पत्तन, पोत परिवहन
एवं जलमार्ग मंत्रालय
MINISTRY OF
PORTS, SHIPPING
AND WATERWAYS

राष्ट्रीय हरित पोत-परिवहन नीति

NATIONAL GREEN SHIPPING POLICY

Minister's Message
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Preface

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List of Abbreviations

- AMSR: Annual Maritime Sustainability Report
- ASEAN: Association of Southeast Asian Nations
- BIS: Bureau of Indian Standards
- CAGR: Compound Annual Growth Rate
- CBI: Climate Bonds Initiative
- CBDR-RC: Common But Differentiated Responsibilities and Respective Capabilities
- CII: Carbon Intensity Indicator
- CO_2: Carbon Dioxide
- CSL: Cochin Shipyard Ltd
- DEA: Department of Economic Affairs
- DG Shipping: Directorate General of Shipping
- DVC: Damodar Valley Corporation
- EEDI: Energy Efficiency Design Index
- EEXI: Energy Efficiency Existing Ship Index
- EPR: Extended Producer Responsibility
- ESG: Environmental, Social, and Governance
- EUSRR: European Union Ship Recycling Regulation
- EXIM Bank: Export-Import Bank of India
- FICCI: Federation of Indian Chambers of Commerce and Industry
- FNPP: Floating Nuclear Power Plants
- GCF: Green Climate Fund
- GCI: Green Compliance Index
- GFI: Greenhouse gas Fuel Intensity
- GFS: Green Fuel Standard
- GFAI: Green Finance Alliance India
- GHG: Greenhouse Gas
- GIFT City: Gujarat International Finance Tec-City
- GMIM: Green Maritime Innovation Mission
- GRSE: Garden Reach Shipbuilders and Engineers
- GSDP: Green Skill Development Programme
- GSP: Green Shipping Programme
- GT: Gross Tonnage
- GTTP: Green Tug Transition Programme
- GW: Gigawatt
- HKC: Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships

- ICMA: International Capital Market Association
- IGF codes: International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels
- IFI: International Financial Institution
- IFC: International Finance Corporation
- IFSC: International Financial Services Centre
- IHM: Inventory of Hazardous Materials
- ILO: International Labour Organization
- IMO: International Maritime Organization
- IMO- DCS: International Maritime Organization- Data Collection System
- IMU: Indian Maritime University
- IMEEC: India–Middle East–Europe Economic Corridor
- INSTC: International North-South Transport Corridor
- IOE: International Organisation of Employers
- IRS: Indian Register of Shipping
- ITIs: Industrial Training Institutes
- IWT: Inland Water Transport
- IWAI: Inland Waterways Authority of India
- JIT: Just-In-Time
- JNPA: Jawaharlal Nehru Port Authority
- LCER: Life-Cycle Emissions Reporting
- LNG: Liquefied Natural Gas
- LT-LEDS: Long-Term Low Emission Development Strategy
- MAKV 2047: Maritime Amrit Kaal Vision 2047
- MBM: Market-Based Measure
- MEPC: Marine Environment Protection Committee
- METF: Maritime Energy Training Facility
- MGTF: Maritime Green Transition Fund
- MIV 2030: Maritime India Vision 2030
- MMT: Million Metric Tonnes
- MoEFCC: Ministry of Environment, Forest and Climate Change
- MoF: Ministry of Finance
- MoPSW: Ministry of Ports, Shipping and Waterways
- MRV: Monitoring, Reporting and Verification
- MSDE: Ministry of Skill Development and Entrepreneurship
- MSMEs: Micro, Small and Medium Enterprises
- MTPA: Million Tonnes Per Annum
- NABARD: National Bank for Agriculture and Rural Development
- NBFC: Non-Banking Financial Company

- NCoEGPS: National Centre of Excellence for Green Ports and Shipping
- NDCs: Nationally Determined Contributions
- NGMCC: National Green Shipping Coordination Cell
- NGSP: National Green Shipping Policy
- NIIF: National Investment and Infrastructure Fund
- NLP-Marine: National Logistics Portal (Marine)
- NGOs: Non-Governmental Organizations
- NSDC: National Skill Development Corporation
- NSIC: National Small Industries Corporation
- NTCPWC: National Technology Centre for Ports, Waterways and Coasts
- OECD: Organisation for Economic Co-operation and Development
- STS: Onshore Power Supply
- PEMS: Portable Emissions Measurement System
- PIB: Press Information Bureau
- PPE: Personal Protective Equipment
- PPPs: Public-Private Partnerships
- R&D: Research and Development
- RE: Renewable Energy
- SBI: State Bank of India
- SBFA: Ship Building Financial Assistance
- SCGJ: Skill Council for Green Jobs
- SCI: Shipping Corporation of India
- SDG: Sustainable Development Goals
- SEBI: Securities and Exchange Board of India
- SEEMP: Ship Energy Efficiency Management Plan
- SIDBI: Small Industries Development Bank of India
- SMART: Specific, Measurable, Achievable, Realistic, and Time-bound
- SMFCL: Sagarmala Finance Corporation Ltd.
- SoC: State of Charge
- SRP: Ship Recycling Plans
- TAMP: Tariff Authority for Major Ports
- UNDP: United Nations Development Programme
- UNEP: UN Environment Programme
- UNESCO-UNEVOC: United Nations Educational, Scientific and Cultural Organization – International Centre for Technical and Vocational Education and Training
- UNIDO: United Nations Industrial Development Organization
- VGF: Viability Gap Funding
- VOCPA: V. O. Chidambaranar Port Authority

- ZEPZ: Zero Emission Port Zones

Chapter 1: National Green Shipping Policy Framework —Foundations and Architecture

1.1 Why India Needs a Unified Green Maritime Framework

India's maritime sector stands at a structural turning point. The country is simultaneously expanding port capacity, scaling inland waterways, modernising shipbuilding, and positioning itself as a logistics and manufacturing hub. Yet this expansion is unfolding in an era where global maritime trade is being rapidly redefined by decarbonisation mandates, lifecycle emissions accounting, ESG-linked finance, and climate-aligned regulation.

The absence of a unified national framework risks fragmented green efforts, regulatory inconsistency, and missed economic opportunity.

India already possesses multiple progressive initiatives —Harit Sagar Guidelines[1], Maritime India Vision 2030[2], Maritime Amrit Kaal Vision 2047[3], the Green Tug Transition Programme[4], ship recycling reforms, and emerging green hydrogen strategies. However, these initiatives operate as sectoral programmes rather than as an integrated decarbonisation architecture. Without a national policy spine, implementation remains uneven, metrics are non-standardised, and long-term signals to investors, ship owners, ports, and financiers remain unclear.

The National Green Shipping Policy (NGSP) addresses this structural gap.

It does not replace existing programmes. Instead, it functions as an umbrella coordination framework that:

- aligns ports, ships, fuels, finance, technology, and skills under a common decarbonisation logic
- establishes measurable national baselines and performance benchmarks
- integrates climate governance with maritime industrial policy
- ensures India's maritime growth remains globally competitive in a carbon-constrained economy

The urgency is not only environmental —it is economic and geopolitical.

Global shipping is entering a regulatory transition driven by the IMO GHG Strategy[5], carbon pricing mechanisms, fuel lifecycle standards, and green corridor agreements. Access to future markets, financing, and trade partnerships will increasingly depend on verifiable decarbonisation performance. Countries that build credible green maritime ecosystems will capture investment, manufacturing leadership, and supply chain advantage.

[1] Harit Sagar Guidelines (https://shipmin.gov.in/sites/default/files/Harit%20Sagar%20-%20Green%20Port%20Guidelines%20.pdf)
[2] Maritime India Vision 2030 (https://sagarmala.gov.in/sites/default/files/MIV%202030%20Report.pdf)
[3] Maritime Amrit Kaal Vision 2047 (https://shipmin.gov.in/en/content/maritime-amrit-kaal-vision-2047)
[4] Green Tug Transition Programme (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2045946)
[5] IMO GHG Strategy (https://www.imo.org/en/ourwork/environment/pages/imo-strategy-on-reduction-of-ghg-emissions-from-ships.aspx)

India's scale gives it a unique opportunity: to industrialise green maritime transition rather than treat it as compliance.

At the same time, India's development trajectory requires a transition that is just, inclusive, and growth compatible. Coastal communities, MSMEs, informal maritime workers, inland operators, and ship recycling labour forces must be integrated into the transition rather than displaced by it. A fragmented approach would widen inequality. A coordinated framework allows climate action to generate jobs, industrial capability, and regional development.

This policy therefore frames maritime decarbonisation as:

- an industrial strategy
- a climate governance framework
- a logistics competitiveness reform
- a social transition programme

Combined into a single architecture.

The NGSP establishes seven national green pillars as the structural backbone of this transformation. These pillars are not thematic silos. They function as interconnected systems spanning vessels, ports, fuels, recycling, finance, skills, and technology. Together they form India's long-term maritime transition blueprint.

1.2 The Seven Pillars of India's Green Maritime Transition

In the spirit of the ancient *Saptasagara* (Seven Seas) that symbolized India's historic maritime reach, the NGSP anchors its strategy on seven interlinked foundational pillars critical to achieving a green maritime future. These pillars are not programmatic labels; they represent systemic transition domains. Each pillar corresponds to a critical emissions source, industrial subsystem, or governance lever within the maritime ecosystem. Progress in one pillar reinforces outcomes in the others. Failure in one weakens the entire transition.

The pillar framework therefore functions as both a strategic map and an implementation scaffold.

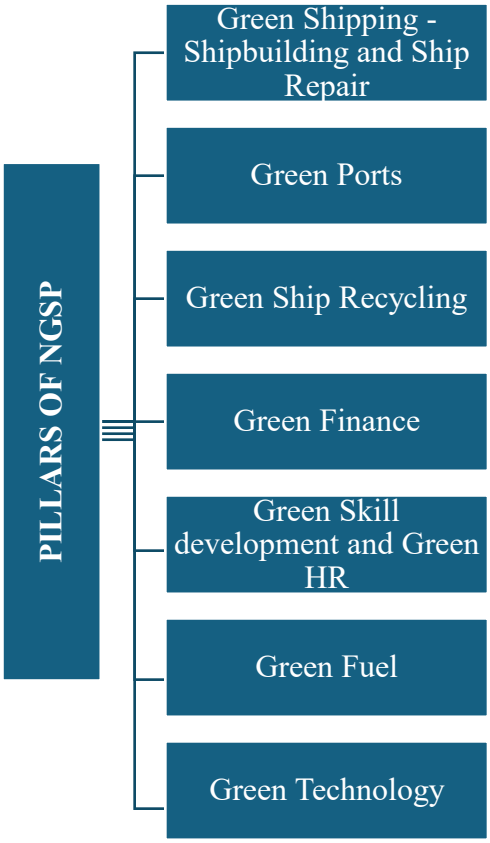

Figure 1 : Seven Pillars of National Green Shipping Policy

Together, they span the full lifecycle of maritime activity—from vessel design to end-of-life recycling, from fuel production to port infrastructure, and from workforce readiness to financial architecture.

1.3 National Implementation Architecture (System Blueprint)

1.3.1 National Green Maritime Coordination Cell (NGMCC): Apex Coordination Authority

India already possesses an institutional foundation for maritime sustainability through the Green Cell established within the Ministry of Ports, Shipping and Waterways (MOPSW). However, the scale of transition envisioned under the National Green Shipping Policy (NGSP) requires this function to evolve from a coordination desk into a full mission-oriented governance platform capable of steering a multi-decade transformation across ports, vessels, fuels, finance, and workforce systems.

Accordingly, the existing Green Cell within MOPSW shall be expanded and formalised as the **National Green Maritime Coordination Cell (NGMCC)**—a strengthened institutional structure with defined authority, staffing, and cross-ministerial mandate.

This is not the creation of a parallel bureaucracy. It is the structured scaling-up of an existing mechanism into a national transition engine. The NGMCC becomes the central operating platform through which India's maritime green transition is coordinated, monitored, financed, and continuously refined.

To ensure continuity and enforceability, the NGMCC shall be formally notified through a Government of India Resolution/Gazette Notification under the Allocation of Business Rules of the Ministry of Ports, Shipping, and Waterways.

The NGMCC shall function as the statutory coordination authority for implementation of the National Green Shipping Policy. Directives issued by the NGMCC relating to certification eligibility, MRV compliance, and access to central maritime funding schemes shall be binding on implementing agencies under MOPSW and aligned central programmes.

This provision ensures that the NGMCC operates as a permanent institutional authority rather than an advisory committee.

1.3.1.1 Purpose and Role

The primary purpose of the NGMCC is to ensure that the seven pillars of NGSP move forward in a synchronized, measurable, and finance-linked manner. Maritime decarbonisation cuts across multiple ministries and regulatory bodies. Without a central coordination spine, policies risk fragmentation, duplication, and delay.

The NGMCC therefore serves as

- the nodal authority for maritime decarbonisation planning
- the convergence platform for inter-ministerial action
- the national custodian of emissions data and MRV systems
- the approving authority for green incentive eligibility
- the anchor for international maritime climate engagement
- the institutional guardian of just transition principles

It translates policy intent into operational alignment.

1.3.1.2 Institutional Positioning within Government

The NGMCC shall function within MOPSW under the administrative control of the Secretary, MOPSW, and operate as a mission directorate dedicated to green maritime transition.

An **Inter-Ministerial Taskforce on Green Shipping (IMTGS)** shall be constituted by MoPSW to support high-level convergence. The Taskforce shall be chaired by the Secretary, Ministry of Ports, Shipping and Waterways (MoPSW), and shall comprise representatives, at appropriate senior level, from the following Ministries/Departments/Agencies:

- Ministry of Petroleum and Natural Gas
- Ministry of Power
- Ministry of New and Renewable Energy
- Ministry of Environment, Forest and Climate Change
- Ministry of Finance / Department of Economic Affairs
- Ministry of Commerce and Industry / DPIIT
- Ministry of Heavy Industries

- Ministry of Steel
- Ministry of Railways
- Ministry of Road Transport and Highways
- Ministry of Skill Development and Entrepreneurship
- Department of Science and Technology
- NITI Aayog
- Ministry of External Affairs
- Directorate General of Shipping
- Inland Waterways Authority

The Chair may co-opt any additional Ministry, Department, Regulatory Body, Public Sector Undertaking, Technical Institution, or Domain Expert as deemed necessary based on the subject matter under consideration. The IMTGS shall constitute for an annual implementation and emissions progress meeting.

The NGMCC acts as the executive arm of this convergence structure.

1.3.1.3 Core Functions

The NGMCC performs six integrated functions:

1. **Policy Coordination**
   Align programmes under MoPSW, MoEFCC, MNRE, Finance, and Skill Development with NGSP targets. Ensure that maritime sustainability is embedded in all relevant schemes rather than treated as a standalone agenda.

2. **Implementation Oversight**
   Approve and track pillar-specific action plans. Review state and port-level Green Action Plans. Monitor the rollout of certification systems, Zero Emission Port Zones, and green infrastructure investments.
3. **Monitoring, Reporting and Verification (MRV)**
   Operate the national maritime MRV backbone through NLP-Marine and associated carbon dashboards. Validate emissions baselines. Maintain performance datasets used for funding and compliance decisions.
4. **Finance Integration**
   Work with Sagarmala Finance Corporation Ltd. (SMFCL) and the Maritime Development Fund to link incentives, concessional finance, and viability gap funding to verified environmental performance.
5. **Technology and Innovation Coordination**
   Guide pilot projects, innovation clusters, and technology standardisation. Ensure adoption pathways remain technology-neutral while aligned with lifecycle emissions goals.
6. **Just Transition Safeguards**
   Ensure inclusion of MSMEs, small ports, informal workers, ship recyclers, and coastal communities. Embed workforce transition and green skilling into all pillar programmes.

1.3.1.4 Composition of the NGMCC

The NGMCC shall be structured as a permanent inter-agency coordination body with both executive and advisory representation.

(1) Permanent institutional members

- Ministry of Ports, Shipping and Waterways (MoPSW)—Chair
- Directorate General of Shipping (DGS)
- Inland Waterways Authority of India (IWAI)
- Indian Register of Shipping (IRS)
- State Maritime Boards (SMB)
- Sagarmala Development Company Ltd (SDCL)
- Sagarmala Finance Corporation Ltd (SMFCL)
- National Centre of Excellence in Green Ports and Shipping (NCoEGPS)
- Indian Maritime University (IMU)
- NITI Aayog (Observer)
- Ministry of Petroleum and Natural Gas (MoPNG)
- If required, any additional Ministry represenative, Department, Regulatory Body, Public Sector Undertaking, Technical Institution, or Domain Expert as deemed necessary based on the subject matter under consideration.
- Centers of Excellences like NTCPWC, CEMS, CMEC, etc.

(2) Rotational advisory participation

- Indian Register of Shipping (IRS)
- Indian Ports Association (IPA)
- Indian National Shipowners' Association (INSA)
- Ship Recycling Industry representatives
- Technical institutions and academic experts
- Civil society and workforce observers

This composition ensures regulatory authority, technical credibility, and industry interface without creating regulatory capture.

(3) Internal Structure

Within the NGMCC, the NCoEGPS will carry out the duties of the permanent secretariat, and the specialized working groups shall mirror the seven NGSP pillars.

Each group coordinates directly with sectoral stakeholders (like the Indian Register of Shipping (IRS), the Indian Ports Association (IPA), the Indian National Shipowners' Association (INSA), the Ship Recycling Industry representatives, technical institutions and

academic experts, civil society and workforce observers, representatives from OEMs and logistics and allied industry experts) and reports into the NGMCC secretariat.

1.3.1.5 Accountability and Reporting

To ensure transparency and institutional accountability:

- The NGMCC shall submit a biannual **(6-monthly)** implementation **and emissions progress** report to the Secretary, MoPSW.
- A consolidated **Annual Green Maritime Report** shall be published for public disclosure.
- Annually reviews shall inform updates to the National Green Maritime Implementation Plan (NGMIP)

Reports will be submitted to MoPSW and made publicly available, except where confidentiality is required for compliance investigations.

Performance metrics are drawn directly from MRV datasets (please refer annexure).

1.3.1.6 Legal Authority and Notification

To ensure continuity and enforceability, NGMCC shall be formally notified through a Government of India Resolution/Gazette Notification under the Allocation of Business Rules of the Ministry of Ports, Shipping, and Waterways.

The NGMCC shall function as the statutory coordination authority for the implementation of the NGSP. Directives issued by the NGMCC relating to certification eligibility, MRV compliance, and access to central maritime funding schemes shall be binding on implementing agencies under MOPSW and aligned central programmes.

1.3.1.7 Dedicated Budget and Staffing Framework

A dedicated budget head shall be established under MOPSW for NGMCC operations. This budget shall support technical staffing, MRV systems, audits, research support, digital infrastructure, and implementation coordination.

The NGMCC shall be staffed through a mixed cadre structure consisting of:

- inter-ministerial deputation
- domain specialists on contractual appointment
- technical consultants for MRV, lifecycle assessment, and certification

Recruitment of technical staff shall follow transparent competency-based selection processes aligned with national public sector recruitment norms in consultation with the DGS and NGMCC secretariat.

1.3.1.8 Binding Linkage to Central Funding and Incentives

Eligibility for Central Green Maritime incentives, concessional finance, viability gap funding, or certification-linked benefits shall be contingent upon compliance with NGMCC-approved frameworks.

All central maritime funding windows aligned with NGSP shall incorporate NGMCC certification and MRV verification as mandatory eligibility criteria.

1.3.1.9 Compliance and Enforcement Mechanism

In cases of persistent non-compliance with NGSP standards or MRV obligations, the NGMCC may recommend graduated corrective actions, including:

- temporary suspension of incentive eligibility
- certification downgrade
- withholding of central financial assistance
- regulatory escalation through DG Shipping or relevant statutory authority
- Corrective measures shall follow defined procedural safeguards, including notice, review, and appeal mechanisms.

1.3.1.10 Financial Governance Alignment

Financing decisions under Sagarmala Finance Corporation Ltd. (SMFCL) and related maritime climate finance instruments shall be aligned with NGMCC-certified eligibility criteria and MRV verification frameworks.

The NGMCC shall define technical eligibility standards, while financial institutions retain fiduciary decision-making authority within those standards.

1.3.2 National Green Maritime Implementation Plan (NGMIP)

A rolling **5-year** implementation plan will be adopted (upto 2030, 2030–2035...), updated biennially and aligned with India's NDCs and IMO trajectories.

Each plan will include:

- **Pillar-specific action items**
- **State-wise and port-wise targets**
- **Fund allocation by SMFCL, including Maritime Development Fund (MDF) and other maritime funds**
- **Technology milestones (e.g., STS readiness, alternative fuel bunkering, LTO batteries)**
- **Skilling quotas and diversity targets**
- **Private sector engagement strategy**

The National Green Maritime Implementation Plan (NGMIP) shall be notified as the official implementation framework of the National Green Shipping Policy. Each 5-year cycle shall be approved by the Ministry of Ports, Shipping, and Waterways and treated as a binding implementation directive for central maritime agencies and aligned funding programmes.

Central maritime funding allocations, incentive schemes, and certification-linked benefits shall be aligned with NGMIP targets to ensure direct linkage between planning and execution.

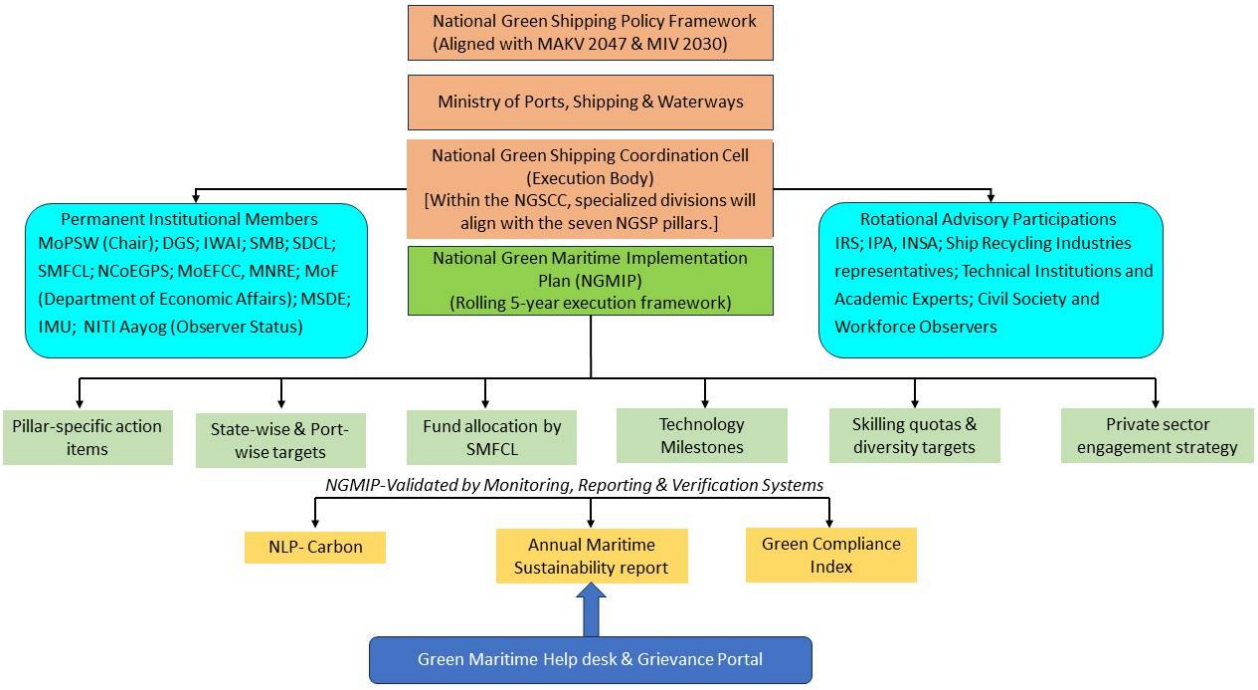

Figure 2: Implementation Flow Chart

1.3.2.1 Proposed National Green Maritime Implementation Plan (NGMIP) 2047: Phased Implementation and Governance Roadmap

India's green maritime transition requires a structured, time-bound, and adaptive implementation strategy—one that addresses present-day gaps while setting ambitious future targets aligned with the IMO GHG Strategy (net-zero by 2050) and India's LT-LEDS (net-zero by 2070). The National Green Maritime Implementation Plan (NGMIP) is proposed as the operational backbone of the NGSP, translating its policy commitments into measurable

actions through phased rollout, institutional integration, and continual stakeholder engagement.

All NGMIP targets shall be anchored to the nationally verified 2021 maritime emissions baseline. Any revision to baseline methodology shall require formal technical review and approval by the NGMCC to ensure consistency, comparability, and credibility of long-term performance tracking.

This prevents shifting benchmarks across implementation cycles.

The NGMIP is structured into three interlinked components:

- **Implementation Phases (up to 2047)**
- **Governance and Monitoring Framework**
- **Stakeholder Roles and Accountability Mechanisms**

1.3.2.2 Phased Implementation Strategy

The NGMIP adopts a *three-phase timeline* to guide India's green maritime transformation focused on goals and targets given under ***MAKV 2047.*** Each phase represents progressive checkpoints toward MAKV 2047 aspirations while enabling NGMCC to operationalize 5-year rolling implementation cycles.

Table 1: Phased Implementation Strategy

Phase	Timeline	Key Actions	Outcomes
Phase I: Foundation and Pilots	Up to 2030	• Launch Green Ship certification (refer chapter 2) and Green Port Performance Index (GPPI)[6] • Roll out STS at 50% of major port berths[7]	Defined baselines, early adoption incentives, pilot corridors, functional MRV, and green

[6] Green Ports Performance Index: https://green-port-shipping.org/gallery/teri_doc_img/10285257Green_Ports_Performance_Index__GPPI__2025_2.pdf

[7] Aligned with Maritime India Vision 2030, Harit Sagar Guidelines, and DGS Circular 09/2025, shore-to-ship (STS) power deployment is structured as a phased transition—covering port crafts (2023), coastal/Indian-flag vessels (2025), and extending to EXIM and foreign vessels by 2030, with Harit Sagar mandating phased availability up to EXIM vessels by 2025. Although policy signals eventual universal OPS adoption by 2030–2035, stakeholder consultations under NGSP identify key constraints, including high berth electrification capex, grid capacity augmentation, and vessel retrofitting readiness.
In this context, ~50% STS coverage across major port berths by 2030 represents the maximum policy-aligned and execution-feasible milestone, focused on high-traffic, OPS-compatible berths to maximize utilization and emissions reduction while supporting renewable energy targets. This forms the foundation for subsequent scale-up to ~90% coverage at major ports and ~75% at non-major ports by 2035, consistent with the long-term objective of fully electrified, carbon-neutral ports under Maritime Amrit Kaal Vision 2047.

Phase	Timeline	Key Actions	Outcomes
		• Pilot-led transition achieving 10–15% alternative fuel penetration in coastal/IWT fleet aligned with MAKV 2047 pilot decarbonisation programme.[8] • Operationalise ESG-linked finance tools via SMFCL • Develop 100% electrification roadmap for cargo handling equipment at major ports. • Rollout MRV platforms (NLP-Marine, proposed NLP-Carbon) (refer page 23) • Establish Maritime Green Skills Clusters[9] (refer chapter 6)	finance instruments

[8] Based on the **Maritime Amrit Kaal Vision** 2047 strategy that prioritises pilot-based adoption of low- and zero-emission vessels, establishment of decarbonisation testbeds, and gradual scaling of alternative fuels such as LNG, hydrogen, ammonia, and biofuels, an initial 10–15% alternative fuel penetration in the coastal and inland waterway fleet by 2030 represents the technically and institutionally feasible transition envelope for the first implementation phase. This level reflects realistic fleet turnover cycles, fuel infrastructure readiness, and vessel retrofit capacity, while remaining consistent with MAKV's emphasis on demonstration projects rather than immediate fleet-wide mandates. A pilot-led penetration band of 10–15% enables validation of safety standards, supply chain reliability, financing mechanisms, and operational performance under Indian conditions, thereby creating the evidence base required for accelerated expansion in the 2030–2040 period and full-system transition in the consolidation phase toward 2047.

[9] Specialized green skills clusters operationalize the human capital dimension of Maritime Amrit Kaal Vision 2047 by ensuring that workforce capacity evolves alongside technological transition. Decarbonisation introduces new competencies in fuel handling, electrical systems, digital monitoring, and safety engineering that cannot be absorbed through conventional training pipelines alone. Concentrated skills hubs enable rapid curriculum development, industry-academia partnerships, and certification frameworks tailored to emerging maritime technologies. Treating workforce transition as infrastructure investment prevents skill shortages from becoming the primary bottleneck in green adoption.

Phase	Timeline	Key Actions	Outcomes
		• All major ports publish carbon-neutral transition roadmaps with interim 2035 emission reduction milestones in comparison with 2021 baseline • Establish Green retrofit incentive scheme for existing coastal/IWT vessels • Establish National Green Maritime Innovation Platform for R&D and commercialization under Centre of Excellences existing • Develop strong marine design ecosystem by identifying design clusters and incentivizing for 'Design in India.' [10]	
Phase II: Expansion and Institutionalisation	2030–2040	• Scale Green Fuel hubs (e.g., DPA, PPA, VOCPA) by operationalising it wherever possible • Green Ship Certification mandatory for new builds	System-wide decarbonisation, green market development, carbon credit exchange, mid-term global alignment

[10] Page no 155, MIV 2030

Phase	Timeline	Key Actions	Outcomes
		• Establish National Maritime Carbon Market[11] • Digital traceability for ship recycling and emissions (refer chapter 5 for more details) • Expansion of ZEPZs to non-major ports[12] • 30% clean fuel adoption in Indian fleet[13]	
Phase III: Consolidation and Global Leadership	2040–2047	• Zero-emission mandates in select zones (e.g., NW1 (Ganga - Bhagirathi - Hooghly river system between Haldia (Sagar) and Prayagraj (1620 km)), Gujarat	Full-scale transformation of port–ship–fuel systems, global competitiveness, domestic technology leadership

[11] A maritime carbon market extends the financing logic embedded in Maritime Amrit Kaal Vision 2047 by introducing market-based incentives that reward emissions reduction rather than relying solely on regulatory compliance. Carbon pricing mechanisms mobilize private capital, encourage technological innovation, and create a transparent valuation of environmental performance. Positioning the carbon market as a complement to existing fiscal incentives ensures policy coherence while avoiding over-reliance on public subsidies. This framework aligns Indian maritime policy with emerging global carbon accounting regimes, protecting long-term trade competitiveness.

[12] The expansion of Zero-Emission Port Zones (ZEPZs) to non-major ports reflects the Maritime Amrit Kaal Vision 2047 principle that sustainability transformation must extend beyond flagship infrastructure to the broader maritime ecosystem. While early decarbonisation efforts are concentrated at major ports due to traffic density and capital availability, long-term emissions reduction requires diffusion of green standards across regional logistics networks. Extending ZEPZ frameworks to non-major ports enables distributed adoption of clean fuels, electrified cargo handling, and low-emission vessel operations, preventing the emergence of a two-tier port system where sustainability is geographically concentrated. This expansion phase also aligns with MAKV's cluster-based development model by embedding green transition into emerging port-industrial ecosystems, ensuring that regional growth corridors are built on low-carbon foundations rather than retrofitted later at higher cost.

[13] Building on the pilot validation achieved in Phase I and consistent with the Maritime Amrit Kaal Vision 2047 transition pathway that emphasizes progressive scaling of low-carbon shipping technologies, a 30% alternative fuel penetration target for the coastal and inland fleet by 2040 represents the first system-wide expansion phase. This threshold corresponds to the expected maturation of hydrogen, ammonia, LNG, and biofuel bunkering infrastructure at major ports, availability of certified low-emission vessel classes, and operational confidence derived from early pilots.

Phase	Timeline	Key Actions	Outcomes
		coast (Marine National Park, Gulf of Kutch)) • Achieve 70% transition to clean fuels[14] • Digitised MRV linked to global shipping networks • All major ports achieve carbon-neutral operations consistent with MAKV 2047. • Export green vessels and maritime technologies (India as R&D-exporter)[15] • National green maritime fuel network integrated with global supply chains. • Position India in top 5 green shipbuilding and leader in recycling nations[16]	

[14] The 70% fleet transition target in the consolidation phase reflects the Maritime Amrit Kaal Vision 2047 objective of positioning India among global leaders in green shipping while recognising that residual conventional fuel usage may persist in specialized vessel classes. By 2047, fuel infrastructure, vessel design standards, and regulatory frameworks are expected to be fully harmonized with international decarbonisation regimes, enabling alternative fuels to become the operational default rather than a niche segment. A 70% penetration level represents effective systemic dominance of clean fuels while maintaining strategic flexibility for technological evolution. This benchmark signals India's transition from adoption to leadership, supporting export competitiveness, green shipbuilding capability, and integration into emerging global low-carbon shipping corridors.

[15] The objective of exporting green vessels and maritime technologies positions India to transition from a technology adopter to a technology originator, consistent with the Maritime Amrit Kaal Vision 2047 ambition of becoming a global leader in shipbuilding, repair, recycling, and maritime innovation. MAKV frames sustainability not only as an environmental obligation but as an industrial competitiveness strategy, where early domestic deployment of low-emission vessels, alternative fuel systems, and digital maritime solutions generates intellectual property, manufacturing capability, and export-ready standards.

[16] Positioning India among the top five global leaders in green shipbuilding operationalizes the Maritime Amrit Kaal Vision 2047 aspiration of transforming the country into a competitive maritime manufacturing and circular-economy hub. MAKV explicitly links shipbuilding modernization and environmentally compliant recycling capacity with Atmanirbhar industrial strategy, recognizing that future global demand will favor yards capable of meeting stringent environmental and lifecycle standards.

This timeline is designed with flexibility to allow policy recalibration based on international developments (e.g., MEPC meetings, COP decisions), market maturity, and evolving climate technologies.

Transition between implementation phases shall be guided by verified performance milestones rather than calendar timelines alone. Progression to subsequent phases shall be validated through MRV assessment to ensure that policy escalation reflects demonstrated readiness.

1.3.2.3 Governance Structure for NGMIP

To ensure integrated and accountable delivery of the NGSP, the following governance structure will anchor the NGMIP:

Table 2: Governance Structure for NGMIP

Level	Entity	Key Roles
Central Apex Body	**NGMCC** chaired by MoPSW	• Strategic oversight Inter-ministerial coordination (MoEFCC, MNRE, MoF, MSDE) Policy coherence with India's LT-LEDS and sectoral missions
Implementation Agency	**To be appointed by NGMCC**	• Technical implementation, monitoring support, training modules, MRV architecture, and innovation pilots
Finance Anchor	**Sagarmala Finance Corporation Ltd (SMFCL) and other maritime funding mechanisms**	• Fund mobilisation (green bonds, blended finance), ESG evaluation, project de-risking
Regulatory Arms	DG Shipping[17], Tariff Authority for Major Ports (TAMP), BIS	• Compliance monitoring, emission standards, performance-linked

[17] Under the proposed Merchant Shipping Bill, 2024, the government plans to rename the Director General of Shipping (DGS) to the Director General of Marine Administration (DGMA). This change is part of an effort to replace the Merchant Shipping Act, 1958, with a framework that better reflects the office's expanded duties in maritime affairs and port security. https://betadgs.dgshipping.gov.in/personnel-branch/personnel-branch-transition-of-dgs-to-dgma

Level	Entity	Key Roles
		incentives, certification frameworks
Digital Backbone	NLP-Marine[18], MAITRI app, and MRV	• Emission accounting, dashboard reporting, digital workflows
Port and State Nodes	Port authorities, State Maritime Boards	• Project execution, local monitoring, community engagement, workforce skilling
Stakeholder Advisory Platform	Green Maritime Partnership Forum (Industry–Academia–NGOs– International Financial Institutions)	• Feedback integration, innovation co-creation, peer benchmarking

The NGMCC shall retain final authority over NGMIP implementation coordination. All participating institutions operate within NGMCC-certified frameworks to avoid duplication and ensure unified delivery.

1.3.2.4 Monitoring, Reporting, and Verification (MRV)

A comprehensive MRV mechanism is essential for transparent delivery, mid-course correction, and international credibility. MRV compliance shall be a mandatory condition for certification status, funding eligibility, and participation in green incentive schemes. Persistent reporting failure or data falsification may trigger audit escalation and temporary suspension from programme benefits.

[18] https://nlpmarine.gov.in/

- **Digital Carbon Dashboard (NLP-Carbon proposed)**: Real-time emission tracking by port, ship type, and fuel cluster.

Operational Monitoring: NLP-Carbon Module within NLP-Marine

The proposed NLP-Carbon system shall function as a dedicated carbon accounting module integrated within the existing National Logistics Portal – Marine (NLP-Marine), rather than as a standalone platform. Its purpose is to provide a continuous, nationally standardized view of maritime emissions performance anchored to India's verified 2021 baseline.

All emissions and performance indicators tracked through NLP-Carbon shall be measured relative to the 2021 national maritime emissions baseline to ensure consistency across implementation cycles and prevent shifting benchmarks.

The NLP-Carbon module shall generate operational KPIs covering emissions intensity, fuel transition, infrastructure electrification, and reporting compliance. These indicators shall allow year-on-year comparison against the baseline and support both national aggregation and entity-level performance tracking (such as port specific, vessel specific, NW specific or coastal shipping specific etc.).

Integration of NLP-Carbon into NLP-Marine shall be implemented under the direction of the NGMCC. A designated working group which is part of NGMCC, shall be responsible for:

- system architecture and digital integration
- defining specific parameters
- verification workflows
- dashboard analytics
- cybersecurity and data governance
- interoperability with national climate reporting systems

Ports, vessel operators, and fuel suppliers shall submit standardized emissions and operational data through NLP-Marine. Working group members will decide and request for third-party verification wherever needed, before inclusion in national datasets.

The NGMCC shall remain the custodian of aggregated emissions data and shall use NLP-Carbon outputs as the primary operational monitoring tool for NGMIP implementation.

- **Annual Maritime Sustainability Report (AMSR)**: Mandatory reporting by all major ports and Indian-flagged shipping entities.

National Accountability: Annual Maritime Sustainability Report (AMSR)

The Annual Maritime Sustainability Report (AMSR) shall provide a verified national overview of maritime decarbonisation progress. It shall function as the primary public accountability document of NGSP implementation.

The report shall include:

- national emissions trajectory and sector breakdown
- port and fleet performance comparisons
- green finance deployment and investment impact
- workforce transition metrics
- compliance improvement trends
- corrective actions and policy adjustments

The AMSR shall be prepared by the NGMCC secretariat. The report shall be independently audited before publication.

The Annual Maritime Sustainability Report shall explicitly track progress against pillar-wise targets defined under the National Green Shipping Policy, and present them as measurable contributions toward the objectives of Maritime India Vision (MIV) 2030 and Maritime Amrit Kaal Vision (MAKV) 2047.

Each edition of the AMSR shall include a dedicated alignment matrix mapping NGSP pillar indicators to corresponding MIV 2030 and MAKV 2047 sustainability milestones. This ensures that maritime decarbonisation is reported not as a standalone environmental agenda, but as an integrated component of India's long-term maritime development strategy.

The AMSR shall be formally submitted to MOPSW leadership as an implementation reflection of national maritime vision targets, enabling strategic review and course correction at the policy level.

- **Green Compliance Index (GCI)**: A composite performance indicator used for eligibility for government incentives and green financing.

Green Compliance Index (GCI)

The Green Compliance Index (GCI) shall serve as the official performance rating system linking environmental performance to eligibility for incentives, concessional financing, and certification benefits under the NGSP. Participation in the GCI framework shall be mandatory for all entities seeking NGSP-linked financial or regulatory support.

The GCI shall evaluate verified performance across four categories:

- emissions reduction relative to the 2021 baseline
- infrastructure and clean energy readiness
- MRV reporting integrity and audit compliance
- transition and innovation efforts

Composite GCI scores shall determine access priority to funding windows, incentive schemes, and certification classifications.

The GCI framework shall be developed and operated by working groups under the NGMCC within twelve months of its establishment. This body shall calculate quarterly ratings using verified NLP-Marine/NLP-Carbon datasets. Independent audit panels accredited by the NGMCC shall review methodology and outputs.

Final certification of GCI ratings shall rest with the NGMCC. Financial institutions operating under NGSP programmes shall align eligibility filters with GCI tiers.

Annually GCI summaries shall be submitted to the MOPSW to guide funding allocation and policy recalibration.

The Green Port Performance Index (GPPI) shall constitute an integrated sub-component of the Green Compliance Index (GCI). Further, all relevant maritime environmental and efficiency assessment frameworks, including but not limited to the Green Fuel Index (GFI), Energy Efficiency Design Index (EEDI), Energy Efficiency Existing Ship Index (EEXI), Fuel Readiness Index, and other notified performance or compliance metrics, shall be comprehensively integrated within the GCI architecture to establish a unified national green maritime performance framework.

- **Alignment with Paris Article 6[19] and IMO GHG Metrics**: Emission data to feed into international offset and compliance mechanisms.

[19]Article 6 of the Paris Agreement enables countries to cooperate voluntarily on emission reductions. It includes: Article 6.2 – allowing transfer of carbon credits between countries; Article 6.4 – establishing a global carbon market mechanism supervised by the UN; and Article 6.8 – supporting

1.3.2.5 Stakeholder-Informed Design

The NGMIP design reflects key recommendations from the stakeholder inputs, including

- Sector-specific implementation cells in ports, aligned with MIV 2030 and MAKV 2047.
- Green procurement mandates across central port and shipping entities via MSMEs
- Dedicated budget head under MOPSW for pilot corridor execution.
- Integration of informal workers and MSMEs into the transition roadmap.
- Alignment with the India Maritime Investment Meet outcomes and International Financial Services Centre – Gujarat International Finance Tec-City (IFSC-GIFT) financing channels.
- Progressive alignment with global benchmarking

1.3.2.6 Stakeholder Alignment and Co-Ownership

The following mechanisms will ensure buy-in and co-ownership, based on extensive stakeholder feedback:

- **Annual National Green Shipping Dialogue**: A multi-stakeholder conference held during the India Maritime Week or other national maritime events to review implementation and foster partnerships.
- **Green Maritime Help Desk and Grievance Portal**, hosted on the DG Shipping Portal Dashboard, for feedback from stakeholders.

The National Green Maritime Implementation Plan (NGMIP) offers a clear, time-bound roadmap to translate the ambitions of NGSP into anchored, scalable action. Through phased targets, institutional accountability, and adaptive governance, the NGMIP aims to establish India not just as a compliant actor but as a leader in sustainable maritime development across the Indo-Pacific.

1.4 Emissions Baseline (2021) and SMART Decarbonisation Targets

1.4.1 National Emissions Baseline

1.4.1.1 Baseline Year and Principle

In keeping with the principle of C**ommon But Differentiated Responsibilities and Respective Capabilities (CBDR–RC)**, India shall adopt **calendar year 2021** as the **national emissions baseline** for the entire maritime sector—covering both **ship-sourced emissions** and **port/terminal operational emissions**. This year aligns with the post-COVID recovery phase, the formalisation of the **Maritime India Vision (MIV) 2030**, and the onset of India's modernisation and decarbonisation strategy.

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non-market approaches like finance, technology transfer, and capacity building without trading emissions.
World Bank. "What You Need to Know About Article 6 of the Paris Agreement." May 17, 2022. https://www.worldbank.org/en/news/feature/2022/05/17/what-you-need-to-know-about-article-6-of-the-paris-agreement.
Also See: United Nations Framework Convention on Climate Change (UNFCCC). "Article 6 of the Paris Agreement." Last updated September 1, 2023. https://unfccc.int/process-and-meetings/the-paris-agreement/article6.

The validated 2021 baseline shall be formally notified by MOPSW upon recommendation of the NGMCC and shall become the official reference benchmark for all NGMIP targets, MRV systems, and funding-linked performance evaluation. Once notified, the baseline shall be binding across all NGSP implementation instruments.

1.4.1.2 Six-Month Confirmation Study

Immediately after the formation of the **National Green Shipping Coordination Cell (NGMCC)**, a **six-month feasibility and confirmation study** will be undertaken to technically validate 2021 as the baseline year. This study will be **led by the Directorate General of Shipping (DGS)** and the **Shipping Corporation of India (SCI)**, with **other stakeholders appointed by MOPSW** (e.g., NCoEGPS, IWAI, IPA, IRS, major ports, OMCs, state maritime boards, and selected operators).

The study will:

1. Produce a **full carbon footprint of India's maritime sector for 2021**, disaggregated into:
    - **Shipping-side emissions:** All ship-sourced GHG emissions (tank-to-wake primary; well-to-wake where life cycle assessment (LCA) data is available).
    - **Port-side emissions:** Scope 1, 2, and 3 emissions from port estate operations, including cargo handling equipment, power generation, lighting, dredging, and administrative functions.
2. Establish **comparative baselines** for each category, enabling independent tracking of reductions in port and shipping domains.
3. Identify **coastal and inland waterway-specific considerations** (e.g., smaller vessel sizes, older fleets, access to compliant fuel, and terminals in eco-sensitive zones).

Please refer to Annexure 1 for the template of the carbon footprint assessment.

A. Scope and Applicability

Ships Covered:

- **International:** All ships ≥5,000 GT calling at Indian ports (cargo, passenger/cruise, and service/support vessels)—aligned with IMO DCS thresholds.[20]
- **Domestic/Coastal:** Indian-flagged vessels ≥400 GT in coastal, inter-island, and offshore service.[21]
- **Inland Waterways:** IWAI-regulated vessels ≥400 GT or equivalent displacement/installed power, with sampling and extrapolation for smaller craft.

Ports and Terminals Covered:

- All **major and non-major ports**, **inland waterway terminals**, and **cruise tourism terminals**, with special modules for:

[20] The Directorate General of Shipping (DGS) Circular No. 13 of 2018 specifically mandates that all Indian-flagged ships of 5,000 GT and above must comply with the IMO Data Collection System.
[21] Harit Nauka Guidelines: These guidelines specifically target the greening of smaller inland and coastal vessels, acknowledging that 400 GT is the "sweet spot" where engine technology for biofuels and battery-electric systems becomes commercially standardized.

- Mixed-use inland ports with combined cargo/passenger functions.
- Cruise terminals handling large passenger volumes in sensitive environments.

B. Methodology for 2021 Carbon Footprint

- **Shipping-side:** Derived from fuel consumption records, AIS-tracked voyage data, IMO DCS, EU MRV, PCS 1x/NLP-Marine, bunker delivery notes, and operator submissions.
- **Port-side:** Based on electricity consumption, fuel use in equipment, on-site generation (diesel, LNG, RE), dredging operations, and waste treatment plants.
- **Verification:** Third-party verification by **IRClass and DGS-approved agencies**.
- **Segmented Output:** Separate intensity metrics for cargo, passenger, coastal, and inland shipping, plus port estate operations.

C. Special Considerations

- Where 2021 data are incomplete, use **conservative default emission factors** and **AIS-derived activity models** to fill gaps, with sensitivities disclosed.
- Legacy vessels (>20 years) will be **segmented** and reported distinctly to inform retrofit/phase-out policies without biasing newer-fleet intensity metrics.
- **Fuel availability:** Compliant or low-carbon fuels may be difficult to access for remote coastal and inland regions; **Fuel Unavailability Report (FUR)** protocols will apply, with operational efficiency measures mandated for voyages with non-compliant fuels.
- **Mixed cargo-passenger operations:** Require tailored emission factor modelling, as seen in river cruise tourism circuits.
- **Eco-sensitive operations:** Certain inland waterways pass through protected zones; emissions and waste management reporting will include **environmental sensitivity mapping**.

D. Fuel Availability Contingencies

To safeguard operational continuity and commercial viability:

- A **Fuel Unavailability Report (FUR)** mechanism (akin to Fuel Oil Non-Availability Report (FONAR))[22] will be instituted by **DGS**. Where compliant/low-carbon fuel is not reasonably available, the master/operator shall file a FUR with evidence of procurement attempts and nearest-alternative bunkering options.
- FUR cases will be **logged, reviewed, and published** (aggregated) by NGMCC; ships will not be penalised for verified unavailability but may be required to implement

[22] "A Fuel Oil Non-Availability Report (FONAR) is to be sent to the flag Administration and to the competent authorities in the relevant port(s) of destination in accordance with regulation 18.2.4 of MARPOL Annex VI. The report should be used to provide evidence if a ship is unable to obtain fuel oil compliant with regulations 14.1 or 14.4 of MARPOL Annex VI, and should detail the attempts made to obtain compliant fuel, including local alternative sources."— IMO Resolution MEPC.320(74), Regulation 18.2 of MARPOL Annex VI.

operational efficiency measures (e.g., **Just-in-Time arrivals**, slow steaming, weather routing) for such voyage(s).

- Repeated or unjustified invocation of Fuel Unavailability Reports shall trigger technical review by the NGMCC and adversely affect compliance ratings under the GCI framework.

E. Review and Evolution

- The **2021 baseline year is fixed**; however, if the confirmation study finds >5% deviation due to data gaps, methodological refinements may be applied without altering the year.
- Periodic review every **3–5 years** to align with evolving IMO GHG guidelines, domestic MRV enhancements, and technology adoption.
- The framework will **evolve through feedback loSTS**, regulatory reforms, and technology deployment—balancing environmental ambition with **commercial viability** to keep India's maritime sector competitive.

1.4.2 SMART Decarbonisation Targets (up to 2070)

The NGSP establishes a sequenced, sector-specific decarbonisation pathway aligned with India's **net-zero commitment by 2070** and consistent with indicative checkpoints in 2030 and 2040 under the **IMO Revised GHG Strategy (2023)**.

The SMART decarbonisation targets defined below shall be operationalised exclusively through the National Green Maritime Implementation Plan (NGMIP), which serves as the execution framework of this policy.

Each target is defined in accordance with the SMART framework—**Specific, Measurable, Achievable, Realistic, and Time-bound**—and is categorised into short-term (up to 2030), medium-term (2030–2040), and long-term (2040–2070) implementation windows.

India's nationally declared net-zero target year is 2070. Accordingly, the long-term decarbonisation horizon of the maritime sector is aligned with 2070. While the IMO global ambition references 2050, India's implementation pathway is structured around the 2047 milestone under Maritime Amrit Kaal Vision (MAKV 2047), with NGMIP serving as the operational roadmap toward the broader 2070 national net-zero commitment.

Coverage and applicability:

- **Ships:** All **Indian-flagged** ships ≥400 GT (coastal and international) and **all foreign ships ≥5,000 GT** calling Indian ports. Priority segments: container, bulk, and tankers, plus **tugs, ferries, and barges** for retrofits.
- **Domestic Vessels:** means any ship, craft, barge, or floating structure, whether self-propelled or non-self-propelled, operating exclusively within the internal waters, territorial waters, or maritime zones of India and not engaged in an international voyage as defined under Regulation I/2 of the International Convention for the Safety of Life at Sea (SOLAS).
- **Ports:** All **major ports**; phased inclusion of **non-major/private ports** and **IWT terminals** (IWAI and SMBs).

- **Data principle:** Where 2021 activity/fuel data are incomplete, actions below prioritize **MRV deployment first**, then lock targets to the confirmed baseline values.
- Target recalibration shall be undertaken through biennial NGMCC-led NGMIP review cycles with stakeholder consultation and formally approved by MOPSW.

A. Short-Term Targets (up to 2030)

Focus: System Readiness, Baseline MRV, Demonstration Projects (Stand-up MRV, confirm 2021 baseline, unlock quick abatement (JIT, STS, onboard carbon capture etc.), kick-off fuels and retrofits, de-risk with finance.)

A1. MRV and Baseline

- **2021 carbon footprint (whole maritime sector)** compiled and published by **Q3-2026** (shipping + port Scopes 1–2, with guidance for Scope 3 where data available).
- **National Baseline (2021)**: As verified by third-party inspection agencies, the baseline data will be promulgated by MoPSW.

A2. JIT / Voyage efficiency (immediate, low-cost)

- **Just-in-Time (JIT) and Virtual Arrival** protocols operational at **all major ports by 2027**; **≥50% of ship calls** on JIT windows by **2028** (measured by % time-at-anchor reduction).[23]

A3. STS and port electrification

- **STS energized at ≥50% berths** at major container/cruise/O&G terminals by **2030** (starting with high-aux-load berths).[24]
- **Port equipment electrification**: **≥50%** of new Rubber-Tyred Gantry Cranes (RTGCs)/Rail Mounted Gantry (RMGs)/yard tractors electric or hybrid from 2030 tenders onward.[25]

[23] Although Just-in-Time (JIT) and Virtual Arrival protocols are not explicitly named in Maritime India Vision 2030 or Maritime Amrit Kaal Vision 2047, both documents mandate comprehensive port digitalisation, real-time vessel information systems, AI-based berth planning, and measurable reductions in vessel turnaround and waiting time well before 2030. These enablers constitute the full technical and institutional foundation required for JIT and Virtual Arrival implementation. Given that JIT is an operational reform requiring minimal capital investment, it is feasible to operationalise JIT and Virtual Arrival protocols at all Major Ports by 2027. A subsequent target of achieving JIT compliance for at least 50% of ship calls by 2028, measured through reductions in average time-at-anchor, reflects realistic uptake across liner and high-frequency services while allowing operational flexibility for irregular calls. Where ports are constrained by existing berth-allocation practices such as seniority-based or first-come-first-serve systems, JIT-aligned virtual arrival windows may be implemented as an overlay rather than a replacement, enabling optimisation of arrival times without altering statutory berth priority rules. Even under such procedural constraints, coordinated arrival management can materially reduce anchorage congestion, auxiliary engine idling, and associated emissions, thereby delivering immediate efficiency and environmental benefits while capital-intensive decarbonisation measures scale in the post-2030 period.

[24] See footnote:7

[25] Instituting a ≥50% electrification requirement for new port equipment tenders is justified by national government policy, with formal targets for over 50% electrification by 2030 and continued acceleration to 2047.

A4. Fuels and bunkering (safe, bankable starts)

- **10% low/zero-emission energy share** in **domestic maritime** by **2030** (indicative mix: **5–6% advanced biofuels**, **3–4% LNG/e-methanol pilots**, **battery-electric** for select IWT/coastal ferries).[26]
- Develop national **Fuel Safety Code** updates issued by **2028 based on IMO**-established **'low flashpoint** fuels—Mandatory IGF Code.'[27]
- **Fuel unavailability SOP:** Adopt the Fuel **Unavailability Report (FUR)** process nationally by **2026**, with **documented mitigation** (JIT speed, STS use, and routing to the nearest compliant supply).

A6. Green corridors and skills

- **International green corridors** (BIMSTEC/ASEAN) and **2 domestic coastal corridors** announced by **2027**, operational by **2029** (with JIT + STS + green bunkering).
- **Green Skills**: **≥10,000 personnel** trained by **2028** (STS, alternative fuels, JIT/VTS, battery safety, methanol/ammonia handling).[28]

A7. Finance and commercial viability

- The Maritime **Green Transition** Fund will be operational by **2026**; **₹-denominated green** bonds/Sustainability-linked bonds (SLBs) will be enabled for STS and retrofits; and standardized **MRV-linked KPIs** for lenders will be available by **2027**.
- **Port tariff incentives** (rebates for JIT adherence/STS usage) piloted at **≥4 major ports by 2027**.

Special notes (coastal/IWT):

- **Fully electric ferry corridors** (e.g., Kochi, Kolkata–Haldia, Guwahati, Varanasi) by **2029**; **shore charging** at corresponding terminals.
- By 2028, all newly constructed coastal and inland vessels ≥130 kW engine power shall meet NOx and SOx emission limits equivalent to MARPOL Annex VI Regulations 13

Also See: "Ports shall make efforts to achieve the target for Electrification of Vehicles/Ports equipments as envisaged in MIV 2030 / Blue Economy 2047 and accordingly, should target more than 50 percent electrification by the Year 2030 which is to be further increased to more than 90 percent by the year 2047." — Harit Sagar: Green Port Guidelines, Ministry of Ports, Shipping and Waterways, Government of India

[26] The 10% low/zero-emission energy share target aligns India's domestic maritime sector with the IMO 2023 GHG Strategy ambition of reaching 5–10% zero/near-zero fuels by 2030, while supporting India's net-zero 2070 trajectory and oil import reduction goals. Advanced biofuels provide immediate "drop-in" decarbonisation using domestic waste-based feedstocks, LNG/e-methanol pilots build early bunkering ecosystems already underway at Indian ports, and battery-electric ferries are technically proven for short IWT/coastal routes. Together, this mix enables early transition without disrupting commercial viability.

[27] The IMO IGF Code establishes mandatory global safety requirements for ships using low-flashpoint fuels, providing an internationally recognized framework for design, storage, and operational risk management. India's draft ethanol fuel standards (MoRTH) and the SIAM alternative fuel framework demonstrate that large-scale adoption of new fuels requires nationally codified safety protocols aligned with global benchmarks. Updating the national Fuel Safety Code by 2028 ensures safe scaling of LNG, methanol, hydrogen, and biofuels in shipping while maintaining regulatory harmonization with IMO practice. https://www.imo.org/en/mediacentre/pressbriefings/pages/01-igf.aspx#:~:text=The%20IGF%20Code%20addresses%20all,using%20this%20type%20of%20fuel.

[28] The 2028 timeline is strategic; it ensures that a "Minimum Viable Workforce" is ready two years before the 2030 IMO and National milestones, preventing a human-resource bottleneck during the peak of the transition.

and 14, through compliant engine certification, approved exhaust after-treatment systems, or verified equivalent national standards.[29]

B. Medium-Term Targets (2030–2040)

Focus: Scaling Infrastructure, Retrofit Programs, Technology Adoption (Lock-in operational gains, scale STS to full at major ports, accelerate retrofits/new build *standards, bring costs down via finance and domestic supply chains.)*

According to MARPOL Annex VI and specifically target of Nitrogen Oxides, which are major localized air pollutants **defines Tier II and Tier III Standards**

The "Tier" system limits emissions based on the engine's rated speed (measured in RPM).

Standard	Implementation	Limit (Approximate)	Technical Requirement
Tier II	Global standard since 2011	**~7.7 to 14.4 g/kWh**	Achieved through internal engine tuning (fuel injection timing, etc.).
Tier III	Mandatory in Emission Control Areas (ECAs)	**~2.0 to 3.4 g/kWh**	Requires **Active After-treatment** (like Selective Catalytic Reduction - SCR) or **Alternative Fuels** (LNG, Methanol).

What "Equivalent" Means: In an Indian policy context, "Tier III-equivalent" allows the government to mandate the same low-emission levels as the IMO standard while allowing for domestic flexibility in how that is achieved (e.g., via battery-electric propulsion or indigenous scrubbers).

B1. Fleet standards and operations

- **≥60% of all Indian-flag newbuilds (2030–2040)** to meet **'Green Ship – Intermediate'** (zero-emission-ready, lifecycle carbon thresholds, digital performance monitoring).
- **Mandatory JIT/Virtual Arrival across all major ports** with **≥90% calls** on JIT windows by **2035**; **average time at anchor reduced ≥50% compared to 2021**.
- **Mandatory weather routing/speed optimisation** for **Indian-flag ≥5,000 GT** by **2032**; demonstrate **≥10% voyage fuel reduction** vs. 2021 baselines on comparable routes.

B2. Ports and STS

- **STS at** 90% of **berths of major ports by 2035**; ≥75% of **berths at non-major ports by 2040**.[30]

[29] Aligning new coastal and inland vessels with Annex VI–equivalent NOx and SOx limits ensures that India's domestic fleet does not lag behind global engine emission standards, even where IMO jurisdiction is not mandatory.
https://www.marpoltraininginstitute.com/MMSKOREAN/MARPOL/Annex_VI/index.htm

[30] Maritime India Vision 2030 identifies shore-to-ship (STS) power as a key intervention for reducing at-berth emissions and quantifies its decarbonisation potential, while DGS Circular 09/2025 and Harit Sagar Guidelines define a phased, vessel-segment–led rollout extending from port crafts (2023) to coastal vessels (2025) and EXIM/foreign vessels by 2030. In parallel, Maritime Amrit Kaal Vision 2047 establishes the long-term pathway toward fully electrified, carbon-neutral ports.
Within this framework, deployment of STS power across ~50% of major port berths by 2030 represents a practical and policy-aligned milestone, prioritizing high-traffic, OPS-compatible berths to maximize

- **Port Scope 1–2 intensity** (tCO_2e per tonne handled): **–35% vs confirmed 2021 baseline by 2035**[31]
- **≥60% RE share** in port electricity by **2032**.[32]

B3. Retrofits and segment focus

- **Retrofit ≥50% of economically feasible coastal/IWT vessels by 2038**, prioritising **tugs,** ferries, and **barges** (hybrid/battery/biofuel/e-methanol kits).
- **Shore-side equipment**: **≥80% cargo-handling equipment** electric/hybrid from 2040 tenders.[33]

B4. Fuels and bunkering

- **≥30% low/zero-emission energy share** across **domestic maritime** by **2040** (incl. **10–15% e-methanol/advanced biofuels**, early **ammonia pilots** for deep-sea; **≥25%** of IWT passenger km electric).
- **National Gateway Terminals** (5 ports) certified **ammonia-ready** by **2036**, with full safety and emergency systems, tested and tried.[34]

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utilization and emissions abatement while accounting for constraints such as grid capacity, capex intensity, and vessel readiness identified through stakeholder consultations. Based on established per-call emission reduction benchmarks, such deployment can deliver on the order of ~0.5 million tonnes of CO_2 abatement annually.
Subsequent scale-up to ~90% coverage at major ports by 2035 aligns infrastructure build-out with asset lifecycles and policy timelines, enabling near-complete elimination of at-berth fossil fuel combustion and supporting the transition to fully carbon-neutral port operations by 2047.

[31] Maritime India Vision 2030 establishes port renewable energy and emissions-intensity objectives (see Initiative 9.1 and Exhibit 9.8), and Maritime Amrit Kaal Vision 2047 sets the strategic technology and investment pathway for post-2030 decarbonisation. Building on these documents, the Directorate proposes a national port intensity target of **–35% Scope-1+2 carbon intensity (tCO_2e per tonne handled) by 2035, relative to the confirmed 2021 baseline**, subject to the MRV, financing and phased implementation framework described below. Delivery will rely on (i) achieving MIV 2030 RE and efficiency KPIs by 2030, (ii) scaling STS and equipment electrification in 2030–33, and (iii) completing targeted fuel-switch and optimisation measures by 2035.

[32] Maritime India Vision 2030, under Initiative 9.1, prescribes a phased increase in renewable energy usage at major ports culminating in more than 60% renewable electricity by 2030. Maritime Amrit Kaal Vision 2047 further establishes port electrification, shore-to-ship power deployment, and carbon-neutral port operations as core long-term objectives. In this context, achieving at least 60% renewable energy share in port electricity by 2032 represents a risk-adjusted and operationally feasible implementation milestone aligned with the documented 2030 ambition. This timeline accommodates infrastructure development, grid integration, and storage deployment while ensuring that port electrification and shore power measures yield genuine emissions reductions. The 2032 milestone therefore operationalises MIV 2030's renewable energy target and supports MAKV 2047's net-zero transition pathway.

[33] Maritime India Vision 2030, under Section 9.3.3 and Initiative 9.5, mandates a two-phased electrification programme for port material-handling equipment, targeting more than 50% electrification by 2030 and requiring ports to mandate electrical equipment as replacements for future purchases to achieve full electrification over the subsequent decade. Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral ports and large-scale electrification of port operations. In this context, specifying that at least 80% of cargo-handling equipment procured through tenders issued from 2040 onward shall be electric or hybrid represents a natural implementation milestone aligned with the documented electrification pathway.

[34] The Harit Sagar – Green Port Guidelines (2023) mandate the establishment of Green Ammonia bunkers and refueling facilities at all Major Ports by 2035 (Annexure-D, EPI No. 10). The Guidelines further require environmental monitoring, baseline GHG studies, emergency response systems, and real-time environmental performance tracking. In this context, certifying five National Gateway

B5. Certification and green ports

- **All Indian Ports to be reviewed under GPPI by 2035.**
- **Zero-Emission Port Zones (ZEPZ)** at 10 ports by **2038** (STS-only berths, zero-emission yard equipment, JIT compliance, and zero/near-zero-emission landside access).

B6. Finance and markets

- Mobilise a minimum ₹50,000 crore in blended finance by 2035 through the Maritime Green Transition Fund (MGTF), NIIF platforms, and IFSC-GIFT capital markets to support shore power (STS), vessel retrofits, and alternative fuel bunkering infrastructure.
- **NLP-carbon and** the GCI framework will be **implemented** in national regulation by **2030**.

The ₹50,000+ crore blended finance target is consistent with transition capital signalled under MAKV 2047, including the ₹25,000 crore Maritime Development Fund corpus, the ₹50,000 crore renewable infrastructure investment target for coastal and inland fleets, and the ₹69,725 crore shipbuilding support package that includes green modernization components. These allocations are designed to act as public seed capital with a 3–4× private multiplier through NIIF and IFSC-GIFT platforms. Mobilising finance at this scale is necessary to de-risk early maritime decarbonisation infrastructure such as STS, retrofits, and clean fuel bunkering.

C. Long-Term Targets (2040–2070)

Focus: System-Wide Decarbonisation and Net-Zero Transition (Green ship newbuilds, green corridors system-wide, ZEZ on main cargo/coastal routes, full fuel transition, durable finance and market integration.)

C1. Newbuilds and fleet turnover

- **100% of new builds delivered post-2045** are **zero-emission capable** (fuel-flex for green ammonia/methanol/hydrogen; lifecycle carbon thresholds (GFI)[35] aligned with global standards).[36]

Terminals as ammonia-ready by 2036, with fully validated safety and emergency management systems, represents a structured implementation of the 2035 infrastructure mandate. This approach enables controlled deployment at high-capacity ports, ensures compliance with Environmental Performance Indicators, and operationalizes the ERC (Eliminate–Reduce–Control) framework prescribed under the Guidelines, while allowing one-year post-infrastructure completion for safety validation, emergency drills, and commissioning audits.

[35] The GHG Fuel Intensity (GFI) is a metric that represents the amount of carbon dioxide (CO_2) equivalent emitted per unit of energy (measured in grams of CO_2 equivalent per megajoule) from marine fuels used by ships. The IMO has set progressive GFI limits, and ships are expected to stay within these limits or face compliance costs. Fuels such as green hydrogen, ammonia, and methanol typically have much lower GFI values, making them attractive under the new regime. https://betadgs.dgshipping.gov.in/download/1758280343_68cd3a97bd74b_20250430070105182899 0merchantshippingnotice4of2025-final.pdf

[36] Requiring all new vessels delivered after 2045 to be zero-emission capable prevents carbon lock-in in assets that will remain operational until 2065–2070, directly aligning fleet turnover with India's Net Zero 2070 pathway and MAKV 2047 carbon-neutral maritime ambition. The mandate mirrors the IMO 2023 GHG Strategy trajectory toward near-zero lifecycle fuel intensity by 2050, ensuring Indian vessels remain commercially viable in global trade. Fuel-flex capability future-proofs ship

- **Last diesel-only new build for public procurement** no later than **2040** (policy signal retained for industry planning.)[37]

C2. Net-zero outcome and zones

- **Sectoral net-zero by 2070**; publish **5-yearly** carbon budgets starting **2040:**
    - Scope 1–2 for ports
    - Scope 1–2 for Indian-flag shipping
- **Zero-Emission Zones (ZEZ)** across **all major cargo and coastal corridors by 2070** (JIT compliance, STS-only at berths, zero-emission last-mile at ports).

C3. Full fuel transition and infrastructure

- **100% transition to low-emission/green fuels in national maritime operations by 2070**; grid-integrated STS nationwide; green hydrogen/ammonia/methanol supply chains matured with Indian manufacturing content.
- **IWT/coastal passenger**: **near-total electrification or other alternate fuel means** adoption by **2047**.

C4. Markets and disclosure

- **Indian fleet MRV integrated with global carbon markets/MBMs by 2040** (subject to equity safeguards)

Cross-cutting guardrails

- **Commercial viability first:** Every mandate pairs with a **finance lever** (tariff rebates, CAPEX support, SLBs, and tax depreciation) and a domestic supply chain **plan** (skills, standards, and safety).
- **Fuel unavailability and safety:** National **FUR**, alternative compliance measures (speed/JIT/STS), updated **bunkering and emergency standards** (methanol/ammonia/hydrogen).
- **Equity and CBDR-RC:** Phased obligations for MSMEs/IWT with **longer glide paths** and **higher grant shares**; technology-neutral pathways.
- **Data to decisions:** Targets ratchet through **biennial NGMCC reviews**, using MRV outcomes and feasibility studies to adjust pace, not purpose.

investments against technology uncertainty while supporting India's National Green Hydrogen Mission and long-term energy security.

[37]Maritime India Vision 2030 establishes a procurement-led transition framework for electrification and emissions reduction within the port ecosystem, while Maritime Amrit Kaal Vision 2047 commits to carbon-neutral port operations and large-scale adoption of alternative marine fuels. Given the typical 20–25 year operational lifespan of publicly procured vessels, continuation of diesel-only newbuild procurement beyond 2040 would extend fossil fuel operations well past the 2047 carbon-neutral milestone. Accordingly, setting 2040 as the final year for diesel-only public procurement aligns vessel lifecycle planning with the decarbonisation trajectory envisaged under MAKV 2047, reinforces the procurement-transition logic embedded in MIV 2030, and provides industry with long-term investment clarity without imposing premature technology lock-in.

Chapter 2: Green Shipping

Working Definition for the Indian Maritime Context

In alignment with international best practices and tailored to India's technological, regulatory, and operational landscape, a **green ship** in the Indian context is being defined as:

"A ship that integrates advanced technologies, low- or zero-emission energy systems, and operational best practices to reduce emissions, fuel consumption, and environmental pollution. The ship shall be compliant with applicable national and international regulatory standards and shall contribute toward India's maritime decarbonization goals. It includes retrofitted ships and newbuilds operating **on low emission/green fuels/green technologies."**

2.1 Rationale

India's **Green Ship** definition under the NGSP is designed to provide clarity, attract investment, and align domestic practices with global decarbonization standards. The policy aims to:

- **Promote investment** in the design, construction, and retrofit of low- and zero-emission vessels under the **Make in India**, **Sagarmala**, and **Maritime India Vision (MIV) 2030** programmes.
- **Guide regulatory recognition** through a **National Green Ship Certification Framework** that is harmonized with global standards, enabling acceptance by flag and port states, and providing approvals/surveys by classification societies.
- **Encourage phased fleet transition** in line with India's **Nationally Determined Contributions (NDCs)** and the **IMO 2023 GHG Strategy** target of net-zero GHG emissions from international shipping by 2050.
- **Enable access to Green Finance** from national and international sources, including **Sustainability-Linked Loans (SLLs)**, **green bonds**, and **multilateral climate funds**.

Incorporating the GFI (GHG Fuel Intensity) Index

To provide a measurable and transparent benchmark for green vessel classification, NGSP incorporate the **GFI Index**[1] — a measure of the total GHG emissions intensity of a ship's fuel use, expressed in **grams of CO_2-equivalent per megajoule (g CO_2e/MJ) of energy generated by combustion of a particular type of fuel**.

How does the two-tier GFI compliance mechanism work?[1]

Ships are evaluated annually (calendar year) based on their GFI performance against a reference trajectory. Those exceeding the intensity limit must buy Remedial Units priced at:

- Tier 1: USD 100 per tonne of CO_2 equivalent for mild non-compliance
- Tier 2: USD 380 per tonne of CO_2 equivalent for significant non-compliance.

Ships that perform better than required can generate Surplus Units, which are tradable or eligible for rewards under the IMO incentive scheme.

Beyond Propulsion: Operational Efficiency Measures

Green shipping under NGSP goes beyond propulsion technologies and includes:

- **Just-In-Time (JIT) arrivals** to reduce idling emissions at anchorages.
- **Weather routing** for optimal fuel consumption.
- **Digital performance monitoring** via platforms such as **NLP-Marine** and port community systems.
- **Lifecycle GHG accounting**, including construction, operation, and end-of-life phases.

By combining **design, fuel, and operational benchmarks**, the NGSP will ensure that India's green shipping transition is **credible, bankable, and globally recognized**.

India's merchant fleet (~1,530 vessels in 2023)[38] is at a critical inflection point. The **Maritime India Vision (MIV) 2030**[39] and **Maritime Amrit Kaal Vision (MAKV) 2047**[40] both acknowledge the need for large-scale retrofitting and new construction of ships with green measures. However, they need a comprehensive vessel-level decarbonization strategy and to identify priority technologies or compliance trajectories. The NGSP addresses this gap

[38] Ministry of Ports, Shipping and Waterways, *Annual Report 2023–24* (New Delhi: Government of India, 2024), https://shipmin.gov.in/publication/annual-reports.
[39] Ministry of Ports, Shipping and Waterways, *Maritime India Vision 2030* (New Delhi: Government of India, 2021), https://shipmin.gov.in/sites/default/files/MIV_2030_report.pdf.
[40] Ministry of Ports, Shipping and Waterways, *Maritime Amrit Kaal Vision 2047* (New Delhi: Government of India, 2023), https://shipmin.gov.in/sites/default/files/MAKV_2047_Report.pdf.

through a structured framework encompassing certification, propulsion, fuel transition, operational efficiency, and MRV mechanisms.

2.2 Strategic Context: What's at Stake?

- **Indian Flagged Fleet** (2023)[41]: ~1,530 vessels, including bulk carriers, container ships, coastal vessels, tugs, and IWT barges.
- **Global Regulatory Trends**: IMO's **GFS (GHG Fuel Standard)**[42] proposal—co-developed by India and Singapore—is expected to introduce **tiered GHG fuel thresholds**, gradually restricting high-emission fuels.
- **Fuel Cost Exposure**[43]: Under new market-based measures (MBMs) adopted globally, India's logistics and international shipping costs are projected to increase by an estimated 5–8% by 2030. However, these costs may be offset by the development of domestic green fuel capabilities and retrofitting opportunities for Indian vessels.
- **Shipbuilding and Repair Infrastructure**:[44] India hosts **28 shipyards** (public and private), yet **fewer than 15%** are engaged in large-scale commercial newbuilds or advanced retrofits. Current decarbonisation efforts in the maritime sector often focus solely on the operational phase of vessels, overlooking the **10–30% of total lifecycle greenhouse gas (GHG) emissions** that occur during **construction**.

To address this risk of **"carbon leakage"**—where operational emission reductions are offset by carbon-intensive shipbuilding methods, potentially outsourced abroad—**India's Green Shipbuilding Strategy** must explicitly account for **embedded carbon** in new vessels and major retrofits. This includes:

- **Raw Material Production:** Emissions from steelmaking for the hull and structure, prioritising green steel (electric arc furnaces, hydrogen reduction).
- **Material Transport:** GHG from moving steel sections to shipyards.
- **Manufacturing:** Energy/fuel use in cutting, blasting, welding, and fabrication.
- **Equipment Production:** Embedded emissions in propulsion, navigation, and auxiliary systems manufactured by OEMs.

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[41] Ministry of Ports, Shipping and Waterways, *Annual Report 2023–24* (New Delhi: Government of India, 2024), https://shipmin.gov.in/publication/annual-reports.
[42] International Maritime Organization. "IMO Approves Net-Zero Regulations for Global Shipping." Press release, April 11, 2025. https://www.imo.org/en/mediacentre/pressbriefings/pages/imo-approves-netzero-regulations.aspx.
[43] Rau's IAS Editorial Team, "IMO's Net Zero Framework for Global Shipping Industry," *Rau's IAS*, May 15, 2025, https://compass.rauias.com/current-affairs/imos-net-zero-framework-global-shipping-industry/.
Also See: Ministry of Ports, Shipping and Waterways, *Maritime India Vision 2030*, Government of India,
2021, https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/Maritime%20India%20vision%202030.pdf.
[44] Ministry of Ports, Shipping and Waterways. *Maritime Amrit Kaal Vision 2047*. New Delhi: Government of India, 2024. https://shipmin.gov.in/sites/default/files/MAKV_2047_Report.pdf.
Also See: and Information System for Developing Countries. "Shipbuilding Financial Assistance Policy 2025: A Maritime Imperative." RIS, May 15, 2025. https://www.ris.org.in/en/node/4155.

- **Equipment Transport:** Logistics emissions from moving equipment to shipyards.
- **Assembly and Sea Trials:** On-site construction, outfitting, painting, testing, and commissioning activities.

Existing Efforts and Opportunities

India has launched several foundational programs:

- **The proposed Harit Nauka Scheme** encourages the use of battery-electric and hybrid propulsion on inland waterways.
- **The Shipbuilding Financial Assistance Scheme (SBFAS)** and the **Shipbuilding Development Scheme (SbDS)**[45] The **Shipbuilding Financial Assistance Scheme (SBFAS)** constitutes a total outlay of **₹24,736 crore**, aimed at supporting domestic shipyards through graded financial assistance ranging from **15% to 25% of vessel cost**, depending on vessel category and value. The scheme includes an **extension of ₹20,554 crore**, along with **₹4,001 crore** for a shipbreaking credit note mechanism and **₹181 crore** for the establishment of a National Shipbuilding Mission.

  Under this framework, financial support is linked to vessel type (non-specialized and specialized) and incentivizes higher domestic value addition through a structured domestic content requirement. Additionally, the shipbreaking credit note provides **40% of the scrap value** as a reimbursable credit toward the construction of new vessels at Indian shipyards, thereby promoting circularity and domestic demand.

- **Just-in-Time (JIT) berthing pilots** and **weather routing platforms** are being tested at Jawaharlal Nehru Port and VOCPA for operational decarbonization.

2.3 Focus Areas

1. Green Ship Certification and Compliance (for Indian flagged and domestic vessels)
   - Establish a National Green Ship Certification Framework, aligned with global benchmarks (EEDI, EEXI, CII)[46].

- **NGMCC** oversees certification and appoint working group members to design and formulate thresholds, and reviews; **DGS** administers compliance. **Classification Society** certifies; **BIS/BEE** maintains factors and handbooks.
- Penalties escalate from corrective action plans to **tender ineligibility** for repeat non-compliance; **bonus tariff** rebates are for outperformers at major ports.
- DGS will be tasked with formulating retrofitting guidelines and emission thresholds for existing ships across segments (cargo, cruise, and coastal) that will also be a sub-part of the **National Green Ship Certification Framework**.
- Compliance with the **provisions of the Merchant Shipping Bill, 2025**[47]—including environmental and sustainability obligations—should be operationalized through integration with **vessel registry updates**. The **proposed Green Shipping Pillar**

[45] https://shipmin.gov.in/en/orders/guideline
[46] Rules on ship carbon intensity and rating system enter into force, https://www.imo.org/en/mediacentre/pressbriefings/pages/cii-and-eexi-entry-into-force.aspx
[47] The Gazette of India, The Merchant Shipping Act, 2025 https://www.dgshipping.gov.in/writereaddata/News/20250825121208872545 3MerchantShippingAct,205.pdf

Working Group would be responsible for coordinating this linkage, ensuring that green compliance parameters such as emissions limits, alternative fuel readiness, and shore-to-ship power compatibility are incorporated into statutory registration, certification, and survey processes.

- Compliance to registry upgrades, incentives under SBFAS, and eligibility for green finance through GCI should be assured by the working group

Tiered Compliance Thresholds – GFI/GFS Model for India

Objective

- To set **progressively tightening limits** on the carbon intensity of marine fuels used in India, expressed in **gCO_2e/MJ**.
- To align domestic shipping with **IMO mid-term measures**, the **EU FuelEU Maritime Regulation**, and emerging **Asia-Pacific green corridor standards**.
- To provide **clarity for shipowners, ports, fuel suppliers, and financiers** on what qualifies as "green" at each stage.
- This framework will be **overseen and periodically reviewed by the National Green Shipping Coordination Cell (NGMCC)**.

1. **Technology Pathways and Propulsion Systems**[48]
   - Promote hybrid-electric, dual-fuel (methanol, biofuels), ammonia, and hydrogen propulsion for new builds and eligible retrofits.
   - Prioritize modular, fuel-flexible platforms in ferry, barge, and short-sea shipping segments.
   - Promote onboard carbon capture and storage technology[49]
   - Pilot **wind-assisted propulsion** and **air lubrication** technologies.[50]
2. **Shipbuilding and Ship Repair Modernization**
   - **Prioritize Green Shipbuilding Clusters** in Andhra Pradesh, Odisha, Gujarat, Maharashtra, and Tamil Nadu, explicitly designed as green innovation hubs to promote carbon-neutral shipbuilding, eco-friendly marine engineering, and adoption of efficient and sustainable technologies in shipyards.[51]

[48] LAUNCH OVER 20 PILOT PROJECTS UNDER INDIA'S GREEN MARITIME SHIPPING PROGRAMME, MAKV 2047
[49] Steam Methane Reforming (SMR) for blue hydrogen and Carbon Capture and Storage (CCS), MAKV 2047

[50] Exhibit 5.10: Key elements of ship design and vessel R&D segments, MIV 2030
[51] India's Green Maritime Odyssey, 15 Dec 2025 11:21AM by PIB Delhi Press Release:Press Information Bureau
See Also: Ministry of Ports, Shipping and Waterways. *Maritime India Vision 2030*. New Delhi: Government of India,

- **Develop strong marine design ecosystem** including green design standards by 2027.[52]
- Develop **modular repair stations** along National Waterways for green tugs and ferries.[53]

3. Operational Optimization and Fuel Efficiency

- Promote JIT arrival, speed optimization, and voyage planning protocols under NLP-Marine[54].
- Institutionalize:
  - Hull maintenance cycles are linked to fuel efficiency baselines.
  - Dynamic trim optimization and slow steaming guidance.
  - Digital twin-based route planning in partnership with NTCPWC and IRS.
- Integrate onboard fuel monitoring systems (FMS) into NLP-Marine or another similar platforms.
- Real-time GHG intensity monitoring by DGS for major Indian-flagged fleets and same data to be uploaded on NLP-Carbon

4. Zero-Emission Zones (ZEZs)[55]

- Identify and designate high-traffic coastal and inland waterways (e.g., Ghogha-Hazira, Varanasi-Haldia) as Zero-Emission Zones (ZEZs).
- Mandate for zero-emission vessels (battery-electric, hydrogen) for government ferry services by 2030.

5. Maritime Clusters and Knowledge Hubs

- Establish green shipping clusters in coastal states, preferably in **Cochin**, **Kolkata**, and **Gujarat**[56].
- Anchor each cluster with R&D centres (e.g., IMU, NTCPWC, NCoEGPS) and incentivize academia–industry–start-up collaboration[57].

2021. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/Maritime%20India%20vision%202030.pdf.
Also See: Infrastructure Development In Shipbuilding Clusters, PIB Delhi, Ministry of Ports, Shipping and Waterways, Government of India, 01 April 2025
https://www.pib.gov.in/PressReleasePage.aspx?PRID=2117250

[52] Initiative 5.4: Develop strong marine design ecosystem by identifying design clusters and incentivizing for 'Design in India, MIV 2030,
[53] DEVELOP SHIP REPAIR CLUSTERS AND SPECIALIZED REPAIR SHOPS, MAKV 2047
[54] Initiative 3.1: Implement National Logistics Portal (NLP)-Marine to enable single integrated platform for EXIM stakeholders, MIV 2030
[55] Designating high-traffic coastal and inland waterways as Zero-Emission Zones (ZEZs) and mandating zero-emission government ferries by 2030 directly advance MIV 2030's clean fuel transition and inland waterway sustainability goals, while operationalizing Harit Sagar's emission reduction framework. The proposal also aligns with MAKV 2047's long-term vision of green maritime leadership and hydrogen-based decarbonisation, positioning India's waterways as future-ready, low-carbon transport corridors.
[56] Enhance Efficiency through technology & innovation, MAKV 2047
[57] Exhibit 10.3: Key research thrust areas to be prioritized by proposed knowledge cluster, MIV 2030

6. Global Benchmarks and Adaptation

- Emulate **Norway's Green Shipping Programme**[58], which uses tiered targets, co-financing, and performance-linked retrofitting.
- Engage with Denmark, the **Maersk Mc-Kinney Møller Centre**[59] and **Global Centre for Maritime Decarbonisation**[60] to accelerate hydrogen and methanol pathways.

7. Fleet Modernization and Investment Planning

- Adapt Korean initiatives under the "Green Ship-K"[61] roadmap, including:
    - Green Technology Verification Systems,
    - Public-private co-financing of low-emission ferries and cargo vessels,
    - Maritime decarbonization R&D alliances.
- Partner with classification societies and testing labs to standardize Life-Cycle Emissions Reporting (LCER).
- Participate in IMO's pilot for fuel lifecycle GHG validation [62] under the GHG Fuel Standard (GFS) by 2027.
- Implement **Green Retrofitting Guidelines** under SBFAS and provide risk-sharing finance for emission control systems.

8. Material-Efficiency and Low-Carbon Design Standards

- **In accordance with class structural rules Material-efficiency targets** to be set for newbuilds (e.g., steel intensity per dwt) to increase the cargo carrying capacity.
- **Design for Disassembly/Reuse** (DfD/R) requirements for selected systems to enable future retrofits and recycling.

Proposed Implementation Plan for Material-efficiency targets:

- Rules and class: **Classification rules to issue** Green Design Notations **incorporating material-efficiency KPIs to be treated as compliance pathways.**
- Digital Tool: **NTCPWC-IIT Madras, Cochin Shipyard R&D, GRSE, and academia to develop** toolkits **and** digital twins **for structural optimisation.**

9. Sustainable Maritime Procurement and Lifecycle Carbon Accounting[63]

All public maritime procurement shall progressively integrate lifecycle carbon performance as a formal evaluation parameter. From 2027 onward, a minimum 20% weighted preference

[58] https://greenshippingprogramme.com/
[59] https://www.zerocarbonshipping.com/
[60] https://www.gcformd.org/
[61] Ministry of Oceans and Fisheries, Republic of Korea. *National Action Plan: Toward Green Shipping by 2050*.2023. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/NAP/R.O.K%20National%20Action%20Plan%20-%20Toward%20Green%20Shipping%20by%202050.pdf.
Also See: Ministry of Oceans and Fisheries, Republic of Korea. "2030 Greenship-K Promotion Strategy." December 23, 2020. https://www.mof.go.kr/index.do?menuSeq=1588.
[62] International Maritime Organization. "Fuel Life Cycle GHG Analysis for Maritime Fuels." https://www.imo.org/en/OurWork/Environment/Pages/Life-Cycle-GHG-Analysis.aspx
[63] PUBLIC PROCUREMENT POLICY FOR VESSELS TO INCLUDE REQUIREMENTS FOR LOW EMISSION SOLUTIONS, MAKV 2047

shall be applied in PSU-funded vessel tenders for verified low-embedded-carbon vessels and shipbuilding inputs, rising to 30–40% by FY2030.

All Indian-flag newbuilds and major retrofits ≥400 GT commissioned under public orders shall disclose lifecycle carbon footprints in accordance with ISO 14067 and recognized Environmental Product Declarations (EPDs).

This framework is designed to align maritime procurement with India's Green Credit Rules, the Carbon Credit Trading Scheme (MoEFCC), and evolving IMO lifecycle assessment standards, while catalysing domestic markets for green steel, low-carbon equipment, and energy-efficient shipyards.

Operational oversight for Green Public Procurement and lifecycle carbon accounting shall be assigned to the Green Finance Working Group under the NGMCC, which will coordinate standards, procurement integration, verification standards, and carbon market linkage across ministries and PSUs.

10. Upstream Innovation: Green Steel, Clean Power, Low-Carbon Fabrication

- **Recognise** green steel **(EAF with high scrap share, or DRI-H_2) via BIS standard; allow** tariff/score premiums **in GPP and private projects.**
- **Target** ≥60% renewable electricity **in shipyard operations by FY30;** 90% by FY35 **(own solar/wind + open access).**
- **Require** low-carbon fabrication **practices for yards above a turnover threshold: automated welding, high-efficiency cutting through CNC, fumes extraction with heat** recovery by leak proof enclosures, and **low-VOC paints.**

Proposed Implementation Plan:

- Performance Linked Incentives (PLIs) and CCfDs: **Extend/align** PLI-Steel **(or create a maritime window) and pilot** Carbon Contracts for Difference **for green-steel offtake to yards.**
- Capex support: **8-10%** capital subsidy **or interest subvention for automation and energy-efficiency upgrades (MoPSW + DHI + SIDBI).**
- Power: **MNRE to fast-track** open access RE **for ports/yards; enable** group captive **with ports as anchor loads.**

2.4 Inland Waterways, Coastal and Cruise Tourism Shipping

A. Inland Waterways Transport (IWT)

1. Fuel and Propulsion Prioritisation

- Mandate a *battery-electric-first* approach for short-route ferries (<50 km) and hybrid-electric for longer routes.

- Introduce **hydrogen derived fuel vessels** for shallow waterways by 2028.[64]
- Encourage retrofits of existing diesel-powered barges with LNG–biofuel dual fuel kits as a transitional measure.

2. **Operational Efficiency**

- Integrate **river condition, depth forecasting systems, air draft and water draft** into voyage planning.
- Develop **modular repair and charging stations** along National Waterways to support green ferries and tugs.

3. **Emission Zones**

    - Identify *priority zero-emission corridors* (e.g., Varanasi–Haldia stretch, Ghogha–Hazira RoPax) with mandatory low/no-emission vessels by 2030.

4. **MRV Adjustments**

    - Use **gCO_2e/tonne-nm** as the primary cargo metric and **gCO_2e/passenger-nm** for ferries.
    - Require data logbooks adapted to smaller vessels with seasonal operational variability.

B. Cruise Ships

1. **Fuel and Energy Systems**

    - Mandatory shore power connection capability (STS) at all major Indian cruise terminals by 2030.
    - Require **hybrid propulsion** (LNG + battery, methanol-ready) for all new cruise vessels operating in Indian waters from 2028 onwards.
    - Incentivise installation of **waste heat recovery systems** and **advanced wastewater treatment** on all Indian-flagged cruise vessels.

2. **Operational and Passenger-Focused Metrics**

    - Adopt **gCO_2e/passenger-nm** as the key MRV metric.
    - Require real-time passenger occupancy reporting linked to emission intensity dashboards.

[64] Introducing hydrogen derived fuel vessels for shallow waterways by 2028 is a strategic step aligned with both the **Harit Nauka Scheme's inland waterway decarbonization targets** and India's **National Green Hydrogen Mission**. The Shipping Corporation of India's plan to retrofit two vessels to operate on green hydrogen or hydrogen-derived fuels by 2027 highlights early adoption of clean fuel technology in maritime sectors.
The Harit Nauka scheme mandates progressive carbon intensity reductions—30% by 2030 and 70% by 2047—and the transition of 50% of inland passenger fleets to green fuels by 2033, moving to 100% by 2045. Hydrogen fuel cells, with their zero-emission operation and suitability for shallow inland waterways, provide a promising solution to meet these timelines.
Pilot vessels operational by 2028 will enable critical validation of hydrogen technology, catalyze infrastructure development for green fuel refueling (targeted for establishment by 2030 under Harit Nauka), and support knowledge exchange among states, directly contributing to the scheme's goal of greening at least 1,000 inland vessels within the next decade and full fleet decarbonization by 2047.

3. **Regulatory Hooks**
    - Include cruise-specific retrofitting guidelines under SBFAS.
    - Apply **stricter CO2, SOx, NOx, PM, CFCs, TBTs and VOCs norms**[65] for cruise vessels operating in designated heritage or ecologically sensitive areas (e.g., Lakshadweep, Andaman).

C. Coastal Shipping

1. **Fuel Transition**
    - Mandate at least **10% green fuel blending** (bio-LNG, bio-methanol) for all coastal vessels above 400 GT by 2030.
    - Prioritise wind-assisted propulsion pilots on short-sea coastal bulk carriers.
2. **Operational Optimisation**
    - Introduce **slow steaming incentive schemes** for voyages under 500 nautical miles.
3. **Infrastructure Support**
    - Develop **coastal green bunkering hubs** at Kandla, Kochi, Chennai, and Paradip with multi-fuel capability.
    - Provide shore to ship (STS) facilities for RoPax and coastal passenger ferries at high-traffic ports.
4. **MRV Specifics**
    - Track **cargo emission intensity** (gCO_2e/tonne-nm)
    - Track **port turnaround emissions** for frequent-calling coastal vessels.

2.5 Implementation Roadmap

The Green Shipping pillar shall be implemented through a phased roadmap aligned with the National Green Maritime Implementation Plan. Short-term actions prioritise certification, MRV readiness for digital tools, and pilot deployment. Medium-term actions to enhance infrastructure and fleet transformation. Long-term actions will complete lifecycle decarbonisation consistent with India's 2070 net-zero commitment.

All certification, funding eligibility, and compliance evaluation shall operate through verified MRV and GCI frameworks under NGMCC oversight.

[65] IMO norms, Annex VI- Regulations for the Prevention of Air Pollution from Ships, https://www.marpoltraininginstitute.com/MMSKOREAN/MARPOL/Annex_VI/index.htm

Table 3: Implementation Roadmap for Green Shipping

Phase	Timeline	Focus Objective	Detailed Actions	Responsible Bodies
Short Term	Up to 2030	System readiness, certification rollout, pilots, regulatory foundation	• Launch National Green Ship Certification Framework (tiers + thresholds) • Integrate MRV and GFI accounting into NLP-Marine • Update SBFAS to support green retrofits and propulsion • Pilot hybrid-electric ferries, battery tugs, methanol vessels • Declare pilot Zero Emission Zones (ZEZ) • Mandate Green Public Procurement for PSU vessels • Deploy Just-in-Time arrival and fuel monitoring protocols • Begin STS rollout at priority berths • Develop lifecycle carbon standards (BIS LCA Code)	NGMCC (oversight), DGS (compliance), IRS (certification) MoPSW SMBs and Ports IWAI BIS/BEE NCoEGPS SMFCL
Medium Term	2030–2040	Scaling infrastructure and fleet transformation	• Mandatory green certification for all new builds • Large-scale retrofit programmes for domestic vessels, ferries, coastal vessels • National multi-fuel bunkering hubs (methanol/ammonia/biofuel)	MoPSW, MNRE, DGS, Major Ports and SMBs, NCoEGPS, BIS, SMFCL, Shipyards and Private operators

Phase	Timeline	Focus Objective	Detailed Actions	Responsible Bodies
			• Embedded carbon disclosure mandatory ≥400 GT • Expand STS to majority of major port berths • Shipyard decarbonisation (renewable electricity + low-carbon fabrication) • Expand Zero Emission Zones to high-traffic corridors • Scale up domestic green shipbuilding supply chains • Procurement of materials with Carbon embedded accounting • National GCI-linked financing becomes standard	
Long Term	2040–2070	Complete lifecycle decarbonisation and net-zero fleet ecosystem	• All new built vessels should incorporate available zero emission technologies • Identify and develop Zero Emission Zone network • STS coverage at Indian coast • Bunkering, storage, handling and transport readiness for hydrogen/methanol/a	NGMCC (national oversight), DGS, Ports, Industry ecosystem

Phase	Timeline	Focus Objective	Detailed Actions	Responsible Bodies
			mmonia supply and value chains • Carbon market integration for shipping • Net-zero Scope 1–2 maritime operations	

Chapter 3: Green Ports

Working Definition for the Indian Maritime Context

Based on international best practices and national priorities, a **Green Port in India** is being defined as

"A maritime gateway that systematically integrates environmentally sustainable practices across operations, infrastructure, and governance. It seeks to minimize emissions and pollution, maximize energy and resource efficiency, preserve ecosystems—atmospheric and aquatic—and contribute to the socio-economic well-being of surrounding communities, while aligning with global decarbonization goals, India's Nationally Determined Contributions (NDCs), and national environmental frameworks such as the *Harit Sagar* guidelines."

3.1 Rationale

The inclusion of a formal definition of **Green Ports** is critical to:

- Anchoring regulatory reforms under Panchamrit Goals[66], Maritime Amrit Kaal Vision 2047, Harit Sagar Guidelines, and Maritime India Vision 2030.
- Supporting the development of a Green Port Index for benchmarking and certification.
- Enabling alignment with IMO conventions and guidelines, MARPOL Annex VI, and the SDG framework (especially SDG 9, 11, 13, and 14).
- Establishing eligibility for green finance, public investment, and ESG-linked incentives.

Green ports are not simply eco-efficient infrastructures—they represent a systematic, **systems-level transformation** of port ecosystems through low-emission operations, clean energy transition, digitalization, and circular economy integration. With international best practices as reference and local realities in view, India's ports are well-positioned to emerge as regional leaders in sustainable maritime infrastructure.

The **NGSP** unifies India's green port efforts through a comprehensive national framework that enforces minimum emission standards, encourages digital tracking and auditing, promotes circularity, and enables scalable adoption of global best practices. This pillar builds on India's existing policies (e.g., *Sagarmala*, *Harit Sagar*, *MIV 2030*, etc.) and stakeholder inputs, which brought to the fore gaps in regulatory harmonization, skill readiness, and funding access.

3.2 Strategic Context and Focus Areas

1. Regulatory Alignment and Green Certification

[66] https://www.pib.gov.in/PressReleasePage.aspx?PRID=1795071&reg=3&lang=2

- Promoting a **Green Port Performance Index** (GPPI) with benchmarks covering GHG emissions, waste recycling, renewable energy share, carbon capture infrastructure, and ecosystem impact.[67]
- Mandate integration with international standards such as **ISO 14001 (Environmental Management)** and **ISO 50001 (Energy Management)**, along with voluntary compliance to **EcoPorts** or **World Ports Sustainability Program** indicators.
- Include a port-level **Fuel Readiness Index into GPPI** to assess and disclose infrastructure readiness for alternative fuels (LNG, methanol, ethanol, ammonia, hydrogen, renewable LPG, and blended biofuels).

2. Emission Standards and Shore to Ship Power Supply (STS)

- Implement phased **shore-to-ship power** at **50% of berths by 2030**, targeting a reduction of **500,000 tonnes** of **CO_2 annually**, with 90% coverage at major ports by 2040.[68]
- Enforce **emission limits** on cargo handling equipment, dredging operations, and vessels at berth, aligned with the **National Action Plan on Climate Change (NAPCC)**, the **International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI**, and evolving IMO GHG regulations.[69]
- Develop port guidelines for **low-emission dredging technologies** and electric/hybrid equipment.[70]

3. Environmental Monitoring and Reporting Systems

- Phase in **Internet of Things (IoT) and Geographic Information System (GIS)-enabled monitoring systems** for emissions, ambient air quality, water quality, and

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[67] https://green-port-shipping.org/gallery/teri_doc_img/10285257Green_Ports_Performance_Index__GPPI__2025_2.pdf

[68] See Footnote:31

[69] Maritime India Vision 2030 positions emissions reduction, port equipment electrification, and shore-to-ship power as core pillars of India's green maritime transition. Maritime Amrit Kaal Vision 2047 advances this framework through commitments to carbon-neutral ports, lifecycle GHG accounting, and alignment with evolving IMO regulations. Enforcing emission limits on cargo-handling equipment, dredging operations, and vessels at berth is therefore a necessary regulatory mechanism to operationalize these commitments. Such limits ensure measurable compliance with MARPOL Annex VI, strengthen preparedness for IMO lifecycle fuel-intensity regimes, and align port-level controls with national climate objectives under the NAPCC. Without enforceable emission standards and monitoring, the decarbonisation pathway envisaged under MIV 2030 and MAKV 2047 cannot be credibly realized.

[70] Maritime India Vision 2030, under Section 9.3.3 and Initiative 9.5 (pp. 230–231), mandates a phased electrification programme for port material-handling equipment and requires ports to prioritize electric replacements for future procurements. Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral ports and establishes sustainability toolkits and KPI-based monitoring frameworks (Technology & Infrastructure section, pp. 26–31; regulatory effectiveness sections, pp. 260–263). In this context, developing formal port guidelines for low-emission dredging technologies and electric or hybrid equipment is necessary to operationalize these commitments. Such guidelines provide standardized technical criteria, emission benchmarks, and compliance mechanisms essential for reducing Scope 1 emissions from heavy port operations and aligning infrastructure development with the decarbonisation pathway envisaged under MIV 2030 and MAKV 2047.

waste discharges—with an initial focus on high-traffic major ports before scaling nationwide.[71]

- Conduct of periodic (annual) **environmental audits**, verified by third parties, with summary results disclosed on the **Swachh Sagar Portal**.[72]
- **Continuous emissions monitoring systems** (CEMS) are to be installed for ships at berth and critical port areas.[73]
- Seaweeds and Seagrass serve as low-cost natural bio-indicators for ecological monitoring, acting as carbon monitors and water-quality sensors. Unlike artificial monitoring systems alone, seaweed ecosystems provide continuous ecological feedback on coastal health a function essential for green maritime governance.
- The monitoring capabilities of seaweeds allow them to detect anomalies such as nutrient enrichment (eutrophication), heavy metal contamination, oil and hydrocarbon pollution, salinity and temperature variability, and ocean acidification trends.

4. Sustainable Infrastructure and Green Building Codes

- Enforce **green building standards** across all new and upgraded port terminals, including the use of **low-carbon concrete, smart HVAC, daylighting systems, and LED retrofits**.[74]

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[71] Maritime India Vision 2030 establishes KPI-based environmental targets and a comprehensive digitalisation roadmap for smart port operations (pp. 120–140; Chapter 9, pp. 228–244). Maritime Amrit Kaal Vision 2047 further mandates integrated KPI dashboards, technology-enabled regulatory oversight, and alignment with evolving IMO emissions frameworks (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). In this context, phased deployment of IoT- and GIS-enabled monitoring systems for emissions, ambient air quality, water quality, and waste discharges represents a necessary implementation mechanism. Initial prioritisation of high-traffic major ports ensures maximum environmental impact and aligns with the phased digital transformation model envisaged under MIV 2030 and MAKV 2047, while enabling scalable nationwide adoption.

[72] Maritime India Vision 2030 establishes measurable environmental KPIs, including emissions intensity reduction, renewable energy adoption, and electrification of port operations (Chapter 9, pp. 228–244; Section 9.3.3, pp. 230–231). Maritime Amrit Kaal Vision 2047 further mandates KPI dashboards, regulatory effectiveness, and digital performance monitoring aligned with IMO environmental standards (Regulatory Effectiveness sections, pp. 260–263; Technology & Infrastructure, pp. 26–31). In this context, requiring annual third-party environmental audits, with summary disclosures on the Swachh Sagar Portal, provides the necessary Monitoring, Reporting, and Verification (MRV) mechanism to ensure credible compliance, enhance transparency, and operationalize the decarbonisation trajectory envisaged under MIV 2030 and MAKV 2047.

[73] Maritime India Vision 2030 establishes measurable emissions reduction targets and promotes shore-to-ship power and digitalised port management systems (Chapter 9, pp. 228–244; Digitalisation sections, pp. 120–140). Maritime Amrit Kaal Vision 2047 further strengthens regulatory effectiveness through KPI dashboards, digital oversight mechanisms, and alignment with evolving IMO environmental frameworks (Regulatory Effectiveness sections, pp. 260–263; Technology & Infrastructure, pp. 26–31). In this context, piloting Continuous Emissions Monitoring Systems (CEMS) for ships at berth and critical port areas represents a data-driven implementation mechanism to validate emission reductions and enhance compliance monitoring. A phased pilot approach, subject to feasibility assessment of cost-effectiveness and data reliability, aligns with the staged technology adoption model envisaged under MIV 2030 and MAKV 2047 and supports India's preparedness for lifecycle GHG and MARPOL compliance regimes.

[74] Maritime India Vision 2030 establishes measurable emissions reduction targets, renewable energy adoption, and energy-efficient port operations under Chapter 9 (pp. 228–244), supported by electrification and smart infrastructure initiatives (Section 9.3.3, pp. 230–231; Digitalisation roadmap, pp. 120–140). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral port ecosystems and KPI-based environmental governance (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). In this context, enforcing green building standards for new and upgraded port terminals—

- Adopt **eco-dredging** methods and biodiversity-safe port design, including **artificial reefs, mangrove buffers, and sediment control systems**.[75]
- Incorporate **nature-based solutions** in coastal protection and port landscaping.[76]
- Strategically integrating nature-based solutions, such as seagrass meadows, seaweed farms, saltmarshes, mangroves, and coral reefs into maritime zones/ports and transport corridors creates vital biological infrastructure. These systems support low-carbon maritime development and climate-resilient ports; for instance, seagrass can sequester carbon up to 35 times faster than tropical rainforests (Reference 1). Hence, these ecosystem-based approach is essential for sustainable coastal construction and long-term maritime management.

5. Waste and Water Circularity Systems

- Mandate **MARPOL-compliant waste reception facilities** for oily waste, ballast water, noxious liquid substances, sewage, garbage, and cargo residues, along with **sediment control**, **stormwater management,** and **oil–water separation systems**.[77]

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including low-carbon construction materials, smart HVAC systems, daylighting design, and LED retrofits—provides a necessary infrastructure-level mechanism to reduce embodied and operational emissions, enhance energy efficiency, and align long-term capital investments with the decarbonisation pathway envisaged under MIV 2030 and MAKV 2047.

[75] Maritime India Vision 2030 establishes sustainable and environmentally responsible port development as a core objective under Chapter 9 (pp. 228–244), emphasizing emissions reduction and integration of environmental safeguards into infrastructure expansion. Maritime Amrit Kaal Vision 2047 further strengthens this mandate through sustainability assessment frameworks, KPI-based environmental governance, and commitments to carbon-neutral and climate-resilient port ecosystems (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). In this context, adopting eco-dredging methods and biodiversity-safe port design—including artificial reefs, mangrove buffers, and sediment control systems—provides a necessary mechanism to minimize ecological disruption, enhance carbon sequestration, and align port expansion with long-term environmental resilience goals envisioned under MIV 2030 and MAKV 2047.

[76] Maritime India Vision 2030 establishes environmental sustainability and integration of ecological safeguards as central to port expansion under Chapter 9 (pp. 228–244) and infrastructure modernization initiatives (pp. 150–180). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral and climate-resilient port ecosystems supported by sustainability assessment frameworks and KPI-based environmental governance (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). In this context, encouraging nature-based solutions in coastal protection and port landscaping—including mangrove buffers, bio-shielding, and green infrastructure—provides a low-carbon, climate-adaptive mechanism to enhance coastal resilience, improve biodiversity, and support long-term environmental performance consistent with the decarbonisation pathway envisioned under MIV 2030 and MAKV 2047.

[77] The Harit Sagar – Green Port Guidelines explicitly require ports to ensure compliance with MARPOL Annex I, IV, and V through adequate waste reception facilities and environmental monitoring systems (Section 4.9, pp. 11–13; Sections 4.12 and 5.1–5.4, pp. 16–20). Maritime India Vision 2030 further establishes environmental sustainability and alignment with international conventions as core objectives under Chapter 9 (pp. 228–244). Maritime Amrit Kaal Vision 2047 strengthens regulatory effectiveness, KPI-based environmental governance, and alignment with evolving IMO frameworks (Regulatory Effectiveness sections, pp. 260–263; Technology & Infrastructure, pp. 26–31). In this context, mandating MARPOL-compliant waste reception facilities for oily waste, sewage, garbage, and cargo residues—along with stormwater management and oil–water separation systems—is essential to operationalize international compliance, safeguard marine ecosystems, and support the carbon-neutral and sustainable port pathway envisaged under MIV 2030 and MAKV 2047.

- Promote **closed-loop water reuse** and enforce the **5R framework** (Refuse, Reduce, Reuse, Repurpose, Recycle) as codified in the Harit **Sagar Guidelines**.[78]
- Integrate **carbon dioxide reception facilities** to store or channel CO_2 captured onboard ships into domestic industrial use (e.g., enhanced oil recovery, food processing, or chemical feedstocks).[79]

6. Renewable Energy Transition

- Incentivize large-scale deployment of **solar PV, floating solar, wind, and hybrid renewable systems** through **viability gap funding, green bonds, and priority clearances**.[80]
- Require a **minimum 60% renewable energy share in port operations by 2030**, scaling to **100% for major ports by 2047**.[81]
- Deploy **battery energy storage systems (BESS)** for grid stability and STS integration.[82]

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[78] The Harit Sagar – Green Port Guidelines explicitly codify the 5R framework (Section 4.7, pp. 9–10) and mandate effluent discharge management and environmental monitoring systems (Section 4.9, pp. 11–13; Sections 4.12 and 5.1–5.4, pp. 16–20). Maritime India Vision 2030 establishes sustainable port operations and environmental footprint reduction under Chapter 9 (pp. 228–244) and infrastructure modernization initiatives (pp. 150–180). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral, resource-efficient port ecosystems supported by KPI-based environmental governance (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). In this context, promoting closed-loop water reuse and enforcing the 5R framework operationalizes circular resource management, reduces freshwater dependency and effluent discharge, and strengthens the sustainability trajectory envisaged under Harit Sagar, MIV 2030, and MAKV 2047.

[79] Maritime India Vision 2030 establishes emissions reduction and adoption of advanced decarbonisation technologies as central objectives under Chapter 9 (pp. 228–244) and promotes future-ready port infrastructure (pp. 150–180). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral port ecosystems and lifecycle GHG accounting aligned with evolving IMO frameworks (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines reinforce environmental monitoring and decarbonisation-oriented infrastructure development (Sections 4.12 and 5.1–5.4, pp. 16–20). In this context, integrating CO_2 reception facilities at ports to manage carbon captured onboard ships provides the necessary infrastructure to operationalize lifecycle emission reductions, prevent atmospheric release, and enable productive industrial utilization, thereby supporting the decarbonisation trajectory envisaged under MIV 2030, MAKV 2047, and Harit Sagar.

[80] Maritime India Vision 2030 establishes phased renewable energy targets for ports and positions energy transition as central to reducing CO_2 emission intensity (Chapter 9, pp. 228–244), supported by electrification initiatives under Section 9.3.3 (pp. 230–231). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral port ecosystems and integration of renewable energy within port infrastructure (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines reinforce renewable energy adoption through Environmental Performance Indicators and green infrastructure mandates (Section 4.16 / Annexure-D; Section 4.5, pp. 14–15). In this context, incentivizing large-scale deployment of solar PV, floating solar, wind, and hybrid renewable systems through viability gap funding, green bonds, and priority clearances is essential to mobilize capital, accelerate deployment, and operationalize the decarbonisation trajectory envisaged under MIV 2030, MAKV 2047, and Harit Sagar.

[81] Maritime India Vision 2030 establishes phased renewable energy adoption and emissions intensity reduction targets under Chapter 9 (pp. 228–244), supported by electrification initiatives under Section 9.3.3 (pp. 230–231). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral port ecosystems and integration of renewable energy within port infrastructure (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines reinforce renewable energy adoption through Environmental Performance Indicators and electrification mandates (Section 4.16 / Annexure-D; Section 4.5, pp. 14–15). In this context, mandating a minimum 60% renewable energy share in port operations by 2030, scaling to 100% for major ports by 2047, provides a measurable and structurally necessary pathway to eliminate Scope 2 emissions, support electrification, and operationalize the decarbonisation trajectory envisaged under MIV 2030, MAKV 2047, and Harit Sagar.

[82] Maritime India Vision 2030 establishes renewable energy adoption and electrification of port operations as core elements of its decarbonisation strategy under Chapter 9 (pp. 228–244) and Section 9.3.3 (pp. 230–

- Assess the potential zone of renewable energy sources, such as tidal and salinity gradient energy, within maritime zones to power port operations.

7. Digitalization and Smart Port Systems

- Deploy **AI-driven port optimization**, **digital twins** for terminal planning, and **smart logistics platforms** (Port Community System (PCS 1x), NLP-Marine) to cut turnaround times and energy wastage.[83]
- Undertake **predictive maintenance** of port assets using IoT sensors to reduce downtime and operational emissions.[84]
- Maximize inclusion of Just in Time Arrival (JIT) of ships subject to feasibility.[85]

8. Public-Private and International Collaborations

- Facilitate **PPP models** for STS, LNG/methanol/hydrogen bunkering, and carbon capture infrastructure.[86]

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231), supported by smart digital infrastructure (pp. 120–140). Maritime Amrit Kaal Vision 2047 further commits to carbon-neutral port ecosystems through integration of renewable energy, storage, and smart grids (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines promote phased shore-to-ship power deployment and renewable energy performance monitoring (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, deployment of Battery Energy Storage Systems (BESS) is essential to stabilize renewable integration, manage peak loads associated with shore power, reduce reliance on fossil backup generation, and ensure reliable grid operations, thereby operationalizing the decarbonisation trajectory envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

[83] Maritime India Vision 2030 emphasizes digital transformation of port operations through the Port Community System and real-time performance monitoring (pp. 120–140), alongside emissions reduction and electrification under Chapter 9 (pp. 228–244). Maritime Amrit Kaal Vision 2047 advances this trajectory through smart infrastructure integration, digital KPI dashboards, and technology-enabled regulatory oversight (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines reinforce operational efficiency and performance monitoring through electrification and environmental performance indicators (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, deploying AI-driven port optimization, digital twins for terminal planning, and smart logistics platforms such as PCS 1x and NLP-Marine provides a systemic mechanism to reduce turnaround times, minimize energy wastage, and operationalize the decarbonisation pathway envisaged under MIV 2030, MAKV 2047, and Harit Sagar.

[84] *Maritime India Vision 2030 promotes smart port digitalisation and real-time data systems (pp. 120–140) alongside emissions reduction and electrification under Chapter 9 (pp. 228–244) and Section 9.3.3 (pp. 230–231). Maritime Amrit Kaal Vision 2047 advances this approach through smart infrastructure integration, KPI-based governance, and carbon-neutral port commitments (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines mandate environmental monitoring and continuous performance improvement (Sections 4.12 and 5.1–5.4, pp. 16–20; Section 4.5, pp. 14–15). In this context, enabling predictive maintenance of port assets through IoT sensors provides a data-driven mechanism to reduce downtime, optimize energy efficiency, prevent emission leakage, and support the decarbonisation pathway envisioned under MIV 2030, MAKV 2047, and Harit Sagar.*

[85] https://greenvoyage2050.imo.org/just-in-time-arrivals/

[86] Maritime India Vision 2030 promotes infrastructure modernization and private sector participation through PPP frameworks (pp. 150–180) and establishes emissions reduction and green technology adoption under Chapter 9 (pp. 228–244). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and green fuel transitions, including hydrogen and methanol infrastructure (Technology & Infrastructure, pp. 26–31), supported by KPI-based regulatory oversight (pp. 260–263). The Harit Sagar Guidelines reinforce phased shore-to-ship power deployment and environmental performance monitoring (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, facilitating PPP models for STS, LNG/methanol/hydrogen bunkering, and carbon capture infrastructure provides a financially viable and implementation-ready mechanism to accelerate decarbonisation, mobilize private capital, and operationalize the sustainability pathway envisaged under MIV 2030, MAKV 2047, and Harit Sagar.

- Align with global programs such as **IMO GreenVoyage2050**, **ASEAN Smart Logistics Network**, and **Clean Energy Marine Hubs (CEM-Hubs)**.[87]
- Participate in **green shipping corridors** with strategic trade partners such Global Maritime Forum (GMF) and the Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping.[88]

9. Port-Level Targets, Skills and Community Integration

- Set **annual GHG reduction targets** for each port based on cargo mix, operational scale, and location, and report them in the Annual Maritime Sustainability Report. [89]
- Create and publicly disclose a **Fuel Readiness Index** for each port.[90]
- Establish **green skills training** for maritime sector professionals in partnership with IMU, IITs, SCGJ, NCoEGPS, and global maritime academies for electric cranes, STS, waste systems, and digital tools.[91]

[87] https://greenvoyage2050.imo.org/ ; https://asean.org/ ; https://www.cleanenergyministerial.org/initiatives-campaigns/hubs/

[88] Maritime India Vision 2030 establishes emissions reduction and sustainable maritime leadership under Chapter 9 (pp. 228–244) and promotes global competitiveness through infrastructure modernization (pp. 150–180). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and green fuel transition pathways (Technology & Infrastructure, pp. 26–31) supported by regulatory alignment with evolving IMO GHG frameworks (pp. 260–263). The Harit Sagar Guidelines reinforce shore-to-ship electrification and environmental performance monitoring (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, participating in green shipping corridors with strategic trade partners provides a coordinated mechanism to scale alternative fuel adoption, extend emissions reduction beyond port limits, strengthen international alignment, and operationalize the decarbonisation trajectory envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

[89] Maritime India Vision 2030 establishes measurable emissions intensity reduction and sustainability KPIs under Chapter 9 (pp. 228–244), supported by digital performance monitoring systems (pp. 120–140). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and KPI-based environmental governance (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines codify Environmental Performance Indicators and mandate environmental monitoring and reporting (Section 4.16 / Annexure-D; Sections 4.12 and 5.1–5.4, pp. 16–20). In this context, establishing annual port-specific GHG reduction targets based on cargo mix, operational scale, and location—accompanied by transparent sustainability reporting—provides a structured, measurable pathway to operationalize decarbonisation commitments under MIV 2030, MAKV 2047, and Harit Sagar.

[90] Maritime India Vision 2030 establishes emissions reduction and green infrastructure modernization under Chapter 9 (pp. 228–244) and promotes future-ready port development integrated with global trade networks (pp. 150–180). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and green fuel transition pathways, including hydrogen and methanol infrastructure integration (Technology & Infrastructure, pp. 26–31), supported by KPI-based regulatory oversight (pp. 260–263). In this context, creating and publicly disclosing a Fuel Readiness Index for each port provides a transparent, measurable mechanism to assess alternative fuel infrastructure preparedness, support investment planning, align with evolving IMO regulations, and operationalize the decarbonisation trajectory envisioned under MIV 2030 and MAKV 2047.

[91] Maritime India Vision 2030 promotes electrification, shore-to-ship power, and renewable integration under Chapter 9 (pp. 228–244) and emphasizes maritime education and industry-academia collaboration for emerging technologies (pp. 200–220). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and smart infrastructure transformation (Technology & Infrastructure, pp. 26–31), supported by institutional strengthening and KPI-based governance (pp. 260–263). The Harit Sagar Guidelines mandate environmental monitoring, waste management systems, and shore power deployment (Sections 4.12 and 5.1–5.4, pp. 16–20; Section 4.5, pp. 14–15). In this context, establishing green skills training partnerships with IMU, IITs, SCGJ, and global maritime academies provides the necessary human capital foundation to safely operate electrified equipment, implement STS systems, manage environmental compliance, and operationalize the decarbonisation trajectory envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

- Engage coastal communities through **CSR contributions of** the **maritime sector and allied industries for green livelihood programs, ecotourism integration, and participatory environmental planning**.[92]

10. Readiness for Future Technologies

- Identify and designate specific **nuclear-ready berths or port zones** for safe reception of **nuclear-powered merchant ships**, in compliance with evolving **IMO-IAEA, National Guidelines**, **and Safety Recommendations** for nuclear propulsion systems and small modular reactors (SMR).
- Ensure workforce and infrastructure preparedness for emerging technologies like **autonomous shipping**, **offshore wind servicing**, and **ocean-based carbon removal platforms**.
- **Ports as Green Fuel Aggregators:** The role of major ports (Kandla, Tuticorin, and Paradip) not just as bunkering points but as **'Strategic Fuel Aggregators'**.

3.3 Terminals: Cruise Tourism, Coastal and Inland Waterways

While the Green Port framework primarily addresses major and intermediate seaports, India's **coastal terminals**, **inland waterway terminals**, and **cruise tourism terminals** require **context-specific greening strategies** that reflect their operational profiles, geographic requirements, and passenger-centric services. These facilities are integral to the **Maritime India Vision (MIV) 2030**, **MAKV 2047**, **Harit Sagar Guidelines**, and India's **National Inland Waterways Development Plan**.

Green Coastal and Inland Waterways Terminals (GIWT)

The IWAI and State Maritime Boards will be responsible for developing the mentioned priorities, under the oversight and periodic review of the National Green Maritime Coordination Cell (NGMCC)/MoPSW.

Priority Areas:

- **Low-Emission Vessel Integration**
    - Encourage a shift from diesel-powered ferries and cargo vessels to **battery-electric, hybrid, CNG, or green hydrogen-fuelled vessels** for inland and coastal transport.
- **Onshore Renewable Energy Systems**

[92] Maritime India Vision 2030 promotes sustainable and inclusive port development under Chapter 9 (pp. 228–244) and emphasizes port-led coastal economic integration (pp. 150–180). Maritime Amrit Kaal Vision 2047 advances carbon-neutral and resilient port ecosystems through integrated environmental governance and institutional strengthening (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines mandate environmental management systems and codify resource sustainability through the 5R framework (Sections 4.12 and 5.1–5.4, pp. 16–20; Section 4.7, pp. 9–10). In this context, engaging coastal communities through CSR-led green livelihood programs, ecotourism integration, and participatory environmental planning aligns port development with environmental stewardship, strengthens social legitimacy, and operationalizes the sustainability pathway envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

  - Install ground-mounted/**floating solar plants**, rooftop PV, or small-scale wind turbines at terminals to power operations, lighting, and STS for vessels.
  - Integrate **battery storage** and **batteries-as-a-service** for energy resilience.
- **Sustainable Terminal Infrastructure**
  - Adapt **green building codes** for passenger terminals with natural ventilation, rainwater harvesting, and LED systems.[93]
  - Use **low-carbon materials** in shipyards, workshops, warehouses, jetties, offshore platforms, floating drydocks, wet basins, pontoons, and storage facilities.
- **Waste and Water Management**
  - Adapt **MARPOL Annex-compliant reception facilities** for sewage and bilge water from inland vessels.[94]
  - Implement **oil–water separators** and prevent any type of discharge into fresh and seawater ecosystems.
- **Digital Operations and Smart Scheduling**
  - Introduce **GPS and AIS tracking** for all domestic vessel movements to minimize idle time and improve efficiency.
  - Develop integrated **passenger and cargo terminal management systems** for effective multi-modal connectivity.
- **Biodiversity Protection**
  - Mandate avoidance of routing through notified marine protected areas.
  - Enforce **speed restrictions** and **propeller guards** in eco-sensitive zones to protect riverine and coastal fauna.
  - Develop **mangrove restoration** and **riparian buffer zones** around terminals.

Implementation Steps

- **Short-term (2025–2027):**
  - Baseline assessment of emissions, waste, and energy use at all operational IWAI and coastal terminals.

[93] https://www.grihaindia.org/files/Manual_VolI.pdf

[94] Maritime India Vision 2030 establishes pollution prevention and alignment with international environmental standards under Chapter 9 (pp. 228–244) and promotes modernization of port infrastructure consistent with global norms (pp. 150–180). Maritime Amrit Kaal Vision 2047 advances environmentally responsible port ecosystems and strengthened regulatory oversight aligned with IMO frameworks (Technology & Infrastructure, pp. 26–31; Regulatory Effectiveness sections, pp. 260–263). The Harit Sagar Guidelines mandate MARPOL-compliant waste reception facilities and effluent discharge controls (Section 4.9, pp. 11–13) supported by environmental monitoring and reporting requirements (Sections 4.12 and 5.1–5.4, pp. 16–20). In this context, promoting MARPOL Annex-compliant reception facilities for sewage and bilge water from inland vessels ensures pollution prevention, regulatory compliance, ecosystem protection, and operationalization of the sustainability objectives envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

  - Pilot 3–5 **fully electric ferry corridors** (e.g., Kolkata–Haldia, Kochi waterways, Varanasi–Dibrugarh, etc.).[95]

- **Medium-term (2027–2035):**
  - Deploy STS at 50% of high-traffic IWT terminals.[96]
  - Achieve a 50% renewable energy share in operations.[97]
- **Long-term (2035–2047):**
  - 100% renewable-powered and zero-emission fleet for inland/coastal terminals.[98]
  - Fully digitized monitoring, reporting, and verification (MRV) for emissions and operational efficiency.

Green Cruise Tourism Terminals (GCTT)

A dedicated **Cruise Tourism Green Transition Committee** (CTGTC) will be established under the Ministry of Ports, Shipping and Waterways (MOPSW) to oversee the development and implementation of green priorities for cruise tourism terminals. The CTGTC will include representatives from the Directorate General of Shipping (DGS), the Indian Ports Association (IPA), State Tourism Departments, the Inland Waterways Authority of India (IWAI), the National Centre of Excellence in Green Ports and Shipping (NCoEGPS), the Indian Maritime

[95] Maritime India Vision 2030 establishes emissions reduction and electrification under Chapter 9 (pp. 228–244) and promotes modernization of coastal and passenger connectivity infrastructure (pp. 150–180). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and integration of electric and renewable-powered maritime systems (Technology & Infrastructure, pp. 26–31), supported by KPI-based governance (pp. 260–263). The Harit Sagar Guidelines reinforce electrification and environmental performance monitoring through shore-to-ship power and emissions indicators (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, piloting 3–5 fully electric ferry corridors provide a scalable demonstration of vessel electrification, reduces operational emissions, strengthens renewable integration, and operationalizes the decarbonisation trajectory envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

[96] Maritime India Vision 2030 establishes phased Shore-to-Ship power rollout and electrification under Chapter 9 (pp. 228–244) and Section 9.3.3 (pp. 230–231) as core decarbonisation measures. Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems and renewable-powered infrastructure integration (Technology & Infrastructure, pp. 26–31), supported by KPI-based emissions monitoring (pp. 260–263). The Harit Sagar Guidelines promote phased STS deployment and environmental performance indicators to reduce at-berth emissions (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, deploying STS at 50% of high-traffic Inland Water Transport terminals extends electrification to emission-intensive inland corridors, reduces localized air pollution, and operationalizes the decarbonisation pathway envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

[97] Maritime India Vision 2030 establishes phased renewable energy adoption and emission intensity reduction under Chapter 9 (pp. 228–244), supported by electrification initiatives under Section 9.3.3 (pp. 230–231). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems through integration of renewable energy and smart infrastructure (Technology & Infrastructure, pp. 26–31), reinforced by KPI-based environmental governance (pp. 260–263). The Harit Sagar Guidelines codify renewable energy performance indicators and promote electrification of berth operations (Section 4.16 / Annexure-D; Section 4.5, pp. 14–15). In this context, achieving a 50% renewable energy share in operations provides a measurable and feasible mid-term milestone that reduces Scope 2 emissions, supports electrification, and operationalizes the decarbonisation trajectory envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

[98] Maritime India Vision 2030 establishes emissions reduction, electrification of harbor crafts, and renewable integration under Chapter 9 (pp. 228–244) and Section 9.3.3 (pp. 230–231). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems through integration of renewable-powered infrastructure and green propulsion technologies (Technology & Infrastructure, pp. 26–31), supported by KPI-based monitoring and lifecycle GHG accounting (pp. 260–263). The Harit Sagar Guidelines reinforce electrification and environmental performance indicators through shore-to-ship power and emissions monitoring (Section 4.5, pp. 14–15; Section 4.16 / Annexure-D). In this context, achieving a 100% renewable-powered and zero-emission fleet for inland and coastal terminals eliminates Scope 1 vessel emissions within port limits, maximizes renewable utilization, and operationalizes the decarbonisation pathway envisioned under MIV 2030, MAKV 2047, and Harit Sagar.

University (IMU), and the Ministry of Tourism, along with industry stakeholders from cruise operators and port authorities. The CTGTC's activities will be periodically reviewed by the National Green Maritime Coordination Cell (NGMCC).

Priority Areas:

- **Passenger-Centric Green Infrastructure**
  - Build **GRIHA**, LEED, **or IGBC-certified terminal buildings** with optimized HVAC systems, natural lighting, and low-carbon construction materials.
  - Provide **STS** to docked cruise vessels to reduce auxiliary engine emissions.
- **Alternative Fuel Readiness**
  - Ensure bunkering infrastructure for **LNG, methanol, ammonia, and renewable LPG** to serve green cruise vessels.
  - Create a **Fuel Readiness Index** for all cruise terminals.
- **Waste and Sewage Management**
  - Install advanced **solid waste segregation** and **waste-to-energy plants** at major cruise hubs.
  - Provide **MARPOL Annex IV sewage reception** facilities with tertiary treatment before discharge.
- **Passenger Flow Optimization and Digitalization**
  - Implement **AI-based passenger scheduling systems** to reduce congestion and energy use in terminal operations.
  - Offer **paperless ticketing and digital customs/immigration processing**.
- **Local Economic Integration**
  - Link cruise tourism with **green-certified local transport** (EV buses, bicycles, pedestrian pathways).
  - Ensure local shore excursions comply with **ecotourism and cultural heritage preservation standards**.
- **Carbon Capture and Storage Integration**
  - Design terminals to receive **captured CO_2 from cruise vessels**, enabling its safe storage or utilization in nearby industries.

Implementation Steps

- **Short-term (2025–2027):**
  - Retrofit existing cruise terminals at **Mumbai, Kochi, Goa, etc.** with STS, waste reception, and passenger flow management systems.
  - Pilot carbon capture reception at one cruise port.
- **Medium-term (2027–2035):**

  - Achieve a **60% renewable energy share** in terminal operations.[99]
  - Establish green certification for all cruise terminals.

- **Long-term (2035–2047):**
  - Fully zero-emission cruise terminals integrated with **sustainable coastal tourism corridors**.

Integration into NGSP

Coastal ports, inland waterway terminals, and cruise tourism terminals shall be formally integrated into the **National Green Shipping Policy's Green Port Performance Index**. However, recognizing their **unique operational, spatial, and environmental contexts**, dedicated **Special Category Modules** will be developed within the certification framework to address:

- **Passenger service requirements** including comfort, accessibility, and safety, with minimal environmental footprint.
- **Smaller operational scale** and infrastructure constraints compared to major ports, requiring adaptable compliance benchmarks.
- **Eco-sensitive zone compliance**, including biodiversity protection measures, habitat restoration, and restrictions on emissions and waste discharge in critical marine and riverine ecosystems.

These modules will specify **performance criteria** for:

- **Energy efficiency and renewable energy adoption** are proportionate to operational scale.
- **Waste, sewage, and bilge water reception and treatment systems** suited for smaller terminals.
- **Digital monitoring and reporting systems** scaled for passenger and cargo throughput.
- **Bunkering infrastructure** for low- and zero-carbon fuels such as renewable LPG, methanol, ammonia, and green hydrogen.
- **Carbon capture reception facilities** where applicable, especially for cruise tourism terminals.

Incentive Mechanisms:

[99] Maritime India Vision 2030 establishes phased renewable energy adoption and emission intensity reduction under Chapter 9 (pp. 228–244), supported by electrification initiatives under Section 9.3.3 (pp. 230–231). Maritime Amrit Kaal Vision 2047 advances carbon-neutral port ecosystems through integration of renewable energy and smart infrastructure (Technology & Infrastructure, pp. 26–31), reinforced by KPI-based governance (pp. 260–263). The Harit Sagar Guidelines codify renewable energy performance indicators and promote electrification of berth operations (Section 4.16 / Annexure-D; Section 4.5, pp. 14–15). Aligning with India's Panchamrit commitment of achieving 50% energy from non-fossil sources by 2030, mandating a 60% renewable energy share in terminal operations provides a measurable, sector-leading milestone that reduces Scope 2 emissions, supports electrification, and operationalizes the decarbonisation trajectory envisioned under MIV 2030 and MAKV 2047.

To accelerate adoption, the MoPSW and State Maritime Boards would prioritize **fiscal and financial incentives** for early adopters of zero-emission terminal and vessel technologies, including:

- **Tax benefits** for capital investment in green infrastructure and clean energy systems.
- **Viability Gap Funding (VGF)** for renewable energy generation, STS (Onshore Power Supply), and alternative fuel bunkering.
- **Green bonds and sustainability-linked loans (SLLs)** for large-scale terminal retrofits and vessel upgrades.
- **Priority berthing and reduced port charges** for compliant vessels.

Monitoring and Governance:

Compliance under these special modules will be monitored through annual third-party audits and reported via the Swachh Sagar Portal. Oversight will be offered by the National Green Shipping Coordination Cell (NGMCC), in collaboration with sector-specific bodies such as the Cruise Tourism Green Transition Committee (CTGTC), relevant State Maritime Boards, and IWAI.

3.4 Implementation Roadmap

Table 4: Implementation Roadmap for Green Ports

Time Horizon	Strategic Focus	Key Actions	Expected Outcome
Short Term (Up to 2030)	Regulatory Alignment & Baseline Deployment	Operationalize Green Port Performance Index (GPPI); integrate ISO 14001 & ISO 50001; launch Fuel Readiness Index; integrate coastal/IWT/cruise terminals into GPPI (special modules)	National certification framework operational
	Shore Power & Emission Standards	Deploy STS at 50% of berths; enforce MARPOL Annex VI-aligned emission limits; issue guidelines for electric cargo equipment & eco-dredging	Measurable emission reduction at berth

Time Horizon	Strategic Focus	Key Actions	Expected Outcome
	Renewable Energy Transition	Achieve minimum 60% renewable energy share in port operations; deploy solar, floating solar, wind; install BESS	Reduced fossil electricity dependency
	Monitoring & Digital Systems	Deploy IoT/GIS systems at major ports; install CEMS; conduct annual third-party audits (Swachh Sagar Portal); expand PCS 1x & NLP-Marine; promote JIT	Transparent MRV and digital efficiency
	Circularity & Waste	Ensure MARPOL-compliant waste reception; implement 5R framework; stormwater & oil–water systems	Improved pollution control & resource efficiency
	Terminals (Coastal/IWT/Cruise)	Pilot electric ferry corridors; retrofit cruise terminals with STS & waste systems; achieve 50% renewable share at high-traffic IWT terminals; establish CTGTC	Context-specific green terminal transition

Time Horizon	Strategic Focus	Key Actions	Expected Outcome
Medium Term (2030–2040)	Full STS & Equipment Electrification	Achieve 100% STS at major ports; expand to high-traffic non-major ports & IWT terminals; scale electric/hybrid equipment & eco-dredging	Full berth electrification at major ports
	Renewable Scale-Up	Expand renewable integration across port clusters; scale BESS and hybrid systems	Near-total clean energy operations
	Smart & Digital Ports	Deploy AI-driven optimization; implement digital twins;	Energy-efficient smart ports

Time Horizon	Strategic Focus	Key Actions	Expected Outcome
		predictive maintenance via IoT; nationwide MRV integration	
	Carbon & Circular Infrastructure	Install CO_2 reception facilities; scale water reuse; expand waste-to-energy at cruise/cargo hubs	Integrated carbon & circular economy systems
	Certification & Reporting	Annual port-level GHG reduction targets; GPPI benchmarking nationwide; disclosure via AMSR	Performance-based governance
	Partnerships	Scale PPPs for STS, bunkering & carbon capture; align with GreenVoyage2050 & green corridors	International alignment & investment leverage

Time Horizon	Strategic Focus	Key Actions	Expected Outcome
Long Term (2040–2070)	Net-Zero Energy Transition	Progress toward 100% renewable-powered operations; integrate microgrids & storage; fully electrified port equipment	Net-zero port operations
	Zero-Emission Berths	Eliminate fossil auxiliary power at berth; universal STS coverage	Zero-emission port interface
	Mature Carbon Systems	Operational carbon capture reception & industrial utilization; fully circular waste & water systems; nature-based coastal protection	Climate-resilient circular port ecosystems
	Future Technologies	Nuclear-ready berths compliant with IMO–IAEA guidance; readiness for autonomous shipping, offshore wind servicing, ocean carbon removal	Future-proof infrastructure

Time Horizon	Strategic Focus	Key Actions	Expected Outcome
	Terminal Integration	100% renewable inland/coastal terminals; zero-emission cruise terminals; full GPPI special module compliance	Integrated national green port ecosystem

Chapter 4: Green Ship Recycling

The Sustainable Ship Recycling pillar of NGSP advances a paradigm shift—from volume-based recycling to a **circular, transparent, and socially responsible industrial model**. In alignment with the **Recycling of Ships Act, 2019**, the HKC (that has come into force on 26 June 2025), the EU-SRR, and evolving global expectations on ESG disclosure and lifecycle emissions, this pillar emphasizes:

- Phase-wise **yard modernization** (e.g. impermeable flooring, enclosed dismantling sheds, stormwater control, etc.);
- **Worker welfare system**, including certified training, insurance, and PPE;
- Deployment of **digital portals** for Inventory of Hazardous Materials (IHM), Ship Recycling Plans (SRP), and compliance audits;
- Integration with India's **carbon registry and circular economy roadmap** (e.g., steel rerolling, EPR guidelines, etc.).

Working Definition in accordance with the Indian Context

Green ship recycling in India refers to the process of dismantling end-of-life ships in compliance with the **Recycling of Ships Act, 2019**, the **Hong Kong International Convention**, and other international/domestic standards. It prioritizes **worker safety**, **environmental protection**, and **resource recovery**, supported by a framework of **certification**, **hazardous material control**, and **regulatory oversight.**

4.1 Rationale

Green ship recycling requires strict adherence to international standards, robust facility management, and strong regulatory oversight. However, significant challenges remain, particularly in regions with weak governance and economic pressures that undermine sustainable practices. Addressing these challenges is essential for the ship recycling industry to minimize its environmental footprint and protect worker safety worldwide.

India is currently placed second in the world in ship recycling by capacity, but the future of this industry lies in aligning with global standards and **redefining leadership not merely by capacity but also by including metrics of sustainability, safety, and transparency**. The NGSP establishes a **Green Ship Recycling Certification Scheme**, digital tracking under the **NLP-Marine architecture**, and linkages to carbon credit systems to monetize avoided emissions through **material recovery** (e.g., ~85–90% steel reuse per vessel).

The NGSP identifies Ship Recycling as a core pillar to promote a **circular maritime economy**, ensure **occupational safety**, and align with **international frameworks** like the *Hong Kong International Convention (HKC)* and the *EU Ship Recycling Regulation (EUSRR)*.

Although the Recycling of Ships Act, 2019, embodies the operative aspects of the Hong Kong Convention (HKC) that came into force on 26 June 2025, a more integrated ecosystem is needed to address persistent concerns—such as exclusion from the EU-approved yards list,

occupational health risks, incomplete accounting of emissions generated during the recycling process, and the need for digital reporting protocols.

4.2 Strategic Context and Focus Areas

1. **Tiered Green Compliance Framework:**

   The working group will institutionalize a tier-based Green Ship Recycling Compliance Framework as described below, distinguishing facilities based on their adherence to HKC/EUSRR protocols, occupational safety standards, and environmental safeguards.

   Green Ship Recycling Compliance Tiers (GSRC-Tiers)

   To incentivize progressive modernization, regulatory adherence, and environmental transparency in India's ship recycling industry, the National Green Shipping Policy (NGSP) 2025 will implement a tiered classification system for all registered recycling yards.

This Green Ship Recycling Compliance Tier (GSRC-Tier) framework will serve as the basis for:

- Regulatory oversight,
- Access to national/international green finance,
- Inclusion in the EU and global approved shipyard lists,
- Targeted incentives under schemes like the Ferrous Scrap Development Fund (FSDF),
- Strategic prioritization in national-level green procurement and circular economy initiatives.

Table 5: GRSC Tier Framework

Tier	Compliance Criteria	Key Features	Support and Benefits
Green Tier 1	Full compliance with **HKC**, **EU SRR**, and **national laws** (Recycling of Ships Act, 2019); Advanced environmental infrastructure	• Impermeable floors, enclosed drainage, stormwater treatment • Digital IHM and SRP system • Verified CO_2 avoidance metrics • Worker health/safety certifications	• Highest access to green finance instruments (green bonds, ESG loans) • FSDF eligibility for advanced automation • Proposed National "Green Yard" certification • Priority in award of

Tier	Compliance Criteria	Key Features	Support and Benefits
		• Certified downstream waste processing	international ship dismantling contracts (e.g., EU/IMO approved)
Green Tier 2	Full HKC compliance with partial adoption of digital and environmental upgrades	• Functional IHM and SRP mechanisms • Partial digital reporting • Basic stormwater and effluent systems • Segregated waste material zones	• Targeted grant/loan access under FSDF • Technical support for Tier 1 transition • Training and digital on-boarding via SCGJ/NSDC • Inclusion in domestic circular economy value chains
Green Tier 3	Basic HKC requirements met; limited infrastructure and digitalization	• Manual dismantling methods • Minimal pollution control infrastructure • Basic waste material segregation • Worker PPE provided but not certified	• Conditional registration under NGSP • Mandated modernization roadmap (5–7 years) • Limited access to public finance • Linked to skill upgrade and compliance-based funding

Implementation and Monitoring

- Oversight Agency: MoPSW, DG Shipping, and in partnership with State Maritime Boards and Classification Societies.
- Verification: Third-party audits (biennial) + online self-reporting dashboard.
- Upgradation Support: Access to tools under the Harit Sagar, FSDF, and SENSREC partnership.

- **Ship Recycling Transparency and Reporting System (SRTRS):**
  A **mandatory reporting platform** to be introduced to track hazardous waste flows, workers' safety practices, and carbon intensity in dismantling.

  Real-time monitoring via **IoT sensors**, **blockchain-based IHM tracking**, and **open-access sustainability dashboards** will underpin transparency and accountability.

  SRTRS will be expanded to mandate quantification of GHG emissions generated during the recycling stage, covering **deconstruction, waste removal, disposal, and transport** phases. This SRTRS will account for:
  - Clearing hazardous loose items.
  - Handling and processing of oils, liquids, and sludge.
  - Sequential dismantling (non-metal followed by metal structures).
  - Oxy-LPG torch cutting and associated energy/fuel usage.
  - Hazardous material removal, packaging, secure storage, and authorized disposal.
  - Machinery dismantling for reuse/recycling.
  - Size-reduction cutting of steel plates for transport.

  This will be standardised and developed by MoPSW, GMB, and technical partners such as TERI, in alignment with ISO 14067 and GHG Protocol standards.

- **Technology Modernization and Infrastructure Support:**

  To address non-mechanized and energy-intensive processes, NGSP will:
  - Promote **robotic dismantling**, **AI-based waste sorting**, and **hot-work emission control systems**.
  - Facilitate development of foundries and furnaces, including **common melting centres** near recycling clusters (e.g., Bhavnagar).
  - Offer **Pay-per-Use advanced equipment** to reduce CAPEX burdens on recyclers.

- Utilisation of the **Ferrous Scrap Development Fund (FSDF)**

  In alignment with the **Ministry of Steel's** *Steel Scrap Recycling Policy* **and MoPSW's FSDF**[100], the NGSP recommends:

[100] Ministry of Ports, Shipping and Waterways, Government of India. *Revised Guidelines for the Utilisation of Ferrous Scrap Development Fund (FSDF)*. New Delhi: Government of India, 2015. https://www.shipmin.gov.in/sites/default/files/3844059200guideFSDF23042015_0.pdf.
Also See: Ministry of Steel, Government of India. *Steel Scrap Recycling Policy*. New Delhi: Government of India, 2019. https://ic-ce.com/wp-content/uploads/2020/10/Steel-Scrap-Recycling-Policy-06.11.2019.pdf.

- Allocation of FSDF grants/loans for upgrading Indian shipbreaking yards with **mechanized cutting, pollution control systems**, and **material segregation and sorting facilities**;
- Funding joint R&D between recycling yards and secondary steel producers for **green steel loSTS (Internet of Ship Tracking Systems/Smart Technologies)**;
- Developing a **certification framework** for ship-recycled ferrous scrap to ensure quality and traceability, making it eligible for use in steelmaking;[101]
- Pilot **ferrous scrap aggregation and pre-processing hubs** adjacent to Alang and other clusters.
- FSDF-supported upgrades must also include **energy-efficiency improvements in dismantling processes such as robotic cutting, high pressure water jet** to reduce emissions intensity per tonne of recovered material.

- **Circular Economy and Green Steel Linkages:**

  Introduce **reuse protocols** for select machinery/components (e.g., engines, pumps, compressors, valves, blowers, turbines, etc.) and collaborate with **steelmakers** to establish **green steel recovery loSTS**, supported by guidelines on **safe rerolling and EPR-based traceability**.

- **International Bilateral Frameworks:**

  Bilateral agreements with key ship-owning countries (EU, Japan, Korea, UAE) for assured supply of ships. Replication of frameworks like the **SENSREC project**[102] (Norway–IMO–Bangladesh) can support policy alignment, worker training, and waste infrastructure upgrades.

- **Digital MRV and Certification Systems:**

  Mandate **digital sustainability certificates** for each recycled ship, covering IHM removal, waste handling, and material recovery efficiency—aligned with ESG reporting norms and enabling access to **Green Finance Instruments**.

- **Skill Development and Safety Training:**

  A national-level training module will be introduced under the **Green Skills pillar**, building competencies in **safe cutting techniques**, **hazardous waste handling** and, **labelling**, and **spill prevention**. Partnerships with IMU and GMB Training Centres will be leveraged for rollout.

[101] Steel Scrap Recycling Policy issued, https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=194359&reg=3&lang=2

[102] International Maritime Organization (IMO). "Safe and Environmentally Sound Ship Recycling in Bangladesh (SENSREC)." https://www.imo.org/en/OurWork/Environment/Pages/SENSREC.aspx.
Also See: Press Information Bureau, Government of India. "MOUs with Foreign Countries for Development of Ports and Manufacture of Ships." November 21, 2016. https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=153961.

- **Worker Welfare and Environmental Insurance:**

  Development of **performance-linked incentives** by the working group based on safety and environmental records, while encouraging uptake of **occupational hazard insurance** and **welfare funds** for shipyard workers.

- **Ship Recycling Carbon Accounting and Reduction Program**

  To close the current gap in emissions data from recycling activities, launch the **Ship Recycling Carbon Accounting and Reduction Program (SRCARP)**:

Objective:
The SRCARP will establish India's first dedicated carbon accounting and reduction framework for the ship recycling sector, with the following initial priorities:

- **Baseline Mapping:**

  Conduct a one-year, sector-wide emissions baseline study for Alang and other recycling clusters, capturing energy/fuel use, cutting processes, waste transport, and disposal-related emissions.

- **Emission Intensity Targets:**

  Establish voluntary yard-level reduction targets (e.g., kg CO_2e per LDT processed) to be progressively integrated into the Green Ship Recycling Certification (GSRC) Tier Framework.

- **MRV Integration:**

  Propose deployment of IoT-enabled real-time fuel and electricity consumption meters at participating yards, with automated data uploads to the Ship Recycling Tracking and Reporting System (SRTRS).

- **R&D Support:**

  Fund and test renewable-powered dismantling systems and alternative low-carbon cutting technologies.

Implementation Strategy

1 – Program Formation

- Constitute a working group under NGMCC with GMB, IRS, NABL-accredited labs, SRIA and technical support by academia.
- Finalise carbon accounting methodology (aligned with ISO 14067 and GHG Protocol).
- Design SRTRS digital platform architecture.

2 – Baseline Study

- Conduct year-long monitoring of pilot and control yards across all major clusters.
- Collect energy/fuel data, cutting process logs, transport emissions, and waste handling records.
- Publish the **National Ship Recycling Carbon Baseline Report**.

3 – Target Setting and MRV Rollout

- Establish voluntary emission intensity targets by yard category (manual, semi-mechanized, and mechanized).
- Roll out IoT meters and SRTRS connectivity to all licensed yards.
- Begin quarterly digital reporting with automated verification flags.

4 – R&D and Reduction Projects (Simultaneously functional to Point 3)

- Fund pilots for:
    - Renewable-powered plasma cutting systems.
    - Heat recovery integration in dismantling processes.
    - Shared compressed-air systems to replace diesel compressors.
- Consolidate and analyse carbon performance verification records to enable decision-making for sector-wide scale-up.

5 – Integration into GSRC Tiers

- Incorporate verified carbon intensity performance into GSRC tier scoring.
- Recognize top-tier performers by according to weightage in quality-cum-cost basis tender evaluation.

4.3 Implementation Roadmap

Table 6: Implementation Roadmap for Green Ship Recycling

Phase	Focus Objective	Detailed Actions	Responsible Bodies	Expected Outcome
Short Term (Up to 2030)	Formalise GSRC, establish transparency systems, baseline carbon accounting, early modernization of the yards and their processes.	Launch: • Green Ship Recycling Compliance Tier (GSRC) framework nationwide and register and classify all licensed yards under the Tier 1–3 system. • The Ship Recycling Transparency & Reporting System (SRTRS) • Digital IHM tracking and blockchain waste reporting • FSDF modernization grants for mechanisation & pollution control • Common melting & scrap aggregation hubs • Worker safety certification programs • Worker insurance & welfare-linked incentives • Bilateral End-of-life ship supply agreements (EU/Japan/Korea/UAE) • National green recycling certification label • Real-time energy consumption and	MoPSW NGMCC oversight, DG Shipping, State Maritime Boards, GMB (Alang cluster), NCoEGPS, Ministry of Steel, FSDF authority, IRS, NABL labs, SRIA, and academia partners.	Establishment of: GSRC; SRTRS; Digital IHM Tracking; FSDF Modernization Grants; Common Melting Hubs; Workers Safety Certification Programs; Worker Insurance; National Green Recycling Certification and Bilateral EOL Ship Supply Agreements

Phase	Focus Objective	Detailed Actions	Responsible Bodies	Expected Outcome
		emissions monitoring in ≥50% of yards. • Pilot robotic/AI dismantling technologies • Mandatory third-party environmental audits		
Medium Term (2030-2040)	Scale mechanization, integrate carbon metrics, industrial circular economy transition	• ≥70% of existing ship recycling yards to be upgraded to GSRC Tier 1 or Tier 2 • Carbon intensity targets to be integrated into GSRC scoring • IoT MRV coverage to be extended across licensed yards • Adopt Robot- driven and/or semi-mechanized dismantling processes. • Integrate scrap supply chain with green steel sector • Lifecycle carbon disclosure per dismantled vessel • Expanded FSDF R&D support for low-carbon cutting technologies • Promote yards in compliance with HKC, EU-SRR and regional regulatory bodies • Workforce professional certification for all ship recycling yards • Scaling-up of Insurance-	DG Shipping MoPSW Ministry of Steel FSDF Recycling clusters NGMCC coordination International certification bodies	Industrial-scale green recycling sector Carbon accounting integrated Circular steel ecosystem operational Global certification competitiveness

Phase	Focus Objective	Detailed Actions	Responsible Bodies	Expected Outcome
		linked safety incentive programs.		
Long Term (2040-2070)	Net-zero ship recycling ecosystem, full lifecycle circularity	• 100% GSRC Tier 1 compliance nationwide • Net-zero carbon dismantling operations • Fully renewable-powered recycling clusters • Closed-loop steel recovery supply chains • Lifecycle MRV integrated with global carbon markets • Zero hazardous discharge yards • Automated dismantling and waste systems universal • Global leadership in sustainable ship recycling • Integration into international green steel markets	NGMCC national oversight MoPSW Industry ecosystem Steel & recycling supply chain	Net-zero ship recycling ecosystem Global benchmark industry Full circular economy maturity

Chapter 5: Green Finance

Working Definition for the Indian Maritime Context

In the context of India's maritime sector, **green finance** is being defined as follows:

"A structured and verifiable financial mechanism—including green bonds, loans, public-private partnerships, and ESG investments—dedicated to the funding of environmentally sustainable maritime projects. This includes projects such as green ship construction, repair and retrofitting, port electrification, clean fuel infrastructure, energy-efficient terminal equipment, and circular economy-driven ship recycling including green steel production. Green finance in India shall align with international principles (e.g., ICMA Green Bond Principles, IFC Performance Standards, EU Taxonomy, IMO Zero-Net Framework) **while being responsive to national sustainability priorities and regulatory frameworks."**[103]

5.1 Rationale

Green finance in India's maritime domain will be anchored in the following principles:

- **Regulatory Alignment:** Compliance with international standards (ICMA, CBI, IFC, ISO) and adaptation under the Indian Securities and Exchange Board (SEBI) ESG disclosure mandates.
- **Maritime-Specific Application:** Prioritization of funding for decarbonization of ships, electrification of ports, alternative bunkering infrastructure (e.g., LNG, green hydrogen), and development of R&D in green propulsion systems.
- **Financial Innovation:** Use of blended finance, viability gap funding (VGF), and maritime green finance platforms for de-risking early-stage technologies.
- **Institutional Anchoring:** Development of a **National Maritime Green Finance Framework** to define eligibility, verification, and impact monitoring protocols.

5.2 Strategic Context and Focus Areas

The green transition of India's maritime sector requires not only regulatory alignment and technological innovation but also a **robust and sector-specific financial architecture** that can **de-risk climate investments, mobilize blended capital, and mainstream ESG-aligned financing**. Recognizing this, the NGSP positions **Green Finance** as a core pillar to unlock transformative growth in low-carbon ports, clean fuel logistics, sustainable shipbuilding, and green technology innovation.

The **scale of maritime transition**—ranging from electrification of ports, deployment of green tugs, retrofitting technically compatible engines with alternate fuels along with installation of energy-saving devices (ESDs) on ships, to hydrogen/ammonia bunkering—demands upwards of **INR 1.5–2 lakh crore (~USD 20–25 billion)**[104] in investments over the next two

[103] Climate Policy Initiative. *Landscape of Green Finance in India 2024* https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2024/
[104] The maritime energy transition in India—covering port electrification, green tug deployment, retrofitting of existing vessels with alternative fuel-compatible engines and energy-saving devices,

decades. Without dedicated financial tools, India risks delayed adoption and missed opportunities in the rapidly consolidating global green shipping economy.[105]

- **Institutional Anchoring: Sagarmala Finance Corporation Ltd (SMFCL)**

  In a landmark move, the Ministry of Ports, Shipping and Waterways (MoPSW) launched **Sagarmala Finance Corporation Limited (SMFCL)**[106] in June 2025 as India's first **dedicated NBFC for the maritime sector**.

Registered with the RBI, SMFCL is designed to:

- **Fill credit and equity gaps** in green port and shipbuilding infrastructure.
- Offer **tailored financing for MSMEs,** renewable energy startups, and maritime technology innovators.
- Act as a **lead financier for ESG-certified projects**, including offshore wind, green hydrogen, and low-emission logistics.
- Facilitate **long-tenure debt and viability gap funding (VGF)** for emerging segments like e-methanol bunkering and zero-emission vessel R&D.

Initial capitalization: ~INR 5,000 crore, with expansion planned via partnerships with multilateral institutions such as the **Asian Infrastructure Investment Bank (AIIB) and Climate Fund Managers.**

- **Maritime Development Fund: Sector-Specific Blended Finance Platform**

The Government of India has announced a **total maritime sector allocation of ₹69,725 crore** to strengthen maritime infrastructure, shipbuilding capacity, and sectoral competitiveness. The allocation is structured across key pillars, including:

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and development of hydrogen/ammonia bunkering infrastructure—will require investments of approximately INR 1.5–2 lakh crore (USD 20–25 billion) over the next two decades, as highlighted in India's Maritime Amrit Kaal Vision 2047 and maritime decarbonisation studies by NITI Aayog and global maritime organizations**.**

[105] Ministry of Ports, Shipping and Waterways, Government of India. *Maritime Amrit Kaal Vision 2047*. New Delhi: Government of India, 2024. https://shipmin.gov.in/sites/default/files/MAKV_2047_Report.pdf.
Also See: India Briefing. "India's 2025 Maritime Push with US$20 Billion Investment and Global Ties." July 10, 2025. https://www.india-briefing.com/news/indias-2025-maritime-push-with-us20-billion-investment-and-global-ties-38114.html/.

[106] Ministry of Ports, Shipping and Waterways, Government of India. "Sagarmala Finance Corporation Limited (SMFCL)." Updated June 26, 2025. https://ddnews.gov.in/en/india-launches-first-maritime-nbfc-sagarmala-finance-corporation-limited-smfcl/.

- **Shipbuilding Financial Assistance Scheme – ₹24,736 crore** (including Shipbreaking Credit Note support of ₹4,001 crore) to promote domestic shipbuilding and enhance global competitiveness.

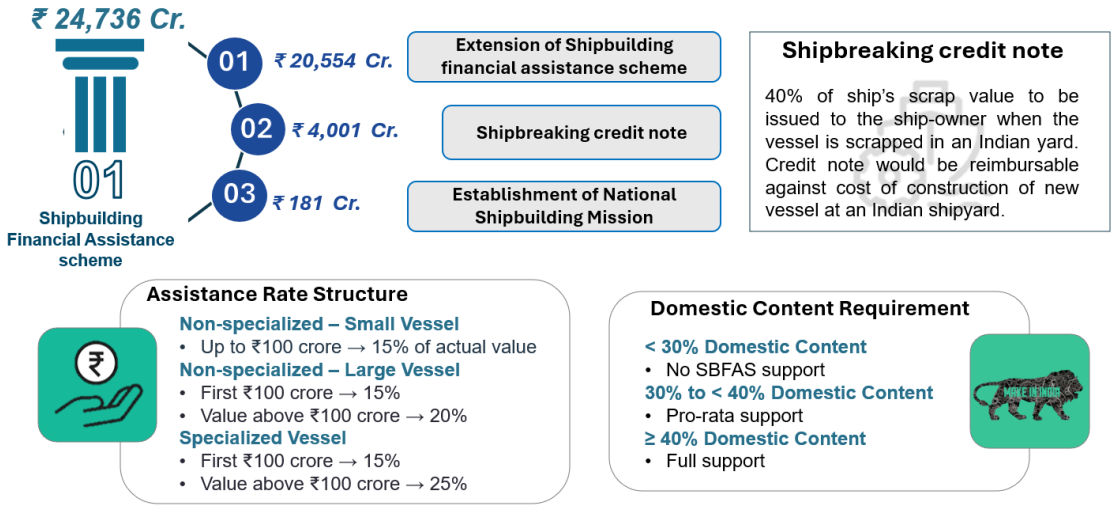

Figure 3: Detailed Description of SBFAS

- **Maritime Development Fund (MDF) – ₹25,000 crore**, comprising a **Maritime Investment Fund of ₹20,000 crore** and an **Interest Incentivisation Fund of ₹5,000 crore**, aimed at mobilizing long-term capital for maritime sector investments.[107]
- **Shipbuilding Development Scheme – ₹19,989 crore** focused on capacity and capability development in shipyards along with credit risk coverage to strengthen the shipbuilding ecosystem.
- **Legal, Policy and Process Reforms**, aimed at improving regulatory efficiency, investment facilitation, and ease of doing business across the maritime sector.

Under the **National Green Shipping Policy (NGSP)**, the **₹25,000 crore Maritime Development Fund (MDF)** can serve as a **blended finance window** to catalyse investments in priority green maritime initiatives, including:

- Green vessel retrofits and low-emission newbuilds
- Port electrification and **Shore-to-Ship (STS)/Onshore Power Supply (OPS)** infrastructure
- Circular economy-linked ship recycling infrastructure
- Digital traceability and monitoring systems (e.g., MRV platforms and NLP-Marine enhancements)

Financial instruments under the fund may include:

- **Green Bonds** (SEBI-compliant)

[107] Ministry of Ports, Shipping and Waterways, Government of India. *Maritime Amrit Kaal Vision 2047*. New Delhi: Government of India, 2024. https://shipmin.gov.in/sites/default/files/MAKV_2047_Report.pdf.

- **Concessional Loans** (via maritime financial institutions such as SMFCL or IFSC-based financing structures)
- **Results-Based Finance (RBF)** linked to emission reductions per tonne of cargo
- **Carbon Credit Advance Purchase Agreements**, aligned with India's **Voluntary Carbon Market framework under MoEFCC**

To further strengthen the **green maritime investment ecosystem**, platforms such as the **India Maritime Investment Meet** and financial facilitation through **IFSC GIFT City** can support the mobilisation of domestic and international capital for sustainable shipping and port infrastructure.

At **the India Maritime Investment Meet 2025 in London**[108], MoPSW showcased India's maritime green finance pipeline and attracted global interest through:

- **100% FDI (Foreign Direct Investment) allowance** in shipping and shipbuilding under the automatic route.
- **Zero GST on ship imports and clean fuel infrastructure.**
- **10-year tax holiday for maritime entities registered under the International Financial Services Centre (IFSC) at GIFT City.**
- **No withholding tax** on maritime capital gains and transactions—positioning GIFT City as India's Green Maritime Finance Gateway.

International institutions including **Standard Chartered, Lloyd's Register, APM Terminals, and Climate Fund Managers** expressed interest in the following:

1. Blended equity-debt platforms for tug hybridization and green corridor deployment.
2. Joint investment vehicles for green hydrogen and methanol bunkering infrastructure at Kandla, Paradip, and V.O. Chidambaranar ports.

- **Proposed Instruments Under NGSP**

Table 7: Proposed Instruments Under NGSP

Instrument	Description	Potential Anchors
Green Maritime Bonds	Bond issuances for port and ship retrofits, green fuel bunkering, digital emissions platforms	SMFCL, DVC, state maritime boards
ESG-linked Port Finance	Loans or equity with performance-based pricing (e.g., lower rate of interest if GHG targets met)	EXIM Bank, SIDBI, SBI Capital Markets
Maritime Climate Credit Facility	Advances paid to ports or shipowners based on ex-ante carbon savings	Ministry of Finance (via GCF accreditation)
Green MSME Maritime Grants	Dedicated green credit line for port service providers, inland vessel builders, and fuel startups	NABARD, NSIC, Startup India

[108] Ministry of Ports, Shipping and Waterways, Government of India. "India Maritime Investment Meet Held in London to Strengthen Global Maritime Partnerships." Press release, July 9, 2025. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2143453.

Blue Economy Impact Funds	Equity investments in sustainable ship recycling, coastal eco-tourism, and circular economy ventures	NIIF, Climate Fund Managers, GFAI
Sovereign Green Guarantee Scheme	Central government partial guarantee for first-mover private green fuel projects	MoPSW

- **Integration with ESG and Carbon Markets**

To scale green finance, NGSP proposes a Maritime ESG Taxonomy that:

1. Defines "green" vs. "transitional" vs. "brown" activities for finance eligibility.
2. Aligns with the **EU Taxonomy, ICMA Green Bond Principles, and IFC Performance Standards.**
3. Enables classification and tagging of all MoPSW and port projects as per ESG criteria.

In addition, **a Carbon Credit Registry** linked with MoEFCC will be developed by working group to allow:

- Emission offsets from green fuel use, STS, zero-emission vessels, and ship recycling.
- Port-wise GHG reduction accounting under a national MRV framework.
- Participation in international offset markets and carbon trading under Article 6 of the Paris Agreement.[109]

- **Stakeholder Recommendations and Policy Actions**

  Based on the *Stakeholder Input Compilation Report* and the *LR Consultative Document*, key actions include:

  - **Capacity-building for financial institutions** on green maritime finance tools.
  - **Training for port financial** managers on ESG project appraisal and blended finance structuring.
  - **Development of a Green Maritime Finance Dashboard** under NLP-Marine (Sagar Setu).
  - **Mandatory ESG reporting** for major ports and public shipping entities.
  - Creating a **Public-Private Green Finance Taskforce**, with representatives from banks, ports, IFIs, shipyards, and regulators.

By consolidating efforts under SMFCL including pooling of capital resources through IFSC GIFT City and enabling ESG-aligned project pipelines across the seven green pillars, **India aims to become a leading hub for maritime green finance in the Indo-Pacific region.**

[109] https://unfccc.int/process-and-meetings/the-paris-agreement/article6

The NGSP recognizes finance not just as a resource but as a transformative enabler to catalyse early adoption, scale innovation, and facilitate access to a cleaner, more resilient maritime economy.

5.3 Implementation Roadmap

5.3.1 Short-Term Implementation (Up to 2030)

Focus: *Institutional setup, taxonomy creation, pilot financing pipelines, de-risking first movers*

Table 8: Short-Term Implementation plan for Green Finance

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
Operationalize SMFCL as sector anchor	Create dedicated green maritime lending window; MSME credit lines; blended finance desk	SMFCL ,RBI oversight	₹20,000+ crore green maritime credit pipeline mobilised
Activate Maritime Development Fund as blended window	Ring-fence MDF green tranche for ports, ships, recycling, MRV	MoPSW , SMFCL + NIIF	Large-scale concessional financing for early adoption projects
Green bond market entry	First sovereign-backed maritime green bond issuance	Ministry of Finance , SMFCL	Establish benchmark yield curve for maritime green bonds
ESG taxonomy & project classification	Launch Maritime ESG Taxonomy aligned with ICMA/EU taxonomy	NGMCC ,SEBI , MoEFCC	All port and ship projects tagged ESG-compliant
Carbon registry integration	Develop Maritime Carbon Credit Registry linked to NLP-Carbon*	NGMCC , MoEFCC	Verified carbon accounting for finance eligibility
First-mover risk protection	Introduce Sovereign Green Guarantee Scheme	Ministry of Finance ,MoPSW	Private capital enters alternative fuel infrastructure
Institutional capacity building	Training for banks, ports, shipyards on ESG project finance	NCoEGPS ,IMU , RBI institutes	Sector-wide financial literacy on green instruments

Short-term outcome:

India establishes a functioning maritime green finance ecosystem capable of underwriting early-stage transition risk.

5.3.2 Medium-Term Implementation (2030–2040)

Focus: *Scaling capital deployment, mainstream ESG finance, public-private partnerships.*

Table 9: Medium-Term Implementation plan for Green Finance

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2040
Scale blended finance platforms	Expand MDF, SMFCL portfolio into hydrogen/ammonia corridors	SMFCL , IFSC GIFT City , NIIF	₹75,000, crore cumulative green investment
ESG-linked port financing	Mandatory ESG performance pricing in port loans	SEBI, Banks , SMFCL	Financial incentives tied to emissions performance
Carbon market monetization	Enable maritime participation in domestic carbon trading	MoEFCC , NGMCC	Revenue generation from emission reductions
Special Purpose Vehicles	Launch Blue Economy Impact Funds	NIIF , Climate funds	Institutional investment equity enters green shipping
International capital integration	Position IFSC-GIFT City as maritime green finance hub	Ministry of Finance , IFSC Authority	Global investors consider India a green maritime gateway
Results-oriented financing	Implement emission-linked payouts	SMFCL ,multilateral banks	Funding support is available after verification of reduction in emissions

Medium-term outcome: Green finance transitions from public funds to a market-driven investment ecosystem.

5.3.3 Long-Term Implementation (2040–2070)

Focus: *Full financial integration of net-zero maritime economy*

Table 10: Long-Term Implementation plan for Green Finance

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2070
Mature carbon finance markets	Integrate maritime fully into global Article 6 markets	MoEFCC, Ministry of Finance	Carbon becomes core maritime revenue stream
Private capital fund support	Reduce dependence on public concessional financing.	Financial markets , private equity	Market-led decarbonisation funding
Lifecycle financing systems	Finance linked to full lifecycle emissions (GFI-aligned)	NGMCC, ESG regulators	Financing tied to lifecycle carbon performance
Global leadership positioning	Export Indian maritime green finance models	MoPSW, IFSC	India becomes Indo-Pacific finance hub

Long-term outcome:

Maritime decarbonization becomes financially self-sustaining.

Chapter 6: Green Skill Development

Green Skill Development in India's Maritime Sector refers to the process of equipping current and future maritime professionals with **technical, managerial, and behavioural skills that support sustainable shipping, green port operations, alternative fuels, green ship construction, sustainable ship recycling** and **decarbonization goals.** It aligns with national programs such as **the Environment Education, Awareness, Research, and Skill Development (EEARSD)** and is implemented through institutions such as **NSDC, Skill Council for Green Jobs (SCGJ), NCoEGPS, IMU, ITIs, and Port training institutes.**

6.1 Rationale

India's green transition in the maritime sector demands **a systemic reorientation of skills and knowledge**—from alternative fuel handling to circular economy logistics, from emission monitoring to sustainable dredging. This definition also highlights:

- **The multi-level nature of skills**—from technicians to regulators and port managers,
- **The need for convergence across education, policy, and private sector hiring**, and
- **The urgency of closing the existing green job demand-supply gap** with focused on simulation-based training along with classroom training in emerging technologies like hydrogen, biofuels, and carbon capture.

India's maritime green transition—driven by decarbonisation targets, the Green Port and Shipping Guidelines, and international sustainability obligations—will require a highly skilled and future-ready workforce. As per the International Labour Organization (ILO), over **24 million green jobs** could be created globally by 2030[110]. India has the potential to contribute significantly to this shift, with **35 million green job**[1] projected by 2047[111], especially across clean energy, port decarbonization, and circular economy-driven maritime operations.

However, India faces a considerable **green skills gap**. According to the government's Economic Survey 2023-24, only 4.4% of youth aged 15–29 receive formal vocational or technical training, while a further 16.6% receive informal training[112], and green job awareness remains low. In maritime domains such as ship recycling, LNG and alternate green fuels bunkering, renewable energy-based port operations, and sustainable shipbuilding, **both technical upskilling, reskilling and awareness generation** are critically required.

6.2 Strategic Context and Focus Areas

6.2.1 Current Initiatives and Ecosystem Mapping

India has taken several important steps to build its green workforce:

[110] https://www.ilo.org/resource/news/24-million-jobs-open-green-economy-0#:~:text=%E2%80%9CPolicy%20changes%20in%20these%20regions,gains%20without%20the%20right%20policies
[111] https://sscgj.in/wp-content/uploads/2023/05/Skills-Lanscape-for-Green-Jobs-Report.pdf
[112] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2034924&reg=3&lang=2

a. Skill Council for Green Jobs (SCGJ):

SCGJ has developed **50+ qualifications**[113] and certification standards across renewable energy, waste management, and energy efficiency. It has collaborated with industry bodies, such as the National Institute of Wind Energy and the Ministry of New and Renewable Energy, to create job-ready curriculum aligned with emerging sectors.

b. Environment Education, Awareness, Research, and Skill Development (EEARSD):

Launched in 2017 by the Ministry of Environment, Forest and Climate Change (MoEFCC), the EEARSD has trained over **~2 lakh candidates**, with over **~60,000 placed** in green sectors including pollution control, biodiversity, and renewable energy. It adopts a **dual approach**: upgrading existing worker capacities and creating new green employment opportunities.[114]

c. Vocational Integration and National Credit Framework (NCrF):

As recommended in the National Education Policy (NEP) 2020, the **National Credit Framework** is bridging general and vocational education. ITIs, polytechnics, and engineering institutions are introducing green modules such as **solar PV systems, hydrogen systems, biofuels, and EV maintenance**.

6.2.2 Challenges in the Green Maritime Skills Ecosystem

Despite growing momentum, systemic issues remain:

- **Need** for **sector-specific green skilling pathways** in shipping, port logistics, and maritime technology.
- **Insufficient industry-aligned curriculum** and hands-on training programs for emerging technologies like hydrogen bunkering, green shipbuilding, or shore power integration.
- **Scarce awareness and outreach** among youth about specific maritime green careers.
- **Under representation of women, PwDs**, and marginalised communities to increase diversity in green maritime training pipelines.
- **Fragmented data systems and certification models**, limiting recognition of green skills nationally and internationally.

6.2.3 Strategic Framework under NGSP

To address these gaps, the NGSP proposes the following integrated green skilling framework:

1. Green Maritime Skills Mission (GMSM)

An inter-ministerial initiative led by MoPSW, in partnership with MSDE, SCGJ, IWAI (NINI), IMU and the Directorate General of Shipping (DGS), to establish India as a **Global Hub for Green Maritime Skills** by 2030.

[113] https://sscgj.in/wp-content/uploads/2016/06/SCGJ-NLissue8.pdf
[114] Dr Mukesh Kwatra in Voices, Business, Environment, TOI-https://timesofindia.indiatimes.com/blogs/voices/green-skill-development-programme-in-india/

Key objectives:

- Develop green maritime job roles and quality personnel (e.g., green tug operator, hydrogen bunkering technician, shore power engineer, etc.).
- Integrate green modules in pre-sea and post-sea maritime training (via DGS, IMU, training institutes).
- Establish Green Maritime Centres of Excellence (GMCoE) across major ports for upskilling.

3. **Three-Tier Training Strategy**

Table 11: Three- Tier Training Strategy

Tier	Focus	Target Group
Tier 1	Mass awareness & orientation	Youth, maritime cadets, entry-level staff
Tier 2	Vocational & hands-on skilling	Technical workers, port operators, SMEs
Tier 3	Advanced research & innovation	Engineers, faculty, startup incubators

6.2.4 Pathways for Implementation

- **Regional skill clusters** near green hydrogen ports (Deendayal, Paradip and VOCPA) aligned with state initiatives.
- Leverage **Digital Platforms** (e.g., DGS e-learning, Swayam, SCGJ) for scalable dissemination.
- Promote **"train-the-trainers and trainer-trainee models"** for standardized delivery across the maritime value chain.
- **International Certification Equivalency** for high-demand job roles (e.g., through partnerships with BIMCO, European Maritime Safety Agency (EMSA), or IMO-accredited training institutions).
- Encourage **Green Entrepreneurship** and MSMEs via mentoring, incubation, and access to finance.

6.2.5 Enabling Inclusion and Just Transition

- Ensure affirmative action policies to train and empower **women, PwDs, and rural youth** in high-growth green maritime roles.
- Develop **green job employment portal** and career support services through DGS platform.
- Ensure social safety nets for the existing workforce to facilitate their transition from fossil-fuel-dependent roles (e.g., coal-handling dock workers).,

6.2.6 Monitoring, Funding and Evaluation

- Annual Green Skills Dashboard to track progress on training, placement, and diversity.
- Allocate a portion of the **Maritime Development Fund** and **Sagarmala Finance Corporation Ltd. (SMFCL)** for green skill capital investments.
- Mandate ports and shipping companies to **earmark CSR budgets** for local skill development aligned with Harit Sagar priorities.

6.2.7 Recommendations and Global Linkages

- Align green shipping skills with evolving IMO regulations (e.g., MARPOL Annexures, MEPC 80 GHG Strategy, etc.).
- Integrate **ILO Just Transition Guidelines** and **OECD green growth principles** into national skilling curriculum.
- Establish bilateral Green Skills Cooperation Agreements with IMO, Denmark (via the Indo-Danish Centre of Excellence (CoE) in Green Shipping), and Japan to imbibe best practices.

6.2.8 Specific Green Skill Development Mandates

India has demonstrated a strong commitment to developing its inland waterways, led by the **Inland Waterways Authority of India (IWAI)**. The **National Inland Navigation Institute (NINI)** in Patna already serves as a capacity-building hub for inland navigation. Under the NGSP, NINI's mandate will be **expanded to function as a National Maritime Energy Training Node** for inland and coastal passenger operations, including cruise tourism.

Inland Waterways

- Develop **specialised training modules** for battery-electric and hybrid propulsion systems, including shore charging infrastructure operation and safety.
- Introduce **Riverine Environmental Compliance Officer** certification covering zero-emission zones, dredging sustainability, and sensitive habitat navigation. Develop a framework in collaboration with institutions such as NINI or similar organizations. Existing certification models (e.g., Environmental Compliance Officer courses covering environmental legislation, EIA, pollution control, and compliance auditing) can serve as a baseline for designing a domain-specific course aligned with maritime and riverine requirements.
- Mandate **digital literacy certification** for barge/ferry masters to operate NLP-Marine integrated MRV dashboards.
- Partner with OEMs to conduct **hands-on maintenance workshops** for hybrid propulsion and energy storage systems.
- Deploy **training simulators** at IWAI hubs (Patna, Guwahati, Kochi etc.) for manoeuvring and voyage optimisation in varying river conditions.

Cruise Shipping (Ocean and River)

- Create **Cruise Sustainability Officer** courses covering waste minimisation, greywater/blackwater treatment, and passenger sustainability engagement.
- Mandate **shore power connection and high-load safety training** for engineering crew at all cruise terminals with cold ironing facilities.

- Develop **energy-efficient hotel load management** courses for cruise engineering teams.
- Partner with hospitality institutes to train catering staff in **eco-provisioning** and food waste minimisation.
- Include MARPOL Annexes compliance modules in all pre-sea and refresher cruise crew training for obtaining the STCW certificates.

Coastal Shipping

- Launch **Coastal Dual-Fuel Operator Certification** for safe handling of alternate green fuels.
- Train onboard personnel as **Continuous Emissions Monitoring System (CEMS) Operators** with NLP-Marine integration skills.
- Create **Green Interface Coordinator** training for shore-based staff to optimise port-vessel coordination in zero-emission zones.
- Integrate **simulation-based voyage optimisation** and slow steaming modules into coastal navigation training programmes.
- Partner with OEMs and classification societies for hands-on training on green retrofits and hybrid propulsion upgrades.

6.2.9 Green fuel-specific training in domestic shipping

- **Specialized Fuel Training for Inland and Cruise Operations:**
  - Expansion of NINI courses to cover alternative fuel bunkering, river-based STS (Onshore Power Supply), emergency response, and pollution prevention for smaller passenger vessels.
  - Development of **practical simulation facilities** in Patna, Guwahati, Varanasi, etc. to provide hands-on training for river cruise circuits on the Ganga, Brahmaputra, and Yamuna.
- **Sector-Specific Safety Codes:**
  - Tailored safety protocols for river cruise terminals, shuttles, jetties, and vessels, adapted to smaller operational footprints and frequent docking patterns.
  - Mandatory drills for all river cruise operators, integrated with **real-time incident reporting systems** feeding into NLP-Marine.
- **Institutional Coordination:**
  - Collaboration with **NTCPWC-IIT Madras**, **CICMT-IIT Kharagpur**, and other academic partners for applied research on fuel systems, vessel retrofits, and eco-friendly cruise terminal designs.
- **Green Cruise Integration:**
  - Launch of **pilot projects** for fully electric or hydrogen-powered river cruises on select National Waterways, with joint training and oversight from METF, NINI, and State Maritime Boards.
- **Community Skill Development:**
  - Training programs for local communities in vessel operations, green maintenance, hospitality, and environmental stewardship along cruise routes, with a focus on youth, women, and minority inclusion.
- **Tourism-Driven International Collaboration:**

- Technical exchanges between NINI, METF, and leading global cruise operators (e.g., Viking, Royal Caribbean) to bring world-class safety and sustainability practices into India's inland cruise industry.
- Annual **international safety workshops and drills** with NDMA, CPCB and global experts on fuel spills, fire control, and evacuation protocols for cruise tourism.

6.2.10 Cross-Sector Support Measures

- Establish **Green Maritime Centres of Excellence** at strategic coastal and inland hubs for role-based training.
- Introduce a **National Green Skills Trainer Accreditation** system to standardise delivery quality across institutes.
- Make **role-specific green skills certification mandatory** for key operational licenses by 2030.
- Augment the DG Shipping platform to maintain a **portable digital record of green skills certifications** for all maritime personnel.
- Provide **CSR-linked incentives** for companies funding training in inland, cruise, and coastal segments.
- Foreign collaboration with MMMCZCS Copenhagen, WMU Stockholm, etc.

India stands at an inflection point to align its maritime sector with a sustainable future. Strategic and inclusive investment in green skill development will not only **empower its demographic dividend** but also **position India as a global leader in green maritime talent exports**. The NGSP's human capital vision must be realized through unified action, innovative public-private partnerships, and a deep commitment to just and equitable transition.

6.3 Implementation Roadmap —

6.3.1 Short-Term Implementation (Up to 2030)

Focus: *System creation, curriculum design, pilot training pipelines, certification architecture*

Table 12: Short-Term Implementation Plan for Green Skilling

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
Launch Green Maritime Skills Mission (GMSM)	Notify national mission integrating MoPSW and MSDE (SCGJ, IMU, IWAI, DGS, etc.)	NGMCC	National green maritime skills framework operational
Develop green job taxonomy	Create certified green maritime job roles	SCGJ , NSDC, IMU ,NCoEGPS	Standardised national certification system

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
Integrate green modules into maritime education	Mandatory green fuel, MRV, STS, recycling modules in pre-sea & post-sea training	DGS ,IMU ,Maritime Training Institutes	Green competencies embedded in competency certificate awarded by competent authority
Establish Green Maritime Centres of Excellence (GMCoE)	Training hubs at major ports and IWAI clusters	MoPSW ,Port Authorities , IWAI	National upskilling infrastructure established
Inland & cruise training upgrade	Develop national inland green training node based on NINI Module	IWAI ,NINI ,State Boards	Dedicated inland/coastal green training pipeline
Digital training architecture	Incorporate the DG Shipping e-learning platform.	DGS , SCGJ ,SWAYAM	Nationwide scalable training access
Trainer accreditation system	National Green Skills Trainer Certification	NCoEGPS , MSDE	Training quality standardised
Inclusion mandate	Reserved quotas for women, PwDs, coastal communities and marginalized communities	MSDE ,MoPSW	Inclusive workforce participation
Certification Acceptance	Link green credentials to the DG Shipping e-learning platform	NGMCC	National & International Recognition Certificates
Issuance of Operating License	Green certification required for operational licenses	DGS , Port Authorities	Skills tied to compliance regime

Short-term measurable outcomes

- ~100000 maritime personnel are trained.[115]

[115] India's core maritime workforce totals around 5–6 lakh personnel, including 3.08 lakh active seafarers (DG Shipping data), over 50,000 direct port employees across 12 major ports, and ancillary shipyard roles. The 100,000 figure targets 15–20% coverage to kickstart the green transition, calculated by prorating the DNV study's high-ambition scenario (450,000 seafarers globally needing training by end-2030 for zero-carbon fuels) to India's ~10% share of the world seafarer pool. This breaks down as ~70,000 seafarers for new tech like shore power and alternative fuels, 20,000 port

- Certified green job roles are created, and GMCoEs will be functional.
- Inland/cruise fuel safety training nationwide
- National trainer accreditation system active

6.3.2 Medium-Term Implementation (2030–2040)

Focus: *Workforce scaling, specialization, international equivalence, industry integration*

Table 13: Medium-Term Implementation Plan for Green Skilling

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2040
Workforce scaling	Train additional ~500,000 green maritime workers[116]	GMSM ecosystem	Mass workforce transition achieved
Advanced fuel specialization	Usage of Hydrogen, ammonia, methanol and other alternative fuels	IMU , OEMs, Classification societies	Alternative fuel competency standardised
International equivalence	Mutual recognition with IMO/BIMCO/EU training bodies	MoPSW, MEA	Indian certification globally recognized
Industry apprenticeship system	Mandatory port/shipyard green apprenticeship programs	Port Authorities, Shipyards, Shipping Companies	Skills directly linked to employment
Maritime green entrepreneurship	Incubation support for green MSMEs and startups	Startup India ,SMFCL	New green maritime enterprises created
Cruise sustainability certification	Mandatory sustainability officer licensing	DGS ,Tourism Ministry	Cruise segment decarbonisation workforce ready
Digital MRV training	NLP-Marine operator certification nationwide	NGMCC ,SCGJ	MRV workforce professionalised
Regional training clusters	Alternate fuels handling, bunkering	State Govts. , MoPSW	Local skill ecosystems mature

operators for green port ops (e.g., GTTP compliance), and 10,000 shipyard staff—directly supporting MIV 2030's mandates for modernized institutes, STCW-aligned simulators, and industry-led skilling to position India as a "Global Hub for Green Shipbuilding" per PIB 2023.

[116] Scaling to full maturity, this covers 80–100% of the expanded workforce, factoring in seafarer growth to ~4 lakh and ancillary roles (1–2 lakh in ports/shipbuilding MSMEs) amid MAKV 2047's net-zero ambitions. Derived from DNV's 800,000 global mid-2030s benchmark, prorated and extended for India's fleet expansion (top-5 shipbuilder goal), it includes recurrent upskilling for digital/green infrastructure like air lubrication and circular economy practices. This aligns with Harit Sagar emission cuts, GTTP, and India's broader 35 million green jobs potential by 2047, ensuring workforce equity through DG Shipping's future strategy for sustainable training pathways.

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2040
	and storage skill zones operational		

Medium-term measurable outcomes

- ≥600,000 cumulative trained workforce
- India is recognised as a hub for green maritime skilling
- All alternative fuel terminals staffed with certified personnel
- Dedicated cruise sustainability workforce

6.3.3 Long-Term Implementation (2040–2070):

Focus: Global leadership, innovation workforce, just transition completion

Table 14: Long-Term Implementation Plan for Green Skilling

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2070
Global training hub positioning	Export Indian green maritime training programs	MoPSW, MEA	India becomes global green maritime academy hub
Research workforce pipeline	Advanced maritime decarbonisation research chairs	IMU ,IITs ,global partners	Innovation-driven talent establishing a blue ecosystem
Full workforce transition	Fossil-dependent maritime jobs reskilled	GMSM ,MSDE	Just transition completed
Continuous lifelong learning	Mandatory re-certification every 5 years	DGS ,NGMCC	Skills remain technology-aligned
Autonomous & AI readiness	New training modules for smart shipping	NCoEGPS ,academia	Future-ready maritime workforce

Long-term measurable outcomes

- Net-zero aligned maritime workforce
- Global training exports
- Fully modernised skill ecosystem
- Just transition safeguards achieved

Chapter 7: Green Fuel

To ensure regulatory clarity and alignment with international decarbonization frameworks, the policy adopts a **Green Fuel Taxonomy** for the maritime sector. This taxonomy distinguishes between **zero-emission fuels, near-zero/carbon-neutral fuels, transitional green fuels, and low-carbon transition fuels**, based on lifecycle greenhouse gas (GHG) emissions, production pathways, and compatibility with the existing maritime fleet.

Zero-Emission Fuels refer to fuels produced entirely from renewable energy sources with minimal lifecycle greenhouse gas emissions. In the maritime context, this category includes **green hydrogen and green ammonia**, produced using renewable electricity and compliant with national standards such as those under India's **National Green Hydrogen Mission**.

Near-Zero / Carbon-Neutral Fuels refer to fuels derived from renewable feedstocks or synthetic processes that significantly reduce lifecycle emissions compared to conventional marine fuels. These include **green methanol (e-methanol and bio-methanol), advanced second-generation biofuels, ethanol, renewable LNG, renewable LPG, Fischer–Tropsch diesel, and dimethyl ether**, produced using sustainable biomass or renewable energy pathways.

Transitional Green Fuels refer to **drop-in renewable fuels that can be used in the existing fleet without significant engine or infrastructure modifications**, enabling immediate emissions reductions while longer-term zero-emission fuel supply chains mature. This category includes **Hydrotreated Vegetable Oil (HVO) and sustainable Bio-VLSFO blends**, which can be used as direct replacements or blended fuels for conventional marine fuel oil and can support near-term improvements in vessel **Carbon Intensity Indicator (CII)** performance.

Low-Carbon Transition Fuels refer to fuels that provide incremental emissions reductions relative to conventional marine fuels and may support the transition toward zero-emission energy systems. These include **Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG)**, where applicable and where lifecycle emissions reductions are achieved through improved efficiency or the integration of carbon-management measures.

The adoption of these fuel pathways in the maritime sector supports the gradual replacement of fossil-based marine fuels and contributes to India's commitments under the **MIV 2030, MAKV 2047, Harit Nauka and Harit Sagar Guidelines**, the **Panchamrit climate commitments**, **Nationally Determined Contributions (NDCs)**, and the **2023 Revised IMO GHG Strategy**, as applicable.

The green fuels will be defined in accordance with standards published by competent authorities in India, viz., green hydrogen as defined by NGHM[117], green methanol by MNRE[118], green ammonia by MNRE[119], etc.

[117] Green Hydrogen Standard for India specifies emission threshold of 2kg CO2 equivalent/kg H2 as 12-month average, India announces defination of Green Hydrogen, 19 Aug 2023, PIB Delhi https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1950421&reg=3&lang=2
[118] No.353/35/2022-NT Government of India Ministry of New and Renewable Energy (Hydrogen Division)
[119] No.353/35/2022-NT Government of India Ministry of New and Renewable Energy (Hydrogen Division)

7.1 India's Current Status and Ongoing Green Fuel Actions

- Presently, India's **fuel mix in shipping** remains 95% reliant on fossil-derived fuels (heavy oil, VLSFO).[120]
- In the global context, Clarksons Research reports that around 21% of newbuild orders include alternative-fuel-ready notations, while alternative-fuel-capable vessels represented roughly 50% of tonnage ordered in 2024.[121]
- **LNG bunkering** is operational at **Cochin Port**[122] and is being scaled up across **Chennai, Paradip, and Ennore** with FSRU and onshore terminals. India has **8 LNG terminals** with growing import capacity—an opportunity to become a regional LNG bunkering hub.[123]
- Companies like **J.M. Baxi Group**[124] are spearheading the private sector's readiness for LNG and future fuel bunkering infrastructure, based on decades of LNG terminal handling experience.
- Through the Indo-Danish Centre of Excellence in Green Shipping—established under the **India–Denmark Green Strategic Partnership**—India is focusing on standards, certification, and global alignment on green fuels for the maritime sector.
- India is also exploring the development of international Green Shipping Corridors, including the **India–Middle East–Europe Economic Corridor (IMEC)** and the **Rotterdam–India–Singapore maritime route**, as flagship pathways for the transport and uptake of green fuels. These corridors are expected to support India's emerging role as a supplier of green maritime fuels and align with national targets to export **11 MTPA of green ammonia by 2030**

7.2 Strategic context and focus areas

7.2.1 Fuel Transition Targets

Overarching Principles

- **Global Compliance for International Trade Vessels**

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[120] McKinsey & Company. (2023). *The shipping industry's fuel choices on the path to net zero*. McKinsey & Company. Retrieved from https://www.mckinsey.com
[121] https://betadgs.dgshipping.gov.in/download/1759311377_68dcf611a7b6c_future-fuel-strategy-compressed.pdf
[122] LNG Terminal, Cochin Port Authority https://cochinport.gov.in/lng-terminal
[123] India Transport Energy Outlook. Council on Energy, Environment and Water (CEEW), 2024. https://www.ceew.in/sites/default/files/ceew-research-transport-energy-use-carbon-emissions-decarbonisation.pdf.
Also See: International Energy Agency. *India Gas Market Report: Outlook to 2030*. Paris: IEA, 2024. https://iea.blob.core.windows.net/assets/ef262e8d-239f-4cfc-8f8c-4d75ac887a0f/IndiaGasMarketReport.pdf.
[124] Exploring Green Ship Fuels in the Maritime Industry for a Greener Earth – J M Baxi Group https://www.jmbaxi.com/newsletter/isuue-xlii/exploring-green-ship-fuels-in-the-maritime-industry-for-agreener-earth.html
Also See: Ministry of Ports, Shipping and Waterways, Government of India. *Maritime Amrit Kaal Vision 2047*. New Delhi: Government of India, 2024. https://shipmin.gov.in/sites/default/files/MAKV_2047_Report.pdf.

  - For **Indian-flagged ships** in **international trade**, the **Greenhouse Gas Intensity (GFI)** of marine fuels shall comply with the proposed **IMO Net Zero Framework** under **MARPOL Annex VI**.
  - The **National Logistics Portal – Marine (NLP-Marine)** shall track and publish the share of zero- and near-zero-emission (ZNZ) fuels in total annual energy use for vessels under this scope.

- **Domestic Trajectory for Coastal and Inland Vessels**
  - For **coastal and IWT vessels**, a dedicated GFI reduction trajectory will be developed by MOPSW/DGS to achieve **Net Zero by 2070**, factoring in **fuel affordability, local availability, infrastructure readiness, and vessel retrofitting potential**.
- **Commercial Sustainability Safeguards**
  - Mandatory green-fuel adoption targets will be **subject to periodic feasibility reviews** (every 3 years) by the National Green Maritime Coordination Committee (NGMCC). This provides a constant 36-month visibility to industry while allowing the Parent ministry to adjust targets.
  - The transition will be driven by **fuel price parity milestones, proven supply chain readiness and evolving IMO fuel regulations**, preventing disruption of maritime trade or modal shift to higher-CO_2-emitting land transport.

7.2.2 Milestones and Recommended Implementation Conditions

Table 15: Milestones and Recommended Implementation Conditions

Period	Target Green Fuel Share*	Priority Fuels	Implementation Conditions / Exceptions
Up to 2030	10–15% in coastal & IWT vessels	Drop-in fuels, hybrids, biofuels, e-LNG, green methanol	• Prioritize **hybrid**, **drop-in**, and **dual-fuel** solutions to avoid stranded assets. • Carbon capture (onboard CCS) pilots eligible for compliance credits. • STS (Shore to Ship Power Supply) to be used where available to reduce fuel dependency. • Fuel blending mandates applied **only where domestic supply meets the projected demand**.
2030–2040	30% in Indian-flagged fleet (domestic & international)	Green hydrogen, green ammonia, green-methanol, bio-LNG	• Target contingent on **at least 5 domestic green-fuel hubs** operational by 2032.

Period	Target Green Fuel Share*	Priority Fuels	Implementation Conditions / Exceptions
			• Flexibility to substitute fuels with equivalent or better lifecycle GHG performance (ISO 14067 / LCA verified) • Transitional credits for hybrid vessels or retrofits achieving ≥50% GFI reduction. • Coastal/IWT exemption could be considered if fuel cost exceeds 2× HFO price for >18 months.[125]
2040–2047	70% across all vessel types	Green Hydrogen, Green ammonia, Green methanol	• Requires full-scale bunkering & safety infrastructure at all major ports and majority of non-major ports.

[125] Exemption from green fuel mandates may be considered for coastal and inland waterways (IWT) vessels where compliant fuel costs exceed **2× the prevailing Heavy Fuel Oil (HFO) benchmark price for a sustained period (e.g., >18 months)**. This reflects the Government of India's **2022 crisis response**, when the Ministry of Ports, Shipping and Waterways directed major ports to waive berth and vessel-related charges for Ro-Pax and passenger ferries following a sharp increase in marine fuel prices, with **VLSFO rising from ₹40,608/KL to ₹80,917/KL**.

Such a safeguard would protect a large share of India's **MSME-operated coastal and inland vessel fleet**, for whom emerging green fuel options—often estimated at **₹80–100/L equivalent**—may be significantly higher than conventional bunker fuels. Without such flexibility, premature mandates could undermine the **Sagarmala programme's modal shift objective**, which promotes coastal shipping and ferry transport as lower-emission alternatives to road transport.

Technical Merits:

An objective trigger based on **2× bunker fuel price benchmarks (e.g., PPAC or international bunker indices)** combined with an **18-month duration threshold** helps distinguish sustained structural price shocks from short-term volatility. The approach complements existing fiscal support mechanisms such as **GST exemptions for inland waterway passenger transport (Notification 12/2017)** and aligns with policy efforts advocating fuel tax rationalization for the maritime sector. This ensures the viability of key coastal ferry routes—such as **Ghogha–Hazira**, which reduced travel time from 12 hours to ~4 hours—while allowing progressive adoption of green fuels as supply chains under initiatives like the **National Green Hydrogen Mission** mature.

Period	Target Green Fuel Share*	Priority Fuels	Implementation Conditions / Exceptions
			• Mandates reviewed in 2040 to align with global market maturity and IMO policy. • Carbon capture (onboard or port-based) is recognised as a compliance mechanism for vessels unable to adopt green fuels. • Exceptions for specialised vessels with no viable green fuel pathway (Approval of DGS on case-by-case basis).

* **Green fuel share** is calculated on a **lifecycle GHG intensity basis** (well-to-wake) using national MRV system data.

Additional Provisions

- **Lifecycle GHG** Accounting: All green-fuel performance will be measured using lifecycle assessment (LCA) methodologies harmonized with IMO GHG Guidelines[126] and BIS/ISO standards.
- **Fossil Fuel Subsidy Phase-out:**
  Gradual removal of fossil fuel tax exemptions by 2035, with revenues channelled into the **Maritime Green Transition Fund (MGTF)** to subsidize green-fuel adoption.
- **Carbon Dioxide Reception Facilities:**
  Major ports to provide CO_2 reception and handling facilities by 2035 to support vessels with onboard CCS technology.
- **Modal Parity:**
  MoPSW to coordinate with MoRTH to ensure that alternative transport modes (road, rail) are subject to equivalent decarbonisation requirements to prevent unfair modal shifts.

2. Production and Supply Chain Development

[126] IMO framework on life cycle GHG intensity of marine fuels (LCA)

- **Green Hydrogen and Ammonia:** Leverage $10 billion private investments (e.g., Reliance Jamnagar hub[127]), supported by the **National Green Hydrogen Mission** and renewable parks[128] in Kutch and Rajasthan.[129]
- **Biofuels:** Establish biofuel hubs in coastal states (e.g., Tamil Nadu, Maharashtra, etc.), using agricultural residues under Ministry of Agriculture partnerships.

3. Port Infrastructure and Bunkering Network

- **Multi-fuel Bunkering Terminals:** Kochi, Chennai, Kandla, Paradip, and Ennore ports are prioritized for LNG, hydrogen, ammonia, methanol and biofuel infrastructure.
- **PPP-led Models:** Projects like Indian Oil and Pavilion Energy's Chennai JV demonstrate how PPPs can scale bunkering and storage facilities. To ensure cost-effective bunkering, major ports designated as green hydrogen hubs shall develop Common User Infrastructure (CUI) for green ammonia and methanol storage and handling under a landlord-PPP model, ensuring open access to all certified fuel producers. A 'Green Shipping Aggregator' mechanism shall be established under SMFCL to pool bunker demand from CPSEs and conduct long-term competitive bidding for green hydrogen derivatives, prioritizing domestic production.
- Prioritize GH2 infrastructure with NGHM-linked pilots for bunkering at major ports and inland waterways by 2028, including safety protocols per ISO/IMO standards and SIMOPS (Simultaneous Operations) for efficient port operations."
- Explicit alignment with NGHM for GH2 production, storage, and maritime applications, including joint MoPSW-MNRE oversight."

4. Regulatory and Financial Enablement

- **Regulatory Standards:** The introduction of a domestic MRV (Monitoring, Reporting, and Verification) framework will be **preceded by a detailed feasibility and impact assessment** to ensure that targets are **practical, cost-effective, and aligned with domestic operational realities**. This assessment will be led by the **National Green Maritime Coordination Cell (NGMCC)** in coordination with the **DGS** and the **NCoEGPS**. The framework will seek harmonization with IMO guidelines and, where feasible, relevant elements of the EU Fit-for-55 package, to enable interoperability without imposing unrealistic compliance burdens.

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[127] Reliance Industries invests $10 billion in green energy https://www.linkedin.com/posts/haush-ltd_reliance-industries-charts-bold-course-towards-activity-7369371926990876674-kwxI#:~:text=Reliance%20Industries%20invests%20$10%20billion,global%20powerhouse%20in%20clean%20energy.

[128] *A renewable energy (RE) park is a concentrated zone of development of renewable energy generation projects and provides developers an area that is well characterized, with proper infrastructure, access to amenities and where the risk of the projects can be minimized. – NTPC Renewables https://ntpcrel.co.in/verticals/re-parks/*

[129] Press Information Bureau, Government of India. "Cabinet Approves National Green Hydrogen Mission." January 4, 2023. https://www.pib.gov.in/PressReleasePage.aspx?PRID=1888545.
Also See: Ministry of New and Renewable Energy, Government of India. "National Green Hydrogen Mission." 2023. https://mnre.gov.in/en/national-green-hydrogen-mission/.

- **Economic Instruments:** Policy measures such as carbon pricing, targeted tax holidays, issuance of green bonds, and the establishment of a **Maritime Green Transition Fund (MGTF)** will be designed and implemented by MoPSW in collaboration with the **Ministry of Finance**, **NITI Aayog**, and the **Securities and Exchange Board of India (SEBI)** for capital market-linked instruments. The MGTF will be administered under the oversight of the **NGMCC/MoPSW**.
- **Blending Mandates:** Minimum blending thresholds for biofuels, renewable LNG, and other low-carbon fuels will be introduced to create **demand certainty** for suppliers. This will be coordinated by the **Ministry of Petroleum and Natural Gas (MoPNG)** and **Ministry of New and Renewable Energy (MNRE)**in consultation with the **Bureau of Indian Standards (BIS)** for fuel quality, compliance, and monitored by **MoPSW** for maritime sector adoption. Implementation will be phased to align with supply chain readiness and cost competitiveness.

5. International Cooperation and Leadership

India aims to lead global cooperation by:

- Establishing green maritime corridors (e.g., **India–Singapore,** India–UAE) and prioritizing GH2 corridors, e.g., India–Australia for GH2 exports; establishing First-Mover Consortium for the India–Europe corridor with supply guarantees from hubs.
- Offering surplus green hydrogen to fuel-importing countries under bilateral maritime decarbonization compacts.
- Collaborating on **standards, certification, and R&D** for fuel handling and onboard usage, drawing from global experience.
- **Becoming a signatory to the Clydebank Declaration**, thereby joining a coalition of like-minded nations committed to developing zero-emission shipping corridors. This membership will strengthen India's ability to establish and scale **green maritime corridors** and secure access to collaborative funding and technical assistance platforms.

6. Institutional Support, Finance, and Standardization

The NGSP proposes:

- **Maritime Fuel Certification Protocols**, aligned with IMO LCA standards, for all alternative fuels.
- **A Green Fuel Fund Window** under the ₹25,000 [130]crore Maritime Development Fund, with Viability Gap Funding (VGF) for bunkering infrastructure and private blending units.
- **Tax exemptions or rebates** on fuel infrastructure and pilot projects.

[130] https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155540&ModuleId=3&reg=3&lang=1

- Creation of a **National Bunkering Map** including safety bunkering standards in accordance with PESO/BIS and IMO interim guidelines for LNG, ammonia, methanol, and hydrogen infrastructure.
- SMFCL shall operationalize a green bunkering infrastructure fund to provide low-cost debt for hydrogen (and its derivatives) storage and fuel handling systems. Notification of SIMOPS protocols for ammonia and methanol bunkering by 2026 to facilitate efficient port operations.

7. Capacity Building and Risk Management

By **2030**, the NGSP aims to:

- **Establish a Maritime Energy Training Facility (METF)** under the **Ministry of Ports, Shipping and Waterways (MoPSW)**, dedicated to training a minimum of **10,000 personnel** every year through hybrid programs in advanced bunkering operations, fuel handling, emergency response, and safety management, with a special focus on alternative fuels.
- **Develop comprehensive, fuel-specific safety codes** and **retrofit protocols** for emerging fuels, particularly ammonia, hydrogen, renewable methanol, renewable LPG, and other hazardous energy carriers.
- **Integrate fuel-handling and safety modules** into **DG Shipping–approved courses**, **NSDC–SCGJ skilling programs**, and **Indian Maritime University (IMU)** curricula, ensuring alignment with international safety frameworks such as the IGF Code, ISO standards, and updated IMO guidelines.

Recognizing the **high-risk profile** of fuels such as methanol, ammonia, and hydrogen, India will:

- **Mandate fuel-specific safety codes** with enforceable compliance requirements for both shore-based and onboard operations in alignment with IMO guidelines.
- **Stipulate periodic risk mitigation drills** at all bunkering terminals, with participation from port staff, ship crews, emergency services, and relevant regulatory agencies.
- **Establish real-time incident reporting and response systems** integrated into the **NLP-Marine platform**, enabling immediate risk communication, centralized data logging, and post-incident analysis.

Institutional Mechanism:

To ensure effective implementation, a Maritime Fuel Safety and Training working group will be constituted under **MoPSW** and overseen by NGMCC. This working group will:

1. Oversee METF operations, curriculum development, and safety code enforcement.
2. Coordinate **research, testing, and simulation exercises** for hazardous fuels in partnership with the **Ministry of New and Renewable Energy (MNRE), Indian Register of Shipping (IRS)**, **Directorate General of Shipping (DGS)**, **National Centre of Excellence in Green Ports and Shipping (NCoEGPS)**, **Indian Maritime**

University (IMU), **Bureau of Indian Standards (BIS)**, and relevant **State Maritime Boards**.

3. Liaise with **NDMA (National Disaster Management Authority)** and **CPCB (Central Pollution Control Board)** for emergency response planning and environmental safety compliance.

This integrated governance framework will ensure that capacity building and risk management efforts are not only technically sound but also **uniformly applied across all ports, bunkering facilities, and maritime training institutes in India**.

7.2.3 Key Enablers and Global Lessons

Drawing from Global Best Practices[131] :

- Develop a fuel-agnostic transition strategy, allowing the co-existence of multiple clean fuels during the shift.
- Carbon pricing instruments will be evaluated for phased introduction post-2030 to steer market behaviour.
- A Green Fuel Interoperability Task Force will coordinate with IMO, ISO, and BIS to develop interoperable fuel standards and supply protocols.

India's emergence as a green maritime fuel hub will be critical not just to its decarbonization targets, but also to **energy diplomacy, coastal economy resilience**, and future-ready trade competitiveness. By aligning public investment, private innovation, and global collaboration, NGSP will transform Indian ports from refueling stops into **strategic green energy nodes**.

7.3 Implementation Roadmap —

7.3.1 Short-Term Implementation (Upto 2030)

Focus: *market creation, pilot fuels, safety frameworks, MRV backbone, early bunkering infrastructure*

Table 16: Short-Term Implementation Plan

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
National fuel transition targets	Notify green fuel trajectory + lifecycle GFI framework	MoPSW , DGS , NGMCC	National green fuel compliance pathway operational
Domestic MRV fuel tracking	Integrate lifecycle fuel tracking into NLP-Marine	NGMCC , NCoEGPS, DGS	Verified national GFI registry

[131] DNV. *Maritime Forecast to 2050: Energy Transition Outlook 2024*. Høvik: DNV, 2024. https://www.dnv.com/maritime/maritime-forecast/; https://www.isesassociation.com/wp-content/uploads/2024/08/DNV_Maritime_Forecast_2050_2024-final-3.pdf.
Also See: Ministry of Oceans and Fisheries, Republic of Korea. "2030 Greenship-K Promotion Strategy." December 23, 2020. https://www.mof.go.kr/index.do?menuSeq=1588.

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
Drop-in fuel adoption	Mandate 10–15% clean fuel share in coastal/IWT fleet	MoPSW , MoPNG ,DGS	Early fuel transition achieved
Biofuel blending framework	Issue maritime biofuel blending standards	MoPNG , BIS ,DGS	Standardised blending regime
LNG transition	Expand LNG bunkering at priority ports	Port Authorities , PPP operators	LNG transition infrastructure scaled
Multi-fuel pilot hubs	Develop minimum 4 (Kandla, Kochi, Tuticorin and Paradip) national green fuel bunkering hubs	MoPSW , State Ports ,GFAI	First hydrogen/methanol/ammonia nodes live
National bunkering map	Publish digital fuel infrastructure atlas	NGMCC , NLP-Marine	Infrastructure visibility enabled
Safety and handling codes	Issue ammonia/hydrogen/methanol bunkering codes	WG , DGS , BIS	Hazardous fuel safety framework operational
Workforce readiness	Establish Maritime Energy Training Facility (METF)	MoPSW ,IMU ,NCoEGPS	10,000 trained personnel
Financial de-risking	Activate MGTF for green fuels and VGF where required	SMFCL ,other lending intuitions	Financing secured for pilot fuel production
International corridor pilots	Launch 2 green fuel corridors	MoPSW ,MEA , partner nations	Global corridor partnerships active
Carbon capture pilots	Recognize onboard CCS compliance credits	DGS , NGMCC	Transitional compliance mechanism for carbon capture process enabled

Short-term measurable outcomes

- 10–15% clean fuel share in domestic fleet
- ≥4 operational multi-fuel bunkering hubs
- METF operational

- Approx. 10,000 certified fuel handlers
- Fuel safety regime enforced
- National lifecycle GFI registry is live

7.3.2 Medium-Term Implementation (2030–2040)

Focus: *scaling production, cost parity, infrastructure maturity, fuel diversification*

Table 17: Medium-Term Implementation Plan

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2040
30% fleet fuel transition	Mandate lifecycle GFI compliance	MoPSW , DGS , NGMCC	Medium-scale fuel shift underway
Green fuel supply chain	Establish ≥5 domestic fuel production hubs	MoPNG ,MNRE ,State Govts	National green fuel production base
Full bunkering network	Multi-fuel infrastructure at all major ports	Port Authorities ,PPP	National bunkering ecosystem
Lifecycle certification	Mandatory LCA verification of fuels	BIS , NGMCC, IRS	Verified fuel sustainability system
Carbon pricing readiness	Introduce pilot maritime carbon pricing	MoF, NITI ,MoPSW ,MoEFCC	Market steering mechanism tested
CO_2 reception infrastructure	Major ports equipped for CCS support	MoPSW , Ports	Carbon capture compatibility built
Private sector scaling	Fuel PPP investments accelerated	SMFCL, IFSC GIFT	Commercial fuel markets mature
International fuel exports	Green fuel export corridors	MoPSW, MEA	India becomes green fuel supplier hub
Modal parity regulation	Align road/rail carbon emission policy	MoPSW, MoRTH	Trade competitiveness preserved

Medium-term measurable outcomes

- 30% lifecycle clean fuel share
- ≥5 national production hubs
- All major ports multi green fuel-ready
- Carbon-verified bunkering ecosystem
- International fuel trade corridors active

7.3.3 Long-Term Implementation (2040–2070)

Focus: *dominant clean fuel economy, fossil phase-down, global fuel leadership*

Table 18: Long-Term Implementation Plan

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2070
70% fuel transition (2047 milestone)	National zero-carbon fuel dominance	NGMCC ,MoPSW	Large-scale fuel shift underway
100% fuel transition (2070)	Fossil marine fuel phase-out	MoPSW , MoPNG	Net-zero maritime energy system
Nationwide bunkering coverage	All ports multi-fuel capable	Ports + State Maritime Boards	Universal fuel infrastructure
Full CCS integration	Ports operate CO_2 logistics chain	MoPSW , Industry	Circular carbon ecosystem
Global Green fuel leadership	India exports clean maritime fuels	MoC ,Trade bodies	Energy diplomacy leadership
Market integration	MRV linked to global carbon markets	MoEFCC , NGMCC	Carbon-aligned maritime economy

Long-term measurable outcomes

- Fossil marine fuels eliminated
- India becomes Indo-Pacific fuel hub
- Net-zero maritime fuel ecosystem

Chapter 8: Green Technology

NGSP identifies green technology as a foundational enabler across all sectors—spanning ship propulsion, energy management, cargo handling, emissions control, and monitoring systems. This includes support for:

- **Next-generation propulsion systems** (e.g., hybrid-electric, hydrogen, wind-assisted, Fuel Cell, nuclear, etc.),
- **Emission reduction technologies** (e.g., scrubbers, onboard carbon capture, etc.),
- **Smart energy and routing systems** (e.g., AI-enabled voyage optimization, digital twins, etc.),
- **Automated and low-emission cargo handling equipment** (e.g., electric cranes, AGVs, etc.),
- **Technology partnerships and Make in India**-based indigenization programs are also important initiatives.

These interventions are critical to meeting India's targets under the **IMO GHG Strategy**, the **Panchamrit declarations**, and national initiatives like **MIV 2030** and the **Maritime Amrit Kaal Vision (MAKV) 2047**.

8.1 Rationale

The NGSP will guide the formulation of a **National Maritime Green Technology Roadmap**—supported by Centres of Excellence, sandbox pilots, standard-setting bodies, and a dedicated innovation fund—ensuring India remains not just a beneficiary, but a global **driver of maritime green technology**.

Consolidated List of Green Technologies

(As prioritized in IMO, MIV 2030, MAKV 2047, and Harit Sagar Guidelines)

Table 19: List of Green Technologies

S. No	Technology Cluster	Description / Use Case
1	Onshore Power Supply (STS) / Cold Ironing	Providing clean shore-side electricity to reduce emissions from ships at berth
2	Hybrid and Electric Vessel Propulsion	Battery-powered or hybrid vessels for inland/coastal operations
3	Green Hydrogen and Fuel Cell Technology	Zero-emission marine propulsion via green hydrogen, including pilot projects at Cochin Shipyard
4	LNG, Methanol, and Ammonia Bunkering Infra	Development of alternate fuel storage, handling, and refuelling infrastructure
5	Wind- and Solar-Assisted Propulsion Systems	Use of sails, rotors, solar panels to assist propulsion

S. No	Technology Cluster	Description / Use Case
6	Exhaust Gas Cleaning Systems (Scrubbers)	For SOx/NOx removal on conventional vessels
7	Port Electrification and Renewable Integration	Rooftop solar, wind turbines, RE-based microgrids in port clusters
8	Smart Cargo Handling and Electrified Equipment	Use of Electric RTGCs, e-cranes, e-trucks, and automated guided vehicles (AGVs)
9	Real-Time Emissions Monitoring and Control	Sensor-based emissions tracking across vessels, ports, and bunkering stations
10	AI-Based Operational Optimization	Route optimization, voyage planning, fuel consumption forecasting, predictive maintenance
11	Digital Twin and Simulation Technologies	Port and vessel-level energy efficiency simulations for design and performance testing
12	Maritime Digital Infrastructure (NLP-Marine, PCS 1x)	Tech-enabled planning, visibility, and GHG data integration
13	Advanced Ballast Water Treatment Systems	Reducing marine invasive species and compliance with IMO Ballast Water Convention
14	Automated and AI-Driven Waste Management	MARPOL-compliant reception facilities with digital logbooks and AI-based segregation
15	Smart Stormwater and Oil-Water Separation	Pollution containment at ports through smart drainage and runoff management systems
16	Energy Storage Systems (ESS)	Port-based battery systems to balance RE generation and peak load
17	Biofouling and Anti-Corrosion Hull Coatings	Low-friction, eco-friendly hull coatings that reduce drag and fuel use
18	Carbon Capture, Utilization, and Storage (CCUS)	Emerging onboard or land-based systems for CO_2 capture and reuse
19	Autonomous or Semi-Autonomous Vessels	For improved energy efficiency and route precision on coastal/inland operations

S. No	Technology Cluster	Description / Use Case
20	Green Tug Transition Technologies	Battery-electric or hybrid tugs under India's Green Tug Transition Programme
21	Eco-Dredging Equipment	Electrified or low-emission dredgers, with silt containment and biodiversity safeguards
22	Sustainable Building Materials in Port Infrastructure	Green-certified cement, recycled steel, fly ash bricks in port and terminal infrastructure
23	Smart Street Lighting and HVAC	LED lighting, motion-sensor systems, and energy-efficient HVAC in port buildings
24	National Ship Design Centre and R&D Platforms	Innovation hubs for green vessel prototypes and marine tech localisation
25	Carbon Accounting and Emission Forecasting Tools	Software for MRV reporting, voyage emissions profiling, carbon credit quantification

Green technology stands at the core of India's maritime decarbonization and sustainability mission. As ports, shipping, and associated logistics strive to reduce emissions, adopt circular economy principles, and become more resilient, the strategic development, localization, and adoption of green technologies are imperative.

Green maritime technology includes a suite of innovations—from zero-emission vessels and shore power infrastructure to carbon capture systems, energy-efficient retrofits, and port digitalisation. India's vision, articulated in **Maritime India Vision (MIV) 2030** and **Maritime Amrit Kaal Vision (MAKV) 2047**, establishes green technology as a cross-cutting enabler of competitiveness and sustainability.

8.2 Strategic Context and Focus Areas

8.2.1 Current Landscape of Green Maritime Technology in India

a. Port-Level Innovation

- Major ports have begun adopting **shore power infrastructure, LNG bunkering, automated cargo handling, and energy-efficient lighting** (MIV 2030).
- India's commitment to developing Green Hydrogen Hub Ports at Paradip, Deendayal, and VO Chidambaranar marks a major leap towards green fuel infrastructure.
- The **Green Port Guidelines (Harit Sagar**) provide a structured framework for green port technologies, including electric equipment, bio-remediation, and stormwater recycling systems.

- **Exploring Nuclear Energy for Port Decarbonization:** To achieve long-term GHG reduction goals, India will assess the **feasibility of nuclear power integration** for port energy needs, including the potential deployment of **Floating Nuclear Power Plants (FNPPs)** to supply clean, stable electricity for shore power, port operations, and bunkering support. This will entail close coordination with the **Atomic Energy Regulatory Board (AERB), Nuclear Power corporation of India Limited (NPCIL), etc.** and alignment with national nuclear safety protocols.

b. Shipping Sector Technology

- **The Green Tug Transition Programme (GTTP)**[132] aims to convert 50% of tugs in major ports to battery-electric, hybrid, or hydrogen-based systems by 2030 and 100% by 2047.
- **Ship-based energy efficiency technologies**[133] like air lubrication, hull coating improvements, wind-assisted propulsion, retrofits etc. are being piloted, though largely through private sector leadership.
- **Nuclear-Powered Vessels and Support Systems:** In parallel, India will study the **safe adoption of nuclear propulsion and floating nuclear platforms** for maritime applications, in line with emerging **IMO–IAEA safety recommendations** and the anticipated revision of the **Nuclear Ship Safety Code**. This exploration will ensure India is prepared to **construct, service, and collaborate on nuclear-powered merchant vessels** as the technology matures.

c. Digital Technologies

- Initiatives such as the **Maritime Single Window, One Nation-One Port, Port Community System (PCS 1x), and SAGAR SETU platform** are enhancing traceability, transparency, and efficiency in logistics and operations.
- **Digital twins, AI-driven port operations, and smart yard planning** are emerging areas, with huge potential.
- **Digital Twin technology** at all designated Hydrogen Hubs to plan, monitor and strategize the hub development.

d. Collaborative Platforms

- **The India–Norway Bilateral Green Maritime Cooperation,** under the **Green Voyage 2050** and Nor-Shipping dialogues, is catalysing adoption of ferry electrification, e-methanol bunkering, and design of low-emission vessels.[134]

[132] Green Tug Transition Program standard operating procedure (2024)GTTP SOP.pdf
[133] 2021 Guidance on treatment of Innovative Energy Efficiency Technologies for Calculation and Verification of the Attained EEDI and EEXI MEPC.1-Circ.896
[134] India, Norway bilateral talks focus on powering Green Maritime Technologies, PIB Delhi, 04 June 2025 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2133875&reg=3&lang=2

- Bilateral R&D is proposed for **Arctic-class vessel design, AI port systems, and zero-carbon ship prototypes.**[135]

8.2.2 Challenges

- **High capital costs** for green retrofits, electrification, and newbuilds.
- **Lack of R&D-industry linkages** to foster indigenous technology development.
- **Limited financial support** for pilot projects and startups in green maritime technologies.

8.2.3 Opportunities and Strategic Recommendations

a. Technology Clusters and R&D Hubs

- Establish **Maritime Green Technology Parks** in partnership with academic institutions and shipyards to incubate indigenous technologies—e.g., hybrid vessel prototypes, hydrogen fuel cells, and shore power modules.
- Develop an **Open Innovation Challenge Platform** called ***Harit Tarang*** *– **Green Technology** **A**ccelerator for **R**esponsible **A**nd **N**ext-**G**en shipping*—under the Sagarmala Innovation initiative for green maritime solutions.

b. Technology Transfer and Co-development

- Operationalize India–Norway technology transfer agreements to scale up ferry electrification, autonomous green vessels, and clean propulsion R&D.

c. Policy Incentives and Standards

- Maritime Green Transition Fund (MGTF) to provide:
  - Viability Gap Funding (VGF) for pilot deployments,
  - Soft loans for startups, and
  - Co-investment with state maritime boards.
- Introduce performance-based incentives for ports and ships adopting green technologies.
- Mandate GPPI and introduce ESI for ports and ships, respectively.

d. Digital Integration for Green Outcomes

- **Establish a platform** as a Virtual Trade Corridor linking energy-efficient and green-certified ports along India–Middle East–Europe Economic Corridor

[135] Ibid

(IMEEC), International North-South Transport Corridor (INSTC), and Eastern Maritime Corridor.[136]

- Promote **blockchain-based traceability systems** for ship recycling, sustainable procurement, and cargo-level GHG accounting.

e. Capacity Building

- Integrate green technology modules in marine engineering curricula and promote **dual-skilling programmes** in port automation and low-emission vessel design.
- Collaborate with Norway and global partners to train seafarers and port officials in **cybersecure green tech systems, zero-emission operations, and R&D Arctic navigation** (focus on ensuring safe and sustainable shipping practices in Arctic waters, addressing the unique operational challenges posed by extreme weather conditions, and minimising environmental impacts).[137]

8.2.4 Towards a Unified National Green Technology Mission

A dedicated **Green Maritime Technology Roadmap 2047** should be developed, encompassing:

- **Technology foresight** and benchmarking,
- **Sector-specific innovation pathways** (ports, ships, shipyards, fuel infrastructure etc.),
- **Financing instruments**,
- **Monitoring and evaluation**, and etc.
- **Global partnerships and trade alignment** (e.g., IMO decarbonisation targets, EU Fuel EU Maritime etc.).

This roadmap should be coordinated by MoPSW with convergence from MNRE (for RE and hydrogen), MoPNG, DST (for innovation), and MSME Ministry (for startup incubation).

Green technology is not an option but a necessity for India's maritime transition. By leveraging international partnerships, local R&D capacity, digital transformation, and robust financing mechanisms, India can emerge as a global leader in sustainable maritime innovation. The NGSP ensures that all interventions—from port development to shipbuilding—embed green technology as a foundational pillar, driving both decarbonisation and competitiveness in the Blue Economy.

[136] India Briefing. "India's 2025 Maritime Push with US$20 Billion Investment and Partnerships." July 10, 2025. https://www.india-briefing.com/news/indias-2025-maritime-push-with-us20-billion-investment-and-global-ties-38114.html/.
Also See: Confederation of Indian Industry. *India–Norway Report: Advancing Bilateral Maritime Cooperation*. New Delhi: CII, 2025. https://www.cii.in/International_ResearchPDF/India%20-%20Norway%20Report_Web.pdf.
[137] Ministry of Ports, Shipping and Waterways, Government of India. "India, Norway Bilateral Talks Focus on Powering Green Maritime Collaboration." Press release, June 4, 2025. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2133875.

8.3 Implementation Roadmap —

8.3.1 Short-Term Implementation (Up to 2030)

Focus: pilot deployment, standards, R&D ecosystem, innovation financing, early adoption

Table 20: Short-Term Implementation Plan

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
National Green Maritime Technology Roadmap	Notify roadmap with priority technology clusters	MoPSW , NGMCC + DST + MNRE	National tech transition blueprint operational
Technology sandbox pilots	Launch sandboxes at 5 major ports[138]	NGMCC ,Port Authorities	Controlled pilot ecosystem established
Maritime Green Tech Parks	Establish 3 R&D clusters (ship, port, fuel tech)	MoPSW , IITs + Shipyards	Indigenous innovation hubs active
Green Technology Fund	Dedicated SMFCL innovation window	SMFCL	Startup and pilot financing available
GTTP execution	Convert 50% major-port tugs to electric/hybrid	MoPSW , Ports	Tug electrification milestone achieved
STS / electrification pilots	Demonstration cold ironing at ports	Ports , Utilities	Shore power adoption proven
Digital twin pilots	Port and vessel simulation systems deployed	NCoEGPS ,Tech partners	Digital efficiency models validated
Nuclear feasibility study	FNPP and nuclear vessel readiness assessment	MoPSW ,NPCIL ,AERB	Policy preparedness established
Green retrofit incentives	Performance-linked retrofit subsidies	MoPSW , SMFCL	Fleet transition catalysed
Technology standards	Issue BIS/IRS green equipment standards	BIS ,IRS , DGS	Standardisation framework stabilised

[138] This aligns with **Maritime India Vision (MIV) 2030**, which promotes development of the maritime sector through **five regional port clusters**. Launching sandboxes at major ports within these clusters will allow pilot testing of innovative technologies and regulatory approaches across different maritime ecosystems, enabling scalable solutions before wider national adoption.

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2030
Open innovation challenge – *Harit Tarang*	Annual national maritime tech challenge	Sagarmala , DST	Startup pipeline activated

Short-term measurable outcomes

- 3 national green tech hubs
- 50% tug electrification
- STS pilots operational
- National standards issued
- Funded startups
- Nuclear readiness assessment completed

8.3.2 Medium-Term Implementation (2030–2040)

Focus: industrial scaling, domestic manufacturing, integration into mainstream operations

Table 21: Medium-Term Implementation Plan

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2040
Mass green retrofit program	Electrification and propulsion upgrades scaled	MoPSW ,Shipyards	Fleet modernization underway
Scaling up electrification of all port equipments	Electric cargo equipment standard	MoPSW, State Maritime Boards,Ports	Low-emission port operations
Hydrogen/fuel-cell ship demonstrations	Commercial alternative propulsion vessels	MNRE, MoPSW, other stakeholders	Zero-emission ship prototypes operationalized
Develop Digital optimisation backbone	Nationwide implementation of AI routing and MRV automation	NGMCC, NLP-Marine	Efficiency gains institutionalised
Autonomous vessel demonstrations	Inland and coastal vessels automation trials	DGS, Industry stakeholders and R&D Institutes	Autonomous vessel ecosystem emerging
Domestic manufacturing push	Make-in-India maritime equipment	MSME ,Industry	Tech supply chain localised

Nuclear integration readiness	Regulatory framework for nuclear ports/vessels	MoPSW, AERB	Safety architecture defined
Export tech corridors	Technology export partnerships	MEA ,Trade bodies	India exports green maritime tech

Medium-term measurable outcomes

- Majority port equipment electrified
- Commercial hydrogen vessels operational
- AI-driven port systems mainstream
- Domestic green tech manufacturing base
- Safety Architecture defined for nuclear integration
- Export-ready technology ecosystem

8.3.3 Long-Term Implementation (2040–2070)

Focus: *full green technology dominance, global leadership, advanced innovation*

Table 22: Long -Term Implementation Plan

Objective	Detailed Actions	Responsible Bodies	Expected Outcomes by 2070
Zero-emission fleet standard	Mandatory green propulsion baseline	MoPSW , DGS	Fossil propulsion obsolete
Autonomous green shipping	Operationalization of autonomous vessel networks	NGMCC, Industry stakeholders	AI-integrated maritime ecosystem
Circular port infrastructure	Carbon-neutral port systems	MoPSW, State Maritime Boards, Ports	Net-zero infrastructure
Nuclear integration (if viable)	Floating Nuclear Power Plant-powered port clusters	MoPSW, AERB, NPCIL	Stable clean baseload energy
Global tech leadership	India exports maritime decarbonisation systems	MoPSW, MEA ,Industry	Global innovation hub status
Continuous R&D pipeline	Next-generation propulsion and energy systems	IITs, Global partners	Technology leadership sustained

Long-term measurable outcomes

- Net-zero technology ecosystem

- India as maritime innovation exporter
- Fossil-based port/ship tech phased out

Annexure 1: Template for 2021 Baseline Maritime Carbon Footprint Assessment

Methodological Basis

India does not currently have a single unified national methodology for calculating a combined shipping-and-port maritime carbon footprint. Therefore, the 2021 baseline assessment is constructed by integrating:

1. The **IMO SEEMP / Data Collection System (DCS)** framework for shipping emissions (MARPOL Annex VI Regulation 28; MEPC.315(74); updated guidance MEPC.395(82))
2. **DG Shipping national fuel consumption data (2021)**
3. The **GHG Protocol structure** adapted to Indian port audits under **Harit Sagar Guidelines**

This hybrid methodology allows India to produce a baseline that is technically aligned with IMO accounting while remaining compatible with domestic port reporting systems.

The purpose of the methodology is reproducibility, comparability, and future MRV integration — not the creation of a new accounting system.

2. Shipping-Side Emissions Methodology

The national baseline for shipping emissions is derived from the **verified 2021 fuel consumption dataset provided by the Directorate General of Shipping (DG Shipping)** for the Indian-flagged fleet. The emissions estimates reported by DG Shipping follow the methodology used under the **IMO Data Collection System (DCS)** framework, which is mandatory for ships ≥5,000 GT under MARPOL Annex VI Regulation 28.

Under this framework, emissions are calculated from reported fuel consumption using the standard emission factors adopted by the International Maritime Organization (IMO).

CO_2 emissions = Fuel consumed × IMO emission factor

Emission factors are taken directly from **MEPC.364(79)**[139], which is the same dataset used in SEEMP and DCS compliance reporting worldwide.

Where full greenhouse gas accounting is required, methane and nitrous oxide are added using the global warming potentials defined in **IPCC AR5 Synthesis Report**. No alternative factors are introduced in the baseline.

DG Shipping's verified 2021 dataset establishes the national emissions baseline for the Indian-flagged fleet:

- **Total emissions:** 4.961 million tonnes CO_2
- **International segment:** 3.995 million tonnes
- **Coastal fleet share:** 38.6%
- **Operational intensity baseline (AER):** 18.51 gCO_2 per GT-nautical mile

[139] https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.364%2879%29.pdf

For comparative analysis across vessel categories and operational segments, **emissions per tonne of fuel consumed will be used as a standardised comparison metric**.

Ships below 5,000 GT are outside mandatory DCS reporting. Their emissions are therefore estimated using AIS-derived activity modelling combined with DG Shipping registry records. This extrapolation ensures that small-vessel activity is not excluded from the national footprint.

Where lifecycle fuel data exists, a well-to-wake adjustment of **15–25%** may be added following the lifecycle tables in **IMO MEPC.391(81)**. This is applied only when verified upstream fuel data is available and is not assumed universally.

3 Port-Side Emissions

There is no IMO-prescribed carbon accounting template for ports. The baseline therefore adopts the **GHG Protocol Scope 1–3 framework**, adapted to Indian port under the **Harit Sagar Guidelines (MoPSW)**.

This approach aligns Indian port reporting with international corporate carbon accounting standards while remaining compatible with domestic environmental audits.

Scope 1 includes direct fuel combustion from yard equipment, auxiliary generators, dredging operations, and ships alongside where fuel use is reported. Standard factors are used:

Type of fuel	Reference	Lower calorific value (kJ/kg)	Carbon content	C_F (t-CO_2/t-Fuel)
1 Diesel/Gas Oil	ISO 8217 Grades DMX through DMB	42,700	0.8744	3.206
2 Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	41,200	0.8594	3.151
3 Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMK	40,200	0.8493	3.114
4 Liquefied Petroleum Gas (LPG)	Propane	46,300	0.8182	3.000
	Butane	45,700	0.8264	3.030
5 Liquefied Natural Gas (LNG)		48,000	0.7500	2.750
6 Methanol		19,900	0.3750	1.375
7 Ethanol		26,800	0.5217	1.913

Figure 2: Conversion factor between fuel consumption and CO2 emission[140]

Scope 2 covers electricity consumption. Emissions are calculated using the 2021 Central Electricity Authority grid average of:

0.72 $kgCO_2$ per kWh

Ports with renewable electricity adjust this factor downward proportionally.

Scope 3 captures outsourced activity such as tug services and contract dredging. These are estimated using activity data multiplied by IMO fuel emission factors.

Port performance is normalised using an intensity indicator:

[140] RESOLUTION MEPC.308(73) (adopted on 26 October 2018) 2018 Guidelines on The Method of Calculation of the attained Energy Efficiency Design Index (EEDI) for New Ships

tCO_2e per tonne of cargo throughput

Harit Sagar audits place the 2021 major port baseline in the range of **0.5–1 gCO_2e per tonne cargo**.

Ports in eco-sensitive regions are flagged with higher uncertainty and prioritized for mitigation measures such as shore power integration.

4. Inland Waterways Integration

Inland waterways fall entirely outside the IMO DCS threshold but represent a meaningful portion of India's domestic maritime activity. They must therefore be incorporated through a nationally adapted method.

In 2021, India's National Waterways handled approximately **111 million tonnes of cargo** and **4.6 million passengers**, served by a fleet of roughly 3,600 vessels below 5,000 GT operating primarily on diesel.

Emissions are estimated using:

Activity data (fuel use or AIS distance) × IMO diesel emission factors

The 2019 inland baseline of **277 kilotonnes CO_2** is projected forward to 2021 using observed sector growth (~2% per year), resulting in an estimated **~290 kilotonnes CO_2e (tank-to-wake)**.

The inland intensity baseline is approximately:

2.6 gCO_2 per tonne-kilometre

This is higher than deep-sea shipping due to smaller vessel size, shallow draft conditions, and older fleet profiles.

Special conditions are documented:

- Average vessel age exceeds 20 years
- Limited access to compliant marine fuels
- Additional Scope 3 emissions from dredging
- Eco-sensitive waterways (e.g., Sundarbans) carry higher uncertainty margins

IWAI already mandates GHG audits under the **National Waterways Act, 2016**, providing an institutional basis for continued tracking.