

Green and Sustainable Investments in Shipping in Asia

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Abstract. Asia's dominant role in global maritime trade places the region at the centre of both shipping-related greenhouse gas emissions and the financing challenge associated with achieving the International Maritime Organisation's net-zero emissions target by 2050. Decarbonising the maritime sector is estimated to require investment exceeding USD 1 trillion, underscoring the critical role of sustainable finance. This paper examines how green shipping corridors function as a financial structuring mechanism to reduce investment risk and mobilise capital for low-carbon maritime assets in Asia. Using a qualitative research approach based on policy analysis and case evidence from India, Singapore, and China, the study finds that corridor-based development enhances project bankability by aggregating demand, improving regulatory certainty, and enabling climate-aligned financing. Financial instruments such as green bonds, blended finance, sustainability-linked lending, and public-private partnerships — aligned with the Poseidon Principles — emerge as key enablers of maritime decarbonization. The paper contributes to sustainable finance and maritime economics literature by positioning green shipping corridors as the operational nexus linking climate policy, financial markets, and measurable decarbonization outcomes.

Key words: Green shipping, green finance, green corridors, green bonds, Decarbonization

1. Introduction

Asia dominates global maritime trade, accounting for a substantial share of vessel traffic, shipbuilding capacity, and port throughput. This central role also positions the region as a significant contributor to shipping-related greenhouse gas emissions, intensifying the urgency for maritime decarbonisation in line with the International Maritime Organization's net-zero emissions target by 2050. While technological pathways for low- and zero-carbon shipping are advancing, their large-scale deployment remains constrained by high capital intensity, infrastructure requirements, and financial risk.

Estimates suggest that achieving maritime decarbonization will require investments exceeding USD 1 trillion by mid-century, highlighting the decisive role of sustainable finance. In response, green shipping corridors have emerged as a strategic instrument capable of aligning regulatory certainty, infrastructure development, and capital mobilization along designated maritime routes.

This paper analyses the role of green shipping corridors in enabling green and sustainable investments in Asian shipping. Focusing on India, Singapore, and China, it examines how policy

frameworks, financial instruments, and public–private partnerships interact to improve investment bankability and accelerate maritime decarbonization.

The primary objective of this study is to evaluate the structural role of Green Shipping Corridors in mitigating financial risks associated with maritime decarbonization and to examine how these corridors function as catalysts for mobilising climate-aligned investments within the Asian maritime sector

China, Singapore, and Japan were selected for this study because they represent leading maritime economies in Asia with significant influence on global shipping activities, port infrastructure development, technological innovation, and the implementation of sustainability initiatives. These nations have also demonstrated active participation in adopting IMO decarbonization strategies and green financing mechanisms

2. Literature Review and Conceptual Framework

Existing literature on green shipping primarily focuses on technological pathways for reducing maritime emissions, including alternative fuels, vessel efficiency improvements, and operational optimization. Studies identify fuels such as liquefied natural gas, green hydrogen, ammonia, and methanol as critical to achieving lifecycle emissions reductions, while also highlighting challenges related to fuel availability, infrastructure readiness, and safety standards.

More recent scholarship introduces green shipping corridors as a mechanism to operationalize maritime decarbonization by concentrating policy coordination, infrastructure investment, and technological deployment along specific routes. These corridors translate global climate ambitions into localized, demonstrable action. However, existing studies often treat corridors primarily as policy or technology pilots, with limited emphasis on their financial structuring role.

Parallel research in sustainable finance emphasizes the growing importance of green bonds, sustainability-linked loans, and climate-aligned lending frameworks such as the Poseidon Principles in shaping maritime investment decisions. While these instruments promote emissions-aligned portfolios, their interaction with corridor-based development, particularly in the Asian context, remains underexplored, forming the central research gap addressed in this study.

While existing studies focus on technological pathways, limited attention is paid to how financial instruments are operationalized through corridor-based mechanisms

Conceptual Framework. Four pillars are the shipbuilding financial assistance scheme, the Maritime development fund, Ship building development scheme.

3. Research Methodology

This study adopts a qualitative and descriptive research design to examine green and sustainable investment trends in Asian shipping. The methodology comprises:

1. Systematic literature review of peer-reviewed journals, IMO reports, policy documents, and sustainability frameworks.

2. Thematic analysis of green finance instruments, policy initiatives, and green corridor developments across Asia.

3. Case study analysis focusing on India, Singapore, and China to assess the interaction between policy support, investment mechanisms, and decarbonisation outcomes.

Secondary data sources include reports from the IMO, World Bank, Maritime and Port Authority of Singapore, Government of India policy documents, and sustainability disclosures from shipping companies and financial institutions.

This study adopts a qualitative research design based on comparative policy analysis and thematic content analysis using secondary sources such as IMO reports, academic literature, policy documents, and sustainability reports.

4. Asia Context: Key Initiatives and Infrastructure

Asian maritime policy frameworks have expanded significantly in response to increasing decarbonisation pressures and evolving global climate commitments. Several leading economies, including South Korea, Vietnam, and Singapore, have implemented policy measures to support fleet retrofitting, energy-efficient shipbuilding, and the adoption of alternative fuels. These initiatives increasingly align national maritime strategies with long-term emissions reduction pathways and investment-led sustainability transitions.

India. India has undertaken a strategic transformation of its shipbuilding and maritime ecosystem, emphasizing low-carbon technologies, alternative fuels such as green ammonia and methanol, and the digitalization of ports and logistics systems. Regional integration forms a central pillar of India's approach, exemplified by initiatives such as the India–Singapore Green and Digital Shipping Corridor, which combines regulatory coordination, infrastructure development, and investment facilitation along key trade routes. China, while maintaining global leadership in shipbuilding capacity, continues to face high absolute emissions due to the scale of its maritime and industrial activities, reinforcing the need for efficiency improvements and progressive fuel transition strategies.

Singapore. Singapore has positioned itself as a regional leader in sustainable maritime development through coordinated investments in clean bunkering infrastructure, port electrification, and advanced digital port systems. Its long-term commitment to carbon neutrality by 2050 is supported by targeted financial incentives and dedicated research institutions focused on low- and zero-carbon maritime technologies, strengthening its role as a hub for green shipping finance and innovation.

These partnerships play a critical role in reducing investment risk, crowding in private finance, and facilitating the knowledge transfer necessary to overcome technological and financial barriers.

Within this regional context, green shipping corridors function as the operational nucleus of a circular ecosystem linking climate policy, sustainable finance, and technological deployment. Policy frameworks provide regulatory certainty, financial mechanisms enable capital mobilisation, and infrastructure and vessel investments deliver measurable decarbonisation outcomes. These outcomes, in turn, reinforce investor confidence and regulatory support, creating a self-reinforcing pathway toward maritime net-zero emissions in Asia. Singapore represents a finance-led corridor model, whereas India follows a policy-driven public investment approach.

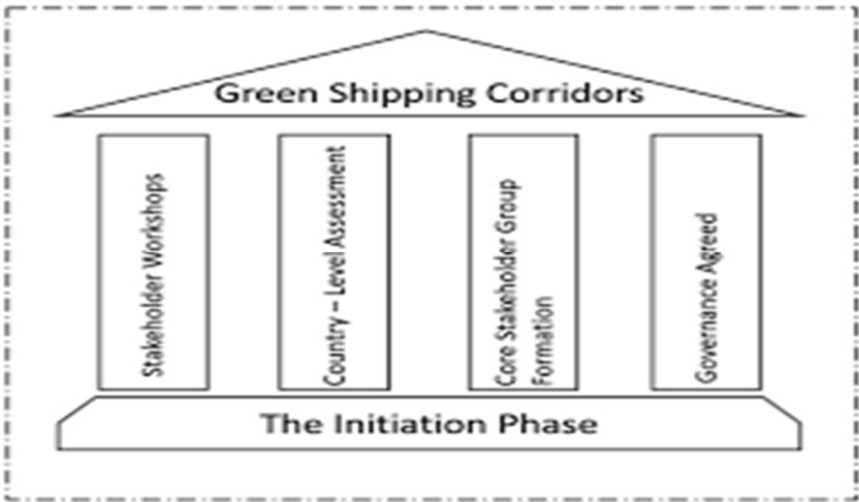


Figure 1. Conceptual Framework of Green Shipping Corridors in Asia

Figure 2 Illustrates the integrative role of green shipping corridors as a financial and policy coordination mechanism for maritime decarbonisation in Asia.



Figure 2. Conceptual Framework of Green Shipping Corridor Finance Ecosystem

The framework is structured around four interlinked pillars:

A conceptual framework figure illustrating the relationship among climate policies, Green Shipping Corridors, financial mechanisms, and sustainable outcomes has been added.

1. Policy and Regulation: National maritime policies, IMO decarbonisation targets, fuel standards, and corridor-level regulatory alignment provide long-term policy certainty.

2. Sustainable Finance Mechanisms: Green bonds, blended finance, sustainability-linked loans, and public-private partnerships aligned with the Poseidon Principles mobilise capital and reduce investment risk.

3. Technology and Infrastructure Deployment: Investments in alternative-fuel vessels, bunkering infrastructure, port electrification, and digital systems enable operational decarbonisation along corridor routes.

4. Decarbonisation outcomes and market confidence: measurable emissions reductions, transparent reporting, and improved asset performance enhance investor confidence and reinforce regulatory support.

The circular interaction among these pillars demonstrates how green shipping corridors create a self-reinforcing investment ecosystem, enabling scalable and bankable pathways toward maritime net-zero emissions in Asia.

5. Investment Opportunities in Asian Shipping

IMO's Marine Environment Protection Committee sent an ambitious new target in July 2023 to achieve net-zero emissions by 2050. The major objective is to increase the demand for vessels that use cleaner fuels, which are less carbon-intensive.

The Poseidon Principles, one of the most pivotal initiatives, which was launched in 2019, is also a framework that was meant for measuring and reporting how well the financial institutions' shipping portfolio aligns with climate targets. These principles are a global framework of financial institutions, including lenders, lessors and guarantors, to assess and disclose the climatic alignment of their ship portfolios with the International Maritime Organization's decarbonisation targets.

The framework comprises four principles: assessment of climate alignment, accountability for reporting progress, enforcement through internal transparency, mechanisms and public disclosure of results. These carbon emissions are measured and evaluated against the decarbonisation trajectories established by IMO. These principles actually promote green shipping by favouring low-emission vessels with finance portfolios. This helps to strengthen the decarbonisation mechanisms in the Asian sector.

Financial mechanisms like green bonds and public-private partnerships play a crucial role by funding the infrastructure and technology upgrades. The green bonds are instruments that finance maritime decarbonisation by raising capital for sustainable projects like retrofits, alternative fuel adoption, port electrification, and emission monitoring systems. Lenders qualify vessels for green bond

proceeds based on environmental performance metrics that align with the Green Bond Principles, EU Taxonomy, Climate Bonds Initiative and Poseidon Principles.

CRAs Asian economies heavily rely on maritime trade; shipping finance plays a crucial role. In Asia, corridors like China-Qingdao-Hamburg, India-Singapore, and Vietnam-Cai Mep links drive trade growth in China, India, and Vietnam, linking to the Poseidon Principles. In India, the new corridors include the India Green Corridors, the India-Denmark Green Corridors, the India-Singapore and the Kandla-Tuticorin Coastal Green Corridor.

The Maritime and Port Authority of Singapore (MPA) has significantly accelerated its commitment with S\$50 million to sustainable maritime practices under the Maritime Singapore Green Initiative (MSGI).

MSGI, which comprises five programmes:

Green Ship Programme. The revised Green Ship Programme (GSP) offers powerful financial incentives, providing up to a 100% concession on initial registration fees and annual tonnage taxes for vessels that meet stringent green criteria. To qualify, ships must either significantly exceed the IMO's Phase 3 EEDI standard, adopt low- or zero-carbon fueled technologies, alternative fuels and efficient vessel design.

There are various green shipping mechanisms in India to facilitate the transition to sustainable maritime operations.

Green bonds. Green bonds in shipping raise capital through debt instruments. These proceeds are exclusively used to finance or refinance projects in the maritime sector. These mechanisms follow rigorous certification standards to ensure that projects align with global climate targets. Green bonds have also become an attractive investment opportunity, as they are risk-adjusted returns compared to conventional bonds. Its yield is a combination of financial gain and social responsibility, which is now a rapidly expanding sector in Asia. In Asia, issuers like COSCO and Mitsui O.S.K. Lines use these instruments to finance environmentally friendly green projects like low-emission vessels and port infrastructure upgrades.

Blended Finance. On December 9, 2015, the Government of India approved the Financial Assistance Policy for Indian Shipyards. This was to provide financial assistance for shipbuilding contracts. India has allocated ₹69,725 crore to reinvigorate its shipbuilding and maritime ecosystem, recognizing the sector's strategic importance. India's four-pillar approach to maritime funding, part of a ₹69,725 crore package approved in September 2025 were:

Four-Pillar Framework for Green Shipping

Pillar 1: Shipbuilding Financial Assistance scheme - It being the cornerstone of India's maritime revival strategy, it allocated a substantial ₹24,736 crore. Its key objective is to provide direct financial assistance to offset the highest cost of construction in India when compared to foreign shipyards, thereby making Indian shipyards globally competitive. This scheme has also introduced a

credit note mechanism, which establishes a direct financial bridge where the act of scrapping the old ship generates a credit that can be used to reduce the cost of the new ship.

Pillar 2: Maritime Development Fund – and financial institutions for loans to reduce the borrowing costs for maritime enterprises. It allocated ₹25,000 crore that is designed to enable long-term financing through equity and debt mechanisms in shipbuilding, shipyards, ports, and related infrastructure, with government contribution capped at 49% in a blended finance model. The Interest Incentivization Fund will have a corpus of ₹5,000 crore for a duration of 10 years. It will incentivise up to 3% to be provided to banks

Pillar 3: The Shipbuilding Development Scheme (SbDS)- with an allocation of ₹19989 will be utilized for establishing greenfield shipbuilding clusters. It also emphasises expanding the brownfield capacity to elevate the existing shipyards to 4.5 million GT. It also establishes the India Ship Technology Centre, which will be an apex body under the Indian Maritime University, which will be focused on research and development, Skill training and also technology transfer to put India as a shipbuilding innovator.

Pillar 4: Skilling & Technical Capability, Legal, Taxation, Policy Reform - It sweeps away roadblocks and fuels investments by overhauling laws, policies, and taxes, while building up worker skills with hands-on training, pushing forward R&D, sticking to top quality standards, rolling out green tech, and locking in robust safety measures. The Hong Kong International Convention (HKC), which mandates global environmental and safety standards for ship recycling, entered into force on June 26, 2025. India leads globally in compliance, with nearly 115 of its 130 ship recycling yards now meeting the HKC requirements.

The Table 1 synthesises regulatory frameworks, financial instruments, and national initiatives shaping investment opportunities in Asian shipping under the International Maritime Organisation's net-zero 2050 strategy. Monetary values are reported as per official government and institutional disclosures.

Table 1: Investment Opportunities in Asian Shipping Under the Decarbonization Framework

Green Shipping Corridors	Corridor-based decarbonization model	Aggregated demand, fuel availability, and regulatory clarity	Project finance, corridor-linked bonds	China–Qingdao–Hamburg, India–Singapore, Vietnam–Cai Mep	Accelerates zero-emission route deployment
MSGI – Green Ship Programme	Vessel incentives	Up to 100% concession on registration & tonnage tax	Capex incentives	Methanol, hydrogen, CII-A vessels	Encourages fleet modernization
MSGI – Green Port & Craft	Port & harbour craft decarbonization	Energy Efficiency Grants, clean harbour craft	Infrastructure finance	Port of Singapore	Cuts port-side emissions
Indian Policy Alignment	Maritime India Vision 2030	Low-carbon tech, shipbuilding revival	Policy-backed finance	India	Long-term maritime sustainability
Indian Long-term Vision	Maritime Amrit Kaal Vision 2047	Net-zero aligned maritime growth	Sovereign-backed funding	India	Structural decarbonization
India – Pillar 2	Maritime Development Fund	₹25,000 crore; blended equity & debt; 3% interest subsidy	Blended finance	Ports, shipyards, logistics	Lowers financing cost
India – Pillar 3	Shipbuilding Development Scheme	₹19,989 crore; greenfield clusters. India Ship Technology Centre	Infrastructure & R&D funding	Under Indian Maritime University	Builds innovation capacity
Circular Economy	Hong Kong International Convention (2025)	Global standards for safe & green ship recycling	Recycling infrastructure finance	India (115+ compliant yards)	Completes sustainable vessel lifecycle

6. Challenges and Barriers

Even though there is significant progress, the transition toward green shipping in Asia faces multiple challenges. High capital costs associated with alternative fuel vessels, retrofitting, and bunkering infrastructure still remain a primary barrier, mostly for small and medium-sized ship-owners. Uncertainty about fuel availability, particularly for green hydrogen, ammonia and methanol, restricts large-scale deployment beyond pilot corridors. Regulatory fragmentation across Asian jurisdictions further complicates implementation, as varying safety standards, fuel certification norms, and carbon pricing mechanisms contribute to compliance challenges. Technology maturity risks, including engine reliability and fuel storage safety, also affect investor confidence. In addition to it, limited access to affordable long-term finance limits the scalability of green shipping initiatives by economies. To manage these barriers, harmonised regulations, risk-sharing financial mechanisms, and coordinated public-private investment strategies are required.

Financial Barriers: High operational expenses and substantial upfront capital requirements create financial constraints within the maritime industry. These financial limitations represent the most significant obstacle to the adoption of sustainable initiatives in ports. It will take at least \$1 trillion to invest in land-based infrastructure and ship-related technologies in order to reduce international shipping's greenhouse gas emissions in half by 2050.

Regulatory Challenges: Policy actions at national, regional and global levels are really important to achieve a net-zero pathway. This is especially true for transition finance which helps industries and economies move toward carbon neutrality. For this to happen, international organisations should work together to develop a framework. This will enable smooth integration across economies and more affordable funding options to overcome financial limitations.

Political Interventions: To reduce carbon emissions in the maritime industry, people with political views must agree on policies. Trade disputes and disagreements over energy are causing problems. This happens to slow down the process. As a result, short term energy security is often prioritised.

Operational and Technical Challenges: The global merchant fleet has a lot of ships, 105,493, to be exact that travel across the ocean. These ships are really big; they weigh 100 tonnes or more. Most of the merchant fleet still uses fossil fuels to move around. The global merchant fleet has a long life, usually between 25 to 30 years. So we must make changes to the merchant fleet a little bit at a time.

For existing vessels, the most straightforward approaches used to reduce energy consumption involve modest, low-cost modifications. Optimising vessel speeds through controlled reductions and air lubrication systems that minimise hull-water. Additional low-investment options such as streamlined routing, eco-friendly antifouling hull coatings to maintain cleanliness and proactive engine maintenance protocols, also increase efficiency. On the other hand, carbon capture technologies are a better option

because they are more flexible. The reason is that alternative fuels require no changes to the structure of the engine, and they work with all types of fuel.

Low-carbon fuels and emission-free fuels are really expensive and hard to find, which is a problem for ship owners who want to switch to low-emission vessels. The thing is, these new fuels are still pretty new so there are a lot of questions about how to keep people safe, what to do in an emergency and how to be prepared for disasters. Ports all around the world are having trouble paying for the special equipment they need to store and give out this fuel to the green-fuel vessels. This is an issue for the green-fuel vessels and the companies that make green fuel.

These systematic challenges underscore a critical financing shortfall in the green shipping sector. Strategic investments deployed through mechanisms such as green bonds, sustainability-linked loans and blended finance provide an effective means to address it. Such instruments derisk the scaling of alternative fuel production, facilitate port infrastructure modernisation and promote multi-stakeholder coordination.

Infrastructure and Safety Challenges of Alternative Fuels in Asian Ports. Although alternative fuels such as Hydrogen and Ammonia are increasingly viewed as promising solutions for reducing carbon emissions in the maritime sector, their large-scale implementation presents significant infrastructure and safety challenges. Hydrogen requires specialized storage systems because of its low volumetric energy density and highly flammable nature. Similarly, Ammonia, despite its carbon-free combustion potential, is toxic and requires stringent handling procedures and dedicated storage infrastructure. Many Asian ports are currently in the early stages of developing bunkering facilities, safety standards, and emergency response systems for these fuels. Investments in port infrastructure, workforce training, and regulatory frameworks will therefore play a critical role in facilitating the successful transition toward green shipping

The SWOT analysis demonstrates that while each country possesses distinct strategic advantages, the successful implementation of green shipping initiatives requires balancing technological development, financial investment, and regulatory adaptation.

Table 2. SWOT table

Country	Strengths	Weaknesses	Opportunities	Threats
China	Strong government support; large shipbuilding capacity	High implementation cost; dependence on fossil-based infrastructure	Leadership in green technologies and alternative fuels	Regulatory complexity and economic fluctuations
Singapore	Global port connectivity; strong financial ecosystem	Limited land and natural resources	Expansion of green bunkering and maritime finance	Competitive regional ports
Japan	Advanced technological innovation; strong R&D capability	Aging workforce and high investment requirements	Development of hydrogen-based shipping technologies	Global market uncertainty and technology adaptation risks

7. Conclusion

Green and sustainable investments are rapidly reshaping the Asian shipping industry, positioning the region as a central driver of global maritime decarbonisation. The convergence of green shipping corridors, innovative financial instruments, and supportive policy frameworks has enabled measurable progress toward low-carbon maritime operations. Asia's experience demonstrates that coordinated action between governments, financial institutions, ports, and shipowners is essential to overcome cost, technology, and regulatory barriers.

India's policy-driven maritime financing model and Singapore's structured incentive-based approach provide replicable pathways for other emerging economies. As climate rules get tougher and investors demand more from companies on sustainability, green finance is turning into a make-or-break edge for shipping firms trying to stay ahead. Boosting teamwork across regions, aligning reporting standards, and ramping up investments in key shipping corridors are essential steps to hit the IMO's net-zero emissions target by 2050.

Future research Directions: the future research areas may be in the field of Quantitative finance modelling, corridor performance metrics, and Carbon pricing impacts

The transition toward sustainable maritime operations in Asia requires not only policy support and innovative financial instruments but also practical readiness in infrastructure and safety systems. The experiences of China, Singapore, and Japan suggest that integrated approaches involving technology, regulation, and investment strategies are essential for achieving long-term maritime sustainability goals.

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