Nordic Energy Research

Governing Strategic Port Capacity for Nordic–Baltic Energy Resilience

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Abstract

The Nordic–Baltic energy transition increasingly runs through its ports. Offshore wind, electrification, alternative maritime fuels and CO_2 infrastructure are expanding their role in the regional energy system, while geopolitical tensions are placing new demands on the same infrastructure for preparedness and military mobility. As ports take on functions whose value extends beyond their commercial operations, the central policy challenge is how to translate their growing system-level criticality into decisions about capacity, investment, priority, redundancy and who bears the associated costs. This brief argues that commercially oriented port governance remains important for allocating scarce land and capital but may underprovide capabilities whose benefits accrue to the wider energy and security system. Nordic–Baltic resilience therefore requires complementary capabilities across the region, deliberate redundancy where disruption would create critical vulnerabilities, and public mandates and finance that reflect the system-level value of strategic port capacity.

Key messages

- **Ports increasingly provide system-critical energy, resilience and defence functions whose value extends beyond their commercial operations.**
- **Regional resilience requires complementary port capabilities alongside targeted redundancy where critical functions cannot be readily substituted.**
- **Strategic capacity requires public mandates and finance where its system-level value is not captured by commercial incentives.**

The overlooked infrastructure of the Nordic–Baltic energy transition

The Nordic–Baltic energy transition is unfolding at sea. Around 60% of energy comes from the sea—whether generated offshore, produced through offshore oil and gas infrastructure, or transported by sea—underscoring how deeply energy security remains tied to maritime infrastructure. Decarbonisation is not diminishing this dependence. It is changing its composition while, in important respects, intensifying it. Oil and gas continue to move through maritime supply chains and offshore installations, even as offshore wind, electricity interconnectors and other subsea infrastructure expand. Shipping itself must decarbonise, requiring ports to accommodate new fuels, bunkering systems, storage facilities and safety requirements alongside existing cargo and energy flows. Ports sit at the centre of this transformation: they connect maritime energy flows to land, service offshore installations, enable the construction and maintenance of new energy assets, and increasingly accommodate new fuels and CO_2 value chains.

This matters particularly in the eight Baltic Sea region (BSR) countries—Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany— where these demands are accumulating across an interconnected system of commercial seaports with energy, logistics and strategic functions spanning both the Baltic and North Sea basins. Maritime decarbonisation adds a further infrastructure challenge: FuelEU Maritime requires the greenhouse-gas intensity of energy used by ships to fall by 2% from 2025 and progressively by 80% by 2050, increasing demand for alternative-fuel and energy infrastructure at ports. Fleet investment is already creating new infrastructure requirements: by the end of 2025, 47% of global orderbook tonnage was alternative-fuel capable, although liquefied natural gas (LNG) still accounted for 80% of this segment. The emerging fuel mix nevertheless extends beyond LNG, with 323 methanol- and 45 ammonia-capable vessels on order, while corresponding bunkering infrastructure remains much less developed. This mismatch reflects a broader supply constraint: only 9% of the announced low-emissions hydrogen project pipeline—a key feedstock for green fuels—to 2030 had reached final investment decision.

Offshore wind illustrates the scale of these infrastructure demands but represents only one component of the wider transformation. Taken together, current targets and planned projects across the eight BSR countries point to roughly 35 GW[1] of additional offshore-wind capacity by 2030. Its expansion requires heavy-load quays, substantial storage and assembly areas, specialised vessels, offshore expertise and long-term operations and maintenance capacity, driving major port adaptation from Rønne and Esbjerg to Paldiski and Ventspils. Subsea cables and interconnectors also depend on ports for installation and, crucially, rapid repair. Oil and gas infrastructure continues to require servicing, while LNG terminals and associated maritime supply chains have acquired renewed importance for regional energy security. Fuel uncertainty is itself an infrastructure challenge. Ports must commit land and

[1] Additional capacity (≥35.1 GW) is the sum of stated planned additions; for Denmark, Germany, Poland, it is calculated as the 2030 target minus installed capacity.

capital to storage, bunkering and safety systems before the dominant fuel pathways are known, while continuing to support existing energy flows. Klaipėda captures this layering: green-hydrogen production and refuelling infrastructure are being added alongside its established LNG terminal. Carbon capture and storage (CCS) adds another emerging maritime value chain, requiring captured CO_2 to be aggregated, temporarily stored and transported through ports to offshore storage sites. In Esbjerg, emerging CO_2 infrastructure is being layered onto an established offshore-energy hub, illustrating how new energy functions are accumulating within existing port-industrial systems. These activities are interdependent, but they also compete for finite space, infrastructure, vessels, skilled labour and capital. The transition is therefore not a linear shift from an old energy system to a new one, but the superimposition of new requirements on infrastructure that must continue to sustain existing energy functions throughout the transition.

At the same time, the regional security environment is changing what ports are expected to do. Russia's war against Ukraine, together with Finland and Sweden's accession to NATO, has increased the strategic importance of Nordic–Baltic ports for reinforcement, military mobility and sustainment. This is already translating into substantial dual-use investment across the region: Klaipėda is undergoing a €201 million expansion supporting offshore renewables and Allied military vessels; Paldiski's €64 million multipurpose quay, designed *inter alia* for offshore wind, received €20 million from the EU's military-mobility envelope; and Riga has received EU military-mobility funding for additional port capacity through a new €10.5 million multipurpose icebreaker. Finland received €6.1 million for the electrified Oritkari rail junction, improving military access to the Port of Oulu. These investments form part of a much larger shift: the EU has committed around €1.7 billion, 8% of which covered maritime projects, to 95 dual-use transport projects across 21 Member States, and the funding is expected to increase tenfold to €17.65 billion from 2028. The distinction between civilian and military infrastructure is consequently becoming less clear. Deep-water berths, reinforced quays, storage and staging areas, cranes and hinterland connections required for commercial and energy activity are also critical assets for defence logistics. Militarisation and decarbonisation are therefore increasingly converging on the same physical infrastructure, creating opportunities for dual-use investment but also harder questions over capacity, access, redundancy and prioritisation. Interview evidence suggests that although military operations may resemble commercial port calls in practice, 'priority is not something that can be negotiated with NATO.'

This convergence places growing pressure on port capacity across the region, but the scope for adaptation is uneven. Ports face a distinctive combination of constraints: waterfront land is scarce and spatially fixed, major infrastructure is capital-intensive and slow to expand, and increasingly specialised equipment and access requirements can limit substitution between ports. These constraints are particularly acute in cities, where port development competes with urban demand for scarce waterfront land. Even ports with greater spatial autonomy face limits: Esbjerg has reached the boundaries of further expansion and increasingly relies on flexible land allocation to accommodate competing uses within its existing footprint. Meanwhile, the growing scale and technical requirements of offshore infrastructure are narrowing the pool of ports capable of supporting its deployment. Institutional constraints

matter too: national frameworks determine whether port authorities may own energy-generation assets or deploy technologies such as drones for offshore servicing. Port capacity is therefore not simply a stock of physical infrastructure, but the ability to mobilise scarce space, specialised assets, investment and regulatory flexibility as strategic demands evolve.

Governing system-critical port capacity

The expanding strategic role of ports has not been matched by an equivalent shift in how they are governed. Although most BSR ports are publicly owned, including Aarhus, Hamburg, Gdańsk and Tallinn, their governance frameworks have largely evolved around commercial and transport functions, with regulation concerned with competition, financial transparency and the division of responsibilities between port authorities and private operators. These models can allocate scarce land and capital efficiently, but what port authorities can invest in, operate or finance varies considerably across national jurisdictions, even as governments increasingly expect them to contribute to energy security, resilience and defence alongside their established commercial functions.

The central tension is therefore not between commercial and strategic ports, but between commercially rational decisions at individual ports and capabilities whose benefits accrue to the wider energy and security system. Spare capacity, strategic redundancy, enhanced security and rapid-recovery capabilities may be difficult to justify commercially where their value lies primarily in avoided disruption or emergency availability. Existing governance frameworks do not consistently determine when such capacity warrants public support, who should bear the associated costs, or who should receive priority when capacity becomes scarce. Interview data suggest that these boundaries are beginning to shift, but with substantial variation.

The key question is whether strategic objectives translate into decisions about where capacity is developed and which uses receive priority. Poland provides the clearest example: although Gdynia was initially designated as the national offshore-wind installation port, concerns over the timely delivery of the required infrastructure led the government to relocate the planned terminal to Gdańsk in 2022, while Świnoujście subsequently emerged as an additional major installation base. Yet strategic importance does not automatically confer priority within the infrastructure systems on which ports depend. Grid capacity makes this tension particularly visible. In Denmark, port electrification can face a sequencing problem: grid expansion depends on demonstrated demand, while constrained capacity can itself limit new electricity-intensive activities. As data centres, battery storage and industry compete for access to an already constrained power system, shortages and long lead times for transformers and other high-voltage equipment further restrict expansion. Decisions over scarce connection and network capacity therefore increasingly determine which activities can develop, where and when, turning allocation into a strategic choice.

The same tension extends to security. BSR countries entered the EU Critical Entities Resilience (CER) regime, which requires Member States to identify critical entities and

strengthen their resilience to disruption, with markedly different national frameworks for identifying and protecting critical port functions.

Table 1. National frameworks for recognising critical port functions in BSR countries

Country	National Framework	Year	Port coverage
Denmark	Resilience of Critical Entities Act	2025	Ports explicitly included; port vulnerability addressed in national assessments since 2005
Sweden	Vital societal functions framework	2008	Ports explicitly included
Finland	Security-of-supply framework	1992	Transport and logistics infrastructure; ports explicit since 2018
Estonia	Emergency Act / vital-services regime	2009	Operation of ports explicitly designated a vital service; omitted in 2017, reintroduced in 2024
Latvia	Objects important to national security	2008	Port facilities explicitly covered; individual designations not public
Lithuania	Enterprises and Facilities of Strategic Importance to National Security	2002	Port and strategic port assets explicitly included
Poland	Crisis Management Act	2007	Transport infrastructure; 11 ports explicitly addressed since 2013
Germany	National Strategy for Critical Infrastructure Protection	2009	Transport and traffic infrastructure; ports explicitly defined with thresholds since 2017

CER therefore overlays markedly different national approaches to identifying, governing and protecting critical port functions. Yet designation does not itself confer strategic priority. Interview data suggest that this distinction is already visible in practice: in Denmark, for example, port representatives noted growing recognition of their critical role without a commensurate shift in government direction or support. Formal recognition matters only insofar as it changes how scarce infrastructure, investment and security resources are prioritised. The governance challenge is therefore not simply to identify critical ports, but to translate their system-level importance into decisions about which capabilities must be maintained, where redundancy is required and who bears the associated costs. Across an interconnected Nordic–Baltic port system, resilience ultimately depends on whether strategic importance translates into capacity that remains available when needed.

From port capacity to regional energy resilience

Uneven port capabilities need not be a regional weakness. Across the Nordic–Baltic region, ports and countries have developed distinct infrastructure, operational experience and expertise that could form the basis of a more complementary energy system. Regional resilience therefore depends on connecting complementary capabilities while maintaining redundancy where critical functions cannot be readily substituted: sharing expertise where it already exists, coordinating investment where infrastructure must function as a network, and ensuring alternatives where disruption at one node could affect energy flows across borders.

Offshore wind shows why regional resilience cannot be reduced to installed port capacity. As turbines and installation vessels increase in scale, the infrastructure required to handle them

is becoming increasingly specialised. Industry experts note that some of the largest installation vessels can access only four European ports. BSR countries host two major heavy offshore-wind hubs, Esbjerg and Cuxhaven, both on the North Sea. Across the Baltic, specialised capabilities are distributed across Rønne, Świnoujście, Gdańsk/Gdynia, Mukran/Sassnitz, Klaipėda, Liepāja, Ventspils, Paldiski and Karlshamn, although their functions, maturity and scale differ substantially. Esbjerg's position, for example, rests not only on quay and marshalling capacity but on an industrial ecosystem accumulated through decades of offshore activity, including specialist firms able to service installation vessels and return them rapidly to operation. A nominally suitable alternative may therefore be unable to reproduce the infrastructure, expertise and operational routines required within a critical deployment or repair window. The relevant question for Nordic–Baltic resilience is consequently not how many ports could theoretically handle offshore wind, but which functions are genuinely substitutable and how quickly alternatives could be mobilised. Nominal capacity may also overstate effective availability where stalled projects leave components occupying scarce quayside and storage space, particularly under landlord models that provide limited incentives to release capacity while lease revenues continue.

Alternative fuels create a different coordination problem. Their viability depends not on individual ports developing the widest possible range of bunkering options, but on compatible infrastructure being available across the routes ships operate. As one interviewee argued, supplying electricity, hydrogen, methanol or ammonia at a major hub such as Hamburg is of limited value if vessels cannot access compatible infrastructure at subsequent ports of call. The transition therefore requires 'collaboration, communication and information-sharing between ports' rather than isolated investment decisions. For the Nordic–Baltic region, this creates a strong case for coordinating investment around shipping corridors and complementary bunkering hubs, reducing the risk of costly duplication in some ports and critical infrastructure gaps in others.

Electrification illustrates how decarbonisation can reconfigure rather than remove infrastructure dependencies. Short-sea shipping is already moving towards electricity, from the fully electrified Helsingør–Helsingborg connection between Denmark and Sweden to battery-electric ferry operations in Finland's archipelagos. Yet deeper electrification also concentrates dependence on the electricity system, potentially exchanging fuel dependence for vulnerability to power disruption. Finland's battery-electric Elektra, for example, retains diesel backup for outages and difficult ice conditions. For ports, resilience may therefore require retaining both storable fuels and the equipment needed to use them, allowing critical operations to continue independently of contemporaneous electricity supply while progressively shifting this reserve capacity towards low-emission alternatives.

Complementarity also requires representation. Interview evidence suggests that the Baltic States remain under-represented in European maritime networks despite their growing strategic importance and expertise. None of the three Baltic States, for example, is currently represented in SEA Europe, the European shipbuilding and maritime equipment association, with Sweden also absent. If Nordic–Baltic resilience is to draw on capabilities and expertise

distributed across the region, the institutions shaping European and regional maritime priorities must also draw on expertise from across that geography.

Securing the maritime energy system

Security is becoming part of what an energy port must provide. As energy systems become more maritime, ports increasingly form the controlled interface between global supply chains and critical infrastructure at sea: equipment is assembled, verified and secured there before deployment, while vessels, personnel and response capabilities remain shore-based. Disruption at this interface can propagate directly into the energy system. Interview data show that a three-day shutdown can exhaust a critical offshore-wind installation window before a specialised vessel must depart; conversely, a vessel sinking in an access channel could immobilise an entire port. Resilience therefore begins with knowing what must be secured against what. Ports face different combinations of physical, cyber, aerial, surface and subsea threats, requiring assessments that identify both which disruptions could disable critical functions and which capabilities are needed to restore them. Criticality can also reside in low-visibility enabling assets. Interview evidence highlights dredging capacity as one example: without rapid access to specialised equipment, disruption to an access channel could render an otherwise operational port inaccessible. The availability, location and rapid mobilisation of such capabilities must therefore form part of resilience planning.

The capacity to manage these threats is as unevenly distributed as the infrastructure itself. Poland and Lithuania illustrate how sustained exposure to geopolitical risk can embed security more deeply into critical-infrastructure governance. In Polish offshore-wind projects, security requirements are legally mandated rather than left to project-level discretion—a distinction that has generated friction with Nordic partners accustomed to greater latitude over security expenditure. Lithuania provides a similar reference point, with interviewees identifying the Port of Klaipėda as a potential benchmark for port preparedness. By contrast, Denmark's high-trust culture has historically been associated with lower threat perception, requiring port security practices to adjust rapidly to a changed strategic environment. As civilian ports increasingly accommodate naval activity, the co-location of military assets, commercial operations and urban areas can create vulnerabilities that established assumptions of port safety may insufficiently capture. These differences create scope for regional learning rather than requiring uniformity: Nordic–Baltic resilience depends on sharing expertise and capabilities from where they are strongest and mobilising them where they are needed, rather than every port developing the same capabilities.

The economics of port security remain poorly aligned with its strategic value. Measures beyond regulatory requirements can be difficult for commercial actors to justify because their benefits largely materialise as avoided disruption, while the consequences of failure extend far beyond the port—from delayed energy projects to interrupted operations and lost revenues. The state therefore has a role in supporting resilience where these system-level benefits cannot be captured commercially, while developers, lenders and insurers can help price the risks that stronger security reduces. Interview evidence suggests one mechanism:



demonstrably stronger protection could eventually translate into lower insurance premiums or more favourable financing conditions, turning resilience from an uncompensated cost into a priced reduction in project risk. As maritime infrastructure becomes more consequential to energy supply, resilience should be valued against the cost of interruption, not the absence of an incident.

Policy priorities

1. **Plan strategic port capacity as a regional system.** Governments should identify which capabilities are critical to Nordic–Baltic energy resilience, where they are concentrated and how readily they can be substituted. Specialised capabilities can be shared where alternatives can be mobilised rapidly, while deliberate redundancy is needed where disruption would create critical single points of failure. Offshore installation and repair capacity should therefore be assessed across the Baltic and North Sea basins and aligned with EU transport and energy planning.
2. **Match strategic responsibilities with public mandates and finance.** Ports cannot be expected to provide all resilience capacity on commercial terms alone. Where governments require spare capacity, reinforced infrastructure, enhanced security or dual-use assets, public support should reflect their system-level value and establish how access is prioritised when capacity becomes scarce. Otherwise, commercially rational investment risks creating an efficient but brittle system in which critical capabilities become concentrated in too few locations.
3. **Build Nordic–Baltic preparedness around complementary capabilities and stronger representation.** Nordic–Baltic cooperation should develop arrangements for accessing specialised infrastructure, expertise, repair and security capabilities across borders, linked to EU resilience priorities and NATO requirements. The region does not need every port to provide every function; it needs distributed capabilities and expertise that can be mobilised when individual nodes fail. Regional and European maritime networks should therefore better incorporate expertise from across the Nordic–Baltic region.