NATIONAL GREEN SHIPPING POLICY- INDIA

Consultative Document

सर्बानंद सोणोवाल
SARBANANDA SONOWAL

सत्यमेव जयते

पत्तन, पोत परिवहन और जलमार्ग मंत्री
भारत सरकार
Minister of Ports, Shipping and Waterways
Government of India

FOREWORD

It is with a deep sense of purpose and optimism that I introduce the Consultative Document on the proposed National Green Shipping Policy (NGSP) for India. This thoughtfully crafted draft, the result of collaborative efforts between Lloyd's Register (LR) and the Directorate General of Shipping (DGS), reflects our government's enduring commitment to advancing sustainable maritime practices and safeguarding our marine environment.

India's maritime industry plays a pivotal role in our economic framework, and I hope the NGSP will set forth a strategic direction to drive decarbonization, innovation, and competitiveness on the global stage. This document delineates clear pathways through green finance, regulatory enhancements, technological integration, and collaborative initiatives, all aimed at minimizing the environmental footprint of maritime activities.

I extend my commendations to the Directorate General of Shipping and Lloyd's Register for their meticulous and thoughtful contribution in drafting this document. Their commitment and insight have established a solid groundwork for India's progression towards achieving net-zero emissions in alignment with our Hon'ble Prime Minister's Panchamrit goals declared at COP-26.

The document will now be subjected to comprehensive stakeholder consultations. I encourage participation from maritime stakeholders, policy experts, environmental groups, and academic institutions to ensure the policy is both inclusive and pragmatic. Your feedback will be invaluable in fine-tuning the policy to reflect the multifaceted needs and aspirations of our maritime sector.

Upon completion of the consultation process and subsequent approval, the Ministry of Ports, Shipping, and Waterways will formalize this document as India's National Green Shipping Policy. This policy will act as a cornerstone in steering the maritime sector towards an environmentally sustainable and economically robust future, establishing India as a leader in green shipping.

Together, let us endeavour to cultivate a maritime industry that harmonizes growth with ecological balance. I look forward to continued collaboration in shaping a resilient and sustainable maritime future for India.

(Sarbananda Sonowal)

Place: New Delhi
Date: 13th February, 2025

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भारत सरकार
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Government of India

Foreword

It is with great enthusiasm that I present the Consultative Document on the proposed National Green Shipping Policy (NGSP) for India. This document reflects an ambitious vision to embed sustainability into the core of our maritime industry, while simultaneously driving innovation and economic resilience.

India's ports and shipping networks serve as vital arteries for our nation's commerce and development. The NGSP represents a pivotal move towards transforming this essential sector into a model of environmental responsibility and global leadership. This policy outlines pathways for integrating sustainable financing, adopting eco-friendly technologies, refining regulatory structures, and enhancing international cooperation to minimize the maritime sector's ecological footprint.

I extend my sincere appreciation to the Directorate General of Shipping and Lloyd's Register for their rigorous and insightful work in shaping this document. Their efforts have been instrumental in crafting a comprehensive framework for India's transition to greener maritime practices.

As this document enters the phase of stakeholder consultations, I urge industry stakeholders, environmental specialists, academia, and policy architects to contribute their perspectives. Your inputs will be critical in shaping a policy that balances the diverse demands of economic progress with ecological preservation.

Upon completion of this consultative process and subsequent endorsement by the Ministry of Ports, Shipping, and Waterways, the NGSP will serve as a cornerstone in steering India's maritime industry towards a sustainable, forward-looking future, while harmonizing with global environmental commitments.

Let's pioneer a new era for India's maritime sector—one that not only fuels our economic ambitions but also exemplifies our dedication to safeguarding the environment.

(Shantanu Thakur)

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सत्यमेव जयते

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GOVERNMENT OF INDIA
पत्तन, पोत परिवहन और
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MINISTRY OF PORTS,
SHIPPING AND WATERWAYS

Foreword for the Consultative Document of National Green Shipping Policy.

It is matter of great pleasure that the Consultative Document on the proposed National Green Shipping Policy (NGSP) for India is ready for consultation. This draft, developed through the concerted efforts of Directorate General of Shipping (DGS) and Lloyd's Register (LR), represents a significant step towards integrating sustainability into India's maritime operations.

This document is in alignment with the Government of India's green policy initiatives as outlined in Maritime Amrit Kaai Vision 2047 (MAKV-47), Maritime India Vision 2030 (MIV 30), and other flagship programs like Harit Sagar, Harit Nauka and the Green Tug Transition Programme (GTTP). Together, these initiatives reflect our holistic commitment to fostering sustainable maritime practices and reducing the environmental footprint of port and shipping operations.

The NGSP outlines a practical framework to guide the maritime sector through the complex process of decarbonization. By emphasizing areas such as green financing mechanisms, regulatory enhancements, technological adoption, and collaborative initiatives, this policy aims to create a balanced approach to achieving environmental goals while maintaining economic growth. -

I would like to acknowledge the contributions of the Directorate General of Shipping and Lloyd's Register for their diligent work on this document. Their insights and technical expertise have helped raft a comprehensive policy framework that will align with National Green priorities as well as those of International Maritime Organization (IMO). The IMO's Revised Greenhouse Gas Strategy 2023 sets forth ambitious targets for achieving net-zero emissions by or around 2050 and reducing greenhouse gas emissions by at least 20% by 2030 and 70% by 2040.

This document will now undergo a series of stakeholder consultations, ensuring that feedback from industry leaders, regulatory bodies, environmental organizations, and academic experts is incorporated. Such inputs will be critical to refining the policy to ensure it meets the diverse needs of India's maritime sector.

Following these consultations and subsequent approval, the Ministry of Ports, Shipping, and Waterways will formalize the document as India's National Green Shipping Policy. This policy will play a vital role in steering the maritime industry towards sustainable practices, positioning India as a responsible leader in global shipping.

I encourage all stakeholders to actively engage in this consultation process. Your contributions will be key to shaping a resilient, efficient, and environmentally responsible maritime future for India.

Sd/-
(T.K. Ramachandran)
Dated: 18th February 2025

श्याम जगन्नाथन, भा.प्र.से.
नौवहन महानिदेशक
एवं अपर सचिव, भारत सरकार

Shyam Jagannathan, I.A.S.
Director General of Shipping &
Additional Secretary to the Govt. of India

सत्यमेव जयते

भारत सरकार
Government of India
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
नौवहन महानिदेशालय
Directorate General of Shipping

Date: 14.02.2025

Message from the Director General of Shipping

It is indeed a privilege to partake in the conceptualization of the Consultative Document on the proposed National Green Shipping Policy (NGSP) for India. This comprehensive draft, meticulously prepared by Lloyd's Register (LR) in collaboration with the Directorate General of Shipping (DGS), marks a milestone in our nation's commitment to fostering sustainable and environmentally responsible maritime practices. This is in synchronisation with the global transition in the two parallel pillars of Technology and Sustainability.

India's maritime sector is a cornerstone of our economic growth, and as we align our national priorities with international goals, the NGSP stands as a strategic initiative to transition our maritime industry towards decarbonization, technological innovation, and global competitiveness. The policy outlines a robust framework addressing key areas such as green finance, green collaboration, green regulations, and the integration of green technologies, aiming to reduce the carbon footprint of our maritime operations.

I extend my sincere gratitude to Lloyd's Register for their invaluable contribution in drafting this consultative document. Their expertise and dedication will provide a solid foundation for India's journey towards achieving net-zero emissions in the maritime sector, in line with our Panchamrit commitments announced at COP-26.

This document will now be paced through stakeholder consultations, and I encourage all industry participants, regulatory bodies, and environmental organizations to provide their insights and feedback. Your contributions are crucial in refining this policy to ensure it effectively addresses the challenges and harnesses the opportunities within our maritime ecosystem.

After due stakeholder consultations and approval by the Ministry of Ports, Shipping, and Waterways (MoPSW), this document is intended to be formally released as India's National Green Shipping Policy. It will serve as a beacon guiding our maritime sector towards a sustainable and prosperous future, positioning India as a global leader in green shipping.

Our lead domain experts Lloyd's Register and all stakeholders involved in this significant endeavour deserve compliments. It is my firm conviction that together, we can steer India's maritime industry towards a greener horizon.

14/02/25

(Shyam Jagannathan)
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As a nation committed to sustainable development, India recognises the urgent need to align its maritime operations with global environmental standards and evolving technological advancements. The National Green Shipping Policy (NGSP), which LR developed in partnership with the Directorate General of Shipping, represents a groundbreaking effort to transform India's maritime sector into a model of sustainability, innovation, and global competitiveness.

LR is honoured to have played a pivotal role in the development of this policy, which is a visionary blueprint to position India as a global leader in sustainable shipping practices. By integrating green finance mechanisms, strengthening regulatory frameworks, and fostering technological advancements, the policy underscores India's alignment with international environmental goals and its dedication to preserving our oceans for future generations.

We are particularly inspired by the alignment of this initiative with India's Panchamrit commitments announced at COP-26. The NGSP embodies the values of collaboration and inclusivity, offering clear pathways to achieve net-zero emissions while addressing the unique challenges of the maritime sector.

Andy Mckeran
Chief Commercial Officer
Lloyd's Register

Document control

Revision history

Revision No.	Date	Revision
1.0	15 Jan 2025	First cut – Draft
2.0	07 Feb 2025	Final Draft

List of Abbreviations

Acronym	Full Form
ABB	ASEA Brown Boveri (Swedish-Swiss multinational electrical engineering corporation)
ADB	Asian Development Bank
AI	Artificial Intelligence
ASEAN	Association of Southeast Asian Nations
BAU	Business as Usual
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
bio-LNG	Bio Liquefied Natural Gas
BMS	Battery Management Systems
BRICS	Brazil, Russia, India, China, South Africa
BRSR	Business Responsibility and Sustainability Reporting
BWTS	Ballast Water Treatment Systems
CAPEX	Capital Expenditure
CCS	Carbon Capture & Sequestration
CCUS	Carbon Capture, Utilization, and Storage
CIF	Climate Investment Fund
CII	Carbon Intensity Indicator
ClassNK	Nippon Kaiji Kyokai (Japanese Classification Society)
CO2	Carbon Dioxide
COP26	26th United Nations Climate Change Conference
DAC	Direct Air Capture
DGS	Directorate General of Shipping
DSME	Daewoo Shipbuilding & Marine Engineering
ECGC	Export Credit Guarantee Corporation of India Limited
EEXI	Energy Efficiency Existing Ship Index
EEZ	Exclusive Economic Zone
EIB	European Investment Bank
EPR	Extended Producer Responsibility
ESG	Environmental, Social, and Governance
ETS	Emission Trading Scheme
EU	European Union
EU ETS	European Union’s Emissions Trading System
EUSRR	EU Ship Recycling Regulations

Acronym	Full Form
EV	Electric Vehicle
EXIM	Export-Import
FAME India	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India
FDI	Foreign Direct Investment
GCF	Green Climate Fund
GE	General Electric
GEF	Global Environment Facility
GFDZs	Green Fuel Development Zones
GHG	Greenhouse Gases
GMC	German Maritime Centre
GMDC	Global Maritime Decarbonization Centre
GoI	Government of India
GRI	Global Reporting Initiative
GRIHA	Green Rating for Integrated Habitat Assessment
GST	Goods and Services Tax
GTTP	Green Tug Transition Program
GW	Gigawatts
HFO	Heavy Fuel Oil
HHI	Hyundai Heavy Industries
HKC	Hong Kong Convention
ICT	Information and Communication Technology
IFC	International Finance Corporation
IGBC	Indian Green Building Council
IIT	Indian Institute of Technology
IMDA	Indian Maritime Data Analytics
IMDF	India's Maritime Development Fund
IMO	International Maritime Organization
IMO DCS	International Maritime Organization Data Collection System
IOCE-SMaRT	Indian Ocean Centre for Excellence for Sustainable Maritime Transport
IoT	Internet of Things
IP	Intellectual Property
IRENA	International Renewable Energy Agency
ISO	International Organization for Standardization
ITM	Industry Transformation Map

Acronym	Full Form
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
JICA	Japan International Cooperation Agency
JIT	Just-In-Time
JNPA	Jawaharlal Nehru Port Authority
KRW	South Korean Won
LCA	Life Cycle Assessment
LDCs	Least Developed Countries
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LNG	Liquified Natural Gas
LT-LEDS	Long-Term Low-Emission Development Strategy
MARPOL	International Convention for the Prevention of Pollution from Ships
MDB	Multilateral Development Bank
MDO	Marine Diesel Oil
MEPC	Marine Environment Protection Committee
MGO	Marine Gas Oil
MIV 2030	Maritime India Vision 2030
MKAV	Maritime Amrit Kaal Vision
MMMCZCS	Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping
MOF	Korea's Ministry of Oceans and Fisheries
MOL	Mitsui O.S.K. Lines
MoPSW	Ministry of Ports, Shipping and Waterways (Government of India)
MPA	Maritime and Port Authority of Singapore
MRV	Monitoring, Reporting, and Verification
MSC	Mediterranean Shipping Company
MSGI	Maritime Singapore Green Initiative
MSME	Micro, Small, and Medium Enterprises
MTI	Maritime Training Institute
NAPCC	National Action Plan on Climate Change
NDB	New Development Bank
NEDO	New Energy and Industrial Technology Development Organization
NEMMP	National Electric Mobility Mission Plan
NGSP	National Green Shipping Policy

Acronym	Full Form
NIS	Norwegian International Ship Register
NOx	Nitrogen Oxides
NYK	Nippon Yusen Kabushiki Kaisha (Japanese Shipping Company)
OPS	Onshore Power Supply
PANI	Portal for Assets and Navigational Information
PE/VC	Private Equity/Venture Capital
PLI	Production-Linked Incentive
PM	Particulate Matter
PPP	Public-Private Partnership
R&D	Research and development
RED	Renewable Energy Directive
RIS	River Information System
RMI	Rocky Mountain Institute
SAARC	South Asian Association for Regional Cooperation
SAFc	Sustainable Aviation Fuel Certificates
SASB	Sustainability Accounting Standards Board
SATAT	Sustainable Alternative Towards Affordable Transportation
SBFAP	Shipbuilding Financial Assistance Policy
SDGs	Sustainable Development Goals
SEBI	Securities and Exchange Board of India
SEEMP	Ship Energy Efficiency Management Plan
SENSREC	Safe and Environmentally Sound Recycling
SIDS	Small Island Developing States
SLBs	Sustainability-Linked Bonds
SLLs	Sustainability-Linked Loans
SMEs	Small and Medium Enterprises
SMI	Singapore Maritime Institute
SOx	Sulfur Oxides
SRS	Singapore Registry of Ships
STS	Shore-to-Ship Power
TCFD	Task Force on Climate-Related Financial Disclosures
TRL	Technology Readiness Level
UAE	United Arab Emirates
UNCTAD	United Nations Conference on Trade and Development

Acronym	Full Form
USA	United States of America
VGF	Viability Gap Funding
WPSP	World Ports Sustainability Program
ZEMBA	Zero Emission Maritime Buyers Alliance
ZEZ	Zero-Emission Zones

Executive summary

The **National Green Shipping Policy (NGSP)** is a strategic initiative designed **to transition India's maritime sector toward environmental sustainability, technological innovation, and global competitiveness**. As a cornerstone of India's economic growth, **the shipping industry handles 95% of trade by volume**, making it essential to adopt a unified policy framework that addresses decarbonization, compliance with international regulations, and the integration of green technologies. The **NGSP envisions a sustainable maritime future, aligning national priorities with international goals and positioning India as a leader in green shipping**.

India has demonstrated a strong commitment to maritime decarbonization through **the Panchamrit framework, announced at COP-26**. This multi-pronged strategy aims to achieve **500 GW of non-fossil energy capacity by 2030, reduce one billion tonnes of carbon emissions by 2030, and achieve net-zero emissions in the maritime sector by 2070**. Key **measures include integrating renewable energy in port operations**, **incentivizing green fuel adoption,** and **investing in advanced technologies such as green hydrogen and carbon capture.**

India's maritime infrastructure is robust, comprising **12 major ports, 217 minor/intermediate ports, and plans for six new mega ports under the Sagarmala Programme**. Government investments, including the Rs. 700 crores allocated for Sagarmala in the 2024–2025 budget, underline the sector's importance. The **NGSP is positioned to further integrate environmental sustainability into this vital sector**. By focusing on **green shipping corridors, innovative port operations, and enhanced ship recycling practices**, the policy aims to maximize operational efficiency while minimizing environmental impacts.

A **comprehensive analysis of current maritime initiatives and identified policy gaps has shaped the NGSP's strategic vision and objectives**. The policy is **not only an environmental imperative but also a catalyst for economic growth and technological advancement**. It aspires to reduce the carbon footprint of maritime operations through clean energy adoption and stringent emission control measures, thereby bolstering India's competitiveness in global trade. Simultaneously, it aims to **promote innovation in green technologies, accelerate research and development in alternative fuels and electrification, and foster a collaborative environment among industry stakeholders, regulatory bodies, and financial institutions**. This integrated approach ensures that India's maritime decarbonization efforts are aligned with international standards and sustainable development goals, ultimately enhancing the country's regulatory credibility and global market standing.

The **NGSP is underpinned by a detailed scenario analysis that explores multiple growth rate scenarios, policy pathways, and emissions estimations, providing a robust basis for strategic decision-making**. By examining medium-growth and conservative pathways alongside global emissions reduction targets, the policy framework is well-equipped to navigate the uncertainties of future maritime trends. In parallel, **a comprehensive financing analysis identifies the necessary financial instruments to support green maritime investments**, highlighting the role of international cooperation and risk-sharing mechanisms in mobilizing capital for the decarbonization of the maritime sector.

At its core, the **NGSP delineates** a series of **interconnected policy actions that span the domains of green finance, green collaboration, and green regulations**. In the realm of green finance, the policy outlines measures to incentivize the development of green technologies, **including production-linked incentives for manufacturers of green technology components, tax benefits under the Make in India initiative, and the establishment of specialized economic zones dedicated to green maritime manufacturing**. Similarly, **financial support is extended to shipbuilders and port operators through enhanced shipbuilding financial assistance schemes, risk-sharing mechanisms for retrofitting, and dedicated funds for green innovation and workforce development.** These financial instruments are designed **to lower the cost barriers to adopting sustainable practices and stimulate investments in alternative fuels, renewable infrastructure, and advanced maritime technologies.**

The policy also emphasizes the importance of green collaboration, **fostering strategic partnerships between domestic and international stakeholders** to accelerate the transfer of clean technology, promote skill development, and enhance research and innovation in the maritime domain. By encouraging multi-stakeholder collaborations, the NGSP aims to create synergies across technology, finance, and regulatory frameworks, thereby strengthening India's overall maritime ecosystem. Concurrently, a comprehensive set of green regulations is being proposed to ensure real-time monitoring, robust environmental auditing, and transparent reporting across all maritime activities. These regulations include the **implementation of mandatory green certification and indexing frameworks for ports and vessels, as well as the development of standardized reporting mechanisms to track progress against emission reduction targets**. Below is the summary table of proposed policy actions:

Elements	Policy Actions
Green Technology	**Green Technology Compliance Framework**: Mandate tiered compliance levels for energy efficiency, low-carbon tech, and digitalization in ships, ports, and shipyards.
	Green Technology Reporting for Maritime Assets: Establish a standardized reporting framework for tracking the adoption of green technologies across maritime assets.
	Strategic Collaborations to Enhance Green Shipping Technology Manufacturing: Develop international partnerships for technology transfer in hydrogen, ammonia, and LNG-based solutions.
	PLI Schemes for Green Technology Manufacturing: Extend production-linked incentives (PLI) to green shipbuilding components like batteries, propulsion systems, and alternative fuel storage.
	Tax Incentives under Make in India: Provide tiered corporate tax benefits, R&D tax credits, and capital investment deductions for green maritime manufacturing.
	Specialized Green Maritime Economic Zones: Develop SEZs in coastal states (Tamil Nadu, Gujarat, Andhra Pradesh) with tax incentives, fast-track approvals, and sustainability-linked loans.
Green Ships	**Green Ship Certification & Compliance Standards**: Mandate Green Ship Certification under the Merchant Shipping Bill, aligned with India's GHG reduction strategy.
	Zero-Emission Zones (ZEZs) for Coastal & Inland Waterways: Designate priority waterways as ZEZs, restricting operations to zero-emission vessels.
	Monitoring, Reporting, & Verification (MRV) Systems: Establish a national emissions tracking framework for compliance with international regulations.
	Skill Development & Knowledge Sharing in Green Shipping: Form partnerships with global institutions, shipbuilders, and IMO to train professionals in green technologies.
	Enhancing Shipbuilding Financial Assistance (SBFA) Scheme: Introduce tiered financial incentives for green ships and retrofit projects.
	Financial Risk-Sharing for Retrofitting: Implement risk-sharing mechanisms, such as loan guarantees and insurance subsidies, to de-risk retrofitting investments.
	Green Innovation Fund: Establish a dedicated fund for research, pilot projects, and technology development in green shipping.
	Green Talent Fund: Support specialized training programs, scholarships, and workforce development initiatives for green maritime professionals.
Green Fuel	**Phased Carbon Pricing for Maritime Fuels:** Introduce a gradually increasing carbon tax on fossil-based maritime fuels to encourage adoption of sustainable alternatives.

Elements	Policy Actions
	Renewable Fuel Mandates & Blending Requirements: Implement minimum blending requirements for biofuels, LNG, and hydrogen in maritime fuels, gradually increasing targets over time.
	Binding Emissions Standards for Green Fuel Adoption: Set regulatory limits on CO_2, NOx, and SOx emissions for vessels, enforcing the adoption of low-emission fuels and technologies.
	Green Maritime Corridors for Alternative Fuels: Establish key domestic and international routes with dedicated green bunkering infrastructure for hydrogen, ammonia, and biofuels.
	Marine Fuel Reporting Mechanism: Develop a standardized system for tracking emissions, fuel consumption, and compliance with fuel transition mandates.
	Green Collaboration and Industry Partnerships: Foster partnerships between industry players, research institutions, and government bodies to accelerate green fuel adoption.
	Subsidies, Tax Incentives & Green Shipping Fund: Provide financial incentives, including subsidies, tax rebates, and a dedicated fund, to lower the cost of green fuels and infrastructure.
	Investment in R&D for Electrolysers, Ammonia Synthesis & Biofuels: Support research and development in green fuel production technologies to enhance domestic capabilities and reduce costs.
	PPP-Enabled Green Fuel Infrastructure Development: Promote public-private partnerships (PPPs) to develop alternative fuel bunkering and supply infrastructure at major Indian ports.
Green Ports	**Emission Standards for Ports:** Set regulatory limits on GHG emissions and mandate onshore power supply to reduce pollution from port operations.
	Green Building and Operational Standards: Enforce sustainable design and energy-efficient infrastructure in all new and retrofitted port projects.
	Green Port Certification and Indexing Framework: Develop a standardized certification system to assess and benchmark port sustainability based on emissions reduction, renewable energy use, and waste management.
	Mandatory Environmental Auditing and Reporting: Require periodic environmental audits and publication of port sustainability performance.
	Real-Time Environmental Monitoring: Implement IoT-based tracking systems for emissions, energy use, and waste management at ports.
	Multi-Stakeholder and International Collaborations: Build partnerships for regulatory alignment, tech transfer, and green financing.
	Research, Development, and Innovation: Advance clean energy, alternative fuels, and smart port technologies.
	Capacity Building and Knowledge Exchange: Strengthen training, certification, and knowledge-sharing for sustainable ports.
	Financial Incentives for Renewable Infrastructure: Provide subsidies, tax benefits, and green bonds for solar, wind, and energy-efficient port technologies.

Elements	Policy Actions
	Incentives for Alternative Fuel Infrastructure: Support the development of bunkering and refuelling facilities for LNG, green hydrogen, and ammonia.
	Viability Gap Funding (VGF) for Green Ports: Establish financial mechanisms to support early-stage investment in green port projects, including electrification and cold ironing infrastructure.
Green Recycling	**Green Ship Recycling Compliance Framework:** Mandate compliance with the Hong Kong Convention (HKC) and EU Ship Recycling Regulations (EUSRR) to reduce emissions and improve safety.
	Ship Recycling Transparency & Reporting Framework: Require shipbreaking yards to report emissions, hazardous waste disposal, and compliance performance.
	International Partnerships for Sustainable Ship Recycling: Engage with global stakeholders for technology transfer, training, and regulatory alignment.
	Green Finance & Incentives for Sustainable Ship Recycling: Introduce subsidies, tax incentives, and viability gap funding to support sustainable shipbreaking practices.
Social and Coastal Community Development	**Financial Support for Economic Resilience Among Coastal Population:** Reducing reliance on traditional fishing requires financial incentives, training programs, and investment in sustainable alternatives like eco-friendly aquaculture, marine ecotourism, and renewable energy projects to create jobs, preserve ecosystems, and ensure long-term economic resilience.
	Partnerships for Employment and Training: Implementing targeted apprenticeships, vocational training, and upskilling programs, policymakers can ensure that local residents benefit from the industry's growth while addressing the sector's evolving skill demands.
	Regulations Aimed at Enhancing Coastal Ecosystem Health: Implementing policies that **regulate overfishing, restore mangroves, and reduce waste** are essential steps in protecting marine life and ensuring ecosystem resilience.
	National Reporting and Governance on Coastal Community Development: Establish a structured framework for collecting data and reporting on fisheries' status and ensuring fair representation of coastal communities in policy formulation.
Pollution Prevention from Maritime Activities	**Financial Support for Pollution Control:** Provide grants and low-interest loans to shipowners and ports for installing emission scrubbers, ballast water treatment systems, and advanced waste management technology
	R&D Partnerships for Pollution Control: Facilitate strategic partnerships between shipping companies, port authorities, and environmental agencies for research, testing, and training aimed at pollution control in the maritime sector
	Ballast water treatment mandate: Mandate all the ships entering Indian waters to use certified Ballast Water Treatment Systems (BWTS) and submit ballast discharge reports.
	Pollution Control Reporting System: Mandate data reporting on pollution control - waste reception, emissions reduction, ballast water treatment compliance

In conclusion, the National Green Ship Policy represents a holistic and forward-looking approach to transforming India's maritime sector. By integrating environmental imperatives with economic and technological advancements, the NGSP provides a roadmap for achieving sustainable maritime growth while meeting international decarbonization commitments. The policy's multi-dimensional strategy—encompassing scenario analysis, financial planning, innovative policy actions, and collaborative regulatory frameworks—positions India to not only safeguard its maritime ecosystem but also to unlock significant economic and social opportunities. Through the coordinated efforts of all stakeholders, the NGSP is set to establish a resilient, low-carbon maritime infrastructure that will serve as a benchmark for sustainable shipping on the global stage.

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1 Introduction

India's shipping industry is a critical pillar of the nation's economic growth and international trade. The sector comprises a diverse range of stakeholders, including shipping companies, ports, shipbuilders, technology providers, fuel producers, environmental agencies, financers, and various government departments. Given this complexity, a **unified and well-coordinated policy framework** is essential to effectively address the challenges and opportunities associated with green shipping.

This report aims to conduct a **comprehensive review of the NGSP** and **develop a detailed project report** to support its legislative approval and implementation.

1.1 India's Commitment to Maritime Decarbonization

India has demonstrated a strong commitment to maritime decarbonization through international and national initiatives. As a member of the International Maritime Organization (IMO), India aligns with the IMO's strategy to reduce greenhouse gas emissions from the maritime sector. India has adopted a multi-pronged strategy under the 'Panchamrit' framework, announced at COP-26. The 'Panchamrit' strategy, is a five-point action plan that aligns with India's enhanced ambitions under the Paris Agreement, which integrates renewable energy use, emission reductions, and long-term sustainability into the maritime industry -

A. **Harnessing Renewable Energy**: India aims to reach **500 GW of non-fossil energy capacity by 2030**, with a focus on integrating renewable energy sources such as solar and wind into port and dockyard operations. Research and development are being prioritized to explore renewable energy-based propulsion systems for ships.

500 GW
of non-fossil energy capacity
by 2030

B. **Green Energy Transition**: India targets **meeting 50% of energy requirements from renewable sources by 2030**, particularly in port operations, and incentivizing green energy use for berthed ships.

C. **Reducing Carbon Emissions**: The country is committed to **cutting one billion tonnes of carbon emissions by 2030** by enforcing stringent emission reduction measures and exploring carbon accounting and trading mechanisms.

D. **Improving Carbon Efficiency**: India is working to **reduce the carbon intensity of its economy by less than 45%**, incorporating energy-efficient technologies in shipbuilding, port operations, and shipping practices, alongside green certification programs for assessing carbon intensity.

E. **Achieving Net-Zero by 2070**: India has laid out a **long-term vision to achieve net-zero emissions** in the maritime sector by 2070. This includes investing in future technologies such as green hydrogen, ammonia fuels, and carbon capture, utilization, and storage (CCUS).

Net-Zero Emissions
by 2070

India is actively implementing several Maritime initiatives aimed towards sustainable ports and vessels, uptake of green fuels and development of inland waterways:

SAGARMALA PORT-LED PROSPERITY | MARITIME INDIA VISION 2030 | GREEN TUG TRANSITION PROGRAM (GTTP) | SHIPBUILDING FINANCIAL ASSISTANCE POLICY | INLAND WATERWAYS DEVELOPMENT

Figure 1: Key Maritime Initiatives

India's Paris Agreement commitments include achieving net-zero emissions by 2070, with the **Long-Term Low-Emission Development Strategy (LT-LEDS)** emphasizing sustainable development and climate resilience. Decarbonizing the maritime sector is key to national efforts to limit global temperature rise to 1.5°C. Aligning

maritime decarbonization efforts with the **Sustainable Development Goals (SDGs)** underscores India's dedication to sustainable growth. Specifically, these efforts support[1]:

Figure 2: Linked Sustainable Development Goals

[1] https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf

1.2 India's Maritime Infrastructure

India's maritime sector serves as the backbone of its trade and commerce, **handling around 95% of the country's trade by volume and 68% by value**[2], underscoring its significance. To adapt to evolving circumstances, it is essential to advance areas such as shipping and ocean resource management, ship design and construction, ports and harbours, human resource development, financial mechanisms, ancillary industries, and the adoption of innovative technologies.

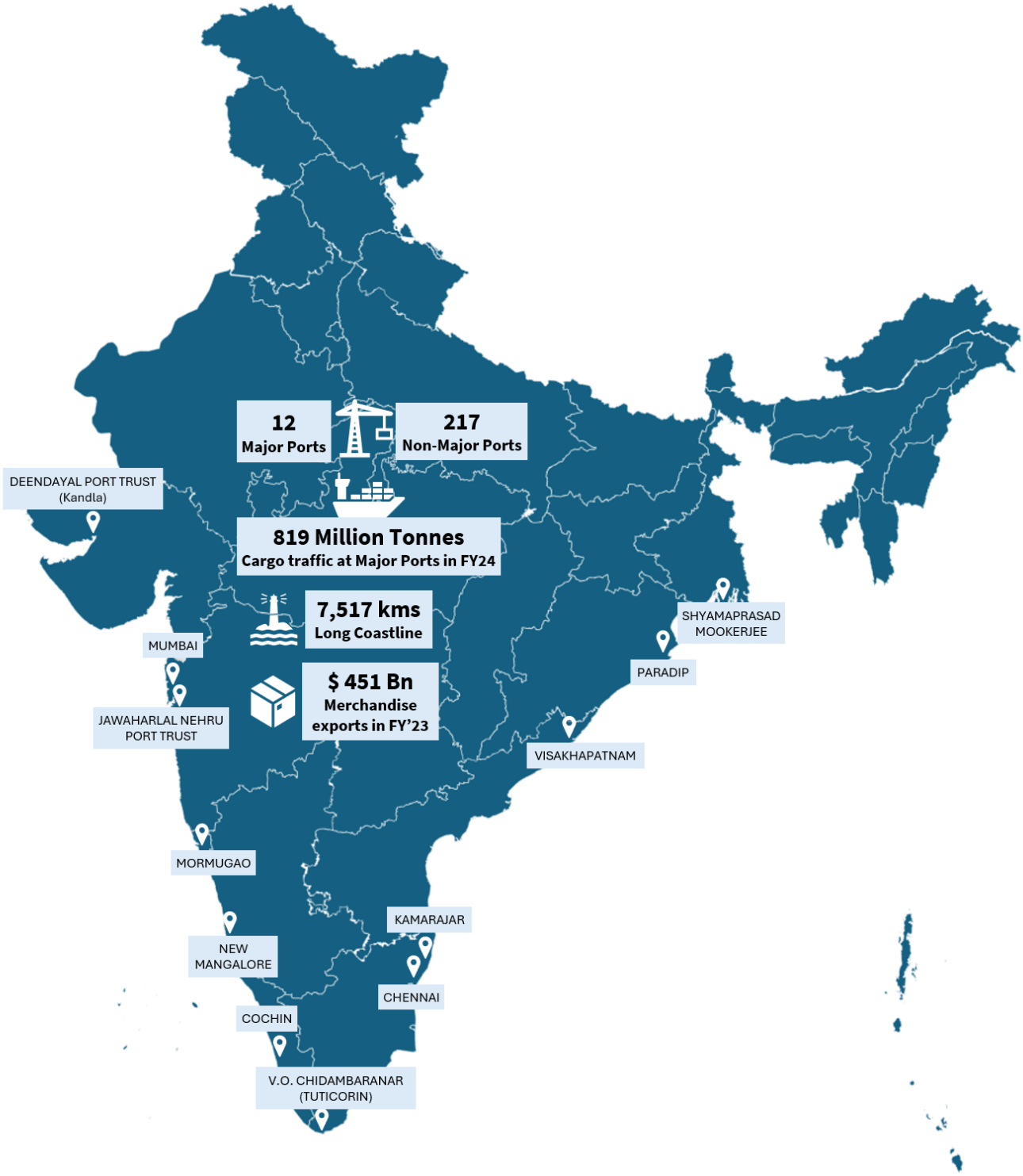


Figure 3: Ports of India

[2] https://shipmin.gov.in/division/shipping

With **12 major ports and over 200 notified minor and intermediate ports**, the country's port infrastructure underpins its growing economy. Under the National Perspective Plan for Sagarmala, six new mega ports will be developed in the country. In the interim budget 2024-2025, **Rs. 700 core (US$ 84.42 million)** has been allocated for the Sagarmala programme[3,4].

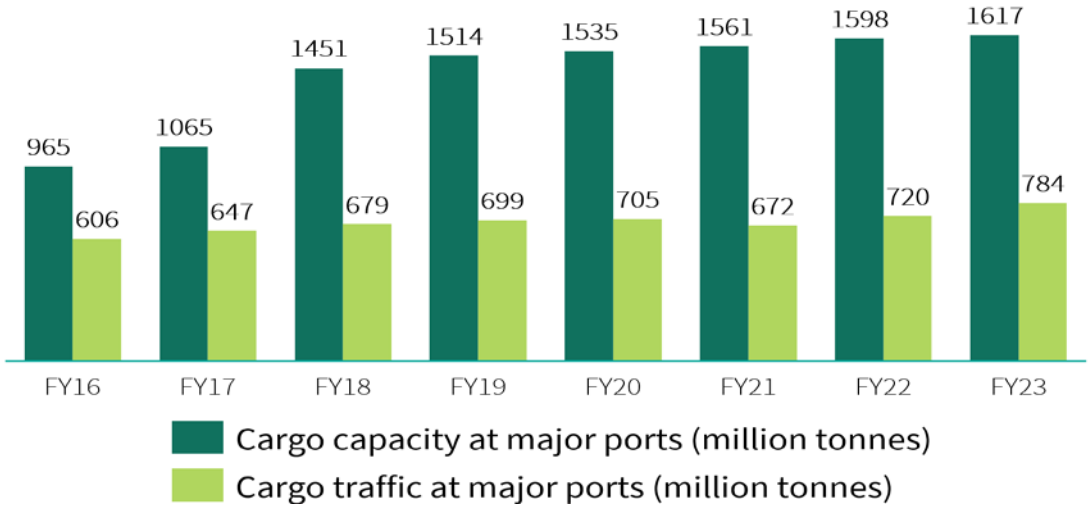


Figure 4: Cargo capacity and traffic at major Indian ports[5]

[6]There are 10 new waterways projects on the Brahmaputra in Assam, enhancing connectivity, boosting river tourism, and facilitating public commute, all under the Sagarmala programme. India also approved a Major Port at Vadhavan, Maharashtra, on 19 June 2024, with a budget of Rs. 76,220 crore (US$ 9.14 billion)[7] to boost EXIM trade, handle mega vessels, and encourage public-private partnerships in infrastructure. With 1,530 ships under its flag in 2023, India plans to add 1,000 ships[8] in the next decade by establishing a new shipping company. Jointly owned by state-run oil, gas, fertilizer firms, the Shipping Corporation of India, and foreign partners, the initiative aims to cut foreign freight costs by one-third by 2047 and boost trade revenue.

1.3 Green Shipping Challenges

The transition to green shipping is hindered by regulatory, financial, and operational barriers that impact various stakeholders across the maritime ecosystem. Inconsistent regulatory frameworks, **infrastructure gaps, and high capital costs** make the widespread adoption of sustainable practices challenging. **Technological limitations, fragmented supply chains, and investment risks further slow the transition**, particularly for shipowners, fuel producers, and logistics providers. Additionally, **stakeholder coordination remains weak**, with key industry players operating in silos, limiting the effectiveness of green initiatives.

A detailed stakeholder-level assessment of these challenges is included in the appendix, offering deeper insights into industry-wide pain points and potential solutions. The table below highlights key cross-cutting challenges that must be addressed to enable an efficient and sustainable transition for India's maritime sector.

[3] https://indiashippingnews.com/budget-2024-highlights-%E2%82%B9700-crore-for-sagarmala-programme/
[4] https://shipmin.gov.in/sites/default/files/Annual%20Report%202023-24_English.pdf
[5] https://www.ibef.org/industry/ports-india-shipping
[6] https://pib.gov.in/PressReleasePage.aspx?PRID=2015088
[7] https://www.ibef.org/industry/ports-india-shipping
[8] https://pib.gov.in/PressNoteDetails.aspx?NoteId=153432&reg=3&lang=1

Themes	Details
Regulatory Gaps and Bureaucratic Delays	Across multiple stakeholders, a lack of clear and coordinated regulatory frameworks emerges as a major challenge. Regulatory bodies face issues such as lengthy approval processes and outdated laws, which lead to the slow adoption of green practices. These delays cascade across logistics providers, inland shipping, and ancillary technology providers, compounding inefficiencies.
Infrastructure Deficiencies -	Significant gaps in infrastructure, especially at ports, inland waterways, and fuel supply chains, hinder the smooth adoption of sustainable practices. Poorly maintained waterways, limited facilities for green bunkering, and a lack of integrated transport networks disrupt operations for logistics providers, inland shipping operators, and maritime fuel producers.
Technological and Resource Limitations	Many stakeholders, particularly ancillary technology providers and shipyards, struggle with the unavailability or high cost of advanced green technologies. This challenge is further exacerbated by limited access to alternative fuels and feedstocks, which remain costly and difficult to scale for local production.
Fragmentation Across Supply Chains -	The logistics and supply chain for green shipping lack integration, leading to inefficiencies in operations, regulatory compliance, and investment flows. Fragmentation across state and national boundaries further complicates efforts to adopt sustainable practices, particularly for inland shipping.
Financial and Investment Barriers -	High costs associated with green transitions—spanning infrastructure upgrades, alternative fuel adoption, and emissions reduction technologies—pose significant financial challenges. Many stakeholders, including maritime fuel producers and ancillary providers, struggle to secure sufficient funding and investment due to unclear return on investment (ROI) and risks associated with new technologies.
Raw Material and Supply Chain Challenges	The maritime fuel producers face difficulties with raw materials for alternative fuels, such as biofuels and hydrogen. Supply chain constraints, coupled with high import dependence, limit the availability and affordability of sustainable options, impacting the entire ecosystem.
Operational and Strategic Barriers -	Immediate compliance requirements place a strain on shipowners and operators, while cargo owners face operational challenges in balancing cost-sharing and efficiency improvements. Inland shipping operators also encounter complex regulatory frameworks and fragmented processes that delay progress.
Long-Term Uncertainty	Stakeholders' express concerns about the long-term feasibility of green transitions. Unclear regulatory pathways, slow updates to standards, and uncertainty around future technologies create hesitation in adopting sustainable practices. This uncertainty is particularly acute for shipyards and ancillary technology providers, who must anticipate and plan for lifecycle emissions.
Coordination and Collaboration Deficiencies	A recurring theme is the lack of collaboration between stakeholders within the maritime industry. Regulatory bodies, financiers, logistics providers, and technology producers often operate in silos, delaying collective progress

Table 1: Green Shipping Challenge - Cross-cutting Themes

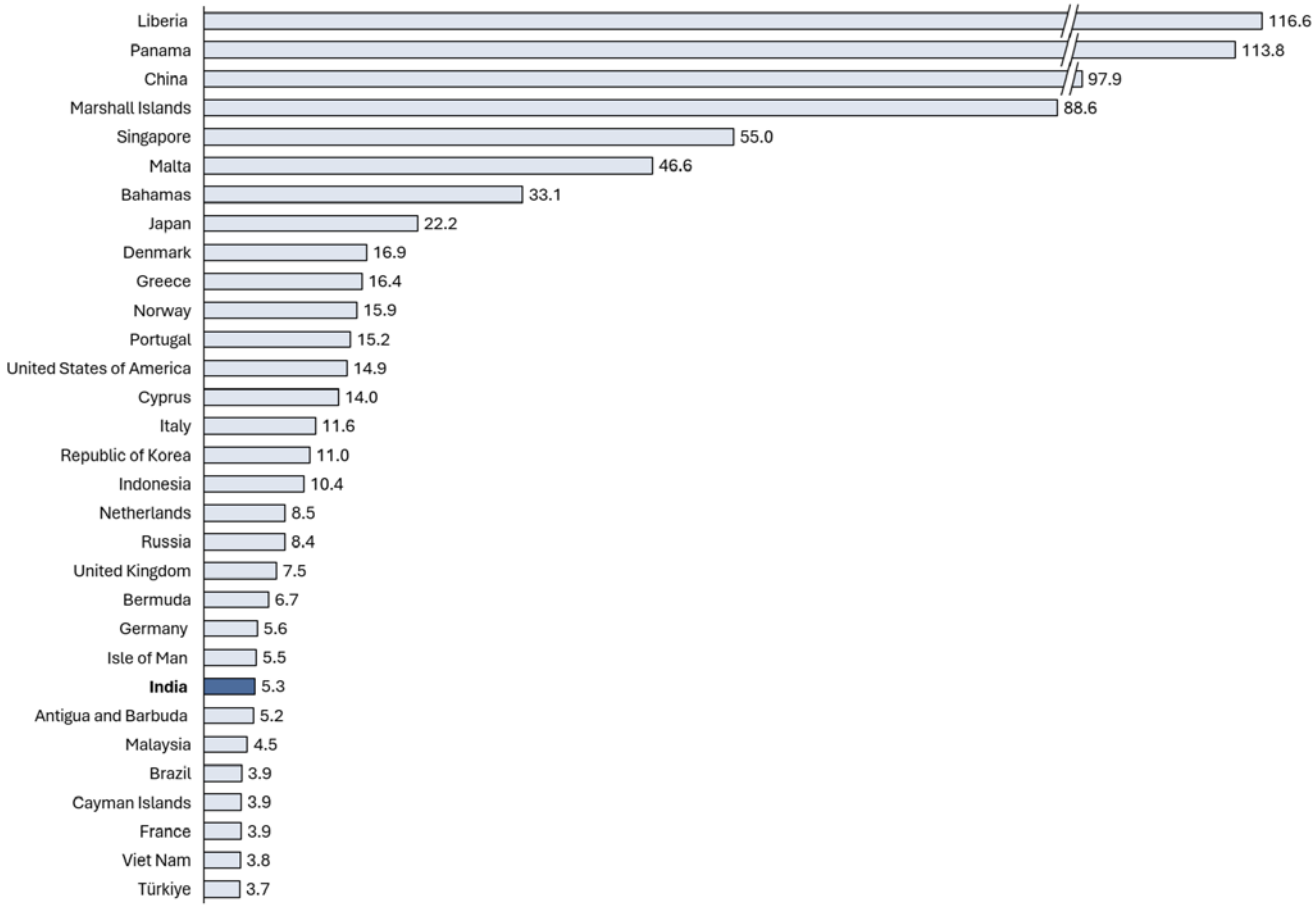
1.4 Need for a National Green Shipping Policy (NGSP)

As the global shipping industry accelerates its decarbonization efforts, **focused and aggressive green shipping practices** can significantly enhance India's competitiveness in international trade. Despite sustained economic

growth, India's maritime sector has relatively low carbon emissions (see Figure 5), indicating **untapped potential** in the global shipping landscape.

A comprehensive **National Green Shipping Policy (NGSP)** is necessary to address the green shipping challenge holistically and:

- **Ensure compliance** with international environmental regulations, particularly those set by the International Maritime Organization (IMO).
- **Promote innovation** in green technologies, such as emission-reducing systems, renewable energy sources, and energy-efficient ship designs.
- **Encourage investment** in shipbuilding, green energy production, and maritime technology development.
- **Foster an integrated approach** to maritime sustainability by aligning national climate commitments with sector-specific policies and international cooperation.



China includes China and Hong Kong SAR. Norway includes Norway (Norwegian International Ship Register (NIS)) and Norway

Figure 5: Carbon dioxide emissions (million metric tons) in 2022 for 33 main flags of registration[9]

[9] https://unctad.org/publication/review-maritime-transport-2023

1.5 Strategic Vision and Objectives

The NGSP aims to serve as a **strategic tool** for India to achieve environmental sustainability while maintaining a competitive edge in maritime trade. Key objectives include:

- **Environmental Sustainability** – Reducing the carbon footprint of the maritime industry through clean energy adoption, emission control measures, and sustainable operational practices.
- **Economic Growth and Competitiveness** – Strengthening India's shipbuilding, port infrastructure, and technological capabilities to position the country as a leader in green shipping.
- **Regulatory Compliance** – Ensuring adherence to global maritime environmental standards and international conventions ratified by India.
- **Technology and Innovation** – Encouraging research and development in alternative fuels, electrification, and digitalization of maritime operations.
- **Stakeholder Collaboration** – Creating a well-coordinated governance structure that brings together industry players, regulatory bodies, and environmental agencies.

The **NGSP is not just an environmental imperative but also a driver of economic and technological progress**. By adopting a structured and forward-looking green shipping policy, India can safeguard its maritime ecosystem while unlocking new economic and social opportunities. This report will provide **a strong foundation for legislative approval and successful implementation**, ensuring that India emerges as a global leader in sustainable maritime practices.

2 Baseline Study

2.1 Green Shipping – Barriers, Solutions & Opportunities

A comprehensive understanding of India's barriers to maritime decarbonization is essential for designing effective policy interventions. Building on the stakeholder challenges identified in Section 1.1, a root cause analysis was conducted, **incorporating insights from the 2022 Green Shipping** Conclave and LR's internal expertise. This approach was taken to ensure that policy recommendations are pragmatic, actionable, and adaptive to India's unique maritime landscape.

To systematically tackle these challenges, **the National Green Shipping Policy (NGSP)** must address two core areas:

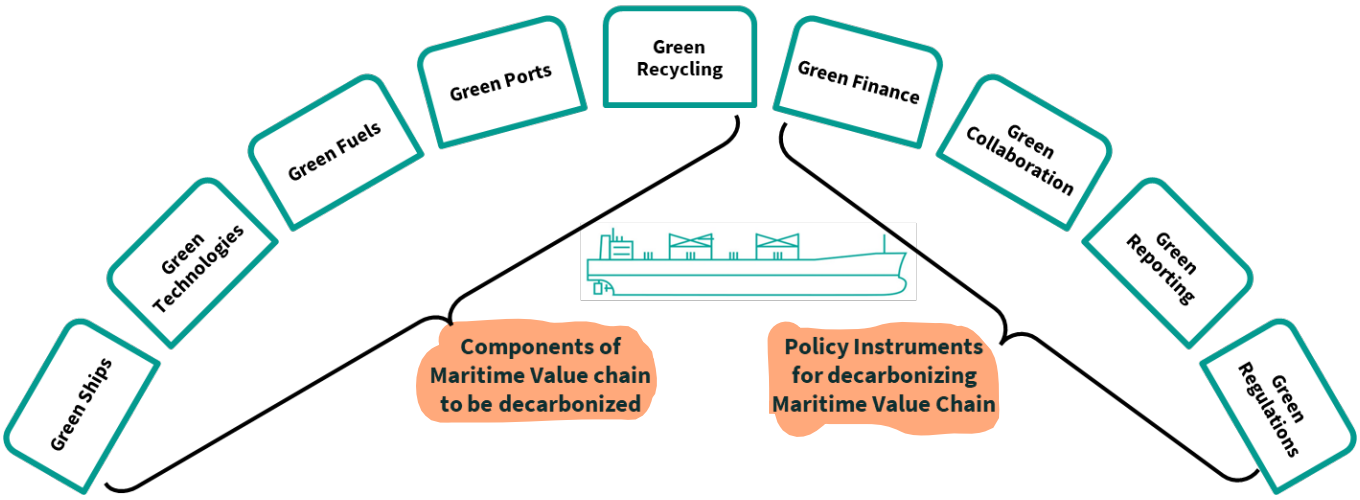


Figure 6: Core Areas of NGSP

- **Decarbonization** of the Maritime Value Chain
    - **Green Ships**: Incentivizing energy-efficient vessel designs and retrofits.
    - **Green Ports**: Upgrading infrastructure for alternative fuel bunkering and shore power.
    - **Green Technologies**: Promoting R&D in energy-saving devices and emission reduction solutions.
    - **Green Fuels**: Establishing supply chains for biofuels, green hydrogen, and LNG.
    - **Green Recycling**: Adopting circular economy principles in shipbreaking and materials recovery.

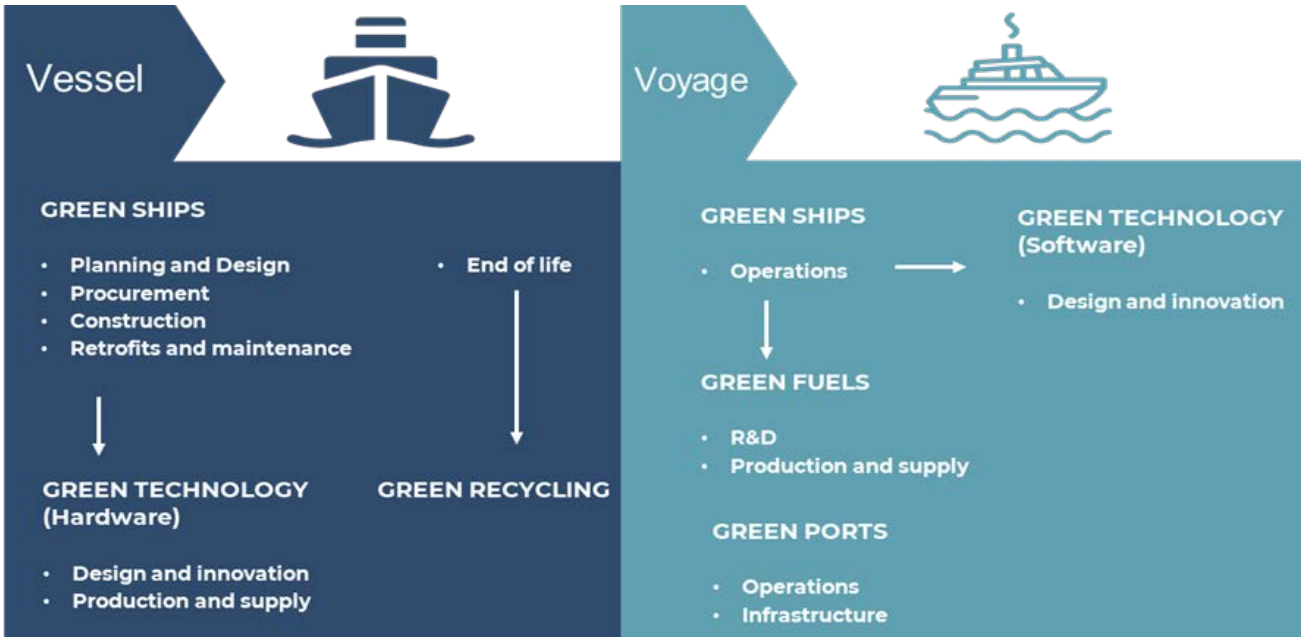


Figure 7: Maritime Value Chain

- Policy **Instruments** to Enable Decarbonization
    - **Green Finance**: Implementing tax benefits, subsidies, and ESG-linked investment frameworks.
    - **Green Collaborations**: Strengthening public-private partnerships for technology transfer and capacity building.
    - **Green Regulations**: Aligning India's policies with IMO's decarbonization strategy and global best practices.
    - **Green Reporting**: Enhancing transparency through emission reporting frameworks.

The challenges and barriers to the components of the Maritime Value Chain and the barriers to their decarbonization were assessed to conduct the root cause analysis and come up with possible solutions.

2.1.1 Green Ships

For shipowners and operators, the **shift toward green shipping is driven by regulatory compliance, fuel cost savings, and long-term sustainability goals**. Green ships incorporate **energy-efficient designs, optimised hull forms, and advanced propulsion systems to reduce emissions** while maintaining operational efficiency. **Alternative fuels such as methanol, ammonia, hydrogen, and biofuels** are increasingly being adopted as viable pathways to decarbonization.

Beyond newbuilds, existing fleets **must undergo strategic retrofits to remain competitive and compliant**. This includes the installation of **energy-saving devices, wind-assisted propulsion, and real-time emissions monitoring systems**. Additionally, **digitalization plays a crucial role, with AI-driven route optimization and fuel consumption analytics** enabling operators to enhance performance and reduce carbon footprints.

2.1.1.1 Critical Barriers

The adoption of green ships faces several critical barriers, primarily **high upfront costs, limited specialised expertise, and stakeholder reluctance**.

The high cost of transitioning to green shipping in India stems from several interconnected challenges. First, **green propulsion systems are expensive** due to the **high cost of producing, storing, and bunkering**

alternative fuels, coupled with **reliance on imported green technology components** such as fuel cells and batteries.

These challenges are **further exacerbated by infrastructure gaps and shortages of skilled labour trained in building, retrofitting, and operating green ships**, which **require significant R&D on ship designs and complex engineering requirements**.

Stakeholder resistance remains a key challenge, as many shipowners **hesitate to invest in green retrofitting or new builds due to concerns over uncertain returns**, particularly for older ships. Furthermore, **the awareness of long-term cost savings and operational advantages of green ships remains low**, slowing the transition toward sustainable maritime operations.

2.1.1.2 Possible Solutions and Key Opportunities

The following solutions outline key opportunities for overcoming critical barriers and driving India's leadership in green shipping:

Solutions	Key Opportunities
Efficient New Builds	Efficiency in design, production process, and indigenization of ancillaries/equipment.
Global Ship Design Hub	Develop advanced ship design expertise to serve global demand.
Hybrid New Builds & Retrofit-Ready Ships	Cost-effective hybrid ships and retrofit-friendly designs for export markets.
Larger Industrial associations	R&D partnerships and repurposing of infrastructure for innovation.
Retrofit Manufacturing Hub	Export retrofit solutions with expertise in design, manufacturing, and service.
Green Fuel Infrastructure	Domestic production, storage, and bunkering of alternative fuels.
Workforce Development	Specialized training in green shipbuilding and alternative fuels.
Financial Incentives & Policy Support	Green financing, tax benefits, and viability gap funding (VGF).
Awareness & Market Promotion	Industry campaigns on long-term cost savings and benefits.
Electric Boats & Ferries	Viability through incentives and infrastructure support.

Table 2: Possible Solutions and Key Opportunities Green Ships

2.1.2 Green Technologies

Green technology plays a pivotal role in accelerating the maritime industry's transition towards sustainability. Technology providers are continuously innovating to develop solutions that reduce carbon emissions, enhance fuel efficiency, and integrate digitalization for optimized operations. These advancements span across propulsion systems, energy storage, carbon capture, and fuel transition technologies.

A fundamental shift is needed in how green technologies are assessed and adopted in the maritime sector. Beyond regulatory compliance, policy interventions must promote lifecycle-based evaluations that consider emissions, energy efficiency, and technological adaptability alongside traditional cost considerations. Leveraging insights from adjacent industries, **maritime technology development must scale up with the support of regulations, infrastructure investments, and customer willingness to share the cost burden of early adoption**.

To maximize the impact of green technologies, seamless integration with existing vessel systems is crucial. By fostering collaboration between shipyards, operators, and technology providers, the maritime sector can create a robust ecosystem that accelerates the adoption of cutting-edge green solutions while ensuring economic viability.

2.1.2.1 Critical Barriers

The widespread adoption of green technologies in India's domestic shipping and shipbuilding sector is hindered by several structural and economic barriers. **High initial costs remain a primary challenge**, driven by the **expensive procurement of energy-efficient systems, emission-reduction solutions, and sustainable materials**. These financial burdens are compounded by **gaps in specialized infrastructure for manufacturing green technology components, inadequate research and development (R&D) on green components, and limited suppliers of raw materials** to cater to increasing global demand. Gaps in specialised expertise and knowledge of green components and digital technologies further exacerbate the challenges.

2.1.2.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green technology.

Solutions	Key Opportunities
Access to Technology for Refit & New Builds	India's engine suppliers have the capability to support refits and new builds, but leveraging European expertise can accelerate progress.
Improved Technology Knowhow & Service Availability	Global engine manufacturers (Wartsila, MAN, Cummins) have strong technical networks in India, enabling local expertise and cost-effective domestic adoption.
India as a Green Technology Manufacturing Hub	India's advanced green technology capabilities in the automotive sector can be leveraged for maritime decarbonization, strengthening local supply chains.
Hybrid Propulsion Systems	Hybrid engines improve efficiency but face challenges such as space constraints, high costs, and reliance on imported components. Supply chain gaps need to be addressed.
Carbon Capture & Sequestration (CCS)	CCS systems require additional space and are still in early-stage development. Research and regulations must evolve to enable adoption on larger vessels.

Table 3: Possible Solutions and Key Opportunities Green Technologies

2.1.3 Green Fuels

Green fuels are at the core of the maritime sector's decarbonization strategy, **offering pathways to reduce reliance on fossil fuels while aligning with the IMO's emissions reduction targets**. Among the most promising alternatives, **hydrogen and its derivatives—such as ammonia and methanol**—stand out due to their scalability and potential to significantly lower carbon footprints. However, their widespread adoption hinges on overcoming key challenges, including production costs, fuel stability, safety considerations, and the development of global bunkering infrastructure.

The transition to green fuels requires a structured and phased approach. **Drop-in biofuels provide an immediate pathway to emissions reduction without requiring major vessel modifications, while synthetic e-fuels, expected to play a larger role from 2030 onwards**, **demand cross-sector collaboration to address cost and logistical barriers**. A crucial factor in scaling these fuels is demand aggregation, as uncertainty between fuel producers and **ship operators perpetuates a "chicken-and-egg" dilemma**.

Industry-wide collaboration is essential to drive progress. **Pilot projects, regulatory alignment, and coordinated investment in supply chain infrastructure can accelerate the technological maturity of green**

fuels. A comprehensive framework that integrates policy incentives, safety regulations, and commercial viability will be key to bridging the gap between innovation and large-scale adoption in the maritime sector.

2.1.3.1 Critical Barriers

The adoption of green fuels in Indian domestic ships faces significant challenges. Diverse fuel options such as **LNG, methanol, biofuels, and e-fuels come with technological complexities and infrastructure limitations, requiring high capital investments and bunkering facilities**. Supply chain constraints include **inefficient collection, transportation, and limited availability of sustainable feedstocks, competing with other industries**. Economic constraints arise from the **high costs of green fuels, price volatility in an underdeveloped market, and potential trade impacts due to increased operational costs.** Industry resistance is driven by **high production costs of alternative fuels, retrofitting expenses, and lifecycle issues for existing fleets**, including premature decommissioning of conventional ships.

2.1.3.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green fuels.

Solutions	Key Opportunities
LNG	High bunkering infrastructure costs; demand aggregation for long-term investment; price volatility and methane slip challenges.
	Variable Gap Funding (VGF) and PPP models to bridge financial gaps.
	Long-term contracts to mitigate price volatility.
	Methane slip reduction through abatement technologies and sourcing from low-carbon LNG suppliers.
Biofuels (Blending)	Immediate and scalable solution; high GHG reduction potential; GOI's National Biofuel Policy supports adoption.
	High feedstock costs due to limited domestic availability and dependence on imports.
Bio-Gas/Bio-LNG	Abundant feedstock (municipal and agri-waste); high technology readiness level (TRL); easy adoption.
	Aggregation and liquefaction challenges for biomass feedstock.
	GOI policies supporting compressed bio-gas need an extension to bio-LNG production.
Hydrogen/Derivatives – Methanol/Ammonia	High TRL with minimal modification needed for storage and handling.
	Lack of developed bunkering infrastructure and global standards.
	Demand aggregation is needed to scale production and investment.
	VGF and PPP models to support infrastructure development.
	Classification societies to establish global bunker standards.
E-Fuels	Abundant renewable energy potential, but technology pathway uncertainty.
	Gradual fuel blending ramp-up to align with supply constraints.

Table 4: Possible Solutions and Key Opportunities Green Fuels

2.1.4 Green Ports

Green ports play a pivotal role in maritime decarbonization by **optimizing operations, supporting alternative fuel bunkering, and integrating renewable energy solutions.** As key **enablers of green shipping, ports must focus on reducing emissions, improving energy efficiency, and fostering collaboration among stakeholders** to accelerate the energy transition.

To achieve sustainability, **ports can adopt smart technologies for vessel scheduling and terminal operations, minimizing turnaround times and energy costs. Just-in-time arrival strategies** and **efficient berthing solutions** can further enhance port efficiency while reducing emissions. Additionally, ports have the opportunity to **optimize land use**, incorporating **carbon capture initiatives or renewable energy generation**, such as offshore wind or solar farms.

Ports also face growing pressure from ship operators, as their **infrastructure and services directly influence vessel Carbon Intensity Indicator (CII) ratings**. Establishing **Green Corridors**—dedicated trade routes supporting zero-emission shipping—**through international collaboration will be essential in scaling up sustainable port operations. Policy interventions, public-private partnerships, and investment in green infrastructure** will be crucial to making ports a cornerstone of the maritime energy transition.

2.1.4.1 Critical Barriers

Developing green ports in India is challenged by **high initial investment costs, limited domestic manufacturing of green technologies, and evolving supply chains. Infrastructure upgrades and workforce training are necessary** for handling new technologies, but **concerns over long payback periods and potential technological obsolescence create stakeholder reluctance**. Addressing these barriers requires **strategic investments, capacity building, and policy incentives** to drive long-term adoption of sustainable port practices.

2.1.4.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green ports.

Solutions	Key Opportunities
Green Corridors	Requires coordinated efforts among governments, industry bodies, and international partners.
	India can leverage its bilateral and multilateral relationships to formalize Green Corridors
	Standardization of digital solutions and harmonization of port systems will enable seamless operations
Just-In-Time (JIT) Arrival & Port Efficiency	Optimizing port design and berthing schedules can reduce congestion and emissions
	Digitalization of port operations and intelligent scheduling can improve turnaround times.
	Linking port efficiency with CII compliance can drive sustainable practices.
	National strategy for JIT implementation can ensure uniformity across ports
Shore Power (Cold Ironing)	Variations in power tariffs and tax structures across states pose challenges.
	India's lower shore power costs compared to Western markets offer an opportunity.

Solutions	Key Opportunities
	A centralized policy, similar to the EV Charging Policy, can standardize shore power infrastructure
	PPPs can support the integration of solar energy and carbon sinks into port infrastructure.
Greener Dredgers & Harbour Crafts	Current efficiency regulations (e.g., EEXI) do not apply to dredgers and harbour crafts
	Gaps in maintenance and energy efficiency training need to be addressed.
	Hybrid diesel-electric dredgers can serve as a transitional solution.
	Phasing out inefficient harbour crafts through regulatory mandates can support energy transition.
Bunkering Hubs for Alternative Fuels	India can emerge as a major bunkering hub for alternative fuels like hydrogen and ammonia
	Demand-supply assessment and regional baseline planning are required.
	Financial mechanisms such as concessional finance and partial credit guarantees can de-risk investments.
	Collaboration across the fuel value chain is crucial for infrastructure development.

Table 5: Possible Solutions and Key Opportunities Green Ports

2.1.5 Green Recycling

Ship recycling is a critical component of the maritime sector's sustainability efforts, ensuring that end-of-life vessels are dismantled in an environmentally responsible manner. The industry has traditionally faced **challenges related to hazardous waste disposal, unsafe working conditions, and inefficient material recovery**. However, with the adoption of green recycling practices, the sector can significantly reduce its environmental footprint while promoting circular economy principles.

Regulatory frameworks such as the **Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC) and the EU Ship Recycling Regulation (EUSRR) are driving improvements in recycling standards.** Additionally, advancements in automation, waste management, and material recovery technologies offer new opportunities to enhance efficiency and reduce emissions. Collaboration among shipowners, recycling yards, and regulatory bodies is essential to ensure compliance and create a sustainable recycling ecosystem.

2.1.5.1 Critical Barriers

India's ship recycling industry faces challenges related **to infrastructure limitations, competition from regional players, and gaps in regulatory enforcement**. **Compliance with environmental and labour laws** remains inconsistent, while underreporting of hazardous materials continues to be a concern. Many recycling yards rely on **unmechanized processes, leading to inefficiencies and higher emissions.** Additionally, labour conditions require improvement to ensure worker safety and rights. Addressing these issues is essential for developing a globally competitive and environmentally responsible ship recycling sector.

2.1.5.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green ship recycling.

Solutions	Key Opportunities
Regulatory Compliance	Ensuring adherence to international regulations like the Hong Kong Convention (HKC) and the EU Ship Recycling Regulation (EUSRR) to improve safety and environmental performance.
Sustainable Dismantling Practices	Adoption of environmentally sound methods such as safer cutting techniques, hazardous waste management, and spill prevention to minimize pollution.
Material Recovery & Circular Economy	Enhancing the recovery and reuse of steel, non-ferrous metals, and other recyclable materials to support circular economy initiatives and reduce demand for virgin materials.
Automation & Technology Integration	Implementing robotic dismantling, AI-driven waste sorting, and advanced monitoring systems to improve efficiency and worker safety.
Worker Safety & Training	Providing enhanced training programs and protective equipment to ensure safe working conditions in recycling yards.
Green Certifications & Incentives	Encouraging shipowners to use HKC-certified yards and incentivizing compliance through financial mechanisms such as green finance or sustainability-linked ship disposal schemes.
Infrastructure Development	Upgrading ship recycling facilities to meet global environmental standards and investing in proper waste disposal infrastructure.
Extended Producer Responsibility (EPR)	Encouraging shipbuilders and owners to consider end-of-life disposal in the design phase, promoting eco-friendly materials and modular construction for easier recycling.

Table 6: Possible Solutions and Key Opportunities Green Recycling

2.1.6 Green Finance

Green finance plays a critical role in facilitating the transition towards a sustainable maritime sector by **ensuring capital flows into environmentally responsible projects**. However, financing green transitions poses inherent risks for investors due to **high initial capital expenditures, fragmented ownership structures, and uncertainties surrounding emerging technologies**. Addressing these challenges requires **coordinated action from governments, financial institutions, and industry stakeholders**.

While mechanisms such as **green bonds and sustainability-linked loans have gained traction** in well-developed banking sectors, accessibility to affordable commercial finance remains a constraint, particularly in developing economies. **De-risking investments through structured financial instruments, blended finance models, and government-backed guarantees can help improve bankability and attract private sector participation.** The International Maritime Organization **(IMO) and other global bodies are driving initiatives to harmonize financing frameworks,** particularly in developing regions where balancing economic growth with sustainability is crucial.

A **long-term approach to investment decisions, incorporating lifecycle cost assessments and risk-sharing mechanisms, can support the viability of green projects**. Leveraging learning from other sectors that have successfully de-risked green investments will further enable the maritime industry to accelerate its sustainability transition.

2.1.6.1 Critical Barriers

India faces several barriers to scaling green finance, including **high initial capital costs, limited access to affordable financing, and an underdeveloped green bond market**. The **absence of a robust green taxonomy and weak carbon pricing mechanisms create uncertainty for investors, while regulatory and policy inconsistencies add to the risk**. Financial institutions often **lack the expertise to assess green projects, and fragmented ownership structures make large-scale investments complex.** Additionally, reliance on **emerging technologies increases perceived risk, and inadequate ESG transparency hinders investor confidence**. Addressing these challenges requires clear national policies, blended finance models, stronger carbon pricing, and enhanced financial innovation to unlock the full potential of green investments.

2.1.6.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green finance.

Solutions	Key Opportunities
Green Bonds & Sustainability-Linked Loans	Expanding the use of green finance instruments to incentivize sustainable investments while ensuring transparency and accountability.
Blended Finance Models	Combining public and private capital to de-risk investments and improve access to affordable financing, especially in developing nations.
Government-Backed Credit Guarantees	Offering partial risk guarantees or concessional financing to lower borrowing costs for green projects.
Carbon Pricing & Market-Based Incentives	Establishing carbon pricing mechanisms and emissions trading schemes to create financial incentives for sustainable shipping investments.
Technology Risk Mitigation	Supporting research, development, and pilot projects through grants, subsidies, and public-private partnerships to accelerate commercial adoption.
Long-Term Lifecycle Financing	Encouraging investment decisions based on total cost of ownership rather than just upfront capital expenditures.
Financial Standardization & Harmonization	Aligning global green finance standards to improve investor confidence and facilitate cross-border investments.

Table 7: Possible Solutions and Key Opportunities Green Finance

2.1.7 Green Collaboration

Collaboration across the maritime industry is essential to accelerate the transition towards sustainability. Green shipping initiatives require **coordinated efforts among shipowners, ports, fuel suppliers, regulators, and financial institutions to overcome technological, financial, and regulatory barriers**. Partnerships between public and private entities can drive innovation, establish best practices, and create incentives for sustainable operations.

Global and regional collaborations, such as green shipping corridors and cross-sectoral alliances, play a crucial role in aligning policies, standards, and investments. Industry-wide cooperation **ensures the scalability of green technologies, facilitates knowledge sharing, and enhances the adoption of sustainable fuels and digital solutions**. Strengthening multi-stakeholder engagement through forums, research initiatives, and pilot projects will be key to unlocking the full potential of green shipping and creating a harmonized approach to decarbonization.

2.1.7.1 Critical Barriers

The critical barriers to green collaboration in India stem from r**egulatory fragmentation, limited industry alignment, and financial constraints.** The absence of standardized policies and frameworks across states and sectors creates inconsistencies in implementing green initiatives. Private sector hesitancy due to high initial investment costs and uncertain returns further slows down collaborative efforts. Additionally, **insufficient cross-sector engagement between maritime, energy, and financial stakeholders, limits knowledge sharing and coordinated action**. The **lack of large-scale pilot projects and green shipping corridors also hinders widespread adoption.** Strengthening policy coherence, incentivizing partnerships, and fostering industry-wide collaboration will be essential to overcoming these barriers.

2.1.7.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green collaboration.

Solutions	Key Opportunities
Public-Private Partnerships (PPPs)	Facilitate investment in green technologies and infrastructure through risk-sharing mechanisms.
Green Shipping Corridors	Encourage international collaboration for zero-emission routes by aligning policies, fuel supply, and infrastructure.
Standardization of Green Regulations	Harmonizing emission standards, fuel certification, and compliance frameworks across regions to streamline adoption.
Cross-Sector Collaboration	Engage with industries like renewable energy and automotive to leverage technological advancements in green fuels and energy efficiency.
Industry Knowledge Sharing	Foster collaboration between companies, governments, and research institutions to share best practices and accelerate innovation.
Joint Investment and Funding Mechanisms	Develop blended finance models, green bonds, and concessional funding to de-risk green investments.
Digitalization and Data Sharing	Promote the use of digital tools and real-time data exchange to improve operational efficiencies and emissions tracking.
Green R&D Initiatives	Strengthen cooperation on research and pilot projects for alternative fuels, vessel efficiency, and carbon capture technologies.

Table 8: Possible Solutions and Key Opportunities Green Collaboration

2.1.8 Green Reporting

Transparent and standardized green reporting is crucial for driving accountability and informed decision-making in the maritime sector. As regulatory frameworks such as the IMO's Carbon Intensity Indicator (CII) and the EU Emissions Trading System (ETS) evolve, **shipping companies and port operators must ensure compliance with increasingly stringent disclosure requirements**. **Effective green reporting enables stakeholders to track progress against decarbonization targets, assess environmental performance, and attract sustainable finance.**

A major challenge lies in the **inconsistency of reporting standards**, with varying frameworks such as the Task Force on Climate-related Financial Disclosures (TCFD), Sustainability Accounting Standards Board (SASB), and Global Reporting Initiative (GRI) leading to fragmented reporting practices. Furthermore, **data availability and accuracy remain key concerns, as robust emissions tracking and lifecycle assessments require harmonized methodologies and technological advancements, including digital monitoring tools and blockchain-based verification.**

To enhance green reporting, industry-wide collaboration is essential to establish standardized metrics, ensure transparency, and align disclosures with global sustainability benchmarks. Leveraging digitalization, regulatory incentives, and best practices from leading global ports and shipping companies will help streamline reporting and drive the industry toward meaningful sustainability commitments.

2.1.8.1 Critical Barriers

The critical barriers to green reporting in India include **challenges in aligning with international sustainability disclosure frameworks, inconsistent regulatory enforcement, and limited access to reliable environmental data**. Many companies struggle with tracking and verifying emissions due to fragmented reporting requirements across industries and varying global standards such as GRI, TCFD, and SASB. **While SEBI's BRSR provides a structured ESG reporting framework, gaps remain in implementation, comparability, and data quality**. Additionally, the **high cost of digital monitoring systems and a shortage of ESG professionals further hinder transparency**. Addressing these barriers requires harmonization of reporting standards, regulatory clarity, and investment in technology-driven data collection.

2.1.8.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green reporting.

Solutions	Key Opportunities
Standardized Sustainability Reporting Frameworks	Aligning with global standards like GRI, TCFD, and SASB can enhance transparency.
Regulatory Clarity and Enforcement	The absence of clear guidelines and enforcement mechanisms makes compliance difficult. Strengthening regulatory frameworks can drive better adoption.
Digital Monitoring and Data Collection	High costs and lack of infrastructure hinder accurate environmental data tracking. Investing in digital solutions can streamline real-time emissions tracking.
Capacity Building and ESG Training	Shortage of skilled professionals affects reporting accuracy. Upskilling industry professionals in ESG and sustainability reporting is critical.
Mandatory vs. Voluntary Disclosure	Companies lack incentives to report voluntarily. Establishing phased mandatory reporting requirements can drive compliance while allowing businesses to adapt.
Third-Party Verification and Assurance	Greenwashing concerns undermine credibility. Encouraging independent audits and verifications can enhance stakeholder trust.
Integration of Financial and Sustainability Reporting	Sustainability data is often siloed from financial reporting, limiting a holistic assessment of business performance. Integrating ESG factors into financial disclosures, aligned with frameworks like ISSB and BRSR Core, can enhance investor confidence and decision-making.

Table 9: Possible Solutions and Key Opportunities Green Reporting

2.1.9 Green Regulations

Green regulations play a crucial role in shaping the transition towards a sustainable and low-carbon economy. In India, regulatory frameworks are evolving to address environmental concerns, but challenges remain in enforcement, alignment with global standards, and **balancing economic growth with sustainability**. Effective green regulations must provide **clear guidelines, incentivize compliance, and create a level playing field for industries adopting green practices**. Policies such as **extended producer responsibility (EPR), carbon pricing mechanisms, and stricter emission norms can drive progress**. Additionally, **collaboration between**

government agencies, industry bodies, and financial institutions is essential to ensure effective implementation and compliance. Strengthening monitoring mechanisms and integrating digital tools can further enhance regulatory effectiveness, ensuring transparency and accountability in environmental performance.

2.1.9.1 Critical Barriers

India faces several critical barriers to effective green regulation, including fragmented policy implementation, **regulatory uncertainty, and weak enforcement mechanisms**. The lack of **coordination between central and state authorities leads to inconsistencies, making compliance difficult for businesses**. Additionally, industries often struggle with the **high costs of adopting green technologies, especially in the absence of financial incentives or clear long-term policy roadmaps**. Limited institutional capacity to monitor and enforce environmental regulations further hampers progress. Aligning national regulations with global sustainability standards while ensuring economic feasibility remains a key challenge in India's green transition.

2.1.9.2 Possible Solutions and Key Opportunities

The table below outlines key solutions and opportunities for green regulation.

Solutions	Key Opportunities
Harmonization of Regulations	Address inconsistencies in enforcement by standardizing green regulations across states.
Policy Stability and Long-Term Roadmap	Reduce uncertainty by ensuring long-term regulatory frameworks and minimizing frequent policy changes.
Incentives for Compliance	Support SMEs and industries by offering tax benefits, subsidies, or reduced compliance costs for adhering to green regulations.
Strengthening Institutional Capacity	Enhance monitoring and enforcement mechanisms by investing in skilled regulatory bodies and digital tracking systems.
Public-Private Collaboration	Engage businesses, industry bodies, and civil society in co-developing practical and effective green policies.
Integration with Global Standards	Align national regulations with international sustainability frameworks (e.g., IMO, EU ETS) to boost credibility and attract green investments.
Sector-Specific Regulatory Pathways	Develop tailored regulatory approaches for different industries to ensure feasibility and sectoral alignment.
Technology and Data-Driven Compliance	Leverage digital tools, AI, and real-time monitoring systems to enhance transparency and accountability in regulatory compliance.

Table 10: Possible Solutions and Key Opportunities Green Regulations

2.1.10 NGSP Focus Areas

The table below summarises the key NGSP focus area coming out from the above assessments

Policy Focus Areas	Key Solutions	Strategic Opportunities
Decarbonizing Ships & Technology Adoption	- Promote energy-efficient ship designs (retrofit-ready & hybrid new builds)	- Position India as a global green ship design and retrofit hub
	- Encourage adoption of hybrid propulsion, CCS, and alternative fuel engines	- Develop a supply chain for hybrid engines and alternative fuel components

Policy Focus Areas	Key Solutions	Strategic Opportunities
	- Leverage India's automotive expertise for maritime technology localization	
Alternative Fuels & Infrastructure	- Invest in LNG, biofuels, methanol, ammonia, and e-fuel supply chains	- Establish India as a leader in alternative fuel bunkering
	- Support demand aggregation & bunkering hubs	- Leverage bio-gas/bio-LNG potential for domestic fuel security
	- Incentivize methane slip reduction and carbon abatement technologies	
Green Port & Shipping Corridors	- Develop green corridors & shore power infrastructure	- Strengthen India's global maritime trade position through efficient, low-carbon port operations
	- Implement Just-in-Time (JIT) arrival systems	- Attract green shipping investments via improved port efficiency
	- Improve port digitalisation & inter-port connectivity	
Ship Recycling & Circular Economy	- Enforce compliance with HKC & EUSRR standards	- Make India a global leader in sustainable ship recycling
	- Improve worker safety, automation & hazardous waste management	- Reduce environmental impact through better material recovery
	- Enhance steel & material recovery for a circular economy	
Financing & Incentives for Green Transition	- Expand green bonds & sustainability-linked loans	- Increase access to capital for shipowners investing in sustainability
	- Offer concessional financing, viability gap funding (VGF), and tax benefits	- Strengthen India's role in global green finance markets
	- Develop carbon pricing mechanisms & emissions trading	
Regulatory Harmonization & Compliance	- Align national green shipping regulations with IMO, EU ETS, and global standards	- Improve India's credibility in global maritime regulations
	- Introduce sector-specific pathways for compliance	- Reduce compliance burden through regulatory predictability
	- Strengthen enforcement via digital monitoring & AI-driven compliance tools	
Capacity Building & Workforce Development	- Upskill workforce in green shipbuilding, alternative fuels, and ESG reporting	- Develop India as a hub for maritime sustainability expertise

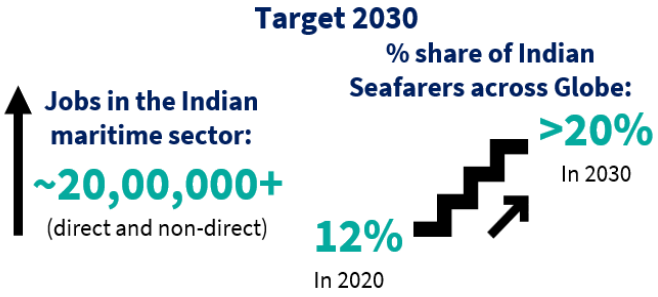
Policy Focus Areas	Key Solutions	Strategic Opportunities
	- Promote industry-academia collaboration for R&D & knowledge sharing	- Improve transparency in ESG reporting & investor confidence
	- Encourage digitalization of emissions tracking & sustainability reporting	
Public-Private Partnerships (PPPs) & Collaboration	- Develop PPP models for green R&D & infrastructure	- Attract foreign investment in India's green shipping transition
	- Facilitate joint funding mechanisms (green bonds, concessional finance)	- Strengthen India's role in global sustainability efforts
	- Promote international collaboration on fuel supply chains & port standardization	

Table 11: Policy Focus Area

3 Review of Current Maritime Policies in India Aimed at Green Shipping

3.1 Maritime India Vision 2030 (MIV 2030)

3.1.1 Overview



Maritime India Vision 2030 (MIV 2030) aims to position India as a global maritime leader through a comprehensive framework of **over 150 initiatives focused on enhancing infrastructure, connectivity, and sustainability in the maritime sector**. A major focus is on infrastructure development, where **MIV 2030 seeks to modernize ports and improve logistics efficiency to reduce costs and enhance operational capabilities**. This includes **upgrading existing port facilities, developing new mega ports, and improving inland waterways** to create a more integrated and efficient transportation network. Additionally, MIV 2030 emphasizes technological innovation, promoting the **adoption of smart technologies in shipping and port operations** to streamline processes and improve safety.

Another critical area of focus is sustainability. **MIV 2030 aims to decarbonise maritime activities by integrating renewable energy solutions and promoting green shipping practices**. This involves reducing greenhouse gas emissions from the maritime sector, which currently contributes significantly to global emissions. The vision also **highlights the importance of capacity building** within the maritime workforce, aiming to develop a skilled labour pool capable of meeting the demands of an evolving industry. By fostering maritime education and training programs, **MIV 2030 seeks to create over 2 million jobs** while reinforcing India's position as a hub for maritime excellence. Overall, Maritime India Vision 2030 represents a holistic approach to transforming India's maritime landscape, aligning with global standards for sustainability and efficiency while driving economic growth.

3.1.2 Gaps/Limitations

The Maritime India Vision 2030 (MIV 2030) sets ambitious goals to elevate India's maritime sector however reveals few gaps in its approach to sustainability and decarbonization. The shortfall lies in the limited emphasis on green shipping practices. While MIV 2030 focuses on infrastructure development and operational efficiency, it lacks a comprehensive framework for integrating sustainable technologies and practices. For example, the **vision falls short of promoting alternative fuels like LNG and hydrogen or incentivizing retrofitting vessels to lower emissions**. Furthermore, the **absence of targeted policies to address financial barriers faced by shipping companies in adopting green technologies** risks slowing the sector's transition to low-carbon operations.

Although MIV 2030 recognizes the importance of sustainability, its strategies for decarbonization remain underdeveloped. The vision highlights port modernization and the adoption of renewable energy in port operations, such as solar and wind power. However, it **provides limited direction for implementing advanced propulsion systems or alternative fuels across the broader shipping industry**, leaving a gap in achieving significant reductions in greenhouse gas emissions.

Additionally, MIV 2030 **lacks detailed plans for establishing green shipping corridors or fostering collaboration with global decarbonization initiatives**. Strengthening these aspects is essential to align India's maritime sector with international sustainability standards and ensure the nation's long-term environmental and economic resilience. Closing these gaps would better position India to lead in sustainable maritime development while meeting global expectations.

3.1.3 How NGSP can contribute

The NGSP can effectively address the gaps identified in the Maritime India Vision 2030 (MIV 2030) related to sustainability and enhance its decarbonisation strategies in the following ways –

A. It can **promote the adoption of alternative fuels** such as LNG and hydrogen

B. It can implement **financial mechanisms, such as subsidies or tax incentives, to alleviate the financial burdens** associated with transitioning to greener technologies

C. It can provide **detailed guidelines for integrating advanced propulsion systems and renewable energy sources** in maritime operations.

D. By **establishing green shipping corridors**, the policy can foster collaboration with international decarbonisation initiatives, aligning India's maritime sector with global sustainability standards.

E. It can address **workforce development by incorporating sustainability-focused training programs** into maritime education curricula. This would ensure that future maritime professionals are equipped with the knowledge and skills necessary to implement green technologies and practices effectively.

3.2 Panch Karma Sankalp

3.2.1 Overview

The Panch Karma Sankalp, introduced during the MoPSW Chintan Shibir**, outlines a transformative roadmap with five focus areas aimed at advancing sustainability, efficiency, and inclusivity in India's maritime sector**. Central to these initiatives is **decarbonization**, with measures such as the **Green Tug Transition Programme** and the development of **Green Hydrogen Hubs at Deendayal Port** and **VO Chidambaranar Port**. These efforts focus on reducing greenhouse gas emissions through eco-friendly tugs and renewable energy adoption, aligning India's maritime industry with global environmental standards and paving the way for leadership in green shipping.

The Sankalp also highlights **digitalization**, envisioning technologically advanced ports and streamlined operations. Plans to **transform Jawaharlal Nehru Port and VO Chidambaranar Port into Smart Ports by 2024** showcase the integration of AI, IoT, and blockchain to enhance decision-making, optimize logistics, and improve operational efficiency. Additionally, a **Single Window Portal for river and sea cruise bookings aims to simplify processes**, improving user experience and boosting maritime connectivity.

Complementing these advancements, **the Sankalp emphasizes port modernization, increased transshipment, and coastal community development.** Efforts to modernize port infrastructure and mechanization are designed to **reduce logistics costs and position India as a global transhipment hub**. Coastal community development initiatives ensure that maritime growth translates into inclusive progress, focusing on **job creation, skill development, and sustainable livelihoods for coastal populations**. Together, these initiatives present a comprehensive vision for a future-ready maritime sector, balancing economic growth, environmental stewardship, and social equity.

3.2.2 Gaps/Limitations

The initiative lacks a comprehensive regulatory framework to enforce the adoption of green technologies and fuels, which may lead to inconsistent implementation across various ports. Additionally, the **financial support provided—30% for green shipping initiatives—may fall short of covering the substantial costs associated with retrofitting or constructing new vessels**. This is particularly concerning for smaller shipping companies that may struggle to secure funding for such investments without more robust financial incentives. There are challenges related to the integration of emerging technologies and stakeholder engagement. While the establishment of smart ports and a Single Window Portal is a positive step, the **current strategy does not**

sufficiently address the need for training and capacity building among port staff to effectively utilize these technologies. Furthermore, the initiative lacks clear metrics for measuring sustainability success, making it difficult to assess progress and adapt strategies accordingly.

3.2.3 How NGSP can contribute

The National Green Shipping Policy (NGSP) can effectively address the gaps identified in the Panch Karma Sankalp in the following ways –

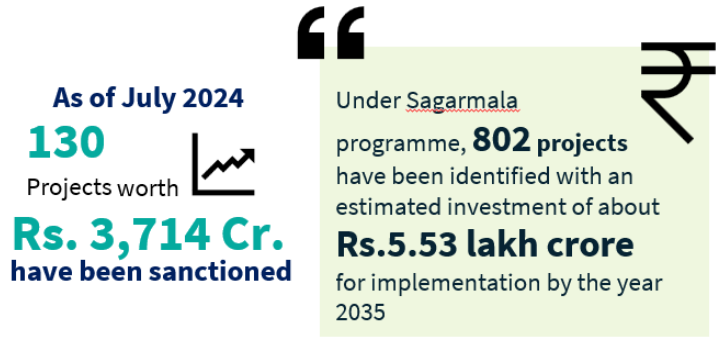
A. It can **establish clear regulations that mandate the use of environmentally friendly technologies across all ports**, ensuring uniform implementation and compliance among stakeholders.

B. It can **introduce enhanced financial incentives, such as grants, or low-interest loans** specifically targeted at small and medium-sized enterprises (SMEs).

C. It can prioritize **training programs for port staff**

3.3 Sagarmala Programme

3.3.1 Overview



The Sagarmala Programme, launched by the Government of India, focuses on **transforming the country's maritime sector through four key areas**. **Port modernization and new port development** aim to enhance the capacity and efficiency of existing ports while establishing new greenfield ports. This is **complemented by port connectivity enhancement**, which seeks to **improve the links between ports and their hinterlands through multi-modal logistics solutions**, optimizing both cost and time for cargo movement. The **initiative also emphasizes port-linked Industrialization**, promoting the **development of industrial clusters near ports and establishing Coastal Economic Zones to streamline logistics for export-import (EXIM) and domestic cargo**.

In addition to infrastructure development, the Sagarmala Programme **prioritizes Coastal Community Development by fostering sustainable growth in coastal regions**. This **includes skill development, livelihood generation, fisheries enhancement, and promoting coastal tourism**. By focusing on these areas, the programme aims to reduce logistics costs for both domestic and international trade while uplifting coastal communities, ultimately contributing to India's economic growth and enhancing its competitiveness in global maritime trade.

3.3.2 Gaps/Limitations

The Sagarmala Programme faces several gaps in facilitating green shipping and sustainable maritime practices. Although the initiative aims to enhance infrastructure and promote economic growth, it has not adequately addressed the management of waste entering coastal areas from major river systems, which contributes significantly to marine pollution. The current approach has been criticized for not integrating existing environmental programs, such as the Swachh Bharat Mission and the National Mission for Clean Ganga, which could provide a more holistic strategy for waste management and pollution control.

The Sagarmala Programme has encountered challenges related to stakeholder engagement and community impact. Local fishing communities have expressed concerns about potential displacement and adverse effects on their livelihoods due to port developments. **The programme's focus on economic growth has sometimes overshadowed the need for sustainable practices that consider ecological balance and social equity.**

Furthermore, there is a pressing need for enhanced financial support and investment mobilization to ensure that green technologies are adopted effectively. Without addressing these gaps, the Sagarmala Programme may struggle to achieve its objectives of promoting sustainable maritime practices while balancing economic development with environmental protection.

3.3.3 How NGSP can contribute

The National Green Shipping Programme (NGSP) can complement the Sagarmala Programme by addressing critical gaps in environmental sustainability and community inclusivity. By establishing a comprehensive regulatory framework, the **NGSP can enforce strict mandates for waste management, emissions control, and biodiversity protection in port expansions and shipping activities**. This ensures that infrastructure development aligns with ecological preservation. These efforts will enhance the overall sustainability of maritime activities while protecting India's coastal and marine ecosystems.

The **NGSP can foster innovation and inclusivity by promoting green technologies and prioritizing community engagement**. Financial incentives, such as subsidies and tax benefits, can accelerate the adoption of cleaner fuels, energy-efficient vessels, and electrified port operations, reducing the maritime sector's carbon footprint. Simultaneously, **involving vulnerable groups like fishing communities in participatory planning processes and offering livelihood support can mitigate socio-economic disruptions caused by port and coastal developments**. Through robust monitoring and evaluation mechanisms, the NGSP can track progress on sustainability metrics like carbon reduction and biodiversity conservation, ensuring accountability. These targeted interventions position the NGSP as a crucial enabler of a balanced approach to economic development and environmental stewardship within India's maritime sector.

3.4 Amrit Kaal Vision 2047[10]

3.4.1 Overview

The Amrit Kaal Vision 2047, developed by the Ministry of Ports, Shipping & Waterways, **builds upon the Maritime India Vision 2030** to establish **world-class ports, enhance inland water transport and coastal shipping, and promote a sustainable maritime sector**. Anchored in India's Blue Economy, the vision was **shaped through 150+ stakeholder consultations and the analysis of 50 international benchmarks**, **identifying 300+ actionable initiatives for ports, shipping, and waterways**. It was **unveiled during the Global Maritime India Summit and is backed by an investment of Rs. 80,000 lakh crores**, driving a transformative shift in India's maritime sector.

Figure 8: Key Themes of Amrit Kaal Vision 2047

This vision sets a clear path for modernization, sustainability, and global competitiveness, **establishing India as a maritime powerhouse by 2047.**

[10] https://shipmin.gov.in/content/amrit-kaal-2047

3.4.2 Gaps/Limitations

While the Vision outlines significant steps toward a sustainable maritime future, there are areas where further attention could enhance its effectiveness. A **more integrated green financing framework** could support the implementation of technologies like hydrogen/ammonia hubs and decarbonization projects, which require substantial capital. Additionally, although the Vision emphasizes international partnerships, increased collaboration with global leaders in sustainable maritime technology and shared research could accelerate the adoption of green innovations. Similarly, a clearer roadmap and supporting incentives for the adoption of low-carbon fuels like LNG, hydrogen, and ammonia could help accelerate their transition. Capacity-building efforts in maritime training are important, and focusing on specialized skills for green technologies could better equip stakeholders for the sector's evolving needs.

3.4.3 How NGSP can contribute

A. **Green financing mechanism to support low-emission projects at ports and in shipping**, including green bonds, carbon markets, and public-private partnerships. Provide tax incentives, grants, and concessional loans to promote green shipbuilding and retrofitting.

B. International **collaborations through research centres on green maritime technologies**, aligning policies with global decarbonization strategies to access cutting-edge solutions.

C. Clear policy roadmap for adopting alternative fuels, with financial incentives and infrastructure development, **including LNG and hydrogen bunkering facilities,** and set specific timelines for fuel adoption.

D. **Green maritime training academies and integrate sustainability into maritime curricula** at all levels, fostering research in decarbonization to build a skilled workforce for green technologies.

3.5 Green Tug Transition Program[11]

3.5.1 Overview

The Green Tug Transition Program (GTTP), launched by the Government of India, focuses on transforming the tugboat fleet operating in Indian major ports to enhance environmental sustainability. One of the **primary objectives is to phase out conventional fuel-based harbour tugs and replace them with "green tugs" powered by non-fossil fuels such as methanol, hydrogen, and ammonia**. The program aims to establish India as a global hub for green shipbuilding **by 2030, with a target of converting at least 50% of all tugs to green technologies** by that year. Initial efforts will begin with the introduction of green hybrid tugs, which will utilize hybrid propulsion systems, setting the stage for broader adoption of sustainable fuel alternatives as the industry evolves.

[12]

In addition to reducing emissions, **the GTTP emphasizes enhancing domestic shipbuilding capabilities through its alignment with the 'Make in India' initiative**. By ensuring that all tugs built under this program are constructed in Indian shipyards, the GTTP aims to stimulate local innovation and create significant employment opportunities within the maritime sector. The program is also **designed to support India's**

[11] https://shipmin.gov.in/sites/default/files/GTTP%20SOP%20with%20forwarding%20letter.pdf
[12] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2045946

commitment to achieving the United Nations Sustainable Development Goals (SDGs), particularly in managing and protecting marine ecosystems from pollution. Through these focus areas, the GTTP represents a significant step towards fostering a greener maritime landscape in India while promoting economic growth and sustainability.

3.5.2 Gaps/Limitations

The Green Tug Transition Program (GTTP), while a significant step towards sustainable maritime practices in India, has several gaps that could hinder its effectiveness in facilitating green shipping. **One primary concern is the high initial costs associated with transitioning to green tugs, which may deter private operators from investing** in the necessary technology. Although the program aims to replace conventional fuel-based tugs with greener alternatives, the financial burden of retrofitting or acquiring new vessels powered by non-fossil fuels like methanol and hydrogen can be substantial. **Without adequate financial incentives or support mechanisms, smaller operators may struggle to comply with the transition timeline**, potentially leading to inconsistencies in implementation across different ports.

There are challenges related to technology readiness and infrastructure. The GTTP plans to introduce battery-electric and hybrid tugs; however, the **availability of supporting infrastructure, such as charging stations and facilities for alternative fuels, remains uncertain**. This lack of infrastructure could impede the operational efficiency of green tugs and limit their adoption. Furthermore, **stakeholder engagement has not been sufficiently emphasized in the program's framework**. Engaging local communities, industry players, and environmental organizations is crucial for ensuring that the transition is not only **technologically feasible but also socially acceptable**. Addressing these gaps will be essential for the GTTP to achieve its ambitious goals of decarbonizing India's maritime operations effectively.

3.5.3 How NGSP can contribute

The National Green Shipping Programme (NGSP) can effectively address the gaps in the Green Tug Transition Program (GTTP) by providing a structured framework that supports the transition to sustainable maritime practices. One of the primary challenges facing the GTTP is the high initial costs associated with adopting green technologies for tugboats. The **NGSP can offer financial incentives and support mechanisms to ease this burden, such as grants or subsidies for operators transitioning to green tugs**. By creating a more favourable financial environment, the program can encourage wider participation among private operators, especially smaller companies that may struggle with the costs of retrofitting or acquiring new vessels.

The **NGSP can facilitate the development of necessary infrastructure to support green tugs, addressing gaps related to technology readiness**. This includes establishing fuelling stations for alternative fuels like hydrogen and methanol, as well as charging facilities for battery-electric tugs. Furthermore, **by promoting stakeholder engagement and collaboration among industry players, local communities, and regulatory bodies, the program can ensure that all voices are heard in the transition process**. This holistic approach will not only enhance the operational feasibility of green tugs but also foster community acceptance and support for sustainable maritime practices. By addressing these gaps, the National Green Shipping Programme can significantly strengthen the effectiveness of the GTTP in achieving its environmental goals.

3.6 Shipbuilding Financial Assistance Policy[13]

3.6.1 Overview

Rs. 337 Crores
of financial assistance to shipyards for delivering
135 vessels
to the domestic and international ship owners

[14]The Shipbuilding Financial Assistance Policy (SBFAP) **focuses on revitalizing India's shipbuilding industry by providing financial incentives to Indian shipyards**. One of the primary objectives of the policy is to promote the "Make in India" initiative by **offering financial assistance for shipbuilding contracts signed between April 1, 2016, and March 31, 2026. The assistance starts at 20% of the contract price and is designed to diminish gradually over the years.** This financial support aims to enhance the competitiveness of Indian shipyards in both domestic and international markets, facilitating the procurement of various vessel orders. **Recent amendments to the policy have further prioritized green technologies, offering up to 30% assistance for vessels utilizing alternative fuels such as methanol, ammonia, and hydrogen fuel cells, thereby aligning with global sustainability goals.**

In addition to promoting green shipping technologies, **the SBFAP emphasizes the development of indigenous manufacturing capabilities**. The policy includes provisions for **higher financial assistance for specialized vessels like wind farm installation vessels and sophisticated dredgers**. By encouraging local production and technological advancement, the **SBFAP aims to reduce dependency on foreign shipbuilding and foster a robust ancillary industry.** Furthermore, the policy's focus on delivering vessels within specified timelines ensures that shipyards remain competitive and responsive to market demands. Overall, the SBFAP serves as a critical instrument for enhancing India's maritime infrastructure while supporting sustainable practices within the shipbuilding sector.

3.6.2 Gaps/Limitations

The Shipbuilding Financial Assistance Policy (SBFAP), while a valuable initiative for promoting green shipping and sustainability, has some areas that could be enhanced to improve its effectiveness. One consideration is the gradual reduction of financial assistance over time, which may create uncertainty for shipbuilders contemplating long-term investments in green technologies. **The current structure, which decreases support from 20% to lower percentages as the program progresses, could potentially discourage shipyards from fully committing to the development of sustainable vessels. A more stable and predictable financial support mechanism might encourage greater investment in innovative technologies that are essential for reducing emissions and promoting sustainability in the maritime sector.**

While the recent amendments incentivize vessels to use green fuels, **expanding eligibility to include a wider range of eco-friendly technologies, such as advanced hull designs and automation**, would enhance its impact on decarbonization. **Addressing operational challenges like the high costs of green fuels and the lack of supporting infrastructure, such as bunkering facilities, is critical**. Additionally, **fostering workforce training to manage new technologies** and engaging stakeholders to align the policy with industry needs can improve its effectiveness. Furthermore, fostering greater stakeholder engagement can ensure that the policy aligns well with the needs and capabilities of shipbuilders and the maritime industry as a whole. By addressing these areas, the SBFAP can strengthen its role in promoting sustainable practices within India's shipbuilding sector.

3.6.3 How NGSP can contribute

The National Green Shipping Programme (NGSP) can play a pivotal role in addressing the gaps in the Shipbuilding Financial Assistance Policy (SBFAP) by introducing targeted interventions that align financial incentives with long-term sustainability goals. For instance, the NGSP can collaborate with the SBFAP to **create a stable and predictable financial support mechanism, ensuring shipbuilders have confidence in investing**

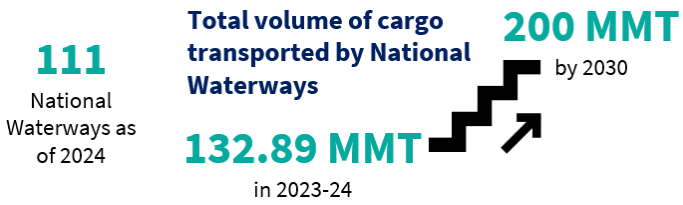
[13] https://shipmin.gov.in/sites/default/files/Amended%20guidelines.pdf
[14] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2037315

in green technologies. This could involve **developing tiered incentives or extending assistance timelines for projects that demonstrate significant environmental benefits, such as vessels utilizing next-generation fuels or advanced energy-efficient designs**. By providing consistent financial support, the NGSP can encourage shipyards to commit to long-term sustainability innovations without fear of financial uncertainty.

The National Green Shipping Programme (NGSP) can complement the Shipbuilding Financial Assistance Policy (SBFAP) by promoting a broader range of eco-friendly technologies, including **advanced hull designs, automation, and digitalisation,** to accelerate decarbonization in the maritime sector. It can support the **development of critical infrastructure, such as green fuel bunkering facilities**, vital for the operational success of sustainable vessels. Additionally, NGSP can lead workforce upskilling initiatives, equipping industry professionals with the expertise needed for advanced shipbuilding technologies. The NGSP can also **enhance stakeholder engagement by establishing platforms for dialogue between policymakers, shipbuilders, and industry experts, ensuring that the SBFAP evolves in line with the industry's needs and technological advancements**. By aligning the SBFAP's objectives with the NGSP's comprehensive sustainability framework, India's maritime sector can achieve a more effective transition toward green and sustainable practices.

3.7 Inland Waterways Development

3.7.1 Overview



[15]The Inland Waterways Authority of India (IWAI) is focused on enhancing the country's inland water transport (IWT) system through several key initiatives. One of the primary areas of emphasis is the **development and modernization of national waterways**. By identifying 26 new national waterways[16] and conducting feasibility studies, IWAI aims to make these routes navigable, **providing an alternative mode of transportation that alleviates congestion on road and rail networks**. This initiative not only promotes cost-effective transport options but **also encourages sustainable practices by reducing reliance on fossil fuel-based transport modes**. The authority is committed to increasing the modal share of IWT from the current 2% to 5% by 2030, aligning with broader goals outlined in the Maritime India Vision.

Another focus area for IWAI is the infrastructure development necessary for efficient IWT operations. This includes **constructing multi-modal terminals, navigational aids, and facilities for vessel repair and bunkering**. The authority is also **investing in digital initiatives such as the River Information System (RIS) and the PANI portal** to enhance navigation safety and efficiency. Additionally, IWAI is actively **promoting passenger and cruise tourism on inland waterways**, which not only boosts economic activity but also raises awareness about the potential of IWT as a sustainable transport option. By integrating these focus areas, IWAI aims to create a robust framework for inland water transport that supports regional connectivity and environmental sustainability across India.

3.7.2 Gaps/Limitations

Despite significant progress, the Inland Waterways Authority of India (IWAI) faces some challenges in enhancing the inland water transport (IWT) system. A major gap lies in the inadequate infrastructure, with many **waterways lacking consistent depth levels, modernized ports, and multi-modal terminals** to support seamless integration with road and rail networks. **Limited private sector participation** further hampers the scaling up of operations, adoption of advanced technologies, and financial sustainability of IWT projects.

[15] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2040915
[16] https://pib.gov.in/PressReleasePage.aspx?PRID=2085230

Additionally, while digital initiatives like the River Information System (RIS) and PANI portal aim to improve navigation and operational efficiency, their uneven implementation reduces the competitiveness of IWT compared to other modes of transport.

Environmental and regulatory challenges also remain significant. **Mechanisms to monitor and mitigate pollution from vessels, manage waste, and address ecological disruptions caused by waterway construction are underdeveloped**. The absence of comprehensive policies for vessel safety, waste management, and operational standards creates uncertainty for operators. Furthermore, low awareness among industries and logistics providers about the benefits of IWT, coupled with poor connectivity to major industrial hubs and limited last-mile infrastructure, restricts its utilization. Addressing these gaps is essential to increasing the modal share of IWT and achieving sustainable growth in India's transport sector.

3.7.3 How NGSP can contribute

A. **Promote the use of green technologies** for the development of eco-friendly dredging techniques, ensuring consistent waterway depth while preserving the environment.

B. Advocate for the creation of **sustainable ports and multi-modal terminals, prioritizing energy-efficient infrastructure** that integrates well with road and rail networks.

C. Introduce **standards and monitoring frameworks for controlling pollution from vessels**, ensuring that waste management systems are in place to protect waterway ecosystems.

D. Support the **creation of comprehensive regulatory frameworks that enforce safety standards for vessels and operational practices**, promoting sustainable and efficient IWT operations.

E. Ensure the development of a predictable regulatory environment, reducing uncertainty for investors and operators.

3.8 Harit Nauka - Green Transition Guidelines for Inland Vessels

3.8.1 Overview[17]

Proposed cut-off/timelines for phasing out of Conventional Fuels and Interim Fuels

Registration of Conventional Fuel based inland vessels	→ 2033
Operation of Conventional Fuel based inland vessels	→ 2045
Registration of Interim Fuel based inland vessels	→ 2045
Operation of Interim Fuel based inland vessels	→ 2055

The "Harit Nauka - Green Transition Guidelines for Inland Vessels" aim to modernize India's Inland Water Transport (IWT) sector by **transitioning from diesel-powered vessels to those using clean fuels like LNG, CNG, electricity, green hydrogen, and methanol**, aligning with **India's COP26 pledge to reduce emission intensity by 45% by 2030**. **The vision is to achieve a complete shift to Green Vessels by 2047**, focusing on developing standardized, eco-friendly vessel designs, creating a supportive operational ecosystem, promoting green passenger transport, fostering indigenous shipbuilding under "Make in India," and providing financial assistance for green vessel initiatives. **Applicable to passenger and Ro-Pax vessels, the guidelines exclude cargo, cruise, and ocean-going vessels**. They outline procurement mechanisms, implementation targets, and periodic reviews to address technological advancements and stakeholder needs, demonstrating India's commitment to sustainable development in the maritime sector.

3.8.2 Gaps/Limitations

The policy currently focuses on a specific segment of inland vessels, notably **excluding cargo vessels, cruise vessels, and ocean-going vessels**. This leaves a significant portion of the inland water transport sector outside its purview. While the guidelines highlight the importance of developing modern, green vessels, **the potential**

[17] https://shipmin.gov.in/sites/default/files/harit.pdf

for retrofitting existing vessels remains largely unexplored. Similarly, the **involvement of the private sector in financing, developing, and sustaining green vessel ecosystems is acknowledged but not elaborated in detail**. Furthermore, the guidelines primarily adopt a domestic perspective, with limited reference to international maritime standards or global best practices.

3.8.3 How NGSP can contribute

The National Green Shipping Policy (NGSP) can effectively address the gaps identified in the Harit Nauka - Green Transition Guidelines for Inland Vessels by:

A. Implementing a **phased integration plan for Cargo vessels and Cruise vessels**.

B. Establishing **pilot programs for cruise vessels to demonstrate the viability of green fuels** and attract private-sector engagement.

C. **Encouraging retrofitting by providing financial incentives** such as grants, low-interest loans and tax credits for operators who retrofit their vessels.

D. **Collaborating with technical institutes to design retrofitting kits** that ensure cost efficiency and safety compliance.

E. Creating a **Public-Private Partnership (PPP) model for green vessel projects and infrastructure projects**.

F. Offering **tax holidays or reduced tariffs** on green technology imports to reduce initial costs for private stakeholders and promote greater participation.

G. Fostering partnerships for technology exchange and joint ventures with international shipbuilders and energy companies.

3.9 Harit Sagar – Green Port Guidelines

3.9.1 Overview[18]

The "Harit Sagar – Green Port Guidelines," issued in May 2023, aim to reduce carbon intensity & promote environmental sustainability in major ports. Aligned with India's COP26 commitments and Maritime India Vision 2030, the guidelines target a **30% reduction in carbon intensity by 2030 and 70% by 2047, with a focus on transitioning to over 60% renewable energy by 2030 and 90% by 2047.** They emphasize **resilient infrastructure, clean energy adoption, waste minimization through the 5R approach (Refuse, Reduce, Reuse, Repurpose, Recycle), and carbon-neutral technologies**. These principles aim to contribute to India's net-zero emission target by 2070, ensuring environmentally, economically, and socially sustainable port operations. The guidelines are mandatory for all major ports in India.

Harit Sagar: Environment Performance Indicator for

Sr. No.	EPIs	Target by 2030	Target by 2047
1	% share of Renewable energy consumption at ports (self generated + procurement from grid)	>60%	>90%
2	% Port equipment/vehicles electrified	>50%	>90%
3	% area under green belt	>20%	>33%
4	% reduction in CO2 emission / ton of cargo (Baseline Year 2023)	>30%	>70%
5	%GHG emission reduction in all coastal/ EXIM vessels	>10%	>50%
6	% reduction in fresh-water consumption / ton of cargo (Baseline Year 2023)	>20%	-
7	% recycle and reuse of consumed water	>100%	-
8	% reduction in energy consumption / ton of cargo (Baseline Year 2023)	>20%	-
9	One no. of LNG bunkering station	By year 2030	-
10	Green hydrogen / Ammonia bunkers and refueling facilities	By year 2035	
11	Adequate number of EV charging stations	By year 2025	-

[18] https://shipmin.gov.in/sites/default/files/Harit%20Sagar%20-%20Green%20Port%20Guidelines%20.pdf

3.9.2 Gaps/Limitations

The guidelines promote the adoption of renewable energy and greener fuels, yet there is scope to better address technological gaps and **emphasize the importance of indigenous research and development in emerging technologies.** While international benchmarks, such as IMO regulations, are referenced, the guidelines could benefit from more explicit alignment with global sustainability goals and practices. Additionally, the role of local communities and other stakeholders affected by port operations is acknowledged but not explored in sufficient detail.

3.9.3 How NGSP can contribute

The National Green Shipping Policy (NGSP) can address gaps in the Harit Sagar – Green Port Guidelines by:

A. **Establishing a fund for R&D in green technologies** such as hydrogen fuel cells, carbon capture, and energy-efficient cargo systems.

B. Launching pilot projects at select ports to refine these technologies before nationwide implementation.

C. Integrating international certifications such as ISO 14001 (Environmental Management) and ISO 50001 (Energy Management).

D. Ensuring alignment with IMO's decarbonization targets to enable participation in carbon credit markets.

E. Conducting stakeholder consultations to guide community benefit programs, including green initiatives and training in sustainable technologies.

3.10 Project Unnati

3.10.1 Overview[19]

Project Unnati, focuses **on enhancing the operational and financial performance of India's 12 major ports through benchmarking with leading international and private Indian ports**. Key objectives include assessing capability maturity, identifying bottlenecks, and implementing actionable solutions to improve efficiency. Implemented initiatives focus on areas such as **infrastructure modernization, mechanization, productivity optimization, and reduction of turnaround times**. The project, limited to major ports under the Ministry's jurisdiction, has successfully enhanced crane density, mechanized operations, improved navigational aids, and streamlined processes.

3.10.2 Gaps/Limitations

The project **primarily focuses on major ports, leaving medium and smaller ports**, which play a vital role in India's maritime ecosystem, less prominently addressed. The framework for engaging private port operators, local governments, and other maritime stakeholders in the design and implementation of improvements could be more clearly articulated. While the emphasis on mechanization and modernization is commendable, the integration of advanced technologies such as AI, IoT, and blockchain for enhancing operational efficiency remains underexplored. Additionally, the focus leans heavily toward physical infrastructure, with comparatively limited attention to workforce capacity building, process optimization, and stakeholder training.

3.10.3 How NGSP can contribute

The National Green Shipping Policy (NGSP) can address gaps in Project Unnati by:

A. Conducting **feasibility studies for smaller ports**.

[19] https://sansad.in/getFile/annex/245/Au1888.pdf?source=pqars

B. Fostering partnerships with state governments and private operators to enhance mechanization, upgrade infrastructure, and standardize processes.

C. Focusing on advanced technologies such as IoT sensors for real-time monitoring, AI-driven analytics, and blockchain for secure and transparent logistics and customs processes.

D. Strengthening capacity building through training modules on emerging technologies, operational best practices, certification programs in equipment handling, process management, and safety compliance.

3.11 Summary of Gap/Limitations and how NGSP can contribute

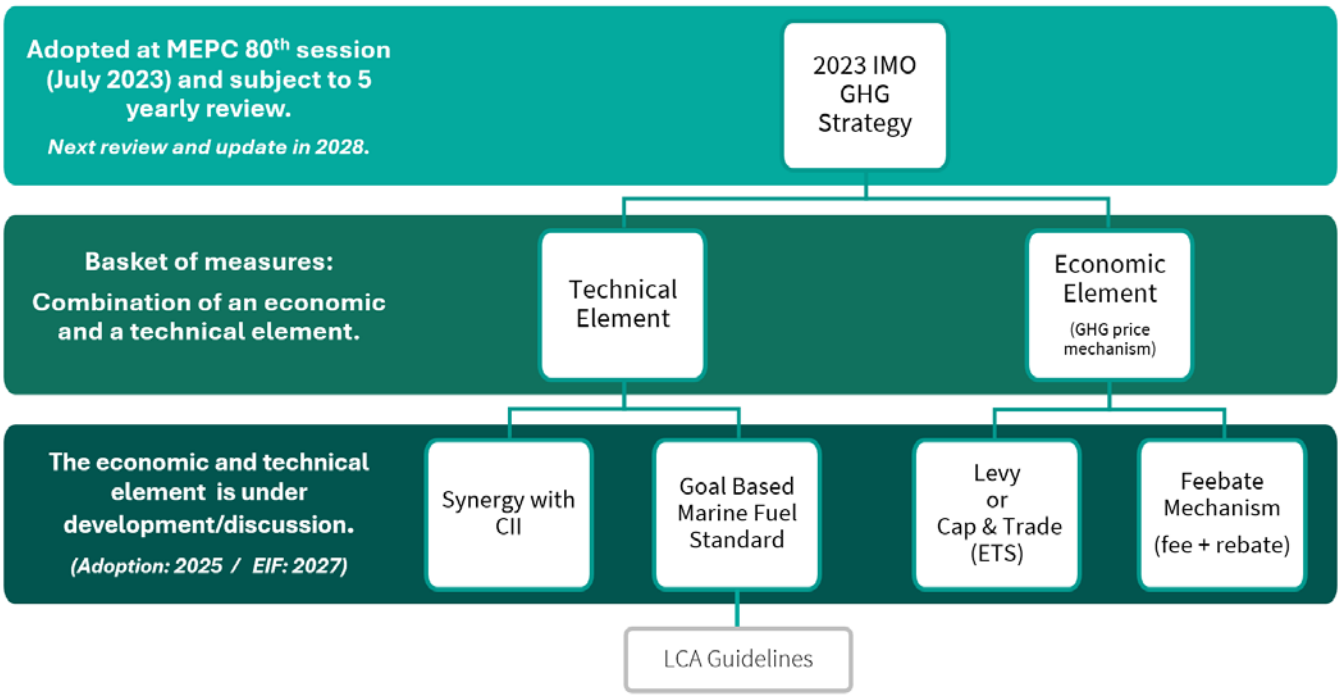
Policy/Programme	Gaps/Limitations	NGSP Contribution
Maritime India Vision 2030 (MIV 2030)	• Limited LNG/hydrogen promotion. • No retrofitting incentives. • No green corridors/global ties. • Limited green tech funding. • Weak propulsion focus.	• Promoting alternative fuels, retrofitting incentives. • Guidelines for advanced propulsion, renewables. • Green shipping corridors for global emissions reduction. • Workforce sustainability training. • Supporting MIV 2030, sustainable growth.
Panch Karma Sankalp	• No green tech/fuel regulations. • Low retrofit/new vessel funding. • Limited tech training for port staff. • No clear sustainability metrics. • Weak local/community engagement.	• Setting eco-tech regulations for all ports. • Financial incentives for small/medium enterprises. • Prioritizing tech training for port staff. • Developing sustainability metrics, engage stakeholders. • Strengthening Panch Karma Sankalp for sustainable maritime.
Sagarmala Programme	• Weak river waste management. • Poor link with Swachh Bharat/Clean Ganga. • Fishing community concerns on displacement. • Growth vs. ecology imbalance. • More funds needed for green tech.	• Enforcing waste, emissions, biodiversity regulations. • Strengthening waste management, link with Swachh Bharat/Clean Ganga. • Promoting green tech with incentives for clean fuels/vessels. • Involving fishing communities, support livelihoods. • Use monitoring for sustainability progress. • Ensuring balanced growth, sustainability in maritime sector.
Amrit Kaal Vision 2047	• Limited focus on green financing • Limited international collaboration on sustainable maritime tech. • Lack of roadmap on low-carbon fuel adoption. • Limited focus on specialized green technology training.	• Develop green financing for low-emission projects (e.g., bonds, partnerships). • Foster international collaborations on green maritime tech. • Create a roadmap with incentives for adopting alternative fuels. • Establish green maritime training academies and integrate sustainability in curricula.
Green Tug Transition Program	• High retrofitting costs deter small operators. • Few financial incentives. • Uncertain infrastructure readiness. • Operational inefficiencies likely. • Weak stakeholder engagement.	• Offering incentives for green tug costs. • Developing infrastructure for green tug fuelling/charging. • Promoting stakeholder engagement for inclusive transition. • Strengthening GTTP with better viability, tech, and community support.

Policy/Programme	Gaps/Limitations	NGSP Contribution
Shipbuilding Financial Assistance Policy	• Reduced aid hinders green investments. • Unstable support for green vessels. • Narrow tech eligibility scope. • Weak industry alignment.	• Creating stable support for green tech • Introducing tiered incentives for eco-friendly projects. • Expanding it to include hybrid, hydrogen, and carbon capture. • Promoting stakeholder engagement, aligning policy with industry. • Aligning with it for effective green transition.
Inland Waterways Development	• Inconsistent depths, old ports, no multi-modal terminals. • Limited private sector role. • Poor digital adoption in IWT. • No pollution monitoring/waste management. • No safety or operational policies. • Low IWT awareness, weak industrial links.	• Promoting eco-friendly dredging for waterway depth. • Advocating for energy-efficient ports and terminals. • Introducing pollution control and waste management standards for vessels. • Supporting vessel safety and operational regulations. • Ensuring stable regulatory environment for investors.
Harit Nauka - Green Transition Guidelines for Inland Vessels	• Excludes cargo, cruise, ocean vessels; no retrofitting focus. • Low private sector role; weak global alignment. • No framework for tracking outcomes.	• Phase green fuel transition in cargo and cruise • Launching cruise vessel pilot programs, attracting private investment. • Offering incentives for retrofitting, collaborate on cost-effective designs. • Creating PPP models with tax benefits for green projects. • Promoting international partnerships for tech exchange and joint ventures.
Harit Sagar – Green Port Guidelines	• Gaps in tech, R&D, and global alignment. • Weak focus on local community impacts.	• Funding R&D in green tech (hydrogen, carbon capture, efficiency). • Launching pilot projects at select ports. • Integrate ISO certifications, align with IMO for carbon credits. • Include stakeholder consultations for community programs, tech training.
Project Unnati	• Overfocus on major ports, neglecting smaller ones. • Unclear private/local government engagement. • Limited use of advanced technologies (AI, IoT, blockchain). • Weak focus on workforce and process optimization.	• Analysis of smaller ports, partner for upgrades. • Focus on IoT, AI, blockchain for logistics. • Enhancing capacity with training and certification program

Table 12: Summary of Gap/Limitations and NGSP Support

4 Benchmarking

4.1 Decarbonisation Efforts by IMO



What are The IMO LCA Guidelines?

The IMO LCA Guidelines provide guidance on life cycle GHG intensity assessment of the fuels and other energy carriers (e.g. electricity). This guidance covers the whole fuel life cycle, from feedstock, extraction, cultivation, recovery, feedstock conversion to a fuel product, transportation as well as distribution, bunkering, and fuel utilization on-board a ship, with all associated emissions.

What is a Feebate Mechanism?

A feebate system is a levy-based system that uses all or part of the revenues raised through the levy/fund/contribution to offer rebates to first movers and reward vessels that are built for and will utilise alternative "clean" marine fuels.

Technical Element	A goal-based marine fuel standard that regulate the phased reduction of the GHG intensity of marine fuels	**Economic Element**	A maritime GHG emissions pricing mechanism

The **IMO's Policy Framework for reducing greenhouse gas (GHG) emissions in the maritime sector**, adopted during the **MEPC 80th session in July 2023**, provides a structured and holistic approach to decarbonization. The framework employs a combination of technical and economic measures, recognizing that achieving significant GHG reductions requires both innovation in technology and financial incentives.

The technical element focuses on a goal-based marine fuel standard to regulate the GHG intensity of fuels, while the economic element introduces pricing mechanisms such as levies, cap-and-trade systems, and feebate mechanisms.

The **feebate system aims to redistribute revenue from levies to reward early adopters of clean marine technologies and fuels**, thereby fostering innovation and accelerating the green transition.

The framework also emphasizes medium-term GHG reduction measures. These measures include **integrating carbon intensity indicators (CII) with technical standards, establishing marine fuel standards, and leveraging market-based mechanisms like carbon pricing**.

Additionally, **Life Cycle Assessment (LCA) guidelines will ensure a comprehensive evaluation of emissions across the lifecycle of marine fuels and technologies**. By providing financial incentives and a clear timeline

for adoption, the policy framework aims to drive early adoption of alternative fuels and green shipping technologies.

Overall, the IMO's approach balances technical advancements with economic tools, ensuring alignment with carbon intensity standards while encouraging innovation. IMO is also committed to support, including through partnerships and provision of financial and technological resources, enhanced technical cooperation, capacity-building activities and technology cooperation, the implementation of the existing short term GHG reduction measures, and initiate efforts to explore renewable fuel production opportunities to be made available to international shipping, notably in developing countries, including LDCs and SIDS, which can be a value add to NGSP.

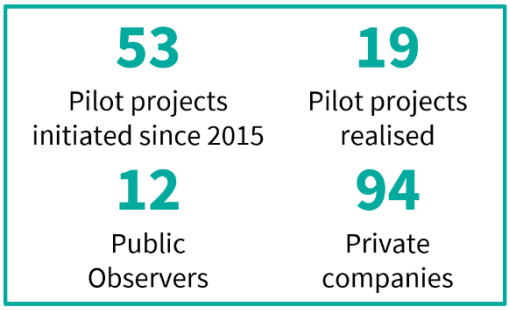
4.2 Green Shipping Policies of Major Maritime Countries

4.2.1 Norway

Norway is committed to **reducing greenhouse gas (GHG) emissions from domestic shipping and fishing by 50% by 2030,** which will require the **introduction of around 700 low-emission and 400 zero-emission vessels across various types**.

4.2.1.1 Green Shipping Programme (GSP)[20]

The Green Shipping Program (GSP) **focuses on sustainable logistics, emission reductions, green jobs**, and increased competitiveness in the maritime sector. It has two key activities: the partnership program and the GSP Service Centre for green fleet renewal. GSP promotes collaboration across the maritime value chain to implement green solutions and establish competitive advantages.



The partnership program **supports pilot projects, starting with feasibility studies to assess technical, economic, and safety aspects**. GSP facilitates these pilots but does not impose obligations on pilot owners during implementation. It encourages reporting on pilot progress to identify challenges and opportunities.

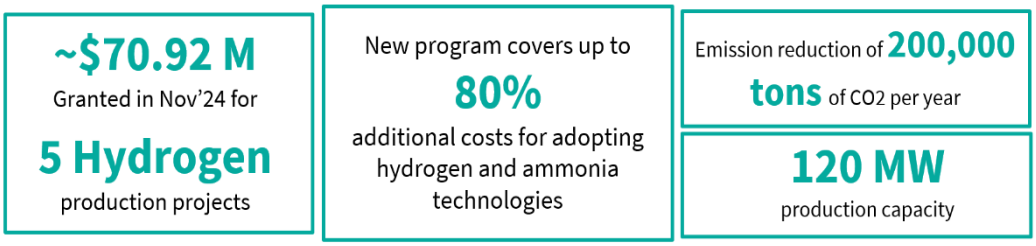
The GSP Service Centre **supports fleet renewal by helping shipping companies transition to greener vessels, reducing emissions, and phasing out older, polluting ships**. It also works to create markets for green technologies, driving the long-term goal of sustainable fleet transformation.

4.2.1.2 ENOVA Funding Mechanism[21][22]

Enova, a Norwegian government agency (under Norway's Ministry of Climate and Environment) dedicated to advancing a low-emission society, **supports projects in energy, climate technology, innovation, and sustainability**.

[20] https://greenshippingprogramme.com/
[21] https://www.offshore-energy.biz/enova-backs-norwegian-shipping-with-investment-in-hydrogen-production-projects/
[22] https://www.enova.no/

Enova is launching a **new program** aimed at **promoting hydrogen and ammonia-powered vessels**. The initiative **offers competitive investment support of up to 80% of the additional costs associated with adopting hydrogen and ammonia technologies**. By stimulating demand, Enova seeks to overcome market barriers and encourage more stakeholders to participate in the transition to cleaner fuels.



The program also plays a critical role in advancing technology development, helping to lower investment and operational costs for hydrogen and ammonia vessels. This effort supports the creation of robust value chains and accelerates the adoption of these sustainable maritime solutions.

4.2.1.3 Key Takeaways for NGSP

A. **Support pilot projects, feasibility studies, and the renewal of older ships with greener alternatives**, fostering collaboration across India's maritime sector to drive the adoption of green technologies and establish sustainable competitive advantages.

B. **Encouraging R&D and technology development** in India, particularly in clean propulsion technologies and alternative fuels, will be critical. Public sector support for pilot projects and industry collaborations can help bridge the technology gap.

C. India could develop a similar **financial mechanism to support green shipping projects, focusing on subsidies, grants, low-interest loans, and green bonds** for vessel retrofitting, infrastructure development, and pilot projects on alternative fuels.

4.2.2 Singapore[23]

4.2.2.1 Green Ship Programme

This program offers **incentives for Singapore-flagged ships that voluntarily implement solutions surpassing the IMO environmental regulatory standards**. Between May 1, 2022, and December 31, 2024, the Maritime and Port Authority of Singapore **(MPA) will provide eligible ships with up to a 100% waiver on initial registration fees and full rebates on annual tonnage taxes, subject to specified guidelines**.

Up to 100%
Waivers on registration fees and tonnage taxes

4.2.2.2 Green Port Programme

The Green Port Programme, updated on May 1, 2022, aims to promote environmental sustainability for ocean-going vessels visiting the Port of Singapore and MPA-licensed harbour craft. From May 1, 2022, to December 31, 2024, the Maritime and Port Authority of Singapore (MPA) will provide **up to a 30% reduction in port dues for vessels that meet the program's environmental standards**.

Up to 30%
Port dues reduction

4.2.2.3 Green Energy and Technology Programme

The Green Energy & Technology Programme seeks to incentivize Singapore-based maritime companies to develop and pilot green technologies, supporting vessels in achieving the goals outlined in the **Maritime Singapore Decarbonisation Blueprint: Working Towards 2050**. Both ocean-going vessels registered under

[23] https://www.mpa.gov.sg/home

the Singapore Registry of Ships (SRS) and harbour craft licensed to operate in the Port of Singapore are eligible to participate in the program.

4.2.2.4 Developments of Green and Digital Corridors

Singapore, Rotterdam, and partners target a 20–30% shipping emissions cut by 2030. Singapore collaborates with Australia, Los Angeles, and Long Beach to promote zero-carbon fuels, **green corridors, and bunkering infrastructure**.

Singapore and Australia are establishing a Green and Digital Shipping Corridor to decarbonise and digitalise shipping routes, aligning with the IMO's net-zero emissions target by 2050. This initiative, under the 2022 Green Economy Agreement, focuses on zero-emission fuels, efficient port operations, and paperless transactions while fostering collaboration across governments and the maritime value chain.

4.2.2.5 Key Takeaways For NGSP

A. India can adopt an **integrated framework** that aligns green shipping, port operations, and technology development with financial and regulatory incentives, ensuring coordinated implementation across the sector

B. India can leverage its geographical and strategic location to **develop as an alternative fuel hub, with infrastructure for LNG bunkering and a focus on emerging fuels like green hydrogen and ammonia.**

C. India can **establish green corridors with major global ports to align decarbonization efforts**, promote low- and zero-emission fuels, and set a roadmap for sustainable trade routes.

4.2.3 South Korea

4.2.3.1 2030 Greenship-K Promotion Strategy[24]

The Republic of Korea's Ministry of Oceans and Fisheries (MOF) launched the "2030 Green Ship-K Promotion Strategy" on December 23, 2020, **aiming to contribute to carbon neutrality in the global shipping industry**. This initiative **focuses on advancing emission-free technologies to reduce greenhouse gas emissions by up to 70% by 2030**. The strategy targets key areas such as ship design, future fuels, renewable energy, and equipment.

Development of technology to reduce GHG by **70%** (40% by 2025 → 70% by 2030)

Achieve 15% rate of conversion to greenships by 2030 (528 out of the 3,542 ships)

As part of the strategy, MOF **plans to convert 15% of the Korean-flagged ships (528 out of 3,542) into greener vessels.** To support this transition, the government is introducing incentives **like reduced eco-friendly fuel fees and port dues**. The green ship initiative is expected to boost both the shipbuilding and shipping industries,

[24] https://www.mof.go.kr/

generating an estimated 5 trillion KRW in sales and 11 trillion KRW in production, while creating over 40,000 jobs by 2030.

The "2030 Green Ship-K Promotion Strategy" will also have global environmental benefits, aiming to reduce 3,314 tons of particulate matter and 4 million tons of greenhouse gases by 2030, thus improving marine and atmospheric conditions.

4.2.3.2 1st Framework on Marine Debris Management[25]

In May 2021, South Korea's Ministry of Oceans and Fisheries (MOF) launched the "1st Framework on Marine Debris Management (2021–2030)" **to address marine debris more systematically**. The framework aims to **reduce marine plastic debris inflow by 60% by 2030, with the goal of achieving zero by 2050.** It is based on a new Marine Debris and Pollutant Management Act, passed in December 2020, and includes five key strategies and 16 implementation projects.

60%

Reduction of the total marine plastics debris inflow by 2030 and

zero by 2050

The first strategy focuses on prevention, introducing measures such as a **deposit system for fishing gear, expanding the use of eco-friendly buoys, and blocking the influx of land-based debris**. The second strategy emphasizes improving **debris collection and delivery, deploying cleaning vessels,** expanding drop-off stations, and developing a forecast system using ICT, drones, and satellites. The third strategy encourages **disposal and recycling,** enhancing infrastructure for managing marine debris and promoting circular economy models in fishing communities.

The fourth strategy enhances the management basis by **creating an interministerial committee and conducting regular analyses of microplastic impacts**. The fifth strategy promotes public awareness through educational programs, cleaning initiatives, and partnerships, including the "Adopt-a-Beach" movement. Through these efforts, the framework aims to reduce the environmental impact of marine debris and foster a sustainable, eco-friendly marine environment.

4.2.3.3 Key Takeaways For NGSP

A. Promote the **conversion of a percentage of Indian-flagged vessels to greener, emission-reducing vessels**. This can be supported through incentives like reduced port dues and eco-friendly fuel fees.

B. Align the green shipping agenda **with job creation and economic growth targets**, aiming for a significant boost in shipbuilding and maritime industries, as seen in South Korea's projection of creating over 40,000 jobs by 2030.

C. Aim to reduce **India's maritime emissions and particulate matter**, contributing to global environmental goals. Target reductions in greenhouse gases and particulate matter similar to South Korea's aim to cut 3,314 tons of particulate matter and 4 million tons of greenhouse gases by 2030.

D. Develop a **comprehensive approach to managing marine debris and plastics, including prevention, collection, and recycling**. This could align with India's efforts to reduce pollution in its seas and rivers, fostering a circular economy in the maritime sector.

[25] https://www.mof.go.kr/

4.2.4 Japan

4.2.4.1 Development of Next-Generation Ships[26]

$280 million
to accelerate the domestic development of zero-emission vessels

Japan has launched a $280 million funding initiative, "Development of Next Generation Ships," to accelerate the domestic development of zero-emission vessels and maintain leadership in sustainable maritime innovation. This program, **part of the government-backed Green Innovation Fund**, supports **projects leveraging alternative marine fuels such as hydrogen, ammonia, and liquefied natural gas (LNG).** Managed by the New Energy and Industrial Technology Development Organization (NEDO), the initiative **aims to achieve commercial operation of vessels emitting virtually no greenhouse gases by 2030.**

The program allocates funds across four key areas. **Kawasaki Heavy Industries will receive ¥21.9 billion to develop marine hydrogen engines and related fuel systems by 2030**. **NYK and ClassNK, among others, will use ¥8.4 billion** for ammonia-related projects, including an ammonia-fuelled tug by 2025 and an ammonia-powered gas carrier by 2027. **K Line and partners will utilize ¥2 billion** to commercialize ammonia-powered ship applications by 2028. Another coalition, including H**itachi Zosen Corp and Mitsui OSK Lines, will receive ¥600 million** to reduce methane slip from LNG-fuelled ships by over 70% by 2026.

4.2.4.2 Roadmap to Zero Emission from International Shipping[27]

Japan's "Roadmap to Zero Emission from International Shipping", represents a bold plan **to transition the maritime sector away from fossil fuels**. Developed by the Ministry of Land, Infrastructure, Transport and Tourism alongside key stakeholders such as the Nippon Foundation and the National Maritime Research Institute, the roadmap aligns with the International Maritime Organization's (IMO) **goals of a 40% reduction in emissions per transport work by 2030 and a 50% reduction in total greenhouse gas (GHG) emissions by 2050.**

39% Synthetic Gas 44% hydrogen and/or ammonia

of marine energy consumption by 2050

Key targets include the development of a "Zero Emission eco-ship" by 2028 and identifying sustainable emission reduction pathways. These pathways envision a gradual shift from liquefied natural gas (LNG) to carbon-recycle methane and the expanded use of hydrogen and ammonia as fuels. **By 2050, synthetic gas and hydrogen/ammonia are projected to account for 39% and 44% of marine energy consumption, respectively, though fossil-based LNG is expected to retain a significant share of 35%.**

To support these transitions, the roadmap includes measures such as the Energy Efficiency Existing Ship Index (EEXI), proposed for implementation by 2023 to enhance operational efficiency. Furthermore, it outlines design concepts for zero-emission ships, including hydrogen-fuelled, super-efficient LNG-powered, ammonia-fuelled, and onboard CO2 capture vessels. Trials for hydrogen and ammonia engines are scheduled for 2026, with commercial rollout planned before 2030.

In parallel, Japan's maritime sector is making strides through independent initiatives. The **e5 Consortium, launched in 2022, aims to establish zero-emission electric shipping infrastructure**, including the **world's first electric tanker powered by lithium-ion batteries**. Similarly, **a working group within the Carbon Capture & Reuse Study Group is exploring methanation technology for carbon recycling in ship fuels**. These efforts underscore Japan's commitment to innovation, sustainability, and workforce renewal, reinforcing its leadership in global maritime decarbonization.

[26] https://www.lloydslist.com/LL1138613/Japan-launches-$280m-green-ship-funding-project
[27] https://www.mlit.go.jp/common/001354314.pdf

4.2.4.3 Key Takeaways For NGSP

A. **Establish dedicated funding programs to develop next-generation zero-emission vessels** using alternative fuels like hydrogen, ammonia, and LNG.

B. **Gradually shift from LNG to hydrogen, ammonia, and carbon-recycle methane, focusing on synthetic and renewable energy sources for the long term.**

C. **Fund pilot projects to trial and demonstrate advanced technologies** like ammonia and hydrogen engines, onboard carbon capture, and energy-efficient ship designs

D. **Support initiatives for zero-emission electric shipping infrastructure and electric vessels**

E. **Invest in workforce training and skill development** to support a sustainable transition, ensuring India's maritime workforce is prepared for emerging green technologies and operations.

4.3 Major Global Collaborations and Strategic Partnerships

4.3.1 Green Shipping Challenge[28]

The United States and Norway are spearheading the Green Shipping Challenge to accelerate the decarbonization of the maritime sector. Initially **launched at COP27, the initiative encourages countries, ports, companies, and other actors in the shipping value chain to make concrete commitments and announce updates aimed at aligning the sector with the 1.5°C global temperature rise limit**. The Challenge **continues at COP29 in Baku, Azerbaijan,** promoting actionable progress toward sustainable shipping.

At COP29, participants unveiled over 40 new commitments under the Green Shipping Challenge. Notable announcements include Canada's allocation of $83.2 million under its Green Shipping Corridors Program to fund projects in Nova Scotia, British Columbia, and Ontario. Additionally, the **Blue Visby Consortium advanced digital and operational innovations, including Digital Twin Virtual Pilots and prototype trials with consortium members**. These trials demonstrated significant greenhouse gas emissions reductions, such as a **29% savings for LPG tankers and up to 28.1% savings for supramax bulk carriers.**

Canada announced **$83.2 M** funding under their Green Shipping Corridors Program

Through collaborative efforts and innovative solutions, the Green Shipping Challenge exemplifies the global commitment to transforming the maritime industry into a leader in climate action.

4.3.1.1 Key Takeaways for NGSP

A. **Stakeholder Commitments:** Encourage measurable, time-bound decarbonization pledges aligned with India's climate goals.

B. **Funding Mechanisms:** Allocate funds for green corridors, pilot projects, and technology innovations.

C. **Digital Innovations:** Promote Digital Twins and operational tools to optimize emissions reductions.

D. **Global Collaboration:** Enhance India's role in international efforts for knowledge-sharing and alignment.

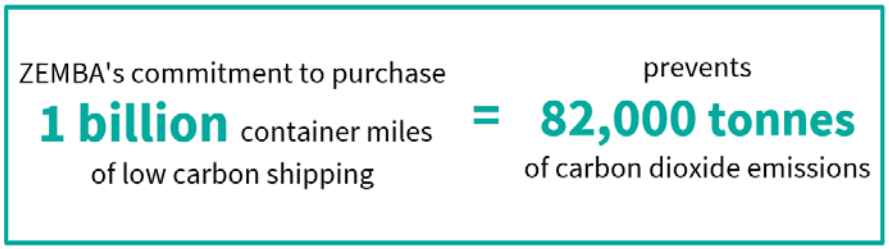
E. **Pilot Projects:** Showcase emission-cutting technologies through trials in Indian ports.

[28] https://greenshippingchallenge.org/

4.3.2 Zero Emission Maritime Buyers Alliance (ZEMBA)[29]

The Zero Emission Maritime Buyers Alliance (ZEMBA) is a pioneering buyers group in the maritime sector, committed to accelerating the commercial adoption of scalable clean energy shipping solutions. By fostering **collaboration among freight buyers and suppliers**, ZEMBA aims to achieve economies of scale and amplify environmental impact beyond what individual stakeholders can achieve alone.

ZEMBA recently **completed its first collective tender for ocean shipping, achieving over a 90% reduction in greenhouse gas emissions compared to traditional fossil fuel-powered services**. This milestone was made possible through a partnership with Hapag-Lloyd, a global leader in container shipping. Hapag-Lloyd will replace approximately 20,000 tons of fossil LNG with biomethane derived from landfill gas and livestock waste, meeting ZEMBA's stringent sustainability criteria and fulfilling the alliance's aggregated tender volume for 2025-2026 on a key route from Singapore to Rotterdam.



In collaboration with **Lloyd's Register, ZEMBA launched a report assessing the readiness of the maritime sector to deploy e-fuels and e-fuel-capable vessels between 2027 and 2030**. The findings indicate sufficient supply and capacity to meet the demand for ZEMBA's upcoming e-fuel-focused tender, set to launch in early 2025. Since December 2023, ZEMBA's membership has grown significantly, with over a dozen new members joining, including **SEKO Logistics, Vaude, and Otto**. This expansion underscores the growing commitment within the industry to transition toward sustainable maritime practices.

4.3.2.1 Key Takeaways for NGSP

A. **Collaborative Demand Aggregation**: Form buyer alliances to scale demand for zero-emission shipping and cleaner fuels like biomethane and e-fuels.

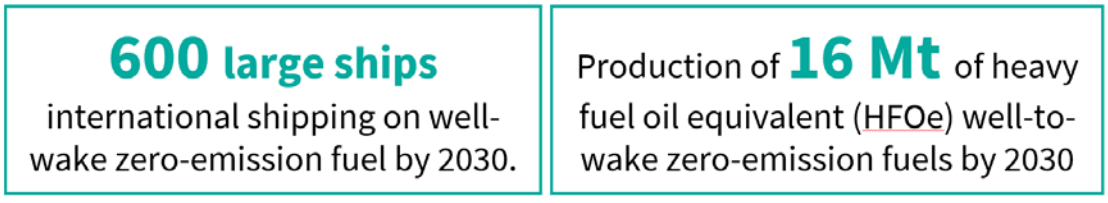
B. **E-Fuel Readiness**: Prepare for e-fuels by assessing supply, incentivizing production, and ensuring fleet compatibility.

C. **Pilot Green Corridors**: Implement pilot projects for zero-emission shipping routes to demonstrate scalability.

D. **Stakeholder Collaboration**: Build diverse partnerships with logistics firms and environmental groups to align with global decarbonization goals.

4.3.3 Mission Innovation - Zero-Emission Shipping[30]

Led by **Denmark, Norway, and the United States, alongside the Global Maritime Forum and the Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping**, this mission aims to transform the maritime industry by introducing commercially viable zero-emission vessels into the global fleet by 2030. The initiative focuses on



[29] https://www.shipzemba.org/
[30] https://mission-innovation.net/missions/shipping/

scaling up the production of zero-emission fuels and developing the necessary port infrastructure to support their adoption, targeting a systemic shift toward sustainable shipping.

The mission's plan emphasizes coordinated innovation across the maritime value chain, driving the sector toward the adoption of well-to-wake zero-emission fuels. It sets ambitious goals in three key areas: ships, fuels, and fuelling infrastructure. **By 2030, the aim is to deploy 600 large ships running on zero-emission fuel, enable the production of 16 million tons of heavy fuel oil equivalent (HFOe) zero-emission fuels, and establish zero-emission bunkering infrastructure at 20 key ports spanning at least three continents.**

This comprehensive approach seeks to position the maritime industry at the forefront of the global transition to sustainable energy, ensuring a significant reduction in greenhouse gas emissions while fostering innovation and collaboration across the sector.

4.3.3.1 Key Takeaways for NGSP

A. **Targeted Zero-Emission Fleet Deployment**: Set specific milestones for deploying zero-emission vessels to build momentum toward green shipping adoption.

B. **Zero-Emission Fuel Scale-Up**: Facilitate production and supply of alternative fuels like ammonia, hydrogen, or methanol, targeting large-scale availability aligned with industry needs.

C. **Bunkering Infrastructure Development**: Prioritize establishing zero-emission refuelling hubs at strategic ports, ensuring global readiness for fuel adoption.

D. **Well-to-Wake Decarbonization**: Focus on entire lifecycle emissions of fuels, ensuring alignment with global best practices for sustainable shipping.

4.3.4 The SENSREC Project[31]

This is a collaboration between Norway and IMO, which aids developing countries in implementing the Hong Kong International Convention for Safe and Environmentally Sound Recycling of Ships. It focuses on policy alignment, capacity building, hazardous waste management, and upgrading ship recycling facilities. **In Bangladesh, SENSREC has conducted studies, provided worker training, and supported hazardous waste infrastructure, now in its third phase.**

Norway has committed
US$ 1.5 M
to support improved ship recycling in Bangladesh

4.3.4.1 Key Takeaways for NGSP

E. **Policy and Regulatory Alignment**: Support India in aligning ship recycling practices with international conventions like the Hong Kong International Convention to ensure safe and environmentally sound recycling in the country.

F. **Capacity Building and Training**: Enhance the capacity of Indian ship recycling facilities through worker training and technical support, fostering a sustainable and skilled workforce in the industry.

G. **Infrastructure Improvement**: Facilitate upgrades to India's ship recycling facilities, focusing on safer and more environmentally responsible waste management practices, ensuring compliance with global standards.

[31] https://www.imo.org/en/OurWork/PartnershipsProjects/Pages/SENSREC.aspx

4.3.5 Katalist[32]

The **Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping (MMMCZCS)[33] and RMI (formerly Rocky Mountain Institute) have launched Katalist, a not-for-profit "book and claim" registry aimed at accelerating the decarbonization of the shipping industry**. Katalist **connects shipping companies using low-emission fuels with cargo owners seeking sustainable supply chains, facilitating the achievement of regulations set by the European Union (EU) and the International Maritime Organization (IMO) to reduce carbon intensity in shipping.**

Over 25 organisations
from across the maritime value chain have contributed to the development and testing of the system

The registry operates on a **chain-of-custody model, allowing cargo owners to claim the environmental benefits of low-emission shipping services without physically receiving them.** This approach enables freight customers to pay a green premium, while ship operators can access a broader market for their services. **Katalist also helps drive investments in lower-emission fuels, boosting commercial availability. Developed with input from over 25 organizations and based on experiences from similar systems like the Sustainable Aviation Fuel Registry (SAFc),** Katalist is positioned as a key enabler in the shipping decarbonization ecosystem.

Katalist provides transparent, consistent, and auditable data on emissions reductions across multiple carriers, ensuring the integrity of sustainability claims. It reduces administrative burdens for carriers and offers them flexibility in fuel choices. It has already attracted attention from cargo owners as it will **enable the Zero Emission Maritime Buyers Alliance (ZEMBA) members to claim sustainable marine fuel tokens generated through ZEMBA's upcoming tender in 2025-2026**. Katalist, supported by a collaborative effort from across the maritime value chain, is paving the way for long-term, sustainable decarbonization in the shipping industry.

4.3.5.1 Key Takeaways for NGSP

A. **Transparent System for Green Fuel Tracking**: Implement a transparent, auditable registry in India to verify green fuel use and ensure credibility in decarbonization efforts.

B. **Support Green Fuel Flexibility**: Allow carriers to choose from available green fuels, reducing administrative burdens while promoting cleaner shipping.

C. **Foster Collaboration**: Promote industry-wide partnerships to drive long-term, sustainable decarbonization in India's maritime sector.

4.3.6 H2Global[34]

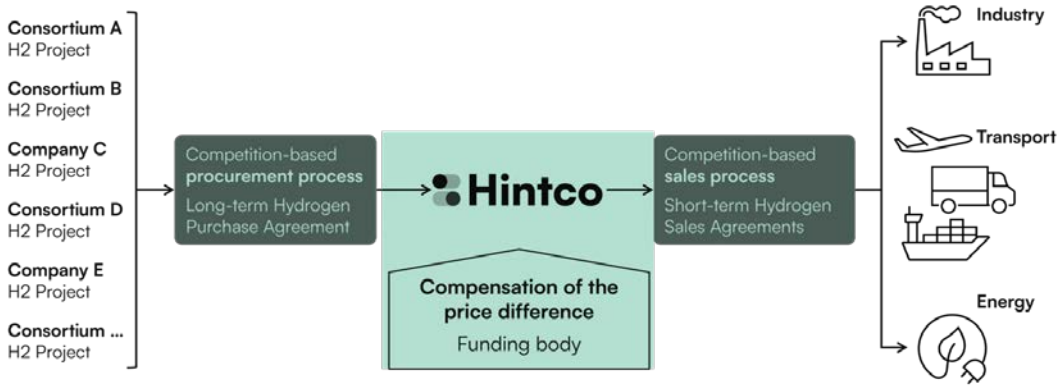
>USD 6 billion
In international funding for the H2Global mechanism as of 2024

The mission of **H2Global is to accelerate the creation of global markets for clean hydrogen and other zero- and low-emission technologies**. Through market-based instruments like the H2Global mechanism, implemented by its subsidiary Hintco, the initiative aims to foster thriving, climate-neutral energy markets that lead to enhanced climate and development outcomes worldwide.

H2Global uses a pioneering double-auction mechanism, facilitated by Hintco as an intermediary, to connect buyers and sellers in the early stages of market development. The mechanism supports demand buildup by **allowing more expensive clean hydrogen products to be sold at lower prices to end consumers, with the price difference covered by public funding or other sources.** This approach simulates a functioning

[32] https://katalist.eco/
[33] https://www.zerocarbonshipping.com/news/press-release-shipping-industrys-decarbonization-enhanced-by-dedicated-book-and-claim-registry/
[34] https://www.h2-global.org/

market, advancing clean hydrogen market creation by addressing key barriers such as price disparities and limited market access.



Source: h2-global.org

The H2Global mechanism is unique for its comprehensive coverage of the entire value chain, from production to consumption, and for providing continuous price discovery. It offers flexibility to off-takers from hard-to-abate sectors, ensuring access to large volumes of clean energy while enhancing regulatory certainty. By using standardized short-term contracts and providing bankability through long-term purchase agreements, H2Global promotes liquidity, market efficiency, and fair pricing. It also allows governments to shape the global market through customized funding windows based on geography, contract duration, and sustainability criteria, supporting energy security and industrial competitiveness.

4.3.6.1 Key Takeaways for NGSP

A. **Support for Clean Hydrogen and Low-Emission Fuels**: Facilitate the creation of markets for clean hydrogen and other low-emission fuels in India by leveraging a market-based mechanism like H2Global, promoting the scale-up of sustainable fuel production.

B. **Encourage Public-Private Partnerships**: Foster collaborations between the Indian government, private sector, and international stakeholders to mobilize capital and accelerate the development of low-emission technologies and infrastructure.

C. **Drive Market Development for Export and Import**: Enable Indian involvement in the global hydrogen market by fostering export and import mechanisms for clean hydrogen and other zero-emission products, positioning India as a key player in the emerging global clean energy landscape.

4.4 Summary of Key Takeaways for NGSP

Green Shipping Policies of Major Maritime Countries	
Country	**Key Takeaways for NGSP**
Norway	• Support pilot projects, feasibility studies, and green ship renewal through sector-wide collaboration. • Prioritize R&D in clean propulsion and alternative fuels with public sector backing. • Develop financial mechanisms (subsidies, grants, loans, green bonds) for retrofitting, infrastructure, and fuel pilot projects.
Singapore	• Adopt an integrated framework linking green shipping, ports, technology, finance, and regulations. • Leverage India's strategic location to develop an alternative fuel hub with LNG bunkering and emerging fuels. • Establish green corridors with global ports for decarbonization, low-emission fuels, and sustainable trade routes.

South Korea	• Promote conversion of Indian-flagged vessels to greener alternatives with incentives like reduced port dues. • Boosting shipbuilding and maritime industries leading to job creation and economic growth • Manage marine debris through prevention, collection, and recycling to support a circular economy.
Japan	• Fund zero-emission vessel development using hydrogen, ammonia, and LNG. • Develop infrastructure for electric shipping and vessels. • Invest in workforce training for green maritime technologies.
Major Global Collaborations and Strategic Partnerships	
Initiative	**Key Takeaways for NGSP**
Green Shipping Challenge	• Encourage time-bound decarbonization pledges aligned with India's climate goals. • Fund green corridors, pilot projects, and technology innovations. • Promote Digital Twins and operational tools for emissions optimization. • Strengthen global collaboration for knowledge-sharing and alignment.
Zero Emission Maritime Buyers Alliance (ZEMBA)	• Form buyer alliances to scale demand for zero-emission shipping and cleaner fuels. • Prepare for e-fuels by assessing supply, incentivizing production, and ensuring fleet compatibility. • Build partnerships with logistics firms and environmental groups for global decarbonization.
Mission Innovation - Zero-Emission Shipping	• Set milestones for deploying zero-emission vessels. • Develop zero-emission bunkering hubs at strategic ports for global fuel readiness. • Ensure well-to-wake decarbonization by addressing full lifecycle emissions of fuels.
The SENSREC Project	• Align ship recycling practices with international conventions for safety and sustainability. • Upgrade recycling facilities for safer, eco-friendly waste management.
Katalist	• Implement a transparent registry to track and verify green fuel use. • Allow carriers flexibility in choosing green fuels to reduce administrative burdens. • Foster industry partnerships for sustainable decarbonization in maritime.
H2Global	• Facilitate markets for clean hydrogen and low-emission fuels through mechanisms like H2Global. • Foster public-private partnerships to accelerate low-emission technologies and infrastructure. • Enable India's involvement in the global hydrogen market for export and import of clean energy products.

Table 13: Key Takeaways for NGSP

5 Policy Framework

A robust policy framework is essential for navigating complex economic, environmental, and financial landscapes. This section outlines a structured approach to **Scenario Analysis and a Comprehensive Funding Strategy**, enabling informed decision-making and financial resilience. Scenario Analysis helps anticipate potential future challenges and opportunities, ensuring adaptability in policy responses. Meanwhile, the Comprehensive Funding Strategy aligns financial resources with strategic objectives, optimizing investment efficiency and risk management. Together, these elements form the foundation for sustainable growth and long-term stability.

5.1 Scenario Analysis

Scenario analysis was conducted to support the **development of a robust policy framework** that enables India's maritime sector to achieve **Net Zero by 2070**. Given the complex interplay of **technology, economics, infrastructure readiness, and regulatory constraints**, a structured approach was required to:

1. **Assess Feasible Decarbonization Pathways** – Understanding different growth trajectories and their implications on emissions reduction helps identify **realistic transition timelines** for alternative fuels and technologies.

2. **Identify Policy Interventions** – By comparing various decarbonization scenarios, policymakers can determine **which regulatory measures, financial incentives, and infrastructure investments** are required to accelerate the adoption of low-carbon fuels and carbon mitigation strategies.

3. **Balance Economic Growth with Sustainability** – The maritime sector is a crucial driver of economic activity, and **policy decisions must ensure a balance between emissions reduction and sectoral growth**, without disrupting trade, shipping, or supply chains.

4. **Quantify Reliance on Carbon Capture and Storage (CCS)** – Given the **uncertainties surrounding the adoption of green fuels**, the scenario analysis helps **evaluate the extent to which CCS will be required** if alternative fuel adoption is delayed or insufficient.

5. **Align with Global Decarbonization Goals** – India's maritime policies must be **aligned with international commitments**, including **IMO targets and the 1.5°C climate goal**, while also considering **domestic constraints and opportunities**.

Through this scenario-based approach, **data-driven insights** were gained into the **trade-offs, risks, and opportunities** associated with different decarbonization pathways. This enabled the recommendations for the **formulation of targeted policies** that can drive the maritime sector toward **a sustainable and economically viable low-carbon future**.

5.1.1 Growth Rate Scenarios

To assess future emissions in the shipping sector, three distinct growth rate trajectories—**low, medium, and high**—were developed based on projected vessel traffic growth outlined in **DG Shipping reports**. Each scenario incorporates different assumptions regarding **industry expansion, fleet modernization, and trade volume growth**, providing a comprehensive framework for evaluating potential emissions outcomes.

1. **Low-Growth Scenario**
    - Assumes **minimal industry expansion**, slower economic growth, and **limited fleet additions**.
    - Results in **relatively lower emissions** due to restrained vessel traffic and trade activity.
2. **Medium-Growth Scenario**

- Represents a **balanced trajectory**, aligning with **steady economic growth** and moderate vessel traffic increases.
- Emissions rise in proportion to industry growth while integrating gradual improvements in fleet efficiency.

3. **High-Growth Scenario**
   - Envisions **rapid industrial expansion**, significant fleet additions, and **higher trade volumes**.
   - Leads to **substantial emissions growth**, reflecting increased shipping activity and infrastructure development.

These scenarios provide policymakers and industry stakeholders with a **range of potential emissions projections**, enabling informed decision-making regarding **investment in sustainable infrastructure** and the formulation of policies to achieve **IMO and Net Zero 2070 targets**.

Efficiency Adjustments and Emission Intensity Reduction

To enhance the accuracy of projections, **efficiency improvements** were integrated into all scenarios. These adjustments assume that **energy use per tonne-mile will decline by 35-40% by 2050**[35], driven by:

- **Advancements in vessel design** and hydrodynamics.
- **Innovations in propulsion systems**, including hybrid and alternative fuel technologies.
- **Operational strategies** such as optimized routing and speed management.
- **Adoption of energy-efficient technologies**, including shore power and carbon capture solutions.

By incorporating these efficiency trends, the scenarios capture **realistic reductions in emissions intensity**, ensuring alignment with **global energy transition goals**. This approach supports the development of **effective strategies** to meet **IMO targets and India's Net Zero 2070 commitments**, even as vessel traffic and trade volumes continue to grow.

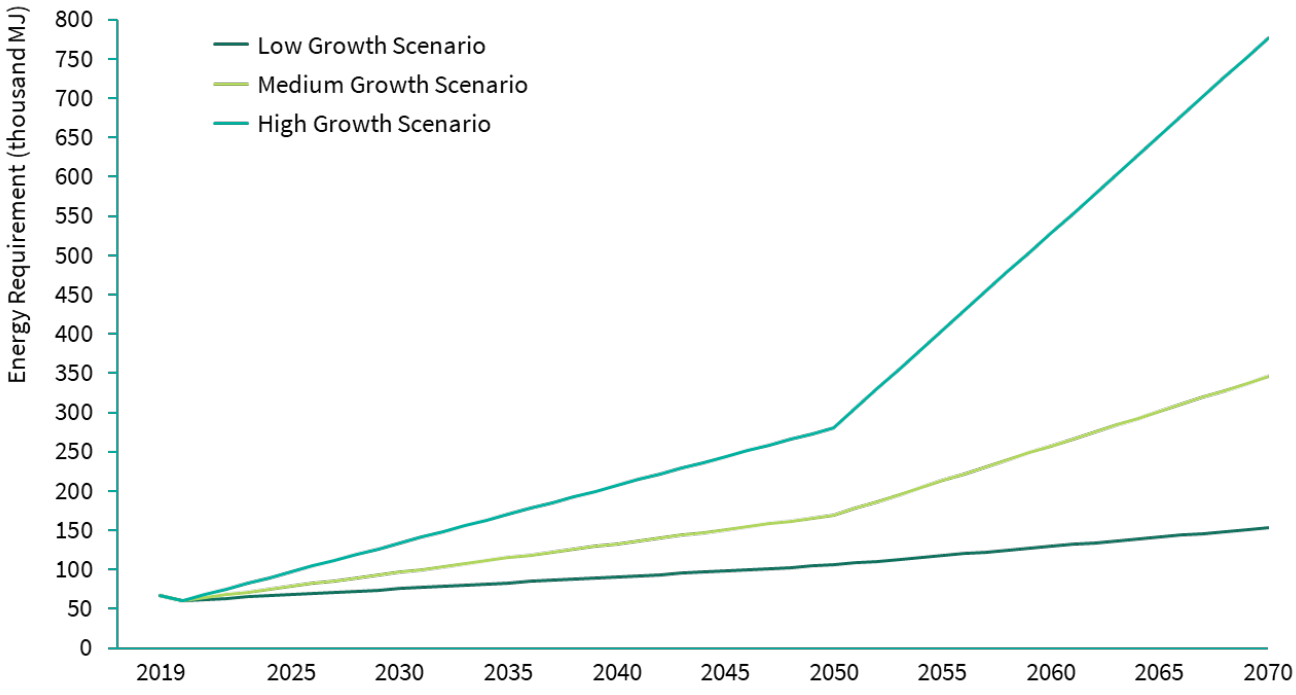


Figure 9: Energy Requirement for Shipping in India

[35] DNV GL Maritime Forecast to 2050 report

5.1.2 Policy Pathway Scenarios

To assess the impact of fuel adoption on emissions reduction and industry transformation, **three distinct policy pathways** were developed:

1. **Business As Usual (BAU)**
2. **Aggressive Uptake of Green Fuels**
3. **Conservative Scenario**

These scenarios consider the **challenges and opportunities** associated with adopting alternative fuels, including the transition to **ammonia[36], hydrogen, biofuels, and LNG**.

Business As Usual Scenario	• Assumes **limited adoption** of alternative fuels, with continued reliance on **conventional marine fuels**. • Leads to **slower progress in emissions reduction**, with only incremental improvements driven by regulatory compliance.
Aggressive Uptake of Green Fuels Scenario	• Envisions **rapid adoption** of **green fuels**, such as ammonia, hydrogen, and biofuels. • Driven by **technological advancements, regulatory incentives, and industry commitment to decarbonization**. • Results in **substantial emissions reductions** and accelerated transition to a **low-carbon maritime sector**.
Conservative Scenario	• Assumes **moderate fuel adoption**, constrained by **infrastructure readiness, fuel availability, and market conditions**. • Reflects **gradual integration** of alternative fuels while still relying on a mix of conventional and transitional fuels. • Emissions reduction occurs at a **slower pace compared to the aggressive scenario**

Table 14: Policy Pathway Scenarios

Future Fuel Mix Estimations across policy pathways

In the policy scenarios, we estimated the future fuel mix for the shipping industry, considering the potential uptake of biofuels, hydrogen, ammonia, and LNG. This fuel mix was designed to reflect varying levels of adoption across the different policy pathways—Business As Usual (BAU), Aggressive Uptake of Green Fuels, and the Conservative Scenario.

Business As Usual Scenario	• The fuel mix remains **heavily reliant** on conventional marine fuels such as **Heavy Fuel Oil (HFO) and Marine Gas Oil (MGO)**. • **LNG** plays a more prominent role as a **transitional fuel**, offering lower emissions than traditional fuels but still contributing to the sector's carbon footprint. • Adoption of **biofuels, hydrogen, and ammonia remains minimal**, leading to **slower progress in emissions reduction**.

[36] The **LR Horizons (April 2021)** report projects that ammonia could play a major role in the future fuel mix, with production potentially reaching **80 million tonnes per year by 2030**.

Aggressive Uptake of Green Fuels Scenario	• Envisions a **rapid shift** towards **renewable and low-carbon fuels**, with **biofuels, ammonia, and hydrogen** becoming key contributors to the fuel mix. • **Biofuels** serve as an **immediate low-carbon alternative**, reducing emissions without requiring significant vessel modifications. • **Ammonia and hydrogen** are expected to **scale up** as production capacity increases and infrastructure improves. • This scenario **aligns with ambitious emissions reduction goals**, leveraging these green fuels to **accelerate decarbonization**.

Conservative Scenario	• **Green fuels are introduced but adopted at a slower pace** due to challenges such as:
	  • **Fuel availability**
	  • **Infrastructure readiness**
	  • **High production costs**
	• **LNG remains a dominant fuel**, providing some emission benefits but still delaying full decarbonization.
	• **Biofuels, hydrogen, and ammonia** see **gradual adoption**, keeping the fuel mix **more reliant on fossil-based alternatives** compared to the aggressive scenario.

Table 15: Future Fuel Mix Scenarios

These future fuel mixes were calculated based on market forecasts, technology readiness, and the expected availability of green fuel production and infrastructure. They play a crucial role in determining the emissions outcomes for each scenario and provide a framework for understanding the investments needed to transition to a more sustainable shipping industry. The estimates align with global decarbonization goals and offer insights into the challenges and opportunities for fuel adoption in the maritime sector.

5.1.3 Emissions Estimation for the Scenarios

Emissions estimation for the different policy scenarios was conducted using emission factors from global databases, including the **EU RED II (Renewable Energy Directive) and other relevant sources**, to account for various fuels' carbon intensity. For each scenario, the **emissions associated with different fuel types were assessed based on their energy content and carbon footprint**.

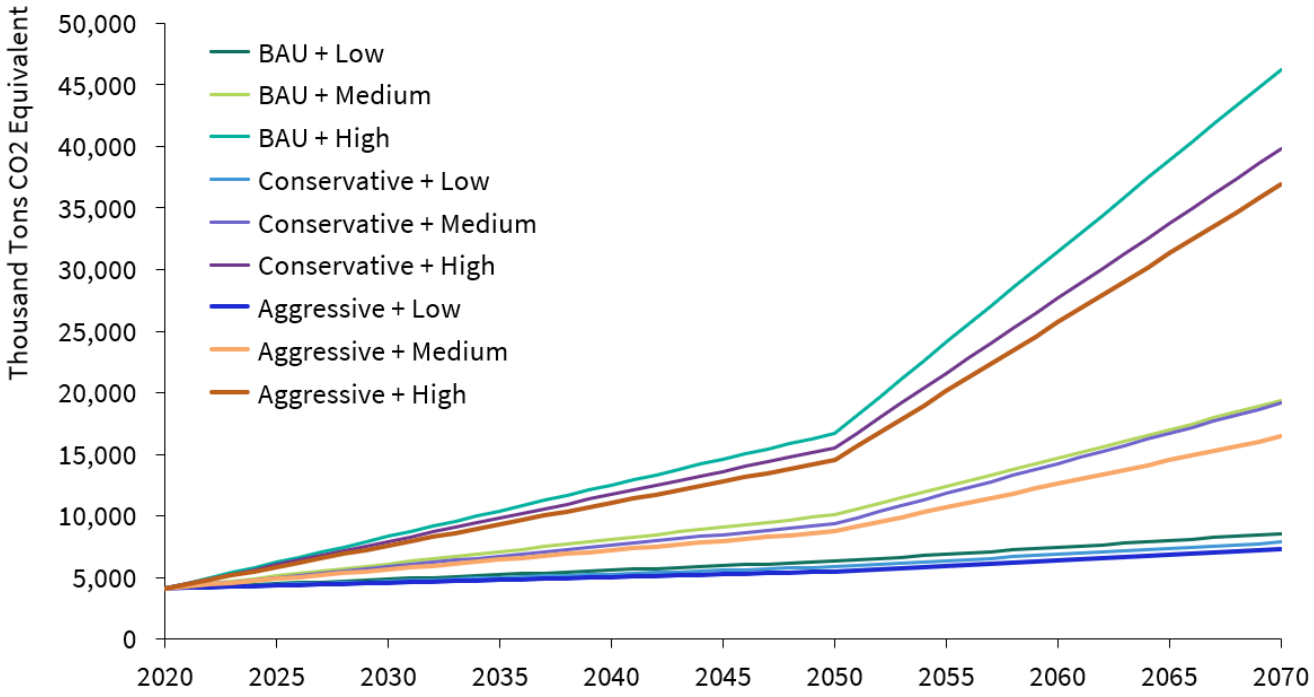


Figure 10: India's WtW Emissions Projection

5.1.4 Global Emissions Reduction Scenarios and Targets

To assess emissions reduction in the shipping sector, four distinct pathways have been developed, aligning with global and national climate targets. These scenarios reflect varying levels of ambition, considering international commitments and India's specific goals.

5.1.4.1 1.5°C Scenario

This pathway aligns with the **Paris Agreement's 1.5°C target**, aiming for **near-zero or net-negative emissions by 2050**. It represents the most ambitious decarbonization trajectory, requiring:

- **Rapid adoption of green fuels** such as **ammonia, hydrogen, and biofuels**.
- **Substantial investments** in **clean energy technologies, carbon capture and storage (CCS)**, and **alternative fuel infrastructure**.
- **Strict international regulations**, market-based incentives, and strong industry collaboration.

This scenario significantly reduces shipping emissions, ensuring alignment with global efforts to limit warming to **1.5°C**. However, it requires **breakthroughs in fuel technology and large-scale infrastructure development**.

5.1.4.2 Minimum IMO Target

This scenario follows the **IMO's initial GHG strategy**, targeting:

- **40% reduction in carbon intensity by 2030** (relative to 2008 levels).
- **50% reduction in overall GHG emissions by 2050**.

Key assumptions include:

- **Gradual transition to low-carbon fuels**, with continued reliance on **LNG, biofuels, and energy efficiency measures**.
- **Moderate uptake of ammonia and hydrogen** by mid-century.
- **Incremental technological improvements**, with conventional fuels still playing a role.

While emissions reductions are substantial, this scenario maintains a **slower pace of fuel transition** compared to the 1.5°C pathway.

5.1.4.3 Striving IMO Target

This scenario is a **more ambitious interpretation of the IMO's targets**, aiming for:

- **50% reduction in carbon intensity by 2030**.
- **Net-zero emissions in shipping by 2050**.

Key elements include:

- **Faster adoption of green fuels** (ammonia, hydrogen, biofuels), with **LNG and conventional fuels phased out by 2040**.
- **Stronger regulatory frameworks** and **market-based incentives** to accelerate decarbonization.
- **Significant technological advancements** in **engine design, fuel storage, and fuel production**.

This pathway supports **net-zero shipping by mid-century**, with innovation and policy enforcement driving fuel transition.

5.1.4.4 Net Zero by 2070 (India Target)

This scenario aligns with **India's national commitment to Net Zero by 2070**, incorporating the maritime sector's role in achieving this goal. Key assumptions include:

- **A gradual transition to alternative fuels**, with **biofuels, ammonia, and hydrogen** introduced at a **slower pace**.
- **LNG continuing as a transitional fuel** until mid-century.
- **Economic and infrastructure challenges** constraining the rapid uptake of green fuels.
- **Diversified fuel mix**, where biofuels serve as a near-term solution, followed by ammonia and hydrogen adoption towards **2050 and beyond**.

While **slower than global benchmarks**, this scenario provides a **structured and realistic decarbonization pathway** for India's shipping sector, ensuring alignment with **long-term sustainability goals**.

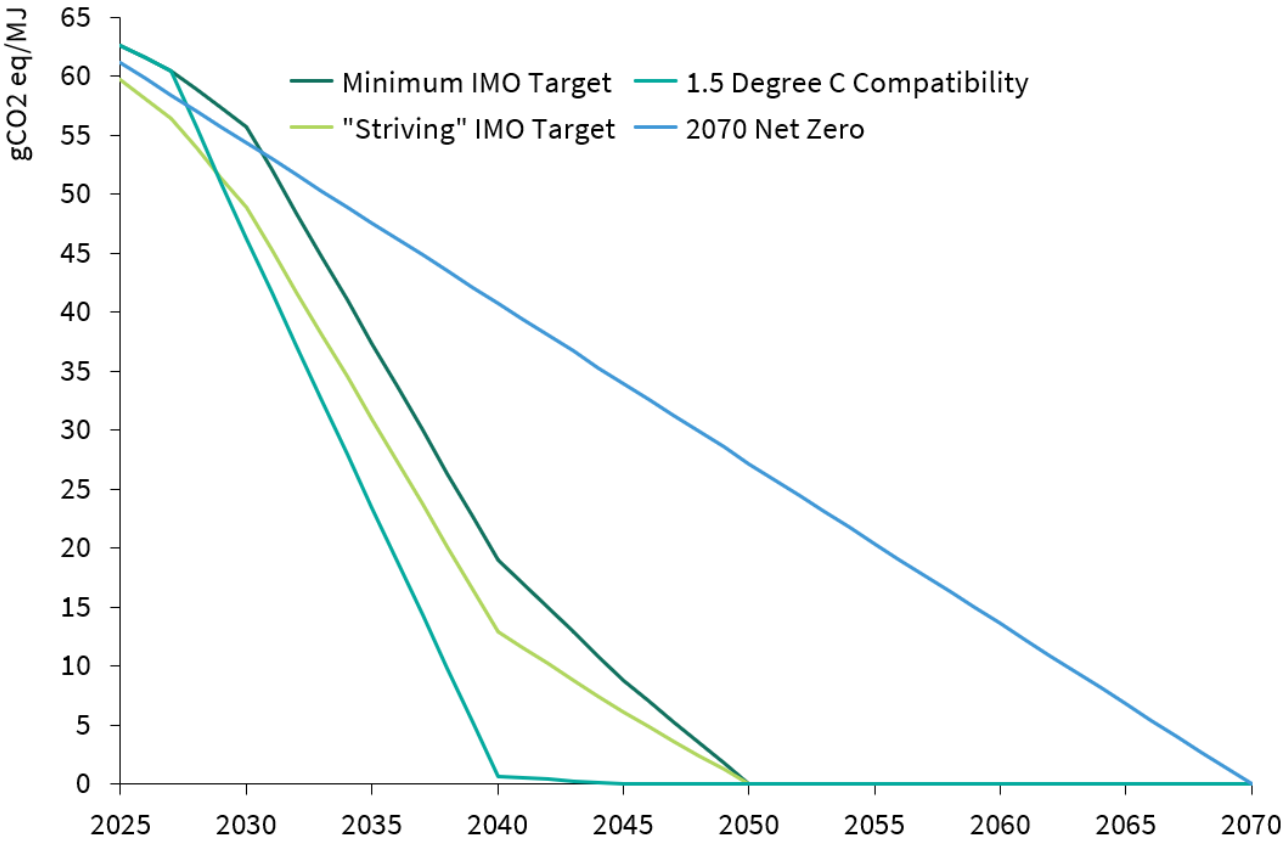


Figure 11: Global Scenarios for Emission Reduction

5.1.5 Scenario Development for Medium Growth Conservative Pathway:

The **Medium Growth Conservative Scenario** serves as a key reference point to understand the **critical interventions required for India's maritime sector** to achieve **Net Zero by 2070**. This scenario assumes **a moderate pace of vessel traffic growth and a gradual transition to alternative fuels**, constrained by technological, economic, and infrastructure limitations. Unlike more aggressive decarbonization pathways, which prioritize rapid fuel adoption, this pathway acknowledges the **practical challenges in scaling up green fuels** and highlights the **role of Carbon Capture and Storage (CCS) as a necessary bridging solution**.

By detailing this scenario, a realistic benchmark is established to:

- **Assess the feasibility of decarbonization under constrained conditions.**
- **Understand the critical reliance on CCS when fuel transitions are delayed.**
- **Identify key policy and technological interventions needed to accelerate progress.**

Fuel Mix for the Scenario:

A. Biofuels (Short-to-Medium Term Solution)

- Biofuels continue to play a **transitional role** due to their compatibility with existing vessel engines.
- Adoption is **limited by feedstock availability, cost constraints, and sustainability concerns** related to the source of biofuels.
- While biofuels contribute to emissions reduction, they are not a long-term standalone solution.

B. LNG and Methanol (Transitional **Fuel Until Mid-Century)**

- **LNG and Methanol** remain dominant transition fuels through the first half of the century, serving as a **bridge toward greener alternatives**.
- LNG, while a lower-carbon alternative to conventional marine fuels, still produces **CO_2 emissions**, requiring **CCS integration** to mitigate its carbon footprint.
- Methanol, including both **fossil-based and bio-derived variants**, gains traction as a **low-carbon fuel** due to its **compatibility with existing internal combustion engines (ICEs)** and growing bunkering infrastructure.
- The role of **LNG and Methanol diminishes post-2050** as **green ammonia and green hydrogen** gain adoption, supported by infrastructure development and regulatory incentives.

C. Ammonia and Hydrogen (2030s–2040s)

- **Ammonia (NH_3)** and **Hydrogen (H_2)** begin to enter the maritime fuel mix **before widespread production becomes fully green**.
- Early use is expected to rely on **blue ammonia and blue hydrogen**, produced from **fossil fuels with CCS**, rather than fully renewable sources.
- Key barriers include **high storage and handling costs, onboard safety concerns, and lack of global bunkering infrastructure**.

D. Green Ammonia and Green Hydrogen (Gradual Adoption Post-2040, Scaling Up After 2050)

- **Green Ammonia and Green Hydrogen**—produced using **renewable electricity via electrolysis**—become increasingly viable as **costs decline and production scales up**.
- **Widespread adoption is projected after 2050**, when:
    - Global regulations mandate near-zero-emission shipping.
    - Large-scale electrolysis facilities and renewable energy investments make production cost-effective.
    - Ports develop **dedicated ammonia and hydrogen bunkering hubs** to ensure availability.
- Infrastructure development, cost reductions, and crew training remain key **bottlenecks to adoption**.

E. Carbon **Capture and Storage (CCS) as a Critical Offset Mechanism**

- Given the **slower transition to ammonia and hydrogen**, **CCS is essential** to mitigate emissions from LNG and biofuels.
- CCS deployment is focused on **critical maritime segments**, particularly those with **limited fuel-switching options**.
- The **effectiveness of CCS depends on large-scale infrastructure investments and regulatory support**.

F. Introduction of **Negative WtW Emission Factor Fuels** to Achieve Net Zero

- The adoption of **biofuels with CCS and eFuels (eLNG, eMethanol, etc.)** derived from **direct air capture (DAC)** presents a pathway to achieving **net zero emissions**.
- **Bio-LNG and Bio-Methanol**, when combined with **carbon capture**, can potentially achieve a **negative Well-to-Wake (WtW) emission factor**, making them a **highly effective transition fuel** in the near term.
- **eLNG and eMethanol**, produced via **electrolysis and captured CO_2**, provide a **long-term decarbonization solution** as costs decrease and renewable energy capacity increases.
- These fuels enable **negative well-to-wake (WtW) emission factors, effectively offsetting emissions from hard-to-abate maritime sectors**.
- **Widespread deployment depends on advancements in carbon removal technologies**, scalability of sustainable feedstock supply, and supportive regulatory frameworks.

5.1.6 Comparative Analysis and Strategic Implications

A comparative analysis of **India's medium-growth scenario** against the following was performed:

- The **IMO's minimum target scenario** (40% carbon intensity reduction by 2030, 50% GHG reduction by 2050).
- The **Striving IMO Target** (more ambitious IMO pathway with net-zero emissions by 2050).
- The **1.5°C scenario** (near-zero emissions by 2050).

The analysis illustrates:

- The **gap between India's projected emissions and global decarbonization targets**.
- The **extent of CCS and negative WtW emission fuels** (e.g. biofuels with carbon capture, e-fuels derived from DAC) **reliance required to meet Net Zero by 2070**, highlighting the risks of delayed fuel transitions.
- The need for **strategic interventions to accelerate clean fuel adoption and reduce dependency on CCS**.

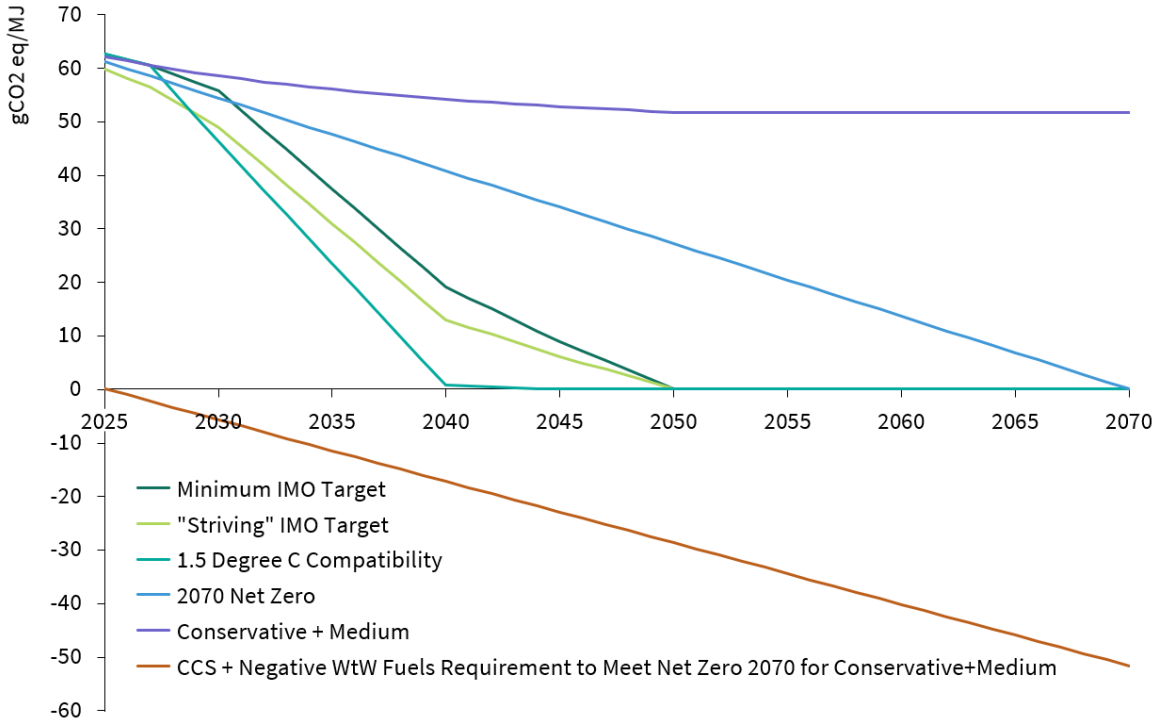


Figure 12: WtW Emissions for the projected scenarios

5.1.7 Energy Mix Estimation for India's Shipping Industry by 2070

The global shipping industry accounted for substantial energy consumption in 2019 and 2020, primarily driven by fossil fuels such as heavy fuel oil (HFO), marine diesel oil (MDO), and marine gas oil (MGO). Projections indicate a significant transformation in the energy landscape for the shipping sector through 2070, driven by decarbonization targets and the global commitment to achieving net-zero emissions. The projection developed by IEA estimates that Ammonia will contribute to 54% of the fuel mix by 2070.

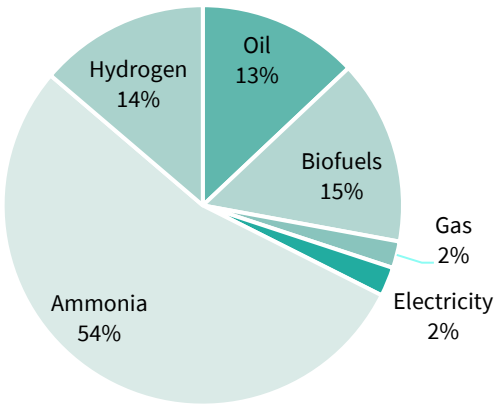


Figure 13: Global Energy Mix by 2070 for the shipping industry

A long-term energy forecast suggests a transition from conventional fossil fuels to alternative low-carbon and zero-emission fuels. By 2050, a significant share of energy consumption in the shipping industry is expected to be met by green ammonia, hydrogen, e-methanol (eMethanol), and e-LNG (electrified liquefied natural gas), with direct air capture (DAC) integration to achieve negative emissions. Carbon capture and storage (CCS) technologies will play a critical role in mitigating residual emissions, supporting the industry's pathway toward achieving net-zero emissions by 2070.

Using global shipping energy consumption data as a baseline, an energy mix forecast was developed for India's shipping sector with a vision for 2070. The transition strategy aligns with India's broader net-zero targets and includes the following key components:

- **Green Ammonia and Hydrogen:** These fuels are expected to play a dominant role in India's maritime decarbonization. Green ammonia, produced using renewable energy sources and electrolysis-derived hydrogen, is projected to account for a significant share of the total energy mix due to its high energy density and compatibility with emerging propulsion technologies.
- **eMethanol:** A viable alternative fuel, eMethanol is expected to be utilized extensively in short-sea shipping and domestic coastal operations. The scalability of eMethanol production using captured CO2 and green hydrogen makes it a promising option for India's energy transition.
- **e-LNG with DAC:** Electrified LNG coupled with direct air capture is proposed as an interim solution for deep-sea shipping. The negative emissions potential of DAC-integrated LNG systems will contribute to overall carbon neutrality while ensuring energy security during the transition phase.
- **CCS Integration:** Carbon capture and storage technologies will complement the adoption of low-carbon fuels, mitigating any remaining emissions. This will be particularly crucial for legacy fleet retrofits and optimizing fuel flexibility in India's maritime sector.

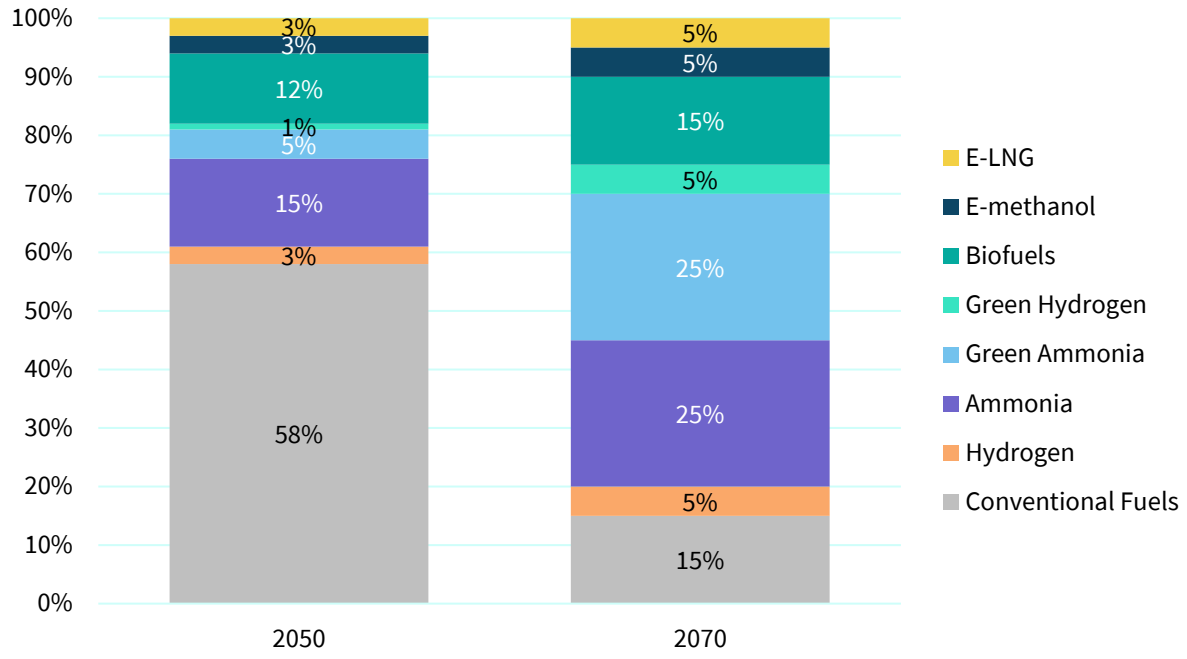


Figure 14: Fuel Mix for India

Table 16: Fuel requirement considering a medium growth trajectory and the above fuel mix

	WtW GHG Emissions (gCO2eq.)		Metric Tonnes fuel consumed	
	2050	**2070**	**2050**	**2070**
Conventional Fuels	89,29,863	47,23,702	2,392	1,265
Hydrogen	4,10,861.5	14,00,614	42	144

Ammonia	6,84,769.1	23,34,357	1,364	4,648
Green Ammonia	0	0	455	4,648
Green Hydrogen	0	0	14	144
Biofuels	0	0	548	1,402
E-methanol	-2,78,980	-9,51,034	188	640
E-LNG	-2,78,980	-9,51,034	103	352

To achieve net-zero emissions in 2070, an estimated 6.55 metric tonnes of CO2 will need to be captured through CCS. This requirement highlights the importance of integrating CCS alongside the adoption of low-carbon fuels to fully neutralize residual emissions and attain decarbonization goals.

The transition of the shipping industry towards low-carbon and zero-emission fuels by 2070 will have far-reaching implications for India's maritime sector. By leveraging ammonia, hydrogen, eMethanol, and e-LNG with DAC, alongside CCS implementation, India can position itself as a leader in sustainable shipping. The integration of these technologies will support India's net-zero ambitions while ensuring compliance with international maritime decarbonization frameworks. Continued investment in infrastructure, research, and regulatory frameworks will be essential to facilitate this energy transition effectively.

5.1.8 Policy Assessment and Interventions

Achieving Net Zero by 2070 under this scenario requires a strong policy framework to support fuel uptake. A policy impact assessment should focus on:

- **Regulatory frameworks:** Evaluating national and international policies, including carbon pricing, emission reduction mandates, and fuel regulations.
- **Financial incentives:** Assessing the role of subsidies, tax benefits, and investment mechanisms to lower the cost barriers for alternative fuels.
- **Market mechanisms:** Understanding how carbon markets and emission trading systems can drive investment in clean technologies.
- **Public-private collaboration:** Facilitating cooperation between government, shipping companies, and fuel producers to accelerate green infrastructure development.
- **Introduction of Negative WtW Emission Factor Fuels:** Supporting the adoption of biofuels with carbon capture and e-fuels derived from direct air capture (DAC) to achieve net zero emissions. These fuels enable negative well-to-wake (WtW) emission factors, effectively offsetting emissions from hard-to-abate maritime sectors. Their widespread deployment depends on advancements in carbon removal technologies, scalability of sustainable feedstock supply, and supportive regulatory frameworks.

By modelling different policy scenarios, this assessment helped identify key enablers and barriers, guiding decision-makers on effective interventions to fast-track decarbonization, minimize reliance on CCS, and integrate emerging negative-emission fuel pathways.

5.2 Financial Analysis

The maritime industry's shift to green technologies and low-carbon fuels is crucial for achieving global sustainability goals, necessitating **strong and inclusive financial models to drive this transition**. Sustainable financing strategies are emerging worldwide, integrating public, private, and multilateral funding sources to attract capital, reduce risks, and promote green investments. By ensuring fair access to funding, these models support a wide range of initiatives—from large-scale innovations to smaller operational enhancements—enabling all stakeholders, from major corporations to small and medium-sized shipowners, to embrace sustainable practices and accelerate the sector's decarbonisation.

5.2.1 Financial Instruments for Green Maritime Investments

5.2.1.1 Green Bonds

Green bonds are dedicated debt instruments designed to finance **specific eco-friendly projects**, making them attractive to ESG-focused investors. Issuers must allocate proceeds exclusively to **green initiatives** such as renewable energy, low-carbon transportation, or emission reduction projects, with strict **reporting and transparency requirements**.

Key examples: NYK Line in Japan is financing LNG-powered vessels, and the Port of Los Angeles is investing in zero-emission port operations through Green Bond proceeds. In India, green bonds can be leveraged to develop green fuel bunkering stations, port electrification, and renewable energy integration.

5.2.1.2 Sustainability-Linked Bonds (SLBs)

SLBs differ from green bonds as they **do not restrict fund usage** but instead impose **financial penalties or incentives** based on the issuer's ability to meet sustainability targets. If an issuer fails to achieve its ESG commitments—such as reducing emissions or increasing renewable energy adoption—the bond's interest rate may increase. This structure allows organizations to align financing with long-term sustainability goals while retaining flexibility in capital allocation.

Key examples: MSC (Mediterranean Shipping Company) issued an SLB linked to carbon reduction targets. In India, SLBs could support transition strategies for shipping companies, encouraging decarbonization commitments without restricting capital use.

5.2.1.3 Sustainability-Linked Loans (SLLs)

SLLs provide **flexible financing** by linking loan terms to a company's sustainability performance. Unlike green bonds, **funds are not restricted to specific projects**; instead, interest rates fluctuate based on meeting predefined **ESG targets** such as carbon emission reductions, energy efficiency, or social impact metrics. This structure incentivizes companies to enhance their sustainability performance over time.

Key examples: Maersk's SLL agreement, linked to its carbon intensity reduction goals. In India, SLLs can provide incentives for fleet modernization, energy-efficient vessel upgrades, and alternative fuel adoption.

5.2.1.4 Public-Private Partnerships (PPPs)

PPPs enable governments and private sector players to collaborate in funding and executing sustainable maritime projects. By combining public resources with private sector expertise, these partnerships drive large-scale green infrastructure projects.

Key examples: Singapore has successfully developed hydrogen bunkering and port electrification through PPPs, while the Netherlands has implemented hydrogen-based port networks. In India, similar models could support the establishment of clean energy-powered ports, zero-emission terminal retrofitting, and hydrogen bunkering facilities.

5.2.1.5 Multilateral Development Bank (MDB) Support

International financial institutions like the World Bank and the Asian Development Bank (ADB) provide concessional loans and grants to accelerate green maritime projects. The Global Maritime Decarbonization Initiative exemplifies how MDBs support low-carbon technologies.

Key examples: For India, MDB funding can be instrumental in financing port electrification, green hydrogen production, and cleaner vessel operations at competitive interest rates.

5.2.1.6 Blended Finance

Blended finance models combine concessional funding from public or philanthropic sources with private capital, reducing investment risks for green projects. This strategy helps bridge financial gaps in high-risk sustainability initiatives by leveraging public funds to attract commercial investments.

Key examples: The World Bank's Climate Investment Platform is a key example of blended finance supporting renewable energy projects. In India, this model can facilitate investments in green shipping corridors, renewable-powered ports, and alternative fuel infrastructure.

5.2.1.7 Government Grant & Subsidies

Direct funding or tax incentives from national and regional governments to accelerate green maritime projects.

Key examples: Norway's Enova grants for zero-emission shipping initiatives.

5.2.1.8 Private Equity & Venture Capital

Investors fund startups and technology firms developing green shipping solutions such as wind-assisted propulsion, zero-carbon fuels, and digital efficiency tools.

Key examples: Windship Technology securing private equity for wind propulsion R&D.

5.2.1.9 Leasing & Alternative Ownership Models

Shipowners lease eco-friendly vessels or alternative propulsion systems instead of purchasing outright, reducing upfront costs.

Key examples: Japanese leasing firms offering LNG-fuelled vessel leasing programs.

5.2.1.10 Green Shipping Fund

Green shipping funds provide **dedicated financial support** for sustainable maritime initiatives, backed by multilateral institutions, **government programs**, and private sector contributions. These funds help de-risk investments in **low-carbon technologies, alternative fuels, and green port infrastructure**, ensuring long-term financing for the industry's decarbonization. They may be structured as **grants, concessional loans, co-financing, or tax incentives**, depending on the funding source.

Key examples: The European Green Shipping Fund (EU-backed) supports investments in LNG-fuelled and hybrid vessels. Norway's Green Shipping Program is a government-led initiative funding zero-emission vessels and green port operations. India's Maritime Development Fund (IMDF) could be expanded to support shore

power electrification, green hydrogen bunkering, and fleet modernisation. China's Green Vessel Financing Scheme provides low-interest loans for eco-friendly shipbuilding.

5.2.1.11 Carbon Pricing Mechanisms

Carbon pricing strategies, such as emissions trading and carbon levies, place a financial cost on carbon emissions, encouraging the adoption of cleaner technologies. The European Union's Emissions Trading System (EU ETS) now includes the maritime sector, while the International Maritime Organization (IMO) is working on a global carbon levy to support decarbonization in developing nations. India can explore similar frameworks to generate funding for low-emission vessel technologies and green fuel adoption.

The table below summarises the key financing instruments for green maritime investments, highlighting their use cases, ideal beneficiaries, and potential applications in India.

Strategy	Use Case	Best For	How India Can Use It
Green Bonds	Dedicated funding for specific sustainability projects	Large corporations investing in green assets	Issuing green bonds to finance **green fuel bunkering stations, port electrification, and renewable energy integration**
Sustainability-Linked Bonds (SLBs)	General financing with penalties/incentives for ESG performance	Companies seeking flexibility while committing to sustainability targets	Encouraging **shipping companies to adopt SLBs for fleet modernization and emission reduction goals**
Sustainability-Linked Loans (SLLs)	Flexible loans with interest rates linked to ESG goals	Shipowners and operators investing in cleaner operations	Providing **low-interest SLLs for energy-efficient vessels, alternative fuel adoption, and fleet upgrades**
Public-Private Partnerships (PPPs)	Large-scale green infrastructure projects	Governments & private investors in port development	**Developing clean energy-powered ports, zero-emission terminals, and hydrogen bunkering facilities** through PPPs
Multilateral Development Bank (MDB) Support	Concessional loans and grants for green projects	Developing nations, ports, and shipping firms requiring low-cost capital	Leveraging **World Bank & ADB funding for port electrification, green hydrogen production, and cleaner vessel operations**
Blended Finance	De-risking private capital by combining public and private funds	High-risk green technology ventures & sustainability initiatives	Creating **blended finance programs to de-risk private investment in green shipping corridors and alternative fuel infrastructure**
Government Grants & Subsidies	Direct funding and tax incentives for green shipping	National & regional maritime authorities, shipowners	Offering **subsidies for electric tugs, LNG-powered vessels, and shore power electrification**
Private Equity & Venture Capital	Financing for startups & tech firms developing green shipping solutions	Emerging maritime tech firms, alternative fuel startups	**Attracting PE/VC funding for Indian startups working on wind propulsion, hydrogen fuel cells, and AI-driven efficiency tools**

Strategy	Use Case	Best For	How India Can Use It
Leasing & Alternative Ownership Models	Access to eco-friendly vessels & propulsion tech without upfront costs	Shipowners and operators reducing CAPEX burden	Encouraging **leasing programs for LNG-fuelled ships and electric ferries to lower upfront investment costs**
Green Shipping Funds	Pooled funding from public & private sources for industry-wide sustainability	Governments, development banks, private investors	Expanding **India's Maritime Development Fund (IMDF) to support shore power, fleet modernization, and green hydrogen bunkering**
Carbon Pricing Mechanisms	Monetizing emissions reduction via carbon levies or trading	Shipping firms investing in low-carbon technologies	Implementing a **carbon pricing framework to encourage shipowners to adopt cleaner fuels and invest in emissions reduction technologies**

Table 17: Choosing the Right Funding Instrument

5.2.2 International Cooperation for Financing Indian Maritime Decarbonization

Decarbonizing India's maritime sector is crucial for meeting global climate targets and aligning with the IMO's Revised GHG Strategy 2023. Achieving this transition requires substantial financial investments, technological advancements, and strategic partnerships. International cooperation plays a vital role in providing financial and technical support, bridging investment gaps, fostering innovation, and enhancing sustainable operations. By collaborating with global organizations, India can leverage concessional financing, international expertise, and policy support to modernize ports, integrate renewable energy, and develop low-carbon logistics systems, driving a sustainable maritime transition.

International funding agencies and organizations play a critical role in supporting green infrastructure, port electrification, and alternative fuel development. These collaborations help accelerate the deployment of sustainable solutions while ensuring alignment with global best practices and regulatory frameworks. By tapping into diverse funding sources, India can implement large-scale green maritime projects that contribute to national and global climate goals.

Funding Agency	Scope	Areas for Collaboration	Reasoning
Asian Development Bank (ADB)	Green infrastructure, port électrification, renewable energy integration	Electrification of ports and inland waterways; development of hybrid logistics systems	ADB has a strong focus on sustainable infrastructure in developing countries, including India's ongoing green corridor projects.
World Bank	Climate Investment Fund (CIF); renewable energy, logistics electrification	Port modernization, alternative fuel infrastructure, and inland waterway electrification	The World Bank has extensive expertise in sustainable infrastructure financing, offering grants and concessional loans.

Funding Agency	Scope	Areas for Collaboration	Reasoning
New Development Bank (NDB)	Infrastructure development in BRICS nations	Financing of green logistics hubs and electrified multimodal networks	NDB focuses on collaborative funding among BRICS nations, making it suitable for large-scale green logistics projects in India.
Global Environment Facility (GEF)	Biodiversity conservation, international waters, and climate change mitigation	Funding alternative fuel infrastructure and port electrification	GEF's focus on climate change mitigation aligns with India's maritime decarbonization needs, especially in ports and alternative fuels.
Green Climate Fund (GCF)	Climate mitigation and adaptation in developing countries	Development of renewable energy infrastructure at ports and alternative fuel production facilities	GCF supports large-scale climate projects, making it ideal for funding India's renewable-powered port initiatives.
International Renewable Energy Agency (IRENA)	Renewable energy investments, technology transfer	Solar and wind energy systems at ports; energy storage solutions	IRENA's expertise in renewable energy and technology transfer can accelerate India's green transition in the maritime sector.
European Investment Bank (EIB)	Concessional financing for low-carbon technologies and zero-emission vessels	Hydrogen and ammonia bunkering infrastructure; financing zero-emission ships	EIB specializes in financing cutting-edge low-carbon technologies, providing access to advanced solutions for India's maritime sector.
Japan International Cooperation Agency (JICA)	Concessional loans for sustainable infrastructure	Pilot projects for green shipping technologies and electrified ports	JICA's focus on innovative green technologies aligns with India's need for alternative fuel infrastructure and pilot projects.
International Maritime Organization (IMO)	Maritime Research Fund; Market-Based Measures (MBMs)	R&D in low-carbon technologies and capacity building	IMO initiatives provide funding and policy guidance, aligning with India's goals for equitable decarbonization in the maritime sector.
Horizon Europe (EU)	R&D grants for innovative green technologies	Collaborative research on hydrogen-powered vessels and energy-efficient hull designs	Horizon Europe supports cutting-edge R&D initiatives, fostering collaboration between India and EU nations on green maritime solutions.
Danish Maritime Authority (Denmark)	Sustainable shipping practices, green technologies	Hydrogen bunkering pilot projects; joint ventures in green fuel technologies	Denmark's expertise in green shipping makes it an ideal partner for advancing India's maritime decarbonization projects.

Table 18: Key Global Funding Agencies and Partnerships for Advancing India's Sustainable Maritime Future

5.2.3 Financial Strategy for Decarbonization of the Indian Maritime Sector

A successful transition to greener and more sustainable maritime operations in India requires a solid financial framework that connects investment needs with appropriate funding sources. This section outlines a structured approach to aligning projected expenditures with viable financing options, identifying areas where government support or other incentives may be necessary. It also provides a clear rationale for funding requirements and actionable steps to secure the necessary resources.

Investment Area	Projected Requirement (INR)	Sustainable Financing Instruments	Gap Funding / Incentives Required
Port Infrastructure	60,000 crore ($7.5 billion)	Green bonds, PPPs for renewable-powered ports, MDB loans for electrification, blended finance for alternative fuel infrastructure.	Government grants, tax incentives for shore power systems, and funding for hydrogen/ammonia bunkering infrastructure.
Shipping Fleet Modernization	90,000 crore ($11.2 billion)	Sustainability-linked loans (SLLs), corporate green bonds, leasing models for LNG/hybrid vessels, MDB funding for retrofitting, green shipping funds.	Subsidies for retrofitting older vessels, low-interest financing for zero-emission vessels, and R&D grants for new designs.
Logistics and Inland Waterways	30,000 crore ($3.7 billion)	MDB loans for multimodal hubs, PPPs for hybrid/electric barges, carbon pricing revenues, green bonds for low-emission logistics infrastructure.	Tax rebates for electric/hybrid barge projects, incentives for battery swapping and charging infrastructure.
Research and Development	23,000 crore ($2.8 billion)	Government R&D grants, private equity/venture capital for clean-tech startups, global climate finance, blended finance for pilot projects.	Government co-funding for alternative fuels, advanced hull materials, and wind-assisted propulsion research.
Training and Capacity Building	8,000 crore ($1 billion)	Capacity-building grants, PPPs for maritime training centres, MDB technical assistance, corporate funding for sustainability training.	Direct government funding for training facilities, skill development curricula, and scholarships for maritime upskilling.
Total	211,000 crore ($26.2 billion)	Mixed financing from sustainable models combined with public sector contributions.	Structured government incentives to address gaps and de-risk early-stage projects.

Table 19: Investing Requirements and Financing Instruments

6 Policy Actions

We propose a **two-pronged approach** to decarbonize India's maritime sector by 2070, inspired by international best practices and aligned with the IMO's strategic goals. This strategy focuses on the following key policy instruments, which form the foundation of the **National Green Shipping Policy (NGSP)**:

- **Driving Policy Instruments**
    - **Green Regulations**
    - **Green Reporting**
- **Supporting Policy Instruments**
    - **Green Finance**
    - **Green Collaborations**

The **driving policy instruments** set clear and firm emission reduction targets for the sector. This includes:

- **Green Regulations:** Policies that enforce emission reduction targets and impose penalties for non-compliance, ensuring accountability.
- **Green Reporting Mechanisms:** Frameworks to monitor and assess emissions reductions, providing transparency and encouraging continuous improvement.

The **supportive policy instruments** are aimed at encouraging the early adoption of sustainable practices. This includes:

- **Green Finance Schemes**: These will provide essential funding, subsidies, incentives, credits, and risk mitigation mechanisms to promote the adoption of green technologies and practices.
- **Strategic Collaborations**: Building national and international partnerships to enhance capabilities and infrastructure in **green technologies, fuels, ports, ships, and operations**.

These instruments serve as enablers, facilitating the maritime sector's shift towards sustainability by fostering collaboration and providing financial support.

Policy actions have been developed and proposed based on the findings of the baseline study, benchmarking and scenario analysis. The intent of the policy areas is to form a foundation and reference point for policymakers to devise a comprehensive green shipping policy. By keeping the root causes at the forefront, these action areas were articulated to target the underlying issues effectively rather than just mitigating their symptoms.

6.1 Green Finance

6.1.1 Policy Area: Green Technologies

6.1.1.1 Policy Action 1: PLI Schemes for Manufacturers of Green Technology Components, Ancillaries, and Systems

India's ambition to become a global leader in green and sustainable ship manufacturing requires overcoming key dependencies on imported components and raw materials. A major challenge lies in developing a robust domestic supply chain for critical marine-grade components, such as green propulsion systems, alternative fuel infrastructure, and advanced shipbuilding materials.

The **Production-Linked Incentive (PLI) Scheme** has played a transformative role in strengthening India's manufacturing capabilities across various industries by providing financial incentives linked to incremental production. A notable success story is the **automobile and auto components sector**, where PLI has accelerated advancements in **electric vehicles (EVs) and hydrogen fuel cell technology**.

Since **shipbuilding shares many similarities with the automotive sector**—being **capital-intensive, technology-driven, and globally competitive**—there are valuable lessons to be drawn from the PLI's impact on the auto industry. By incentivizing domestic production, the scheme has spurred **innovation, investment, and reduced reliance on imports**, making India a competitive player in the global market.

Currently, **the PLI scheme does not extend to the maritime and shipbuilding sector**. However, **amending the policy to include green marine-grade components and raw materials** could provide a significant boost to India's shipbuilding industry. This could drive **technological advancements in sustainable ship design, promote local manufacturing of critical components, and reduce dependence on foreign supply chains**.

Expected Outcome

- **Lower production costs** for domestic manufacturers, making locally produced green technology components more competitive.
- **Increased local production** of advanced marine technologies, reducing dependency on imports.
- **Job creation in green shipbuilding and maritime technologies**, fostering a skilled workforce for next-generation ship manufacturing.
- **Strengthening India's position** as a global hub for sustainable shipbuilding, enhancing export potential.

Key Considerations for Policy Makers

To ensure effective implementation, policymakers may introduce **direct financial incentives of 10-20% on incremental sales revenue** for companies engaged in manufacturing green maritime components and ancillaries. These incentives can be phased out as market maturity is achieved, ensuring a self-sustaining ecosystem.

The following **critical components and materials**, currently reliant on imports, should be prioritized for domestic production under the PLI scheme:

1. Energy Storage Systems

- **Marine Batteries** – Marine-grade lithium-ion batteries for hybrid and electric vessels.
- **Battery Management Systems (BMS)** – Essential for optimizing performance, longevity, and safety.

2. Alternative Fuel Infrastructure

- **Cryogenic Tank Manufacturing** – Specialized tanks for storing LNG, liquid hydrogen, and ammonia.

3. Advanced Materials

- **Marine-Grade Steel** – High-tensile, corrosion-resistant steel for ship construction.
- **Carbon Fiber Composites** – Lightweight, high-strength materials for hulls and superstructures.

4. Propulsion and Renewable Systems

- **Electric Motors** – High-efficiency propulsion systems for hybrid and electric ships.

- **Wind-Assisted Propulsion Systems** – Rotor sails and wind turbines for fuel savings.
- **Fuel Cells** – Hydrogen fuel cells enabling zero-emission propulsion.

5. Digital and Automation Technologies

- **IoT Sensors** – Advanced monitoring systems for fuel efficiency, emissions, and vessel health.
- **AI & Navigation Systems** – Autonomous navigation and route optimization technologies.

6. Coatings and Treatments

- **Anti-Fouling Coatings** – Eco-friendly, high-performance coatings, currently dependent on imports.
- **Advanced Thermal Insulation Materials** – Essential for LNG and hydrogen storage systems.

6.1.1.2 Policy Action 2: Tax Incentives Under the Make in India Initiative

The Indian government is actively fostering a **business-friendly environment** to attract **foreign and domestic investment** and strengthen domestic manufacturing under the **Make in India** initiative. A key strategy to support this initiative is the introduction of **targeted tax incentives** to encourage investment in **green maritime manufacturing**.

By implementing **tiered tax incentives** tailored to **MSMEs and large enterprises** engaged in green shipping technology, India can attract **higher investments** in sustainable shipbuilding and **advanced component manufacturing**.

Expected Outcome

- **Lower cost of doing business** in the initial setup years, encouraging both **domestic and foreign investment** in sustainable shipbuilding.
- **Increased profitability**, incentivizing companies to **scale up** green maritime manufacturing.
- **Reduction in dependence on imports**, making **local production cheaper** and more competitive.
- **Stimulation of cutting-edge research** in **green maritime solutions** and **digital decarbonization tools**.

Key Considerations for Policy Makers

India principally employs **R&D tax allowance (super deductions), tax holidays, custom duty exemptions for imports, write-offs on R&D expenses, and depreciation allowance for capital expenditure** in the high technology industries. Policymakers should **deploy similar tax incentives specifically for manufacturing of green shipping technology and components.** Some options could be –

- **Tax Holidays for new green tech manufacturers:** Newly established manufacturing units in green shipping technology can be granted a 5 to 10-year tax holiday where they are exempt from corporate income tax.
- **Reduced Corporate Tax Rates:** Companies manufacturing green components and providing digital green technologies (hydrogen propulsion systems, advanced batteries, AI-based fuel efficiency systems, and emission tracking software etc.) can be eligible for a lower than standard corporate tax rate – 5% to 10% for MSMEs and 15% for large players.

- **Import Duty Rebates:** 100% waivers or reductions in customs duties on imported components and raw materials essential for producing green shipping technology (such as Hydrogen fuel cells & electrolysers, advanced battery storage systems, smart maritime sensors and IOT modules, lightweight composite shipbuilding materials etc.)

- **Capital Investment Deductions**: Companies can be eligible to deduct the complete or percentage value of their capital investments towards green tech production from their taxable income, effectively lowering their tax liability. For instance, companies investing in green component factories or green fuel refuelling stations can claim a 100% deduction on capital expenditures for MSMEs and 50% for large players

- **Tax Credits on R&D:** Businesses investing in digital decarbonisation technologies such as AI-powered ship management software, blockchain-based carbon tracking, and smart emission control systems can get upto 100% tax deduction on R&D expenses.

- **Special incentives to attract Foreign Direct Investment for international investors such as -**

    - **Tax-Free Dividends**: Allow tax exemptions on dividends earned from investments in green shipping projects for a specified period (e.g., 10 years).

    - **Foreign Investment Protection Fund:** Establish a fund to underwrite risks faced by foreign investors in India's green shipping projects, covering currency fluctuations in taxes, policy changes, or market disruptions.

    - **Zero Export Duties**: Allow foreign companies manufacturing green shipping components in India to export products without paying export duties for the first 10 years

6.1.1.3 Policy Action 3: Specialized Design and Manufacturing Hubs (Or economic zones) for Green Maritime Manufacturing subject to key financial benefits

India's ambition to become a global leader in green and sustainable ship manufacturing requires addressing key dependencies such as **high initial investments, expensive raw material, R&D costs, energy expenses, logistics costs, labour cost, and regulatory compliance costs**. These can be addressed by **special economic zones (SEZs) dedicated to the design and manufacturing of green shipping technology**, and that are integrated with domestic and global supply chains for alternative fuel propulsion and hybrid engines.

Expected Outcome

Reduced investment risks, increased ease of doing business in green tech manufacturing, and consequently **increased domestic production, innovation, and skilled labour**. **Boost export competitiveness** in international markets and **increase manufacturing volume** to benefit from economies of scale

Key Considerations for Policy Makers

Specialised green clusters for the design and manufacturing of green technology and components, tailored to India's maritime and industrial strengths will be crucial in efficiency increasing production capacity of green shipping components. These hubs can be located in maritime states like Tamil Nadu, Gujarat, and Andhra Pradesh for producing green components. These specialised zones can provide –

- **Tax Incentives & Financial Support:** The zones should offer tax exemptions, duty-free imports of raw materials, sustainability linked loans, cheaper land leases and direct access to funding that would reduce the financial burden.

- **Innovation & R&D promotion:** The zone should provide R&D grants, and collaboration with technology firms to cut development expenses

- **Enhanced Infrastructure & Facilities:** The zone should provide state-of-the-art manufacturing facilities, research centres, and integration with localised supply chains to lower procurement costs.
- **Access to Skilled Labour:** The zone should include training centres and partnerships with universities, ensuring a steady supply of skilled workers.
- **Export Incentives:** The zone should provide export credits and insurance. To add to that, with reduced production and logistics costs, domestic exporters can compete for overseas sales, with reduced overall export cost. Export Credit Guarantee Corporation of India Limited (ECGC), under the administrative authority of the Ministry of Commerce and industry, can be onboarded for the provision of export incentives. ECGC is essentially an export promotion organisation, seeking to improve the competitiveness of the Indian exports by providing them with credit insurance covers.
- **Sustainability & Green Energy Integration:** The zone should integrate renewable energy sources, circular economy practices, and eco-friendly industrial processes.
- **Fast-Track Regulatory Approvals:** The zone should offer streamline bureaucratic processes, accelerating project approvals and reducing delays.

Global Best Practices in promotion of domestic manufacturing of green shipping components

South Korea has implemented policies and incentives to reduce the cost of producing green ships domestically by focusing on manufacturing green components and driving innovation. The South Korean government, through its **"Korean New Deal"** and **"Green Ship-K"** initiative, provides a detailed case study of effective policy design.

Through its green finance initiatives, it has increased domestic manufacturing of green shipping materials. Companies like Hyundai Heavy Industries (HHI) and Daewoo Shipbuilding & Marine Engineering (DSME) are now producing LNG tanks and propulsion systems domestically, reducing reliance on imports.

Domestic production of marine batteries has also scaled significantly in South Korea, led by companies like LG Chem and Samsung SDI.

The cost of LNG-powered ships in South Korea has dropped by approximately 20% due to increased domestic component production and government subsidies. Subsequently, South Korea has become a global supplier of LNG and hydrogen technologies, exporting components and vessels to Europe and Asia. Development of hybrid propulsion systems that combine LNG, batteries, and hydrogen fuel cells, positioning South Korea as a leader in next-generation green ship technologies.

6.1.2 Policy Area: Green Ships

6.1.2.1 Policy Action 1: Enhancing Financial Incentives through the Shipbuilding Financial Assistance (SBFA) Scheme

Optimize the **Shipbuilding Financial Assistance (SBFA) scheme**, which currently offers a **30% subsidy** for green ships constructed in India, by introducing **tiered financial support mechanisms** to accelerate **sustainable shipbuilding and retrofitting**.

Expected Outcome

- **Increased financial support** for shipyards adopting green technologies.
- **Development of new skills** in domestic shipbuilding through experience in **eco-friendly vessel manufacturing**.

- **Encouragement for shipbuilders** to exceed regulatory compliance and invest in **advanced sustainability innovations**.
- **Reduction in emissions** from both newly built and retrofitted vessels.

Key Considerations for Policy Makers

By providing various financial support mechanisms with SBFA and expanding coverage to retrofits and digitalisation, can accelerate the transition to green shipbuilding.

- **Tiered Incentives for Higher Environmental Standards:** Introduce a **performance-based subsidy structure**, where funding increases based on the ship's **energy efficiency and emissions reduction capability**:
    - 30**% base subsidy** for ships meeting current **green ship** eligibility criteria.
    - **35-40% subsidy** for vessels with **higher fuel efficiency** and **lower lifecycle emissions**, integrating technologies such as:
        - Hydrogen propulsion systems.
        - Wind-assisted propulsion.
        - Next-generation battery systems.
    - **45% subsidy** for ships achieving **net-zero emissions**, utilizing:
        - Full electrification.
        - Hydrogen or ammonia fuels.
        - Hybrid renewable energy solutions.
- **Expansion to Retrofitting incentives:** Extend SBFA support to retrofitting existing vessels by offering a 20-25% subsidy for:
    - **Installation of hydrogen fuel cells** or **hybrid propulsion systems**.
    - **Conversion to LNG, ammonia,** or **methanol-based propulsion**.
    - **AI-driven fuel optimization** and **emissions monitoring**.
    - **Energy-efficient hull coatings and waste heat recovery systems**.
- **Promoting Hybrid & Fully Electric Vessels for Coastal & Inland Shipping:** Provide an **increased subsidy of up to 50%** for:
    - **Hybrid and fully electric vessels operating** in **coastal and inland waterways.**
    - **Zero-emission passenger ferries** and **cargo vessels to accelerate the shift toward sustainable inland water transport.**
- **Supporting Locally Manufactured Green Technologies:** Provide **higher financial assistance to shipbuilders using domestically produced green shipping components** - additional 5-10% subsidy for ships integrating Made-in-India green tech.
- **Priority Processing for SBFA Application for Green Ships:** Create a fast-track approval process for shipbuilders applying for SBFA subsidies for green vessels.

6.1.2.2 Policy Action 2: Financial Risk-Sharing Mechanisms for Retrofitting Existing Ships

The long-term **cost-benefit equation** for retrofitting **green shipping technologies** remains uncertain, posing financial risks for **shipowners, equipment manufacturers, and financiers**. To **accelerate retrofitting adoption**, risk-sharing mechanisms must be introduced to **mitigate financial exposure and encourage investment** in sustainable maritime technologies.

Expected Outcome

- **Reduced financial risk** for shipowners, technology providers, and investors.
- **Increased adoption of green retrofitting solutions** across the shipping sector.
- **Market confidence in retrofitting technologies** through risk-sharing incentives.

Key Considerations for Policy Makers

Risk-Sharing Instruments for Retrofitting

Some of the risk sharing instruments that could be considered by policymakers as incentives are -

- **Guarantee Schemes:** Government-backed loan guarantees for shipowners investing in alternative fuel retrofits, hybrid propulsion systems, and emission reduction technologies**.**
- **Insurance Subsidies:** Lower insurance premiums for ships retrofitted with green technologies, reducing financial uncertainty around performance and reliability.
- **Public-Private Partnerships (PPPs):** Collaborate with private sector investors and financial institutions to co-fund retrofitting initiatives and share adoption risks.
- **Government Procurement Programs:** Create market demand for green retrofits by prioritizing eco-friendly vessels for state-run shipping operations and coastal ferries. Reserve 30% of government ship procurement for green ships.
- **Green Bonds & Concessional Financing** – Introduce government-backed green bonds and concessional financing options for shipowners & port operators investing in green retrofitting, fuel transition, and newbuilds.

Global Best Practices for Risk Mitigation

- **Norway's Green Shipping Program:** Offers subsidies and grants for hybrid, electric, and hydrogen-powered vessel retrofitting, including zero-emission ferries for state services.
- **Japan's Zero-Interest Loans for Retrofitting**: Provides financial incentives for hydrogen and ammonia-based retrofits.
- **Singapore's Green Ship Programme**: Offers tax rebates, grants, and reduced port fees for ships adopting LNG propulsion and energy-efficient retrofits.
- **European Union's Emissions Trading System (EU ETS)**: Allows shipowners to earn carbon credits for emissions reductions, making retrofitting financially viable.
- **Canada's Clean Growth Program**: Provides grants and carbon offset credits to encourage green technology adoption in maritime and industrial sectors.
- **China's Green Ship Promotion Program**: Supports state-owned fleets in transitioning to sustainable vessel operations through targeted financial support.

6.1.2.3 Policy Action 3: Green Innovation Fund for Research, Development, and Innovation in Green Shipping

Establish a **Green Innovation Fund** to **support specialized research, technology development, and skill-building initiatives** in green shipping. The fund could be financed through a **dedicated allocation from the Maritime Development Fund or other financial mechanisms**, ensuring a **sustainable pipeline of funding for maritime decarbonization projects**.

Expected Outcome

- **Sustained financial support** for **green maritime research and innovation**.
- **Advancements in fuel efficiency, vessel safety, and environmental performance** beyond cost reductions.
- **Skilled workforce development** for emerging green shipping technologies.
- **Alignment with SDG 9 (Industry, Innovation, and Infrastructure)** by promoting maritime technological progress.
- **Strengthened global competitiveness** for India's **green shipbuilding sector and retrofit solutions**.
- **Improved stakeholder awareness** of **long-term benefits** of green shipping, driving **informed investments**.

Key Considerations for Policy Makers

The **Green Innovation Fund** can be used to finance:

- **Research and Payback Studies**: Evaluate **performance, reliability, and financial feasibility** of **green fuels, propulsion systems, and emissions reduction technologies**, ensuring compliance with **international standards**.
- **Retrofit Hubs & Pilot Projects**: Establish **dedicated testing hubs** for **retrofitting government-owned vessels** or through partnerships with leading **shipping companies**.
- **Educational and Training Programs**: Develop **curriculums and certifications** based on **real-world learnings from innovation projects** to upskill maritime professionals

Global Best Practices in Green Shipping R&D Funding

- **Norway's Green Coastal Shipping Programme**: Funds **cost-benefit studies on energy-saving technologies** and promotes awareness campaigns for industry adoption.
- **Denmark's Green Ship Initiative**: Conducts **payback studies on LNG propulsion and hybrid systems**, demonstrating economic and environmental advantages.
- **Germany's German Maritime Centre (GMC)**: Invests in research on **air lubrication systems and exhaust gas cleaning**, using findings to **educate ship operators**.
- **Singapore's Maritime Port Authority (MPA)**: Supports **studies on LNG and hydrogen fuels**, integrating financial and environmental insights into policy campaigns.

6.1.2.4 Policy Action 4: Green Talent Fund for Maritime Workforce Development in Green Shipping

Establish a **Green Talent Fund** to support **specialized training programs** in **green ship design, alternative fuel systems, and smart shipping technologies**. This fund can be financed through **a dedicated allocation from the Maritime Development Fund** or **other financial strategies**, ensuring a **future-ready maritime workforce** equipped to meet green shipping demands.

Expected Outcome

- **Development of specialized maritime skills** in **design, installation, maintenance, and safe operation** of:
    - **Green propulsion systems** (hydrogen, ammonia, LNG, battery-electric).
    - **Energy-saving devices** (air lubrication, wind-assisted propulsion).
    - **Alternative fuel technologies** (methanol, biofuels, hybrid propulsion).
    - **Smart shipping technologies** (AI-driven fuel optimization, emissions monitoring).
- **Alignment with SDG 4 (Quality Education)** by investing in **human capital and workforce development** for sustainable maritime transport.

Key Considerations for Policy Makers

Through the proposed **Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMaRT)**, the fund can provide **targeted financial support** for:

- **Green Shipping Scholarships & Fellowships**: Offer funding for students pursuing **advanced degrees and research** in **sustainable shipping technologies**.
- **Apprenticeship & On-the-Job Training Programs**: Develop **collaborations between shipyards and green technology companies** to train maritime professionals.
- **National Training Scheme for Seafarers**: Provide **low-cost specialized training** to equip seafarers with skills in **operating retrofitted vessels and managing new fuel systems**.
- **Grants & Tax Incentives for Universities & Private Sector**: Support **R&D initiatives** in green ship technologies by offering **financial incentives** to institutions and industry partners.

Global Best Practices in Green Maritime Workforce Development

- **Singapore's Maritime Singapore Green Initiative (MSGI) & Sea Transport ITM**: Offers **subsidized training in green propulsion, energy-saving, and smart shipping technologies**.
- **Singapore Maritime Institute (SMI) & Global Maritime Decarbonization Centre (GMDC)**: Provides **degree programs, executive training, and research grants** for sustainable shipping.
- **Maritime** and **Port Authority of Singapore (MPA)**:
    - Covers **up to 90% of course fees** for maritime workforce reskilling.
    - Provides **salary support for companies investing in green skills development**.
    - Offers **tax breaks for maritime R&D and training investments**.

6.1.3 Policy Area: Green Fuels

6.1.3.1 Policy Action 1: Financial incentives and funding support to drive green fuel production, adoption and export in India

India's transition to **green fuels** in the **maritime sector** is essential for achieving **net-zero emissions** and reducing dependence on **imported fossil fuels**. Currently, green fuels are 30-50% more expensive than conventional marine fuels like Heavy Fuel Oil (HFO) and Marine Gas Oil (MGO). This price gap makes the transition financially unviable for shipping companies operating on thin profit margins. Global models, such as the **EU's FuelEU Maritime initiative** and **Norway's Green Shipping Programme**, demonstrate how **targeted financial incentives** can accelerate the adoption of green fuels. By supporting domestic fuel manufacturers through capital subsidies, tax breaks, and research grants, the policy will enable cost reductions and economies of scale. As production scales up, unit costs of green fuels will decrease, making them more commercially viable. In the current state, implementing Viability Gap Funding (VGF), production-linked incentives (PLI), and tax exemptions can bridge the cost gap between green fuels and conventional fuels to accelerate adoption. Further, low-interest loans and government-backed risk-sharing mechanisms will create an attractive investment environment in green fuel production plants, green fuel supply chains, and bunkering infrastructure. Additionally, government support for export-oriented production capacity and trade partnerships will allow India to supply green fuels to global shipping hubs. Over time, this will foster a self-sufficient green fuel ecosystem, ensuring price stability and long-term energy security for India's maritime sector

Expected Outcome

- **Increased domestic production and availability of green fuels**
- **Lower cost differential between green and conventional marine fuels:** As global green fuel production increases and technology matures, costs will naturally decline, but short-term financial support will kickstart adoption and maintain industry competitiveness.
- **Private sector investments in green fuel infrastructure:** The maritime industry is capital-intensive, hence private players may invest in unproven or high-risk fuel alternatives only with financial security and incentives. Additionally, strategic partnerships with venture capital firms, climate funds, and global green energy investors will further mobilize private capital into the sector.
- **India as a competitive export-oriented green fuel hub:** By positioning itself as a regional leader in green fuel production, India can capture the growing export market in South Asia and beyond.

Key Considerations for Policy Makers

- **Subsidies** for **Green Fuel Production**:
    - **Capital Subsidies (30-50%)**: Support the establishment of **green hydrogen, ammonia, methanol, and biofuel (Bio-LNG, Bio-Methanol etc.) production plants**. Higher subsidies for **early adopters** can drive initial market growth.
    - **Production-Linked Incentives (PLI)**: Financial incentives tied to **incremental production volume** to **reduce costs** and encourage large-scale **domestic production**.
    - **Subsidies for Raw Materials & Equipment (10-20%)**: Subsidies for **electrolysers (for hydrogen production), carbon capture technologies, and biofuel feedstocks** to reduce **input costs**.
    - **Subsidies for methane slip reduction in LNG production and supply chains**: Subsidies for technologies used in reducing methane emissions across LNG production, liquefaction, transport, and bunkering, such as improved leak detection and repair systems, and methane recovery systems

- **Tax Incentives** for **Green Fuel Producers & Suppliers**:
    - **Corporate Tax Holiday (10 years)**: Full or partial tax exemptions on profits from **green fuel production** to encourage investment.
    - **GST Waivers & Reductions**: Lower **GST rates** for **green fuels** and **critical inputs**, including **renewable electricity, biomass, methane abatement, and ammonia synthesis components**.
    - **Accelerated Depreciation (up to 40%)**: Faster depreciation for investments in **green fuel production and storage infrastructure**, improving financial viability.
- **Green Shipping Fund** for **Research, Innovation, and Market Development**:
    - A **₹10,000 crore Green Shipping Fund** to provide **low-interest loans, grants, and risk-mitigation support** to:
        - **Fuel producers** developing green fuels.
        - **Port authorities** investing in **green bunkering infrastructure**.
        - **Shipping companies** transitioning to **low-carbon operations**.
    - **International Climate Finance Integration**: Co-finance initiatives through:
        - **IMO's GreenVoyage2050 Program**
        - **International Finance Corporation (IFC) Sustainability Bonds**
        - **Green Climate Fund (GCF) for Maritime Innovation**
- **Infrastructure-Linked Incentives** for **Green Fuel Adoption**:
    - **Land Allocation support**: Preferential land access in **port-based industrial zones** for green fuel plants and **dedicated fuel export and supply zones**.
    - **Reduced Import Duties**: Lower duties on **electrolysers, catalysts, hydrogen compression, and storage equipment** to reduce **capital costs**.
    - **Public-Private Partnerships (PPPs)**: Encourage **private sector investments** in **green fuel bunkering infrastructure**, using **Norway's LNG model** as a reference.
    - **Integration with Existing** Policies:
        - Expand the **National Biofuels Policy (2018)** and **SATAT scheme** to incentivize **biogas production for bio-LNG**.
        - This would enhance **bio-LNG availability**, reduce **GHG emissions**, and support **agricultural waste utilization**.
    - **Raw Material** Availability:
        - Secure **renewable energy** for **green hydrogen production**.
        - Strengthen **feedstock supply chains** for **biofuels** to prevent market disruptions from competing industries.

6.1.3.2 Policy Action 2: Investment in R&D for Electrolyser Manufacturing, Ammonia Synthesis, and Biofuel Production

India's transition to green fuels for maritime applications requires a strong focus on domestic research and development (R&D) to reduce reliance on imported technologies and accelerate commercialization. Electrolysers for green hydrogen production, ammonia synthesis technologies, and advanced biofuels are critical for establishing a sustainable fuel ecosystem. While India has made progress in green hydrogen under the National Green Hydrogen Mission, gaps remain in cost reduction, efficiency enhancement, and scalability of electrolyser manufacturing. Additionally, the production and utilization of ammonia as a marine fuel require substantial advancements in storage, handling, and combustion technologies. Biofuels, including advanced bio-methanol and second-generation biodiesel, hold significant potential for decarbonizing short-sea shipping and inland waterways. Strategic R&D investments in these areas will help India develop indigenous solutions, reduce costs, and position itself as a leader in green maritime fuel technologies.

Expected Outcome

- Accelerated development of cost-effective electrolysers, enabling large-scale green hydrogen production for maritime applications.
- Enhanced domestic ammonia synthesis technologies, reducing reliance on imports and ensuring a steady supply of low-carbon maritime fuel.
- Increased production and adoption of advanced biofuels, particularly second-generation biofuels, for reducing emissions in short-sea and inland shipping.
- Strengthened collaboration between research institutions, industry, and government, fostering innovation in green fuel technologies.

Key Considerations for Policy Makers

Policymakers should allocate dedicated R&D grants and tax incentives to companies and institutions engaged in green fuel research, prioritizing the following technology areas:

1. **Electrolyser Manufacturing**
    - **Solid Oxide & PEM Electrolysers:** Advanced, high-efficiency electrolysers suitable for large-scale hydrogen production.
    - **Localized Supply Chains:** Development of domestic supply chains for catalysts, membranes, and other key components.
    - **Availability of Raw Materials:** Green hydrogen production requires significant amounts of renewable energy, making the expansion of clean power infrastructure a critical factor. Stable and cost-effective access to essential raw materials such as platinum and iridium for electrolyser production must also be ensured.
2. **Ammonia Synthesis and Storage**
    - **Next-Generation Ammonia Production:** Research on low-energy Haber-Bosch alternatives, electrochemical ammonia synthesis, and catalysts to enhance efficiency.
    - **Cryogenic Storage & Bunkering Infrastructure:** Development of safe, scalable storage and handling technologies for ammonia-based marine fuel.
    - **Availability of Raw Materials:** While nitrogen, a key component for ammonia, is abundantly available in the atmosphere, its extraction and conversion into fuel require energy-intensive processes.

Investment in energy-efficient production methods and renewable energy sources is essential to maintain cost competitiveness.

3. **Biofuel Production and Integration**
    - **Second-Generation Biofuels:** Focus on waste-based bio-methanol and biodiesel production for reducing feedstock competition with agriculture.
    - **Marine Engine Adaptation:** Research into biofuel-compatible engines and retrofitting technologies for existing vessels.
    - **Availability of Raw Materials:** The production of biofuels is dependent on feedstock availability, which can be affected by competing demands from the agriculture and energy sectors. Ensuring a stable supply of non-food-based feedstocks, such as agricultural waste and algae-based biofuels, will be critical for cost stability and scalability.

6.1.3.3 Policy Action 3: Accelerating Green Fuel Adoption Through PPP-Enabled Bunkering Infrastructure Development at Major Indian Ports.

As India transitions towards alternative fuels such as hydrogen, ammonia, and biofuels for maritime applications, a robust bunkering infrastructure is essential to support widespread adoption. The government's initiative to develop three major Green Hydrogen Hubs at Paradip, Tuticorin, and Kandla presents a strategic opportunity to integrate maritime bunkering facilities with these hubs. However, the high capital costs, technological complexities, and uncertain demand growth create challenges for private sector investments. A Public-Private Partnership (PPP) model can accelerate the development of bunkering infrastructure by leveraging government support while attracting private sector expertise and funding.

Globally, countries like Singapore, Japan, and the Netherlands have successfully implemented PPP-driven green fuel bunkering networks, ensuring seamless supply for alternative fuel-powered vessels. By strategically developing LNG, hydrogen, and ammonia refuelling stations at key Indian ports, India can position itself as a leader in green maritime energy, reducing reliance on imported fossil fuels and aligning with global decarbonization efforts.

Expected Outcome

- Establishment of a **reliable green fuel supply chain**, ensuring uninterrupted availability for domestic and international vessels.
- Acceleration of India's **transition to alternative fuels**, reducing maritime sector emissions and supporting **IMO's 2050 decarbonization goals.**
- Integration of bunkering infrastructure with India's **Green Hydrogen Hubs** to maximize production and utilization of clean fuels.
- Attraction of **foreign investments and shipping operators**, strengthening India's competitiveness as a sustainable maritime hub.
- Generation of employment in **fuel handling, logistics, and port infrastructure development**, boosting the green economy.

Key Considerations for Policymakers

To ensure the success of PPP-based green bunkering infrastructure, policymakers may consider the following measures:

- **Integration with Green Hydrogen Hubs:** Align bunkering infrastructure with existing hydrogen production centres at Paradip, Tuticorin, and Kandla, ensuring a streamlined fuel supply chain.
- **Viability Gap Funding (VGF):** The government can provide up to 40% capital cost support for initial investments in bunkering facilities, reducing financial risks for private players.
- **Revenue-Sharing Models:** A hybrid revenue-sharing approach between the government and private firms can incentivize long-term participation in bunkering operations.
- **Financial Incentives for Early Adopters:** Introduce tax benefits, subsidies, and preferential port tariffs for shipping companies using green fuels to encourage early adoption.
- **Strategic Location Selection:** Initial pilot projects should focus on high-traffic maritime hubs like Mumbai, Chennai, Kochi, and Visakhapatnam, with phased expansion based on demand.
- **Technology Standardization:** Collaboration with global regulatory bodies like IMO and IRENA to ensure compliance with international fuel quality and safety standards.

6.1.4 Policy Area: Green Ports

6.1.4.1 Policy Action 1: Financial Incentives for Renewable Infrastructure

Encourage the adoption of renewable energy and energy-efficient technologies at ports through subsidies, tax benefits, and green bonds to reduce dependency on fossil fuels and improve environmental sustainability.

Expected Outcome

- **Accelerated Renewable Energy Adoption**: Increased installation of solar panels, wind turbines, and energy-efficient port equipment, enhances port resilience against fluctuating energy costs. India aims to meet 50% of port energy needs by 2030 through solar power expansion at all major and non-major ports.
- **Reduction in Carbon Footprint**: Lower greenhouse gas (GHG) emissions from port operations due to decreased reliance on diesel-powered equipment, leading to cleaner air and water quality. Electrified Cranes can result in up to 70% reduction of fuel consumption.
- **Cost Savings & Operational Efficiency**: Long-term reduction in energy costs through efficient systems. LED lighting systems can lead to 30% reduction in electricity usage for lighting. Improved overall sustainability scores will boost global competitiveness.

Key Considerations for Policy Makers

- **Providing financial incentives:** Possible Fiscal Incentives for Green Ports Projects in India could include:

Incentives	Description	Expected Impact
Capital Subsidies	Government funding for up to 30% of initial project costs for Major Ports and up to 60% for Minor Ports to support renewable energy and cold ironing initiatives.	Encourages adoption of green technologies; reduces financial barriers for ports.
Tax Rebates	Tax exemptions for green port infrastructure investments, including renewable energy and waste management.	Attracts private investors by improving return on investment.

Incentives	Description	Expected Impact
Custom Duty Exemptions	Waivers on imported equipment for renewable energy and emission control technologies.	Reduces project costs for ports adopting advanced technologies.
Performance-Based Incentives	Financial rewards for ports achieving specific sustainability milestones (e.g., emission reductions).	Motivates continuous improvement in sustainability practices.
Green Port Fund	Dedicated fund to provide low interest loans and grants for green port projects. ADB's $500 million funding for renewable energy projects; can be extended to port infrastructure.	Ensures sustained funding for long-term green port initiatives.

Table 20: Possible Financial Incentives

- **Financial Planning & Risk Management**: Develop phased and tiered investment strategies to manage high upfront costs to ensure equitable development. Ensure sustainable funding models with public-private partnerships.
- **Scalability & Accessibility:** Ensure financial incentives are accessible to ports of all sizes. Provide technical assistance for smaller ports to adopt renewable solutions.
- **Monitoring & Transparency**: Implement strict reporting frameworks to track impact. Use third-party audits to verify energy efficiency improvements.

6.1.4.2 Policy Action 2: Incentives for Alternative Fuel Infrastructure

Support the development of bunkering and refuelling infrastructure for alternative fuels like LNG, green hydrogen, and ammonia by providing financial assistance, policy incentives, and regulatory benefits.

Expected Outcome

- **Expanded Availability of Green Fuels**: Increased port readiness for alternative fuel bunkering. Encouragement for shipping companies to transition to cleaner fuels.
- **Lower Maritime Emissions**: Significant reduction in CO_2, NOx, and SOx emissions. Enhanced air quality in port cities and surrounding regions.
- **Improved Market Competitiveness**: Ports with green fuel infrastructure attract more eco-conscious shipping lines. Strengthened positioning of Indian ports in global sustainable trade.

Key Considerations for Policy Makers

- **Infrastructure Investment Strategy**: Plan phased rollouts of green fuel bunkering facilities. Ensure adequate supply chains for alternative fuels.
- **Safety Frameworks**: Establish clear safety and operational standards for alternative fuel handling. Align policies with global alternative fuel regulations (IMO, MARPOL).
- **Incentivizing Industry Adoption**: Offer financial incentives for early adopters of green fuels. Encourage private sector investment through public-private partnerships.

6.1.4.3 Policy Action 3: Viability Gap Funding (VGF) for Green Infrastructure and Port Projects

Establish a Viability Gap Funding (VGF) mechanism specifically for green port projects, offering financial support to cover initial investment costs and making projects more attractive to private investors.

Expected Outcome

Attract private investment to develop green infrastructure, accelerate green technology adoption and enhance port sustainability.

Key Considerations for Policy Makers

A significant part of India's ambition to decarbonize the maritime sector will require the decarbonization of ports, with sustainable practices employed in ports which form an important section of the maritime value chain. Key initiatives and projects that could be supported through these financial instruments –

- **A National Green Corridors Map** which can enhance port infrastructure by guiding the development of essential facilities such as bunkering stations for alternative fuels at strategically identified locations. This infrastructure is crucial for supporting the transition to greener fuels, enabling ports to accommodate new fuel types like LNG and hydrogen. Additionally, the map can facilitate upgrades to port operations, including electrification and the integration of renewable energy sources such as solar and wind power, ultimately fostering a more sustainable maritime environment.
- Develop **EV charging infrastructure** for electric trucks, cranes, and shore power for vessels to reduce emissions and fuel use. Collaborate with logistics companies, vehicle manufacturers (e.g., Tata Motors, Ashok Leyland), and charging providers (e.g., Tata Power, Fortum) to accelerate the shift to low-emission vehicles. India plans to have 100% of the cargo handling systems and hybrid cranes electrified by 2040 and 100% LED lighting systems by 2026
- Shore-to-Ship Power (STS), also known as cold ironing, enables docked vessels to draw power from the port's grid instead of running their engines. This significantly reduces greenhouse gas emissions, noise pollution, and fuel consumption during berthing, improving air quality in port cities, supporting healthier living conditions for nearby communities STS implementation at major ports such as Mumbai, Tuticorin, and Paradip is expected to eliminate up to 500,000 tonnes of CO_2 annually across the country, making it a cornerstone of India's green port strategy. India aims to equip 50% of berths with such systems by 2030 through the implementation of Onshore Power Supply (OPS) systems at major ports.

6.1.5 Policy Area: Green Recycling

6.1.5.1 Policy Action 1: Green Finance & Incentives for Sustainable Ship Recycling

Introduce **Green Finance Mechanisms** to support shipbreaking yards in adopting **clean technologies, emission-reducing processes, and worker safety improvements**.

Expected Outcome

- Increased investment in environmentally responsible ship recycling infrastructure.
- Lower cost burden for shipbreaking yards transitioning to green operations.
- Expansion of India's market share in compliant ship recycling services.

Key Considerations for Policy Makers

- **Subsidies & Viability Gap Funding (VGF):** Provide financial assistance for shipyards investing in pollution control technologies, worker safety measures, renewable energy adoption, and scrapping older vessels by recycling and replacing them with new, energy-efficient ships built in India
- **Green Tax Incentives**: Offer tax breaks to ship recycling companies adopting zero-discharge dismantling and hazardous waste recycling innovations.
- **Green Certification-Linked Benefits**: Shipyards achieving Level 3 and Level 4 compliance under the Green Ship Recycling Framework should receive preferential financing and insurance premium discounts.
- **Public-Private Partnerships (PPPs):** Encourage collaboration between ship recyclers, environmental technology firms, and financial institutions to develop eco-friendly shipbreaking infrastructure.
- **Innovation Grants:** Provide grants for Indian shipbreaking yards to improve environmental safety, hazardous waste disposal & automation

6.1.6 Policy Area: Social and Coastal Community Development

6.1.6.1 Policy Action 1: Financial Support for Economic Resilience Among Coastal Population

Reducing economic reliance on traditional fishing and other vulnerable maritime sectors requires the development of alternative, sustainable income sources. **Eco-friendly aquaculture, community-based marine ecotourism, and renewable energy projects can provide stable employment while preserving marine ecosystems**. **Eco-friendly aquaculture can create sustainable food production and trade opportunities, while marine ecotourism will generate jobs in hospitality, conservation, and guided experiences**. Investment in renewable energy projects such as offshore wind farms and solar-powered fishing boats will introduce new employment avenues while reducing carbon footprints. By diversifying coastal economies, communities can mitigate risks associated with declining fish stocks and environmental disruptions, ensuring long-term economic resilience.

Expected Outcome

- Enhanced economic stability for coastal communities, through reduced dependency on industries susceptible to climate change and resource depletion.
- Improved financial security and long-term economic opportunities for coastal livelihoods

Key Considerations for Policy Makers

- **Financial incentives** and investment in training programs for eco-friendly aquaculture and marine ecotourism
- **Microfinancing options for coastal entrepreneurs** to invest in alternative livelihoods
- **Public-private partnerships to expand renewable energy initiatives** in coastal regions
- **Incentives for maritime startups and businesses** to generate employment

6.1.7 Policy Area: Pollution Prevention from Maritime Activities

6.1.7.1 Policy Action 1: Financial Support for Pollution Control

Provide grants and low-interest loans to shipowners and ports for installing emission scrubbers, ballast water treatment systems, and advanced waste management technology.

Expected Outcome

Faster adoption of green pollution-control technologies across India's maritime sector

Key Considerations for Policy Makers

It is important to prioritize financial support for domestic shipowners and small port operators who may struggle with compliance costs

6.2 Green Collaboration

6.2.1 Policy Area: Green Technologies

6.2.1.1 Policy Action 1: Strategic Collaborations to Enhance Green Shipping Technology Manufacturing

Facilitate **strategic international partnerships and technology transfer agreements** to strengthen India's **green shipping technology manufacturing capabilities** and accelerate domestic expertise in **low-carbon maritime solutions**.

Expected Outcome

- **Enhanced technological expertise** in green shipping manufacturing.
- **Access to cutting-edge research and innovation** through **mutually beneficial collaborations**.
- **Accelerated development** of **domestic green shipping technology production**.

Key Considerations for Policy Makers

The focus areas for these collaborations should include (but not be limited to) **hydrogen and ammonia fuel technologies, LNG infrastructure and dual-fuel engine systems, advanced battery systems and energy-efficient hull designs**. Possible collaboration options that policymakers can consider –

- **UK Partnership on Green Shipping Research & Production**: Explore **joint R&D programs** with the UK, leveraging existing defence cooperation on **electric propulsion systems for the Indian Navy**.
- **Technology Transfer Agreements with Marine OEMs**: Engage with **leading marine technology manufacturers (e.g., MAN Energy Solutions, Wartsila)** to secure **technology licensing and local production agreements**, backed by **government purchasing commitments**.
- **Global Partnerships for Green Shipping Initiatives**: Identify opportunities for collaboration with **leading maritime nations (e.g., Norway, Japan, South Korea, Singapore)** to co-develop and **source critical green technologies**.

Technology Area	Country	Leading Companies	Key Achievements/Adoptions
Advanced Engine Technologies			
Dual-Fuel Engines	Germany, Finland	MAN Energy Solutions, Wartsila	Dual-fuel engines for LNG and methanol adoption on large cargo vessels.
Hydrogen Fuel Cell Systems	Norway, Japan	Ballard Power Systems, Kawasaki	Deployment of hydrogen-powered ferries and port handling equipment.
Ammonia Combustion Engines	Japan, Denmark	Mitsubishi, MAN Energy Solutions	Development of ammonia-compatible engines for long-haul shipping.
Methanol-Compatible Engines	Sweden, Finland	Maersk, Wartsila	Integration of methanol propulsion in large container ships.
Innovative Decarbonization Technologies			
Carbon Capture and Storage (CCS)	Norway, Japan	Equinor, Northern Lights Project	Piloting onboard CCS systems for maritime emissions reduction.

Technology Area	Country	Leading Companies	Key Achievements/Adoptions
Wind-Assisted Propulsion	Finland, Sweden	Norsepower, Oceanbird	Installation of rotor sails and wing sails on commercial vessels.
Advanced Energy Storage Systems	USA, Switzerland	Tesla, ABB	Development of large-scale marine battery systems for hybrid-electric ships.
Air Lubrication Systems	UK, Japan	Silverstream Technologies, Mitsubishi	Adoption of air lubrication systems to reduce hull drag on container ships.
Energy Efficiency Techniques			
Optimized Hull Designs	South Korea, Japan	Hyundai Heavy Industries, Mitsui	Launch of advanced hull forms for ultra-large container ships.
Smart Ship Technologies	Norway, Finland	Kongsberg, Wartsila	Deployment of IoT systems for real-time performance monitoring and optimization.
Heat Recovery Systems	Switzerland, USA	ABB, MAN Energy Solutions	Deployment of waste heat recovery systems to improve overall energy efficiency.
LED Lighting and Energy-Saving Devices	USA, Germany	Osram, GE Lighting	Adoption of energy-efficient lighting across major fleets.
Digitalization Adding to Green Initiatives			
Predictive Maintenance Systems	Finland, Germany	ABB, Wartsila	Real-time monitoring systems integrated into shipping fleets globally.
Route Optimization Software	Denmark, USA	Kongsberg, Maersk	AI-powered route optimization software to reduce emissions and fuel consumption.
Blockchain Technology	USA, Singapore	IBM, TradeLens	Blockchain adoption for secure and transparent maritime supply chains.
Other Evolving Technologies			
Autonomous Vessels	Norway, Finland	Rolls-Royce, Kongsberg	Development of fully autonomous vessels for coastal shipping.
Additive Manufacturing (3D Printing)	USA, Germany	GE Additive, Siemens	Utilization of 3D printing for spare parts and onboard manufacturing.
Advanced Ballast Water Treatment	Sweden, USA	Alfa Laval, Ecochlor	Compliance with IMO standards using advanced ballast water treatment systems.
Renewable Energy Integration	Japan, Netherlands	Eco Marine Power, SolarDuck	Solar and wind energy solutions integrated into port and ship operations.

Table 21: Possible Technology Collaboration Partners

6.2.2 Policy Area: Green Ships

6.2.2.1 Policy Action 1: Collaborations for Skill Development and Knowledge Sharing in Green Shipping

Facilitate **strategic partnerships** to develop **specialized training programs** for maritime professionals and promote **knowledge sharing** of **green shipping technologies and best practices** across the industry.

Expected Outcome

- A skilled maritime workforce trained in the **design, installation, maintenance, and operation** of:
    - **Green propulsion systems** (hydrogen, ammonia, LNG, battery-electric).
    - **Energy-saving devices** (wind-assisted propulsion, air lubrication).
    - **Alternative fuel systems** (methanol, biofuels, hybrid technologies).
    - **Smart shipping technologies** (AI-driven efficiency tools, emissions tracking).
- Increased **industry-wide awareness and adoption** of best practices in **green shipbuilding, retrofitting, and operations**.

Key Considerations for Policy Makers

- Specialized Training and Certification Programs
    - Develop **certified courses on green technology and green ship operations** in partnership with **leading technology institutes and shipbuilders**. For e.g. The **IOCE-SMarT** (expected at **MTI Powai**) could collaborate with **IIT Bombay** and **global green technology providers** to create a **specialized curriculum**.
    - Partner with **IMO, classification societies, and global maritime academies** to offer specialized **training certifications.** in green shipping
    - Enhance dedicated knowledge of ESG and sustainability reporting standards among maritime executives.
- Industry-Wide Knowledge Sharing Task Force
    - Establish a **task force** comprising representatives from:
        - **Ministry of Ports, Shipping** and **Waterways (MoPSW)**.
        - **Logistics and shipbuilding companies**.
        - **Environmental and regulatory experts**.
    - The task force will **identify best practices, standardize training modules, and promote industry-wide knowledge exchange**.

6.2.3 Policy Area: Green Fuel

6.2.3.1 Policy Action 1: Green Collaboration and Industry Partnerships

India's transition to **sustainable maritime fuels** depends on **strategic collaborations** with **global and domestic industry stakeholders**. These partnerships are essential to overcoming challenges such as **fuel availability, infrastructure development, and regulatory alignment**, while also accelerating **technology transfer and investment** in alternative fuels. Strengthening industry alliances will position India as a **regional leader in green maritime innovation** and reduce reliance on fuel imports

Expected Outcome

- **Faster Transition to Green Fuels:** The establishment of industry partnerships will facilitate the rapid deployment of alternative fuels in India's maritime sector. Collaborations will enable the country to address fuel supply chain challenges, ensure the scalability of new technologies, and reduce barriers to entry for alternative fuel adoption.
- **Creation of Green Jobs:** Industry collaborations focused on green fuel infrastructure and technology manufacturing will result in the creation of high-skill jobs in sectors such as manufacturing, R&D, and infrastructure development. This will not only help the maritime industry transition but also stimulate employment in the wider economy.
- **Technological Innovation and Knowledge Transfer:** Collaborative efforts will bring together expertise and experience from various sectors, leading to new technological breakthroughs and the efficient implementation of global best practices in India's maritime industry.

Key Considerations for Policymakers

- **International Collaborations**: Partner with global organizations such as:
    - **Maersk Mc-Kinney Møller Centre for Zero Carbon Shipping** – for R&D in alternative fuels and ship decarbonization strategies.
    - **International Renewable Energy Agency (IRENA)** – for policy alignment, capacity-building, and green energy deployment in maritime transport.
- **Domestic Industry Partnerships**: Engage with **technology firms, shipbuilders, and fuel producers** to develop:
    - **Green fuel production infrastructure** (hydrogen, methanol, ammonia, biofuels).
    - **Marine-grade fuel cells, batteries, and cryogenic storage systems** to reduce dependency on imports.
- **Public-Private Partnerships (PPPs)**: Facilitate **joint ventures and co-investment models** for **scaling green fuel adoption**
- **Green Fuel Clusters:** Creating green fuel clusters that bring together key stakeholders from the government, private sector, and academia could facilitate information sharing, technology development, and the establishment of collaborative frameworks for joint projects.

6.2.4 Policy Area: Green Ports

6.2.4.1 Policy Action 1: Multi-Stakeholder and International Collaborations

To drive the transition towards green ports, collaboration between governments, private sector entities, international organizations, and research institutions is essential. Establishing robust public-private partnerships (PPPs), intergovernmental alliances, and sectoral working groups will accelerate the adoption of green technologies and sustainable port operations. At the international level, engagement with bodies like the IMO, ASEAN, SAARC, EU, and World Bank will enable knowledge transfer, regulatory harmonization, and access to financing mechanisms for green port initiatives.

Key areas of collaboration include:

- **National-Level Partnerships:** Coordination between port authorities, maritime regulators, logistics providers, and technology firms to implement green solutions.
- **International Cooperation:** Participation in IMO's Green Voyage 2050, the European Green Ports Initiative, ASEAN Smart Ports Network, and similar global platforms.
- **Cross-Border Sustainability Agreements:** Bilateral and regional agreements for clean shipping corridors, emissions reduction protocols, and joint research programs.

Expected Outcome

- Harmonized sustainability standards that enable seamless green shipping and trade compliance across regions.
- International partnerships facilitate investments from climate funds, green bonds, and development banks for port decarbonization projects.
- Participation in global initiatives allows ports to adopt emerging clean energy solutions, AI-driven port operations, and digital emissions monitoring systems.

Key Considerations for Policy Makers

- Establish dedicated national and regional task forces to drive collaborative green port initiatives.
- Ensure international partnerships align with national policies and trade commitments.
- Develop incentives for private sector participation and foreign direct investment (FDI) in sustainable port infrastructure.
- PPP models in Green Ports can be around:

Category	Examples of PPP Models	Advantages
Renewable Energy Projects	Solar farms, wind turbines, and energy storage systems jointly developed by private firms and port trusts.	Reduced financial burden on the government; faster implementation through private sector expertise.
Infrastructure Upgrades	Development of cold ironing and LNG bunkering facilities in partnership with private investors.	Access to global expertise and investment capital.
Digitalization Initiatives	AI-driven smart port systems and IoT infrastructure co funded by private tech firms.	Accelerated adoption of advanced technologies; increased operational efficiency.

Table 22: PPP Examples to Co-develop and Implement Sustainable Port Initiatives

6.2.4.2 Policy Action 2: Research, Development, and Innovation

Innovation in low-carbon port technologies, alternative fuels, automation, and energy efficiency is critical for decarbonizing port operations. Strengthening R&D collaborations between government agencies, academia, startups, and private industry will drive breakthroughs in green maritime infrastructure.

Key focus areas:

- **Clean Energy & Electrification**: Research in shore power, hydrogen-based port operations, and solar/wind energy integration for ports.
- **Alternative Fuels & Zero-Emission Technologies**: Joint R&D on green hydrogen, ammonia, biofuels, and hybrid propulsion systems for port equipment and auxiliary vessels.
- **Digital & Smart Port Technologies**: Development of AI-driven cargo optimization, digital twins, IoT-based emissions monitoring, and blockchain-enabled green logistics.

Expected Outcome

- Development of cost-effective, scalable green port solutions.
- AI-driven automation and smart port technologies optimize fuel consumption and reduce emissions resulting in higher energy efficiency
- Green innovation positions ports as preferred hubs for sustainable maritime trade.

Key Considerations for Policy Makers

- Establish Green Port Innovation Funds to support R&D and pilot projects.
- Ensure research translates into real-world applications through industry collaborations.
- Facilitate Intellectual Property (IP) and knowledge exchange through open-access innovation frameworks while ensuring the protection of strategic national interests.

6.2.4.3 Policy Action 3: Capacity Building and Knowledge Exchange

A skilled workforce and well-informed stakeholders are essential for the successful implementation of green port strategies. India aims to train 10,000 port operators and staff on green technologies by 2030 and plans to introduce nationwide awareness campaigns for stakeholders and the public to build support for green port initiatives. Key focus areas of these campaigns should be:

Table 23: Possible Stakeholder Engagement Framework for Green Ports

Stakeholder	Role	Examples
Port Authorities	Planning and implementation of green initiatives, monitoring compliance, and managing resources.	Major ports like JNPA, Paradip, and Tuticorin are leading renewable energy integration projects.
Maritime Boards	Overseeing green initiatives in non-major ports and ensuring policy alignment with national goals.	Gujarat Maritime Board's renewable energy projects and coastal infrastructure development.
Local Governments	Facilitating permits, ensuring community welfare, and aligning green port initiatives with urban planning.	Support for waste management and renewable energy integration projects in port-adjacent areas.

Stakeholder	Role	Examples
Technology Providers	Deployment of AI, IoT, and automation for energy efficiency and operational optimization.	Collaborations with companies like Siemens and ABB for smart port systems.
Industry Leaders	Co-investment in renewable energy projects, green fuel infrastructure, and cold ironing systems.	Partnerships with Maersk for green fuel corridors and Shell for LNG bunkering.
Academic Institutions	Research and development of innovative solutions tailored to Indian port operations.	IIT Madras's involvement in digitalizing port logistics and operational workflows.
Local Residents	Workshops, town halls, and campaigns to raise awareness about green port benefits.	Community programs around Paradip Port to highlight air quality improvements from green initiatives.
Fishermen Communities	Training on sustainable fishing practices and integrating their needs into port development.	Joint projects with coastal communities near Tuticorin to promote eco-friendly livelihoods
Educational Institutions	Student outreach programs, internships, and competitions to foster interest in maritime sustainability.	Collaboration with local schools and colleges for environmental awareness initiatives.

Expected Outcome

- Trained personnel capable of implementing and maintaining sustainable port systems.
- Enhanced understanding of international regulations ensures smooth adoption of green policies.
- Industry awareness and stakeholder Buy-in will increase engagement from shipping lines, logistics providers, and investors.

Key Considerations for Policy Makers

- Establish dedicated Green Port Training Centres with industry collaborations.
- Develop nationally recognized Green Port Operator Certification Programs.
- Ensure training programs are accessible to small and mid-sized ports through digital platforms.

6.2.5 Policy Area: Green Recycling

6.2.5.1 Policy Action 1: International Partnerships for Sustainable Ship Recycling

Facilitate strategic **global partnerships** to strengthen India's capabilities in sustainable ship recycling through technology transfer, best practices sharing, and regulatory alignment.

Expected Outcome

- Access to cutting-edge ship recycling technologies, such as low-emission dismantling and automated waste segregation.
- Capacity-building programs for shipyard workers on sustainable dismantling techniques and hazardous waste management.
- Improved industry credibility, attracting foreign investment and shipowners seeking compliant end-of-life vessel disposal options.

Key Considerations for Policy Makers

- **Bilateral Agreements with Leading Maritime Nations:** Establish partnerships with Norway, the Netherlands, Japan, and South Korea, which have strong expertise in green ship recycling practices.
- **Industry-Academia Collaboration:** Engage with global universities and research institutions to develop training programs and R&D initiatives focused on green ship recycling.
- **Participation in International Ship Recycling Forums:** India should actively participate in IMO working groups and EU-recognized ship recycling platforms to align its policies with evolving global regulations

6.2.6 Policy Area: Social and Coastal Community Development

6.2.6.1 Policy Action 1: Partnerships for Employment and Training

The expansion of maritime industries such as **port operations, shipbuilding, logistics, and marine tourism can create significant employment opportunities for coastal communities**. By implementing **targeted apprenticeships, vocational training, and upskilling programs**, policymakers can ensure that local residents benefit from the industry's growth while addressing the sector's evolving skill demands.

Expected Outcome

- Reduced dependency on seasonal or informal work
- Steady talent pipeline for ports, shipping companies, and related businesses.
- Reduced migration pressures

Key Considerations for Policy Makers

Facilitate collaboration between industry stakeholders, training institutions, and local governments to align local hiring, skill development, and workforce integration for the coastal population.

6.2.7 Policy Area: Pollution Prevention from Maritime Activities

6.2.7.1 Policy Action 1: R&D Partnerships for Pollution Control

Facilitate strategic partnerships between shipping companies, port authorities, and environmental agencies for research, testing, and training aimed at pollution control in the maritime sector.

Expected Outcome

- Accelerated innovation in pollution control and faster cleanup of pollution events
- Reduced long-term damage to marine ecosystems

Key Considerations for Policy Makers

- A research and testing centre to develop cost-effective ballast water treatment solutions customized for Indian conditions in collaboration with IMO and private sector
- Joint task forces to respond swiftly to oil spills and marine debris incidents

6.2.8 Policy Area: Cross Segment

6.2.8.1 Policy Action 1: R&D Partnerships for Pollution Control

Facilitate the creation of a **national coalition comprising shipowners, fuel producers, government agencies, and industry stakeholders** to coordinate investments, policies, and best practices for a unified green shipping transition strategy.

Expected Outcome

- Accelerated adoption of low-carbon and zero-carbon fuels through coordinated R&D and deployment.
- Streamlined regulatory alignment to enhance compliance with global decarbonization targets.
- Increased investment in green maritime infrastructure and fuel supply chains.

Key Considerations for Policy Makers

- **Establishment of a central IMDA platform to drive policy dialogues, research initiatives, and funding mechanisms** for decarbonization projects.
- Development of public-private partnerships to incentivize alternative fuel adoption and green technology investments.
- Formation of **working groups to address regulatory challenges, fuel supply security, and economic viability** of net-zero solutions in Indian shipping.

6.3 Green Regulations

6.3.1 Policy Area: Green Technologies

6.3.1.1 Policy Action 1 - Green Technology Compliance Framework

Mandate the adoption of **green technologies and digital solutions** in maritime assets and operations by establishing a **Green Compliance Status** based on levels of technology adoption. This framework will drive **energy efficiency, operational optimization, and emissions reduction** across the Indian maritime sector.

Expected Outcome

- Improved energy efficiency in maritime assets.
- Enhanced operational efficiency in ports, shipyards, and shipping companies.
- Accelerated decarbonization across the maritime industry.

Key Considerations for Policymakers

- **Applicability:** The regulation should cover **all commercial ships, ports, shipyards, and shipping companies** operating within **Indian territorial waters or registered under the Indian flag**.
- Proposed levels of the green compliance status -
    - **Level 1:** Basic compliance with minimal green technology adoption, achieving **low emissions reduction**.
    - **Level 2:** Adoption of **low-carbon technologies** leading to **moderate emissions reduction** through technology-driven optimizations.
    - **Level 3:** Integration of **advanced green technologies and digital solutions**, resulting in **significant emissions reduction**.
    - **Level 4:** Adoption of **deep decarbonization technologies** across the **entire value chain**, achieving **near net-zero emissions**.
- Tiered benefits could be applicable for various levels of compliance status

6.3.2 Policy Area: Green Ships

6.3.2.1 Policy Action 1: Tiered Green Ship Compliance Standards and Certification

Introduce Green Ship compliance framework under the **Merchant Shipping Bill**, aligned with India's GHG reduction strategy and tiered based on the size and capacity of the ship owners/operators.

Expected Outcome

- Increased adoption of **green technologies** in shipbuilding and operations.
- Improved **energy efficiency** and **emission reduction** across the shipping sector.
- Simplified compliance for small shipowners

Key Considerations for Policymakers

- **Applicability:** All **new merchant ships** built from **2030 onwards** must obtain **Green Ship Certification** based on:
    - **Energy Efficiency Design Index (EEDI)** – Efficiency standard for new ships.
    - **Carbon Intensity Indicator (CII)** – Operational performance assessment.
    - **Alternative Fuel Compliance** – Compatibility with **green hydrogen, ammonia, methanol, LNG**.
    - **IMO MARPOL Annex VI Compliance** – Adherence to global **SOx and NOx emission reduction standards**.
    - **Level of green technology adoption** - Indicated by green compliance status with respect to policy action 7.3.1.1. with the following proposed levels -
        - Level 1: Basic compliance with minimal green technology adoption, achieving low emissions reduction.
        - Level 2: Adoption of low-carbon technologies leading to moderate emissions reduction through technology-driven optimizations.
        - Level 3: Integration of advanced green technologies and digital solutions, resulting in significant emissions reduction.
        - Level 4: Adoption of deep decarbonization technologies across the entire value chain, achieving near net-zero emissions.
- **Compliance ratings:** Define compliance ratings based on the above criteria ranging from basic, enhanced, intermediate, and advanced compliance.
    - Mandate **basic compliance** for all Indian-flagged ships by **2030.**
    - Mandate **intermediate compliance** for all **coastal and inland waterways vessels** by **2030**
    - Mandate **advanced compliance** for all **coastal and inland waterways** vessels by **2035**
- **Tailored Standards:** Introduce a tiered compliance system based on the size and capacity of the shipping enterprises. For example:
    - **Tier 1:** Micro enterprises with basic compliance requirements.
    - **Tier 2:** Small enterprises with intermediate reporting and technological requirements.
    - **Tier 3:** Medium and large enterprises with full compliance

6.3.2.2 Policy Action 2: Zero-Emission Zones (ZEZs) for Coastal and Inland Waterways

To accelerate the **decarbonization** of India's **inland waterways** and protect **eco-sensitive regions**, the government can designate specific **coastal and inland routes** as **Zero-Emission Zones (ZEZs)**. Only **zero-emission vessels**—including **fully electric, hydrogen-powered, or hybrid vessels operating in low-emission mode**—will be permitted in these areas.

Expected Outcome

- **Technology transition** toward zero-emission vessels.
- **Improved air quality** and **marine biodiversity protection** in sensitive waterways.
- **Increased adoption of green technologies** in inland and coastal shipping.

Key Considerations for Policymakers

- **Selection of Priority ZEZ Locations** (based on **environmental sensitivity, traffic density, and strategic importance**):
    - **National Waterway 1 (Ganga-Bhagirathi-Hooghly)** – High traffic and eco-sensitive.
    - **National Waterway 2 (Brahmaputra River)** – Rich biodiversity requiring protection.
    - **National Waterway 3 (Kerala Backwaters)** – Tourism hub, ideal for vessel electrification.
- **Renewable Energy Infrastructure:** Charging stations in ZEZs must operate on **100% renewable energy**.
- **Diesel Vessel Ban:** Restrict **new diesel vessel registrations in ZEZs after 2028**.
- **Enforcement Mechanisms:** Introduce **non-compliance penalties** to ensure adherence

6.3.3 Policy Area: Green Fuels

6.3.3.1 Policy Action 1: Phased Carbon Pricing Mechanism to Promote Sustainable Maritime Fuels and Low-Carbon Shipping in India

India's maritime sector relies heavily on **marine diesel oil (MDO) and heavy fuel oil (HFO)**, significantly contributing to **carbon emissions**. To drive a transition toward **low-carbon fuels**, a **phased carbon pricing mechanism** can be introduced, making fossil fuels **progressively less competitive** compared to **green alternatives** like **LNG, biofuels, and hydrogen**.

Expected Outcome

- **Increased Adoption of Green Fuels:** Higher fossil fuel costs would encourage shifting to LNG, biofuels, and hydrogen, accelerating India's green shipping transition.
- **Reduction in Carbon Emissions:** Encouraging low-emission fuels will help India meet its national and international climate commitments.

Key Considerations for Policymakers

- **Phased Carbon Pricing:** Implement a gradual carbon tax on fossil-based marine fuels, starting at a modest carbon tax rate (e.g., 2-3% per year) and gradually increasing it over the next 10-15 years. This gives the industry time to adopt new technologies and scale up their green fuel infrastructure.
- **Industry consultation:** Engage with industry stakeholders, including shipping companies and fuel providers, to ensure that the tax structure is implemented in a way that does not unduly burden them. Providing feedback from the industry could ensure the transition is practical and feasible.
- **Incentivizing green fuel production:** Policies that support the production of biofuels, LNG, and hydrogen within India can complement the carbon tax, making green fuels more available and affordable for the maritime sector.

6.3.3.2 Policy Action 2: Introduction of Renewable Fuel Mandates, Blending Requirements, and an Emissions Trading System for the Maritime Sector

To accelerate **green fuel adoption** in India's maritime sector, the government can implement **renewable fuel mandates and blending requirements**, ensuring a **progressive shift toward cleaner fuels** such as **biofuels,**

LNG, and hydrogen. Additionally, an **Emissions Trading System (ETS)** can be introduced to create **market-driven incentives** for emissions reductions.

Expected Outcome

- **Stable Market for Green Fuels:** Increased demand certainty will drive investment in domestic biofuel, LNG, and hydrogen production infrastructure**.**
- **Incentivized Cleaner Fuel Adoption:** Mandates will encourage shipping companies to transition to low-carbon fuels, leading to significant emissions reductions**.**
- **Alignment with Global Sustainability Goals:** Strengthens India's position in green maritime technology while ensuring compliance with international climate commitments**.**

Key Considerations for Policymakers

- **Renewable Fuel Mandates & Phased Blending Requirements**:
    - Introduce **a phased blending mandate**, requiring **5-10% of maritime fuels** to be **renewable** in the initial phase.
    - Gradually increase the blending target to **20% by 2035** as domestic green fuel production scales up.
    - Apply mandates to **ships operating within India's Exclusive Economic Zone (EEZ)** to **ensure broad sectoral coverage**.
    - Allow flexibility for industry adaptation while ensuring a clear transition roadmap
- **Emissions Trading System (ETS)**:
    - Allocate **carbon credits based on emissions targets** for shipping companies.
    - Enable companies with **lower emissions** to **trade excess credits** with those exceeding their limits, creating a **financial incentive for emissions reduction**.
- **Support for Green Fuel Production & Infrastructure:**
    - Provide policy incentives, financial support, and R&D investment to expand domestic production of biofuels, LNG, and hydrogen.
- **Flexibility for International Shipping:**
    - Align blending mandates with global standards to avoid operational challenges for international vessels.
    - Consider reciprocity agreements for international shipping companies complying with similar regulations in other jurisdictions.

6.3.3.3 Policy Action 3: Implementation of Binding Emissions Standards and Regulatory Framework for Green Fuel Adoption

In addition to **carbon pricing** and **renewable fuel mandates**, India can establish **binding emissions standards** for vessels operating in its **territorial waters**, setting **clear regulatory thresholds** for **carbon, sulphur, and particulate emissions**. Over time, these **standards can be progressively tightened** to accelerate **green fuel adoption** and **reduce maritime emissions**.

Expected Outcome

- **Increased Use of Green Fuels:** Regulatory requirements will drive the adoption of LNG, biofuels, hydrogen, and ammonia-based fuels, lowering overall maritime emissions.
- **Innovation:** Stricter standards will accelerate investment in low-emission propulsion systems, including carbon capture and hybrid fuel technologies.

Key Considerations for Policymakers

- **Mandatory Emission Limits**:
  - Set **specific emission thresholds** for **carbon, sulphur (SOx), and particulate matter (PM)** from ships.
  - Implement a **progressive roadmap** to **tighten standards** over time, ensuring a **gradual transition**.
- **Compliance & Accountability**:
  - Require **periodic emissions audits** to **assess vessel performance** and enforce **regulatory compliance**.
  - Introduce **penalties for non-compliant vessels** and **incentives (e.g., tax credits, port fee reductions)** for ships exceeding compliance targets
- **Phased Implementation of Standards:** Begin with achievable targets and progressively tighten limits on sulphur content, PM, and carbon emissions over 5-7 years.

6.3.3.4 Policy Action 4: Establishment of Green Maritime Corridors for Alternative Fuels

India's maritime sector is at a **pivotal stage in its transition toward low-carbon shipping**. Establishing **Green Maritime Corridors**—dedicated shipping routes supported by **alternative fuel infrastructure**—can accelerate the adoption of **green hydrogen, ammonia, methanol, biofuels, and LNG**. These corridors will serve as **early-stage demonstration projects**, attracting investment in sustainable maritime operations.

Potential International Green Corridors Routes:

Route	Distance	Cargo Profile	Reasons
India - Singapore	~3,200 km	Containers, electronics, chemicals	A strategic route for energy and container trade; Singapore's advanced green port infrastructure aligns well with India's transition goals.
India - UAE	~2,500 km	Crude oil, LNG, industrial machinery	A critical corridor for energy exports; the UAE's focus on hydrogen and clean energy matches India's green initiatives.
India - Europe (Rotterdam)	~8,500 km	Bulk cargo, textiles, green fuels	Enhances India's aspirations to become a major green fuel exporter; aligns with Europe's stringent decarbonization policies.
India - East Asia (Japan, Korea)	~6,000 km	Automotive parts, consumer electronics	Fosters collaboration with technologically advanced ports; East Asia's commitment to zero-emission shipping corridors complements India's goals.

India - Australia (Sydney)	~8,000 km	Iron ore, coal, hydrogen derivatives	A key route for resource and energy exports; potential for green hydrogen trade aligns with Australia's hydrogen strategy.
India - South Africa (Durban)	~7,000 km	Chemicals, machinery, agricultural products	Promotes South-South cooperation; Durban's initiatives in shore power and alternative fuels complement India's objectives.

Table 24: Potential International Green Corridors Routes:

Expected Outcome

- **Accelerated Green Fuel Adoption**: Dedicated bunkering infrastructure at Indian ports will provide certainty for shipowners, encouraging investment in low-emission vessels.
- **Modernization of Port Infrastructure:** Ports will be equipped with green fuel storage, distribution, and digital emissions tracking systems, strengthening India's global position in sustainable shipping.
- **Increased Global Competitiveness:** India's early investment in green corridors will attract foreign investment and position the country as a preferred partner for eco-conscious trade.
- **Reduction in Maritime Emissions:** Lower CO_2, SOx, and NOx emissions from vessels operating in green corridors will improve air and water quality along India's coastal and oceanic zones.

Key Considerations for Policymakers

- **Strategic Route Selection and Phased Implementation:** The selection of high-volume shipping routes where green fuel adoption is both logistically feasible and economically viable will be critical to the success of Green Maritime Corridors. Initially, the focus should be on major container ports such as JNPT, Chennai, and Cochin, expanding gradually to secondary ports and coastal shipping routes. A phased rollout, beginning with short-sea and feeder routes like Chennai–Andaman or Visakhapatnam–Haldia, will allow for testing and gradual scaling before transitioning to international trade corridors (e.g., India–Singapore, India–Rotterdam, India–Colombo).

- **Incentivizing Green Fuel Infrastructure Development:** Policymakers must introduce capital subsidies and tax benefits for port operators investing in hydrogen, ammonia, and biofuel bunkering facilities. The establishment of Green Fuel Development Zones (GFDZs) within port premises will be instrumental in creating an integrated ecosystem where fuel production, storage, and refuelling operations can co-exist. Public-Private Partnerships (PPPs) should be actively encouraged to mitigate the high capital investment risks associated with green fuel supply chains, leveraging both domestic and international funding sources.

- **International Collaboration and Trade Alignment:** India must engage in strategic partnerships with major maritime hubs such as Singapore, the UAE, and European ports to align green corridor regulations, bunkering standards, and fuel supply protocols. Strengthening India's involvement in global maritime decarbonization forums, including the IMO and BIMSTEC, will be essential in securing joint ventures for alternative fuel infrastructure development. Additionally, participation in global carbon pricing mechanisms will provide shipowners with financial incentives to transition toward sustainable fuel alternatives.

- **Benefits and incentives for vessels using green fuels:** Provide incentives such as reduced port fees, fuel subsidies, and priority berthing for vessels using green fuels. Emphasise that all newly constructed vessels be dual-fuel ready, ensuring long-term compatibility with green maritime corridors.

6.3.4 Policy Area: Green Ports

6.3.4.1 Policy Action 1: Establish Stringent Emission Standards

Indian Ports consume 500 MW annually, 70% from fossil fuels, accounting for 3% of India's total emissions. To mitigate the environmental impact of port operations, stringent emission standards must be enforced for greenhouse gases (GHG) and air pollutants (CO_2, NOx, SOx). This includes setting clear regulatory limits, mandating the use of cleaner fuels, requiring shore power infrastructure at berths, and promoting electrification of port equipment. Compliance will be ensured through digital monitoring, periodic audits, and enforcement mechanisms, with incentives for early adopters and penalties for non-compliance.

Expected Outcomes

- Significant Emission Reductions as lower GHG and air pollutant emissions improve air quality and contribute to climate goals.

  Enhanced Energy Efficiency as adoption of shore power and electrification reduces fuel consumption and operational costs.

- Improved Port Competitiveness as green-compliant ports attract eco-conscious shipping lines and investors, strengthening global positioning.

Key Considerations for Policy Makers

- Phased Implementation of standards will set realistic timelines to allow ports to transition while maintaining operational efficiency.
- Infrastructure investment provides financial support and incentives to develop shore power and electrification infrastructure.
- Effective enforcement establishes robust monitoring, reporting, and compliance mechanisms with transparent penalty structures.
- Alignment of regulations with IMO and MARPOL guidelines to ensure international consistency and facilitate trade.

6.3.4.2 Policy Action 2: Adopt Green Building and Operational Standards

To enhance sustainability in port infrastructure and operations, ports must adopt green building standards and eco-friendly operational practices. New port constructions and major retrofits should comply with recognized sustainability frameworks (e.g., LEED, IGBC, GRIHA), integrating energy-efficient designs, renewable energy systems, and sustainable materials. Additionally, ports must implement environmentally responsible operational practices, such as waste segregation, recycling protocols, and sustainable dredging techniques, to minimize ecological impact.

Expected Outcome

- Lower Carbon Footprint as energy-efficient buildings and renewable energy integration reduce overall emissions.
- Resource optimization as improved waste management and water conservation enhance operational sustainability.
- Resilient and Future-Ready Ports as green-certified infrastructure ensures long-term environmental and economic benefits.

Key Considerations for Policy Makers

- Provide financial or regulatory benefits to ports adopting certified green building standards.
- Develop uniform sustainability criteria to ensure consistency across all ports.
- Train port authorities and operators in sustainable construction and operational best practices.

6.3.5 Policy Area: Green Recycling

6.3.5.1 Policy Action 1: Green Ship Recycling Compliance Framework

Establish a **tiered Green Ship Recycling Compliance Framework** to ensure that shipbreaking and recycling practices in India adhere to international environmental and safety standards, minimizing emissions and hazardous waste. This framework will align with the **Hong Kong International Convention (HKC)** and the **EU Ship Recycling Regulation (EUSRR)**, driving sustainable practices in shipbreaking yards.

Expected Outcome

- Reduction in carbon emissions and hazardous waste from ship recycling operations.
- Improved environmental and occupational safety standards in shipbreaking yards.
- Promotion of circular economy principles by maximizing material recovery and reuse.
- Strengthened global competitiveness of India's ship recycling industry.

Key Considerations for Policy Makers

- **Applicability:** The framework should cover all shipbreaking yards in India, ensuring compliance with both national and international environmental regulations.
- **Proposed** Compliance **Levels:**
    - **Level 1:** Basic compliance with HKC and EUSRR, ensuring safe disposal of hazardous materials.
    - **Level 2:** Adoption of improved environmental management systems, with enhanced waste treatment and emission control measures.
    - **Level 3:** Integration of advanced green technologies such as automated cutting, robotic dismantling, and AI-driven material recovery, leading to significant reductions in emissions and hazardous waste.
    - **Level 4:** Full decarbonization of ship recycling processes, powered by renewable energy, circular economy practices such as recycling targets for high-value materials (steel & copper), achieving near zero-emission operations.
- **Certification & Enforcement:** Shipyards must undergo regular audits and third-party certification to qualify for Green Ship Recycling Compliance status.

6.3.6 Policy Area: Social and Coastal Community Development

6.3.6.1 Policy Action 1: Regulations Aimed at Enhancing Coastal Ecosystem Health

The sustainable growth of India's maritime sector must be inclusive, ensuring that coastal communities directly benefit from industry advancements. Implementing policies that **regulate overfishing, restore mangroves, and reduce waste** are essential steps in protecting marine life and ensuring ecosystem resilience. These actions not only safeguard biodiversity but also help strengthen natural defences against climate impacts, promoting long-term sustainability for both the environment and coastal communities.

Expected Outcome

- Enhanced marine ecosystems, ensuring the sustainability of fish populations and improving food security for coastal communities.
- Strengthened natural defences against coastal erosion and extreme weather events, protecting both habitats and human settlements.
- Cleaner oceans, preserving marine biodiversity and improving water quality.

Key Considerations for Policy Makers

- Implement sustainable fisheries policies that **regulate overfishing** and promote **responsible aquaculture** to protect marine biodiversity
- Launch **mangrove restoration** and **coastal afforestation mandates**
- Introduce **waste management regulations** to reduce marine pollution, particularly **plastic waste**

6.3.7 Policy Area: Pollution prevention from maritime activities

6.3.7.1 Policy Action 1: Ballast water treatment mandate

Mandate all the ships entering Indian waters to use certified Ballast Water Treatment Systems (BWTS) and submit ballast discharge reports.

Expected Outcome

Minimized spread of invasive marine species and enhanced protection of coastal biodiversity. Cleaner oceans, preserving marine biodiversity and improving water quality

Key Considerations for Policy Makers

Availability of onshore ballast water reception facilities and partnerships with global BWTS manufacturers will be crucial to lower costs for Indian shipowners

6.4 Green Reporting

6.4.1 Policy Area: Green Technologies

6.4.1.1 Policy Action 1: Green Technology Reporting for Maritime Assets

Establish a **standardized reporting framework** to track the adoption of **green technologies and digitalization** across all maritime assets, ensuring **data transparency and informed policymaking**.

Expected Outcome

- **Improved data availability** on green and digital technology adoption.
- **Enhanced transparency** for regulatory bodies and industry stakeholders.
- **Better monitoring of progress** in maritime decarbonization efforts.

Key Considerations for Policy Makers

- **Applicability:** Require **all commercial ships, ports, shipyards, and logistics operators** to submit an **annual report** detailing the status of:
    - **Energy Efficiency Technologies** (e.g., air lubrication systems, wind-assisted propulsion, hybrid engines).
    - **Alternative Fuel Readiness** (e.g., LNG, hydrogen, ammonia, methanol compatibility).
    - **Emission Reduction Measures** (e.g., carbon capture, waste heat recovery, exhaust gas treatment).
    - **Digitalization Levels** (e.g., AI-driven fuel optimization, smart port automation, blockchain in logistics, predictive maintenance platforms).
- **Integration with Existing Regulatory Frameworks:** Align reporting requirements with **BRSR Core, IMO DCS, and EU ETS** where applicable.
- **Verification & Compliance:** Establish **independent audits or digital verification mechanisms** to ensure **accuracy and prevent greenwashing**.

6.4.2 Policy Area: Green Ships

6.4.2.1 Policy Action 1: Establishment of Monitoring, Reporting, and Verification (MRV) Systems for Emissions Monitoring

To support India's transition to **sustainable shipping**, a **comprehensive Monitoring, Reporting, and Verification (MRV) system** should be developed to track **emissions from maritime activities**, ensure **compliance with international standards**, and enhance **transparency in emissions data.**

The MRV system can be modelled after successful global frameworks, such as those used in aviation and road transport, where emissions are meticulously tracked and reported. By developing such a system tailored for the maritime sector, India will be better positioned to optimize the performance of its vessels and lower the carbon footprint in its shipping industry.

Expected Outcome

- **Improved Emission Tracking and Management:** MRV systems will enable real-time tracking of emissions from ships. This includes capturing emissions data from vessels powered by alternative fuels, hybrid systems, and even zero-emission technologies. By continuously monitoring emissions, stakeholders can pinpoint vessels with the highest environmental impact and take corrective actions where needed.

- **Optimized Vessel Performance:** Data from MRV systems will provide **critical insights into fuel consumption, emission trends, and operational performance.** By assessing this data, ship operators can optimize vessel performance, reduce fuel consumption, and improve overall energy efficiency. This can result in substantial cost savings while also supporting India's sustainability agenda.

- **Enhanced Compliance with International Standards:** The establishment of MRV systems will ensure that Indian vessels meet or exceed the IMO's mandatory greenhouse gas (GHG) emissions regulations. The **data gathered will be used to demonstrate compliance with global standards**, such as the IMO's Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII). This will position India as a responsible maritime nation adhering to the highest environmental standards.

- **Greater Transparency in Emissions Data:** The MRV system will provide a **platform for transparent emissions data that is publicly accessible**, promoting accountability within the industry. It will also enable stakeholders, including regulators and the public, to track the progress of the Indian maritime industry toward sustainability and decarbonization goals.

Key Considerations for Policy Makers

- **Technological Infrastructure and Integration:**
    - Deploy **IoT sensors, AI analytics, and big data platforms** for real-time emissions tracking
    - Ensure **interoperability** between ship operators, port authorities, and regulatory bodies
    - Consider **government incentives** for private players to develop **compatible and standardized monitoring systems**.

- **Development of a National Reporting Framework:**
    - **Establish a national MRV reporting framework** to ensure that emissions data from ships is standardized and centrally reported.
    - Develop a **centralized platform** for ships to submit emissions data, supporting **compliance tracking**.
    - Define **low-emission and zero-emission vessel thresholds** with **performance-based incentives** (e.g., tax benefits for compliant vessels, penalties for non-compliance).

- **Incentivizing Adoption of MRV Technology:**
    - Incentives for shipowners and operators to adopt the MRV systems could include **financial subsidies or tax credits** for the installation of emissions monitoring equipment.
    - The government may also consider offering **grants or low-interest loans** to encourage the use of state-of-the-art emissions monitoring and data management technologies.
    - For ship operators, especially smaller ones, these technologies can come at a significant initial cost. Therefore, incentivizing technology adoption will be critical for achieving widespread compliance with emissions reporting standards.

- **Training and Capacity Building:**

- The success of the MRV system depends heavily on the capacity of personnel in both public and private sectors to effectively interpret and act on emissions data. Policymakers should consider investing in **training programs for relevant stakeholders, including port authorities, shipping companies, and regulatory bodies**, to ensure that they can operate and maintain the MRV systems effectively.
- Moreover, industry-specific **workshops and seminars could be organized to raise awareness** about the importance of emissions monitoring and the regulatory landscape in the maritime sector.

- **Public-Private Collaboration:**
  - Foster **partnerships between government, shipping companies, technology providers, and research institutions** to share **financial and technical responsibilities**.
  - Engage industry stakeholders in **policy design** to balance **regulatory objectives with operational feasibility**
- **Global Benchmarking and Transparency:**
  - Align India's MRV framework with **international best practices**, such as **IMO's SEEMP, IMO 2020 sulfur cap, and EU ETS**.
  - Implement **regular public reporting** to increase **credibility in global decarbonization efforts**.

6.4.3 Policy Area: Green Fuel

6.4.3.1 Policy Action 1: Marine Fuel Reporting and Certification

Develop a **national framework** for reporting, certifying, and regulating green fuels in India's maritime sector.

Expected Outcome

Establish a **comprehensive fuel data system** to monitor green fuel adoption and ensure alignment with India's **decarbonization targets**.

Key Considerations for Policy Makers

- Implement a **mandatory fuel reporting mechanism** requiring all ships at Indian ports to disclose **fuel type, quantity, and origin**.
- Require **fuel producers and suppliers** to report **carbon intensity factors**, covering **lifecycle emissions** from production, transportation, storage, and combustion.
- Define **quality and safety standards** for green fuels, ensuring compliance through a structured certification process.
- Mandate **annual fuel usage and emissions reporting** for ships and bunker suppliers.
- Introduce tiered compliance levels for marine fuel stakeholders based on their adherence to sustainability and regulatory benchmarks.
- **Integrating Digital and Emissions Monitoring Systems:** The deployment of smart port technologies will be necessary to track fuel consumption, emissions reductions, and compliance with environmental standards in real time. Establishing a digital monitoring system that quantifies carbon reductions will allow shipping companies and port authorities to participate in carbon credit trading, creating

additional financial incentives for sustainable operations. This will also enhance transparency and accountability in India's maritime decarbonization initiatives.

6.4.4 Policy Area: Green Ports

6.4.4.1 Policy Action 1: Green Port Certification and Indexing Framework

The proposed Green Port Certification and Indexing framework aims to **assess, certify, and benchmark port sustainability using standardized metrics** like **emissions reduction, renewable energy adoption, waste management, and water quality**. This initiative aims to enhance competitiveness, attract global trade, and align Indian ports with international environmental standards, supporting India's decarbonization goals.

The proposed Green Port Index methodology is as follows:

Aspect	Description	Proposed Implementation
Objective	Evaluate and rank ports based on sustainability and environmental impact.	Development of a national-level Green Port Index.
Parameters	Include energy efficiency, emissions, waste management, renewable energy integration, and biodiversity.	Multi-criteria evaluation covering operational and environmental aspects.
Scoring System	Weighted scores for different parameters based on their impact on sustainability.	Dynamic scoring to reflect advancements in technologies and global best practices.
Data Collection	Real-time monitoring using IoT devices, periodic audits, and self-reported data by ports.	Implementation of centralized data platforms for seamless data sharing and analysis.

Table 25: Proposed Green Port Index Methodology

The proposed Green Port Certification and Standards Act aims to mandate certification of ports based on various sustainability criteria. Implementation will be overseen by the Ministry of Ports, Shipping and Waterways (MoPSW) in collaboration with an independent Green Certification body. Further, the proposed evaluation criteria for Green Port Indexing are as follows:

Evaluation Criteria	Description	Weightage (%)
Energy Consumption	Efficiency in energy use, including adoption of renewable energy.	25%
Emission Reduction	Reduction in GHGs, SOx, and NOx emissions from port operations and docked vessels	30%
Waste Management Efficiency	Recycling rates, safe disposal of hazardous waste, and circular economy initiatives.	15%
Renewable Energy Integration	Percentage of total energy derived from renewable sources.	20%
Biodiversity Conservation	Measures to protect and restore ecosystems within and around port premises.	10%

Table 26: Proposed Evaluation Criteria for Green Port Indexing

The proposed Indian Green Port Certification Framework establishes clear policies, benchmarks, and incentives to promote sustainable ports. It includes monitoring, capacity building, and public awareness initiatives. Key components are outlined below:

Framework Component	Description	Implementation Plan
Policy Foundation	National-level policy outlining the importance and methodology for Green Port Certification	Drafting under the Ministry of Ports, Shipping, and Waterways (MoPSW).
Technical Guidelines	Detailed technical criteria and benchmarks for evaluation.	Development with input from international experts and Indian environmental agencies.
Capacity Building	Training programs for port operators and management teams.	Partnership with maritime training institutes and universities.
Incentives	Financial and non-financial rewards for certified ports.	Government subsidies, reduced tariffs for eco-friendly practices.
Monitoring and Reporting	Regular data collection and analysis to update Green Port Index.	Establishment of a dedicated Green Port Monitoring Cell.
Public Awareness	Dissemination of certification results to stakeholders and the public.	Annual Green Port Summit to showcase top-performing ports.

Table 27: Policy Framework Components

Expected Outcome

- Uniform benchmarking of port sustainability performance.
- Recognition and incentives for high-performing ports.
- Improved accountability and motivation for continuous environmental improvements

Key Considerations for Policy Makers

- Ensure global alignment with recognized green port standards like Green Marine (North America), EcoPorts (Europe).
- Implement a clear tiered certification model for transparency based on Green Port Index Scores. A tiered ranking (e.g., Gold, Silver, Bronze) to recognize ports that exceed baseline environmental performance standards can motivate incremental improvements.
- Annual or biennial reviews to ensure sustained performance and reflect technological advancements. Third-party verification can be considered for credibility and transparency.

6.4.4.2 Policy Action 2: Mandatory Environmental Auditing and Reporting

Introduce a legally binding requirement for ports to conduct periodic environmental audits and publicly disclose sustainability reports. These audits should be third-party verified and cover:

- **Emissions and Energy Usage:** CO_2, NOx, and SOx emissions from port operations, fuel consumption data, and energy efficiency ratings.
- **Waste and Water Management:** Compliance with zero-discharge policies, hazardous waste disposal practices, and wastewater treatment standards.

- **Biodiversity and Marine Impact:** Monitoring of coastal ecosystems, impact of dredging activities, and habitat conservation efforts.

Best practices for implementation:

- **Third-Party Audits:** Independent environmental auditing agencies should verify port sustainability claims to prevent greenwashing.
- **Annual ESG Reporting:** Ports must publish standardized sustainability reports based on Global Reporting Initiative (GRI) or Task Force on Climate-Related Financial Disclosures (TCFD) frameworks.
- **Digital Audit Trails:** Use technologies like blockchain to ensure data integrity and traceability.

Expected Outcome

- Standardized reporting improves transparency, stakeholder trust, regulatory oversight, and investor confidence.
- Regulatory Compliance & Risk Mitigation: Regular audits help ports pre-emptively address environmental risks and avoid regulatory penalties.
- Data-Driven Decision-Making: Ports can use audit findings to optimize energy consumption, refine waste management strategies, and improve emissions control measures.

Key Considerations for Policy Makers

- Capacity Building for Compliance: Provide technical assistance and digital tools to support ports in meeting reporting obligations.
- Ensure alignment with World Ports Sustainability Program (WPSP), and India's ESG reporting standards.
- Establish penalties for non-compliance, such as higher port fees, restrictions on new infrastructure projects, or exclusion from green finance eligibility.

6.4.4.3 Policy Action 3: Implement Real-Time Monitoring and Data Platforms

Deploy IoT-enabled environmental monitoring systems to provide real-time data on air and water quality, emissions, energy consumption, and port waste management. Digital platforms should integrate:

- IoT Sensors & Smart Meters: Installed at berths, fuel stations, and cargo handling areas to track emissions, fuel efficiency, and pollution levels.
- AI & Predictive Analytics: Use big data and machine learning models to forecast pollution trends, optimize port energy usage, and predict environmental risks.
- Cloud-Based Data Portals: Centralized dashboards where ports, regulatory bodies, and the public can access sustainability performance metrics.
- Efficient Handling of Ships with Just-In-Time (JIT) systems: It reduces emissions from berthing delays. For instance, ships idling due to berthing delays emit approximately 20 tonnes of CO2 per day. Ports adopting JIT systems, like Los Angeles, saved 50,000 tonnes of CO2 annually. Globally, reducing berthing delays could save an estimated 500 million tonnes of CO2 annually.

Expected Outcome

- Early warning systems detect pollution spikes, enabling real-time mitigation strategies.
- AI-driven optimization reduces fuel waste, enhances cargo flow efficiency, and minimizes energy losses.
- Implementing JIT systems reduces unnecessary fuel consumption, leading to a drastic decrease in port-related carbon footprints.
- Automated data collection streamlines compliance with national and international sustainability requirements.

Key Considerations for Policy Makers

- Provide financial incentives and technical support for ports to adopt IoT and AI-based monitoring systems.
- Establish uniform data collection protocols to ensure interoperability across different ports and regulatory agencies.
- Encourage technology partnerships with digital solution providers, research institutions, and global smart port networks.
- Invest in digitalized scheduling platforms, vessel tracking systems, and real-time communication frameworks between ports and shipping lines.

6.4.5 Policy Area: Green Recycling

6.4.5.1 Policy Action 1: Ship Recycling Transparency & Reporting Framework

Implement a **Mandatory Ship Recycling Reporting Framework** to enhance transparency, track compliance with environmental and safety regulations, and monitor the industry's carbon footprint.

Expected Outcome

- Standardized data collection on emissions, waste management, and worker safety in shipbreaking yards.
- Increased accountability and improved compliance with international regulations.
- Availability of verifiable data to support green certification and investment decisions.

Key Considerations for Policy Makers

- **Annual Sustainability Reporting**: Require shipbreaking yards to submit reports on hazardous waste disposal, emission reduction measures, and worker safety initiatives.
- **Digital Monitoring & Tracking**: Use IoT sensors and blockchain-based tracking systems to monitor ship dismantling processes and material recovery efficiency in real time.
- **Integration with Global Standards**: Align reporting frameworks with HKC, EUSRR, and India's ESG disclosure norms to ensure international recognition of India's ship recycling industry.
- **Public Data Access**: Establish an open database for stakeholders, including investors, regulatory agencies, and industry associations, to track ship recycling performance.

6.4.6 Policy Area: Social and Coastal Community Development

6.4.6.1 Policy Action 1: National Reporting and Governance on Coastal Community Development

Establish a structured framework for collecting data and reporting on fisheries' status and ensuring fair representation of coastal communities in policy formulation. The reporting framework would help in sustainable resource management, and economic inclusion, strengthening governance mechanisms for coastal community development while respecting traditional maritime practices.

Expected Outcome

- Enhanced data collection and periodic reporting on fisheries' health to aid policymakers in implementing evidence-based regulations, preserving marine biodiversity, and preventing overexploitation
- Access to global markets through certification programs and trade partnerships, improving economic resilience while safeguarding cultural heritage for indigenous and small-scale fishers

Key Considerations for Policy Makers

- Define a structured reporting mechanism governed by regional councils, ensuring equal representation of indigenous groups, fishers, policymakers, and industry stakeholders.
- Implement data-driven fisheries management strategies through regular monitoring, scientific research, and traditional ecological knowledge.
- Develop fair-trade certification mechanisms to integrate small-scale fishers into global supply chains.

6.4.7 Policy Area: Pollution prevention from maritime activities

6.4.7.1 Policy Action 1: Pollution Control Reporting System

Mandate data reporting on pollution control - waste reception, emissions reduction, ballast water treatment compliance etc. by Indian ports and ships calling at Indian ports.

Expected Outcome

- Prevention of illegal dumping of ship waste into Indian waters
- Increased port-level accountability for marine pollution management
- Better tracking of air and marine pollution

Key Considerations for Policy Makers

- Require ships to submit reports on bilge water, sewage, and hazardous waste disposal before departure and integrate this with port inspections
- Require ports to submit reports on waste reception facilities, water treatment facilities, shore power supply etc.

6.5 Summary Table: Proposed Policy Actions and policy integration

Element	Policy Actions	Existing Policies Integration
Green Technology	**Green Technology Compliance Framework**: Mandate tiered compliance levels for energy efficiency, low-carbon tech, and digitalization in ships, ports, and shipyards.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047), Harit Nauka Scheme
	Green Technology Reporting for Maritime Assets: Establish a standardized reporting framework for tracking the adoption of green technologies across maritime assets.	Harit Sagar Guidelines, Maritime India Vision 2030 (MIV 2030)
	Strategic Collaborations to Enhance Green Shipping Technology Manufacturing: Develop international partnerships for technology transfer in hydrogen, ammonia, and LNG-based solutions.	National Hydrogen Mission, Methanol Economy, Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	PLI Schemes for Green Technology Manufacturing: Extend production-linked incentives (PLI) to green shipbuilding components like batteries, propulsion systems, and alternative fuel storage.	FAME India Scheme and NEMMP, Subsidy Scheme for Building Green Ships (SBFA), Make in India
	Tax Incentives under Make in India: Provide tiered corporate tax benefits, R&D tax credits, and capital investment deductions for green maritime manufacturing.	Make in India, Sagarmala Programme
	Specialized Green Maritime Economic Zones: Develop SEZs in coastal states (Tamil Nadu, Gujarat, Andhra Pradesh) with tax incentives, fast-track approvals, and sustainability-linked loans.	Sagarmala Programme, National Offshore Wind Energy Policy
Green Ships	**Green Ship Certification & Compliance Standards**: Mandate Green Ship Certification under the Merchant Shipping Bill, aligned with India's GHG reduction strategy.	DGS Order on Norms for Ships, Harit Nauka Scheme
	Zero-Emission Zones (ZEZs) for Coastal & Inland Waterways: Designate priority waterways as ZEZs, restricting operations to zero-emission vessels.	National Action Plan on Climate Change (NAPCC), Harit Nauka Scheme
	Monitoring, Reporting, & Verification (MRV) Systems: Establish a national emissions tracking framework for compliance with international regulations.	Harit Sagar Guidelines, Maritime India Vision 2030 (MIV 2030)
	Skill Development & Knowledge Sharing in Green Shipping: Form partnerships with global institutions, shipbuilders, and IMO to train professionals in green technologies.	Maritime Amrit Kaal Vision-2047 (MAKV-2047), Blue Economy Policy, MIV 20230
	Enhancing Shipbuilding Financial Assistance (SBFA) Scheme: Introduce tiered financial incentives for green ships and retrofit projects.	Subsidy Scheme for Building Green Ships (SBFA), Maritime India Vision 2030 (MIV 2030)
	Financial Risk-Sharing for Retrofitting: Implement risk-sharing mechanisms, such as loan guarantees and insurance subsidies, to de-risk retrofitting investments.	Subsidy Scheme for Building Green Ships (SBFA), FAME India Scheme and NEMMP
	Green Innovation Fund: Establish a dedicated fund for research, pilot projects, and technology development in green shipping.	National Action Plan on Climate Change (NAPCC), Maritime Amrit Kaal Vision-2047 (MAKV-2047)

Element	Policy Actions	Existing Policies Integration
	Green Talent Fund: Support specialized training programs, scholarships, and workforce development initiatives for green maritime professionals.	Blue Economy Policy, Maritime Amrit Kaal Vision-2047 (MAKV-2047
Green Fuel	**Phased Carbon Pricing for Maritime Fuels:** Introduce a gradually increasing carbon tax on fossil-based maritime fuels to encourage adoption of sustainable alternatives.	Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Renewable Fuel Mandates & Blending Requirements: Implement minimum blending requirements for biofuels, LNG, and hydrogen in maritime fuels, gradually increasing targets over time.	National Hydrogen Mission, National Biofuel Policy, Methanol Economy
	Binding Emissions Standards for Green Fuel Adoption: Set regulatory limits on CO_2, NOx, and SOx emissions for vessels, enforcing adoption of low-emission fuels and technologies.	Harit Nauka Scheme, DGS Order on Norms for Ships
	Green Maritime Corridors for Alternative Fuels: Establish key domestic and international routes with dedicated green bunkering infrastructure for hydrogen, ammonia, and biofuels.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Marine Fuel Reporting Mechanism: Develop a standardized system for tracking emissions, fuel consumption, and compliance with fuel transition mandates.	Harit Sagar Guidelines, Maritime India Vision 2030 (MIV 2030)
	Green Collaboration and Industry Partnerships: Foster partnerships between industry players, research institutions, and government bodies to accelerate green fuel adoption.	National Hydrogen Mission, National Biofuel Policy, Methanol Economy
	Subsidies, Tax Incentives & Green Shipping Fund: Provide financial incentives, including subsidies, tax rebates, and a dedicated fund, to lower the cost of green fuels and infrastructure.	Subsidy Scheme for Building Green Ships (SBFA), FAME India Scheme and NEMMP
	Investment in R&D for Electrolysers, Ammonia Synthesis & Biofuels: Support research and development in green fuel production technologies to enhance domestic capabilities and reduce costs.	National Hydrogen Mission, Methanol Economy, National Biofuel Policy
	PPP-Enabled Green Fuel Infrastructure Development: Promote public-private partnerships (PPPs) to develop alternative fuel bunkering and supply infrastructure at major Indian ports.	National Hydrogen Mission, Sagarmala Programme, Blue Economy Policy
Green Ports	**Emission Standards for Ports:** Set regulatory limits on GHG emissions and mandate onshore power supply to reduce pollution from port operations.	Harit Sagar Guidelines, National Action Plan on Climate Change (NAPCC)
	Green Building and Operational Standards: Enforce sustainable design and energy-efficient infrastructure in all new and retrofitted port projects.	Harit Sagar Guidelines, Sagarmala Programme
	Green Port Certification and Indexing Framework: Develop a standardized certification system to assess and benchmark port sustainability based on emissions reduction, renewable energy use, and waste management.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047)

Element	Policy Actions	Existing Policies Integration
	Mandatory Environmental Auditing and Reporting: Require periodic environmental audits and publication of port sustainability performance.	Harit Sagar Guidelines, Blue Economy Policy
	Real-Time Environmental Monitoring: Implement IoT-based tracking systems for emissions, energy use, and waste management at ports.	Harit Sagar Guidelines, Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Multi-Stakeholder and International Collaborations: Build partnerships for regulatory alignment, tech transfer, and green financing.	Sagarmala Programme, Maritime India Vision 2030
	Research, Development, and Innovation: Advance clean energy, alternative fuels, and smart port technologies.	Sagarmala Programme, Harit Sagar Guidelines
	Capacity Building and Knowledge Exchange: Strengthen training, certification, and knowledge-sharing for sustainable ports.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Financial Incentives for Renewable Infrastructure: Provide subsidies, tax benefits, and green bonds for solar, wind, and energy-efficient port technologies.	Harit Sagar Guidelines, Maritime India Vision 2030 (MIV 2030)
	Incentives for Alternative Fuel Infrastructure: Support the development of bunkering and refuelling facilities for LNG, green hydrogen, and ammonia.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Viability Gap Funding (VGF) for Green Ports: Establish financial mechanisms to support early-stage investment in green port projects, including electrification and cold ironing infrastructure.	Sagarmala Programme
Green Recycling	**Green Ship Recycling Compliance Framework:** Mandate compliance with the Hong Kong Convention (HKC) and EU Ship Recycling Regulations (EUSRR) to reduce emissions and improve safety.	Ship Recycling Act, Blue Economy Policy
	Ship Recycling Transparency & Reporting Framework: Require shipbreaking yards to report emissions, hazardous waste disposal, and compliance performance.	Ship Recycling Act, Harit Sagar Guidelines
	International Partnerships for Sustainable Ship Recycling: Engage with global stakeholders for technology transfer, training, and regulatory alignment.	Ship Recycling Act, Blue Economy Policy
	Green Finance & Incentives for Sustainable Ship Recycling: Introduce subsidies, tax incentives, and viability gap funding to support sustainable shipbreaking practices.	Ship Recycling Act, Blue Economy Policy, Maritime Amrit Kaal Vision-2047 (MAKV-2047)
Social and Coastal Community Development	**Financial Support for Economic Resilience Among Coastal Population:** Reducing reliance on traditional fishing requires financial incentives, training programs, and investment in sustainable alternatives like eco-friendly aquaculture, marine ecotourism, and renewable energy projects to create jobs, preserve ecosystems, and ensure long-term economic resilience.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047), Sagarmala Programme, Blue Economy Policy

Element	Policy Actions	Existing Policies Integration
	Partnerships for Employment and Training: Implementing targeted apprenticeships, vocational training, and upskilling programs, policymakers can ensure that local residents benefit from the industry's growth while addressing the sector's evolving skill demands.	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Regulations Aimed at Enhancing Coastal Ecosystem Health: Implementing policies that **regulate overfishing, restore mangroves, and reduce waste** are essential steps in protecting marine life and ensuring ecosystem resilience.	Harit Sagar Guidelines, National Action Plan on Climate Change (NAPCC)
	National Reporting and Governance on Coastal Community Development: Establish a structured framework for collecting data and reporting on fisheries' status and ensuring fair representation of coastal communities in policy formulation.	Blue Economy Policy, Sagarmala Programme
Pollution Prevention from Maritime Activities	**Financial Support for Pollution Control:** Provide grants and low-interest loans to shipowners and ports for installing emission scrubbers, ballast water treatment systems, and advanced waste management technology	Green Tug Transition Programme (GTTP), Subsidy Scheme for Building Green Ships (SBFA), Harit Nauka Scheme, Harit Sagar Guidelines
	R&D Partnerships for Pollution Control: Facilitate strategic partnerships between shipping companies, port authorities, and environmental agencies for research, testing, and training aimed at pollution control in the maritime sector	Maritime India Vision 2030 (MIV 2030), Maritime Amrit Kaal Vision-2047 (MAKV-2047)
	Ballast water treatment mandate: Mandate all the ships entering Indian waters to use certified Ballast Water Treatment Systems (BWTS) and submit ballast discharge reports.	Ship Recycling Act, Harit Sagar Guidelines
	Pollution Control Reporting System: Mandate data reporting on pollution control - waste reception, emissions reduction, ballast water treatment compliance	Harit Sagar Guidelines, National Action Plan on Climate Change (NAPCC)

Table 28: Policy Actions and Instruments for Green Shipping

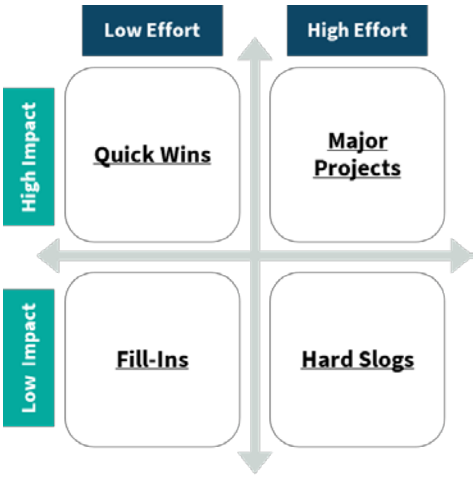
7 High-level Implementation Roadmap

The roadmap has been developed using a structured prioritization process based on the **Action Priority Matrix**. The matrix provides a framework for the evaluation of policy actions across two key dimensions -

- **Expected Level of Impact** – The extent to which the policy action is expected to contribute to the policy objectives
- **Expected Implementation complexity** – The ease of implementation expected based on high-level assumptions on political, economic, social, technological, legal, and environmental considerations.

The policy actions were assessed across these two key dimensions and were accordingly classified into 4 key quadrants

- **Quick Wins –** High-impact, low-effort actions that should be prioritized for immediate implementation.
- **Major Projects –** High-impact, high-effort actions that require significant investment but are essential for long-term success.
- **Fill-Ins –** Low-impact, low-effort actions that can be addressed as time and resources allow.
- **Hard Slogs –** Low-impact, high-effort actions that may have limited value and should be reconsidered or deprioritized



The approach enabled the development of a high-level pathway for the implementation of proposed policy actions. The resulting roadmap is expected to ensure that resources are allocated effectively and that policy actions are sequenced for optimal impact and feasibility. The timeframes for short-term, mid-term, and long-term actions may be adjusted based on periodic reviews of the policy and its implementation, allowing for flexibility in response to evolving circumstances and insights gained during execution.

Short Term (2025-2030)

Policy Actions	Key themes
Tiered Green Technology Compliance framework for ships, ports, and shipyards.	Green Regulations, Green Technology
Green Technology Reporting mechanism for Maritime Assets	Green Reporting
Strategic Collaborations to Enhance Green Shipping Technology Manufacturing	Green Collaboration, Green Technology
PLI Schemes extended to green shipbuilding components and technologies	Green Finance, Green technology
Tax Incentives for green technology manufacturing under Make in India	Green Finance, Green technology
Green Ship Certification & Compliance Standards	Green Regulations, Green Technology
Skill Development & Knowledge Sharing in Green Shipping	Green Collaboration, Green Ships

Policy Actions	Key themes
Enhancing Shipbuilding Financial Assistance (SBFA) Scheme to introduce tiered financial incentives for green ships	Green Finance, Green Ships
Marine Fuel Reporting Mechanism	Green Reporting, Green Fuel
Renewable Fuel Mandates & Blending Requirements	Green Regulation, Green Fuel
Green Collaboration and Industry Partnerships	Green Collaboration, Green Fuel
Subsidies, Tax Incentives & Green Shipping Fund	Green Finance, Green Fuel
Investment in R&D for Electrolysers, Ammonia Synthesis & Biofuels	Green Finance, Green Fuel
Green Building and Operational Standards	Green Regulation, Green Port
Green Port Certification and Indexing Framework	Green Reporting, Green Port
Multi-stakeholder and International Collaborations	Green Collaboration, Green Port
Research, Development, and Innovation	Green Collaboration, Green Port
Capacity Building and Knowledge Exchange	Green Collaboration, Green Port
Financial Incentives for Renewable Infrastructure	Green Finance, Green Port
Incentives for Alternative Fuel Infrastructure	Green Finance, Green Port
Viability Gap Funding (VGF) for Green Ports	Green Finance, Green Port
Green Ship Recycling Compliance Framework	Green Regulation, Green Recycling
Ship Recycling Transparency & Reporting Framework	Green Reporting, Green Recycling
Green Finance & Incentives for Sustainable Ship Recycling	Green Finance, Green Recycling
International Partnerships for Sustainable Ship Recycling	Green Collaboration, Green Recycling
Financial Support for Economic Resilience Among Coastal Population	Green Finance, Social and coastal community development

Policy Actions	Key themes
Partnerships for Employment and Training of coastal populations	Green collaboration, Social and coastal community development
Regulations aimed at Enhancing Coastal Ecosystem Health - regulated overfishing, mangroves restoration, waste reduction	Green regulation, Social and coastal community development
National Reporting and Governance on Coastal Community Development	Green reporting, Social and coastal community development
Financial Support for Pollution Control: emission scrubbers, ballast water treatment systems, and advanced waste management technology	Green Finance, Pollution prevention from maritime activities
R&D Partnerships for Pollution Control	Green Collaborations, Pollution prevention from maritime activities

Mid-Term (2030-2035)

Policy Actions	Key themes
Specialized design and manufacturing hubs for green shipping technologies	Green Finance, Green Technology
Monitoring, Reporting, & Verification (MRV) Systems	Green Reporting, Green Ships
Binding Emissions Standards for Green Fuel Adoption	Green Regulation, Green Fuel
Green Maritime Corridors for Alternative Fuels:	Green Regulation, Green Fuel
PPP-Enabled Green Fuel Infrastructure Development	Green Finance, Green Fuel
Zero-Emission Zones (ZEZs) for Coastal & Inland Waterways	Green Regulations, Green Ships
Emission Standards for Ports	Green Regulation, Green Port
Mandatory Environmental Auditing and Reporting	Green Reporting, Green Port
Real-Time Environmental Monitoring	Green reporting, Green Port
Ballast water treatment mandate	Green Regulation, Pollution prevention from maritime activities
Pollution Control Reporting System	Green Reporting, Pollution prevention from maritime activities

Long-Term (Beyond 2035)

Policy Actions	Key themes
Phased Carbon Pricing for Maritime Fuels	Green Regulation, Green Fuel

To align with IMO's 2023 GHG reduction strategy and India's national sustainability commitments, the following milestone targets can be incorporated into the policy document:

Year	Proposed Target for India
2025	Establish a Green Shipping Framework, mandating emission reporting and setting incentives for green fuel adoption. Identify and designate at least three green ports with shore power infrastructure.
2030	Reduce carbon intensity of Indian shipping by 30% (aligned with IMO). Ensure at least 10% of total energy used in shipping comes from zero or near-zero GHG fuels. Retrofit at least 20% of the fleet with energy-efficient technologies. Establish green fuel bunkering stations in major ports (hydrogen, ammonia, biofuels).
2035	Achieve a 50% reduction in carbon intensity. Require all new vessels built in India to be net-zero capable. Expand green corridors to connect major domestic and international trade routes. Scale up electrification in inland waterways.
2040	Reduce absolute GHG emissions by 70%. Mandate zero-emission operations for coastal and inland vessels. Ensure at least 30% of total fuel consumption in Indian shipping comes from low/zero-emission fuels.
2047 (India@100)	Achieve net-zero emissions in domestic shipping. Ensure 100% green energy use in major ports. Require all new commercial vessels registered in India to operate on zero-emission fuels.
2050	Achieve net-zero emissions for international shipping under India's registry, fully aligned with IMO's 2050 target.

Rationale & Impact:

- **2025-2030:** Focus on policy development, pilot projects, and infrastructure.
- **2030-2040**: Scale-up green fuels, efficiency upgrades, and fleet modernization.
- **2040-2050:** Achieve full decarbonization and global alignment.

Appendix

Green Shipping Challenge – Stakeholder Perspective

Understanding green shipping challenges from the value chain stakeholder perspective helps holistically identify issues that require attention and action within the domestic context. LR identified the long and short-term sustainability challenges faced by maritime stakeholders to get insights into industry-wide pain points, evolving trends, and opportunities, which can inform the formulation of targeted, impactful, and forward-looking policies

Stakeholders	Short Term Challenges	Long Term Challenges
Ship Owners/ Operators	**Immediate Compliance** Ship owners must quickly adapt to new regulations and carbon tax mechanisms which require significant investments and may result in operational disruptions. **Technological Limitations** Existing technologies for reducing emissions may not be readily available or feasible for all types of ships, leading to challenges in finding suitable short-term solutions.	**Transition to Alternative Fuels** The energy transition presents ship owners with the complex task of navigating the technological challenges and regulatory hurdles, while ensuring economic viability to modernise fleets. **Balance Cost Pressures** Managing future cost implications requires strategic allocation of resources for owners to effectively manage fluctuating fuel prices, capital-intensive technologies, crew training expenses, safety and security costs etc.
Cargo Owners/ Charterers	**Chartering & Operational Strategies** Optimising operations within dynamic market conditions to balance emissions reduction with business continuity. Charterers are also challenged to align their vessel selection criteria to include vessel efficiency considerations. **Share the Cost** Negotiating and implementing cost-sharing agreements with ship owners to incentivize efficiency improvements.	**Regulatory Compliance** Chartering activities must align with the regional and international emission reduction targets of the maritime industry and promote responsible environmental stewardship. **Digital Transformation** Automation and digitalization of chartering processes challenge charterers to enhance transparency and leverage data analytics for informed decision-making and risk management.

Stakeholders	Short Term Challenges	Long Term Challenges
Shipyards	**Technological Limitations** Automation and optimisation of the existing processes to address the short-term uptake in ESDs retrofits and meet the demand for modern newbuilds. **Transition to Alternative Fuels** Address the uncertainties around future technologies. Collaborate with ship owners for sustainable designs and innovation.	**Regulatory Compliance** Adapt to shifting regulatory standards for shipyards and incorporate climate change mitigation in business practices. **Lifecycle Emissions** Approaching shipbuilding from a lifecycle assessment angle to ensure that emissions intensity of entire newbuilds is optimised across materials, supply chains and construction processes
Ports/ Terminals	**Technological Limitations** Adapt existing infrastructure to support and accommodate the uptake of alternative fuels. Share learnings and develop blueprints on the safe handling of all the different fuels. **Reduce Port Emissions** Identify the risks from ports' emissions profile and implement measures to reduce their emissions by adopting clear ESG practices.	**Regulatory and Safety Compliance:** Adapt to shifting regulatory standards for port and coastal regions and incorporate climate change mitigation in business practices to maintain their competitiveness **Technological Advancement** Upgrade infrastructure to support modern, alternative fuelled vessels with lower carbon intensity. Encouragement of wider application of renewable energy throughout ports.
Financiers	**Mobilise Sustainable Capital** Facilitating investments in emerging technologies aimed at reducing carbon emissions. Enhance partnerships with governments and other stakeholders to jointly finance green shipping. **Understand Portfolios Impact** Understanding the emissions profile of ship finance portfolios and making efforts to link green projects with suitable loan mechanisms.	**Develop New Financial Instruments** Create specialized financial products to support the uptake of alternative fuels and sustainable initiatives. Focus on re-balancing their portfolios to align with ESG practices. **De-risk investments** Implementing strategies to mitigate investment risks associated with climate change by providing e.g., cheaper capital, governmental guarantees, and subsidies.

Stakeholders	Short Term Challenges	Long Term Challenges
Regulatory Bodies	**Lengthy Approval Process** The approval process for new green regulations can be slow due to bureaucratic delays. This prevents the timely resolution of critical issues in the maritime industry. **Coordination Issues** With different agencies handling various aspects of the maritime industry, there is often a lack of coordination resulting in delay in decision-making related to new green regulations.	**Slow implementation** Slow implementation of green initiatives such as stricter emissions standards, sustainable fuel usage, and decarbonization strategies poses challenges to achieving sustainability goals. **Slow updates to regulations** Many maritime regulations in India are outdated and do not align with international standards or modern green shipping practices as prescribed by IMO
Logistics Providers	**Infrastructure Deficiencies** Poor road and rail connections between ports and inland hubs disrupt the adoption of a completely green channel for the movement of goods and commodities. **Regulatory Hurdles** Lack of standardization and the presence of manual systems complicate the paperwork involved in international shipping.	**Fragmented Logistics Network** Many players in the supply chain, including the transporters, warehousing providers, and port and terminal operators, often work in silos. Lack of integration among these entities leads to inefficiencies and delays in the shipping process and higher overall emissions. **Adoption of New Technology** Indian technology providers face challenges in adopting green technologies due to cost, infrastructure limitations, and lack of digital literacy in certain regions
Inland Shipping	**Underdeveloped Infrastructure** Many inland ports lack modern infrastructure, including green fuel bunkering, limiting green shipping operations. **Poorly Maintained Waterways** Existing technologies for sustainable maintenance of waterways like dredging may not be readily available or feasible for all types of ships.	**Complex Regulatory Framework** Inland shipping is subject to various state and central regulations, which can be inconsistent and unclear, causing delays and confusion for operators. **Financing & Investment Issues** Private and government financing is often insufficient for the development and modernization of infrastructure, vessels, and technology needed to improve the sector and make it competitive vis-à-vis other modes of transportation.

Stakeholders	Short Term Challenges	Long Term Challenges
Maritime Fuel Producers	**Downstream Infrastructure Limitations** Ports are not yet equipped with infrastructure to handle and supply these alternative fuels to ships. This creates a significant barrier to transitioning the maritime industry **Complex Raw Materials Supply chain** Producing green maritime fuels requires sustainable feedstocks, such as algae or agricultural waste for biofuels, or green hydrogen, which is currently expensive and limited in supply.	**Regulatory Challenges** The transition to green fuels involves changes in regulatory frameworks, including standards for fuel quality, emissions, and certification. India's regulatory system will need to adapt to accommodate and support the development of green maritime fuels. **Technological Advancement** The cost of scaling up green fuel production also presents a challenge for India, especially as the country seeks to balance economic growth with environmental objectives.
Ancillary Technology Providers	**Regulatory Compliance** Adapt to shifting regulatory standards for the broader maritime industry and incorporate climate change mitigation in business practices is difficult, especially for small service providers **Technological Limitations** Existing technologies for reducing emissions may not be readily available or feasible for all types of ancillary technology providers, leading to challenges	**Regulatory and Safety Compliance:** Adapt to shifting regulatory standards for port and coastal regions and incorporate climate change mitigation in business practices to maintain their competitiveness **De-risk investments** Implementing strategies to mitigate investment risks associated with climate change by providing e.g., cheaper capital, governmental guarantees, and subsidies.

Table 29: Stakeholders Green Shipping Challenges

Root Cause Analysis

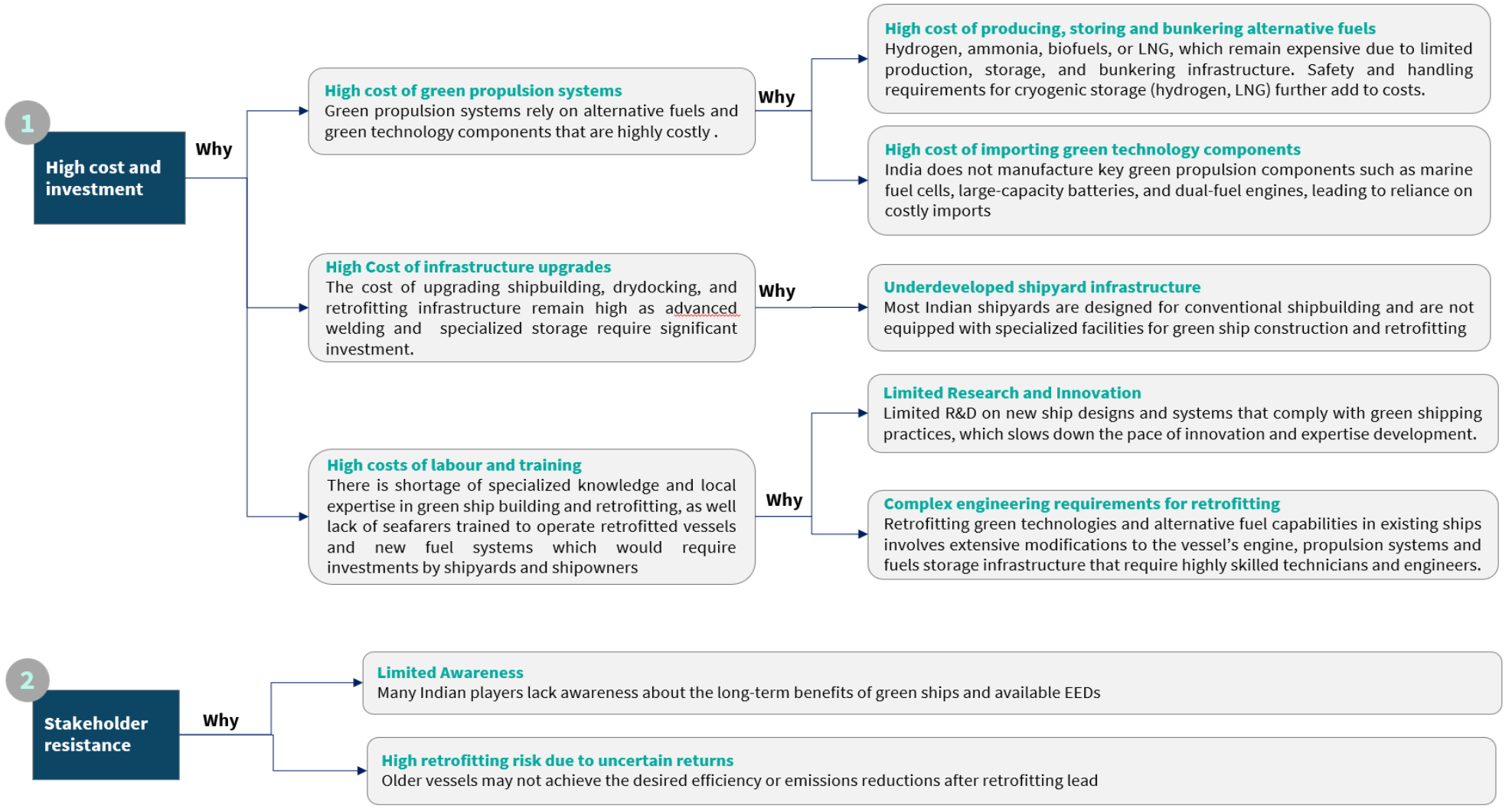


Figure 15: Root Cause Analysis for Barriers to Green Ship and Technology

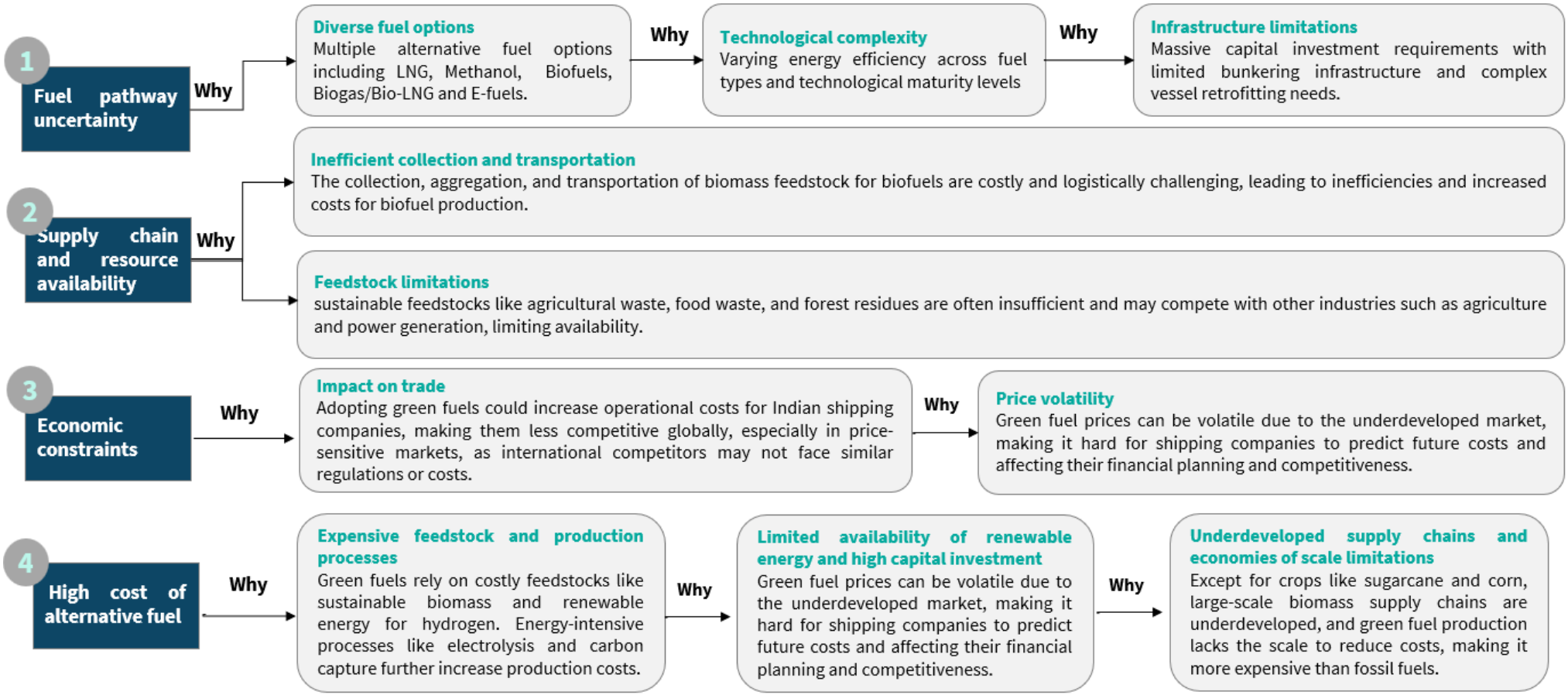


Figure 16: Root Cause Analysis Barriers to Green Fuel

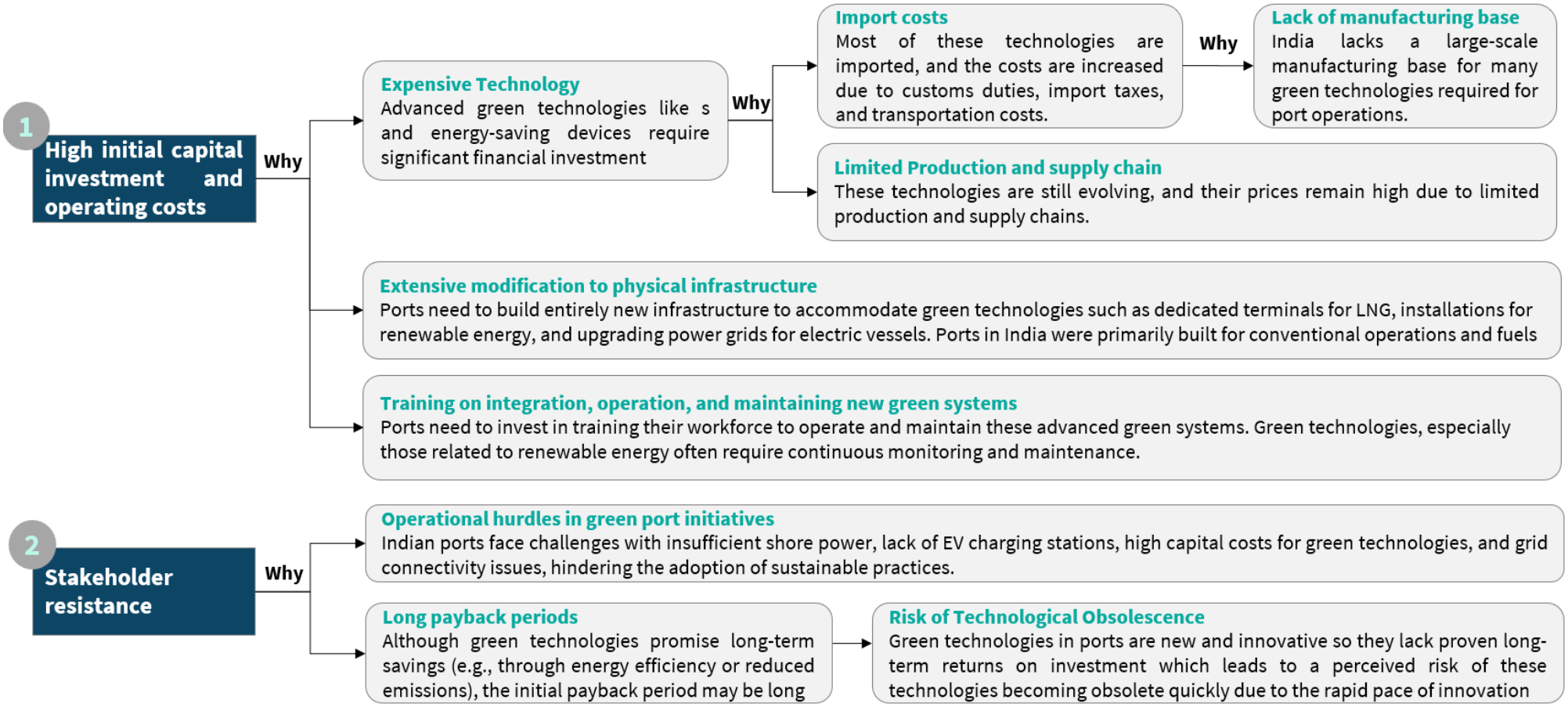


Figure 17: Root Cause Analysis to the Barriers of Green Port

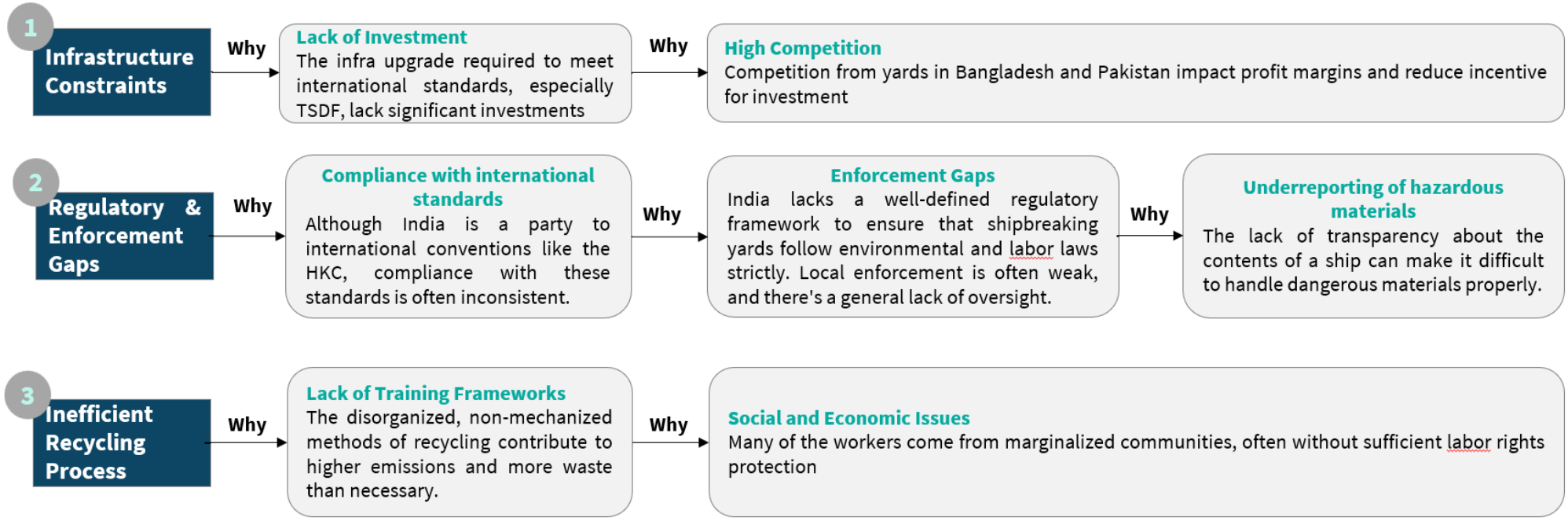


Figure 18: Root Cause Analysis Barriers to Green Recycling

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