

## INDIA-DENMARK COOPERATION ON GREEN SHIPPING, MARITIME DECARBONISATION, AND ENERGY TRANSITION

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### **Background**

The transition towards low-emission shipping is beginning to alter the foundations upon which maritime economies compete. Each initiative carries forth a consequential wave, reshaping the priorities and requirements of stakeholders across the wider maritime ecosystem. The challenge, therefore, is no longer confined to improving vessel efficiency or replacing conventional marine fuels; ships operating on alternative fuels require corresponding systems of production, storage, transport and bunkering; ports would require new infrastructure and energy connections; regulators, in turn, would require new standards and safety frameworks; and shipping companies would demand better access to finance, technology and commercially viable cargo routes. As these requirements accumulate, this maritime transition increasingly intersects with the wider transformation of interconnected energy, industrial, technological, regulatory, and commercial systems.

These developments have significantly shaped the character of India-Denmark bilateral relations. India and Denmark occupy markedly different positions within the global maritime economy, and it is precisely this asymmetry that gives their emerging cooperation on green shipping its particular significance. Denmark is a technologically advanced European middle power with a globally significant shipping sector, sophisticated maritime institutions, and considerable experience in renewable energy, offshore wind, and the development of emerging green technologies. Its maritime economy has consequently encountered the pressures of decarbonisation from a position of technological and institutional maturity. India, by contrast, is a rapidly rising major economy whose maritime transition is unfolding alongside expanding energy and trade requirements, a large and growing maritime workforce, extensive port infrastructure, increasing shipbuilding ambitions, and a strategically important geographical position along major international trade routes. The two countries are therefore approaching many of the same transition objectives from substantially different starting points.

This difference should not necessarily be understood as an asymmetry in which one country possesses capabilities that the other lacks. Rather, it creates the possibility of complementarity. The value of the partnership, consequently, lies less in the replication of Danish experience in India than in the possibility of adapting relevant elements of that experience to Indian conditions while simultaneously creating opportunities for technologies, business models, and institutional practices, to operate at a considerably larger scale. This distinction is particularly important in the context of “green” shipping. The maritime transition is not proceeding in accordance with a single technological or regulatory pathway. The suitability of alternative fuels, the pace of fleet transition, the development of bunkering infrastructure, and the integration of renewable energy, will vary according to national energy systems, port characteristics, industrial capabilities,

regulatory environments, and commercial requirements. A relatively small, technologically advanced maritime economy and a large, rapidly expanding economy will inevitably encounter different constraints even when pursuing similar decarbonisation objectives. Comparative cooperation can therefore generate value not because the two countries are at identical stages of transition, but because their different experiences can illuminate how common objectives may be pursued under different conditions.

The strategic value of the India-Denmark partnership thus lies in combining technological and institutional experience with scale and deployment potential.

## **Institutional Framework**

The institutional foundations of India-Denmark cooperation in the maritime domain can be traced to January 2019, when a Memorandum of Understanding on maritime issues between India and Denmark was approved.<sup>1</sup> This envisaged cooperation and investment across maritime sectors, the exchange of expertise and information to strengthen capabilities in quality shipping, cooperation in “green” maritime technology and shipbuilding, maritime training and education, and research and development in merchant shipping and maritime transport. The proposed framework was also intended to strengthen cooperation and coordination in the maritime sector while supporting wider bilateral and international engagement.<sup>2</sup>

The character of this cooperation broadened with the establishment of the “India-Denmark Green Strategic Partnership” (GSP) in September of 2020.<sup>3</sup> The GSP was conceived as a wider political framework for bilateral cooperation, and included areas such as energy, climate change, the environment, and water, a circular economy, sustainable urban development, business and trade, science and technology, and shipping. Rather than constituting a sector-specific framework for green shipping, it situated maritime cooperation within a broader agenda of green growth and sustainable development. This distinction is significant. As the decarbonisation of maritime transport increasingly depends upon developments in interconnected sectors such as energy production, technology, infrastructure, regulation, and trade, the broader architecture of the GSP provides a suitable basis for situating the maritime transition within the wider systems on which it depends.

The “Joint Action Plan for 2021-2026” subsequently provided greater structure to this partnership by identifying specific areas and mechanisms through which bilateral priorities could be pursued.<sup>4</sup> Cooperation continued through the “Joint Commission” and specialised “Joint Working Groups” covering areas such as renewable energy, shipping and ports, science and technology, environment, digitisation, energy cooperation, and water. This institutional scaffolding provides multiple channels through which India and Denmark can address different components of a transition that increasingly cuts across conventional sectoral boundaries.<sup>5</sup>

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<sup>1</sup> Government of India, Cabinet, “Cabinet approves MoU on Maritime issues between India and Denmark”, 10 January 2019, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1559483&reg=48&lang=2>

<sup>2</sup> Green maritime technology was, therefore, already embedded within the bilateral maritime agenda before the subsequent expansion of cooperation under the GSP.

<sup>3</sup> Government of India, Ministry of External Affairs, “Joint Statement for India-Denmark Green Strategic Partnership”, <https://www.mea.gov.in/bilateral-documents?dtl/33069/Joint+Statement+for+IndiaDenmark+Green+Strategic+Partnership>

<sup>4</sup> Denmark in India, Green Strategic Partnership, “Joint Action Plan 2021-2026”, <https://um.dk/indien/en/denmark-in-india/green-strategic-partnership/india-denmark-joint-action-plan-2021-2026/>

<sup>5</sup> Maritime decarbonisation, for instance, requires not only changes in vessels and fuels, but also corresponding developments in energy systems, port infrastructure, digital technologies, regulatory frameworks, skills and commercial models.

The maritime relationship subsequently entered a more specialised phase. The scope of the 2019 Memorandum of Understanding, which had been revised in 2022, was further widened in 2024 through its extension and the inclusion of a dedicated provision for establishing a “Centre of Excellence”. The expanded framework brought greater emphasis to green maritime technology and green shipping, while also encompassing port digitalisation, automation, cybersecurity, maritime training and the development of hydrogen- and ammonia-based fuels for shipping. It thus marked a progression from a broad framework for maritime cooperation towards a more focused engagement with the technological, infrastructural, human-capital and regulatory requirements of maritime decarbonisation.

The “Indo-Danish Centre of Excellence in Green Shipping” represents an important institutional component of this progression.<sup>6</sup> Its establishment provides a dedicated mechanism for deepening expertise in green maritime technologies and facilitating knowledge exchange between the two countries. Its significance extends beyond technology transfer alone, as the Centre provides a potential platform for connecting green-fuel development, port infrastructure, digitalisation, and the wider operational requirements of a lower-emission maritime sector. The Centre represents an effort to develop sustained institutional capacity around the maritime transition rather than limiting bilateral engagement to sporadic or individual projects and exchanges.

An important manifestation of this evolving cooperation is the development of “green shipping corridors”.<sup>7</sup> Nearly a year after the renewal of the 2024 MoU on maritime affairs, India and Denmark identified “green corridors” as a priority area, with pre-feasibility work being undertaken through the Centre of Excellence. The “Mærsk McKinney Møller Centre for Zero Carbon Shipping”, in collaboration with the “Ministry of Ports, Shipping and Waterways” and other relevant Indian ministries, is undertaking the study to assess potential pathways for the development of such corridors. Further to the focus on green shipping corridors, India-Denmark cooperation has produced several related outcomes in the development of alternative marine fuels and the broader transition towards sustainable shipping. In this context, the “India-Denmark Centre of Excellence and Green Shipping Partnerships”, in collaboration with the Ministry of Ports, Shipping and Waterways, the Ministry of New and Renewable Energy, Cochin Shipyard Limited, TERI, and the Danish Maritime Authority, conducted a two-day “Green Fuels Workshop for Sustainable Shipping” in Kochi on 21-22 August 2025. Among other outcomes, the workshop identified two to three pilot green-corridor routes for development during 2025-27.<sup>8</sup>

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<sup>6</sup> Denmark in India, Strategic Sector Cooperation, “Maritime”, <https://um.dk/indien/en/denmark-in-india/strategic-sector-cooperation/maritime/?utm>

<sup>7</sup> Mærsk McKinney Møller Centre for Zero Carbon Shipping, “Green shipping corridors can play an important role in decarbonizing the maritime industry before 2050”, <https://www.zerocarbonshipping.com/green-corridors>

<sup>8</sup> DG Shipping India (Social Media – Facebook), “India and Denmark Centre of Excellence and Green Shipping Partnerships in collaboration with Ministry of Ports, Shipping and Waterways, MNRE, CSL, TERI, and DMA conducted a two day Green fuels workshop for sustainable Shipping at Kochi on 21/22 August 2025”, <https://www.facebook.com/DGShippingIndia/posts/india-and-denmark-centre-of-excellence-and-green-shipping-partnerships-incollabo/122141752958659990/>

See Also: <https://dgma.gov.in/gallery/engineering-wing/green-shipping-fuels-and-power-to-x-ptx-workshop-and-training> — Similar discussions were further advanced (after the Maritime India @ Net Zero Initiative) through the Green Shipping Fuels and Power-to-X (PtX) Workshop and Training held in New Delhi from 20-22 January 2026. The engagement brought together key Indian and international stakeholders, including the Directorate General of Shipping, the Ministry of New and Renewable Energy, the Danish Maritime Authority, GIZ India, the Royal Embassy of Denmark, the Danish Energy Agency, GH2 India and TERI’s National Centre of Excellence in Green Shipbuilding and Ports. The three-day programme addressed PtX fuel pathways, maritime decarbonisation strategies, the IMO’s lifecycle-assessment guidelines, emerging approaches to standards and certification for green fuels, and the infrastructure and regulatory requirements for green shipping corridors.

The significance of these developments lies in the fact that a green shipping corridor cannot be understood simply as a designated maritime route. Its viability depends upon the simultaneous alignment of several components, including suitable vessels, reliable supplies of alternative fuels, bunkering infrastructure, safety and regulatory arrangements, cargo demand, financing, and commercially viable operating conditions. The development of such corridors therefore brings into closer proximity several areas of the maritime transition that have traditionally been addressed through distinct institutional and sectoral channels.

This convergence is also reflected in India's emerging national approach towards green shipping. The Directorate General of Shipping's "Maritime INDIA @ Net Zero" initiative, organised with the Ministry of Ports, Shipping and Waterways and the "National Centre of Excellence for Green Ports and Shipping" at TERI, in January, 2026 represented "*a high-level, multi-ministerial, and multi-stakeholder platform intended to translate the National Green Shipping Policy into coordinated national action*".<sup>9</sup> The initiative adopts a systems-level approach structured around seven pillars:

1. Green Ships.
2. Green Fuels.
3. Green Ship Recycling.
4. Green Ports.
5. Green Technology.
6. Green Finance.
7. Green Skill and Capacity Building.

## Ports as Nodes of Assessment

It is within this broader convergence that the role of ports assumes particular significance. Of the different components of the maritime transition, ports provide one of the clearest physical interfaces between shipping and the wider energy and industrial systems upon which its decarbonisation depends. They are simultaneously gateways for trade, consumers of energy, nodes within logistics networks, and potential sites for the storage and bunkering of alternative fuels.

The expanding role of ports in the maritime transition is particularly significant in the Indian context, given the scale and diversity of the country's port network. Traditionally understood as nodes facilitating the movement of cargo between maritime and land-based transport systems, ports are increasingly acquiring functions that connect them to wider energy and industrial systems. The transition towards lower-emission shipping is very likely to reinforce this development. The adoption of alternative marine fuels, for instance, will require ports to develop appropriate storage and bunkering facilities, while the decarbonisation of port operations will necessitate greater integration of electrification, renewable energy, and energy-efficiency measures. Ports may consequently assume a more central role in connecting maritime activity with the wider energy transition.

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<sup>9</sup> Government of India, Ministry of Ports, Shipping and Waterways, Directorate General of Maritime Administration (DGMA), "Advancing India's Maritime Transition Towards Net Zero", [https://www.dgma.gov.in/engineering-wing/maritime-india-net-zero?utm\\_](https://www.dgma.gov.in/engineering-wing/maritime-india-net-zero?utm_)

The development of green-fuel infrastructure provides one indication of this changing role. The establishment of “Green Hydrogen Hubs” at Deendayal Port, VO Chidambaranar Port, and Paradip Port under the “National Hydrogen Mission” points towards the potential for ports to participate in the generation, storage, and movement of emerging energy products.<sup>10</sup> In fact, the relationship between ports and the energy transition extends beyond alternative marine fuels. India’s identified offshore-wind potential, concentrated primarily along the Gujarat and Tamil Nadu coasts, creates additional potential for interface between maritime infrastructure and renewable-energy development.<sup>11</sup> Ports can eventually support the construction, installation, operation, and maintenance of offshore renewable-energy infrastructure, while their existing logistics capabilities and industrial hinterlands can support associated supply chains. The development of offshore wind, therefore, carries implications not only for their direct purpose, but also for the future functions and infrastructure requirements of ports themselves.

Naturally, the implications of this transition are unlikely to be uniform across India’s port network. Ports differ significantly in their cargo profiles, industrial hinterlands, geographical characteristics, connectivity, existing infrastructure, and access to energy resources. An energy-intensive industrial port may, therefore, possess opportunities that are quite different from those of a major container gateway, while a port located in proximity to substantial renewable-energy resources may be better positioned to support particular green-fuel pathways. The transition would organically produce differentiated port functions. Such differentiation has direct implications for maritime competitiveness. As environmental performance becomes increasingly embedded within shipping and logistics decisions, access to reliable low-emission infrastructure may influence the attractiveness of individual ports. The capacity to provide alternative-fuel bunkering, shore-side electricity, efficient cargo-handling systems and appropriate safety and regulatory arrangements could increasingly form part of a port’s competitive proposition. Conversely, ports that are unable to adapt to changing technological, environmental and regulatory requirements may face difficulties in retaining or attracting particular categories of shipping and cargo activity.

For India, the challenge is, therefore, not simply to improve the environmental performance of existing ports, but to determine how different ports can participate most effectively in the emerging maritime-energy system. Such an approach requires great attention to the specific characteristics and comparative advantages of individual ports rather than the application of a uniform transition model. It also creates a substantive area for India-Denmark cooperation. Danish experience provides useful reference points for examining how ports can acquire functions extending into renewable energy, industrial activity and operational decarbonisation.

The subject of “Ports” provides a useful vantage point from which to examine the convergence of green shipping and the wider energy transition. They bring vessels, fuels, energy systems, infrastructure, logistics, industry and regulation into a common operating environment.

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<sup>10</sup> Government of India, Ministry of Ports, Shipping and Waterways, “Three Major Ports Recognised as Green Hydrogen Hubs under National Green Hydrogen Mission”, 10 October 2025,

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=2177591&reg=48&lang=2>

<sup>11</sup> Government of India, Ministry of New and Renewable Energy, “Potential offshore wind zones off the coast of Gujarat and Tamil Nadu identified; Planning completed for offshore transmission capacity for 05 GW each off Gujarat and Tamil Nadu coast: Union Power & NRE Minister Shri R. K. Singh”, 20 July 2023,

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=1941109&reg=48&lang=2>

See Also: Government of India, Ministry of New and Renewable Energy, “Offshore Wind”, <https://mnre.gov.in/en/off-shore-wind/>



## Situating India-Denmark Cooperation at the Port-level

Examining the convergence of Indo-Danish aspirations at the port level is, therefore, important not only to understand the practical requirements of maritime decarbonisation, but also to assess how India's ports can adapt to, and potentially derive competitive advantage from, the changing conditions of the international maritime economy. Danish experience provides a useful comparative lens through which to examine the evolving role of ports within the maritime-energy transition. The value of such comparison, however, lies less in identifying a single Danish model for replication than in examining how different port environments have responded to the interaction between maritime activity, energy systems, and decarbonisation. The experiences of Esbjerg and Aarhus are particularly instructive in this regard, as they represent different configurations of port-led transition.

The Port of Esbjerg provides an important example of the relationship between port development and the expansion of offshore renewable energy.<sup>12</sup> The port has evolved alongside Denmark's offshore-wind sector and has developed into a significant logistics and service centre for offshore-wind activities.<sup>13</sup> Its functions increasingly intersect with a wider industrial and energy ecosystem, creating linkages between port infrastructure, offshore energy, logistics, maritime services, and associated industrial activity. For India, the relevance of Esbjerg lies in the opportunity to examine how port infrastructure can support an energy transition that extends beyond the immediate requirements of shipping.

This is particularly pertinent given India's emerging offshore-wind ambitions and the potential role of ports in supporting the construction, installation, operation and maintenance of offshore renewable-energy infrastructure.<sup>14</sup> Esbjerg should not, however, be treated as a model that can simply be transferred to the Indian context. Its development has been shaped by Denmark's geographical characteristics, institutional arrangements, industrial base, and long-standing investment in offshore wind. India's circumstances differ considerably in terms of scale, port diversity, energy requirements, and the maturity of its offshore renewable-energy sector. The more useful exercise would, therefore, be to identify the underlying relationships that have contributed to Esbjerg's development — the alignment of port infrastructure with emerging energy requirements, the integration of maritime and industrial activities, and the role of port governance in facilitating new forms of economic activity.

The Port of Aarhus offers a complementary perspective. As a major commercial port, its experience provides an opportunity to examine decarbonisation within an established port environment rather than principally through the expansion of a new energy-oriented industrial ecosystem.<sup>15</sup> Such experience is

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<sup>12</sup> Henrik Sornn-Friese et al, "The port authority as system builder in cross-border regionalization: An exploratory study of port Esbjerg in the development of north sea wind", *Maritime Transport Research* (4), June 2023,

<https://www.sciencedirect.com/science/article/pii/S2666822X23000035>

<sup>13</sup> State of Green, "From fishing hub to the world's largest offshore wind port", 26 February 2025,

<https://stateofgreen.com/en/solutions/from-fishing-hub-to-the-worlds-largest-offshore-wind-port/>

<sup>14</sup> Aditya Rebbapragada, "Developing offshore wind energy in India", Norton Rose Fulbright, February 2023,

<https://www.nortonrosefulbright.com/en-in/knowledge/publications/bbbb6e0c/developing-offshore-wind-energy-in-india>

<sup>15</sup> Aarhus Havn, "The Port of Aarhus enters crucial phase on the road to CO2 neutrality", 20 October 2025,

<https://www.portofaarhus.dk/en/nyheder/aarhus-havn-gar-ind-i-afgorende-fase-pa-vejen-mod-co2-neutralitet>

See Also: Safety4Sea, "Port of Aarhus to provide shore power to container ships", 24 January 2025, <https://safety4sea.com/port-of-aarhus-to-provide-shore-power-to-container-ships/>

relevant to Indian ports that will need to reduce the emissions associated with their own operations while continuing to accommodate growing cargo volumes and maritime activity.<sup>16</sup>

This comparative exercise could also contribute to the wider India-Denmark green-shipping agenda. If ports are increasingly becoming the interface between maritime transport and the energy transition, then understanding different models of port adaptation becomes relevant to the development of green fuels, green shipping corridors, and wider maritime-energy systems. Danish ports can serve as practical reference points through which India can assess the institutional and operational choices involved in integrating maritime infrastructure with the emerging requirements of a lower-emission economy.

Another avenue for bilateral cooperation would be the establishment of a structured and jointly feasible Track 1.5 synchronisation mechanism. Such an initiative could provide a periodic assessment of the maritime transition across a common analytical matrix comprising six interrelated domains—

1. Fuel pathways and bunkering readiness;
2. Fleet transition and vessel readiness;
3. Port infrastructure and energy integration;
4. Workforce development and certification;
5. Regulatory adaptation; and
6. Commercial viability

Rather than duplicating existing studies or creating an additional layer of institutional activity, the mechanism could synthesise findings emerging from the different bilateral and national workstreams, enabling areas of convergence, divergence, and interdependence to be identified systematically. The proposed matrix could assess fuel pathways in terms of production, availability and bunkering readiness; fleet transition through vessel readiness, retrofit pathways, and emerging adoption trends; and port infrastructure through energy integration, bunkering capacity, and operational preparedness. Workforce development could be assessed in relation to training and certification requirements, while regulatory adaptation could consider the evolution of relevant national and international frameworks. Commercial viability could, in turn, examine market demand, investment trends, and the practical conditions influencing implementation. Considered collectively, these domains would provide a more integrated assessment of transition readiness, while also helping to identify where progress in one domain may be contingent upon, or constrained by, developments in another.

## Conclusion

India-Denmark cooperation on green shipping is entering a phase in which the principal opportunity lies in connecting existing areas of engagement rather than establishing additional parallel mechanisms. The measures identified in this paper could strengthen the translation of bilateral cooperation into context-specific approaches for India, while providing a more systematic basis for assessing the evolving requirements of a competitive yet transforming maritime ecosystem.

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<sup>16</sup> Ministry of Ports, Shipping, and Waterways, “Harit Sagar- Green Port Guidelines” <https://shipmin.gov.in/en/content/harit-sagar-green-port-guidelines-may-2023>

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