Ports of the Future, Keys for Change

Ports Position Paper



SEAS AT RISK

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Executive Summary

Ports are essential to Europe's economy and its connection to the rest of the world. EU ports handle around 3.4 billion tonnes of goods each year, account for around 74% of the EU's external trade and support more than 423 000 direct jobs.

But ports are more than gateways for goods. They sit at the intersection of shipping, energy, industry, transport and marine ecosystems. Decisions made in and around ports therefore have consequences far beyond their perimeter.

This central role also creates significant environmental pressures. Ports are hotspots for air, water, noise and light pollution, while infrastructure development and growing cargo and energy needs place increasing pressure on coastal and marine ecosystems. As ports adapt to the energy transition, demand for new infrastructure and limited coastal space will intensify these pressures unless development is well managed.

Why are ports a hub for change?

The same characteristics that concentrate environmental pressures in ports also make them powerful levers for change.

Because shipping, industry and trade converge in ports, actions taken there can accelerate change across the entire supply chain. Ports can help drive cleaner shipping, the uptake of zero- to near-zero and renewable fuels, improve the circular use of goods and resources, and protect and restore the coastal and marine ecosystems on which communities and economies depend.

What does a clean port really mean?

A clean port is not just a port with lower emissions.

A true, clean port protects and restores its waters and ecosystems around it. It reduces air pollution, underwater and airborne noise, and harmful artificial light. It accelerates the need to shift away from fossil fuels while using energy, land and materials efficiently. It also provides a safe, healthy and accessible place for workers and communities.

This requires particular attention to space. Alternative fuels, renewable energy, industrial activity and growing cargo are all competing for increasingly limited space around the port. The energy transition must not become a new justification for expanding into fragile coastal ecosystems or weakening environmental safeguards. Ports must first make better use of existing space, cooperate with neighbouring ports and actively contribute to restoring biodiversity and natural marine habitats.

Ports and system thinking

Ports cannot become sustainable if they are treated as isolated infrastructures.

Every port is interconnected in wider systems: the natural systems of estuaries and coastlines, global shipping and trade routes, energy and industrial systems, and the network of regional ports they operate within.

Ports cannot become sustainable if they are treated as isolated infrastructures.



A systems change approach creates exciting, new opportunities for ports. Something that individual ports cannot do alone. Ports can cooperate rather than duplicate infrastructure, specialise according to regional needs and environmental constraints, and pool investment in renewable energy and bunkering capacity. This can reduce pressure for unnecessary expansion whilst strengthening competition.

This would, therefore, go beyond making individual ports cleaner. European policy should enable ports to be the drivers of a wider transition across shipping, industry and energy transition.

Four priorities for sustainable European ports:



1. Make ports climate-neutral

Use ports to accelerate the decarbonisation of shipping and port operations through electrification, the uptake of wind propulsion vessels, energy efficiency, and genuine zero- to near-zero emissions, while avoiding dependencies on fossil fuels and their infrastructures.



2. Make ports clean and biodiverse

Protect and restore port waters, while systematically reducing air, noise, and light pollution. Port development should prioritise nature-positive planning, better use of existing space and ecosystem restoration over expansion into fragile coastal and marine habitats.



3. Make ports circular hubs

Turn ports into hubs for circular resource use by improving the reuse of materials, energy and waste streams within ports and enabling industrial symbiosis with surrounding cities, industries and regions.



4. Put safety and people at the heart of ports

Ensure that the transition towards sustainable ports improves conditions for workers and surrounding communities. Ports should be safe and healthy for their workers, while port development should reduce environmental burdens on neighbouring communities and give people a meaningful role in decisions taken that affect their coastline and quality of life.

Introduction

For centuries, ports have served as vital hubs of commerce, production and employment, connecting global trade flows and enabling the movement of goods, energy and materials that our entire economies currently depend on.

As the EU Ports Strategy, adopted in March 2026, highlights, ports handle around 74% of the EU's external trade, 3.4 billion tonnes of goods and nearly 395 million passengers each year, while supporting more than 423 000 direct jobs. Beyond their logistical role, ports also host major industrial clusters, making them multifunctional hubs.[1] This strategic role gives ports considerable influence over the direction of the transition to a sustainable and decarbonised future, but also a responsibility to ensure that the transition serves climate, nature and people.

It is time to acknowledge that the port model that has developed over the past decades - based on continuous economic and spatial growth, competing for cargo flows and (fossil-fuelled) industrial activity - has reached its limits. Ports are hotspots of air, water, noise and light pollution, and the pressures placed on natural and urban environments extend well beyond port perimeters. They are major sources of greenhouse gas (GHG) emissions, both from shipping and from the industries they host, while continued fossil fuel investment locks in emissions for decades. Most ports sustain ever-growing material flows, reinforcing a linear economic model based on extractive industrial activity that is opposed to the circularity and absolute reductions in energy and material use our societies urgently need, to halt ecological overshoot and GHG emissions.

Yet, because ports are so central to our societies they also hold the key to changing course. As key leverage points in our energy, material and trade systems, ports can become leading forces in many transitions now underway, helping steer our economies back within planetary boundaries. While every port is different, with its own context, challenges and operations, this paper describes common issues and puts forward both broad and specific recommendations, with a focus on European seaports. Four thematic areas structure the recommendations: climate-neutral ports, clean and biodiverse ports, circular ports, and safe and just ports. These four themes can be mapped onto planetary boundaries currently under acute strain: climate change, biodiversity loss and novel entities, biogeochemical flows, and the social foundations any transition depends on.

Across all four themes, the vision is guided by recurring principles, including the reduction of unnecessary material and energy throughput; the repurposing of existing infrastructure before expanding; the prioritisation of zero-emission and circular activities over fossil-based ones; and the protection of workers, communities and ecosystems.



A climate-neutral port

As the latest IPCC report confirms, human-caused climate change is leading to widespread adverse impacts and damages to people and nature, with coastal geographies and vulnerable communities being affected disproportionately.[2]

While the 1.5°C target of the Paris Agreement is has become difficult to meet, every reduction in emissions counts to limit further warming and align with other climate frameworks, such as the EU's Fit for 55. Ports are uniquely positioned to act: even amid unclear international commitments, their local governance and direct influence over infrastructure and energy supply make them critical enablers of GHG emission reductions and the decarbonisation of the shipping sector.[3]

Decarbonised shipping

Today, shipping is responsible for about 3% of all the anthropogenic carbon emissions – comparable to a major industrialised country like Germany or Japan – and 12% of total transport-related CO2 emissions – about the same as aviation. As global shipping activity grows, absolute GHG emissions continue to rise, now 9.6% higher than a decade ago.[4] Ports have valuable keys in hand to drive efforts to cut CO2 and other potent climate forcers, including black carbon and methane – a strong GHG released from LNG engines and carriers.

Recommendations:

1. Energy demand reduction and efficiency measures must be first and foremost in efforts to reduce shipping's climate impact. Speed reduction is one of the most effective ways, as it is immediately applicable and does not require technological modification. Beyond cutting air pollutants, underwater noise and collision risk, slower speeds save fuel: a 10% and 20% reduction in ship speed can lower CO2 emissions by approximately 13% and 24% respectively. Ports should incentivise this, through priority berthing or reduced port fees for ships maintaining reduced speeds across their itinerary, and by implementing shared Just In Time (JIT) arrival systems, letting ships sail slower instead of waiting for a berth.[5]

2. Alongside efficiency measures, wind propulsion is another effective way to decarbonise the global shipping fleet: wind-assisted propulsion systems (WASP) could contribute up to a third of IMO's 2030 GHG target.[6] It also reduces the need for fuel storage and handling infrastructure, easing spatial pressure on ports. Ports can accelerate adoption by adapting logistics (air draft limits, crane configurations) and port fees, offering berth priority and eventually integrating wind readiness requirements into future standards. To reinforce the sector and its ecosystem, they should attract and support enterprises and shipyards that design, develop and install WASP.

3. Electric batteries and genuinely renewable fuels of non-biological origin (RFNBOs) will play a complementary role where direct energy savings are not sufficient, but they do require significant infrastructure adaptation. Since RFNBO deployment adds further spatial pressure on already constrained port areas, repurposing existing assets must be prioritised over new development, with strict safeguards against port expansion. Infrastructure deployment should be coordinated across the EU port network to ensure complementarity, with ports required to develop strategic plans aligned with European climate targets and fuel regulations. Special attention must go to abating nitrogen emissions from new fuels, like hydrogen and ammonia, as well as ammonia leakage.

4. Continued investment in fossil fuel terminals and infrastructure undermines the energy transition and must urgently be halted. Ports should develop fossil fuel phase-out plans, covering their own activities and those of tenants and associated industries, with clear timelines for ending handling, storage and bunkering activities of heavy fuel oil, followed quickly by other fossil fuels such as marine diesel oil, marine gas oil and LNG. They should be coordinated with national action plans and aligned with the Paris Agreement targets.

Beyond fuel and infrastructure transitions, ports can achieve further GHG emissions reductions through smarter operations and cross-port collaboration, such as green shipping corridors with other ports, prioritising reduced speeds, wind power and renewable-based shore power. To avoid these corridors remaining isolated showcases, they must ultimately be scaled up across the wider port network.



The port of Rotterdam

Decarbonised ports

Over 6% of Europe's maritime GHG emissions occur during port operations, with the majority originating from vessels at berth.[7] Associated road and rail transport represents around one-fifth of the carbon emissions in ports, while a smaller yet significant share comes from port operations themselves – including equipment such as cranes, straddle carriers and port vessels.[8] Additionally, many ports host carbon-intensive industries that further contribute to overall emissions. By implementing the right measures and supporting research and innovation, ports worldwide can substantially reduce these emissions and lower their carbon footprint.

Recommendations:

1. In 2023, vessels at berth emitted an estimated 8.3 million tonnes of CO_2 in European ports alone.[9] To tackle this major source of GHG emissions, ports should build out electric grids and accelerate the deployment of standardised Onshore Power Supply (OPS) systems. In the EU, better legal frameworks (like the Alternative Fuels Infrastructure Regulation) and financial frameworks (like earmarked Multiannual Financial Framework funding) are needed both to meet the current OPS requirements and to expand them to a broader range of ships. The Electrification Action plan announced in the EU Ports Strategy should address grid congestion, permitting and OPS pricing. However, this must not come at the expense of nature. As recalled in the Ports Strategy, the Commission's Grids Package proposes to presume that grid infrastructure is of 'overriding public interest', but this risks greenlighting projects despite negative effects on protected habitats and species, and in some cases without a dedicated environmental assessment.[10]

2. Onshore port equipment is a significant source of emissions, with container handling equipment (CHE) alone generating 10-15 million tonnes of CO_2 annually worldwide.[11] To cut these emissions, ports must rapidly electrify equipment – including straddle carriers, cranes, and terminal tractors – optimise terminal layouts and invest in electric grid capacity. Equally, ports must cut emissions by electrifying their own fleet wherever feasible. For heavy duty vessels such as tugs or work boats, whose energy demands quickly exceed battery capacities, locally produced e-fuels offer an alternative.

3. Port electrification requires both grid upgrades and a reliable energy supply. With their large open spaces and coastal locations, ports are generally well-positioned to generate significant renewable energy. By incentivising the installation of solar panels on roofs and unused land, deploying wind turbines wherever feasible, and supporting research on tidal energy production, ports can harness this potential.[12] At the same time, ports must rethink their hinterland connections: electrifying trucks, shifting cargo to rail and clean inland waterways, and expanding intermodal terminals can substantially cut transport-related emissions while easing congestion.

A clean and biodiverse port

Historically, ports have been centres of both commerce and pollution. In ancient and medieval times, waste from people, animals, sewage systems and crafts contaminated the waters of port cities, bringing diseases like cholera, typhoid and plagues.

Later, during industrialisation, coastal development, coal smoke, oil spills and chemical effluents from factories and ships turned ports into heavily polluted zones, destroying coastal habitats and resulting in major loss of marine life in ports and estuaries.

While the types, sources and intensity changed throughout time, ports have remained hotspots of pollution. The latest ESPO Environmental Report shows that even in 2026, air quality, water quality and port waste ranked among the top environmental issues for European ports.[13]

Healthy waters

With 80% of EU sea waters flagged as 'problem areas' in a recent EEA study on marine pollution, ports emerge as critical pollution hotspots.[14] The One Planet Port Vision Report found that none of the surface water around the Port of Rotterdam currently meets EU ecological standards, with open-loop exhaust gas cleaning systems alone responsible for the large majority of all ship-based water discharges.[15] Ship-source contamination more broadly includes fuel leaks, release of toxic chemicals from ship hulls, underwater noise, and the discharge of residues. Land-source pollution adds chemical industry discharges, sewage and thermal pollution, while dredging and new port infrastructure further degrade water quality, blue carbon ecosystems and marine habitats.[16],[17]

Recommendations:

1. EU port waters fall under two directives, each with gaps. The Water Framework Directive (WFD) covers estuaries and nearshore coastal waters, but not pressures such as underwater noise, litter and invasive species. The Marine Strategy Framework Directive (MSFD) covers coastal waters only for aspects the WFD does not address, and assesses Good Environmental Status (GES) at marine-region scale, which rarely reflects port conditions. Yet port waters are part of the wider marine ecosystem, and shape whether GES can be achieved. Member States should therefore include port waters in MSFD monitoring and measures, with targets for the pressures the WFD misses. For estuary ports, which the MSFD does not cover, WFD river basin management plans should address these pressures.

2. Exhaust gas cleaning systems (otherwise known as scrubbers) are used on vessels to remove SOx emissions from ships' exhausts. By spraying seawater into the exhaust gas stream, open loop scrubbers catch air pollutants and discharge them into the sea, harming marine life. In line with a 2025 OSPAR decision for internal waters and port areas in the North-East Atlantic Ocean, ports in all EU regions should ban the discharge of scrubber wastewater in port areas.[18],[19]

3. While renewable ammonia continues to be proposed as an alternative fuel to decarbonise shipping, its reactive nitrogen footprint must be addressed alongside its carbon benefits. Bunkering ammonia in ports would introduce a new source of reactive nitrogen into waters and airsheds already under high nitrogen stress.[20] Ports adopting ammonia should therefore require lifecycle nitrogen accounting, mandate leak detection and vapour recovery, and apply the same no-discharge, onshore-treatment logic as for scrubber wastewater to all nitrogen-bearing effluent, including tank cleaning residues and purge water.

4. Hand in hand with the protection and regeneration of natural areas in ports, small-scale nature-based solutions can also contribute towards restoring biodiversity in port waters. Installing living seawalls instead of flat concrete quays and biogenic reefs, for example mussels and oyster beds, supports marine life while also providing ecological services such as erosion reduction and wave energy absorption. Floating wetlands can further improve water quality by absorbing excess nutrients, while surface textures and sloped seawalls can be used in new port construction to support the settling of native marine species.[21]

Beyond these, water quality in and around ports faces many additional threats that require urgent action: the introduction of invasive species through ballast water discharge, the leaching of toxic biocides from antifouling coatings, discharges of emerging contaminants like pharmaceuticals and microplastics from industrial sites and shipyards, poorly regulated stormwater runoff, and dredging operations that resuspend sediments and pollutants into the water. Stricter standards, a phase-out of biocide-based antifouling, nature-based stormwater management and environmentally sensitive dredging practices must be put in place to address these pressures.

Clean air

Air pollution is a persistent issue in port environments. A recent EEA briefing based on 2021 and 2023 data shows that, after two decades of decline, NOx (nitrogen oxides) emissions in ports are on the rise again, and particulate matter (PM) concentrations are still remarkably higher in port areas compared to



surrounding regions. Shipping is even projected to become the main source of transport-related air pollution in coastal cities by 2030, directly raising cardiovascular and neurological risks for port workers and nearby communities.[22] While shipping is generally the largest source of NO2 emissions in ports, other sources – such as road transport – also play a significant role.[23]

Recommendations:

1. Ships at berth and diesel-powered port equipment are major sources of local air pollution. In US ports alone, a staggering 27 000 tonnes of combined air pollutants is estimated to come from berthed vessels annually, contributing to 15-30% of local NOx levels and 10-20% of PM.[24] A fast buildout of OPS, replacing onboard fossil-based energy production with grid electricity, can significantly improve air quality. In addition, diesel-powered tugs, pilot boats, straddle carriers, cranes and terminal tractors should be replaced with electric or e-fuel versions. More efficient terminal layouts, including automated stacking cranes, can cut energy use and emissions further.[25]

2. The EU Emissions Trading System (ETS) exemption for smaller vessels leaves a significant share of port-city shipping traffic - including many short-sea, feeder and inland-adjacent vessels - outside its emissions pricing coverage, even where these vessels contribute meaningfully to local air pollution and public health burdens in port cities. This exemption gap should be closed, or accompanied by equivalent local air quality measures, so that vessel size does not determine which port-city residents are protected from shipping-related air pollution.

Beyond shipping and port equipment, several further sources of air pollution in ports demand urgent action. Inland vessels must equally be incentivised to transition to zero-carbon fuels or battery power. Road transport - sometimes surpassing international shipping in local NO2 concentrations - must be tackled through electrification and a modal shift to rail and clean inland waterways.[26] Industrial activities require strict emission standards on dry bulk handling, chemical cargoes and other harmful port operations.

Darkness and silence

Today, ports are also major hubs of light and noise pollution. Light from industrial sites can disrupt nocturnal wildlife, while their sound pressure affects the surrounding fauna and urban environment.[27] Additionally, the shallow and busy waters in and around ports result in high levels of underwater radiated noise (URN), disturbing marine mammal communication and leading to overall habitat degradation and biodiversity loss.[28]

Recommendations:

1. Underwater radiated noise (URN) is strongly linked to vessel speed: steaming at 75% of maximum design speed during the whole travel can already cut URN by up to 40%.[29] All vessels in port waters, including access channels and the outer port zone, should navigate at a maximum of 10 knots or minimum steering speed.[30] Ships should also be incentivised to adopt other URN-mitigating measures, such as optimised controllable-pitch propellers, with priority berthing for ships travelling at reduced speed or holding a quiet-vessel notation. Ultrasonic antifouling, which can cause permanent hearing damage to marine mammals, needs to be banned.[31] Ports should be required to systematically monitor and record vessel underwater noise using recognised international methods, feeding into a shared EU-level register to track pressures and support progress toward GES under the MSFD.[32]

2. Industrial sites, cargo handling, ships at berth, and road and rail transport are all significant sources of terrestrial noise pollution in ports, with sound levels frequently exceeding 90dB(A) - high enough to cause lasting harm to workers and nearby communities.[33] Addressing port noise pollution requires a combination of measures, including onshore power supply systems, quieter machinery, natural noise barriers around cargo areas, strict industrial emission standards, and night-time restrictions on the loudest activities.[34]

3. To combat light pollution in ports and reduce disturbance to birds, bats and marine wildlife, better regulation at EU and international level is needed. Clear light pollution measures will enable ports to implement coherent mitigation plans that combine technological solutions, such as shielded and adaptive lighting, with strategic measures like regulating blue-light illuminance and establishing dark corridors within port perimeters.[35]

Beyond vessel traffic, dredging and other port infrastructure works are also significant sources of underwater noise. Their impact should be mitigated through technical noise-reducing measures and by scheduling activities outside breeding and migration seasons for sensitive species.

Thoughtful planning

Space in ports is limited and will tighten further as more infrastructure for alternative fuels, with lower energy densities and higher storage and handling complexities, is introduced alongside existing fossil fuel infrastructure. This spatial pressure can drive port expansion into surrounding socially constrained inland zones or natural environments, fragmenting habitats and creating migration barriers for migratory species, especially fish. Additionally, inter-tidal habitats in estuaries and around ports are very sensitive and serve as carbon sinks. Their loss has serious implications for the biodiversity of the whole area.[36]

Recommendations:

1. Port expansion on fragile coastal ecosystems, such as wetlands, salt marshes, seagrass meadows and benthic habitats, is incompatible with binding EU biodiversity and nature restoration goals, as well as EU environmental law like the Birds and Habitats Directives. While the EU Ports Strategy treats ports as expanding multifunctional hubs, a policy shift away from default port expansion towards thoughtful port planning is urgently needed: capacity growth and fast permitting must not become a route into fragile habitats. Instead, strategic spatial decisions must prioritise brownfield redevelopment, co-usage of existing assets and cooperation with other ports in the region.

2. Every port is unique. Port spatial planning must consider the broader natural systems in which ports operate and protect the ecosystem functions they depend on, such as river dynamics. Lower estuary ports can play key roles in global trade, but ports in upper estuaries often entail high maintenance costs to counter natural sedimentation and cause significant ecological harm, including damage to blue carbon storage. Their long-term relevance should be critically assessed.[37] Within their boundaries, ports must boost biodiversity by dedicating and reconverting large spaces to biodiversity-rich areas, light- and noise-free zones and ecological corridors. Where feasible, green corridors can support sustainable mobility links between port and city, and swimming areas can reconnect communities with the waterfront.

3.

European port planning must be considered within Maritime Spatial Planning (MSP) to ensure coherence with the EU's climate, energy and biodiversity objectives, as well as with other sectoral policies, such as fisheries and aquaculture. Port expansion projects should always be subject to relevant environmental assessments, including Environmental Impact Assessments (EIAs) in line with the EIA Directive and, when the project has impacts on a Natura 2000 site, Appropriate Assessments in line with the Habitats Directive. To inform these assessments with qualitative data and close current knowledge gaps, ports need transparent monitoring and standardised reporting.[38]



A circular port

While operational impacts are substantial, the largest share of a port's environmental impact stems from the industrial activities it hosts, including refineries, steel producers, chemical plants and other heavy industries.[39]

Companies within the Port of Rotterdam alone directly emit around 20 Mt of CO_2 each year - nearly 15% of the Netherlands' total.[40] In Belgium, the industrial cluster of the Port of Antwerp-Bruges represents more than 10% of national annual CO_2 emissions. To turn the tide, ports must promote a circular economy sector that reduces unnecessary material throughput and builds on local supply chains.

Internal symbiosis

Ports have the power. Through concession policies, they shape the industrial profile of their own port area and the surrounding region. Moreover, as most ports have a majority of public shareholders, they carry the responsibility of ensuring that activities operate in the broader interest of society. By actively promoting more sustainable forms of economic activity, such as circular economy activities, ports can strengthen internal industrial symbiosis and take up their responsibility.

Recommendations:

1. Today, ports are still largely structured around linear supply chains. Recent academic research on European ports shows that the implementation of circular economy practices remains "moderate to low".[41] By attracting more circular economy-focused concessions and by connecting resource and energy streams - such as chemicals, mineral and organic waste, wastewater, and also heat - between different port activities, ports can leverage their unique position at the node of flows. Shipyards play a particular role in this transition: adopting high recycling standards for ship recycling facilities worldwide helps accelerate the circular port economy, decarbonise the steel sector and strengthen material autonomy.

2. To recycle waste streams from ships, every port must be equipped with effective port reception facilities (PRFs), capable of collecting and treating all ship-generated waste, including oily and noxious liquid substances (MARPOL Annex I & II), sewage (Annex IV) and garbage including plastic waste (Annex V). Despite existing obligations under both MARPOL and the EU PRF Directive, compliance and enforcement remain inconsistent: estimates suggest that around 10% of sewage that should be delivered onshore is never received by PRFs and may be discharged illegally.[42] Ports must ensure their facilities are adequate, accessible and actively used, with rigorous Port State Control enforcement to close these gaps.

3. The offshore renewable energy (ORE) sector is rapidly expanding its footprint in ports, serving as a critical hub for the manufacturing, assembly and maintenance of wind turbines. As turbines increase in size, ports need more space to handle larger components. To accommodate this growth, ports must prioritise concessions for renewable energy activities over fossil industries, repurposing existing infrastructure – including former fossil fuel terminals – where possible. The spatial growth of ORE must, however, never become a justification for port expansion into urban areas or ecologically sensitive coastal environments.

4. The EU plans a rapid scale-up of carbon capture and storage (CCS), aiming to store 280 million tonnes annually by 2040.[43] The infrastructure required for capture, storage and transport will however place additional spatial pressure on ports, where CCS risks prolonging fossil-based industrial activities and blocking real decarbonisation. Ports should not allow CCS infrastructure that delays fossil fuel phase-out or crowds out space needed for genuine zero-emission, circular and nature-positive activities. Any CCS-related development should be subject to strict public-interest tests, as well as full climate and environmental scrutiny.

External symbiosis

Ports do not operate in isolation. They exist alongside urban areas, local economies, and networks of industries and other ports. By engaging more with these external contexts, ports can create forms of symbiosis beyond their boundaries, generating value for the surrounding communities and the ports themselves.

Recommendations:

1. While ports operate in global economies, there is much to gain by investing in the local economy as well. Ports sit at the intersection of material, energy and logistics flows, making them natural anchors for circular urban economies. By connecting port industries with city waste streams – turning urban waste into biogas, recirculating wastewater, or feeding secondary materials back into local production – ports can shorten supply chains, reduce resource dependency and create local employment. Ports must actively develop such city-port symbiosis through their concession and investment policies, treating the adjacent city as both a supplier of materials and a market for circular products.[44]

2. Heat networks are another powerful way to leverage the proximity of ports and cities. Large port industries generate vast amounts of waste heat that is currently lost to the atmosphere or discharged into waterways. By recovering this heat to supply nearby homes and businesses, ports can drastically reduce CO_2 emissions of urban areas while lowering household heating costs. Projects such as the Antwerp North Heat Network illustrate the potential: when fully realised, this network could reduce CO_2 emissions by around 80 000 tonnes per year.[45] Port authorities must actively facilitate and incentivise heat recovery as part of their concession and energy strategies.

3. Ports often compete for the same cargo flows and investments, driving overcapacity and undermining environmental ambition. Rather than competing, ports should collaborate and develop complementary specialisations – particularly for the fuel transition, where building infrastructure for every alternative fuel at every port is neither financially nor spatially feasible. Port policies must therefore actively facilitate structured collaboration, moving from isolated competition towards complementary, networked port systems.



The port of Antwerp

A safe and just port

While ports are essential hubs for climate action, biodiversity and economic activity, they are also fundamentally human environments.

In Europe alone, around 200 million people live in coastal regions, often in close proximity to port activities, and in 2022, the European port activities sector employed 423 000 people within port perimeters.[46] Ensuring that ports are safe and just places to work and live alongside is therefore a core condition for any future-proof port.

Safety first

Exposed both to the forces of nature and the inherent dangers of industrial activities, ports have always been environments with elevated risk. Even today, safety challenges remain significant: dock work is considered as a high-risk sector, with injury and fatality rates well above the EU average. Improving safety should never be optional and must prevail at all levels: for port workers, but also for port communities and the marine environment.

Recommendations:

1. According to a recent study, over 500 fatalities have been registered in ports worldwide since the beginning of the century.[47] In Flanders alone, around 1000 work accidents are still reported every year in the port sector.[48] Beyond physical injury, port workers are also disproportionately exposed to air and noise pollution, with long-term health consequences that remain poorly monitored. Port workers globally have a right to safe working conditions and should be protected by the highest safety standards, as mandated by the International Labour Organisation (ILO). This includes rigorous inspection, mandatory safety training and enforceable health and exposure limits.

2. Ports play an increasingly important role in protecting coastal zones from flooding, storms and sea-level rise. While protecting workers and nearby communities is essential, hard engineering solutions such as seawalls should be limited, with priority given to soft and nature-based solutions working with natural coastal processes like sediment-trapping wetlands. All measures taken should be part of an integrated coastal zone management approach. In the most vulnerable areas, port space should be returned to nature.

3. Port safety also means reducing vessel collisions. Up to half of maritime accidents occur in port and terminal areas, driven by narrow and shallow waterways and increasing ship sizes.[49] In addition, tens of thousands of marine mammals are estimated to be injured or killed annually by vessel strikes, with port waters and approaches among the highest-risk zones. Collision risk is highly speed-sensitive: a 10% reduction in vessel speed cuts lethal whale strike risk by around 50%, and 20% by nearly 80%.[50] Ports should therefore cap speeds at 10 knots in outer harbour waters, and develop incentives for ships following routing measures designed to reduce the collision risk with marine mammals.

4. Ports play a critical role in different forms of organised crime. This includes drug trafficking, but also increasingly illegal wildlife and plant trade, like live animals, ivory and protected timber.[51] In line with IMO Guidelines, port facility security plans should be reviewed and, where appropriate, adjusted to enhance efforts to prevent and suppress wildlife smuggling, including closer cooperation between customs authorities and environmental agencies.

People's ports

The port of the future belongs to the people. Ports rely on workers - often drawn from surrounding communities - and shape the lives of local residents, yet these voices are often missing from decision-making processes. Additionally, as the sector undergoes major transitions, the risk of job displacement is real and unevenly distributed. Ensuring fair working conditions, supporting workers and strengthening social equity through social dialogue is essential.

Recommendations:

1. Port workers worldwide must benefit from decent, fairly and equally paid and secure employment, with strong social protection and the right to collective bargaining through trade unions. Working conditions should ensure access to health support, including dedicated mental health services. Women and other underrepresented groups should be able to build careers in ports, free from discrimination and harassment. As automation and the energy transition reshape port work, workers must also have access to training, re-skilling and upskilling – and be actively involved in shaping the transition pathways that affect jobs.

2. Ports must be governed in the interest of society, through transparent and democratic social dialogue and decision-making. This is particularly important where port authorities are publicly owned or publicly mandated, as decisions on concessions, land use and infrastructure can lock in economic models for decades. Ports therefore carry a responsibility beyond commercial performance: port workers, trade unions, civil society and local communities should be systematically involved in port governance, including representation on boards of directors, and must have equal access to information and meaningful participation in decisions, including public-private investments, redevelopment and climate adaptation projects.



Conclusion

Ports are under pressure. Environmentally, they remain hotspots of air, water, noise and light pollution, while contributing significantly to GHG emissions through shipping, industrial activities and hinterland transport. The energy transition is adding new demands on already constrained port areas, risking further encroachment on fragile coastal ecosystems. Economically, competition between ports drives overcapacity and undermines the ambition needed to support the transition. And meanwhile, port workers and nearby communities continue to bear the greatest burden, living with pollution and its impacts on their health and quality of life.

Yet ports are also uniquely positioned to lead change. With the right policies in place, ports can dramatically improve local air and water quality and reverse their impact on surrounding ecosystems. They can become active drivers of shipping decarbonisation and the energy transition more broadly, while ensuring that transition does not come at the expense of the surrounding natural habitats. They can move beyond linear throughput models to become anchors of circular regional economies, connecting material and energy flows between industries, cities and supply chains. They can ensure the transition is just, by guaranteeing safe and decent work and involving port workers and communities in the decisions that affect them.

But none of this happens in isolation. By definition, ports are nodes in a wider system, whether a global trade system, a regional network of ports, or a living system of estuaries, coastlines and marine habitats. Strategic decisions on fuel infrastructure, spatial planning, industrial concessions or port expansion can therefore not be made well by individual ports alone. Cooperation and specialisation, guided by ambitious policies and holistic strategies, are essential: they empower ports to meet their responsibility towards society and become drivers of the most important transitions of our time.

Endnotes

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