HGVs and cars passing through the port. Within these categories there are further complexities. For example, for vessels, what constitutes "in the port" varies. Gothenburg counts all ship emissions from 8 miles out to sea as part of its emissions inventories. Other ports use different distances. This means that in a port like Gothenburg ship emissions in transit are a much higher proportion of the total than had they chosen a 2km boundary. These sorts of methodological choices and no consistency in approach between ports also mean that comparison of different ports' emissions is extremely difficult.

The choice of a narrow or wide cast is essentially around the issue of a port's relative control over emissions. The argument for a wide cast is that ships' emissions often dwarf the emissions of the port's own operations, so even if a port has limited control over these emissions, it is wrong to exclude them, as managing to even partially reduce these emissions could have greater impact than reducing the entirety of the port's own emissions to zero. The argument for a narrow cast is that "*it is wrong to count emissions we don't control. It would be buck passing – allowing justification for any failure by saying that important stuff is what we don't control*"[37].

This report recommends ports cast the net wide, for two reasons.

The first is that Scope 3 emissions will almost always be the overwhelming percentage of emissions. In Aberdeen, measures on LED lighting in particular have reduced the port electricity, and across the estate land-side electricity is around 7.5 GWh/year. By contrast, ships at berth in the harbour use over 50GWh/year. As the ships are producing this electricity using highly polluting marine fuel oil, and Scottish grid electricity is far cleaner, the disparity in emissions is over 100:1. See table below:

Table 1: Carbon dioxide emissions from electricity use, land-side and vessels, Aberdeen

Aberdeen[38]	Electricity/year (GWh)	Emission intensity (t/GWh)	tCO2/yr
Vessels' use of electricity at berth	52.8	654	34,530
Land-side port electricity use	7.5	41.4	310

This situation is similar in studies in ports all around the world – Chennai, Gothenburg, Barcelona, Portsmouth.

The second is that ports may not have control but they do have influence over these wider emissions, and so a decent strategy should investigate what measures could reduce them. This is an issue occurring in other sectors. At a local authority level, councils are setting climate change strategies, covering issues such as road transport. A local authority has some control here – it sets local transport strategies, and controls planning. However this is only partial – it doesn't control individual drivers' actions, or National Government policy on road building and EV charging points. But there are measures it can take, and authorities try to integrate their strategies with these other actors' actions. The same approach should apply to ports. Ports also have differing levels of influence over the various types of scope 3 emission. Ports have more potential control over emissions at berth than they do over emissions in transit in the port, as they can provide shore power facilities. But they have some level of influence over emissions in transit – either through measures on speed in port, or introducing just-in-time or similar management systems to cut time waiting for berths, or environmental port dues incentive schemes.

The IMO have produced global guidance for ports on emissions, in their two GLOMEEP guides. This guidance covers local air pollutants as well as GHGs such as CO_2. On this issue of coverage, the IMO leave the decision to ports, saying:

"*'Where, geographically, is the inventory going to account for emissions from port-related sources and which activities are going to be included?' The answers to these two fundamental questions are informed and shaped by the drivers, intended uses, pollutants and sources to be included in the emissions inventory*"

On drivers, the IMO say "*it is important to catalogue all current drivers*[1] *and try to anticipate emerging or future drivers, so that the inventory is developed to address all drivers*".

This document contends that the biggest of these drivers is the pressure from Scottish, EU and international entities to reduce the air quality and climate change impacts of shipping, which will only increase. In this context, ports will have a pivotal role. Much of the transition to net-zero will come from electrification and new zero-carbon fuels, both requiring substantial shore-side infrastructure. Ports will have a pivotal role in enabling these transitions, bringing together stakeholders from electricity networks, local authorities, shipping operators and infrastructure providers. Their role is therefore far greater than just their own in-port scope 1 and 2 emissions, and a best-practice port climate change strategy should reflect this.

2.2 Prioritisation

A number of UK ports have targets to be carbon-neutral, for example Tyne, Portsmouth, Shoreham (2030), Peel Ports (2040), and such targets are also set at other ports worldwide for example San Diego (2035) and Valencia (2030). These headline targets however tend to be just for the port's own scope 1 operations. By contrast, a number of other ports set their strategies based on Scope 3 emissions – for example:

- Oslo, 85% by 2030, "*this target includes emissions from ships entering and leaving the port and at berth*"
- Gothenburg, 70% on 2010 levels by 2030, all emissions including shipping to 8 nautical miles out.
- London – sets differentiated targets for the Port of London Authority's own emissions, inland shipping, and international shipping.
- Portsmouth – includes vessels' emissions in its inventories "*from the Outer Spit Buoy inwards (4.6 nautical miles)*".

It should be a short in-house exercise for most ports to calculate the rough relative importance of the various scope 1, 2 and 3 emissions. Although detailed inventories are useful, their absence should not be a reason for delay in developing strategies to reduce the biggest emission sources in port. As one European port operator said:

> "*Rough estimation is good enough. You need to move into the actions. 35% or 39% is not the issue – just get on with it. Move from inventories to action as soon as possible. Expect and accept that the numbers you will get are going to be rough. To make a real difference, move outside of the port authority area. It's harder, but will have bigger impacts*."

Another European port interviewed suggested the same, when asked about long-term targets:

> "*What's important is the next five years. Focus there*".

Readily available port-call data on at-berth and in-transit times coupled with ship power/energy consumption values can show reasonably quickly the extent to which ship emissions dominate over in-port energy use. Ship strategies are likely to need to be the focus:

[1] "Drivers" = the main potential reasons for conducting an emissions assessment, eg requirements or pressure to reduce air quality or GHG emissions

- Aberdeen: ship electricity consumption at berth: 53 GWh, port's land-side electricity consumption: 7.5 GWh.
- Gothenburg: 81% of emissions at sea, 12% road, 7% terminals[39].
- Oslo: 55,000 t/yr. 51% ships in port, 34% ships in transit, 14% land-based activity[40]
- Chennai: ships manoeuvring/hoteling 156,000 t/yr, port-own emissions 7,000 t/yr,[41]

This report also recommends ports undertake early first-cut analysis of the breakdown of emissions within the largest emissions sources. Port-call data analysis shows which berths are most in demand, and also which vessels and operators have the greatest power consumption. For Aberdeen the highest demand for electricity at berth comes from the category of Multi-Purpose Supply Vessels, comprising 60% of the total. For other categories, ferries, safety vessels and general cargo vessels had similar electricity usage at berth, however provision of shore-power is more likely to be successful for ferries. For ferries versus general cargo ships, the reason is simply the number of vessels involved: 4 frequent long-stay callers vs 120 infrequent short-stay callers. For ferries versus safety vessels, the power demand per hour is far higher for ferries. In each case, it is likely to be more economic, and easier to negotiate the use of shore-power, with the smaller number of ferry operators.

In summary, ports should

- Undertake an initial assessment covering all emissions, including scope 3;
- Focus on highest emissions sources;
- Focus on the biggest emitters within these highest emissions sources;
- Focus on emissions reductions in the short-term.

2.3 Integration

Ports face two main environmental drivers – air quality and climate change. Because they both derive mainly from burning fuel oils, actions to reduce fuel oil use will tend to make progress on both issues. But ports will need to take care here, particularly if they are increasingly involved in broader stakeholder discussions about future infrastructure provision. Ammonia can lower GHG emissions, but still leave a local NOx problem. LNG can cut local air pollution, but is still a highly carbon-intensive fuel. Location matters too – ports may want to prioritise GHG reductions in parts of their estate where the local air quality benefits will be greatest – in areas nearer to population centres.

Climate change mitigation strategies will also need to be closely linked to other drivers. All of these can also be thought of through the lens of "resilience". Ports and societies need to be resilient in the face of unpredictable future change, stresses and shocks. Ports need to be prepared and able to cope with future climate change impacts (such as increased storm surges), as well as ride the huge transformations coming from transitions to new technologies to prevent climate change. Ports are also part of and influenced by rapid global shifts occurring in digitisation, automisation, 3D-printing and big-data analytics. Port resilience issues are addressed in detail in a March 2021 report by Button et al[42].

One pivotal issue for ports will be how quickly the approach to energy and electricity will need to change. In the past, energy has not be a port's core business. This will change very fast as all aspects of port energy use increasingly electrify, and new energy vectors such as hydrogen start to be deployed at scale. As port equipment electrifies, and as vessel and vehicle electricity demands increase, and as ports generate and store more power, ports will need to develop increasingly

sophisticated smart power grids and power management systems, balancing and managing electricity flows.

A further integration issue is around just transition. What is now required in shipping, and society more generally, is a rapid transition. The Scottish Government has rightly focussed on the necessity that this is also a "just transition" – to ensure that communities and jobs are protected. The UK has seen terrible social and economic impacts when industries have suddenly fallen – coal mining in the 1980s, fishing in the 1960s. It's essential to ensure climate change policy provides for and protects communities during the urgent and rapid transitions now required to protect society against growing climate change impacts. The Scottish Government's March 2021 Just Transition Commission's recommendations should be integrated into port climate change strategies[43]

Because each port has different circumstances, the Sustainable Development Goals of the United Nations[44], used by many authorities and corporations, can be a useful framework for ensuring ports consider the full range of synergies when developing and implementing climate change strategies.

Figure 2: The United Nations Sustainable Development Goals

2.4 Supporting ports

Although ports have a pivotal role in shipping decarbonisation, they need policy support. Because marine oil is untaxed internationally and does not pay the cost of its pollution, these fuels have an unfair competitive advantage over low-carbon fuels and shore-power. In the medium-term this can be solved at an international level through carbon pricing, but its absence in the short-term national governments have a role to play. Similarly, port investments in shore-power are capital intensive, and in all other parts of the world have required some state support.

The Scottish Government has world-leading ambition on climate change overall, but like their UK counterparts' Clean Maritime Plan, there is a lack of policy on shipping and ports to help this sector

decarbonise. The announcement that any Scottish Freeport incentives will be linked to delivering net zero is very welcome, however this report suggests that support is made available for all Scottish ports to develop priority actions specific to their port, with funding available to implement them, and policy to facilitate it – for example exemptions from taxation on shore-power to level the playing field with untaxed marine fuel oils. Other bodies could strengthen links between economic and climate change objectives as is being proposed with the freeports. For example, Scottish Enterprise's post-Brexit policy for state-aid funding for ports could include an objective to deliver on net-zero, as well as just "delivering economic benefits to Scotland"[45], as is the case with SE's Environmental Protection subsidy scheme[46].

Appendices

1) Existing guidance for ports:

The UK Department of Transport has guidance for ports in preparing air quality strategies – this guidance includes CO_2 emissions as well as local air pollutants such as NOx, SOx and particulates[47]. It also refers to two excellent guides from GLOMEEP: on broad emissions inventories[48], and strategies for emissions reduction[49]. DEFRA also have guidance for using emissions factors in energy-to-emission conversion calculations[50].

The European Sea Ports Organisation have a 2021 port environmental management guide[51].

DNV.GL have a new publication "Ports: green gateways to Europe"[52]- which sets out the main challenges and actions for ports over the coming decades.

Many academic publications have reviewed port strategies and action on emissions reduction. Some of the main publications' focus is set out below. Alamoush et al 2020[53], Sdoukopoulos et al 2019[54] and Bjerkan et al 2019[55] categorise emissions reduction areas. Bergqvist et al 2019[56] covers a range of green port actions, including hinterland strategies, stakeholders, and incentive schemes, Alamoush et al 2021a assess port policy options[57]. Christodolou et al 2019[58] and Poulsen 2018[59] and look at prioritisation methods. Alamoush et al 2021b make broader links between port sustainability and the UN Sustainable Development Goals[60]. Azarkamand 2020[61] set out carbon footprinting methodologies and provide a bespoke footprinting tool. Cammin et al 2020[62] focus on smart ports and the need for greater and better data collection and management systems. Roy et al 2020[63] focus on factors in design and operation of smart-grids, Sadiq et al 2021[64] review port electrification options.

2) Categorising areas and measures for emissions reduction

Main areas for emission reduction:

Area	Category	Ownership/"scope" (S1,S2,S3)
Land-side	Mobile equipment (gantries, cranes, forklifts)	Port-owned (S1)
		Tenant-owned (S3)
	Buildings	Port-owned (S1)
		Tenant-owned (S3)
	Energy generation and storage assets (solar PV, wind, batteries	Port-owned
		Tenant-owned

On the water	Vessels at berth	Port-owned (S1)
		Non-port owned (S3)
	Vessels in transit/manoeuvring in port	Port-owned (S1)
		Non-port owned (S3)
	Vessels at sea	Port-owned (S1)
Hinterland	Vehicles using port (HGVs/cars/rail)	Non-port owned (S3)
		Port employees' vehicles (S3)
	Source of electricity	S2

Main actions for emissions reduction:

Category	**Action**
Land-side mobile equipment	Switch to electric/hybrid Use lower-carbon fuel eg HVO Energy harvesting (eg crane braking)
Buildings	LED lighting throughout the port Energy efficiency measures in buildings
Vessels at berth	Provision of shore-power
Vessels in transit/manoeuvring	Speed restrictions Reducing turn-around times Just-in-time berthing/efficient vessel handling Green vessel port dues incentive schemes
Hinterland	Support modal shift of freight eg to rail Provision of EV charging points Truck congestion reduction measures Minimum emission standards/incentives for HGVs/vehicles Employee travel plans Port vehicle procurement
Energy assets	Renewable power generation Battery storage Smart-grid power/energy management systems
Management	Comprehensive emissions and energy inventories Setting targets and strategies, with public reporting Resilience/adaptation planning Decarbonisation clauses in tenant contracts
Integration	With nearby industry (re CCS, offshore wind, hydrogen) With city authorities eg re wider air pollution strategies Circular economy initiatives Port procurement policy Sourcing of electricity Contribution to other goals (Just transition, biodiversity) Engagement with shipping operators, other ports, regulators re wider policy changes to support maritime decarbonisation Participation in pilot projects around provision of alternative fuel infrastructure

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